ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY REPORT FOR THE PROPOSED CONSTRUCTION OF THE KISUMU – MALABA STANDARD GAUGE RAILWAY PROJECT

FINAL REPORT

JANUARY 2026

Dar Al -Handasah Consultants
(Shair and Partners)

Ecoscience Engineering Limited

CERTIFICATION

Preparation of this Environmental and Social Impact Assessment (ESIA) Study was commissioned by KRC in fulfilment of requirements of the Environment Management and Coordination Act, 1999; Legal Notice No. 101; The Environmental (Impact Assessment and Audit) (Amendment) Regulations of 2019.

Proponent: KENYA RAILWAYS CORPORATION

Name of Contact Person: Eng. Tobias Otieno

Designation: General Manager - Engineering & Technical Services

Signature / Date / Official Stamp: 05/03/2026

GENERAL MANAGER
ENGINEERING AND TECHNICAL SERVICES DEPT.
KENYA RAILWAYS CORPORATION
P. O. Box 30121 - 00100, NAIROBI-KENYA

Submitted by:

Dar Al Handasah Consultants (Shair and Partners) in association with Ecoscience and Engineering Limited

NEMA Reg. No: 11492

Approved by: Philip Abuor (Lead Expert no. 1710)

Signature/Date/Official Stamp:

dar Dar Al-Handasah Shair and Partners

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PROPONENT DETAILS

Kenya Railways Corporation (KRC)

P.O. Box 30121 – 00100

Workshop Road, Kenya Railways Headquarters,

Off Haile Selassie Ave, Nairobi

Kenya.

Dar Al- Handasah Consultants (Shair and Partners)

6th Floor, Sifa Towers,

Ring Road Kilimani

P.O. Box 76225-00508,

Nairobi, Kenya.

In Association with:

FIRM OF EXPERTS

Ecoscience Engineering Limited

NEMA Reg No: 11492

11th Floor, Mitsumi Business Park,

Muthithi Road, Westlands

P.O. Box 55533- 00200

Nairobi – Kenya

Mobile: +254713566825

Telephone: +254(020)2000582

Email: info@ecoscience.co.ke

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ABBREVIATIONS

^0C	Degrees Celsius
AoI	Area Of Influence
ACC	Area County Commissioner
AIDS	Acquired Immunodeficiency Syndrome
BETA	Bottom-Up Economic Transformational Agenda
CBD	Convention of Biological Diversity
CBOs	Community Based Organizations
CIDP	County Integrated Development Plan
CDRI	Coalition for Disaster Resilient Infrastructure
CEC	County Environment Coordinator
CRA	Commission for revenue Allocation
DCC	Deputy County Commissioner
DD	Data Deficient
EHS	Environment Health and Safety
EMCA	Environmental Management and Coordination Act
EMP	Environment Management Plan
E&S	Environmental and Social
ESCA	Environmental and Social Compliance Audit
ESIA	Environmental and Social Impact Assessment
ESF	Environmental and Social Framework
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Safeguards
FGD	Focus Group Discussion
g	Grams
GBV	Gender Based Violence
GPS	Geographic Positioning System
GRC	Grievance Redress Committee
GVA	Gross Value Added
HIV	Human Immunodeficiency Virus
HSE	Health Safety and Environment
ICD	Internal Container Depot
IFC	International Finance Corporation
IIBP	International Industrial Best Practices
ILO	International Labour Organization
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
KESHP	Kenya Environmental Sanitation and Hygiene Policy
KNBSA	Kenya National Biodiversity Strategy and Action Plan
KRC	Kenya Railways Corporation
KWS	Kenya Wildlife Services

MEA	Multilateral Environmental Agreements
MGR	Metre Gauge Railway
NCA	National Construction Authority
NEMA	National Environmental Management Authority
NEP	National Environmental Policy
NGO	Non-Governmental Organizations
NMK	National Museum of Kenya
NT	Near Threatened
NORM	Naturally Occurring Radioactive Materials
NTU	Nephelometric Turbidity Unit
ODF	Open Defecation Free
OHS	Occupational Health and Safety
OSHA	Occupational Safety and Health Act
PAPs	Project Affected Persons
PS	Performance Standards
PES	Payment for Environment Services
PM	Particulate Matter
PPM	Parts Per Million
PPE	Personal Protective Equipment
PS	Performance Standards
PPV	Peak Particle Velocity
RAP	Resettlement Action Plan
SEP	Stakeholder Engagement Plan
SHIFA	Social Health Insurance Act
SGR	Standard Gauge Railway
TDS	Total Dissolved Solids
TOR	Terms of Reference
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
VECs	Valued Environmental and Social Components
$\mu g/m^3$	Micrograms per Cubic Meter
WBG	World Bank Guidelines
WRA	Water Resources Authority

CHAPTER 1.0 INTRODUCTION

1.1 Project Background

Kenya Railways Corporation (KRC) is a State Corporation under the Ministry of Roads and Transport. It was established in 1978 under the Kenya Railways Corporation Act (Cap 397) following the collapse of the East African Community in 1977, which previously managed the East African Railways and Harbours Corporation. According to Cap 397, the functions of KRC include:

- Development, operation, and maintenance of railway infrastructure in the country
- Ensuring the safety and security of railway transport
- Mobilization of funding and financing for the Corporation's activities
- Facilitating public–private partnerships for the development, operation, and maintenance of railways
- Ensuring compliance with relevant regional and international transport conventions that promote economic and environmental sustainability
- Undertaking research and promoting innovations in the railway sector
- Providing technical capacity development through the Railway Training Institute (RTI)
- Ensuring effective and efficient service delivery in railway operations

Managing rail assets, including land, buildings, workshops, permanent way, signaling and telecommunications systems, rolling stock, vessels on Lake Victoria, and the Railway Museum

Kenya aims to become a prosperous, industrializing, middle-income country, and efficient transport infrastructure is central to achieving this aspiration. The country has adopted a comprehensive transportation corridor approach aligned with national and regional development frameworks, including the United Nations 2030 Agenda for Sustainable Development, the African Union Agenda 2063, the East African Community Vision 2050, Kenya Vision 2030, and the Bottom-Up Economic Transformation Agenda (BETA). Section 3.4 of Kenya Vision 2030 underscores the goal of developing an integrated network of roads, railways, ports, airports, water and sanitation systems, and telecommunications.

The proposed SGR project entails the planning, design, construction, and operation of a modern, high-capacity railway to facilitate the movement of passengers and freight across major economic zones. The alignment will traverse diverse environmental, social, and land-use settings, including urban, peri-urban, agricultural, and environmentally sensitive areas. The project is expected to significantly enhance the regional rail network, improve the standard of Kenya's railway system, and ease pressure on the existing transport infrastructure.

The Government of Kenya, through Kenya Railways, has already completed the Mombasa–Nairobi SGR (Phase 1) and the Nairobi–Naivasha SGR (Phase 2A), in line with KRC's mandate to provide safe, reliable, and efficient rail transport services. However, Phase 2A currently terminates at Suswa in Narok County.

