STATE PARTY: UNITED REPUBLIC OF TANZANIA

WORLD HERITAGE SITE: SERENGETI NATIONAL PARK

RESPONSIBLE MINISTRY: MINISTRY OF NATURAL RESOURCES AND TOURISM

RESPONSIBLE MANAGEMENT: TANZANIA NATIONAL PARKS

A REPORT ON STATE OF CONSERVATION OF SERENGETI NATIONAL PARK WORLD HERITAGE PROPERTY (N.156)

DATE OF SUBMISSION: 1st February 2024

State Party: United Republic of Tanzania

Name of World Heritage Property: Serengeti National Park

Geographical coordinates: Long. 34° - 35°15′ E, Lat. 1° 15′ - 3° 20′ S

Date of inscription on the World Heritage List: 30.10.1981

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SECRETARY GENERAL OF THE UNITED REPUBLIC OF TANZANIA NATIONAL COMMISSION FOR UNESCO

EXECUTIVE SUMMARY

This State of Conservation report is prepared as a result of the decision 45 COM 7B.76 adopted by the UNESCO World Heritage Committee on the State of the Heritage Site "Serengeti National Park".

Measures taken as the results of Committee decisions under the auspices of the United Republic of Tanzania are elaborated and responded to, and the status of implementation is provided in respective decision points.

Overall, most of the decisions implementation, and actions thereafter were contingent on the invited Reactive Monitoring Mission (RMM) visits that was conducted between the 15th -19th of January 2024. The State party was keen and participatory during the visit to ensure RMM can access all important sites with regard to the mission agenda during visits. This will allow the Committee and State Party to have a joint way forward on issues and concerns addressed during the 45 COM Meeting.

Nevertheless, the state party continues to monitor progress through follow-up and taking proactive measures on issues that may affect the Heritage Site OUVs in the long run if not resolved. Issues under close follow include proposed dam development projects upstream of the Mara River basin, the inclusion of ecologically important Speke Gulf into the Heritage Site Boundary, and monitoring the cumulative impact of the development within the property by subjecting relevant safeguards before development is approved.

The state Part continues to work collaboratively and liaise with the neighboring State Party of Kenya and in consultation with the World Heritage Monitoring Centre on issues of mutual concern like ensuring the ecological integrity of cross-border/transboundary ecological connected/contiguous ecosystems. This includes ensuring a Joint Water Allocation Plan is developed and finalized for the Mara River basin and options of extending the heritage site with the contiguous transboundary landscape of the "African Great Rift Valley-The Maasai Mara" -on the tentative list.

It is the state party's intention and expectations that the recent RMM visits will shape and provide a platform to mutually address issues and concerns observed to ensure the heritage OUVs are maintained.

45 COM 7B.76

Serengeti National Park (United Republic of Tanzania) (N 156)

The World Heritage Committee,

Having examined Document WHC/23/45.COM/7B.Add,

Recalling Decisions 35 COM 7B.7, 38 COM 7B.94, 42 COM 7B.96 and 44 COM 7B.15 adopted at its 35th (UNESCO, 2011), 38th (Doha, 2014), 42nd (Manama, 2018) and its extended 44th (Fuzhou/Online, 2021) sessions respectively,

3. Expresses its continued concern about the proposed dam projects upstream of the property in the Mara River basin, which could have a negative impact on the Outstanding Universal Value (OUV) of the Serengeti National Park and Kenya Lake System in the Great Rift Valley World Heritage properties;

Response

The State party appreciates the observation and concern of the World Heritage Centre on the potential impacts that the proposed dams will have on the Outstanding Universal Value (OUV) of the Serengeti Heritage Site. The State Party invited the State Party of the Republic of Kenya who joined the UNESCO RMM through virtual meeting to discuss the matter. The representative of State Party of the Republic of Kenya has confirmed to the Reactive Monitoring Mission that the government of Kenya only received the proposed dams' development from NELSAP but no further discussion and commitment have been done for dam project implementation. Note that detailed official information and updates will be provided by the RMM report.

4. Welcomes the ongoing efforts by the States Parties of the United Republic of Tanzania and Kenya to develop a Joint Water Allocation Plan (JWAP) for the Mara River basin but notes with concern that no update is available on the status of all dam projects in the Mara River basin, in particular, the different projects proposed in Kenya;

Response

As one of the efforts to retain the permanent flow of the Mara River, Tanzania has finalized the preparation of the Water Allocation Plan (WAP). The plan was prepared in collaboration between the Ministry of Water, Department of Water Resources, Lake Victoria Basin Water Board, and the Mara Mori Catchment and approved in 2020. The approved WAP entails;

- Determine management and development of Water Resources
- To ensure the availability of water resources to meet environmental water flow and social-economic development
- Based on the current usage of water resources, WAP has set a projection of long-term demand for water resources.

Similarly, Environmental Assessment flows have been developed as part of the Water Allocation Plan (WAP). Environmental flow assessment was completed in 2018 with respective projected medium and long-term flows stipulated. The report has been included in the Water Allocation Plan for the Mara River catchment report. It is envisaged that the water allocation Plan for Tanzania will be harmonized with that of Kenya to develop a Joint Water Allocation Plan (JWAP). This will be coordinated through the East Africa Community by the established Lake Victoria Basin Commission Secretariat (LVBC). The State Party invited the Lake Victoria basin representative (board member for LVBC) to meet RMM (15th – 19th January 2024) for discussion on this matter.

5. Reiterates its request to the States Parties of the United Republic of Tanzania and Kenya to submit to the World Heritage Centre as soon as possible, and before the requested Reactive Monitoring mission takes place, an update on the status of all dam projects proposed in the Mara River basin and urges them again not to make any decisions on infrastructure development that could affect the water flow into the Mara River before the JWAP is agreed and the impacts on the OUV of the property are thoroughly assessed;

Responses

The State Party has invited representative of the State Party of the Republic of Kenya through virtual meeting for discussion with RMM visits and managed to give updates on the matter including assuring the mission that no further development will be done without notifying / involvement of the two State Parties. However, the State Party will continue to make close follow up and notify in case of any development. Further information will be provided by the UNESCO RMM report visited the State Party between 15th – 19th January 2024.

6. Also welcomes the approval by the State Party to expand the Serengeti National Park to include the ecologically important Speke Gulf and encourages the State Party to submit a boundary modification to reflect this extension on the World Heritage property in line with the provisions in the Operational Guidelines as soon as the process of the extension under national law is completed;

Response

The State Party has already approved the proposal to annex the Speke Gulf to the Serengeti National Park to include the ecologically important Speke Gulf. The evaluation for the affected communities in voluntary relocation of the area has been completed and verified by the treasury for compensation based on Tanzania laws. Thereafter, the boundary modification of the Heritage site will be done accordingly.

7. Regrets that in spite of its previous request, the State Party did not submit the Various documents requested in Decision 42 COM 7B.96 and also urges again the State Party to submit the following documents as soon as possible, and before the requested Reactive Monitoring mission:

a) The approved 2014-2024 Management Plan for the property, including details of any changes to the zonation of the property,
b) The Route Option Selection Report and the feasibility study and preliminary design, including a map of the proposed alignments,
c) The Strategic Environmental Assessment (SEA) and the Comprehensive Transport and Trade System Development Master Plan; State of conservation of properties WHC/23/45.COM/7B.Add, p. 136 inscribed on the World Heritage List

Responses

The State party understands the importance of availing these documents for review by advisory bodies. These documents along with others as requested were made available to the UNESCO RMM visited to Serengeti National Park between 15th – 19th January 2024. It is anticipated that these documents will be shared to the WHC through RMM report

8. While noting the confirmation that the State Party will maintain the northern road traversing the property as a gravel road under Tanzania National Parks (TANAPA) management, reiterates its request to the State Party to confirm its

previous commitment to reserve the road mainly for tourism and administrative purposes (Decision 35 COM 7B.7) and to abandon the construction of the proposed northern highway (Decision 38 COM 7B.94);

Response

The stretch of the northern road traversing through the Serengeti National Park from Tabora B to Klein's gate in the property will remain under the management of Tanzania National Parks and will be maintained as a gravel road for Tourism and administrative duties.

9. Expresses concern about the reported construction of a golf course in the Ikoma Wildlife Management Area, adjacent to the property and a key main migration corridor for the wildebeest, and requests the State Party, given its potential impact on the OUV of the property, to pause the further development of this project until a full Environmental and Social Impact Assessment (ESIA), in line with the new Guidance and Toolkit for Impact Assessments in a World Heritage Context, is submitted to the World Heritage Centre and reviewed by IUCN, in line with the requirements of the Operational Guidelines;

Response

Although construction of the Golf Course is outside of the boundary limit of the property and does not fall under the Wildlife Management area but a public land within Serengeti District under the ownership of Tanzania National Parks with title deed No. 1457MRLR dated 28th December 2020 covering an area 427.154 ha. Considering the potential impact on the OUV of the property, a State Party has taken precautionary measures and subjected the Golf Course construction to full Environmental and Social Impacts Assessment (ESIA) by the State Party Environmental Management Act, 2004.

Subsequently, the ESIA has been conducted awaiting certification, and will be submitted to the WHC for review

10. Also notes with concern that the increasing density of lodges, tented camps and other tourism infrastructure in the property and along the migration routes in the wider Serengeti ecosystem is increasingly likely to impact the wildebeest migration, one of the main attributes of the OUV;

Response

Tourism accommodation facilities (lodges, tented camps, and other tourism infrastructure) in the property have been strategically planned and implemented following the General Management Plan (2014 – 2024) already submitted to WHC. However, most of the facilities located along the migration routes are seasonal camps that stay temporarily (3 – 6 months) with less impact to OUV (wildebeest migration). The State Party will continue to monitor and act accordingly, in case of any impact including relocation of the seasonal camps where necessary

11. Further notes that the State Party finally invited the requested joint Wolrd Heritage Centre/IUCN Reactive Monitoring mission and also requests that the mission be undertaken as soon as possible to review the state of conservation of the property, including all the threats and issues cited above, as well as to assess the implementation of the previous Committee decisions and mission recommendations;

Response

The State Party invited the joint RMM which successfully took place between 15th – 19th January 2024. The state Party awaiting for RMM report.

12. Requests the State Party to submit to the World Heritage Centre, by 1 February 2024, an updated report on the state of conservation of the property and the implementation of the above, for examination by the World Heritage Committee at its 46th session.

Response

The report is submitted timely as requested.

Tanzania National Roads Agency

Serengeti Southern Bypass: Transport Options & Trunk Road Concepts to Reduce Traffic Crossing the Serengeti National Park

Preliminary Design and Feasibility Study

VOLUME 1

Feasibility Summary Report

February 2023

FINAL

Gauff Consultants Tanzania

Serengeti Southern Bypass: Transport Options & Trunk Road Concepts to Reduce Traffic Crossing the Serengeti National Park

PRELIMINARY DESIGN AND FEASIBILITY STUDY
VOLUME 1: FEASIBILITY SUMMARY REPORT
FEBRUARY 2023

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Rev. 0 – February 2023

Serengeti Southern Bypass Preliminary Design and Feasibility Study

The Serengeti Southern Bypass Road Preliminary Design and Feasibility Study at hand addresses the integration and development of north-western Tanzania, while at the same time safeguarding the world-famous Serengeti National Park by providing an alternative route that does not cross the property's Outstanding Universal Value.

From the findings of this study, these overarching set of objectives are best achieved through the upgrading of the entire project road network (Karatu – Mbulu – Maswa plus Katesh – Haydom and Lalago – Kolandoto) of 513.6 km at a total cost of USD 622.6 million offering a technically, environmentally and economically viable option with an Economic Internal Rate of Return of 22.5%.

In the event that funds are insufficient this road network could be phased starting with the 358.9 km long route from Katesh to Haydom and on to Maswa at a total capital cost of USD 443.2 million followed by the 154.7 km road from Karatu to Haydom at a total investment cost of USD 179.4 million to connect the district headquarters of Mbulu and the beneficiaries along this route.

To maximise the desired impact of the proposed Serengeti Southern Bypass this study identified a set of measures that need to be considered and integrated as part of the project's implementation.

This Preliminary Design and Feasibility Report consist of the following volumes and sub-volumes:

Vol. 1	**Feasibility Summary Report**
Vol. 2A	Topographic Survey Report
Vol. 2B	Hydraulics, Hydrology and Structures Report
Vol. 2C	Materials Investigations and Pavement Design Report
Vol. 2D	Geometric Design Report
Vol. 2E	Book of Drawings
Vol. 3	Environmental and Social Impact Assessment Report
Vol. 4	Economic Analysis Report

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ABBREVIATIONS

AADT	Annual Average Daily Traffic
AAGR	Annual Average Growth Rate
ADT	Average Daily Traffic
AMSL	Above Mean Sea Level
ANAW	African Network for Animal Welfare
BMI	Business Monitor Intelligence
CBA	Cost – Benefit Analysis
CDWTV	Classified Direction Wise Traffic Volume
CTCP	Central Transport Corridor Project
EAC	East African Community
EAR	East African Rift
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ESIA	Environmental and Social Impact Assessment
FPIC	Free, Prior and Informed Consent
GIS	Geographic Information System
GDP	Gross Domestic Product
GoT	Government of Tanzania
HDM-4	Highway Design Model 4
KfW	Kreditanstalt für Wiederaufbau (German Development Bank)
MCA	Multi Criteria Analysis
MESA	Million Equivalent Standard Axles
NMT	Non-Motorised Transport
NPV	Nett Present Value
OD	Origin – Destination
PMDM	Pavement and Materials Design Manual (1999), Tanzania
RAP	Resettlement Action Plan
RoW	Right of Way
RUC	Road User Costs
SCS	Soil Conservation Service
SNP	Serengeti National Park
TA	Technical Assistance
TANAPA	Tanzania National Parks Authority

TANROADS	Tanzania National Roads Authority
TAWIRI	Tanzania Wildlife Research Institute
TIAR	TANROADS Investment Appraisal Manual
TLC	Traffic Load Class
TRRL	Transport and Road Research Laboratory
TZS	Tanzanian Shilling
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USD	United States Dollar
VEF	Vehicle Equivalence Factors
VOC	Vehicle Operating Costs
VOCS	Vehicle Operating Cost Savings
WB	World Bank
WWF	World Wildlife Fund

1 INTRODUCTION AND PROJECT CONTEXT

1.1 Structure of the Report

This submission consists of a number of Volumes and sub-Volumes, together making up the Preliminary Design and Feasibility Report. All the various aspects of this submission are discussed in this main report which serves as a summary report. Each Chapter relates to a Volume or sub-Volume of the report where these aspects are summarised.

Volume 2 consists of a number of sub-Volumes, together making up the Technical Reporting. At first the Topographic survey is discussed since the Preliminary Design as well as the Environmental and Social studies all depend on the topography and the required width of the road. Volumes 2B and 2C discuss the technical subjects required for the Preliminary Design i.e. Hydraulics, Hydrology and Structures Reports and the Materials and Pavement Report. This all culminates into the Preliminary Geometric Design which is discussed in Volume 2D. The technical reporting is completed with sub-Volume 2E, the Book of Drawings, containing all required drawings for a Preliminary Design. This is followed by the reporting on the finding of the Environmental and Social studies in Volume 3. Finally, the Economic Analysis of the variants and the Conclusions of the overall study is discussed in Volume 4.

In summary the layout of the reporting is as follows:

Volume 1: Summary Report (this report)

Volume 2: Technical Reporting

- Volume 2A: Topographic Survey
- Volume 2B: Hydraulics, Hydrology and Structures
- Volume 2C: Materials Investigations and Pavement Design
- Volume 2D: Geometric Design
- Volume 2E: Book of Drawings

Volume 3: Environmental and Social Impact Assessment

Volume 4: Economic Analysis

The layout of the specific volume at hand, the Summary Report (Volume 1) is structured as outlined in the following table:

Table 1-1: Report Structure

Chapter	Outline
1. Introduction and Project Context	Introduces the general context and background of the project and describes the project area. The Chapter also provides a description of the objectives and purpose of the study.
2. Topographic Survey	Describes the approach and methodology of the Topographic Survey carried out for the preliminary design.
3. Hydraulics, Hydrology and Structural Design	Explains the approach used for the Hydraulic and Hydrology studies as well as the design approach for the Structural Design.
4. Materials Investigations and Pavement Design	Presents the approach towards the Materials Sampling and Testing activities undertaken for the study.

5. Geometric Aspects of the Route Design	Gives a summary of the main aspects of the geometric alignment design.
6. Construction Costs	Presents the background of the Cost Estimates which are presented in Annex 1.
7. Social and Environmental Aspects and Findings	Summarises the approach and philosophy used for the Environmental and Social aspects of the Feasibility Study
8. Economic Analysis	Provides results of the economic analysis and assesses the effects of the project road on safeguarding the integrity of the Serengeti National Park and its contribution towards the development of the remote areas of north-western Tanzania.
9. Conclusion and Recommendations	Presents the outcome of the study as well as the overall conclusions and recommendations.

1.2 General Context

Tanzania[1] is well endowed with a wide variety of natural resources including fertile soils coupled with a favourable climate suitable for agriculture, abundant fishery resources from a 1,424 km[2] coastline on the Indian Ocean and about 62,000 km² inland water bodies[3] including about 51% of the world's second largest inland fresh water body, Lake Victoria. It also has mineral deposits including gypsum, phosphate soda ash, salt, iron ore, nickel, copper cobalt gold and numerous gemstones as well as large recently discovered offshore natural gas reserves.

The country is also fortunate to have vast areas of ecologically unique habitats, including four natural United Nations Educational, Scientific and Cultural Organization (UNESCO) heritage sites[4], namely the Serengeti National Park (SNP), Ngorongoro Conservation Area, Selous Game Reserve and Africa's highest mountain, Kilimanjaro National Park. The SNP received prestigious awards in 2013[5] and 2019[6] making it the flagship of Tanzania's tourism sector, which in 2018 was the leading foreign exchange earner[7].

Despite this favourable disposition, Tanzania remains a low-income country[8] with relatively few economically active centres in Dar-es-Salaam, Arusha, Mwanza and Dodoma. This leaves many areas largely undeveloped. The north-western part of Tanzania contains many such under-developed areas, including the Mara region, the northern part of Simiyu region and the western part of Manyara region, all of which are relatively isolated from the rest of the country and are characterised by high levels of poverty.

1 Tanzania's total surface area is about 947,300 km[2].

2 Including Zanzibar and Pemba islands. The country's shore line from its borders with Kenya to Mozambique is 1,084 km.

3 FAO Aquastat information

4 Tanzania has a total of 7 UNESCO world heritage sites: Ngorongoro Conservation area (natural/cultural), Kilwa-Kisiwani ruins and Songo Mnara (cultural), Serengeti National Park (natural), Selous Game Reserve (natural, but endangered), Kilimanjaro National Park (natural), Zanzibar stone town (cultural) and Kondoa Rockart Sites (cultural).

5 International businessmen group Global Trade Leaders Club has selected the Serengeti National Park as the global winner of the 2013 International Award in Tourism, Hotel and Catering Industry.
: https://www.tanzaniainvest.com/tourism/tanzania-serengeti-national-park-wins-prestigious-global-tourism-award and follow us on www.twitter.com/tanzaniainvest: https://www.tanzaniainvest.com/tourism/tanzania-serengeti-national-park-wins-prestigious-global-tourism-award

6 World Travel Awards: https://www.worldtravelawards.com/winners/2019/africa

7 Bank of Tanzania Monthly Economic Report Jan. 2018, Chart 5.3 (p.10): Receipts from tourism for the year ending 2018 was USD 2.449 billion.

8 World Bank country classification of "low-income" includes countries with a gross national income per capita of USD 995 or below.

To link, integrate and develop the aforementioned isolated areas, the Government of Tanzania (GoT) proposed in 2010 to construct a paved road through the SNP as the most direct route.

This proposal was challenged at the East African Court of justice by the African Network for Animal Welfare (ANAW), a charitable Pan-African animal welfare and Serengeti Watch, a community-centred organization, and supported by wildlife conservation bodies worldwide. The major contention raised by these bodies was that opening a paved road to the general public would cause irreversible damage to the SNP through impacting on wild animals' migratory routines, wildlife poaching, air quality and noise, soils, flora and fauna, road safety and increased accidents.

In addition, Serengeti had been declared a "World Heritage Property" of "outstanding universal value" according to UNESCO and therefore its protection and conservation was a matter of international concern.

Notwithstanding these valid concerns threatening the integrity of the SNP's abundance of diverse wildlife in general and its wildebeest migration specifically, a solution was required to promote the economic development of the north-western part of Tanzania, which is the genesis of this feasibility study at hand.

1.3 Project Introduction

1.3.1 Project Background

Building on the contextual background described in the previous section, the original concept of a bypass around the Serengeti National Park stemmed from a compromise between:

1) on the one hand, the proposal to construct a paved road through the Serengeti National Park (SNP) as the most direct route to link, integrate and develop the north-western part of Tanzania, specifically (i) the Mara Region, (ii) the northern part of Simiyu Region and (iii) the western part of Manyara Region all of which have been relatively isolated from the rest of the country and are characterised by low levels of development and high incidence of poverty; and

2) on the other hand, the need to minimise the detrimental effects of any such road on the Serengeti National Park and the Ngorongoro Conservation Area, both of which are UNESCO world heritage sites.

These conflicting interests were evaluated by the East African Court of Justice which, in June 2014 issued a ruling that barred the construction of a road through the SNP. This ruling led to the need for a bypass around the Serengeti National Park if the objective of integrating, connecting and developing north-western Tanzania was to be fulfilled. Since a northern bypass would inevitably involve crossing into Kenya, the obvious choice was to investigate the route options south of the Serengeti National Park.

In support of this objective, and always with the aim of preserving the Serengeti National Park, the German Government offered assistance to the Government of Tanzania via the so-called Serengeti Package -described further in volume 4- which includes the Preliminary Design and Feasibility Study of the Serengeti Southern Bypass. Thus, the Serengeti Southern Bypass Feasibility Study is regarded as an integral part of a wider comprehensive package that adopts a holistic approach to address a multitude of interests.

1.3.2 Available Route Options

The route options available to motorised vehicles travelling from Arusha to Musoma or vice versa within a corridor between the international border with Kenya in the north and the central corridor

via Babati, Singida and Shinyanga in the south are summarised by their lengths in the following table and illustrated in the accompanying map overleaf showing a total of six possible routes.

Table 1-2: Route Option Lengths

Route options Between Arusha and Musoma							
No.	Via Points	Colour	Bituminous	Unsealed	Total	via Park	
1	Serengeti:Mto wa Mbu - Loliondo - Nyamuswa	Magenta	569.3	57.3	626.6	⚠	57.3
2	Serengeti: Karatu - Nyamuswa	Orange	227.0	298.0	525.0	⚠	202.0
3	Karatu - Oldeani - Lake Eyasi	Purple	351.4	321.7	673.1		Nil
4	Karatu - Mbulu - Haydom - Maswa	Green	356.9	379.5	736.4		Nil
5	Babati - Katesh - Haydom - Maswa	Yellow	451.4	297.0	748.4		Nil
6	Babati - Katesh - Singida - Nzega - Shinyanga	Black	863.7	96.3	960.0		Nil
Source:Consultant's estimates.							

Two of the existing routes are through the SNP (route 1 and 2). These offer the shortest distances but will result in irreversible environmental damages including the disruption of the world-famous wildebeest migration if upgraded to a bituminous standard.

Route 1: also known as the Northern Serengeti Route (NSR) is via Mto wa Mbu, following a northerly direction close to Lake Natron near the border with Kenya and onward to Loliondo. It then enters the SNP at Klein's Gate, traversing about 57 km of the park, exiting at Tabora B Gate in the North West and continues on to Nyamuswa and eventually on to Musoma (total length of some 626 km between Arusha and Musoma). This route was proposed to be upgraded by GoT in 2010, which was opposed world-wide. A ruling by the East African Court of Justice provided a permanent injunction to upgrade the road in the SNP along this route. However, it is noteworthy that plans to upgrade the road sections outside the SNP on this route are still in place and construction has commenced. The road section between Mto wa Mbu and Sale (junction to Loliondo) is currently under construction to bitumen standard and has therefore been considered as a bituminous road for purposes of this Study. The remaining section from Loliondo to Klein's Gate on the border of SNP is understood to be earmarked for similar upgrading, but in the absence of any definite activities in this regard, it is considered as a gravel road.

Route 2: is the shortest existing road-link between Arusha and Musoma with a total length of some 525 km and is classified as a primary/trunk road (T17). It passes via Karatu, then through the "Greater Conservation Area" comprising of Ngorongoro Conservation area (83 km) and the Serengeti National Park (119 km) and then on to Nyamuswa and Musoma. Although it offers the shortest route, it crosses two national conservation/park areas along a 202 km gravel road and involves park entry and exit procedures and fees twice, lengthening the travel time and increasing the trip cost

In view of the environmentally damaging effects caused by an upgrade of both routes and with regard to route 1, the aforementioned ruling of the East African Court of Justice and for route 2 the 202 km gravel road through two conservation and park areas, neither of these two routes are feasible options and are only referred to as a reference for alternative by-pass options.