The existing Meter Gauge Railway (MGR) network covers approximately 2,046 km across the country, including the 1,082 km mainline along the Northern Corridor from Mombasa to Malaba, and seven branch lines, as summarized in the table below:

Branch line	Distance in KM	Status
Nakuru-Kisumu	216.7	Operational
Thika-Nanyuki	177	Operational
Konza-Magadi	146.3	Operational (Leased)
Kisumu-Butere	69	Rehabilitated
Gilgil-Nyahururu	76.8	Rehabilitated
Voi-Taveta	118.6	Not operational
Leseru-Kitale	64.9	Rehabilitated

Source- KRC Strategic Plan 2023-2027

The development of the Standard Gauge Railway (SGR) began in 2014 with the construction of Phase 1 (Mombasa–Nairobi, 472 km), followed by Phase 2A (Nairobi–Naivasha, 120 km) completed in 2017. Both phases are fully operational for passenger and freight services.

Kenya Railways Corporation now proposes the construction of SGR Phase 2C (Kisumu–Malaba, 107 km) to enhance regional connectivity from Mombasa to Malaba and onward to Uganda, South Sudan, Rwanda, and the Democratic Republic of Congo. Rail transport is considered safer, more energy-efficient, and environmentally friendly due to its lower carbon footprint. The project is also expected to stimulate socio-economic development locally and regionally.

The proposed Kisumu–Malaba alignment starts at Korando B (Otonglo, km 373+800), traverses the northern outskirts of Kisumu City to Kisian, proceeds northwest to Yala (km 412+000), passes through Butere, Musanda, Koyonzo, and Amukura, and terminates at Malaba (km 482+804). Intermediate stations are proposed at Yala and Mumias (km 440+700). The project will improve regional transport efficiency and strengthen Kenya's rail infrastructure.

SGR Phase 2C passes through five counties: Kisumu, Siaya, Vihiga, Kakamega, and Busia. Key components include the railway track, sleepers, bridges, tunnels, stations, and locomotives, with a terminal station and logistics hub planned for Malaba.

In line with Kenyan Environmental Impact Assessment (EIA) regulations, the project requires an ESIA study to be submitted to NEMA. Kenya Railways Corporation has appointed Dar Hadassah, in association with Ecoscience & Engineering Limited (a NEMA-registered firm of experts), to undertake the ESIA. This document constitutes the ESIA Report for the proposed SGR Phase 2C project.

1.2 Project Need and Justification

Kenya's rapid economic growth in recent years has outpaced the development of its transportation infrastructure, particularly the railway system. The existing metre-gauge railway, built in 1901, has limited capacity, low efficiency, and inadequate service levels, making it unable to meet the rising demand for passenger and freight transport. As a result, over 90% of transport volume has shifted to road networks, increasing congestion and pressure on the road system. These constraints now pose a significant bottleneck to national and regional economic development.

Although minor rehabilitation works have improved the metre-gauge railway, it still meets only a fraction of Kenya's transport needs. In contrast, a standard gauge railway provides greater capacity, higher speeds, and improved passenger comfort. The SGR currently under development will connect to the existing Mombasa–Nairobi–Naivasha line, forming a key section of the East African Standard Gauge Railway network. Designed to China's Class I railway standards, the new line marks an important step toward modernizing Kenya's rail infrastructure and advancing the goals of Vision 2030.

The proposed Kisumu–Malaba SGR serves as a major transport corridor for western Kenya, supporting natural resource development, industrial growth, and daily passenger travel. When completed, it will ease the constraints caused by the existing transport system, enhance regional connectivity, and unlock economic potential along the corridor. The project is therefore essential to sustaining Kenya's rapid economic growth and supporting long-term regional development.

1.3 Project Objectives

The Standard Gauge Railway (SGR) is a flagship Vision 2030 project aimed at modernizing Kenya's transport sector by replacing the ageing meter-gauge system with a faster, more efficient, and reliable rail network. The SGR Phase 2C project will deliver multiple socio-economic, environmental, and infrastructural benefits throughout its pre-construction, construction, operation, and decommissioning phases.

Key objectives and benefits include:

- Reduced Transport Costs: Lower transportation costs across Kisumu, Vihiga, Siaya, Kakamega, and Busia counties, and improved regional trade links with Uganda, Rwanda, Burundi, DRC, and South Sudan.
- Environmental Benefits: Reduced carbon emissions due to decreased reliance on road transport.
- Industrial Growth: Support for industrialization through efficient freight movement and the emergence of industries linked to railway operations.
- Economic Growth: Contribution to GDP growth during both construction and operational phases.
- Strengthened Regional Logistics: Enhanced role of the Port of Kisumu as a key transport and logistics hub for the East African region.
- Preservation of Road Infrastructure: Less strain on roads as freight shifts from trucks to rail.
- Reduced Travel Time: Faster and more reliable travel between Kisumu and Malaba.
- Improved Freight Security: Enhanced safety and security of goods compared to road transport.

- Industrial Park Development: Promotion of industrial parks and Special Economic Zones (SEZs) along the corridor, including Nasewa SEZ, Malaba SEZ & Industrial Park, and the Mundika Industrial Park.
- Job Creation: Employment opportunities for both skilled and unskilled workers during construction and operation, with long-term benefits for regional railway capacity.
- Growth of New Sectors: Expansion of services such as hospitality, accommodation, food, and informal enterprises.
- Increased Local Input Demand: Boost in demand for locally produced materials including steel, cement, aggregates, electrical components, roofing materials, and glass.
- Improved Road Safety: Fewer heavy trucks on the Kisumu–Malaba road, reducing accidents and enhancing safety.
- Regional Integration and Growth: Strengthened economic ties and resource development within the East African region.
- Tourism Promotion: A safer and more affordable travel alternative to inland parks, reserves, and western Kenya, supporting tourism development.

1.4 Purpose of the ESIA

Railway lines and ports are classified as high-risk projects under Kenya's EMCA 1999 (Amended 2015), Second Schedule, as updated by Legal Notice No. 31 of April 2019. Such projects require a full Environmental and Social Impact Assessment (ESIA) and preparation of a detailed Study Report.

This ESIA has been conducted in line with Section 58 of EMCA and the EIA/EA Regulations (2003), as well as relevant guidelines, IFC Performance Standards, and the World Bank Group EHS Guidelines (2007).

The main purpose of the ESIA is to ensure a comprehensive assessment of the project's environmental and social risks and compliance with Kenyan laws and international best practice. Specifically, the ESIA aims to:

- Identify significant environmental and social impacts and propose appropriate mitigation measures.
- Verify compliance with national environmental regulations and industry standards.
- Establish baseline data to support monitoring and evaluation during the project lifecycle.
- Assess climate change risks and vulnerabilities affecting the project.
- Recommend cost-effective mitigation measures for anticipated impacts.
- Provide guidance to stakeholders on managing adverse social impacts.
- Develop a project-specific Environmental and Social Management Plan (ESMP).
- Produce an ESIA Study Report consistent with EMCA CAP 387, summarizing findings and recommendations.

1.5 Overview of Project location/Route Alignment

The geographical location and route of the railway are shown in Figures 2 and 3 below. The Kisumu–Malaba Standard Gauge Railway begins at Korando B–Otonglo area (Km 373+800) and proceeds westward along the northern edge of Kisumu City to Kisian. It then turns northwest to Km 412+000, where the Yala intermediate station will be established.

From Yala, the railway continues northwest, passing through towns such as Butere and Musanda, before reaching the Mumias intermediate station at Km 440+700. It then proceeds further northwest through Koyonzo and Amukura, ultimately terminating at Malaba. The total length of the proposed railway line is approximately 109 km.

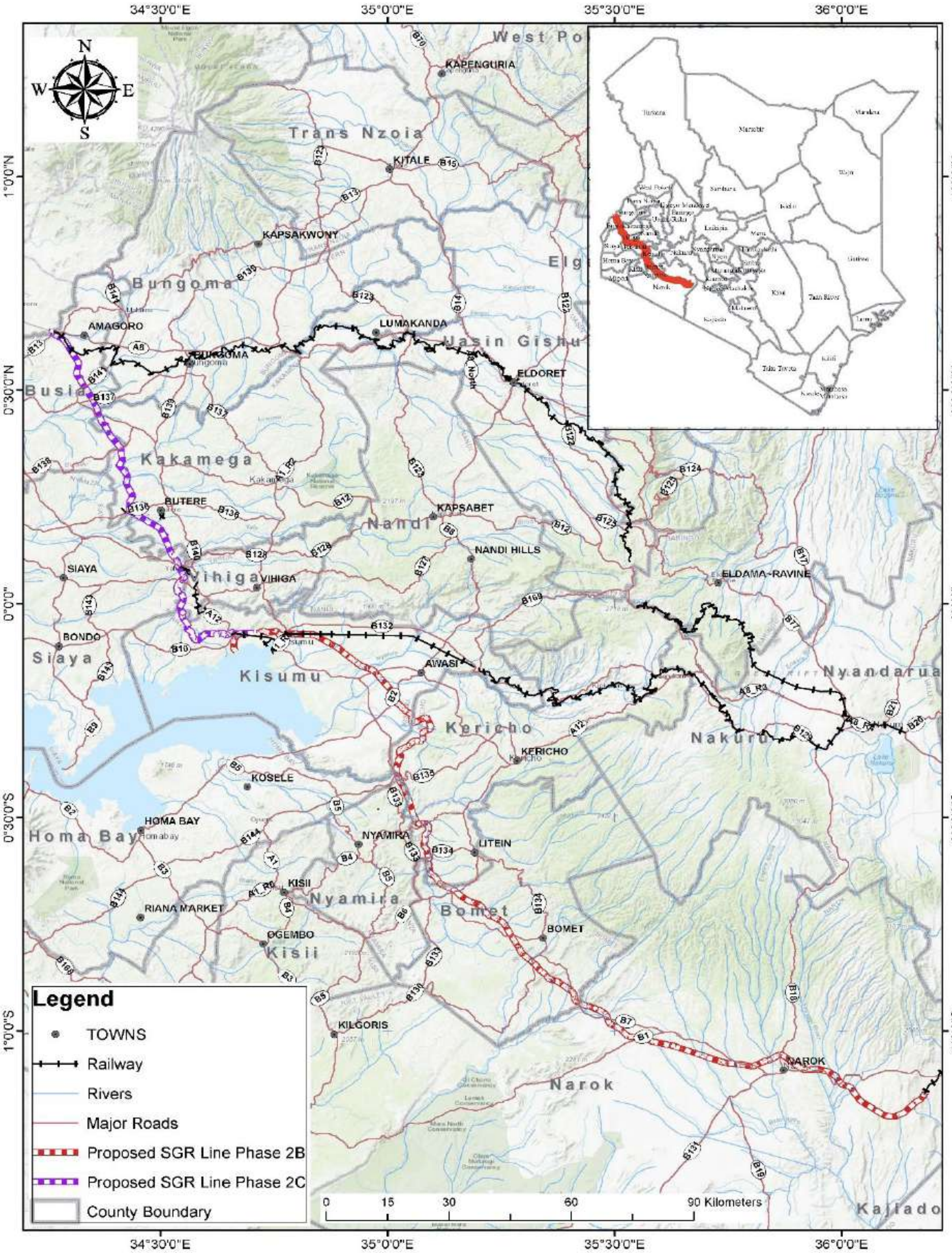

Figure 1: The Proposed SGR Phase 2B and Phase 2C

Source-Ecoscience &Engineering Ltd.