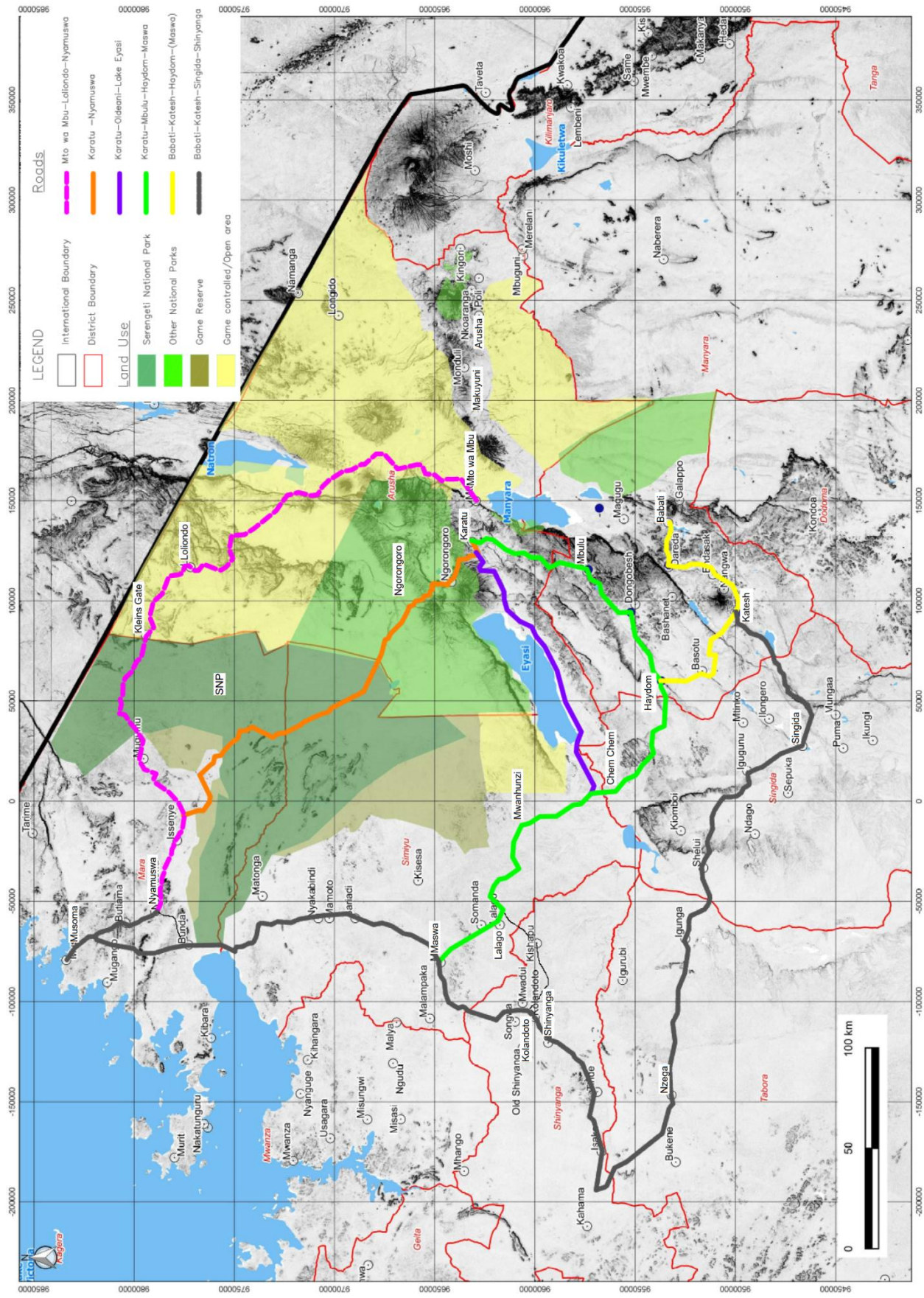


Figure 1-1: Map of Route Alternatives between Arusha and Musoma

The first realistic option bypassing the SNP (route 3) skirts Lake Eyasi on its southern shore and is about 148 km longer than the shortest route (through the SNP) and represents one of the two pre-determined route options evaluated under this study. This route passes through the regionally renowned onion-growing area of Mang'ola, and also traverses the territory of the Hadzabe hunter-gatherer tribe and further along its path at Chem Chem joins up with the existing gravel road between Mbulu and Mwanhunzi. Both Feasibility Study and Detailed Design have been undertaken for this route, but its implementation awaits the final outcome and decision of this Study.

Slightly further south are two route options which share significant lengths of road along their alignment and also some of the aforementioned Lake Eyasi route. Both routes pass through Haydom, while one is via Mbulu (route 4) and the second is via Katesh (route 5) located on the central corridor. This second supplementary route excludes the sections between Karatu – Mbulu – Haydom, thereby omitting Mbulu town altogether. These are some 211 km and 223 km longer than the shortest route respectively, but only 63 km and 75 km longer than the Lake Eyasi route. These two route options were included in the so-called Mbulu route option and evaluated as part of this study. These provide alternatives that circumvent the proximity of the Ngorongoro Conservation Area and traditional Hadzabe tribe, while at the same time offers improved road access to numerous settlements including Mbulu, Dongobesh, Katesh and Haydom.

Finally, the most southern route is part of the Central Corridor via Makuyuni – Babati – Katesh – Singida – Nzega – Shinyanga offering an alternative with a bituminous surface along 90% of its length, but some 435 km longer than the shortest route. Since this option is already largely upgraded to bitumen standard and is significantly longer, it is not included in the evaluation as an alternative in this study. Nonetheless, it is an important transport corridor providing a significant source of diverted traffic onto the project road, and a potentially threatening source of diverted traffic to the SNP.

The route options that are expected to address the aforementioned project objectives as well as the overall development objective were the Lake Eyasi road (route 3) and the so-called Mbulu route (route 4) with its sub-options as prescribed in the ToR:

1. The road from Karatu to Maswa via Mbulu, Haydom, Chem Chem (Sibiti Bridge crossing), and Mwanhunzi referred to as "KMM" (short for "Karatu – Mbulu – Maswa") with a total length of 446.6 km after improvement of its alignment;
2. The supplementary alternative route (added on the recommendation of the client and donor in February 2018) starting in Katesh on the Central Corridor via Haydom, Chem Chem, and Mwanhunzi to Maswa with a total length of 358.9 km referred to as "KHM" (short for "Katesh – Haydom – Maswa"); and
3. A combination of the above-mentioned two routes, KHM plus the link road between Katesh and Haydom referred to as "KMM+KH" (short for "Karatu – Mbulu – Maswa plus Katesh – Haydom") amounting to a total length of 513.6 km including alignment improvements.

1.3.3 Project Area

With a starting-point in Karatu and alternative link start-point in Katesh and an end-point in Maswa the various sub-routes investigated for the project road traverse 5 regions; Arusha, Manyara, Simiyu, Shinyanga and Singida, while the regions of Mara[9], Mwanza and Tabora are also anticipated to be affected by the project road, though less directly. Some 33% of the country's population (50 million) reside in these eight regions. The number of beneficiaries are augmented if one takes into account the regional, national and international transporters and travellers.

9 After the removal of the Bunda – Nyamuswa link originally included in the study, Mara region is not traversed by the project road.

While the regional aspects provide a general overview and represent the indirect project area, the direct area of influence of the project road was defined as a 10 km wide corridor (5 km either side of the project road, based on the distance that allow residents to travel from the homestead to a nearby regional market and back on the same day), the projects' areas of direct influence is indicated in Table 1-3 below.

Table 1-3: Road Lengths and Areas by District - Project Area of Influence

District	Karatu - Maswa		Karatu - Maswa + Haydom - Katesh Link		Katesh - Haydom - Maswa	
	Length (Km)	Area (Km2)	Length (Km)	Area (Km2)	Length (Km)	Area (Km2)
Babati	-	-	8.0	80	8.0	80
Hanang	5.0	50	64.0	590	59.2	549
Karatu	64.3	643	64.3	643	-	-
Kishapu	53.0	530	53.0	530	53.0	530
Maswa	76.5	765	76.5	765	76.5	765
Mbulu	97.3	608	97.3	608	11.7	109
Meatu	77.5	667	77.5	667	77.5	667
Mkalama	73.0	679	73.0	679	73.0	679
Grand Total	446.6	3,942	513.6	4,562	358.9	3,378

Source: Consultant's evaluations.

The population (as at 2019) in the project areas – defined as a 10 km wide corridor – is estimated at 451,800 for "KMM", 509.900 for "KMM+KH" and 407,700 for "KHM", bearing in mind their respective areas of influence.

1.4 Objectives and Purpose for the Study

1.4.1 Study Objectives

The overarching development objective of the Serengeti Bypass Road is to improve the regional road network and access to the remote north-western part of Tanzania thereby contributing to the advancement of its economic development, while at the same time reducing the expected traffic crossing the SNP to safeguard its unique ecological integrity and status as a UNESCO world heritage site as well as the country's tourism flagship.

With this in mind, the more specific project objective of the Serengeti Bypass Feasibility Study is to assess the feasibility of the upgrading of the chosen route, the Mbulu Route, to a regional Trunk Road and prepare a preliminary design for this route.

Although the two aforementioned objectives are linked to each other, it must be recognised that the fulfilment of the project objective does not necessarily imply that the overall development objective is fully achieved.

1.4.2 Study Purpose

In line with the objectives described in the previous section, the purpose of this Feasibility Study is two-fold. First, the study assesses the effects that the upgrading of the selected route is expected to have on the overall development objectives in terms of offering an attractive realistic alternative route south of the SNP to safeguard its integrity and at the same time its contribution towards the socio-economic development of the north-western area of Tanzania. Second, it evaluates the economic viability of the selected route to ascertain the best suited technical engineering alternative and determine the economic justification of implementing the road in its own right.

Furthermore, this study also investigates the relationship between the two distinct and potentially conflicting objectives of reducing traffic crossing the SNP while promoting development in the north-western region of Tanzania. In this respect the Study includes a critical assessment of the role of the project road and additional related push and pull factors and measures that affect the achievement of the said objectives.

The combined results of both specific analytical evaluation of the selected route as well as a more general contextual assessment of the overall related effects are intended to assist TANROADS and the development partners with the decision to commit funds towards the implementation of the proposed Serengeti Southern Bypass Road.

1.5 Scope of Services

Bearing in mind the objectives stated in Section 1.4.1 above, the general overall scope of services as stipulated in the ToR is to “investigate the alternative routes and recommend the best route based on technical, economic, social and environmental assessment”.

For the overall study this means that, apart from the mentioned relevant aspects that need to be investigated, these aspects need to be taken into a wider context e.g. determine the effectiveness of the route in preventing traffic going through the SNP.

1.6 Approach and Methodology

The approach and methodology adopted in the Feasibility Study for the Serengeti Southern Bypass is based on the prescribed scope of services summarised in the previous section as well as considerations of the objectives stated in Section 1.4.1 and the purpose of the study described in Section 1.4.2.

This Feasibility Study was undertaken in two phases. The first phase comprised a separate Route Options study to analyse and compare two pre-determined alternatives for the Serengeti Southern Bypass in order to evaluate which one best meets the objectives of the study which, to repeat, are to improve connectivity to the north west of Tanzania and to reduce traffic travelling through the Serengeti National Park. A Route Option Assessment was therefore undertaken for the two main route options, as specified in the Terms of Reference:

1. The Mbulu Route from Karatu – Mbulu – Haydom – Sibiti River Crossing – Bukundi – Mwanhunzi – Lalago – Maswa (Nyalikungu), with a length of approximately 379 km (excluding the link between Kolandoto and Lalago); and
2. The Lake Eyasi Route from the Oldeani junction – Mangola – along the east side of Lake Eyasi – Sibiti River Crossing – Bukundi – Mwanhunzi – Lalago – Maswa (Nyalikungu), with a length of approximately 314 km (most of these sections are currently being investigated in a Feasibility Study by others)[10].

Assessments of additional optional shortcuts / link roads included:

1. Haydom to Katesh measuring a total of 67 km;
2. Kolandoto to Lalago measuring about 62 km.

To comprehensively assess the two route options and recommend the preferred route option for subsequently conducting the full Feasibility Study, various issues were taken into consideration including:

[10] The section Oldeani – Sibiti River – Lalago – Kolandoto, a major part of this route, is the subject of a Feasibility and Detailed Design Study of Intercontinental Consultants and Technocrats (ICT).

- Preliminary cost-benefit analysis;
- Wildlife and environmental impacts;
- Social aspects;
- Technical engineering (geometrical factors and drainage requirements);
- Political goodwill and support.

Both quantitative and qualitative assessments were combined into a Multi Criteria Assessment (MCA) matrix to ensure that all relevant aspects were taken into account. The final results of the MCA exercise revealed that the Mbulu Route scored consistently higher than the Lake Eyasi Route. The Mbulu Route alternative was therefore chosen as the preferred route option to proceed into the second phase of the Study, comprising of the Preliminary Design and Feasibility Study. Furthermore, given that the Client had defined various options along the Mbulu route and shortcuts, three routes and their respective links were incorporated for inclusion in the Feasibility Study analysis, these being:

- Karatu – Mbulu – Maswa and Lalago – Kolandoto Link, referred to as “KMM”;
- Karatu – Mbulu – Maswa plus Katesh – Haydom and Lalago – Kolandoto Links, referred to as “KMM+KH”); and
- Katesh – Haydom – Maswa and Lalago – Kolandoto Link, referred to as “KHM”, added after a meeting in February 2018 with TANROADS and the donor, KfW.

The Nyamuswa – Bunda shortcut originally in the ToR was excluded since this was taken up in a separate project.

A schematic flow chart of the approach adopted to fulfil the scope of services and attain the purpose of this study is presented in Figure 1-2 overleaf.

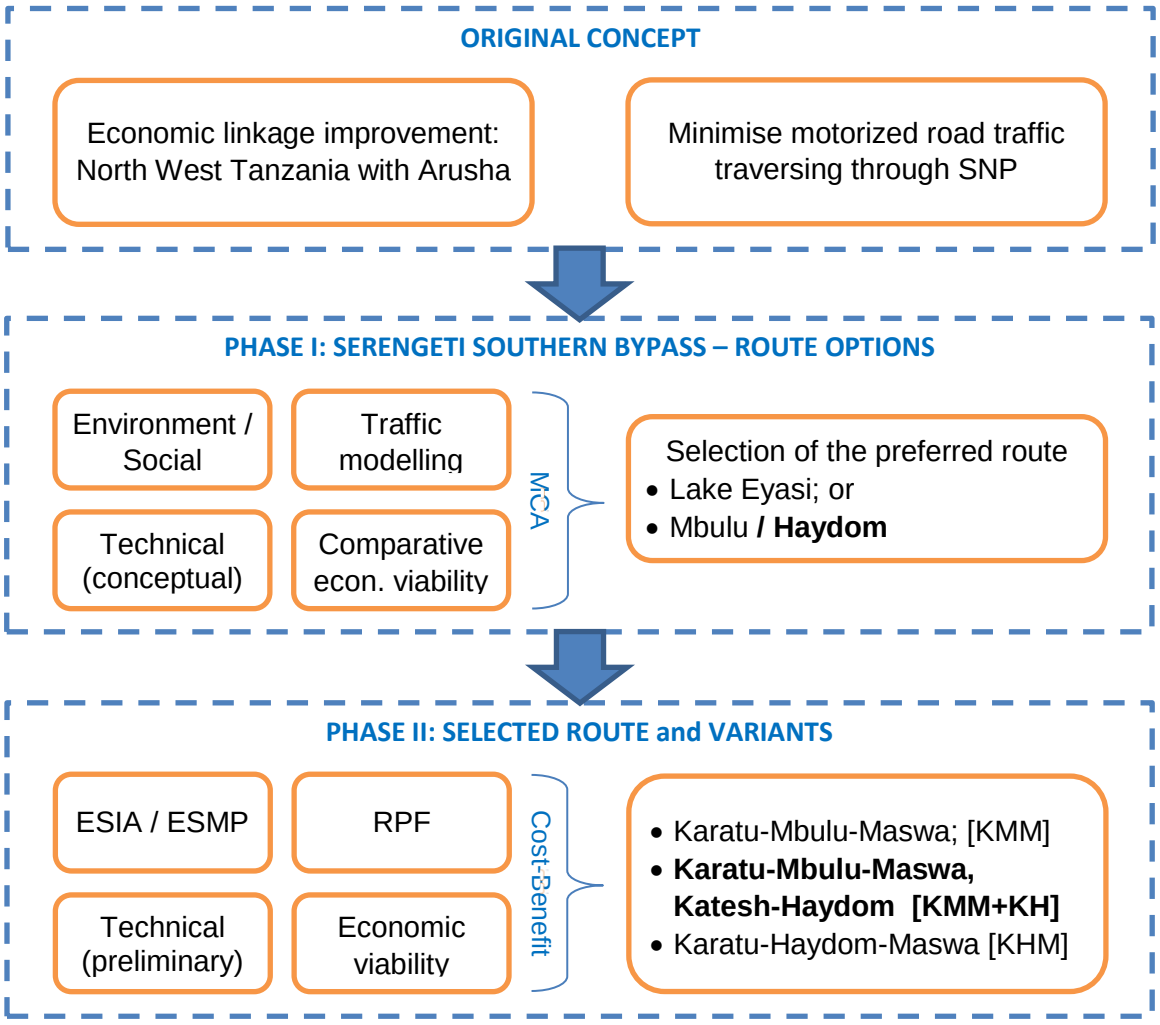
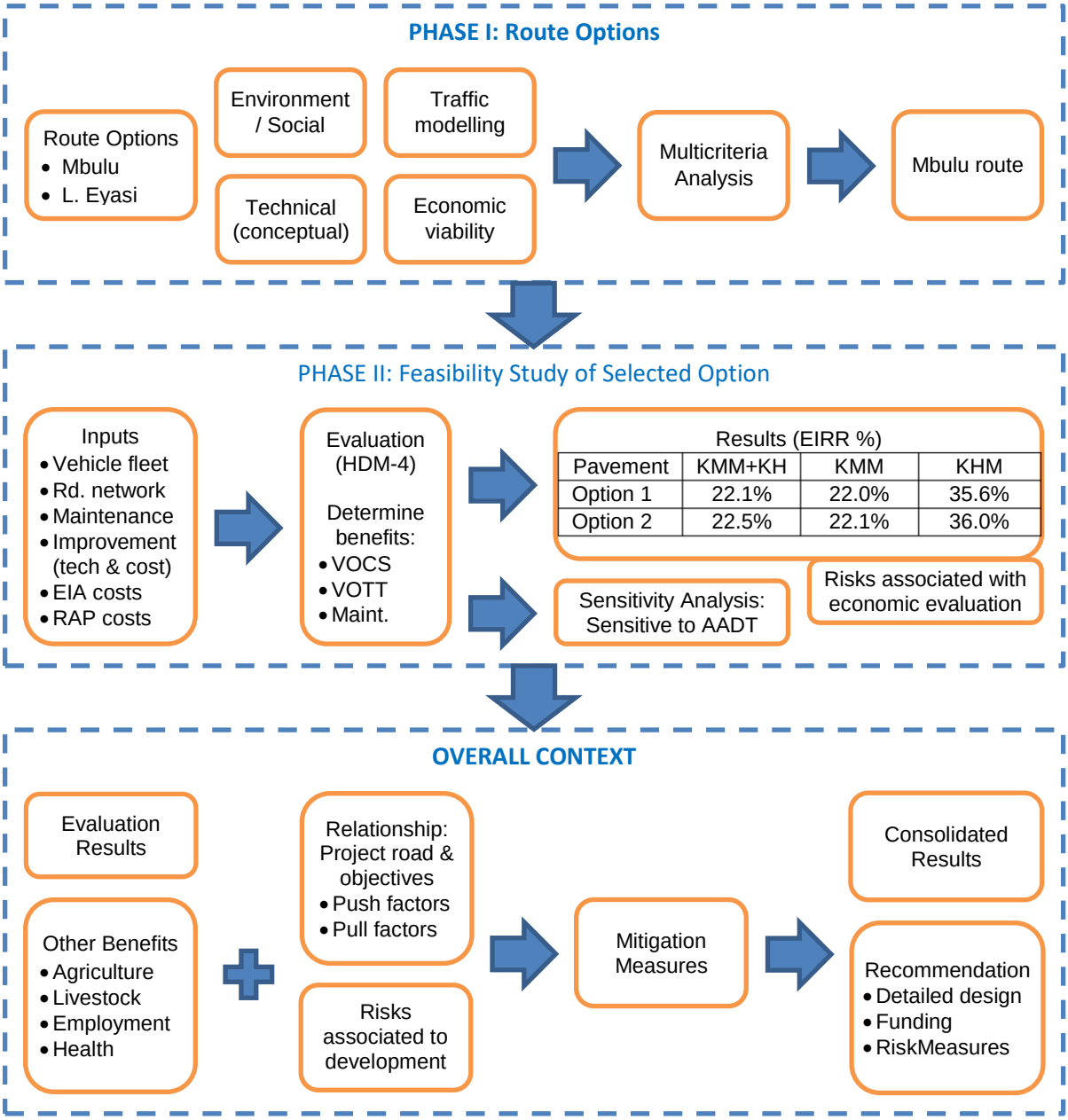


Figure 1-2: Schematic Diagram to Show Study Approach

1.7 In Summary

The Serengeti Southern Bypass Preliminary Design and Feasibility Study at hand addresses the integration and development of north-western Tanzania, while at the same time safeguarding the world-famous Serengeti National Park by providing an alternative route that does not cross the property's Outstanding Universal Value.

The study was carried out in two phases as captured in the flow chart overleaf.



Note: Option 1 = stabilised base, Option 2 = granular base

Figure 1-3: Schematic Activities and Consolidated Results

The economic indicator results of the investigations and analyses illustrated in the flowchart above are captured in the following table;

Table 1-4: Summary Economic Indicator Results

Indicator	Unit	Option	KMM+KH	KMM	KHM
NPV @ 12%	USD million	Option 1	224.682	191.457	432.583
	USD million	Option 2	228.769	192.437	434.757
EIRR	%	Option 1	22.1	22.0	35.6
	%	Option 2	22.5	22.1	36.0
Total Financial	USD million	Option 1	640.266	573.662	454.290
Investment Cost	USD million	Option 2	622.586	561.262	443.219
Total Financial Unit	USD million/km	Option 1	1.426	1.284	1.266
Cost	USD million/km	Option 2	1.212	1.257	1.234
Road length	Km		513.6	446.6	358.9
Source: HDM-4 runs and Consultant's estimates and calculations					

Note: Option1 = Stabilised base, Option 2 = Granular base

Following the identification of potential impacts in the EIA (both positive and negative) an Environmental and Social Management System (ESMS) will be implemented. The ESMS provides a mechanism for ensuring that mitigation measures identified in the EIA and associated ESMMP are adequately implemented. Moreover, the ESMS provides a framework for monitoring, compliance auditing and inspection programmes, which assist the project in meeting its commitments, as stipulated in Tanzanian regulations and lender standards. With the implementation of the Plan all impacts are reduced to Moderate and Minor significance.

Provided the proposed mitigation measures are implemented it is recommended the project continues as planned.

From the results above, all three sub-routes are economically viable (adopting a cut-off value of 12%).

For all three economically viable sub-routes, the granular base pavement (Option 2) was found to be the most favourable.

The total (financial) investment costs indicated in Table 1-4 were broken down into 7 construction lots, none of which exceeded a road length of 83 km to enable the project to be implemented within a construction period of two years.

A subsequent sensitivity analysis carried out on all three sub-route options involving variants of normal AADT traffic, traffic growth, capital costs and combinations thereof, revealed that:

- The economic indicators remain robust to changes in the normal AADT and volumes of diverted traffic;
- All three sub-route options demonstrate adequate robustness to changes of capital investment costs.

Considering other (exogenous) benefits including those from agriculture and livestock (producer surplus), employment generation (all quantified) and health (not quantified) additional benefits can be expected from these sectors in reaction and as a result of constructing the Serengeti Southern Bypass. Their addition will only affirm and improve the economic viability already established in the foregoing. An overview of the economic results from Table 1-4 and the aforementioned additional exogenous benefits is provided in Table 1-5 overleaf, which illustrates the overall results.

Table 1-5: Consolidated Overall Results

Cost or Benefit	Unit	KMM	KMM+KH	KHM
Econ. Indicators (Chapter 6) NPV EIRR	 USD million %	 192.437 22.1%	 228.769 22.5%	 434.757 36.0%
Agriculture producer surplus	USD million	34.5	37.7	28.1
Livestock producer surplus	USD million	9.52	10.89	8.24
Incremental employment/GDP	USD million USD million	from 0.81 (2023) to 28.53 (2042)	from 0.92 (2023) to 32.65 (2042)	from 0.74 (2023) to 25.77 (2042)
Revenues w.r.t. SNP from: 200 vpd through SNP Total SNP (at risk)	 USD million USD million	 20.5 607.1	 20.5 607.1	 20.5 607.1
Health	Not quantified	Connects Haydom in **2** directions (From Mbulu, east to Karatu and west to Maswa via Haydom)	Connects Haydom in **3** directions (From Haydom, east to Karatu via Mbulu, west to Maswa and South to Katesh)	Connects Haydom in **2** directions (From Haydom, west to Maswa and south to Katesh)

As highlighted in Table 1-5, the KHM sub-route option yields the highest economic indicators while the KMM+KH sub-route returns the most favourable option with regard to additional exogenous effects. This should be included in the overall decision for the implementation of the Serengeti Southern Bypass. In this regard notably high economic indicator results for KHM are not only counter balanced by the outcome of the above mentioned exogenous benefits, but also by the fact that this route excludes a vital part of the "Mbulu route" (Karatu – Mbulu – Haydom) and thereby excluding the district headquarter of Mbulu from the opportunity and part of the objective of developing the north-west of Tanzania.

Based on TANAPA data relating to the number of visitors and the average spending of international and domestic visitors to SNP, the total estimated revenue for 2023 was calculated to be around USD 607 million out of which only some 3% (USD 20.5 million) are revenues estimated from vehicle entrance fees. The table 1-5 above illustrates that a road through the SNP is likely to detrimentally affect this income received by Tanzania's economy and would be a far greater loss than the USD 20.5 million income from vehicle entrance alone. In other words, the project safeguards an estimated income to the economy of around USD 586 million (i.e. 607 – 20.5). Furthermore, it is expected that any of the three SNP bypass project options will achieve this effect.

With consideration to the overall development objective an analysis of its two potentially opposing components (economic development versus safeguarding the environment of SNP) was assessed separately, which can be summarised as follows.

The development of the remote North West regions of Tanzania would be accelerated through an improved direct road connecting Musoma with the nearest economically active centre of Arusha. The direct route could be provided by any one of the following: (i) the Northern Serengeti Route via Mto wa Mbu, Loliondo, Klein's Gate, Tabora B, Nyamuswa (ii) the T17 via the NCAA and SNP, (iii) the Lake Eyasi route, and of course (iv) the Serengeti Southern Bypass via Mbulu and/or Katesh. However, the selection of upgrading one or more of these routes will have significantly different results affecting the second component of the overall objective and/or the project objective as briefly outlined below.

Upgrading either of the routes through the SNP will maintain and attract additional traffic through the SNP (and NCAA) and hence directly counter-act on one of the components of the overall development objective. Most important this would undoubtedly result in irreversible environmental damages to the property of the OUV of the SNP and possibly NCAA. With such consequence in mind all measures must be put in place to strengthen the ruling of the East African Court of Justice restraining the construction of an upgraded road between Klein's Gate and Tabora B.

Upgrading the Lake Eyasi route would directly compete for the same traffic and thereby erode the economic viability of the sub-route options KHM and KMM+KH.

Therefore, only the implementation of the sub-route option KHM and/or the preferred KMM+KH would attain or contribute to the fulfilment of all objectives set out in this feasibility study.

Considering the various aspects addressed in the foregoing it is therefore recommended to:

- Implement KMM+KH, or if funds are not sufficiently available;
- Implement KHM as a first phase and add the part from Karatu to Haydom at a later stage (phased implementation). Consider implementing the second phase by a single funding source and contractor.

To avoid forecast traffic volumes to “disappear” to other routes and either erode the economic viability of the preferred route or counter-act against the objective of reducing traffic in the SNP It is recommended to stay the upgrading of the Lake Eyasi route and implement the following mitigation measures:

Physical measures: include traffic calming measures (speed humps), vehicle portals, reduce road width, cutting direct route connections, stringent traffic control measures, signage to discourage through traffic and removing the routes from google maps as the shortest/fastest route;

Institutional and legislative measures: specific action plan vis-à-vis traffic regulation, revise fees schedule to increase charges for through traffic, increase human and technical capacities of SNP to implement traffic regulating activities, formulate environmental policy;

Development Policy measures involve inclusion of the results of this study into the infrastructure development plan and implement the various road projects in the region in a manner that maximises the effect of the Serengeti Southern Bypass road as an alternative route between Arusha and Musoma.

2 TOPOGRAPHIC SURVEY

2.1 Introduction

The ToR indicated that the topographic survey could be limited to a centreline survey with the use of a handheld GPS. Since this is not accurate enough to base a preliminary design on, the Consultant chose to do the centerline survey and cross-sections with professional equipment. Apart from professional survey data was downloaded from the Internet to use as basis for the design in addition to undertaking a preliminary survey.