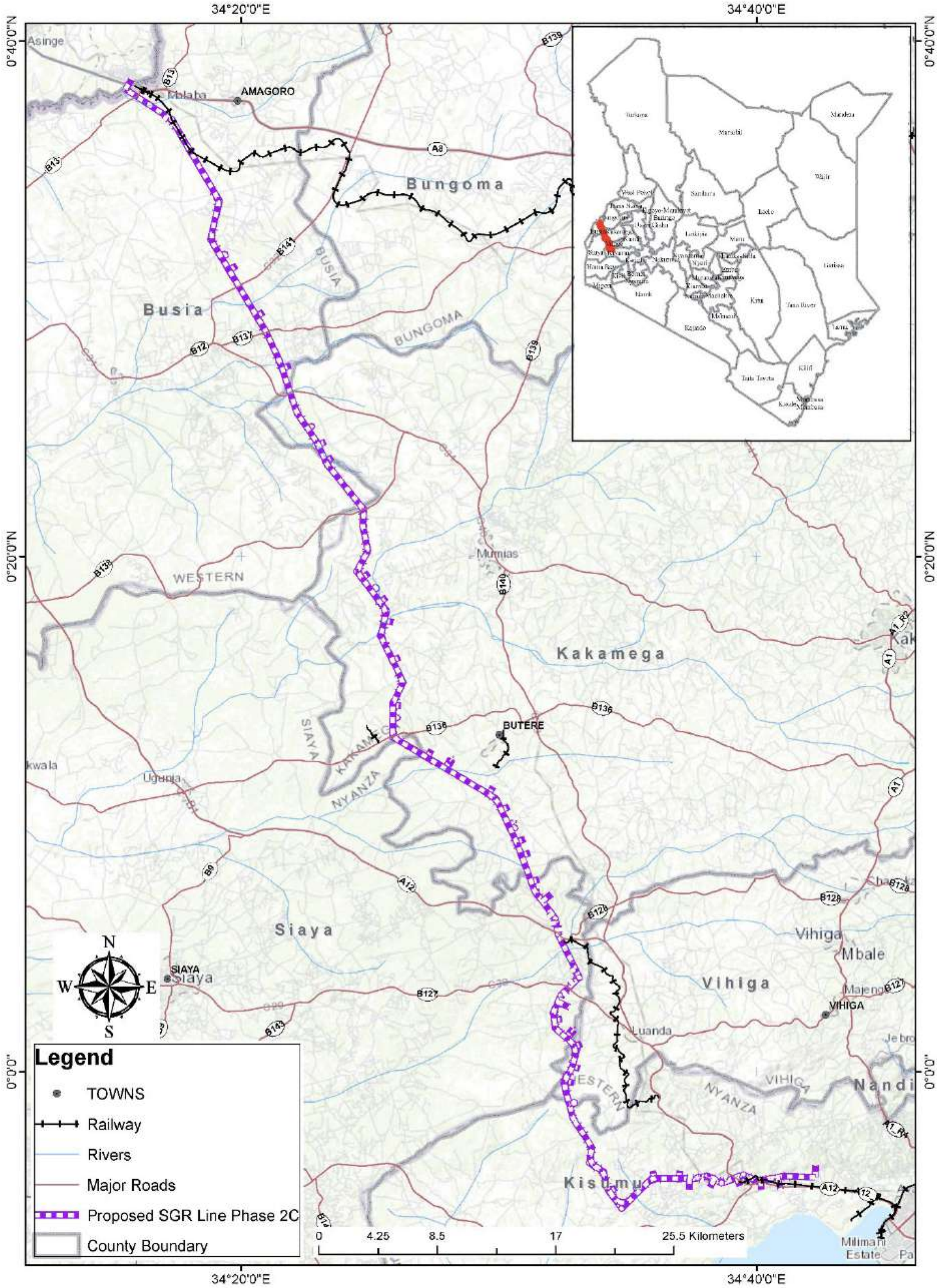

Figure 2: Proposed Route alignment for SGR Phase 2C

Source-Ecoscience &Engineering Ltd

1.5.1 Some of Traversed Features in the Route Alignment

The proposed Kisumu–Malaba Standard Gauge Railway is located in the northwestern region of Kenya. The project begins at Korando B–Otonglo area (Km 373+800) along the Kisumu–Busia highway, proceeds toward Kisian, then turns northwest and terminates at Malaba in Busia County.

The alignment traverses' key towns including Kisumu, Yala, Butere, Musanda, Mumias, Koyonzo, and Amukura before reaching Malaba. Figures 3–6 below illustrate selected features along the route, captured during the screening site visit conducted in May 2025.

Figure 3: Part of exposed Kisima hills

Figure 4: A silted River within the project area

Figure 5: Part of River Nzoia

Figure 6: MGR Crossing R.Yala

1.6 Environmental and Social Consultants Team

The key Dar Hadassah and Ecoscience & Engineering Limited consultants that conducted the ESIA Study are presented in **Table 1** below:

Table 1: ESIA Consultants for the project

Name	Role	Organization	Years' Experience	Tasks
Philip Abuor	Project Lead Expert	Ecoscience	18	Technical review and input to ESIA
Caleb Mango	SIA/Consultant	Ecoscience	20	Social Safeguard Expert
Eddy Okello	Environmentalist	Ecoscience	11	Environmental impact Assessment
John Opiyo	Biodiversity Specialist	Ecoscience	10	Ecology and Biodiversity.
Franklin Rono	Climate Specialist	Ecoscience	8	CRA/CV Assessments
Kevin Majuek	Environmentalist	Ecoscience	15	Report Compilation
Naumy J.Kurui	H&S Advisor	Ecoscience	10	Preparation of OSH Plans
Eng.Daniel Kariuki	Truck Expert/ Hydrologist	Dar	10	Project Description and Alternatives/Railway Safety.
Calvince Arum	Environmentalist	Ecoscience	15	Project Manager

1.7 Structure of this ESIA report

This document presents the main Environmental and Social Impact Assessment (ESIA). The ESIA structure is presented in **Table 2** below.

Table 2: Main ESIA report structure

	Chapter	Contents
	Executive Summary	Presents summarized essential information contained in the report for decision-makers, stakeholders, and the public.
1	Introduction	Provides the description of the project background, location, purpose, objectives, NEMA reporting requirements, study methodology and the overall report structure
2	Project description	Presents the project design and implementation strategies
3	Analyses of Project	Gives an analysis of project alternatives including the no-project

	alternatives	option.
4	Policy, Legal and Regulatory framework	Outlines the overview of relevant legislative regulatory and framework, international guidelines and conventions relevant to this project.
5	Methodology	Provides the framework and process for how impacts are identified, analyzed, and evaluated.
6	Baseline environmental and socioeconomic conditions	Provides description of the baseline environmental and social setting of proposed project and surrounding areas, e.g. climate, soils, geology, vegetation, fauna, land use, socio-economic profile and cultural heritage
7	Climate Change Risk Assessment and Vulnerability Assessment	Identifies Climate-related risks to the project and provides mitigation measures.
8	Public Participation and Stakeholder Engagement	Gives description of the objectives, methods used and summary of results of the public consultation activities undertaken during the project report stage.
9	Project Impacts, Analysis and Mitigation Measures	Provides description of the objectives, methods used and summary of results of the public consultation activities undertaken during the project report stage.
10	Environmental and social management plan	Presents the proposed Environmental and Social Management Plan (ESMP) and site-specific sub-plans
11	Environmental and Social Monitoring Plan	Provides the proposed Environmental and Social Monitoring Plan (ESMP)
12	Conclusions and Recommendations	Briefly presents the environmental and social acceptability of the project, considering the impacts and mitigation measures identified during the assessment process
13	References	Lists all the reference material used in the course of the study.

1.8 Project proponent

KRC proposes to construct Standard Gauge Railway (SGR) track herein referred to as SGR Phase 2C, 107km (Kisumu- Malaba) aimed at improving the regional connectivity from Mombasa to Malaba and Kampala with links to South Sudan, Rwanda and Democratic Republic of Congo. Further, Rail transportation is considered the safest form of transit, and also can help the environment by reducing carbon footprint. Additionally, the project is aimed at promoting socio-economic development of the country and the entire region.

- **Mandate**

The KRC is mandated to establish and operate rail, road and Inland, waterways transport services,

and facilities
The specific mandates of the Corporation include;
i) Provide skills and technology for the railway sector;
ii) Provide efficient and effective railway services;
iii) Leverage assets to grow business; and
iv) Promotion, facilitation and participation in national and metropolitan railway network development.

- **Vision Statement**

To be a provider of world class rail services

- **Mission Statement**

To upgrade and develop an integrated rail network that is safe, reliable and sustainable in providing railway services.

1.9 Roles and Responsibilities

To ensure effective implementation of mitigation measures, the roles and responsibilities of key stakeholders are defined in **Table 3** below.

Table 3: Roles and responsibilities

Stakeholder	Role	Responsibilities
KRC	Project owner	• Ensure the ESIA study is successfully undertaken. • Ensure the final ESIA report is submitted to NEMA. • Pay the license fee and obtain a valid NEMA license.
ESIA Consultants	Undertake ESIA study	• Conduct environmental and social baseline studies. • Conduct stakeholder and public participation. • Identify potential impacts and develop mitigation strategies • Prepare and submit ESIA report to KRC and NEMA for review and subsequent licensing.
NEMA	Licensing and regulatory services	• Review, approve/reject ESIA report. • Issuing ESIA licenses and improvement orders.
County Governments of Kisumu, Siaya, Vihiga, Kakamega and Busia	Local coordination and community liaison.	• Participate in ESIA report review and communicate feedback to NEMA • Support issuance of relevant permits. • Community mobilizations and facilitation of barazas and meetings.