2.1.1 Survey Scope

In accordance with the Terms of Reference, the main objective of the preliminary topographical survey was to capture important ground features along Karatu – Chem Chem, Lalago – Maswa and Haydom – Katesh road sections.

The scope of the topographic survey is:

(i) Surveying of existing road centerline (CL)

(ii) Establishment of control points along the corridor;

(iii) Preliminary profile survey at every 50 m interval along the existing CL and cross section survey at every 5 m interval up to 30 m on either side of the existing CL.

(iv) Surveying of existing road structures, i.e., bridges, culverts, drifts.

(v) Surveying of existing selected topographical features including road junctions, access roads adjoining the study roads and rivers; and

(vi) Data processing and reporting.

2.2 Control Survey

The control survey was carried out in accordance with the Land Surveying and Mapping Regulations of Tanzania (Land Surveying Regulations CAP 390). Primary and Secondary Control Points were established and the Road Centerline was surveyed.

All points were checked and differential levelling was carried out. The points were erected at inter visible distances as required.

Figure 2-1. Observation of Primary Control Point.

2.3 The Topographic Survey

Based on the established control points network, topographical survey using GNSS RTK measurements was carried out in order to collect co-ordinate data (x, y, z) for all topographical features. The scope of the topographical survey is summarized below:

- Survey of road centerline
- Survey of road edges
- Toe lines of fills and cuts
- Longitudinal and transverse drains/ ditches

In addition, the survey was limited to only the following man-made topographical features including:

- Existing civil structures such as bridges, culverts, and drifts
- Existing road junctions
- Rivers

The topographical surveying data was processed using QGIS and AutoCAD Civil 3D software. The two software's were used for post processing of the data.

2.4 Further Data collection

Since modern surveys rely more and more on airborne LIDAR, which gives a highly accurate Digital Terrain Model, a complete DTM was downloaded through professional Internet sources. These data are highly accurate and assists the Consultant in the setting up of a full DTM of the project alignment. The Consultant has married the collected data with the survey data to double-check the accuracy. It appears that the downloaded DTM is matching with the surveyed control points.

2.5 The Chem Chem – Kolandoto Section

ICT has undertaken a Detailed Design on the T37, Kolandoto to Oldeani. A part of this route is embedded into the Mbulu Route namely Kolandoto to Chem Chem. Upon review of the topographic survey it became clear that there is a discrepancy in elevation of some 100 m at the Kolandoto side and about 20 m on the Chem Chem side. The Consultant has raised this issue on multiple occasions and discussed with the Client how this should be resolved. The Client has resolved that the difference in elevation is to be noted on the drawings and in the reporting. During the Detailed Design Phase (not part of this study) the section in question will then have to be re-surveyed.

2.6 The Topographic Survey Report

The full report on the Topographic Survey is submitted as Volume 2A.

3 HYDRAULICS, HYDROLOGY AND STRUCTURAL DESIGN

3.1 Introduction

This Chapter summarises the full Hydraulics, Hydrology and Structures Report, which has been submitted as Volume 2B. In order to assess the drainage requirements of the Serengeti Southern Bypass project road drainage structures, a flood-flow hydrology analysis was undertaken for the major water channels crossing the proposed road alignments.

The project road comprises hydrological and hydraulic evaluation of the following proposed alignment sections;

- Main Road: Karatu - Maswa Road Section 385 km
- Link 1 Road: Haydom - Katesh Road Section 67 km
- Link 2 Road: Lalago - Kolandoto Road Section 62 km

Estimates are required of the magnitude of flood events that may be expected to be equalled or exceeded for specified return periods. These estimates can be used for the evaluation or design of road drainage hydraulic structures; they can also be used to assess the risk of damage during any construction period. The return periods are as given in Table 3-1.

Table 3-1. Return Flood Flow Periods.

Type	Size (m)	Return Period
Pipe Culvert	0.9	1:10 yrs
Box Culvert	< 2.5 x 2.5	1:25 yrs
Box Culvert	< 4 x 4.0 x 4.0	1:50 yrs
Bridges	> 20	1:100 yrs

3.2 Review of ICT Hydraulics and Hydrology Report

A review was done on the previous studies/ reports done on the road project. The main document available on previous study done was “The Final Feasibility Study and Preliminary Design Report – by Intercontinental Consultants and Technocrats Pvt. Ltd- ICT dated March 2015. The study was for upgrading of the Kolandoto – Lalago - Mwanhunzi – Oldeani B Junction Road (338 km). Also incorporated in this study was the Sibiti Bridge and approach roads Final Design Study Report – by InterConsult Ltd dated August 2010.

The resulting drainage structures recommended in the previous study done by ICT in 2015 had some variance in sizes to those recommended in this report. The variance is mainly attributed to the meteorological data used for the establishment of the design flood for the drainage structures’ sizing. Whilst the ICT report relied on only one meteorological station data from Shinyanga to represent the rainfall pattern throughout the project road, this report incorporated additional local data from Mbulu and Karatu meteorological stations which are located closer to the project road. The recommendations from this updated report therefore present more optimised drainage structures sizes and locations derived from the updated final road alignment.

3.3 Catchment Areas

To enable proper calculation of the runoff, catchment areas, slopes, channel slopes, soil characteristics and predominant vegetation cover are established.

3.4 Precipitation

Daily rainfall data from meteorological stations located at Mbulu, Shinyanga and Karatu. The rainfall/ precipitation data obtained comprised the following:

- Mbulu Met. Station with daily records from Apr'1980 to Dec'2016,
- Shinyanga Met. Station with daily records from Apr'1992 to Mar'2016,
- Karatu Met. Station with daily records from Apr'1980 to Apr'2009.

In general, mean temperatures in Tanzania do not show wide variations throughout the year, although considerable seasonal spatial variations exist, these being largely attributed to altitude. Tanzania has a tropical climate. In the highlands, temperatures range between 10 and 20 °C during cold and hot seasons respectively. The rest of the country has temperatures rarely falling lower than 20 °C. The hottest period extends between November and February (25–31 °C) while the coldest period occurs between May and August (15–20 °C).

Tanzania has two major rainfall regions. One is unimodal (December - April) and the other is bimodal (October -December and March - May). The former is experienced in southern, south-west, central and western parts of the country, and the latter is found to the north and northern coast. In the bimodal regime the March - May rains are referred to as the long rains or Masika, whereas the October - December rains are generally known as short rains or Vuli.

Various studies on climate variability and change indicate that impacts of global warming include increased temperature, severe droughts and similarly severe floods. The adoption of historical data whilst integrating current meteorological data is deemed suitable for the hydrological assessment especially where the actual data applicable to the respective project catchment is utilized. Figure 3-1 and Figure 3-2 show the average monthly rainfall and maximum rainfall for the different stations (1980 – 2016).

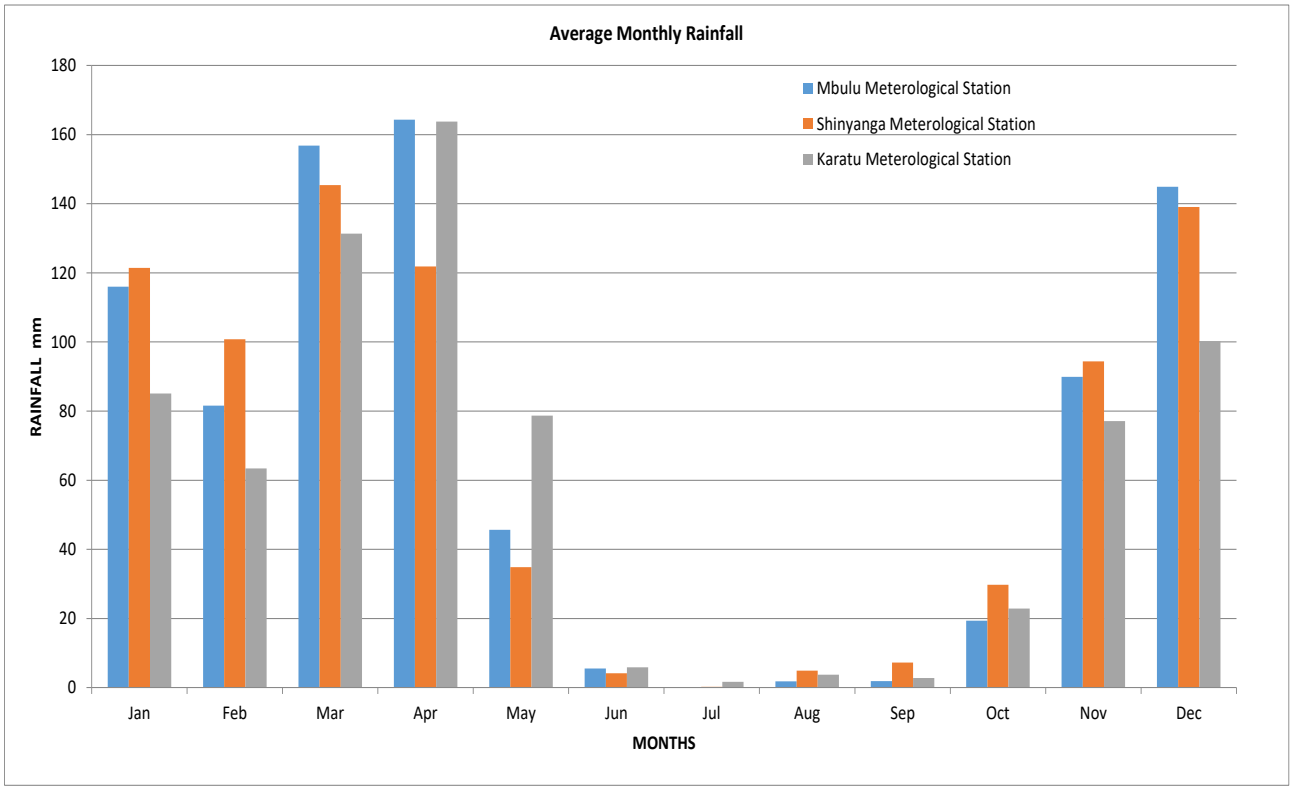


Figure 3-1. Average Monthly Rainfall for the Different Stations (1980 – 2016).

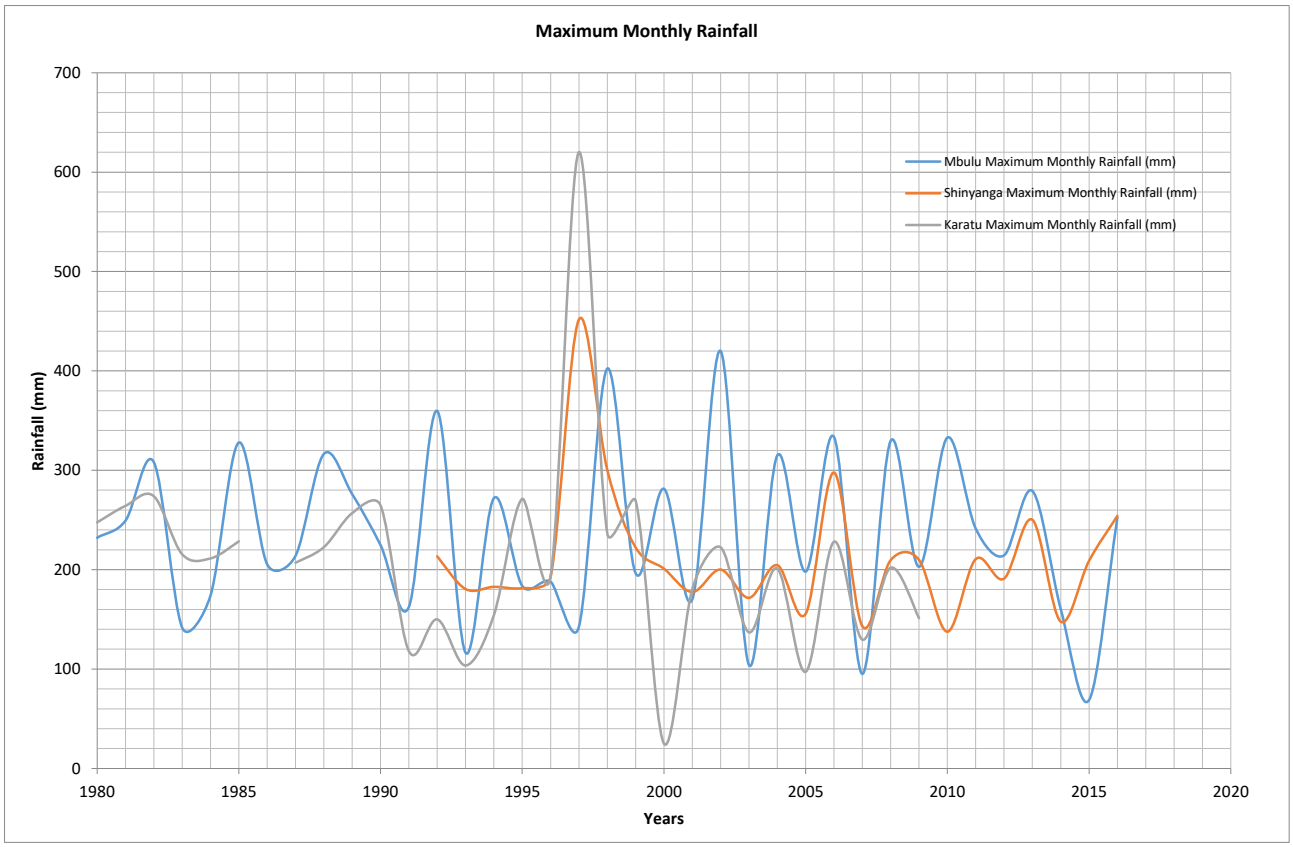


Figure 3-2. Maximum Monthly Rainfall for the Different Stations.

Table 3-2 gives the maximum precipitation projections from various extreme events that was established from the rainfall data. This precipitation data is utilised in the subsequent flood estimations caused by these projected events along the respective road sections where applicable.

Table 3-2. Summary of Rainfall Projections.

Return Period (yr)	Design Rainfall Data (mm)		
	Karatu	Mbulu	Shinyanga
5	44.25	47.03	41.42
10	55.02	57.26	48.80
25	78.95	79.56	60.20
50	105.55	102.04	72.09
100	141.12	130.87	86.33

3.5 Estimation of Flood Flows

To establish an order of magnitude for the design flood for various rivers/ streams at the project road crossings, three methods were used, namely the TRRL[<11>] the, Modified Richard's (Rational) Method and the Soil Conservation Society-SCS Curve Number Method.

3.5.1 The TRRL Method

This method was specifically developed by the Transport and Road Research Laboratory (TRRL) UK for the East African Governments for use in small to medium catchments (less than 200 km^2) in

1. Transport and Road Research Laboratory, Department of Environment. TRRL Laboratory Report 706

East Africa region. This method has been used extensively in Tanzania for various rivers/ streams catchments that are within the size limitation of the original model.

The TRRL method considers two phases of storm run-off; namely the period between the rain hitting the ground surface and flowing into a water course and the passage of the flood down the water course to the catchment outfall. This method also takes into consideration that run-off does not occur uniformly over a catchment and that some parts of a catchment area are less permeable than others due to variation in soil type.

3.5.2 The Modified Rational Method

This method is one of the most commonly used deterministic methods due to its simplicity. It is reported to give consistently good results for a wide range of river catchment sizes in most parts of Africa (and elsewhere) and, hence, is commonly used in flood studies (ref. Flood Hydrology for Southern Africa 1990, Flood Studies Report UK 1975, Australian Rainfall & Runoff 1987, Hydrology India 1997). The method has been modified to take account of the local topography and meteorological data thus expanding its effectiveness in larger catchments compared to the original model which effectiveness had limitation on the catchment areas only up to 20 km².

The method takes into account the rainfall pattern and intensity, the size, shape and slope of the catchment and run-off characteristics in the form of a run-off coefficient, C. The catchment characteristics comprising drainage areas, land slopes and catchment lengths were obtained from both physical inspection and information from topographical mapping for the respective areas.

3.5.3 The SCS Curve Number Method

This method was developed by the United States Soil Conservation Society- US SCS for application in various areas including the tropical areas in East Africa. The SCS procedure expresses the runoff discharge as the difference between a 24 hours rainfall and the amount of water retention into the ground. There is an established relationship between the direct runoff with cumulated rainfall, ground absorption and retention. These are also related to soil and cover conditions that are expressed by the Curve Number (CN).

3.6 Estimation of Flood Flows

Following calculation and/ or determination of the appropriate parameters for each catchment along the project road structure, these were input to the TRRL, Modified Richard's (Rational) and SCS Curve Number models for subsequent calculation of flood flows at the respective project road crossings. The catchment areas as delineated from the DEM/ DTM topographical mapping and satellite imagery for each respective drainage catchment for major crossings are appended herein.

The effects of climate variability and change are duly noted for consideration, which have been indicated as impacts of global warming including increased temperature which impacts directly on humidity and rainfall occurrence. The key impacts from the climate variability and change therefore manifests in the catchment areas as severe droughts and similarly severe floods. These effects of climate variability and change have been incorporated in this hydrological assessment in the determination of the effective runoff coefficient. Due consideration has been allowed for future degradation of the prevailing river/ stream catchments due to the negative effects of climatic changes and human interference on the environment.

3.7 Hydraulic Opening of Proposed Structures

In Consultant's design a 0.5 m free-board allowance has been incorporated on all new box culverts and 1.5 m for all bridges at the project road crossings. The devastating effects of debris conveyed from upstream that eventually cause blockage and hence overtopping of the drainage structures

are renowned. Hence the importance of provision of adequate free-board allowance and flushing flow velocity at the road drainage structure cannot be over-emphasised.

For purposes of ensuring that the hydraulic opening of the existing or proposed structure was sufficient, flood flow velocities were calculated, and the respective Froude Number established. For all proposed culverts the flood flow velocity was limited to below 3.0 m/s whilst for all proposed bridges the flood flow velocity was limited to below 2.0 m/s. These flood flow velocity limitations would still enable sufficient hydraulic openings even in situations where the watercourse channel banks are not able to restrict/ contain the design flood during flow routing through the proposed structures.

With regards to hydraulic capacity, the findings are contained in the Hydraulics and Hydrology Report but generally there is need to enhance the capacity of most bridge/box culvert openings either by increasing the length/width or clearance height. However, it is the deck cross-sections that were found to be insufficient for almost all existing bridges as the average width is less than the proposed road width. This, coupled with the need to enhance the hydraulic capacity of most bridges, required the design of new bridges altogether.

The hydraulic capacity calculations for the structures takes the above into the account.

3.8 Structural Design

The consultant carried out a condition survey of the drainage structures along the entire road alignment and prepared an inventory report for the same. The existing bridges were inspected at the beginning of the study to determine their current condition and adequacy in view of the upcoming road design. The bridges were evaluated for hydraulic capacity, geometric adequacy and also structural soundness.

Visual observation as at the time of inspection established that a number of the concrete bridges and box culverts are in fairly good structural condition. However, majority of the existing composite bridges exhibit numerous defects such as corrosion of steel & spalling of the concrete, damage to bearing seats, exposed reinforcement and evidence of corrosion of reinforcement. They were constructed to low standards (as evident from the reinforcement bars used) and show clear signs of distress. The vast majority should be replaced with properly designed structures.

3.8.1 Pipe Culverts

Existing drainage structures include Dia. 600 mm, Dia. 900 mm and Dia. 1200 mm. Though most of them are structurally in good condition, they are blocked by silt and debris and would require cleaning. Almost all the existing Dias. 900 mm and 1200 mm pipe culverts require extension to fit the new road widths. However, all the Dia. 600 mm culverts are to be removed and replaced with the larger diameter ones.

The Consultant has proposed the use of Weholite HDPE pipe culverts on a number of pilot sections. This system is more environmentally friendly than the conventional concrete culverts and already in use in other parts of the world. In Tanzania this type of culverts is produced in a factory in Dar es Salaam. For more info please refer to the Hydraulics, Hydrology and Structural Report (Vol. 2B).

3.8.2 Chem Chem – Kolandoto Section

On the section for which a detailed design has been produced (Chem Chem - Kolandoto) it appears that capacities and numbers could well be overdesigned by the design Consultant. Potential savings may be achieved on this section.

3.9 Proposed New Bridges

The significantly high number of bridges in this project has necessitated a design concept which would enable the contractor(s) to work fairly quickly in order to deliver the project in time. Preliminary evaluation of the river channels' profiles and widths together with hydrological considerations has enabled us to adopt standardized spans of 20 m and 25 m or multiples of these, which should enable the contractor(s) to repetitively use deck shuttering material. At a fairly good number of the bridge locations, the finished road level (FRL) is relatively high (above 5m) above the sandy river beds. This could present a difficulty of propping deck shuttering from the sandy river beds.

The preliminary design considerations were governed by the factors highlighted in the paragraph above. The obvious construction to meet these requirements economically is a composite construction utilizing either high-yield steel beams or precast post-tensioned I-beams with an in-situ concrete deck. In this type of construction, the wet concrete of the deck slab is carried by shuttering supported off the beams, avoiding propping from the river bed.

As no drilling/ground probing has been undertaken at this feasibility stage it is difficult to gauge the exact nature/strength of the substratum material. Thus, to reduce the weight of the superstructures (to avoid potential future problems with bearing capacities), we have adopted a composite deck with high yield steel beams. Alternative precast beam and steel I-beams for a span of 25 m weigh approximately 360 KN and 97 KN respectively, the steel beam having approximately a quarter of the weight of the precast beam. The proposed steel beams also offer the advantage of offsite fabrication in a workshop potentially leading to time saving.

Likewise, to forestall the effects of potential differential settlement over supports, we have designed the beams, as well as the deck as simply supported. This is because continuous bridges are subject to additional stresses over supports in the event of differential settlement.

4 MATERIALS INVESTIGATIONS AND PAVEMENT DESIGN

4.1 Materials Investigations

4.1.1 Introduction

The Materials Investigation and Pavement Design Report (Volume 2C), which forms part of the design report, presents the results of materials investigations carried out as part of the Feasibility Study for the Serengeti Southern Bypass road to bituminous standards.

The investigations conducted include, identifying, sampling and testing of potential construction materials in the vicinity of the project road

The report deals with the materials programs, undertaken by the Consultant. The programs consist of field investigations, sampling and testing of natural subgrade along the project road.

Further the report deals with presentation of results of field investigations carried out on potential sources of natural gravel and hard rock. Adequate quantities for the project can be found from the identified borrow pits. The project area is rich in gravel materials and further investigation of materials during construction period will almost certainly reveal more locations of good quality gravel.

An appraisal of few potential sand and water sources is also presented.

4.1.1.1 Geology, Topography and Geomorphology

The geology of the project area comprises, undifferentiated basalt of variable mineralogy and texture and metamorphic rocks composed of granite, gneiss, schist, amphibolites and quartzites and phylites. The undifferentiated volcanic rocks like basalt, lavas, scoria, volcanic ashes and pyroclastic flows are common in the northern part of Mbulu and Katesh area.

The altitude of project area ranges from 1,000 m at around Sibiti Bridge to 2,000 m at around Mbulu area. Due to these large differences in elevation there is a wide range of climatic conditions in the project area.

The landscapes of Karatu to Sibiti Bridge section are highly contrasting, ranging from highly dissected hilly and mountainous areas to extended alluvial and lacustrine plains. The section from Sibiti Bridge to Kolandoto is dominated by flat terrains. Katesh to Haydom link is mainly flat and the link between Lalago to Maswa is dominated by rolling terrain.

4.1.1.2 Climate, Rainfall, Land Use and Vegetation

The project area has a tropical climate, warm but not too hot because of altitude. On the plateau, temperatures vary with altitude, but they are usually mild or warm for most of the year. Most part of the project area lies in tropical climate; where summers have a good deal of rainfall, while the winters have very little. The project site and its proximity are characterized by mainly mixture of bush, thickets with small Acacia and shrubs. The bushes composed of short and scattered trees interspaced with short grasses.

4.1.2 Materials Investigations

The preliminary materials investigations were conducted in accordance with the Terms of Reference. It consisted of site reconnaissance, field exploration and analysis of the findings of the field exploration. Volume 2C – Materials Investigation and Pavement Design Report elaborates extensively on the findings per section of the main project road Karatu - Mbulu - Haydom -

Chem Chem - Lalago - Maswa, including the two Link Roads Haydom - Katesh and Lalago - Kolandoto.

4.1.2.1 Gravel and Hardstone Sources

A total of 75 existing and potential gravel sources, 9 rock sources, 13 sand sources and 10 water sources were identified and investigated along the sections of the project road as listed in Table 4-1.

Table 4-1. Number of Potential Sources Located in Sections of the Project Road.

Section	Road/Link Name	Borrow Pits	Quarries	Sand sources	Water Sources, (Perennial)
1	Karatu – Mbulu	6	3	3	2
2	Mbulu – Haydom	17	1	2	2
3	Haydom – Mkalama – Chem Chem	8	1	2	1
4	Chem Chem – Bukundi – Mwanhunzi	10	-	1	2
5	Mwanhunzi - Lalago - Maswa	17	2	4	-
6	Haydom Katesh	7	2	-	2
7	Lalago – Kolandoto	10	-	1	1
	TOTAL	75	9	13	10

4.1.2.2 Alignment Subgrade Soil

The main factors that govern the types of soils and their distribution in the project road alignment are parent material, topography and drainage pattern. Reddish clayey soils occur on the foot slopes of basic metamorphic hills while Reddish loamy soils occur on the foot-slopes of granitic hills. That's why reddish silty clays are common on the upland plains and along the escarpments. Brown silty clays, loamy soils and sandy soils occupy the better drained parts of the upland plains. These areas are also characterized by the omnipresence of eroded or vegetated termite mounds.

Dark, sticky, expansive clays (Black Cotton Soils) and friable, calcareous clays occupy the poorer drained parts of the project area, such as the lowland plains and the swamps.

Sampling at 5 Km interval along the alignment of the road was carried out. The following test were carried out on each sample in accordance with the AASHTO T99 Testing Method:

- Particle size distribution
- Atterberg limits including linear shrinkage
- Compaction tests for determination of moisture/density relationship
- CBR tests (4-days soak) – 3-point method.

4.1.2.3 Sand and Water Sources

Sand and water sources have been sampled for testing and analysis. From the geology and topography of the area it's hard to locate reliable natural sand source for the concrete works of the project. Most of the sources observed are limited in quantity, contaminated with clay and are far from the project corridor. Tests conducted on sand samples as per BS1377 are:

- Sieve Analysis,
- Specific Gravity and
- Organic Matter Content

Most of the potential water sources are fresh waters from perennial rivers and seasonal streams. The seasonal streams can be collected in small reservoirs for use in dry seasons. The chemical tests carried out on the few water samples to check the:

- PH,
- Chloride content,
- Sulphide content,
- Salinity and
- Total Dissolved Solids.

4.1.3 Conclusions and Recommendations

4.1.3.1 Earthworks

Serengeti – Southern Bypass road is a gravel road and have been in service for many years. Other than the sections with recent re-gravelling and grading, most part of the road is corrugated and full of potholes. The width of the road is not uniform; there are many locations with very poor drainage conditions; where the road level is lower than the sides and would require raising. Therefore, reworking of the road prism, cut to fill, fill from borrows, and removal of problem soil and replacement with an improved material are the major earthwork activities expected in the project area.

There will be no problem of gravel material for fill and improved subgrade within reasonable haulage distances in the project area.

4.1.3.2 Problematic Soils

The native subgrade along part of Serengeti Southern bypass project road is partly composed of soils which potentially exhibit the following characteristics:

- AASHTO index values of more than 20 (Expansive)
- AASHTO index values of less than 20 (Weak)
- Linear shrinkage values of 10 or greater
- Swell at 100% MDD, Standard AASHTO greater than 2%
- CBR at 100% MDD, Standard AASHTO and after 4 days soak less than 3%

In summary the following sections were identified to have problem soils:

Mbulu-Haydom

Km 114+407 to Km 130+107 – Dark Brown Silty Clay S3

Km 140+110 to Km 149+807 - Dark Brown Silty Clay S3

Haydom-Chem Chem

Km 174+950 to km 178+075 – Potentially Expansive

Km 218+950 to km 220+400 – Potentially Expansive

Chem Chem – Lalago

Km 221+100 to Km 221+560 – Weak Soils

Km 237+160 to km 242+160 – Weak Soils

Km 310+050 to Km 318+050- Expansive Soils

Km 331+015 to Km 340+015 – Expansive Soils

Lalago-Maswa

Km 377+885 to km 383+815 –Weak Soils

Haydom-Katesh

Km 11+000 to Km 17+200 – Potentially Expansive

Km 33+000 to Km 37+000 – Potentially Expansive

Lalago-Kolandoto

0+000 to Km 9+500– Potentially Weak

Km 15+500 to Km 40+000 – Potentially Weak

In most part of the sections covered with potentially expansive soil subgrade, the expansive soil is shallow (0.6 m) and overlying gravelly or Sandy material. In such cases, removing the whole part of the problem soil and replacing it with a better quality material is the best solution.

In areas where the problem soil is thicker, the following treatment operations are recommended for construction of embankments on these sections.

1. Remove the expansive soil below the ground level to a minimum depth of 1m over the full width of the road.
2. Replace the excavated material in above with a fill material, which is as impermeable as possible and having a minimum CBR of 4.0% at 95% MDD (AASHTO T-180), a maximum CBR swell of 2.0% and a minimum PI of 15%.

The solution proposed involves excavating the expansive clay to the depth specified below OGL and replacing it with compacted, impermeable, non-expansive backfill material and utilizing the excavated clay to flatten the side slopes as much as possible. This slope should be minimum of 1:4 (V:H) and may be even up to 1:6. If removal of only some of the clay is to be carried out, then the exposed clay should be covered immediately to prevent loss of moisture.

Further investigation is recommended during detailed design stage to determine the extent and degree of expansiveness.

4.1.3.3 Construction Materials

Subbase

Tests on most of the samples collected from the potential and existing sources of gravel indicate that there will be shortage of natural gravel to be used as subbase. There are few sources with a CBR value above 30. Therefore, using of cement/lime stabilization of the natural gravel material to increase its strength would be an option.

Borrow Material

Natural granular materials are abundantly available and can easily be located in the major section of the project area. Lateritic gravels and weathered granite and quartzite are the most common natural gravels available for selected subgrade layers and fill for embankments in the project area.

Quarry Sites

Representative samples have been collected from each identified source and tested. The samples have been subjected to Los Angeles Abrasion (LAA), Sodium Sulphate Soundness (SSS), Ten percent Fines Value (TFV), Specific Gravity and Water Absorption tests. There are some potential sources along the sections of the road that qualify for AC, crushed stone base and aggregates for concrete works.

Water and Sand Sources

Most of the rivers along Serengeti Southern Bypass project road are seasonal and can only be used during the wet season. There are also few Lakes in some of the sections. Therefore, for the most part of the project road, the main source water would be by drilling of boreholes and making ponds (small reservoirs) along alignment of the road.

Natural sand is scarce in the project area, and the only identified sources that comply with the ASTM specifications are along the following road sections:

Mbulu-Haydom

KM 102+341 RHS Garbabi Offset 410 m

Haydom-Mkalama-Chem Chem

Mkalama Km 211+151

Chem chem – Lalago

Chobe River, Km 279+908

Sanga River, Km 326+522

Lalago-Maswa

Mangu River, Km 358+308

Lalago-Kolandoto

Jungu River, Km 28+800

In order to supplement the identified sand sources, crushed quarry dust (fine aggregate) could be used as an alternative source of sand for concrete works.

4.2 Pavement Design

4.2.1 Introduction

The project road sections are designed to carry traffic over 20 years of design period. At present, the traffic on the project road sections is quite low due to the gravel road links. However, it is expected that traffic trends will change with diverted traffic mainly from the Makuyuni – Babati – Singida – Nzega – Shinyanga route once the road sections are upgrading to bitumen standard.

4.2.1.1 Vehicle Equivalence Factors

Vehicle Equivalence Factors were calculated based on:

(i) All trucks carrying loads to the legal limit (All fully loaded).
(ii) Legal Limit Axle Loads lowered by 25%, as 20-30% of trucks run empty.

The calculated VEF are tabulated in Table 4-2 below.

Table 4-2. Vehicle Equivalence Factors.

VEF	Bus (>=40 Seats)	Medium Goods Vehicle (MGV, 2 Axles)	Heavy Goods Vehicle (HGV, 3 Axles)	Very Heavy Goods Vehicle (VHGV, >=4 Axles)	Full Trailer
Legal Limit	1.17	1.83	2.74	4.57	5.49
75% of Legal Limit	1.17	1.37	2.06	3.43	4.12

4.2.1.2 Traffic Growth Factor

The traffic growth rates determined from the traffic modelling were used for the Traffic Projections as indicated in Table 4-3 below.

Table 4-3. Traffic Growth Rates.

Period		AAGR
Construction	2018 to 2022	7.00%
Y1 to Y5	2023 to 2027	7.00%
Y6 to Y10	2028 to 2032	6.50%
Y10 to Y20	2033 to 2042	3.00%

4.2.2 Design Traffic

Traffic data for the wider project area was collected during the Route Option Selection phase and entered into PTV Visum Traffic Modelling software. It was used to analyse the road network within the project's area of influence to simulate the current levels and movement of traffic on the Mbulu Route and the Haydom – Katesh shortcut option and to make forecasts of future traffic levels and distribution on the basis of the collected data and developed scenarios.

Traffic projections were carried out for various sections of the project road for a 20-year design and the results are summarized in Table 4-4, using VEF's for both the legal load limit and 75% of legal load limit.

Table 4-4. Summary of Traffic Projections.

Section	Reference Chainage (km)	Projected 20 yr traffic loading (Legal Limit) (ESA x 106)	TLC (Legal Limit)	Projected 20 yr traffic loading (75 % Legal Limit) (ESA x 106)	TLC (75% of Legal Limit)	Design TLC
1.2 Karatu - Mbulu	0+000 - 78+000	10,684,721	TLC 20	8,796,910	TLC 10	TLC 10
1.3 Mbulu - Dongobesh	78+000 - 114+407	4,701,992	TLC 10	3,871,229	TLC 10	TLC 10
1.4 Dongobesh - Haydom	114+407 - 156+085	10,319,703	TLC 20	8,143,154	TLC 10	TLC 10
1.6 Haydom - Chem Chem	156+085 - 221+100	12,605,085	TLC 20	9,946,522	TLC 10	TLC 10
1.7 Chem Chem - Lalago	221+100 - 349+785	16,577,358	TLC 20	13,080,996	TLC 20	TLC 20
1.9 Lalago - Maswa	349+785 - 383+813	4,839,209	TLC 10	3,825,690	TLC 10	TLC 10
1.5 Haydom - Katesh	0+000 - 67+223	2,773,858	TLC 3	2,191,757	TLC 3	TLC 3
1.8 Lalago - Kolandoto	0+000 - 62+167	11,848,016	TLC 20	9,366,580	TLC 10	TLC 10

The forecasted traffic loading falls into 3 different Traffic Classes: TLC3, TLC 10 and TLC20 for various sections of the road.

As the proportion of heavy axles (>13 t), relative to the total calculated equivalent standard axle load, does not exceed 50% the pavement design is based on the General Loading category.

Furthermore, as 20 to 30% of the trucks are running empty, the Design Traffic is based on VEF's equal to 75% of the legal limit.

4.2.3 Pavement Design

From the materials investigations it is evident that suitable sources for both gravel and hard stone are available in all road sections, although natural gravel would require either cement/lime modification or stabilization for use as base or subbase. Pavement design options involving both

granular base and cemented base have therefore been carried out. The design procedure set out in PMDM-1999 has been followed.

For Pavement design two alternative pavement structures have been selected based on economy and technical considerations, namely: a cemented base course designed for all climates (Option 1) and a granular base course designed for a Dry/Moderate climatic zone (Option 2). The pavement structures based on the required classes of traffic loadings and in situ subgrade class have been determined from Table 8.6 and Table 8.4 of the Design Catalogue.

4.2.4 Recommended Pavement Structure

In recommending the preferred pavement option the cost aspect have been taken into consideration. Pavement Option 2 is less costly than Option 1. Apart from this, shrinkage cracking of cemented materials tends to be unavoidable. Cracks which propagate to the pavement surface provide pathways for the infiltration of moisture which can lead to weakening of sub-base layers and sub-grade below. The extent and severity of cracking depends on the cement content, material type, initial moisture content and drying and curing conditions, controlling of which requires high degree of Quality System in place.

It is therefore recommended that a pavement design Option 2 is adopted as given in Table 4-5.

Table 4-5. Recommended Pavement Option for Complete Alignment.

	Traffic Class	Surfacing	CRS Crushed Rock Base	CRR Crushed Rock Base	C2 Cement Stabilised Subbase	C1 Cement Stabilised Subbase	G45 Natural Gravel	G15 Natural Gravel	G7 Natural Gravel
Karatu - Mbulu									
0+000 - 13+000	TLC 10	DSD		150		200		150	
13+000 - 25+000	TLC 10	DSD		150		200			
25+000 - 34+500	TLC 10	DSD		150		200		150	
34+500 - 78+700	TLC 10	DSD		150		200			
Mbulu - Haydom									
78+700 - 88+545	TLC 10	DSD		150		200			
88+545 - 114+410	TLC 10	DSD		150		200		150	
114+410 - 130+105	TLC 10	DSD		150		200		150	150
130+105 - 140+110	TLC 10	DSD		150		200		150	
140+110 - 149+805	TLC 10	DSD		150		200		150	150
149+805 - 156+085	TLC 10	DSD		150		200		150	
Hatdom – Chem Chem									
156+085 - 174+275	TLC 10	DSD		150		200			
174+275 - 178+075	TLC 10	DSD		150		200		150	
178+075 - 183+050	TLC 10	DSD		150		200		150	
183+050 - 218+085	TLC 10	DSD		150		200			
218+085 - 221+100	TLC 10	DSD		150		200		150	
Chem Chem - Mwanhunzi - Lalago									
221+100 - 236+760	TLC 20	50mm AC		150	150	150		150	
236+760 - 300+050	TLC 20	50mm AC		150	150	150		150	150
300+050 - 302+050	TLC 20	50mm AC		150	150	150		150	

	Traffic Class	Surfacing	CRS Crushed Rock Base	CRR Crushed Rock Base	C2 Cement Stabilised Subbase	C1 Cement Stabilised Subbase	G45 Natural Gravel	G15 Natural Gravel	G7 Natural Gravel
302+050 - 311+050	TLC 20	50mm AC		150	150	150		150	150
311+050 - 318+050	TLC 20	50mm AC		150	150	150		150	
318+050 - 331+015	TLC 20	50mm AC		150	150	150		150	150
331+015 - 348+485	TLC 20	50mm AC		150	150	150		150	
349+485 - 349+785	TLC 20	50mm AC		150	150	150		150	150
Lalago - Maswa									
349+785 - 354+985	TLC 10	DSD		150		200		150	150
354+985 - 365+585	TLC 10	DSD		150		200		150	
365+585 - 371+085	TLC10	DSD		150		200			
371+085 - 377+785	TLC 10	DSD		150		200		150	150
377+785 - 383+813	TLC 10	DSD		150		200		150	
Haydom - Katesh									
0+000 - 11+000	TLC 3	DSD	150				200		
11+000 - 49+700	TLC 3	DSD	150				200	150	
49+700 - 52+600	TLC 3	DSD	150				200		
52+600 - 67+223	TLC 3	DSD	150				200	150	
Lalago - Kolandoto									
0+000 - 9+500	TLC 10	DSD		150		200		150	
9+500 - 15+500	TLC 10	DSD		150		200			
15+500 - 40+000	TLC 10	DSD		150		200		150	
40+000 - 48+500	TLC 10	DSD		150		200		150	150
48+500 - 62+167	TLC 10	DSD		150		200			

5 GEOMETRIC ASPECTS OF THE ROUTE DESIGN

5.1 Introduction

This Chapter discusses the geometric design aspects of the design as adopted for the Mbulu Route, the Haydom – Katesh and Kolandoto – Lalago link roads as presented in Volume 2D of this submission.

The road should be upgraded in such a way so that sub-standard curves and gradients are avoided to the maximum extent in order to promote efficiency and enhance safety. Bypasses and re-alignments are envisaged for more heavily populated areas and where hilly terrain can be bypassed. A visual inspection was undertaken to inform the team on the actual situation on the ground.

5.2 Design Principles and Background

This design at hand is a **Preliminary Design**. This means that certain elements are not fully worked out i.e. details of cross-sections, super elevation and road widening etc. These items need to be considered in the respective Detailed Design for each Lot. The design is based on the following assumptions and design basis:

- Present Alignment
  The design follows as much as possible the present alignment as so to limit negative impacts on the population living adjacent to the road and to minimise land acquisition. In a limited number of cases the design can deviate from the existing alignment i.e. curve improvements, safety considerations and for environmental and social reasons.
- Optimising Earthworks
  The design tries to limit the amount of earthworks required to arrive at an optimum, compliant and safe alignment.
- Good phasing between Horizontal and Vertical Design
  The design looks carefully at the interaction between Horizontal and Vertical Elements in the design to safeguard correct visibility lines and safe rideability. In general this means that the design takes into account the lengths of the horizontal and vertical curves, intersection points of horizontal and vertical curves, the positioning of the start of horizontal and vertical curves in relation to sight distances and the sequence of sags and crests etc. to arrive at a safe, aesthetic and economic design.
- Hydraulics and Hydrology
  The design has fully incorporated the required drainage facilities, structures and outfalls.
- Optimising for various road users
  The design includes a robust speed drop assessment to determine the correct locations of climbing lanes. In urban situations, where there will be a mix of road users, the design provides for separate NMT- and pedestrian facilities, bus stops and layby's, traffic calming measures and appropriate road furniture so that the road can be used in a safe manner by all road users. At junctions, the horizontal and vertical curvature will be such that required visibility is assured so that all road users can safely use the facility.
- Right of Way
  It has been assumed that the Right of Way outside urban areas is 60 m. Within urban areas the design width has been kept as limited as possible since the exact RoW is not clear.

5.3 Terrain and topography

The western part of the project area is located at an altitude varying between 1,000 m (Lake Eyasi) to 1,350 m at Maswa. The eastern part of the project area is more or less located on a relatively flat plateau with some hilly terrain, reaching altitudes of about 2,000 m. In the south and east the plateau is delineated by the Dabil and Magara Escarpments. Moving towards the west the change in altitude is more gradual.

The Mbulu Route starts in Karatu at 1,500 m and leads south to Mbulu at 1,700 m, reaching maximum altitudes of 1,800 m. It then leads to the south-west climbing to a maximum of 2,000 m to descend reasonably quickly through Haydom to Sibiti Bridge. From there the route rises quite gradually to reach some 1,350 m at Maswa.

5.4 Design Standards

5.4.1 Design Class

The preliminary design is carried out in accordance with the Tanzania Road Geometric Design Manual (2011) and the Pavement and Materials Design Manual (1999). In accordance with the results of the traffic forecasting (see Volume VIII), a road design class of DC3 has been adopted in accordance with Table 5-1 and

Table 5-2[12].

Table 5-1. Functional Class and Access Control.

Functional Class	Level Access Control	
	Desirable	Reduced
A: Trunk Roads	Full	Partial
B: Regional Roads	Full or Partial	Partial
C: Collector Roads	Partial	Partial or Unrestricted
D: Feeder Roads	Partial or Unrestricted	Unrestricted
E: Community Roads	Unrestricted	Unrestricted

Table 5-2. Road Design Class and Functional Class.

Road Design Class	AADT (Veh/Day) in design year	Functional Class				
		A	B	C	D	E
DC1	>8000					
DC2	4000 – 8000					
DC3	1000 – 4000					
DC4	400 – 1000					
DC5	200 – 400					
DC6	50 – 200					
DC7	20 – 50					
DC8	<20					

12 Road Geometric Design Manual, Ministry of Works, 2011

5.4.2 Cross Section

In accordance with the results of the traffic forecasting (see Route Option Selection Report), a road design class of DC3 will be adopted. This class has the following specifications:

- Lane width: 2 No. lanes, 3.5 m wide;
- Shoulder width: 2 No. shoulder, 2 m wide;
- Design speed: 80 – 100 km/h;
- Max. Gradient: 7%;

The manuals give guidelines for the geometric in all its aspects e.g. for urban, rural, rolling, mountainous and flat terrain, including typical cross sections these environments.

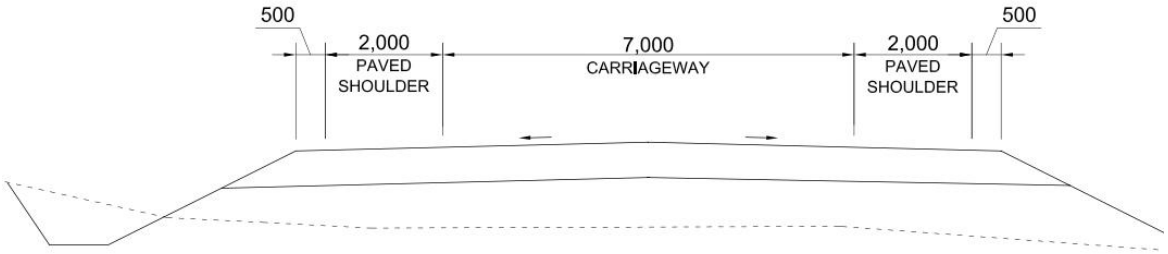


Figure 5-1. Sample of typical cross-section for rural environment.

5.4.3 Design Speed

Geometric elements of the road such as vertical and horizontal alignment, sight distances and superelevation are all related to the design speed. This can be defined as the maximum safe speed that can be maintained over a given section of the road. Table 5-3 gives the desirable and minimum design speed for the different types of terrain.

Table 5-3. Design Speeds for Road Design Class 3.

Design Class	Carriageway Width (m)	Recommended design speed (km/h)			Minimum design speed (km/h)		
		Flat to Rolling	Rolling to Hilly	Mountainous	Flat to Rolling	Rolling to Hilly	Mountainous
DC3	7.0	110	80	70	100	80	60

5.5 Alignment Details

5.5.1 Karatu – Mbulu

This section is generally undulating and leads over mountains around Km 38 and Km 50. Deviations are foreseen to bypass these mountains around Km 35 – Km 40 as well as the indigenous forest which forms part of Lake Manyara National Park. A number of alternatives were investigated. For the alignment around Km 35 – 40 options closer to the existing road were looked at but discounted since the amount of earthworks would increase substantially compared to the chosen alignment. For the deviation around Km 50, the indigenous forest at Lake Manyara National Park similar considerations apply. The alternative options result in massive earthworks and an undulating road which is not desirable. This can also be concluded while looking at Figure 5-2 and Figure 5-3. Many contour lines cross alternative options indicating that extensive earthworks are required to arrive at an aesthetic and safe alignment which may not be the most economical solution.

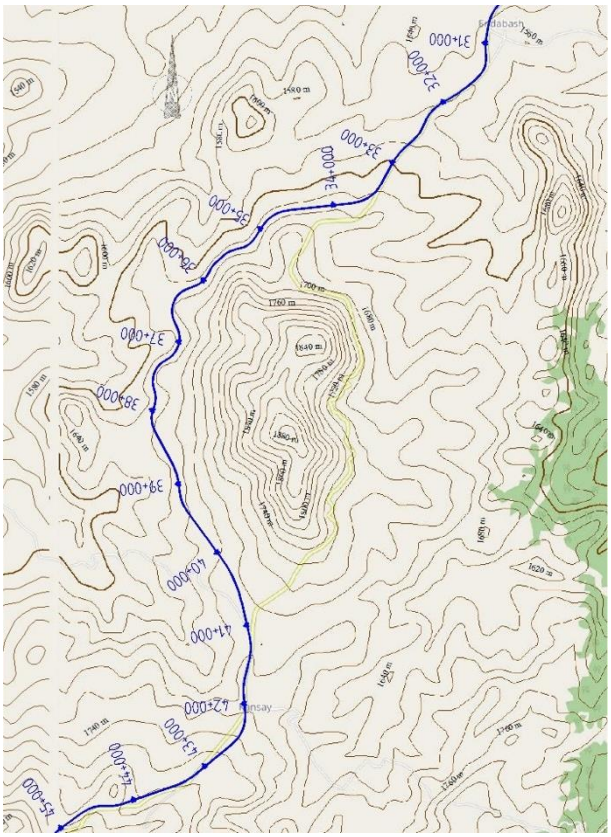


Figure 5-2. Deviation Km 34 - 41

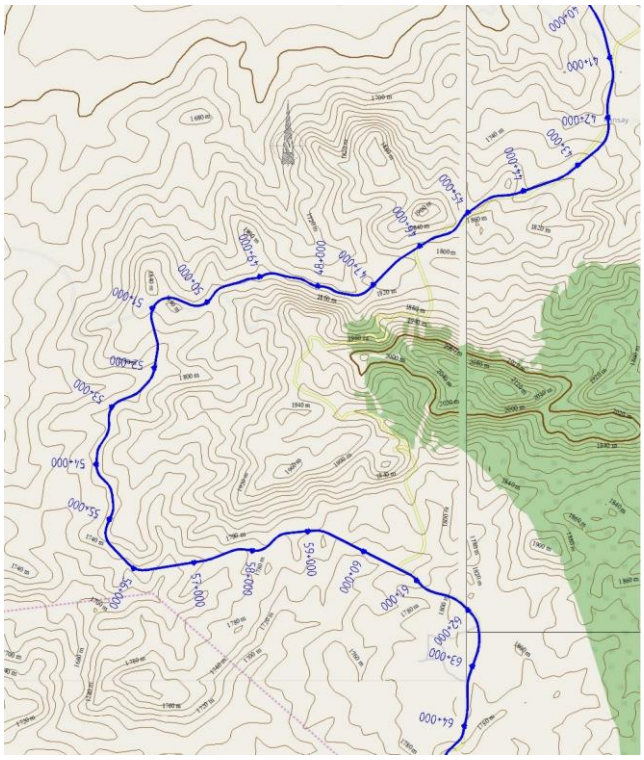


Figure 5-3. Deviation Km 46 - 61

5.5.2 Mbulu – Sibiti Bridge

This section leads from Mbulu to Dongobesh, Haydom, Nkalama and ends at Sibiti Bridge. The designed alignment passes through Dongobesh and continuous to Haydom. Just before Haydom the present alignment passes a bridge in an ascending curve. To improve the gradient and road safety in this section the Consultant has changed the alignment to arrive at a less steep gradient. The final major realignment is located around Km 187 towards Mkalama. A deviation has been decided upon to improve on the overall road alignment and to be able to maintain the design speeds. Alternatives were investigated but would result in extensive earthworks and an undulating road which is not desirable from the road safety aspects.

5.5.3 Sibiti Bridge

Regarding the geometric design of this section, no major issues are encountered. Apart from two significant curve improvements (both side approaches to Sibiti Bridge) no realignments are foreseen. The road has recently been built to gravel standard and only accommodates a carriageway of 6 m width. The Consultant undertook to improve the design to accommodate a 7 m carriageway, including the 2 m shoulders on either side.

5.5.4 Sibiti Bridge – Lalago

This section forms part of the route currently under detailed design by ICT for upgrading to bituminous standard. The design for this section allows for a carriageway of 6.5 m width with 1.5 m shoulders. The Consultant undertook to improve the design to accommodate a DC3 class with 7 m carriageway and 2 m shoulders on either side.

5.5.5 Lalago – Maswa

No major issues are encountered on this section, it is straight and fairly flat.

5.5.6 Haydom - Katesh

This route also connects the Mbulu Route to the Babati – Singida Road (T14). It starts about 4 km east of Haydom and leads south to Mogitu, near Katesh, via Basotu. The route has a gentle alignment through rolling terrain. The route is some 64 km long and has few features as S-curves and steep gradients. The design takes this into account. Along Lake Basotu the road is diverted towards the west and raised considerably as so to prevent possible future flooding and for environmental reasons.

5.5.7 Lalago – Kolandoto

The Kolandoto – Lalago route is about 62 km long and forms part of the route currently under detailed design by ICT for upgrading to bituminous standard. This route will therefore not be part the design, only some small vertical and horizontal improvements have been carried out. The design allows for a carriageway of 6.5 m width with 1.5 m shoulders. The Consultant undertook to improve the design to accommodate a 7 m wide carriageway and 2 m shoulders on either side.

5.6 Ancillary Details

5.6.1 Signalisation, Road Furniture and Road Side Equipment

Throughout the alignment the design provides for the required and appropriate road signs, road markings, guardrails, marker posts etc.

5.6.2 Street lighting

Well-designed, street lighting is a valuable infrastructure investment because it can provide social and economic benefits to the community. BS EN 13201 – “Performance Requirements for Road Lighting” provides the standard to provide sufficient light levels, uniformity and target contrast according to the type of road. It equally guides the reduction of glare and light pollution. It should have a low installation cost, consume as little electric energy as possible, and require as little maintenance as possible, so as to minimize the total cost of ownership.

The design of the road lighting has been done according to “BS EN 13201 - Performance Requirements for Road Lighting”.

5.6.3 Weighbridges

Four weighbridges are foreseen. One will be located in the Lalago – Kolandoto link road near Kishapu and one near Mwanyagula on the main project road between Sibiti Bridge and Lalago. Weighbridges are also planned on the main alignment at the junction with the link road at Haydom, as well as near Mbulu between Mbulu – Karatu.

5.6.4 Truck Stops

On the project road truck stops are foreseen near Mwanhunzi, Haydom and Mbulu. Since the truck stops are located close to these towns, they will be of the basic type e.g. parking for some 10-15 trucks with toilet facilities.

5.7 The Chem Chem – Kolandoto Section

The design, which is undertaken by Intercontinental Consultants and Technocrat Pvt. Ltd. (ICT), has been reviewed by the Consultant. The Consultant has found two major issues, namely overdesign of hydraulic structures and insufficient road width. These issues are addressed in Volume 2B and Volume 2D of this submission.

6 CONSTRUCTION COSTS

The project has been divided into 7 Lots. The Lots are based on more or less equal distances so that the construction can be completed within a reasonable period of time. The Lots are set up as given in Table 6-1.

Table 6-1. Lots, Names and Lengths.