Stakeholder	Role	Responsibilities
Local Communities / Project-Affected Persons (PAPs)	Primary stakeholders	• Participate in public consultation meetings • Provide local knowledge and feedback. • Participate in ESIA report validation.

1.10 Project Timelines and Estimated Cost

According to the feasibility study report, land acquisition, demolition, and construction preparation are expected to take approximately 6 months. Earthworks, as well as medium and minor bridge and culvert construction, will take about 21 months. Major and super-major bridge construction will also require 21 months, while tunnel construction is projected to last 24 months.

Track laying and girder erection are estimated to take 16 months. Construction of the four electrical systems (communication, signaling, power supply, and electrification), station buildings, and E&M supporting works will span 18 months. Joint commissioning and test runs will require an additional 3 months. Overall, the total construction period is estimated at 3 years.

The total estimated project cost is USD 1,229.37 million, translating to approximately USD 9.76 million per kilometer of track.

CHAPTER 2.0 PROJECT DESCRIPTION AND ITS COMPONENTS

2.1 Introduction

This chapter presents a detailed description of the proposed Standard Gauge Railway (SGR) Project and its principal components. It outlines the essential construction and operational requirements, including inputs and materials, expected outputs and waste streams, machinery and equipment needs, workforce demands, project scheduling, investment considerations, and the anticipated lifespan of the railway infrastructure.

To facilitate a clear understanding of the project's structure and progression, the chapter is organized into thematic sections covering the pre-construction activities, the operational and maintenance framework, and the decommissioning phase. It further provides a comprehensive definition of the project and an overview of the route alignment across the five counties—Kisumu, Vihiga, Siaya, Kakamega, and Busia—through which the Kisumu–Malaba SGR Phase 2C will traverse.

The subsequent sections elaborate on the alignment characteristics, key engineering structures, and the spatial distribution of stations and ancillary facilities, providing a foundation for appreciating the project's technical, environmental, and socio-economic dimensions.

2.2 Route Alignment

The Kisumu–Malaba Standard Gauge Railway begins at Korando B Otonglo (km 373+800), proceeds westward along the northern edge of Kisumu City to Kisian, then turns northwest toward km 412+000 where the Yala intermediate station is proposed. The line continues northwest through towns such as Butere and Musanda, with the Mumias intermediate station located at km 440+700. It then proceeds further northwest, passing through Koyonzo and Amukura, before terminating at Malaba. The total length of the line is approximately 109 km. The proposed Phase 2C SGR traverses five counties: Kisumu, Vihiga, Siaya, Kakamega, and Busia. The proposed railway line and its associated infrastructure will be implemented in the counties as displayed below;

i) Kisumu County

The phase 2C alignment within Kisumu County traverses two sub-counties: Kisumu West and Seme. Within these two sub counties, the railway line and associated infrastructure within the County will include:

- Track lay out of approximately 23.67 Km railway line within Kisumu County from Korando B Otonglo to near Otwero primary school (km373+800-km397+470);
- Construction of 1 passing at Kisian West and 1 future passing Station at Ramula, respectively;
- Construction of 3 tunnels;
- Construction 7 bridges (Major and Super Major Bridges);
- Right of Way (ROW); general alignment (70m) and station areas (100-300m);

The **Figure 7** below illustrates the route alignment within Kisumu County.

Figure 7: Layout plan SGR Phase 2C Alignment – Kisumu County

ii. Vihiga and Siaya Counties

The alignment within Vihiga and Siaya Counties traverses Luanda Sub-County in Vihiga, and Gem and Ugunja Sub-Counties in Siaya. Within these two Counties, the railway line and associated infrastructure will include:

- Track layout of approximately 3.43Km railway line within Vihiga County from near Otwero primary school to Puche area (km397+470-km398+500 & km399+000 + km401+400);
- Track layout of approximately 15.66km railway line within Siaya County from near Ramula to near Kalanyo (km398 +500 – km399+000 & km401+400-km414+600& km427+000 – km428+960;
- Stations, 1 intermediate station in Yala;
- 1 tunnel at Mariwa;
- ROW: general alignment of 70m and station areas (200 - 300m).

The general arrangement of the railway track and associated infrastructure is illustrated in **Figure 8** below.

Figure 8: Layout plan SGR Phase 2C Alignment – Siaya and Vihiga Counties

iii. Kakamega County

The alignment within Kakamega traverses 4 Sub-Counties: Butere, Khwisero, Mumias West and Matungu. Within these 4 Sub Counties, the railway line and associated infrastructure within the county will include:

- Track lay out of approximately 35.729km railway line within Kakamega County from Kalanyo through Manyulia Musanda, Mumias west to Munami (km 414+600-km 427+000, km 428+960-447+000 & km451+411-km456+700);
- Stations comprising of 1 intermediate station (Mumias), 3 passing station (Manyulia, Manyulia and Mungatsi);
- Stations comprising of 1 intermediate station, 1 passing station, 1 future passing station;
- 6 bridges (Major and Super Major Bridges), crossing River Lusumu and River Nzoia
- 1 tunnel;
- ROW: general alignment of 70m and station areas (200- 300m).

The concept layout plan is as shown in **Figure 9** below.