Lot Number	Name	Length (Km)
1	Karatu – Mbulu (incl. Mbulu)	79
2	Mbulu – Haydom	70.5
3	Haydom – Chem Chem (incl. Haydom)	67.1
4	Chem Chem - Mwanhunzi	80
5	Mwanhunzi – Lalago - Maswa	82.9
6	Haydom – Katesh (Link A)	67
7	Lalago – Kolandoto (Link B)	62.2

The construction cost estimates have been calculated for the different Lots separately and for the complete project including the 2 link roads (Lots 6 and 7). Table 6-2 below gives the overall cost estimate for Option 1 of the complete project whereas Table 6-3 gives the same for Option 2. The cost estimates for the various individual Lots and options are given in Appendix 1.

Table 6-2. Cost Estimate for Option 1 (Stabilised Base - Complete Project).

Project Summary of Bills of Quantities Option 1 - Stabilized Base		
Bill No	**Description**	**USD**
1000	General	31,024,341
2000	Drainage	35,922,335
3000	Earthworks and Pavement Layers of Gravel or Crushed Stone	301,852,097
4000	Bituminous Layers and Seals	76,115,457
5000	Ancillary Roadworks	21,514,873
6000	Structures	39,758,668
7000	Testing and Quality Control	43,750
8000	Dayworks	3,259,368
9000	Street Lights	10,904,978
10000	Weighbridge and Truck Parks	8,000,000
A	Subtotal of Bills	528,395,867
B	Physical Contingency (7.5% of A)	39,629,690
C	Financial Contingency (7.5% of A)	39,629,690
D	TOTAL COSTS	607,655,247

Table 6-3. Cost Estimate for Option 2 (Granular Base - Complete Project).

Project Summary of Bills of Quantities Option 2 - Granular Base		
Bill No	**Description**	**USD**
1000	General	31,024,341
2000	Drainage	35,922,335
3000	Earthworks and Pavement Layers of Gravel or Crushed Stone	293,988,689
4000	Bituminous Layers and Seals	76,115,457
5000	Ancillary Roadworks	21,514,873
6000	Structures	39,758,668
7000	Testing and Quality Control	43,750
8000	Dayworks	3,259,368
9000	Street Lights	10,904,978
10000	Weighbridge and Truck Parks	8,000,000
A	Subtotal of Bills	520,532,459
B	Physical Contingency (7.5% of A)	39,039,934
C	Financial Contingency (7.5% of A)	39,039,934
D	TOTAL COSTS	598,612,327

The construction cost estimates are used as a basis for the Economic Analysis which is discussed in Chapter 8 of this Summary Report and Volume 4.

7 SOCIAL AND ENVIRONMENTAL ASPECTS AND FINDINGS

This Chapter summarises the Environmental and Social Impact Assessment Study as presented in Volume 3 of this submission.

7.1 Introduction

The EIA process has to be undertaken in accordance with the Environmental Management Act (EMA) (No. 20 of 2004) and the Environmental Impact Assessment and Audit Regulations (EIA Regulations) (GN 349 of 2005). These Regulations provide for the National Environment Management Council (NEMC) to oversee the EIA process. An EIA Certificate must be granted prior to commencement of the Project.

The key stages for this EIA were:

- Screening;
- Scoping;
- Baseline data collection;
- Assessment of impacts and mitigation;
- Interaction with design and decision-making processes (including stakeholder engagement); Submission of the EIA to the NEMC for consideration;
- Management system integration; and
- Uncertainty and change management.

7.1.1 Project Environment

The majority of the physical sensitivities are applicable across the entire Bypass route, and encompass air quality, noise, seismic activity, soils, topography, surface water, groundwater and land use. The key biodiversity sensitivities are a.o. natural habitats, wildlife, wetlands, forests, rivers and streams and lakes. Key socio-economic sensitivities include a.o. land cover, populated centres and livelihoods.

It is worthy to note that the Project will not directly affect indigenous peoples. ESS 7 recognizes that Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities have identities and aspirations that are distinct from mainstream groups in national societies and often are disadvantaged by traditional models of development. In terms of the Project, the Hadzabe are a forest-dwelling hunter-gatherer indigenous group residing in some of the Districts traversed by the proposed Bypass road. During the EIA process, specific engagement meetings were held to hear the views of the Hadzabe, to determine whether the specific requirement of FPIC as detailed in the ESS 7 would be applicable in this Project. Following this process and additional research, it was determined that the route selected by the Project (also known as the Mbulu route) deviates substantially away from the traditional / sacred places of the community and would thus not cause any direct impacts on the Hadzabe which would require FPIC.

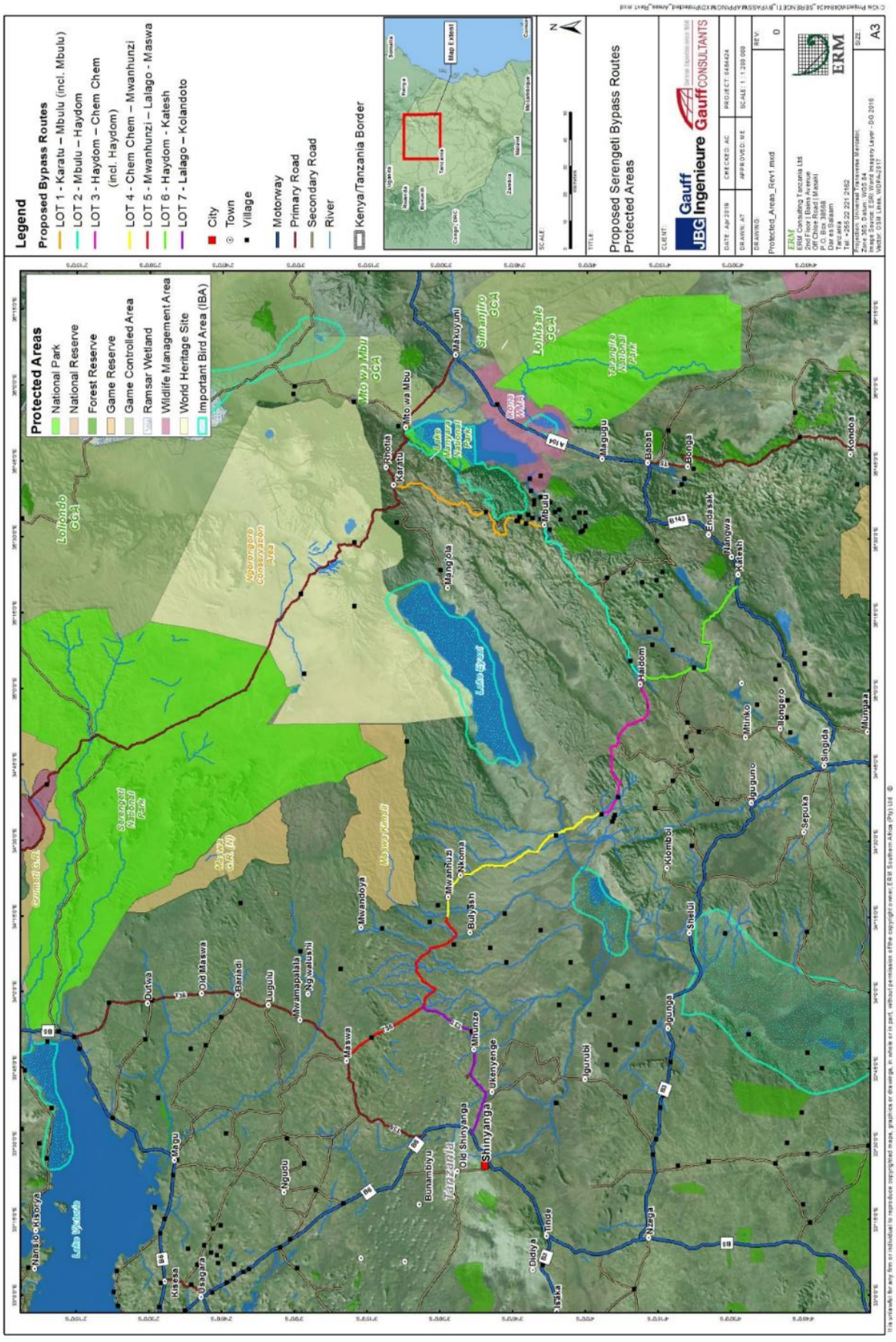


Figure 7-1. Layout of Protected Areas and Key Biodiversity Areas within the broader Study Area.

7.2 Stakeholder Engagement

The objectives of the stakeholder engagement are to ensure that an open, inclusive and transparent process of appropriate engagement and communication will be undertaken to make sure that stakeholders are well informed about the proposed Bypass as it develops. Information will be disclosed as early and as comprehensively as possible and appropriate. Stakeholders are included in the scoping of issues, the assessment of impacts and the generation of mitigation and management measures in the finalisation of the EIA. Open dialogue engagement will help establish and maintain a productive relationship between the proposed bypass and stakeholders. This will support not only an effective EIA but will assist in identifying possible impacts.

7.3 Project Grievance Redress Mechanism

A GRM will be set up and operated to ensure that all complaints from local communities are dealt with appropriately, with corrective actions being implemented, and the grievant being informed of the outcome. A GRM must be applied to all complaints from affected parties. The Proponent will maintain a grievance database, which will contain all the information on complaints or grievances received from the communities or other stakeholders.

7.4 Environmental and Social Impacts

A summary of impacts to the Physical, Biological and Socio-economic Environments assessed as part of this EIA process in provided in Table 7.2 overleaf. Note these impacts were assessed using a methodology that comprises a number of steps that collectively assess the manner in which the Project will interact with elements of the physical, biological, cultural or human environment to produce impacts to resources/receptors.

7.5 Design/Realignment Considerations

Through interaction between the EIA team and the design and planning team certain sections of the proposed bypass alignment has been reconsidered and realigned. Although the current alignment for the bypass has been used as the basis for this EIA study, TANROADS and Gauff acknowledge that the EIA is a key influencer on design (primarily alignment) of the bypass. Accordingly, key decision-making and refinement of project design will continue post- EIA, in response to identified environmental and social impacts and in response to suggestions for realignment opportunities from various stakeholders.

Any further changes between now and final design (specifically to alignment) of the bypass will need to be subjected to the environmental and social change management mechanism as defined in Chapter 8 of the EIA (Vol. 3). Substantive design changes that might potentially alter the EIA findings (i.e. those that result in changes to the predicted significance of environmental and social impacts) will need to be subject to re-assessment, further stakeholder consultation, supplementary reporting and revision of the Project's ESMMP. Typically, such substantive changes will be submitted as an addendum to this EIA.

Table 7-1. Summary of Impact Significance prior to, and post mitigation.

Impact Description	Phase	Impact Prior to Mitigation	Impact without Mitigation
Physical Environment			
Risk of Climate Change on the Proposed Bypass	Construction, Operation	Negligible to Major	Negligible to Moderate
Impacts on Air Quality related to Dust Emissions	Construction, Operation	Major	Minor
Operational Traffic Dust Emissions	Operation	Positive	Positive
Operational Traffic NO_2 Emissions	Operation	Minor to Major	Minor
Noise Impacts from the Construction Phase	Construction	Minor to Major	Minor
Noise Impacts during the Operational Phase	Operation	Minor to Major	Minor to Negligible
Impacts from Soil Erosion	Construction	Moderate	Minor
Impacts on Agricultural Potential	Construction	Moderate	Minor
Impacts to Surface Water Quality and Flow	Construction	Major	Moderate
Biological Environment			
Loss of Natural Habitat	Construction	Major	Minor
Impacts to Lake Habitats	Construction	Major	Moderate
Impacts to Riverine and Wetland Ecology	Construction	Moderate	Minor
Fragmentation of Wildlife Movement	Construction, Operation	Minor	Negligible
Impacts to Fauna	Construction, Operation	Moderate	Minor
Increase in Invasive species	Construction	Moderate	Minor
Disruption of Ecosystem Services	Construction	Moderate	Minor
Socioeconomic Environment			
Impacts to Temporary Loss of Livelihoods during Construction	Construction	Major	Minor
Impacts Associated with Physical Displacement	Construction, Operation	Critical	Moderate
Impacts Associated with Economic Displacement	Construction, Operation	Critical	Moderate
Impacts on Labour and Working Conditions	Construction	Moderate	Minor
Impacts Associated with Transmission of Vector Borne and Communicable Diseases	Construction, Operation	Major	Moderate
Impacts Associated with Transmission of Sexually Transmitted Diseases	Construction, Operation	Major	Moderate
Impacts Associated with Social Cohesion, Including Gender Based Violence	Construction, Operation	Major	Moderate
Impacts on Community Security	Construction	Minor	Negligible
Impacts Associated with Displacement of Community Infrastructure	Construction, Operation	Major	Minor
Impacts to Cultural heritage	Construction	Major	Minor
Unplanned Events			
Impacts Associated with Construction Traffic Movements	Construction	Major	Minor
Accidents associated with Operational Traffic Movements	Operation	Major	Moderate

Impact Description	Phase	Impact Prior to Mitigation	Impact without Mitigation
Accidental Spills of Equipment Fuel, Oils, Chemicals, and Waste	Construction	Moderate	Minor
Impacts on Groundwater Quality during Construction	Construction	Moderate	Minor
Positive Impacts			
Impacts on Employment, Procurement and the Economy	Construction, Operation	Positive	Positive
Reduction of the Impacts on the Serengeti National Park	Construction, Operation	Positive	Positive

7.6 Environmental and Social Management

In order to avoid, minimise and reduce negative impacts, and to ensure opportunities for the enhancement of positive impacts are realised, an Environmental and Social Management and Monitoring Plan has been produced (See Annex D to Vol. 3). The ESMMP provides the following:

- The objectives and purpose of the plan;
- Applicable phases of the Project when the Management Plan is required;
- The Project related activities resulting in the impact, requiring the elaboration of each Management Plan;
- An overview of the responsibility for the implementation of each Management Plan;
- A summary of the Performance criteria to which the Management Plan must aim to comply (which will include Tanzanian legal requirements, the WB ESS, or applicable good practice), that is relevant to each Management Plan;
- Mitigation measures (actions) required during various Project phases (viz. pre-construction, construction and operational phases), that are identified and described in the EIA; and
- Monitoring requirements, including targets, performance indicators and reporting requirements.

The vehicle for the *integrated* management and *implementation* of the ESMMP is an ESMS. An ESMS is a requirement of the WB ESS 1. In addition to the ESMMP, a Project specific Resettlement Policy Framework (RPF) has been developed (refer to Annex C of Vol. 3). The RPF is a separate and stand-alone document that establishes the resettlement and compensation principles, organisational arrangements and design criteria to be applied to meet the needs of the people who may be affected by the Project.

7.7 Key Limitations and Corrective Actions

The key limitations associated with the EIA, the importance of these limitations to the overall Project are as follows:

- An Environmental and Social Commitment Plan has not yet been developed (Important).
- Detailed surface and groundwater studies have not been undertaken (Important but beyond scope).
- Baseline $N0_2$ and TSP/PM_{10} measurements were not taken as part of the EIA (Moderately important).
- Baseline noise measurements were not taken as part of the EIA (Moderately important)
- There is limited quantifiable data on key sensitivities, particularly for abundance and locations of Colobus Monkeys west of Haydom (Moderately important).
- The World Bank ESS requirements are not addressed for a little-known district forest reserve west of Haydom (Moderately important).

- Impacts to natural habitats do occur; however, mitigation of the biodiversity impacts do not strive to meet no net loss requirements (Important but beyond EIA scope).
- The Pre-feasibility design does not include the exact locations of planned construction activities (e.g. laydown areas, quarries and borrow pits, and construction camps). Accordingly, the full extent of economic displacement is not known, and severance impacts cannot be fully known at this stage (Important but beyond EIA scope).
- The survey team had limited ability to collect household health data, due to the risk of cultural resistance to certain questions (Moderately important).

7.8 Conclusion

To provide the vehicle for the integrated management of the aforementioned critical and other potential impacts identified in the EIA (both positive and negative) an Environmental and Social Management System (ESMS) will be implemented. The ESMS provides a mechanism for ensuring that mitigation measures identified in the EIA and associated ESMMP are adequately implemented. Moreover, the ESMS provides a framework for monitoring, compliance auditing and inspection programmes, which assist the project in meeting its commitments, as stipulated in Tanzanian regulations and lender standards. With the implementation of the Plan all impacts are reduced to Moderate and Minor significance.

In summary, the project is committed to working with the local community and authorities during the construction and operation of the project and will maintain open dialogue as part of their ongoing stakeholder engagement activities. Provided the proposed mitigation measures are implemented it is recommended the project continues as planned.

8 ECONOMIC ANALYSIS

This Chapter summarises the findings, results, conclusions and recommendation of the economic analysis for the Preliminary Design and Feasibility Study of the Serengeti Southern Bypass project as contained in Volume 4 of this study.

8.1 National and Regional Economy

In preparation for the economic evaluation and in particular, for the derivation of growth rates adopted in the traffic growth sets the economic performance was assessed and summarised as in the following.

8.1.1 Economic Performance

Tanzania's population of slightly over 50 million is growing at a rate of 2.78%. This is accentuated with a high rate of urbanisation[13] and this has increased consumer and credit demand as well as increased demand for social amenities and infrastructure. As measured by the gross domestic product at constant (2007) prices, the Tanzanian economy grew at an average 6.7% per annum between 2006 and 2016 including a consistent growth of 7.0% in the last three years on record (2014 – 2016).

Agriculture (primary sector) contributed some 29% to GDP at current prices in 2016 (and 21% in 2016, constant values). It is the single largest employer and provides a livelihood for 82% of Tanzania's population [1]. In terms of GDP at constant prices, Industry and Construction (secondary sector) contributed about 24% to GDP in 2016, overtaking Agriculture in as recently as 2015. The services (tertiary) sector emerged as the strongest economic sector with GDP contributions of 40% and 49% in current and constant terms respectively.

The Second Five Year Development Plan (FYDP II) 2016/17 – 2020/21 adopts the theme of "Nurturing Industrialization for Economic Transformation and Human Development" incorporating the main focus on growth and transformation and poverty reduction. The FYDP II also implements Tanzania's Development Vision (TDV) 2025 which aspires to have Tanzania transformed into a middle income, semi industrialized nation by 2025.

Despite the impressive growth of GDP mentioned above, it falls short of the 8% - 10% p.a. target of the Tanzania vision 2025. For the same five-year period, per capita income increased from USD 749 in 2010 to TZS USD 897 in 2015 [2] implying an average annual growth of 3.67%. To improve on this performance, the FYDP II, amongst others, emphasises the development of infrastructure including the Central, North-West and Mtwara Development Corridors.

According to the Tanzania Economic Outlook, 2017 [3] "*Tanzania's economic growth is expected to average 6.2 % between 2017 and 2026. The growth is underpinned by infrastructure development* [as advocated by Tanzania's Development Vision 2025] *and a growing consumer base. Heavy infrastructure investment into rail, port and road is expected to be one of the main drivers of Gross Domestic Product (GDP) growth between 2017 and 2026…".*

Details of efforts of developing the primary (agriculture and livestock), secondary (industry and construction) and tertiary (services) sectors are provided in volume 4.

Significant improvements of indicators related to human development (HDI) and poverty (MPI) were recorded by UNDP between 2010 and 2015, but still low, placing Tanzania in position 151 out

13 Estimated at 30 % according to World Bank

of 188. Furthermore, a regional disparity remains with high levels of poverty in regions with rural characteristics including Manyara, Mara, Simiyu and Shinyanga.

8.1.2 Regional Economy

As identified in the pre-feasibility study, there are eight regions deemed to be affected by the possible project routes namely; Arusha, Manyara, Singida, Tabora, Shinyanga, Simiyu, Mwanza and Mara. Whilst details for each of these are provided in Volume 4, some highlights are summarised below:

- The largest population (2012 figures) resides in Mwanza region, while
- The largest economy in terms of regional GDP is Arusha, followed by Manyara. Mwanza and Mara;
- Annual population growth ranges from 1.9 % in Simiyu to 3.2 %in Manyara;
- The smallest household size is in Arusha (4.4 per household) while the largest households are found in Simiyu Region (6.9) and Tabora (5.9);
- Mwanza and Mara have the highest road network densities while Manyara and Tabora have the lowest density of paved and unpaved road networks.

In the context of the project area (10 km corridor along the project road network) the most important economic activity is agriculture, deploying some 68% of the economically active population. Livestock, hunting and fishing accounts for some 6 % economically active people.

8.1.3 Economic Growth Outlook

Given real annual growth averaging 6.7% over the period 2006 to 2015, together with an average elasticity of demand for transport of 1.04, average annual growth rate of the order of 7.0% for the immediate and short-term periods is considered to be realistic. This is in line with recorded growth in constant GDP ranging between 7.0% and 7.3% per year over the last four years.

The economic outlook forecast [3] for the short to medium term period 2017 to 2026 is 6.2% per annum. International Monetary Fund (IMF) short term projections over the period 2019/20 to 2022/23 lie in the range 6.6% to 7.0% per annum[14]. The IMF's projected annual average growth over the medium to long term, 2022 to 2036, is 6.5%[15].

As reflected in the above forecasts, the long-term annual growth of GDP is expected to reduce as the implied GDP per capita grows into absolute and real levels of a middle-income country, otherwise also referred to as the compounding effect typical of long-term economic forecasts.

8.2 Phase I: Route Option Selection

This Feasibility Study for the Serengeti Bypass road was undertaken in two phases to reach the overall results on (a) the viability of upgrading the project road and (b) achieving the overall development objective.

In Phase I a route options assessment was carried out comprising initial engineering investigations and conceptual designs, detailed traffic studies, environmental and social scoping studies and a preliminary economic assessment all converged into a Multicriteria Analysis to determine the preferred route from the predetermined options of:

14 IMF Country Report No. 18/346, November 2018 (Table 5).

15 IMF Country Report No 16/253, July 2016. Debt Sustainability Analysis, June 2016 (Table 2).

1. The Mbulu Route from Karatu – Mbulu – Haydom – Sibiti River Crossing – Bukundi – Mwanhunzi – Lalago – Maswa (Nyalikungu), with a length of approximately 379 km before re-alignment and 385 km after improvements of the road alignment (excluding the link between Kolandoto and Lalago); and
2. The Lake Eyasi Route from the Oldeani junction – Mang'ola – along the east side of Lake Eyasi – Sibiti River Crossing – Bukundi – Mwanhunzi – Lalago – Maswa (Nyalikungu), with a length of approximately 314 km.

From the aforementioned MCA the Mbulu route emerged as the preferred option, which was confirmed and selected by TANROADS in 2018. This was carried forward to the next phase of the study.

8.3 Phase II: Evaluation of Selected Route Option

While this part of the report primarily addresses the project objective of determining the economic viability of the chosen route and its sub-options in line with the requirements of the ToR, the second phase also covers the factors that link the project objective to the overall development objective of reducing traffic crossing the SNP, while at the same time stimulate development of the remote north western part of Tanzania.

8.3.1 Sub-Route Options Investigated

Phase II of the study focused on the selected Mbulu route, for which three sub-route options were identified:

1. The road from Karatu to Maswa via Mbulu, Haydom, Chem Chem (Sibiti Bridge crossing), and Mwanhunzi referred to as "KMM" (short for "Karatu – Mbulu – Maswa") with a total length of 446.6 km (after alignment improvements and including the link between Kolandoto and Lalago);
2. The supplementary route starting in Katesh on the Central Corridor via Haydom, Chem Chem, and Mwanhunzi to Maswa with a total length of 358.9 km referred to as "KHM" (short for "Katesh – Haydom – Maswa", including the Kolandoto Lalago road link), but excluding a vital part of the "Mbulu route", namely Karatu – Mbulu – Haydom; and
3. A combination of the above-mentioned two routes, KHM plus the link road between Katesh and Haydom referred to as "KMM+KH" (short for "Karatu – Mbulu – Maswa plus Katesh – Haydom") amounting to a total length of 513.6 km (after alignment improvements and including the Kolandoto Lalago road link) encompassing the full project road network.

For these routes detailed investigations, including topographic survey, hydrological analysis, materials investigations and preliminary road design were undertaken in parallel to environmental and social impact assessments (ESIA), the findings and costs of which are incorporated in the economic evaluation of volume 4.

8.3.2 HDM-4 Input Data

As prescribed by the ToR, the Highway Development and Management (HDM-4) software was used to derive the economic indicators (NPV and EIRR) providing a measure of the project's economic viability. The key parameters adopted for the economic analysis are summarised in the table below.

Table 8-1: HDM-4 Analysis – Selected Evaluation Criteria

Parameter	Value
Homogenous road sections	27 (11 project, 16 diversion sections)
Analysis base year	2019
Construction duration	Two years
Capital cost distribution	(2021, 2022) 35%, 65%
Technical alternatives	Option 1: stabilised base (cement stabilised), and Option 2: granular base (crushed rock)
Year of opening to traffic	2023
Forecasting period	20 years after upgrading
Project appraisal period	2019 – 2042
Discount Rate	12%* (also 5%, 8%, 10%)

Note: * the rate conventionally applied by the international funding agencies for transport infrastructure investment appraisal.

Source: Consultant's estimate

Following the structure of the HDM-4 model, relevant data was obtained and entered into the various modules of the software:

Vehicle Fleet

The economic analysis distinguishes 9 categories of motorised traffic, namely passenger cars, utilities, minibuses (up to 14 passengers), medium busses (15 to 30 passengers), large busses (> 30 passengers), light trucks (GVW < 8t), medium trucks (2 axle, > 8t <10t), heavy truck (GVW < 30t), articulated truck. For each of these categories the following information was obtained and captured in HDM-4:

- Financial and economic prices for new vehicles and tyres;
- Vehicle utilisation including average kilometres, occupancy, ;
- Loading including operating weight, equivalent standard axle loading;
- Operating costs comprising of unit maintenance costs, overheads, work and non-work related costs and cargo holding time as well as unit costs of fuel and lubricants.

Existing Road Network

The existing road network considered in this study extends well beyond the project road due to the significant volume of diverted traffic expected from the realisation of the intended project road. A total of three road transport corridors/routes have been identified, namely, (i) the "northern" route either via Mto wa Mbu – Loliondo – Klein's Gate or via Karatu – Nyamuswa (T17), (ii) the "Central" and project route and (iii) the "southern" route via Babati – Singida – Shinyanga as shown in the following table.