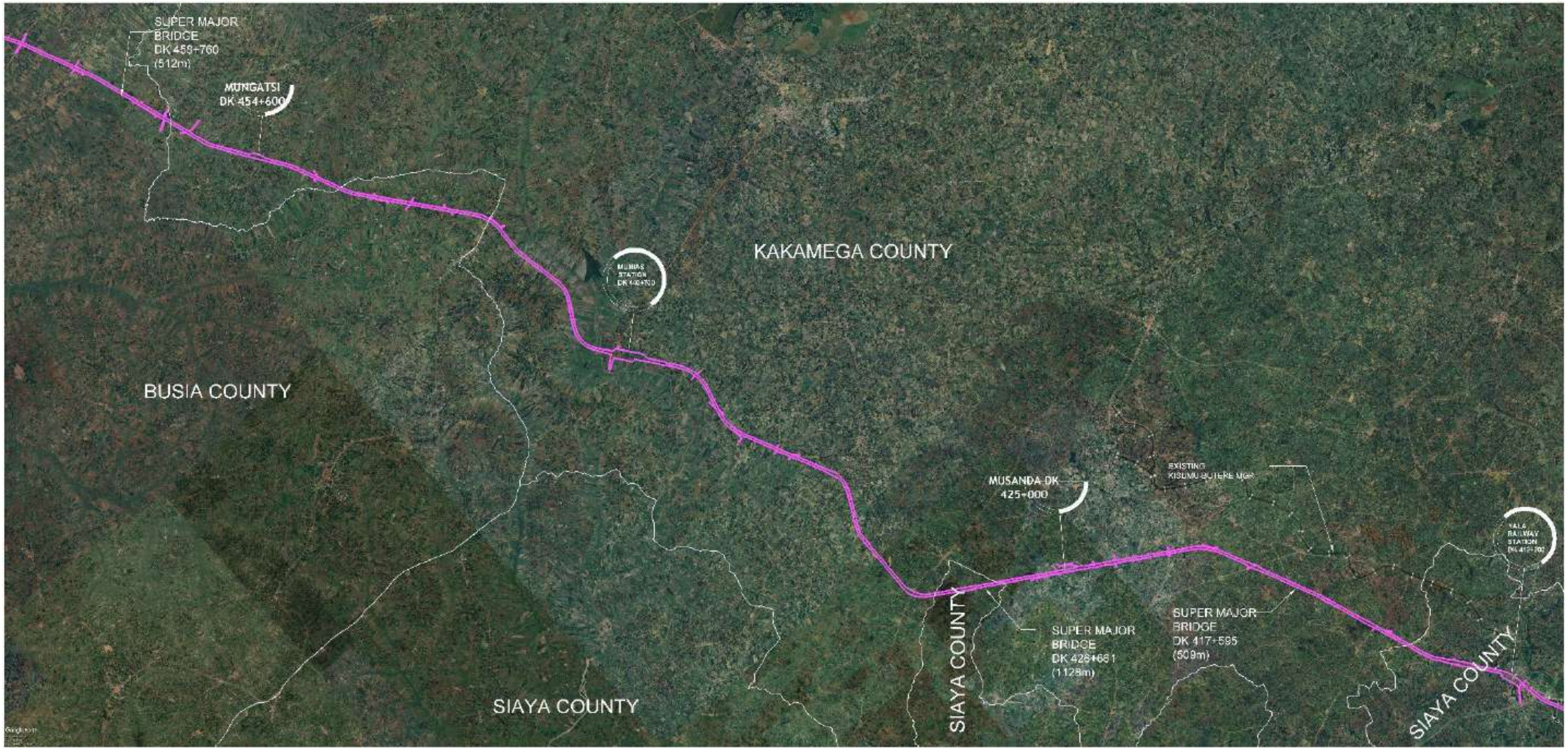

Figure 9: Concept layout plan SGR Phase 2C Alignment – Kakamega County

Source: KRC

iv. Busia County

The alignment within Busia County traverses 4 sub-counties: Butula, Nambale, Teso Central and Teso North. Within these 4 sub counties, the railway line and associated infrastructure within the county will include:

- Track lay out of approximately 30.516Km railway line within Busia County from Munami through Amakura, Kotur, Kamolo to Malaba (km447+000 - km 451+411 & km456+700-km482+804);
- 2 Stations including 1 terminal station at Malaba (km 482+300), and 1 Passing at Amakura;
- 3 Bridges (Major Bridges at km458+760); crossing River Sio, River Walachi and River Malaba;
- Commercial Logistics Hub at Malaba;
- Freight Station at Malaba km482+662;
- ROW: general alignment of 70m and station areas (200- 300m).

The concept layout plans are as shown in **Figure 10** below

Figure 10: Layout plan SGR Phase Alignment – Busia County

Source: KRC

2.1.1 Overview of Salient features

The **Table 4** below highlights the salient features of each county within the Phase 2C project

Table 4: Salient features of each county

County	Salient Features
Kisumu	• Length 23.67 Km railway line within Kisumu County (km373+800-km397+470); • 1 Passing and 1 Future Passing Stations, • 3 Tunnels; • 7 Bridges (Major Bridges); • Right of Way (ROW); General alignment (70m) and Station Areas (100-300m);
Kakamega	• Length (km 414+600-km 427+000, km 428+960-447+000 & km451+411-km456+700);– 35.729Km, • 1 intermediate station, • 3 passing station, • 6 Major Bridges, • General alignment 70m & Station Areas (200m – 300m)
Vihiga	• Length (km397+470-km398+500 & km399+000 + km401+400); (3.43Km)
Siaya	• Length (km398 +500 – km399+000 & km401+400-km414+600& km427+000 – km428+960;(15.66Km), • 1 intermediate station, • 1 tunnel, • 3 Major Bridges, • General alignment 70m & Station Areas (200m – 300m)
Busia	• Length (km447+000 - km 451+411 & km456+700-km482+804) (30.516Km) • 1 Terminal station, • 1 passing station • 3 Major Bridges,

County	Salient Features
Kisumu	• Length 23.67 Km railway line within Kisumu County (km373+800-km397+470); • 1 Passing and 1 Future Passing Stations, • 3 Tunnels; • 7 Bridges (Major Bridges); • Right of Way (ROW); General alignment (70m) and Station Areas (100-300m);
	• General alignment 70m & Station Areas (200m – 300m)

2.2 Project Components

The key project components of the proposed SGR are listed below:

- Bridges;
- Tunnels;
- Railway Stations;
- Logistic Hubs;
- Rolling Stocks (Locomotives and Cars);
- Track structures and foundation
- Signaling and Communication

Some of these components listed above are discussed below;

2.2.1 Stations

The project includes the development of nine **(9)** stations along the alignment, which are functionally categorised to serve the operational needs of the railway and the economic requirements of the region. The siting and design of these stations represent significant nodes of development and potential environmental impact.

Station Categories: The stations are classified as follows:

- **Terminal Station (1 No.):** The proposed main station at Malaba Terminal Station, the most significant facility proposed at the Malaba border station. This is designed as a large, complex facility serving as a major international logistics hub. It will need to accommodate customs and immigration facilities, freight marshalling yards, container handling equipment, and extensive warehousing to manage the cross-border flow of goods between Kenya and Uganda.

- **Intermediate Stations (2 No.):** These were proposed in Yala and Mumias. They were designed to handle both passenger traffic and local freight, acting as vital economic interfaces for the surrounding communities.

- **Passing Stations (6 No.):** These are smaller, primarily technical stations designed to allow trains travelling in opposite directions on the single-track line to pass each other safely. These include the proposed Kisian West, Ramula, Manyulia, Musanda, Mungatsi and Amakura

Key Station Designs:

- **Yala and Mumias Stations:** These intermediate stations are designed as combined passenger and freight facilities. They will include passenger platforms, station buildings, and dedicated freight yards with loading/unloading tracks and warehousing. They are also the designated sites for proposed Commercial Logistics Hubs.

- **Malaba Terminal Station:** This is the most complex station zone, comprising a Terminus Station for passengers, a separate Freight Station. This separation of functions is designed for operational efficiency but will require a significant land footprint and careful management of local traffic.

There will be 9 stations in total. These will include 1 terminal station, 2 intermediate and 6 passing stations. **Table 5** below presents the number and nature of stations and the status of stations.

Table 5: The stations along the proposed railway line

S/N	Station	Station Center Mileage	Distance between Stations(km)	Station Nature
1	Kisian West	km386+900		Passing station
2	Ramula	Km396+900	10	Passing station
3	Yala	km412+000	15.1	Intermediate station
4	Manyulia	km418+650	6.65	Passing station
5	Musanda	km430+900	12.25	Passing station
6	Mumias	km440+700	9.8	Intermediate station
7	Mungatsi	km454+000	13.3	Passing station
8	Amukura	km467+900	13.9	Passing station
9	Malaba	km481+000	13.1	Terminus station

Source: Feasibility Study Report for Kisumu Malaba (SGR Phase 2C), June 2023

2.2.2 Technical Standards of the proposed SGR

The technical standards for Phase 2C are consistent with those established for the rest of the SGR network to ensure complete operational interoperability. These standards are not merely guidelines but are fundamental design parameters that dictate the physical form and operational capacity of the railway. They represent the engineering of the project, and understanding their implications is critical to assessing the environmental and social impacts. **Table 6** below summarizes the technical standards of SGR project.

Table 6: Technical standards of railway

Item	Kisumu-Malaba
Railway classification	China Railway Class I
Number of main tracks	Single-track
Design running speed	Passenger train: 120km/h; freight train: 80km/h
Minimum radius of curve	Generally, 1200m, 800m in difficult conditions; determined in combination with design speed for speed limiting terminal sections
Ruling grade	Double-locomotive: 12‰
Track type	Jointed track
Track Structure	Ballasted
Traction type	Diesel (with electrified conditions reserved)
Locomotive type	Passenger locomotive: DF11; freight locomotive: DF8B
Traction mass	4,000t
Effective length of reception tracks	880m; Reserve for 1,050 m
Block type	Automatic block between stations
Construction clearance	Basic structure clearance for double-deck container transport
Train Operation Control System	CTCS-0
Coupler type	Automatic Coupler

Table 7 below summarizes the implications of technical standards on ESIA study.

Table 7: Implications of technical standards to ESIA study

Parameter	Specification	Implication for Physical Works and Environmental Interaction
Railway Class	China Railway Class I	This is the highest classification for a mixed-traffic railway, mandating a design philosophy centred on high safety margins, long-term durability, and operational resilience. For the ESIA, this means that the physical works will be substantial. The requirement for a smooth and stable track

		bed necessitates large-scale earthworks, high-quality, certified construction materials (ballast, concrete, steel), and robust, large-scale structural designs for all bridges and tunnels, leading to a significant construction footprint.
Design Speed	Passenger: 120 km/h; Freight: 80 km/h	The design speeds are a primary determinant of the track's geometry. To ensure safe and comfortable operation at 120 km/h, the horizontal alignment is restricted to large curve radii, and the vertical profile to gentle gradients. In the undulating terrain of Western Kenya, achieving this geometry requires extensive "cut-and-fill" operations to smooth the natural landscape, dictating the width of the land corridor and the scale of earthworks.
Traction Type	Diesel (with provision for future electrification)	The infrastructure must be designed to accommodate the dynamic loads, weight, and operational characteristics of heavy diesel locomotives. For the ESIA, this has direct implications for the operational phase, particularly in relation to noise (engine rumble) and atmospheric emissions (exhaust fumes), which will be primary considerations for communities near the alignment. The provision for future electrification also means that vertical clearances at bridges and tunnels are larger than would otherwise be required.
Ruling Gradient	12‰ (1.2% grade)	This is the maximum allowable longitudinal slope of the track and is the single most important factor driving the scale of earthworks. Adhering to this gentle gradient across the hilly and undulating terrain is the primary reason for the project's extensive deep cuttings and high embankments, as well as the need for numerous viaducts and tunnels to maintain a smooth vertical profile that locomotives can safely and efficiently climb.
Track Structure	Ballasted track with jointed rails	This traditional track structure requires the quarrying, crushing, and transport of vast quantities of high-quality stone (ballast) to form the track bed. Sourcing this material will have off-site impacts at quarry locations. Operationally, the joints between the rails produce a characteristic rhythmic "click-clack," which is a key component of the railway's noise signature and a primary source of potential noise disturbance.
Right-of-Way	70m (general); 100-300m (stations)	This legally defined corridor represents the area of permanent land acquisition and direct physical disturbance. All construction activities, permanent structures, drainage systems, and operational safety zones are contained within this footprint. For the ESIA, it is the primary boundary for assessing direct impacts on land use, biodiversity, and community severance.

2.2.3 Railway Track

The main line of the Kisumu–Malaba Railway is designed with heavy-duty, ballasted tracks and a jointed rail system. Currently, two types of track systems exist jointed tracks and continuous welded rail (CWR) and for the proposed SGR, the jointed track option has been selected. The line is constructed to the standard gauge of 1.435 m, which is wider and more stable than the existing metre-gauge railway. The railway is currently being developed as a single-track line.

2.2.4 Bridges

There are a total of 29 bridges spread through the corridor with 7 in Kisumu County, 1 in Vihiga County, 5 in Siaya County, 12 in Kakamega County and 4 in Busia County. The bridges are listed in the table below.

Table 8: Schedule bridges

No.	Location (km)	Span	County/River	No.	Location (km)	Span	County/River
1	377+500	Super major (1,813m)	Kisumu MGR & Kisian River	16	417+625	18/32	Kakamega
2	379+600	830m	Kisumu	17	420+171	8/32	Kakamega
3	381+500	Major (650m)	Kisumu	18	421+664.5	13/32	Kakamega
4	382+550	150m	Kisumu	19	426+711	31/32	Kakamega
5	383+750	11/32	Kisumu	20	431+794	9/32	Kakamega
6	385+550	16/32	Kisumu	21	435+264.5	4/32	Kakamega
7	389+700	11/32	Kisumu	22	438+326.5	8/32	Kakamega
8	398+600	Super major (1,248m)	Vihiga/Siaya	23	439+695.5	12/32	Kakamega
9	399+769	4/32	Siaya	24	441+854	3/32	Kakamega Nzoia River
10	401+213	11/32	Siaya	25	451+411.5	8/32	Kakamega/Busia
11	403+744	10/32	Siaya	26	452+653	8/32	Kakamega
12	407+739.5	Super Major (608m)	Siaya	27	458+760	16/32	Busia
13	410+436.5	Super Major (998m)	Siaya Yala River	28	462+937	20/32	Busia Mayanja River
14	414+582.5	7/32	Siaya/Kakamega	29	466+778	18/32	Busia
15	416+598	2/32	Kakamega				

Source: SGR Phase 2C Resettlement Action Plan study report, June 2025

2.2.5 Road Crossings

Some of the crossings along the corridor are shown in the table 9 below;

Table 9: Road Crossings

Grade separated crossings	Grade separated crossings
• Kisumu – Busia highway crossing in Kisumu County at Ojola area km379+700 (Viaduct) • Maseno – Kombewa road at km394+650 (tunnel) • Butere – Ugunja Road at km422+150 (over pass)	• Siaya County at Yala Town km410+890 • Luanda Town – Siaya Town road at km406+450 at Sinaga • Luanda Town – Sagam market road at km404+300 • Mumias – Busia Road at km456+930 Nambale Kotur Road at km465+500

The SGR intersects the MGR line at several points, including around km377+508 (Kisian), km378+500, km380+995 near Lela. It also runs within the MGR line in parts of Kisumu town and the Kisian and Yala areas. Key river crossings will include River Yala, River Nzoia, River Sio, among others.