Table 8-2: Existing Road Network

Route	From	To	Code	KMM+ KH	KMM	KHM	Length (Km)	Pavement	AADT			
									2019 Base + Sibiti Bridge	2023 Karatu - Mbulu - Maswa (KMM)	2023 KMM + Katesh - Haydom (KH)	2023 Katesh - Haydom - Maswa (KHM)
North	Makuyuni	Mto wa Mbu	N01	✓	✓		35.9	Bituminous	1,692	3,109	3,107	2,007
	Mto wa Mbu	Loliondo	NSR01				209.0	Bituminous	238	283	283	279
	Loliondo	Klein's Gate	NSR02				51.6	Bituminous	238	283	283	279
	Klein's Gate	Tabora B	NSR03				57.3	Unsealed	238	283	283	279
	Tabora B	Nyamuswa	NSR04				109.7	Bituminous	238	283	283	279
	Nyamuswa	Bunda	N04				24.6	Bituminous	351	434	434	444
	Mto wa Mbu	Karatu	N02	✓	✓		28.0	Bituminous	2,636	4,418	4,428	3,192
	Karatu	Nyamuswa	N03				298.0	Unsealed	816	840	840	847
SSB Project Road	Karatu junction	Karatu outskirts	SSB1A	✓	✓		0.8	Unsealed	1,325	3,234	3,235	1,599
	Karatu outskirts	Mbulu	SSB1B	✓	✓		78.2	Unsealed	660	2,091	2,093	880
	Mbulu	Dongobesh	SSB2A	✓	✓		40.5	Unsealed	532	1,213	1,215	316
	Dongobesh	Haydom	SSB2B	✓	✓		30.0	Unsealed	535	1,227	1,228	507
	Haydom	Chem Chem	SSB3A	✓	✓	✓	67.1	Unsealed	533	1,495	1,495	1,122
	Chem Chem	Sibiti bridge	SSB4A	✓	✓	✓	20.2	Unsealed	536	1,637	1,637	1,265
	Sibiti bridge	Mwanhunzi	SSB4B	✓	✓	✓	59.8	Unsealed	585	1,702	1,702	1,327
	Mwanhunzi	Lalago	SSB5A	✓	✓	✓	48.8	Unsealed	967	2,202	2,202	1,827
	Lalago	Maswa (Nyalikungu)	SSB5B	✓	✓	✓	34.1	Unsealed	267	719	719	710
	Haydom	Katesh	SSB6A	✓		✓	67.0	Unsealed	469	458	460	1,124
Cen-tral	Lalago	Kolandoto	SSB7A				62.2	Unsealed	841	1,633	1,633	1,267
	Maswa (Nyalikungu)	Bunda	C01	✓	✓	✓	149.0	Bituminous	903	1,215	1,215	1,214
South	Makuyuni	Babati	S01			✓	89.1	Bituminous	2,159	1,962	1,960	3,008
	Babati	Dareda	S02			✓	24.2	Bituminous	1,063	923	922	1,795
	Dareda	Katesh	S03			✓	45.1	Bituminous	943	765	764	1,690
	Katesh	Singida	S04				90.6	Bituminous	1,291	1,828	1,829	1,389
	Singida	Nzega	S05				220.0	Bituminous	2,070	1,958	1,958	2,324
	Nzega	Shinyanga	S06				77.8	Bituminous	1,482	1,708	1,708	1,526
	Shinyanga	Kolandoto	S07				23.9	Bituminous	2,709	3,146	3,146	2,780
			TOTAL	659.4	592.4	604.4						

Note: Lengths in this table are before alignment improvements.
Source: Consultant's evaluations

Detailed input data regarding the road network for the project road sections (11 in total, marked "SSB" in the table above) as well as the input data for those non-project road sections (16 in total) from which diverted traffic is expected to divert on to the upgraded SSB-project route are provided in volume 4.

The year-on-year traffic forecasts over the evaluation period by vehicle type used in this economic analysis is performed by the HDM-4 model based on the 2019 base year AADT, diverted traffic flows effective from 2023 and traffic growth sets

Maintenance and Improvement Works' Standards

TANROADS has installed a Road Maintenance Management System (RMMS), which focuses on maintenance programming and implementation of works in the regions and data consolidation for medium to long term planning at the TANROADS HQs using the HDM-4 model. In conjunction with the maintenance handbook the RMMS produces two types of budget:

- Unconstrained Budget: as the name suggests, is the budget, which reflects all the maintenance needs of the roads and allocates the full amount required, with the assumption that all the funds are fully available. This is the budget that is submitted to the Central Government so as to request funds at the beginning of the financial year. The Central Government, through the Road Funds Board then allocates funds for maintenance works which is usually well below the amount given in the Unconstrained Budget. This budget is applied to the "with project" scenario.
- The allocated amount is entered into the RMMS by the ROs to generate a revised "Constrained Budget", which reflects the realistic situation. In this process the RMMS spreads and prioritises the actual amount allocated over the various maintenance

requirements for the road network for the financial year. This is adopted for maintenance standards applicable to the "without project" scenario.

The maintenance standards associated with the aforementioned maintenance handbook and RMMS budgets, applied to the "with" and "without" project scenarios for unsealed and paved bituminous road surfaces is provided in the following table.

Table 8-3: Maintenance Standards Adopted for Without and With Project Cases

Sce-nario	Operation	Code	Lover Value	Intervention Criteria	Upper Value	Cost Unit	Financial Cost	Economic Cost	Comment
BITUMINOUS SECTIONS									
Without Project	Edge repair	EDGE	1400	Edge break (m2/km)	3500	m2	142.57	116.91	
	Patching	PATCH	8	Potholing (no./km)	22	m2	142.57	116.91	
	Crack sealing	CRACK	10	Wide structural cracking (%)	50	m2	3.51	2.88	
	Drainage	DRAIN	1	Interval (yr)	2	km	2,350.00	1,927.00	
	Surface dressing single	SBSD	3	Interval (yr)	5	m2	4.66	3.82	
	Miscellaneous	MISC	0	Year	1	km/yr	1,744.92	1,430.83	Includes Spot Sealing, Slope Erosion Grass cutting/Bush clearing
With Project	Edge repair	EDGE	4	Roughtness (IRI)	6	m2	142.57	116.91	
	Patching	PATCH	4	Roughness (IRI)	6	m2	142.57	116.91	
	Crack sealing	CRACK	5	Wide structural cracking (%)	15	m2	3.51	2.88	
	Drainage	DRAIN	1	Interval (yr)	2	km	2,350.00	1,927.00	
	Surface dressing single	SBSD	6	Interval (yr)	8	m2	4.66	3.82	Thickness = 12mm
	Miscellaneous	MISC	0	Year	1	km/yr	1,744.92	1,430.83	Includes Spot Sealing, Slope Erosion Grass cutting/Bush clearing
UNSEALED SECTIONS									
Without Project	Grading	GRADE	0	Interval (yr)	1	km	342.17	280.58	
	Drainage	DRAIN	1	Interval (yr)	2	km	2,350.00	1,927.00	
	Regravelling	REGRVL		Gravel thikness	150	m3	10.53	8.63	Lateritic gravel, final thickness = 200mm
Notes: Standard conversion factor: 0.82									
Source: TANROADS Maintenance Manual.									

As detailed in the preliminary design part of this study, two main technical options were considered, which can be broadly summarised as:

Option 1: stabilised base (cement stabilised), and

Option 2: granular base (crushed rock)

Estimates of the investment costs including construction costs, resettlement of PAPs and environmental mitigation measures were estimated and considered in the economic analysis as summarised in the following two tables. The first, Table 8-4 showing the total financial investment costs for each of the sub-route options by road section.

Table 8-4: Financial Cost Summary by Sub-Route Option and Road Section

Option	Section	Road Name	Fincncial Cost KMM	Financial Cost KMM+KH	Financial Cost KHM
Option 1	1A	Karatu junction - Karatu outskirts	1,602,698	1,602,698	
	1B	Karatu outskirts - Mbulu	97,926,969	97,926,969	
	2A	Mbulu - Dongobesh	44,943,639	44,943,639	
	2B	Dongobesh - Haydom	41,502,570	41,502,570	
	3A	Haydom - Chem Chem	85,729,005	85,729,005	85,729,005
	4A	Chem Chem - Sibiti bridge	23,879,016	23,879,016	23,879,016
	4B	Sibiti bridge - Mwanhunzi	80,490,584	80,490,584	80,490,584
	5A	Mwanhunzi - Lalago	70,416,366	70,416,366	70,416,366
	5B	Lalago - Maswa (Nyalikungu)	44,943,136	44,943,136	44,943,136
	6A	Haydom - Katesh		66,603,885	66,603,885
	7A	Lalago - Kolandoto	82,228,489	82,228,489	82,228,489
		TOTAL Option 1	**573,662,472**	**640,266,357**	**454,290,481**
Option 2	1A	Karatu junction - Karatu outskirts	1,563,536	1,563,536	
	1B	Karatu outskirts - Mbulu	94,632,564	94,632,564	
	2A	Mbulu - Dongobesh	43,309,461	43,309,461	
	2B	Dongobesh - Haydom	39,861,520	39,861,520	
	3A	Haydom - Chem Chem	82,735,325	82,735,325	82,735,325
	4A	Chem Chem - Sibiti bridge	23,898,877	23,898,877	23,898,877
	4B	Sibiti bridge - Mwanhunzi	80,494,494	80,494,494	80,494,494
	5A	Mwanhunzi - Lalago	70,328,391	70,328,391	70,328,391
	5B	Lalago - Maswa (Nyalikungu)	43,953,101	43,953,101	43,953,101
	6A	Haydom - Katesh		61,324,235	61,324,235
	7A	Lalago - Kolandoto	80,484,859	80,484,859	80,484,859
		TOTAL Option 2	**561,262,128**	**622,586,363**	**443,219,282**
Source: Consultants estimates and calculations/					

The total (financial) investment costs indicated in Table 8-4 were broken down into 7 construction lots, none of which exceeded a road length of 83 km to enable the project to be implemented by local contractors.

Table 8-5: Financial Cost Summary Costs by Construction Lot

Option	Lot	Road Name	Construction + Environmental Mitigation	Land Acquisition	Resettlement	Total Financial Costs (USD)	Total Unit Costs (USD/Km)	Length (Km)
Option 1	1	Karatu Junction - Mbulu	96,939,167	1,540,500	1,050,000	99,529,667	1,259,869	79.0
	2	Mbulu - Haydom	84,021,459	1,374,750	1,050,000	86,446,209	1,141,958	75.7
	3	Haydom - Chem Chem	83,263,415	865,590	1,600,000	85,729,005	1,283,368	66.8
	4	Chem Chem - Mwanhunzi	102,637,600	1,032,000	700,000	104,369,600	1,304,620	80.0
	5	Mwanhunzi - Maswa	112,740,092	1,069,410	1,550,000	115,359,502	1,391,550	82.9
	6	Haydom - Katesh	65,039,585	864,300	700,000	66,603,885	994,088	67.0
	7	Lalago - Kolandoto	80,376,109	802,380	1,050,000	82,228,489	1,322,001	62.2
		TOTAL Option 1	625,017,427	7,548,930	7,700,000	640,266,357	1,246,625	513.6
Option 2	1	Karatu Junction - Mbulu	93,605,600	1,540,500	1,050,000	96,196,100	1,217,672	79.0
	2	Mbulu - Haydom	80,746,231	1,374,750	1,050,000	83,170,981	1,098,692	75.7
	3	Haydom - Chem Chem	80,269,735	865,590	1,600,000	82,735,325	1,238,553	66.8
	4	Chem Chem - Mwanhunzi	102,661,371	1,032,000	700,000	104,393,371	1,304,917	80.0
	5	Mwanhunzi - Maswa	111,662,082	1,069,410	1,550,000	114,281,492	1,378,546	82.9
	6	Haydom - Katesh	59,759,935	864,300	700,000	61,324,235	915,287	67.0
	7	Lalago - Kolandoto	78,632,479	802,380	1,050,000	80,484,859	1,293,969	62.2
		TOTAL Option 2	607,337,433	7,548,930	7,700,000	622,586,363	1,212,201	513.6
COSTS BY LOT								

The conversion of the financial costs to their economic equivalents, as required for the economic evaluation is carried out through the application of the standard conversion factor of 0.82 as stipulated in the ToR.

The engineering data related to the two technical options considered, including revised lengths resulting from improvements of the existing road alignment, are detailed in volume 4.

Configuration Sets

Apart from HDM-4 data outlined and summarised in the foregoing the following information was obtained and entered into the configuration constituents of the model:

- Traffic flow patterns (inter-urban);
- Speed flow type (two-lane);
- Accident classes as determined from information obtained from police stations in the project area and costs, which were valued in accordance to the TANROADS Investment Appraisal Manual;
- Climate Zones were defined for “lowlands”, “midlands” and “highlands” based on relevant meteorological data obtained for relevant stations within the project area.

8.3.3 Economic Evaluation Results

As outlined above, the parameters regarding the vehicle fleet, existing road network, traffic volumes (based on the traffic studies in the route options phase), maintenance and improvement works and their economic costs[16] were entered into the HDM-4 model used to derive the economic indicators. The results of this economic evaluation yielded favourable results, which suggest that all three sub-route options are economically viable for both technical options as summarised in the table below.

Table 8-6: Summary Economic Indicator Results

Indicator	Unit	Option	KMM+KH	KMM	KHM
NPV @ 12%	USD million	Option 1	224.682	191.457	432.583
	USD million	Option 2	228.769	192.437	434.757
EIRR	%	Option 1	22.1	22.0	35.6
	%	Option 2	22.5	22.1	36.0
Total Financial	USD million	Option 1	640.266	573.662	454.290
Investment Cost	USD million	Option 2	622.586	561.262	443.219
Total Financial Unit	USD million/km	Option 1	1.426	1.284	1.266
Cost	USD million/km	Option 2	1.212	1.257	1.234
Road length	Km		513.6	446.6	358.9
Source: HDM-4 runs and Consultant's estimates and calculations					

For all three economically viable sub-routes, the granular base pavement (Option 2) was found to be the most favourable.

The total (financial) investment costs indicated in Table 8-6 were broken down into 7 construction lots, none of which exceeded a road length of 83 km to enable the project to be implemented within a construction period of two years.

A subsequent sensitivity analysis carried out on all three sub-route options involving variants of normal AADT traffic, traffic growth, capital costs and combinations thereof, as shown in the following table;

16 Using a standard conversion factor (SCF) of 0.82 as prescribed in the ToR.

Table 8-7: Sensitivity Analysis Results

		NPV in USD million (@12%)			EIRR (in %)		
Scenario	**Option**	**KMM+KH**	**KMM**	**KHM**	**KMM+KH**	**KMM**	**KHM**
Base	**Option 1**	**224.682**	**191.457**	**432.583**	**22.1**	**22.0**	**35.6**
	Option 2	**228.769**	**192.437**	**434.757**	**22.5**	**22.1**	**36.0**
Scenario 1	Option 1	153.375	150.462	349.264	19.0	19.7	31.3
AADT Normal & DT -20%	Option 2	157.821	151.787	351.626	19.3	19.8	31.6
Scenario 2	Option 1	189.399	185.173	404.928	20.5	21.4	34.0
AADT Normal & DT -10%	Option 2	192.678	186.337	407.199	20.9	21.5	34.4
Scenario 3	Option 1	261.128	256.817	519.321	23.7	24.9	39.3
AADT Normal & DT +10%	Option 2	265.000	257.589	521.392	24.0	25.0	39.7
Scenario 4	Option 1	147.849	122.626	379.674	17.6	17.4	29.7
Capital costs +20%	Option 2	153.002	124.041	382.441	17.9	17.5	30.0
Scenario 5	Option 1	186.265	157.041	406.129	19.7	19.5	32.4
Capital costs +10%	Option 2	190.886	158.239	408.599	20.0	19.6	32.8
Scenario 6	Option 1	263.098	225.872	459.037	25.0	25.0	39.5
Capital costs -10%	Option 2	266.653	226.635	460.915	25.4	25.1	39.9
Scenario 7 (combined)	Option 1	149.846	150.654	378.390	18.2	19.0	30.9
AADT -10%, Costs +10%	Option 2	154.658	152.035	380.958	18.5	19.1	31.3
Note: "DT" = Diverted Traffic							
Source: HDM-4 runs							

The main observation made from the sensitivity analysis is that the economic results remain robust for all sensitivity tests conducted, providing comfort of the results reported for the base case.

Considering other (exogenous) benefits including those from agriculture and livestock (producer surplus), employment generation (all quantified) and health (not quantified) additional benefits can be expected from these sectors in reaction and as a result of constructing the Serengeti Southern Bypass. Their addition will only affirm and improve the economic viability already established in the foregoing. The magnitude of these additional benefits are shown in the following table.

Table 8-8: Consolidated Results

Cost or Benefit	Unit	KMM	KMM+KH	KHM
Econ. Indicators (Chapter 6) NPV EIRR	 USD million %	 192.437 22.1%	 228.769 22.5%	 434.757 36.0%
Agriculture producer surplus	USD million	34.5	37.7	28.1
Livestock producer surplus	USD million	9.52	10.89	8.24
Incremental employment/GDP	USD million USD million	from 0.81 (2023) to 28.53 (2042)	from 0.92 (2023) to 32.65 (2042)	from 0.74 (2023) to 25.77 (2042)
Revenues w.r.t. SNP from: 200 vpd through SNP Total SNP (at risk)	 USD million USD million	 22.5 607.1	 22.5 607.1	 22.5 607.1
Health	Not quantified	Connects Haydom in **2** directions (From Mbulu, east to Karatu and west to Maswa via Haydom)	Connects Haydom in **3** directions (From Haydom, east to Karatu via Mbulu, west to Maswa and South to Katesh)	Connects Haydom in **2** directions (From Haydom, west to Maswa and south to Katesh)

As highlighted in Table 1-5, the KHM sub-route option yields the highest economic indicators while the KMM+KH sub-route returns the most favourable option with regard to additional exogenous effects, which need to be included in the overall decision for the implementation of the Serengeti Southern Bypass. In this regard notably high economic indicator results for KHM are not only counter balanced by the outcome of the above mentioned exogenous benefits, but also by the fact that this route excludes a vital part of the “Mbulu route” (Karatu – Mbulu – Haydom) and thereby

excludes the district headquarter of Mbulu from the opportunity and part of the objective of developing the north-west of Tanzania.

Notwithstanding the positive results described above, three risks were identified, which would erode and possibly eradicate the economic viability of the project road, these being:

1. Inadequate funding for the project road resulting in one or more of the 7 construction lots left at the current gravel standard. This is expected to significantly reduce normal AADT and diverted traffic volumes and hence erode the benefits from savings in vehicle operating costs and time savings;
2. Construction of the Lake Eyasi Route, which will undoubtedly "compete" for regional traffic between Arusha and Musoma and hence reduce normal and diverted AADT traffic forecast for the selected Mbulu sub-route options; and
3. Poor maintenance of an upgraded Serengeti Southern Bypass road, which will result in the degradation of the road surface faster than planned and hence increase vehicle operating costs.

To ensure that the project objective (economically viable project road) is achieved it will be important to address all risks outlined above.

Assuming that this is the case and that the sub-option with the most favourable economic indicators is constructed, the study assessed the relationship between the project road and the overall development objective (to promote economic development in the northwest part of Tanzania while at the same time reduce traffic crossing the SNP).

The SNP is a listed UNESCO World Heritage Site alongside the NCAA (also a World Heritage Site), both with Outstanding Universal Value. An increase in traffic in and particularly through these properties will cause irreversible environmental damage. Currently there are two routes traversing the SNP; the Northern Serengeti Road (via Mto wa Mbu, Loliondo, Klein's Gate, Tabora B, Nyamuswa) with some 57 km through the park and the regional trunk road T17 via both the NCAA and SNP with 202 km through the combined "Greater Conservation Area" . Since these are both shorter road connections between Arusha and Musoma than any of the alternative routes south of these areas there is a real risk of traffic using these routes, particularly if they are upgraded and consequently made more attractive for through traffic. Since the NSR only cuts some 57 km across the park, and does not traverse the NCAA, the upgrading of this road has a higher risk of attracting large volumes of traffic through the park. Although it is a considerably shorter distance through the park, the potential environmental damage is as high as the other (T17) route since it cuts across migratory routes of the world-famous migration in the Serengeti – Mara ecosystem. Although a permanent injunction was issued in mid 2014 by the East African Court of Justice there is limited comfort that this will abate some 300 vehicles each day from using this route at present, particularly if the roads outside the park (Mto wa Mbu – Sale and Tabora B – Nyamuswa) are planned or being upgraded to bitumen standard.

Taking into account the scenario that both aforementioned road sections along the NSR are upgraded the traffic model does nonetheless forecast a significant diversion of traffic out of the SNP and onto the Serengeti Southern Bypass based mainly on (a) slower speeds through the SNP with (b) associated increases in travel time and (c) higher unit vehicle operating costs. This is assumed to divert 60% of total AADT once the Serengeti Southern Bypass is open to traffic. Other factors were identified that both push traffic out of the SNP and pull it onto the project road, which provided a foundation to formulate a set of measures, which can broadly be summarised as follows:

Physical measures: include traffic calming measures (speed humps), vehicle portals, reduce road width, cutting direct route connections, stringent traffic control measures, signage to discourage through traffic and removing the routes from google maps as the shortest/fastest route;

Institutional and legislative measures: specific action plan vis-à-vis traffic regulation, revise fees schedule to increase charges for through traffic, increase human and technical capacities of SNP to implement traffic regulating activities, formulate environmental policy;

Development Policy measures involve inclusion of the results of this study into the infrastructure development plan and implement the various road projects in the region in a manner that maximises the effect of the Serengeti Southern Bypass road as an alternative route between Arusha and Musoma.

In essence, these measures discourage or minimise the attraction of using the shorter route(s) through the NSR and thereby increase the intended function and achievement of the overall development objective attached to this project. In this regard, the suggested mitigation measures must be considered seriously and developed further.

The most relevant components with sequenced activities and associated main findings and results of the Serengeti Southern Bypass feasibility Study can be consolidated in a simplified schematic as shown in Figure 8-1.

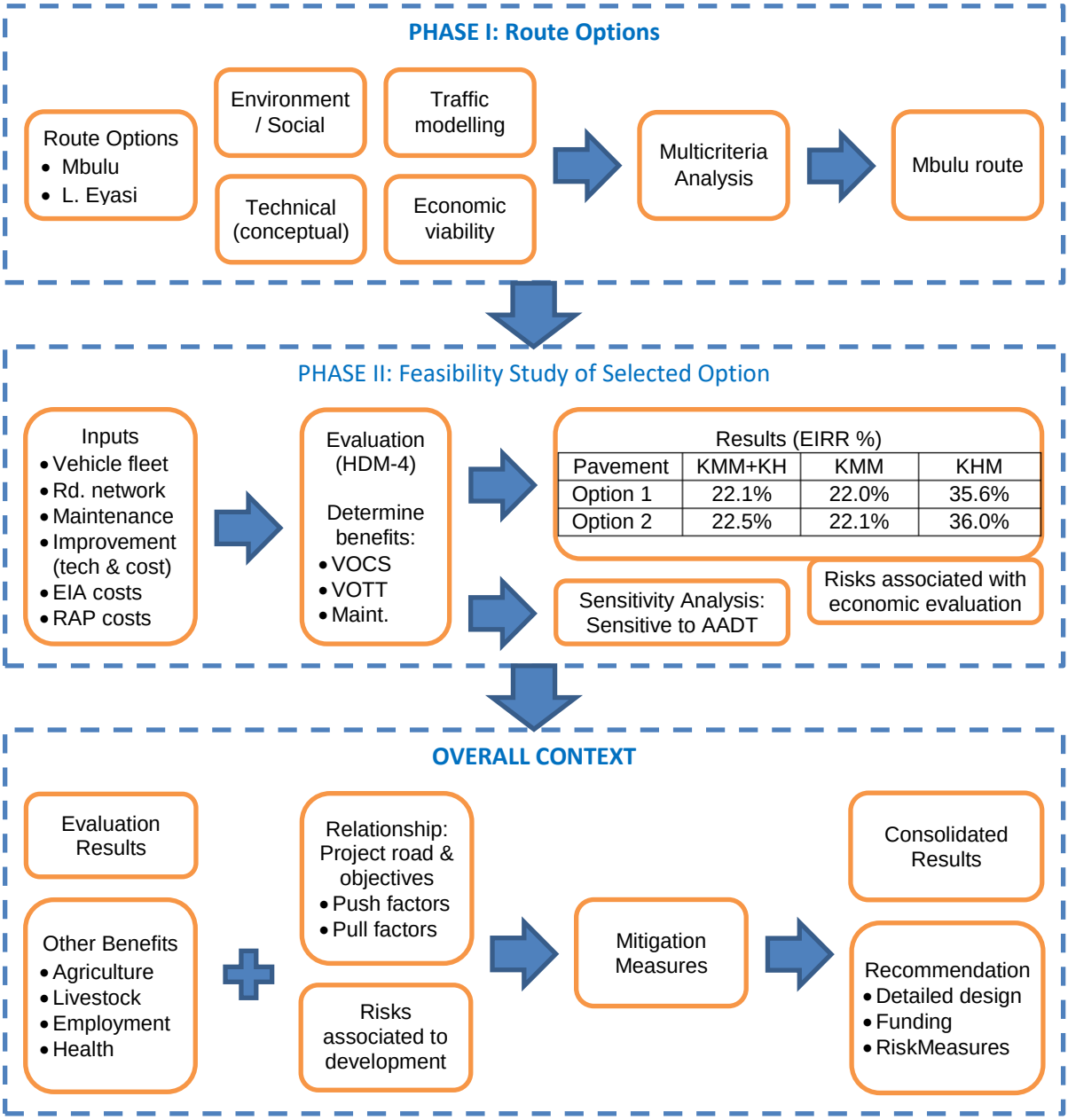


Figure 8-1: Schematic Activities and Consolidated Results

9 CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

Based on the main findings and results obtained in the foregoing with reference to the purpose of this feasibility study (Section 1.4.2), the following conclusions could be made:

From the route options analysis carried out in phase I of this study the Mbulu route was concluded to be the preferred route of the Serengeti Southern Bypass, which was subsequently confirmed and selected by TANROADS.

Addressing the overall development objective, the construction of the Serengeti Southern Bypass via Mbulu will:

- Reduce traffic crossing the SNP by some 40% in 2023 to 60% by 2042. Traffic forecasts through the SNP in 2042 is modelled to reduce from some 1,500 vehicles per day in the without project case by about 900 vpd to around 600 vpd in the *with project* case for the same year, thereby providing a significant contribution to safeguarding the integrity of the SNP;
- At the same time, the proposed bypass provides a continuous bituminous trunk road between Arusha and Musoma offering a trade-off of some 57 km gravel road through the SNP plus an additional 52 km gravel stretch between Loliondo and Klein's Gate (i.e. a total of 109 km) against a 211 km longer route via Katesh and Haydom or 223 km longer via Mbulu. In addition, the project road would offer a 435 km shorter route for traffic travelling between Arusha and Musoma via Babati, Singida and Shinyanga. The project road will therefore improve the current connectivity of the north-western parts of Tanzania with Arusha and the rest of the country.

The study also concludes that these beneficial effects towards the fulfilment of the overall development objective will only be realised if:

- The shorter gravel road sections through the SNP (57 km) and between Loliondo and Klein's Gate (52 km) are not upgraded;
- The T17 through the SNP and NCAA is not upgraded to bitumen standard;
- All road sections of the proposed Serengeti Southern Bypass are constructed without one or more sections left in the current gravel standard;
- Maintenance of the upgraded project road is carried out as planned.

Turning to the second objective of the feasibility study the economic evaluation can be concluded with the following observations:

- The economic indicators obtained for all sub-route options (KMM, KHM) and the combined option (KMM+KH) wielded positive results for both technical engineering design options considered (stabilised base or granular base) at the 12% discount rate cut-off value. Thus, any of the route-sub options and either of the technical alternatives were assessed to be economically viable;
- The most favourable economic indicators were obtained for the KHM sub-route option;
- The option with a granular base (Option 2) was found to be the most favourable.

With regard to the project objective the KHM Option 2 offers the highest economic indicator results. However, this excludes the road sections between Karatu – Mbulu – Haydom (Lot 1 and lot 2) and therefore excludes the benefits of linking the district headquarter of Mbulu and the area of impact along this 154.7 km road, which offer substantial additional benefits as established from an analysis of exogenous effects from agriculture, livestock, employment generation and health. For all of these, the KMM+KH sub-route option provides the highest benefits.

In summary, all three sub-route options are economically viable. Furthermore, based on the topics investigated in the feasibility study the sub-route options KMM and KMM+KH of the Mbulu route will significantly contribute to achieving the development objective of improving connectivity of north-west Tanzania to the rest of the country, while at the same time reduce traffic crossing the Serengeti National Park. Considering all aspects, the Karatu – Mbulu – Maswa plus Katesh – Haydom (KMM+KH) sub-route was found to be the most favourable option. To maximise the desired impact of this sub-route option, it will be necessary to elaborate and implement a number of physical, institutional and policy measures that support the reduction of traffic through the SNP.

9.2 Recommendation

To arrive at a comprehensive recommendation for the construction of the Serengeti Southern Bypass the following aspects are considered:

- The economic viability of the project road (project objective);
- Costs and funding of lots;
- Additional benefits from additional lots and selected economic activities and;
- Diverting traffic from the SNP (part of the development objective)
- Improving connectivity to North West parts of Tanzania (part of development objective).

From the results and conclusions in the previous sections, the preferred route sub-option is the Karatu – Mbulu – Maswa plus Katesh – Haydom link (KMM+KH), offering:

- An economically viable solution;
- A preferred solution with a granular base (Option 2);
- The lowest unit cost solution (per km).
- Highest indicative exogenous benefits from agriculture, livestock and employment generation as well as the highest ordinal value of benefits in the health sector;
- A complete road network including Mbulu and thereby supporting the economic development of the remote north-west of Tanzania.

Subject to funds, the addition of the 154.7 km road between Karatu and Haydom (via Mbulu) at a cost of USD 179.4 million (Option 2) should be included in view of the above mentioned benefits plus the potential of this already sizeable settlement to grow into a stop-over centre for traffic between Arusha and Musoma offering a strong pull factor for traffic that would otherwise use the route through the SNP.

In any event, the success of the various sub-route options assessed in terms of their economic viability assumes that the traffic forecast to use the selected option(s) do not divert to other alternative routes including the route via Lake Eyasi and/or the two routes through the SNP.

The above, so far only addresses the economic viability and relative affordability of the project route sub-options and therefore covers only the project objective.

Ascending to the hierarchy of the overall development objective an analysis of its two potentially opposing components was assessed separately, which can be summarised as follows.

The development of the remote North West regions of Tanzania would be accelerated through an improved direct road connecting Musoma with the nearest economically active centre of Arusha. The direct route could be provided by any one of the following: (i) the Northern Serengeti Route via Mto wa Mbu, Loliondo, Klein's Gate, Tabora B, Nyamuswa (ii) the T17 via the NCAA and SNP, (iii) the Lake Eyasi route, and of course (iv) the Serengeti Southern Bypass via Mbulu and/or Katesh. However, the selection of upgrading one or more of these routes will have significantly different

results affecting the second component of the overall objective and/or the project objective as briefly outlined below.

Upgrading either of the routes through the SNP will maintain and attract additional traffic through the SNP (and NCAA) and hence directly counter-act on one of the components of the overall development objective. Most important this would undoubtedly result in irreversible environmental damages to the property of the OUV of the SNP and possibly NCAA. With such consequence in mind all measures must be put in place to strengthen the ruling of the East African Court of Justice restraining the construction of an upgraded road between Klein's Gate and Tabora B.

Upgrading the Lake Eyasi route would directly compete for the same traffic and thereby erode the economic viability of the sub-route options KHM and KMM+KH.

Therefore, only the implementation of the sub-route option KMM+KH would attain or contribute to the fulfilment of all objectives set out in this feasibility study.

Considering the various aspects addressed in the foregoing it is therefore recommended to:

- Implement KMM+KH, or if funds are not sufficiently available;
- Implement KHM as a first phase and add the part from Karatu to Haydom at a later stage (phased implementation). Consider implementing the second phase by a single funding source and contractor.

To avoid forecast traffic volumes to "disappear" to other routes and either erode the economic viability of the preferred route or counter-act against the objective of reducing traffic in the SNP It is recommended to stay the upgrading of the Lake Eyasi route and implement the following mitigation measures:

Physical Measures along the Northern Serengeti Route

1. Construction of speed humps;
2. Maintain restrictions on vehicle size, weight, speed and hours of access, including the construction of vehicle portals;
3. Reduce width of roads in the park;
4. Cut direct link roads;
5. Implement additional traffic control measures outside the park;
6. Stop issuing entry permits to commercial traffic entering the park;
7. Implement a minimum stay of 12 hours in the park;
8. Erect signboards at Karatu and Nyamuswa stating that the road is not allowed to be used for transit purposes;
9. Engage the developers of Google Maps and request that the road through SNP is not shown as the shortest/fastest;

Institutional and Legislative Measures for SNP and NCAA

10. Develop a specific action plan to implement necessary measures to regulate traffic, including a revision of the fees schedule;
11. Strengthen human and technical capacities of SNP to implement the above stated action plan;
12. SNP to develop and integrate suitable environmental management standards vis-à-vis motorised traffic inside the park;

Development Policy aspects

13. Optimise the implementation of planned road infrastructure projects in the north west of Tanzania to maximise the desired effects of the Serengeti Southern Bypass road.

The combined set of recommendations stated above is deemed to achieve the project objective and significantly contribute to the overall development objective. With this aim in mind, the option of not constructing the Serengeti Southern Bypass and the associated mitigation measures is not an environmentally responsible choice, a disservice to Tanzania's tourism and to the generations to come.

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APPENDICES

APPENDIX 1

CONSTRUCTION COST ESTIMATES

CONSTRUCTION COST ESTIMATES
OPTION 1 – STABILISED BASE

Lot 1 - Summary of Bills of Quantities Option 1 - Stabilized Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	983,150
	Kerb Stones and Block Paving	1,683,950
	Others (Stone Pitching, Gabions, Remove Structures et	2,255,274
	Sub Total	**4,922,374**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	10,150,000
	Earthworks - Spoil	4,983,600
	Subgrade	1,556,093
	Stabilisation	26,862,400
	Others (Clearing, Topsoil, Roadbed etc)	7,091,607
	Sub Total	**50,643,700**
4000	**Bituminous Layers and Seals**	
	Prime Coat	2,218,730
	Double Surface Dressing	9,107,910
	Sub Total	**11,326,640**
5000	**Ancillary Roadworks**	**4,916,448**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	2,491,683
	Bridges	0
	Sub Total	**2,491,683**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**2,049,754**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	1,500,000
	Truck Parks	1,250,000
	Sub Total	**2,750,000**
A	**Subtotal of Bills**	**84,294,928**
B	**Physical Contingency (7.5% of A)**	**6,322,120**
C	**Financial Contingency (7.5% of A)**	**6,322,120**
D	**TOTAL COSTS**	**96,939,168**

Lot 2 - Summary of Bills of Quantities Option 1 - Stabilized Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	932,000
	Kerb Stones and Block Paving	518,800
	Others (Stone Pitching, Gabions, Remove Structures et	1,224,990
	Sub Total	**2,675,790**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	5,015,000
	Earthworks - Spoil	1,040,000
	Subgrade	7,403,000
	Stabilisation	9,043,000
	Others (Clearing, Topsoil, Roadbed etc)	24,660,000
	Sub Total	**47,161,000**
4000	**Bituminous Layers and Seals**	
	Prime Coat	2,132,500
	Double Surface Dressing	8,741,250
	Sub Total	**10,873,750**
5000	**Ancillary Roadworks**	**3,595,073**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	995,340
	Bridges	1,912,000
	Sub Total	**2,907,340**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**654,856**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	0
	Truck Parks	0
	Sub Total	**0**
A	**Subtotal of Bills**	**73,062,138**
B	**Physical Contingency (7.5% of A)**	**5,479,660**
C	**Financial Contingency (7.5% of A)**	**5,479,660**
D	**TOTAL COSTS**	**84,021,459**

Lot 3 - Summary of Bills of Quantities Option 1 - Stabilized Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	517,900
	Kerb Stones and Block Paving	2,040,200
	Others (Stone Pitching, Gabions, Remove Structures et	1,674,855
	Sub Total	**4,232,955**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	6,930,000
	Earthworks - Spoil	4,075,000
	Subgrade	302,500
	Stabilisation	23,419,000
	Others (Clearing, Topsoil, Roadbed etc)	5,637,900
	Sub Total	**40,364,400**
4000	**Bituminous Layers and Seals**	
	Prime Coat	1,930,610
	Double Surface Dressing	7,931,385
	Sub Total	**9,861,995**
5000	**Ancillary Roadworks**	**3,383,612**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	539,524
	Bridges	3,730,000
	Sub Total	**4,269,524**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**2,346,154**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	1,500,000
	Truck Parks	1,250,000
	Sub Total	**2,750,000**
A	**Subtotal of Bills**	**72,402,970**
B	**Physical Contingency (7.5% of A)**	**5,430,223**
C	**Financial Contingency (7.5% of A)**	**5,430,223**
D	**TOTAL COSTS**	**83,263,415**

Lot 4 - Summary of Bills of Quantities Option 1 - Stabilized Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	708,400
	Kerb Stones and Block Paving	2,403,300
	Others (Stone Pitching, Gabions, Remove Structures et	3,300,982
	Sub Total	**6,412,682**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	14,838,800
	Earthworks - Spoil	4,393,500
	Subgrade	3,124,000
	Stabilisation	20,596,580
	Others (Clearing, Topsoil, Roadbed etc)	5,141,078
	Sub Total	**48,093,958**
4000	**Bituminous Layers and Seals**	
	Prime Coat	1,757,605
	Asphalt Concrete	9,644,100
	Double Surface Dressing	3,170,192
	Sub Total	**14,571,897**
5000	**Ancillary Roadworks**	**1,762,858**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	4,743,572
	Bridges	6,293,000
	Sub Total	**11,036,572**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**927,793**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	0
	Truck Parks	1,250,000
	Sub Total	**1,250,000**
A	**Subtotal of Bills**	**89,250,088**
B	**Physical Contingency (7.5% of A)**	**6,693,757**
C	**Financial Contingency (7.5% of A)**	**6,693,757**
D	**TOTAL COSTS**	**102,637,601**

Lot 5 - Summary of Bills of Quantities Option 1 - Stabilized Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	995,500
	Kerb Stones and Block Paving	3,482,500
	Others (Stone Pitching, Gabions, Remove Structures et	5,122,802
	Sub Total	**9,600,802**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	16,396,400
	Earthworks - Spoil	6,858,000
	Subgrade	2,508,000
	Stabilisation	14,878,000
	Others (Clearing, Topsoil, Roadbed etc)	13,531,562
	Sub Total	**54,171,962**
4000	**Bituminous Layers and Seals**	
	Prime Coat	1,843,300
	Asphalt Concrete	5,975,200
	Double Surface Dressing	5,603,850
	Sub Total	**13,422,350**
5000	**Ancillary Roadworks**	**2,816,673**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	2,534,874
	Bridges	6,729,000
	Sub Total	**9,263,874**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**2,064,873**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	1,500,000
	Truck Parks	0
	Sub Total	**1,500,000**
A	**Subtotal of Bills**	**98,034,862**
B	**Physical Contingency (7.5% of A)**	**7,352,615**
C	**Financial Contingency (7.5% of A)**	**7,352,615**
D	**TOTAL COSTS**	**112,740,092**

Lot 6 - Summary of Bills of Quantities Option 1 - Stabilized Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	604,300
	Kerb Stones and Block Paving	1,075,000
	Others (Stone Pitching, Gabions, Remove Structures et	1,411,043
	Sub Total	**3,090,343**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	5,060,000
	Earthworks - Spoil	2,605,000
	Subgrade	1,540,000
	Stabilisation	15,141,000
	Others (Clearing, Topsoil, Roadbed etc)	4,971,160
	Sub Total	**29,317,160**
4000	**Bituminous Layers and Seals**	
	Prime Coat	1,544,000
	Double Surface Dressing	7,087,500
	Sub Total	**8,631,500**
5000	**Ancillary Roadworks**	**3,028,900**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	1,791,269
	Bridges	4,360,000
	Sub Total	**6,151,269**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**1,142,660**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	0
	Truck Parks	0
	Sub Total	**0**
A	**Subtotal of Bills**	**56,556,161**
B	**Physical Contingency (7.5% of A)**	**4,241,712**
C	**Financial Contingency (7.5% of A)**	**4,241,712**
D	**TOTAL COSTS**	**65,039,585**

Lot 7 - Summary of Bills of Quantities Option 1 - Stabilized Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	834,500
	Kerb Stones and Block Paving	3,676,190
	Others (Stone Pitching, Gabions, Remove Structures et	4,531,252
	Sub Total	**9,041,942**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	10,388,000
	Earthworks - Spoil	4,477,500
	Subgrade	1,798,500
	Stabilisation	13,795,400
	Others (Clearing, Topsoil, Roadbed etc)	4,060,018
	Sub Total	**34,519,418**
4000	**Bituminous Layers and Seals**	
	Prime Coat	1,390,100
	Double Surface Dressing	6,756,750
	Sub Total	**8,146,850**
5000	**Ancillary Roadworks**	**2,011,309**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	1,943,534
	Bridges	5,816,000
	Sub Total	**7,759,534**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**1,718,888**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	1,500,000
	Truck Parks	0
	Sub Total	**1,500,000**
A	**Subtotal of Bills**	**69,892,269**
B	**Physical Contingency (7.5% of A)**	**5,241,920**
C	**Financial Contingency (7.5% of A)**	**5,241,920**
D	**TOTAL COSTS**	**80,376,109**

Project Summary of Bills of Quantities Option 1 - Stabilized Base		
Bill No	**Description**	**USD**
1000	General	33,057,185
2000	Drainage	39,976,888
3000	Earthworks and Pavement Layers of Gravel or Crushed Stone	304,271,597
4000	Bituminous Layers and Seals	76,834,982
5000	Ancillary Roadworks	21,514,873
6000	Structures	43,879,797
7000	Testing and Quality Control	43,750
8000	Dayworks	3,259,368
9000	Street Lights	10,904,978
10000	Weighbridge and Truck Parks	9,750,000
A	Subtotal of Bills	543,493,417
B	Physical Contingency (7.5% of A)	40,762,006
C	Financial Contingency (7.5% of A)	40,762,006
D	TOTAL COSTS	625,017,429

CONSTRUCTION COST ESTIMATES
OPTION 2 – GRANULAR BASE

Lot 1 - Summary of Bills of Quantities Option 2 - Granular Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	983,150
	Kerb Stones and Block Paving	1,683,950
	Others (Stone Pitching, Gabions, Remove Structures et	2,255,274
	Sub Total	**4,922,374**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	10,150,000
	Earthworks - Spoil	4,983,600
	Subgrade	1,527,900
	Stabilisation	14,333,050
	Crushed Rock	9,658,789
	Others (Clearing, Topsoil, Roadbed etc)	7,091,607
	Sub Total	**47,744,946**
4000	**Bituminous Layers and Seals**	
	Prime Coat	2,218,730
	Double Surface Dressing	9,107,910
	Sub Total	**11,326,640**
5000	**Ancillary Roadworks**	**4,916,448**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	2,491,683
	Bridges	0
	Sub Total	**2,491,683**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**2,049,754**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	1,500,000
	Truck Parks	1,250,000
	Sub Total	**2,750,000**
A	**Subtotal of Bills**	**81,396,174**
B	**Physical Contingency (7.5% of A)**	**6,104,713**
C	**Financial Contingency (7.5% of A)**	**6,104,713**
D	**TOTAL COSTS**	**93,605,601**

Lot 2 - Summary of Bills of Quantities Option 2 - Granular Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	932,000
	Kerb Stones and Block Paving	518,800
	Others (Stone Pitching, Gabions, Remove Structures et	1,224,990
	Sub Total	**2,675,790**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	5,015,000
	Earthworks - Spoil	1,040,000
	Subgrade	7,381,000
	Stabilisation	7,820,000
	Crushed Rock	9,288,000
	Others (Clearing, Topsoil, Roadbed etc)	13,768,976
	Sub Total	**44,312,976**
4000	**Bituminous Layers and Seals**	
	Prime Coat	2,132,500
	Double Surface Dressing	8,741,250
	Sub Total	**10,873,750**
5000	**Ancillary Roadworks**	**3,595,073**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	995,340
	Bridges	1,912,000
	Sub Total	**2,907,340**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**654,856**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	0
	Truck Parks	0
	Sub Total	**0**
A	**Subtotal of Bills**	**70,214,114**
B	**Physical Contingency (7.5% of A)**	**5,266,059**
C	**Financial Contingency (7.5% of A)**	**5,266,059**
D	**TOTAL COSTS**	**80,746,231**

Lot 3 - Summary of Bills of Quantities Option 2 - Granular Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	517,900
	Kerb Stones and Block Paving	2,040,200
	Others (Stone Pitching, Gabions, Remove Structures et	1,674,855
	Sub Total	**4,232,955**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	6,930,000
	Earthworks - Spoil	4,075,000
	Subgrade	302,500
	Stabilisation	12,430,800
	Crushed Rock	8,385,000
	Others (Clearing, Topsoil, Roadbed etc)	5,637,900
	Sub Total	**37,761,200**
4000	**Bituminous Layers and Seals**	
	Prime Coat	1,930,610
	Double Surface Dressing	7,931,385
	Sub Total	**9,861,995**
5000	**Ancillary Roadworks**	**3,383,612**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	539,524
	Bridges	3,730,000
	Sub Total	**4,269,524**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**2,346,154**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	1,500,000
	Truck Parks	1,250,000
	Sub Total	**2,750,000**
A	**Subtotal of Bills**	**69,799,770**
B	**Physical Contingency (7.5% of A)**	**5,234,983**
C	**Financial Contingency (7.5% of A)**	**5,234,983**
D	**TOTAL COSTS**	**80,269,735**

Lot 4 - Summary of Bills of Quantities Option 2 - Granular Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	708,400
	Kerb Stones and Block Paving	2,403,300
	Others (Stone Pitching, Gabions, Remove Structures et	3,300,982
	Sub Total	**6,412,682**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	14,835,200
	Earthworks - Spoil	4,393,500
	Subgrade	3,118,500
	Stabilisation	13,970,810
	Crushed Rock	6,655,540
	Others (Clearing, Topsoil, Roadbed etc)	5,141,078
	Sub Total	**48,114,628**
4000	**Bituminous Layers and Seals**	
	Prime Coat	1,757,605
	Asphalt Concrete	9,644,100
	Double Surface Dressing	3,170,192
	Sub Total	**14,571,897**
5000	**Ancillary Roadworks**	**1,762,858**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	4,743,572
	Bridges	6,293,000
	Sub Total	**11,036,572**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**927,793**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	0
	Truck Parks	1,250,000
	Sub Total	**1,250,000**
A	**Subtotal of Bills**	**89,270,758**
B	**Physical Contingency (7.5% of A)**	**6,695,307**
C	**Financial Contingency (7.5% of A)**	**6,695,307**
D	**TOTAL COSTS**	**102,661,371**

Lot 5 - Summary of Bills of Quantities Option 2 - Granular Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	995,500
	Kerb Stones and Block Paving	3,482,500
	Others (Stone Pitching, Gabions, Remove Structures et	5,122,802
	Sub Total	**9,600,802**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	16,284,400
	Earthworks - Spoil	6,875,500
	Subgrade	3,151,500
	Stabilisation	12,514,100
	Crushed Rock	7,009,000
	Others (Clearing, Topsoil, Roadbed etc)	7,400,062
	Sub Total	**53,234,562**
4000	**Bituminous Layers and Seals**	
	Prime Coat	1,843,300
	Asphalt Concrete	5,975,200
	Double Surface Dressing	5,603,850
	Sub Total	**13,422,350**
5000	**Ancillary Roadworks**	**2,816,673**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	2,534,874
	Bridges	6,729,000
	Sub Total	**9,263,874**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**2,064,873**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	1,500,000
	Truck Parks	0
	Sub Total	**1,500,000**
A	**Subtotal of Bills**	**97,097,462**
B	**Physical Contingency (7.5% of A)**	**7,282,310**
C	**Financial Contingency (7.5% of A)**	**7,282,310**
D	**TOTAL COSTS**	**111,662,082**

Lot 6 - Summary of Bills of Quantities Option 2 - Granular Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	604,300
	Kerb Stones and Block Paving	1,075,000
	Others (Stone Pitching, Gabions, Remove Structures et	1,411,043
	Sub Total	**3,090,343**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	5,060,000
	Earthworks - Spoil	2,605,000
	Subgrade	6,290,000
	Stabilisation	0
	Crushed Rock	5,800,000
	Others (Clearing, Topsoil, Roadbed etc)	4,971,160
	Sub Total	**24,726,160**
4000	**Bituminous Layers and Seals**	
	Prime Coat	1,544,000
	Double Surface Dressing	7,087,500
	Sub Total	**8,631,500**
5000	**Ancillary Roadworks**	**3,028,900**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	1,791,269
	Bridges	4,360,000
	Sub Total	**6,151,269**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**1,142,660**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	0
	Truck Parks	0
	Sub Total	**0**
A	**Subtotal of Bills**	**51,965,161**
B	**Physical Contingency (7.5% of A)**	**3,897,387**
C	**Financial Contingency (7.5% of A)**	**3,897,387**
D	**TOTAL COSTS**	**59,759,935**

Lot 7 - Summary of Bills of Quantities Option 2 - Granular Base		
Bill No	**Description**	**USD**
1000	**General**	**4,722,455**
	(incl Eng. Accommodations, Cars and Equipments,	
	Relocation of Services, ESMP, HIV/AIDS programs)	
2000	**Drainage**	
	Concrete Pipe Culverts incl inlet and outlet	834,500
	Kerb Stones and Block Paving	3,676,190
	Others (Stone Pitching, Gabions, Remove Structures et	4,531,252
	Sub Total	**9,041,942**
3000	**Earthworks and Pavement Layers of Gravel or Crushed Stone**	
	Earthworks - Fill	10,388,000
	Earthworks - Spoil	4,477,500
	Subgrade	1,782,000
	Stabilisation	7,028,200
	Crushed Rock	5,267,500
	Others (Clearing, Topsoil, Roadbed etc)	4,060,018
	Sub Total	**33,003,218**
4000	**Bituminous Layers and Seals**	
	Prime Coat	1,390,100
	Double Surface Dressing	6,756,750
	Sub Total	**8,146,850**
5000	**Ancillary Roadworks**	**2,011,309**
	(incl Guardrails, Roads Signs, Road Marking,	
	Landscaping etc)	
6000	**Structures**	
	Box Culverts	1,943,534
	Bridges	5,816,000
	Sub Total	**7,759,534**
7000	**Testing and Quality Control**	**6,250**
8000	**Dayworks**	**465,624**
9000	**Street Lights**	**1,718,888**
10000	**Weighbridge and Truck Parks**	
	Weighbridge	1,500,000
	Truck Parks	0
	Sub Total	**1,500,000**
A	**Subtotal of Bills**	**68,376,069**
B	**Physical Contingency (7.5% of A)**	**5,128,205**
C	**Financial Contingency (7.5% of A)**	**5,128,205**
D	**TOTAL COSTS**	**78,632,479**

Project Summary of Bills of Quantities Option 2 - Granular Base		
Bill No	**Description**	**USD**
1000	General	33,057,185
2000	Drainage	39,976,888
3000	Earthworks and Pavement Layers of Gravel or Crushed Stone	288,897,689
4000	Bituminous Layers and Seals	76,834,982
5000	Ancillary Roadworks	21,514,873
6000	Structures	43,879,797
7000	Testing and Quality Control	43,750
8000	Dayworks	3,259,368
9000	Street Lights	10,904,978
10000	Weighbridge and Truck Parks	9,750,000
A	Subtotal of Bills	528,119,509
B	Physical Contingency (7.5% of A)	39,608,963
C	Financial Contingency (7.5% of A)	39,608,963
D	TOTAL COSTS	607,337,435

APPENDIX 2
COMMENTS AND RESPONSES

Comments on Draft Final Feasibility Study and Preliminary Design **TANROADS**

S/N	TanRoads Comment	TanRoads View	Consultant's Response February 2021
1	Some of the areas demarcated to have expansive soils with Wetted Plasticity Index of more than 20%, were verified and found with Wetted Plasticity Index (PIw) of less than 20% with CBR of less than 3% which justify to be weak soils but not expansive	Verify and revise the report accordingly	Correction made in Table 10-2 and Section 10.1.3
2	In section 4.1.1 (page 4-1) of the materials report, it is stated that the sampling was not taken at realigned section between km 46 and 60 because was not accessible and is in high cut section, and that the tests would not be representative.	Test results for the missing chainages should be included in the report.	The section passes through an area with very dense bush and through hilly terrain. The location of alignment test pits at km 50 and 55 is inaccessible and thus sampling could not be carried out. Samples along the realignment section have been taken at Km 46 and at km 60 as these were the extents that were accessible from either end on foot. For this preliminary design stage the assessment of alignment soils along this realignment section has therefore been made based on results of samples taken from either end of the realignment section at Km 46 and Km 60 in combination with the visual classification from google earth. This section would require further investigation during detailed design stage, and this requirement will be indicated in the report.
3	Some areas were noted to be with likely problematic soil, but have not been discussed in the materials report.	Problematic soil locations should be analysed.	Amendment made in section 5.1.3 of and 11.2 the Report.

4	The Coordinates of open pits for alignment soil sampled by Consultant have not been shown in the report, hence imposing difficulties in tracing the pitted locations, only chainages are shown.	The location of alignment soil should indicate the chainages and coordinates.	The coordinates have been included in Appendix 2
5	The report indicates two types of chainages being the Design Chainages and Test pit chainages. The two chainages seem to confuse because the Test pit chainages restart at every village/town centers and do not match with the design chainages. This anomaly was noted along Karatu – Mbulu (Sand source), Hydom –Katesh and Lalago – Kolandoto sections (Gravel sources)	The chainages be consistent.	The Test Pit (TP) chainage is what the sample was referenced as for testing. The design chainage is the location of the TP as per designed alignment. The anomaly has been corrected.
6	The preliminary bills of quantities is missing	BOQ should be submitted.	The BOQ is provided under confidential cost estimate.
7	We are looking forward to receive the updated versions of ESIA and Annexes, ESMMP, RPF and SEP	Updated versions of documents should be submitted	ERM has now updated the V4.0 ESIA to address comment No. 10 to 13 below, including all the Annexures**.**
8	The steps of obtaining the NEMC approval as well as for public disclosure of the E&S documentation should followed accordingly	NEMC process of approval of ESIA reports should be followed.	We are assuming that now with these last comments received from TANROADS and the Letter of No Objection received from KFW, that the ESIA is now ready for submission to NEMC. As we have repeatedly said, ERM will submit the report to NEMC once payment for the draft deliverable (ie this ESIA) has been received.

			Next Steps will include the following: ERM would 1) Have Prof. Mato (whom is an independent Tanzanian Environmental Consultant) review and sign-off the ESIA; 2) Have TANROADS as ultimate client sign-off the ESIA (we assume that this has in effect being done, with the last of the comments now received; and 3) Have Prof. Mato be the one who formally lodges the ESIA with the NEMC.

9	Because the pavement structure will have not negligible impact on the total budget for the works, please add contingencies to all the cost estimates of the preliminary design when the project costs are communicated officially. It is very likely that costs would increase during detailed design, and not only for the pavements.	Revise the cost accordingly	The Cost estimate includes for 7.5% physical and 7.5% financial contingencies.
10	The acknowledgement part should be given by (TANROADS) and not the Consultant.	Revise accordingly	ERM has now removed the ERM acknowledgment and has left a placeholder in the amended V4.0 ESIA where TANROADS can add their acknowledgment.
11	Only name of the EIA Expert who conducted the study should appear on the cover page, and not the firms, the names of firm i.e. ERM and ARDHI University should not appear on the cover page unless they are registered by NEMC and registration evidence given as appendix.	Revise accordingly	Only ARDHI University (whom are registered with NEMC) now appears on the cover page of the ESIA. ERM will obtain ARDHI's NEMC registration certificate once ARDHI (i.e. Prof. Mato) has reviewed and signed-off the ESIA. The certificate will be added to the ESIA as an Annex prior to formally lodging with the NEMC.
12	On Environment Impact Assessment (EIA) Study team only names of EIA registered expert should appear with original signature, the list of other team members should be omitted otherwise their contribution can be reflected in acknowledgment part.	Revise accordingly	All names have been removed in the amended V4.0 ESIA. Only Prof. Mato's name now appears in the List of ESIA Study Team.
13	Environment and Social Monitoring should be described in a separate chapter, as per Environment Management Act (EMA) 2004 and EIA Regulation Amended 2018.	Revise	This has now been presented as a standalone chapter (Chapter 9) in the amended V4.0 ESIA.

MATERIALS INVESTIGATIONS AND PAVEMENT DESIGN REPORT

S/No	Feature	Observations	Recommendation	Tanroads view	Consultant response (April 2020)	Tanroads view (July 2020)	Consultant response (Feb 2021)
1.	Sand Sources, page 4-7	In Appendix 5, there is no comparison of test result with a requirement and no conclusion on the suitability of sand is defined on page 4-7	In Appendix 5, the test results shall be compared with min/max requirements and conclusion on suitability shall be defined on page 4-7	No conclusion is drawn on the suitability of the tested sand samples. Moreover, on page 4-7, sand sources are indicated at chainage 7+700 (LHS) and 63+600. However, chainages in Appendix 5 are indicated to be 10+956 (LHS) and 73+195(RHS). These discrepancies should be reconciled.	Min and Max values have been included in Appendix 5. In section 11.3.4 of the report the general conclusion is that natural sand is scarce in the project area. Therefore, crushed quarry dust shall be the main source of sand for concrete works. The chainages have been corrected.	The Consultant should verify the general conclusion on the suitability of the sands by giving relevant clauses in the ASTM standard that specify the limits for maximum organic content and the limits of particle density for sand, which have been used as basis for assessing quality of the sands.	The chainages have been reconciled. The suitability of sands has been assessed on the basis of maximum organic/deleterious content and the limits of particle density for sand as per ASTM C33 standard. The limits are indicated on the Tables in Appendix 5.
2.	Homogenous sections, page 9-4	In the visual inspection, BCS was noted from km13.5-17.2 and from km 33-37. This is not reflected in the homogenous sections of Table 9-2 and Fig 9-5	Reconcile Table 9-2 and Figure 9-5. Figure 9-5 the blue shaded is labelled as S7 while the legend is labelled as S3	Revise	This has been corrected.	Systematic assessment of laboratory consistency characteristics should be adopted in identifying and classifying potential expansive soils. Visual inspection provides just clues and should not be	For this preliminary design stage the alignment soil sampling and testing was carried out at 5 km intervals. With such large interval, statistical method as per PMDM ignores soil classes of short stretches.

						used as the main criteria for assessment. Guidance provided in the PMDM 1999 should be used for the assessment.	Thus assessment of areas traversing potential expansive soils is based on visual inspection coupled with analysis of available Laboratory sample results. During detailed design alignment soil sampling & testing would be carried out at closer intervals in order to delineate sections traversing expansive soils more accurately as per guidance in PMDM 1999.
3.	Sand Sources, page 9-7	No discussion on the availability and acceptability of sand sources for Haydom-Katesh link. Moreover, there is no discussion or test result for water source for all sections except for Haydom-Katesh section	Discuss source of sand for Haydom-Katesh section and indicate source of water for sections not covered in the report	Information is added, however, based on the tests results there should be a conclusion in the Report on suitability and adequacy in terms of quantity of the materials.	In section 11.3.4 of the report, the general conclusion is that natural sand is scarce in the project area. Therefore, crushed quarry dust shall be the main source of sand for concrete works.	In conjunction to comment 1 above, the Consultant should revisit the classification and suitability assessment of sands before this conclusion is made.	This has been reassessed and reported on.

	Page	Observation/Shortfall	Recommendations	Response	TANROADS observations on the Responses	Consultant's Response Feb 2021
4.	4-2	Figure 4-1 has a vertical axis labeled "% index value" while there are four curves in the Figure	The Figure should include a "KEY" to clearly identify the different curves	Noted and amended in the revised report.	Not revised, (see Pg 4-2)	A legend identifying the different curves as LL, PI, GI, LS is shown on Fig.4-1. For clarity the word "KEY" has be added to the legend.
5.	4-5	Statement in Section 4.1.3 contradicts Figure 4-5 that indicates 14% of the road section passes through S3 sub-grade material.	The statement need to be justified else it is misleading	Figure 4-5 deleted. The statement refers to short stretches of expansive soils sections in areas of poor drainage.	Confirm whether the deletion has not affected the quality of report	Confirmed
6.	4-7	Under QS-3 there is a statement that the source was not sampled for testing the rock is identical to that of QS-2	The statement is unfounded unless Justified by testing. The Consultant should be tasked sample and test the material	These potential quarries are in close proximity to each other and due to environmental reasons it is unlikely that both would be opened by the potential Contractor. Both quarry sources were included as potential indicative sources for this preliminary design phase for further investigation during Detailed Design Phase.	Not properly Addressed, since no representative samples taken for lab test.	QS-3 was identified only as a potential hardstone source for this preliminary design stage, for possible further investigation during detailed design. As it was not tested, reference to it will be removed from the report.

	Page	Observation/Shortfall	Recommendations	Response	TANROADS observations on the Responses	Consultant's Response Feb 2021
7.	5-2	Figure 5-1 has a vertical axis labeled "% index value" while there are four curves in the Figure	The Figure should include a "KEY" to clearly identify the different curves	Noted and amended in the revised report.	No action taken	A legend identifying the different curves as LL, PI, GI, LS is shown on Fig.5-1. For clarity the word "KEY" has been added
8.	6-2	Figure 6-1 has a vertical axis labeled "% index value" while there are four curves in the Figure	The Figure should include a "KEY" to clearly identify the different curves	Noted and amended in the revised report.	KEY not included	A legend identifying the different curves as LL, PI, GI, LS is shown on Fig.6-1. For clarity the word "KEY" has been added.
9.	6-4	Figure 6-5 and Table 6-2 are not consistent with regard to sub-grade classification. Where do the 7% for S3 and 21 % for S7 come from while Table 6-2 has no S3 or S7 classifications? The percentages indicated in Figure 6-5 are not consistent with the length of homogeneous stretches as per indicated chainages,	Figure 6-5 and Table 6-2 should be harmonized. The text should include how the percentages shown in Figure 6-5 have been arrived at.	See answer 4 above. Figure 6-5 deleted.	The omission of the sections (ch.169+200 to 173+000, 213+500 to 216 +600) which were classified as S1(poor subgrade soil) in the previous submission has somehow affected the quality of report ,since it has ignored part of the stretch formerly considered to be Black cotton soil section.	These sections have not been omitted. In the revised report these are referenced as follows: Km 174+400-178+200 Km 218+420-221+515. The soil classification has been changed from S1 to Expansive.
10.	7-4	There is a possibility of typing errors on some of the chainages in Table 7-2.	The data entries in Table 7.2 should be checked for errors and corrected accordingly	Typing error noted and corrected in the revised report.	No action taken (Table 7.2, Pg.7-4)	In table 7-2 the corrected corresponding chainages are:

	Page	Observation/Shortfall	Recommendations	Response	TANROADS observations on the Responses	Consultant's Response Feb 2021
		There is chainage of km 217+000 to 332+600 followed by a chainage km 232+600 to km 237+600 (332 might be a typing error There is also a chainage of km 313+600 to km 226+600 followed by chainage of km 326+600 to km 335+600 (226 might be a typing error)				Km 221+560 to Km 237+160 and km 331+015 to km 340+015
11.	8-1	Figure 8-1 has a vertical axis labeled "% index value" while there are four curves in the Figure	The Figure should include a "KEY" to clearly identify the different curves	Noted and corrected in the revised report.	No action taken	A legend identifying the different curves as LL, PI, GI, LS is shown on Fig.8-1. For clarity the word "KEY" has been be added.
12.	8-3 to 8-4	Figure 8-5 and Table 8-2 are Consistent with regard to sub-grade classification. Where does the 22% S 15 come from while Table 8-2 has S 15 classification? The percentages indicated in Figure 5 are not consistent with the length homogeneous stretches in line with chainages indicated in Table 8-2.	Figure 8-5 and Table 8-2 should be Harmonized. The text should include information on how the percentages shown in Figure 8-5 have been arrived at.	See answer 4 above. Figure 8-5 deleted.	Figure 8-5 deleted. However, changes made in Table 8-2 has altered the subgrade classification which formally was said to be S3 and then are reported to be S15 (367+400 to 374+400). Clarify the discrepancies	The section division has been revised to Km 363+985-km 371+585. The material in this section is Redish Brown Gravel. The subgrade classification has been corrected to S15 Class.
13.	10.1	Figure 10-1 has a vertical axis	The Figure should include a	Noted and corrected in the	No action taken (Figure	A legend identifying the

	Page	Observation/Shortfall	Recommendations	Response	TANROADS observations on the Responses	Consultant's Response Feb 2021
		labeled"% index value" while there are four curves in the Figure	"KEY" to clearly identify the different curves	revised report.	10.1,Pg10-1)	different curves as LL, PI, GI, LS is shown on Fig.10-1. For clarity the word "KEY" has been added.
14.	10-3 to 10-4	Figure 10-5 and Table 10-2 are not consistent with regard to sub-grade classification. Where does the 7% for S7 come from while Table 10-2 has no S7 classification? The percentages indicated in Figure 10-5 are not consistent with the length of homogeneous stretches in line with chainages indicated in Table 10-2.	Figure 10-5 and Table 10-2 should be Harmonized. The text should include information on how the percentages Shown in Figure 8-5 have been arrived at.	Please see answer to 4 above. Figure 10-5 deleted.	Figure 10-5 has been deleted and table 10-2 improved	Issue closed.

Contents in Appendices to the materials Report

15.	Borrow Pit materials	Some of the MDD's are very low compared to the values that would be expected e.g. MDD of 1591 kg/m3 for BP2 at Bassodawish offset along Karatu - Mbulu section and MDD of 1445 kg/m3 for BP2 at Boboa offset alone Mbulu - Havdom section.	The low MDD test results need to be checked if they relate to material characteristics or test errors by repeating the tests.	The MDD of some materials is low due to the sandy nature of the materials, which improves with depth.		Issue closed.
		Significant repetitions material characteristics, in terms of grading, Atterberg Limits, compaction and CBR values, exist in the document that casts doubts whether the recorded test results are genuine e.g. Mwanuzi - Lalago and Lalago - Kolandoto (see Annex I)	The observations casts doubts on the integrity or competence of the Consultant to be trusted with this type of object.	Incorrect information was included in the Report. This has now been corrected in the revised report.	Has incorporated with new test results. However, the design chainage location has changed but with the same Borrow pit name (Along Mwanuhuzi – Lalago, Lalago –Maswa). Bring the clarification	This is due to realignment that resulted in shift of chainages. The revised chainage refers to the new designed chainage.
16.	Subgrade Materials	The indicted Subgrade classes for a significant number of subgrade materials are not consistent with the recorded CBR values at 95% MDD.	The subgrade classification need to be corrected to reflect the test results.	As the testing was done as per AASHTO light compaction (T99) CBR values are taken at 100% MDD.		Issue closed.
		Some of the AASHTO classifications in the document are also not consistent with the recorded particle size distribution	The AASHTO classifications should be corrected in line with the recorded particle size distribution and	Noted and Revised.		Issue closed.

		and Atterberg limits	Atterberg Limits.			
17.	Appendix 4	Some of the rock quarry samples were not tested for LAA, TPF values, SSS and/or ACV.	The Consultant should be tasked to carry out all required tests on quarry Material sources.	This is due to use of mechanical crusher by the laboratories, which results in the crushed material becoming too finely crushed and not enough for all tests. As indicative testing, for preliminary design, the reported results are sufficient. Further testing is required at Detailed Design Stage.		The missing information was not provided by the Arusha Regional Lab, although the tests were requested.
18.	Appendix 5	Significant repetitions material grading characteristics from different sources of fine aggregates exist in the document that casts doubts whether the recorded test results are genuine (e.g. Out of 13 samples from different sources spread along the project route, a set of five (5) samples have exactly the same particle size grading and another set of four (4) samples have exactly the same particle size grading (Annex II)	This is a further justification on lack of Integrity and/or of the Consultant to be trusted with the project of this nature.	Incorrect information was included in the Report. This has now been corrected in the revised report.	Revised with new test results but chainage locations for the BPT name in the new submission has changed.	This is due to realignment that resulted in chainge shift. The revised chainage refers to the new designed chainage.

COMMENTS ON THE DRAFT FEASIBILITY STUDY AND PRELIMINARY DESIGN REPORT FOR THE CONSULTANCY SERVICES FOR STUDY AND DESIGN OF TRANSPORT OPTIONS & TRUNK ROAD CONCEPTS TO REDUCE TRAFFIC CROSSING THE SERENGETI NATIONAL PARK					
S/No	Feature	Issue	Recommendation		
GEOMETRIC DESIGN REPORT				**TANROADS VIEWS**	**Consultants response Feb 2021**
19.	Design standards, page 3-3	Administrative and functional classification of the Road not defined and as such the use of Table 3-3 not explained	Before standard of the Road is defined, its administrative and functional classification shall be defined	However, the added text does not clearly indicate whether the road is classified as “Class A” or “Class B”	The main road is classified as Class A and the Link Roads classified as Class B. Text in section 3.5.1 amended to identify the main road and the link road classification.
20.	Design speed page 3-7	It is indicated that Appendix 4 contains speeds adopted for various sections. However, the criteria for adopting the different design speeds not explained	The Consultant need to conduct terrain classification of the project as per the requirement of the design manual	Not addressed	Terrain Classification has been conducted and sections designated into Flat, Rolling or Mountainous terrain. See Appendix 4 of the Geometric Design Report. The Design Speed has been selected based on Terrain Classification with due consideration to sections passing settlements. For sections traversing flat to rolling terrain a design speed of 100 Kph is selected, while for sections in rolling

					terrain a design speed of 80 Kph has been adopted. For sections through settlements a design speed of 50 kph has been adopted. However, where possible a higher design speed of 80 kph through settlements is used.
21.	Superelevation page 3-8	The manual recommends maximum 8% superelevation for flat, rolling and hilly terrain. However, the Consultant opted to use maximum superlevation of 6% throughout the project	Consultant needs to stick to the recommendation of the manual unless acceptable justification is presented and approved by the Employer	Clarification not satisfactory	Recommendation of the manual have now been complied with.
22.	Vertical Alignment Design, page 3-9/3-10	The Consultant included Tables from GDM for K-values, maximum gradient and critical length of grade	The Report shall discuss locations of steep slope and maximum grade adopted and any effort made to avoid or reduce locations of steep slopes. If an avoidable what design options will be provided to reduce its impact on traffic operation? Moreover, the Report should indicate if minimum grade requirement is met.	Not addressed	The steps that have been taken include realignments of the horizontal alignment, the use of climbing lanes and relief grades as indicated in paragraph 3.8 of the Volume 2D.

23.	Coordination of Horizontal and vertical alignment	No discussion about the need to coordinate the horizontal and vertical alignments	The coordination of horizontal and vertical alignments should be considered at this stage of study. In the process of coordination, an increase in quantities might arise which will impact outcome of the feasibility study	Indicate the page.	Coordination has now been considered in the design. Please ref. para 3.5.2 of Volume 2D. The quantities are within the requirement limits for preliminary design.
24.	Realignments Figure 4-2, Figure 4-3	It looks the realignments will increase length of the project. No discussion if comparison using multicriteria analysis was applied to justify the realignments	Factors like length, gradient, number of drainage structures, susceptibility to flooding, impact on social and environmental factors, overall increase in cost and travel time etc shall be taken into consideration		This was done in the Route Options Report.
25.	Sand Sources, page 4-7	In Appendix 5, there is no comparison of test result with a requirement and no conclusion on the suitability of sand is defined on page 4-7	In Appendix 5, the test results shall be compared with min/max requirements and conclusion on suitability shall be defined on page 4-7	No conclusion is drawn on the suitability of the tested sand samples. Moreover, on page 4-7, sand sources are indicated at chainage 7+700(LHS) and 63+600. However,	Repeated comment. Same as 1 on Materials and Pavement Report.

				chainages in Appendix 5 are indicated to be 10+956(LHS) and 73+195(RHS). These discrepancies should be reconciled.	
26.	Sand Sources, page 9-7	No discussion on the availability and acceptability of sand sources for Haydom-Katesh link. Moreover, there is no discussion or test result for water source for all sections except for Haydom-Katesh section	Discuss source of sand for Haydom-Katesh section and indicate source of water for sections not covered in the report	Information is added, however, based on the tests results there should be a conclusion in the Report on suitability and adequacy in terms of quantity of the materials.	Repeated comment. Same as Comment 3 on Materials and Pavement Report
27.	Horizontal alignment general	Short length of horizontal curves Ratio between successive curves	GDM recommends minimum curve length of 150m For consecutive curves, the ratio of larger curve radius to	Not addressed	This requirement has now been complied with. In locations where the length of the

			the small radius curve should be 1.5		circular curve is less than 150m, transition curves have been used and the total length of the curve for compliance check has been determined by adding half the length of the transition curves on each side as this contributes to the total length of the circular curve, in line international standards. For consecutive curves the ratio of the larger curve to the smaller curve is less than or equal to1.5
28.	Coordination of Horizontal and Vertical curves	Horizontal and vertical curves are not coordinated	Horizontal and vertical curves ends shall either coincide or adequately separated.	Not addressed	This requirement has now been complied with.
29.	SSB-PR-D-11- SSB-PR-D-25	Further to general comment that vertical design could be improved for project, the design in these sections looks like a replica of the existing ground profile	The vertical design should be as smooth as possible and avoid the appearance of undulation. For general guidance to vertical alignment design refer to AASHTO recommendations on pages 282 and 283	Not addressed and justification not satisfactory	The vertical design has been improved throughout including compliant PVI spacing's, removing short curves and grade lengths and combining / rationalizing shorter elements into longer smoother elements. The alignment no longer just follows the existing and is in compliance with AASHTO.
30.	SSB-PR-D-12	Between 32+300-33+500, the average grade is 5.6% and the length of grade is 1200m, which is far more than the	It is recommended that relief grade be introduced in between and climbing lane shall be considered. The profile of existing road between km 32 and 41 could be	Not addressed	The vertical alignment has been improved by providing a relief grade of 4.5% over a length of 235 m, followed by a grade of 2.8%.

		recommended critical length of 370m.	presented for comparison.		
31.	SSB-PR-D-27	In the profile drawing, chainage 77+950 looks a natural low point, but there is no cross culvert proposed at the location	Clarify	Not addressed	A culvert at the low point has been provided and has been shown at Km 77+942.
32.	SSB-PR-D-27 to SSB-PR-D-30	Steep slope as much as 7.9%	Consultant need to check viability of trail route shown on google map east of the proposed route which runs from Mbulu to km 86.5	Consultant's assertion that there is no better alternative will be evaluated further.	The alignment has been agreed to in the Route Option Report.
33.	SSB-PR-D-31	Short grade tangents between long vertical curves	Tangents and vertical lengths in the section shall appear balanced.		The vertical alignment in this section has been improved.
34.	SSB-PR-D-63	Many horizontal and vertical curves	Some of the curves could be eliminated or combined. The radius of horizontal curve at 181+371 could be increased as there is no settlement around	Not addressed	Horizontal curves have been increased to optimize the design speed where there are no restrictions. The vertical design has been improved throughout including compliant PVI spacings, removing

					short curves and grade lengths and combining / rationalizing shorter elements into longer smoother elements. The alignment no longer just follows the existing.
35.	SSB-PR-D-72/74	Many horizontal and vertical curves Black cotton soil section 213+500-216+600 as reported in the Materials Report	Some of the curves could be eliminated or combined and grade could be raised in consideration of BCS	Not addressed	The horizontal and vertical alignment has been improved. The vertical alignment in the black cotton soil section has been revised. (Revised corresponding chainage for BCS Section is Km 218+950 to 220+400).
36.	SSB-PR-D-76	Not clear why fill height is excessive at 218+150	Consultant should provide realistic design	Response not satisfactory.	Vertical alignment has been revised. Revised corresponding chainage is Km 223+096 and new drawing No. is SSB-PR-D-78.
37.	SSB-PR-D-81	Flat slopes as flat as 0.02% adopted	Minimum slope shall be 0.5%	Response not satisfactory.	Vertical alignment has been revised.to a minimum slope of 0.5%.
38.	SSB-PR-D-096	At chainage 275+079, Appendix 1-6 show the presence of existing bridge 100mx3m to be replaced. However, the condition survey does not reflect that.	Clarify	The correction should be to Appendix 1-6, where existing bridges are indicated to be available while the structures are	For the Sibiti Bridge project from Km 221+100 to km 241+212, the Kolondoto to Sibiti section from Km 241+212 to Km 349+770, and the Lalago-Kolandoto section in Appendix 1-6 of the Hydrology report the column heading “existing structures” in fact shows the structures as proposed in the design

		Similar condition applies to bridge at 278+177 and 279+989		drifts	undertaken by ICT, and is not related to the inventory of existing structures contained in Appendix 5. For Clarity, the Column heading for sections designed by ICT in Appendix 1-6 of Volume 2 B has been corrected to "ICT Design Proposal"
39.	SSB-PR-D-098	Profile low point is at 280+100 but the culvert is at 279+989	Location of the culvert shall be adjusted to the low point	Not addressed	The revised location of this is at km 284+375 and coincides with the river crossing point seen on plan and profile drawing SSB-PR-D-99. At this location a 20x3 m single span bridge has now been provided.
40.	SSB-PR-D-102	3 and 5 consecutive sag and summit curves respectively	These curves could be combined	Not addressed	The vertical alignment has been improved The revised drawings are SSB-PR-D-105/106.
41.	SSB-PR-D-103	It is not clear why the vertical profile should come and touch the ground level at 294+950.	The back grade could be lowered and the PVI 294+838 lifted to create a smooth profile.	Not addressed	The vertical alignment has been improved The revised drawings are SSB-PR-D-104
42.	SSB-PR-D-117	Vertical design does not show river profile and existing bridge for proposed bridge at 337+544	Adjust drawing	Not addressed	The drawing has been revised and the ground profile shows the river profile. The revised corresponding chainage is km 341+875. The revised drawings are SSB-PR-

					D-119.
43.	SSB-A-PR-D-12/13	Subgrade of section from 33+000-37+000 is reported as BCS	In the vertical design lifting the profile above the ground level could be considered	Not addressed	The vertical alignment has been raised at this section.
LALAGO-KOLANDOTO PLAN AND PROFILE DRAWINGS					
	SSB-B-PR-D-005/006	Grade as small as 0.06% adopted	Consultant need to adhere to the GDM requirement of 0.5%	Response not satisfactory	The vertical alignment has been revised to comply with the GDM requirement of 0.5%
44.	SSB-B-PR-D-006	From the Arial image, there is an indication of stream at the low point of 16+300 but no structure is proposed	Consultant need to check	Although consultant indicated that a culvert is introduced it is not reflected in the profile drawing	A 0.9 m dia. Pipe culvert has been provide at km 16+300 and the location is shown on drawing No. SSB-B-PR-D-006.
45.	SSB-B-PR-D-017	The bridge at 47+938 is an existing bridge to be replaced. The profile however does not show the river profile at the crossing and hence misleading.	Consultant need to adjust the profile drawing based on river channel survey	Indicate the bridge and its elevations	The drawing has been revised and the ground profile shows the river profile on Drawing SSB-B-PR-D-017.
TYPICAL DRAWINGS					

46.	SSB/PR/F 002	Section A-A did not show detail of the splinter island and paved chevron	Section A-A could be extended up to end of chevron marking and additional section perpendicular to island and minor road could be more explanatory	Not addressed	The splinter island is a standard raised kerb and this has been indicated. Further, the junction drawing has been improved by showing the detail of the chevron markings.
47.	SSB/PR/J 004	Rumble strip dimension not as per the manual	The GDM specifies a maximum height of 15mm. Consultant need to adhere to the manual recommendations	Addressed	Issue closed.

RESPONSE TO COMMENTS ON THE ECONOMIC ANALYSIS REPORT FOR SERENGETI SOUTHERN BYPASS

S/N	**Comments**	**Consultant response**	**TANROADS observations**	**Consultant's response February 2021**
48.	Appendix 1 contains the description of National Economy, Regional Economy, Traffic data, HDM-4 configuration data sets and estimation of Exogenous benefits reports. These reports should not be termed as an appendix. They are required to be part of the main report section.	Relevant information was moved from the Annex to the main report, however detailed data and derivations were kept in an Appendix to maintain the readability of the main report. The structure of the Annex was improved to split the topics into relevant Appendices.	The Consultant not Incorporated the comment. The section still at the appendix section.	To maintain readability relevant parts of the information was moved to the main report. All detailed information is still available in the Annex. The current report structure incorporates comments from all stakeholders and is aimed at optimising the readability and not diverting attention to non-essential (support) information, while at the same time provide all background and support data in the relevant Appendix.

				On specific request from TANROADS all information regarding the National Economy was placed into the Main report (Vol 4), retaining only support tables in the Appendix. Thus, e.g. the regional economies providing a basis for the exogenous benefits is split such that the detailed tables and explanations are provided in the Appendix, while the findings and interpretations thereof are presented in the main report (Volume 4). In addition, an Executive Summary (Volume 1) was prepared for high level stakeholders, which distils only the essential information required to attain an accurate overview of the study findings, results and conclusions
49.	Comment which also was discussed during the last meeting: Economic Appraisal Results presented on table 6-1 page 6-2 indicated that the project is having the same EIRRs for the KMM+KH, KMM and KHM roads despite the change of the discount rate of 12%, 10%, 8%, 5% and 0%.	Not covered.	The Consultant is required to clarify.	As was clarified in the meeting that presented the first draft report. The IRR is the discount rate at which the NPV is equal to zero and does not depend on the discount rate. Raising or lowering the discount rate in a project does not affect the rate

				that would have caused it to break even. Since the different discount rates will return the same IRR, the IRR was not repeated for the different discount rates used. To illustrate the aforementioned relationship between the discount rate, NPV and EIRR, the following chart plots the NPV against the discount rate for KMM+KH, Option 1.