Figure 11: Proposed Viaduct crossing at Ojola, Kisumu County

Figure 12: Proposed crossing at Yala Town

2.2.6 Tunnels

The corridor has 4 tunnels found necessary in the face of the steep terrains in Kisumu and parts of Siaya County sections of the route. The tunnels are as follows;

- Tunnel No. 1 of 740m long from km389+000 to km389+740 in Kisumu County
- Tunnel No. 2 of 780m long from km390+150 to km390+930 in Kisumu County
- Tunnel No. 3 of 2,050m long from km394+650 to km396+700 in Kisumu County
- Tunnel No. 4 of 755m long from km402+715 to km403+470 in Siaya County

Figure 13: Proposed Tunnel 3 (2050m) at Mariwa area, km 394+000

2.2.6 Track structure and Foundation

The long-term stability and performance of the railway are dictated by the quality of its track structure. The design specifies a heavy-duty, ballasted system engineered to support a maximum axle load of 25 tonnes.

The structure consists of the following key components:

- **Subgrade (Foundation):** A robust 2.5-meter-thick subgrade bed forms the core foundation. It is constructed in two highly compacted layers using specified gravel, crushed stone, and sandy soils (Groups A, B, and C) to create a stable, load-bearing platform and prevent long-term settlement.
- **Ballasted Track Bed:** A 50 cm deep, double-layer Class I ballasted track-bed is laid on top of the subgrade. This crucial layer of crushed stone provides excellent drainage and allows for precise, ongoing adjustments to the track's alignment, which is essential for maintenance.
- **Sleepers and Fasteners**: The mainline will utilize New Type II prestressed concrete sleepers at a density of 1,760 sleepers per kilometer. These are vital for transferring forces from the rails to the ballast. They are secured with a Type II elastic fastening system, which maintains the precise 1,435 mm standard gauge and absorbs train-induced vibrations.
- **Rails:** The design specifies 60 kg/m standard steel rails, a profile appropriate for the heavy freight demands and 25-tonne axle loads.

2.2.7 Locomotive facilities

Passenger train locomotive routing: Rebuild the diesel locomotive (DF4D) of the Nairobi locomotive depot to take on the passenger train locomotive routing between Nairobi and Malaba.

Freight train locomotive routing: Rebuild the diesel locomotive (double locomotives of DF8B) of Nairobi locomotive depot to take on the freight locomotive routing between Nairobi and Malaba. The crew working system proposed is crew shifting system with configurations of short term and long-term locomotives as shown in **Table 10** below.

Table 10: Type and number of Locomotive facilities

Item	Passenger Train Locomotive		Freight Train Locomotive	
Type of locomotive	DF4D	DF4D	DF8B	DF8B
Number of locomotives	4	6	56	100

2.2.8 Signalling and Communition & Power Supply System

1. Signalling System

The signalling system is designed to ensure safe and efficient train operations, matching the standards of the existing Mombasa-Nairobi SGR.

- **System Type:** The project adopts a **Computer Interlocking (CI) system** for stations.
- **Traffic Control:** It utilizes a **Centralized Traffic Control (CTC)** system.
    - **Integration:** The new CTC system will be incorporated into the existing **Nairobi CTC Dispatch Centre**. A new CTC dispatcher station will be added to the centre, while station-level subsystems (including self-regulating equipment and maintenance terminals) will be installed at new stations.

    - **Network:** The system uses an independent double-loop self-healing network for high reliability.
- **Train Control System (CTCS)**
    - The line is equipped with the **Chinese Train Control System (CTCS)**.
    - **Automatic Blocking:** An automatic blocking system is used for the interval between stations to manage train spacing and safety.
- **Safety & Monitoring**
    - **Signal Monitoring:** A centralized signal monitoring system is deployed to oversee equipment status.
    - **Lightning Protection:** Comprehensive lightning and electromagnetic compatibility protection is implemented for all indoor and outdoor signal equipment.

2. Communication System

The communication infrastructure is robust, supporting both voice and data for operations, safety, and passenger services.

- **Transmission System:** A **SDH (Synchronous Digital Hierarchy)** transmission system is used to carry various services (signalling, video, voice) over optical fibre cables.
- **Mobile Communication (GSM-R)**
    - **Technology:** The **GSM-R** (Global System for Mobile Communications – Railway) standard is adopted.
    - **Coverage:** It uses a single network coverage mode. Tunnels are covered using distributed base stations and leaky coaxial cables.
    - **Usage:** It supports train dispatching, maintenance communication, and train control data transmission.
- **Dispatching Communication:** A dedicated digital dispatching system connects all stations to the central dispatching centre.
- **Video Monitoring:** An **Integrated Video Surveillance System** is installed at stations, bridges, and key facilities. It connects to the existing regional node centre, with cameras in high-risk and high-traffic areas.
- **Other Systems:**
    - **Video Conferencing:** Connected to the existing MCU at the dispatching centre.
    - **Clock System:** A master-slave synchronization system ensures unified time across the network, utilizing GPS/BITS signals from the Nairobi centre.
    - **Optical Cable Monitoring:** Installed to monitor the integrity of the fibre optic network.

3. Power Supply (Electric Power)

- **Power Sources:**
    - **External Supply:** Reliable **220V or 380V external power** is sourced from the national grid (Kenya Power) for stations, communication base stations, and radio units.
    - **Reliability:** Key loads (Signal, Communication, etc.) are treated as **Secondary Loads**, requiring high reliability.
- **Backup Power:**
    - **Diesel Generators:** Stations and critical facilities are equipped with **auto-start diesel generators** to ensure continuity during grid outages.

- **UPS/Batteries:** Communication and signalling equipment rooms are fitted with **Uninterruptible Power Supply (UPS)** systems and sealed valve-regulated lead-acid (VRLA) batteries (providing -48V DC) to bridge the gap between grid failure and generator start-up.

- **Distribution:**
  - **Station Loads:** Concentrated loads at stations include signalling rooms, communication rooms, water pumps, and station lighting.
  - **Section Loads:** Scattered loads along the line include radio base stations and interval signalling equipment.
  - **Lighting:** Comprehensive indoor and outdoor lighting is provided for stations, yards, and tunnels (including emergency lighting).
- **Traction Power (Future):** While the line initially operates with diesel locomotives, the design (clearances, etc.) reserves provisions for **future electrification** (overhead catenary system), which would require 110kV external power feeds to traction substations in the long term.

2.2.9 Operations

1. Operational Model & Management

- **Unified Management:** The railway will not be operated in isolation. It is recommended to be unified with the Mombasa-Nairobi and Nairobi-Malaba SGR lines under a single dedicated operating company. This approach mirrors the current model where a dedicated operator (currently engaged by Kenya Railways) manages the infrastructure to ensure efficiency and reduce costs.
- **Operating Strategy:** The line is designed for mixed passenger and freight traffic, serving as a critical link in the East African Railway Network corridor.

2. Traffic Organization

<u>Passenger Transport</u>

- **Service Frequency:**
  - **Initial & Near Term:** 2 pairs of trains per day.
  - **Long Term:** 3 pairs of trains per day.
- **Capacity:** Trains will initially have a capacity of **1,300 passengers**, increasing to **1,600 passengers** in the long term.
- **Speed:** Designed for a maximum operating speed of **120 km/h** for passenger trains.

<u>Freight Transport</u>

- **Primary Cargo:** The line is dominated by "pass-through" freight traffic. Key commodities include **containers (approx. 30% of volume)**, coal, fuel/petroleum products, and cement.
- **Container Strategy:**
  - **Initial Phase:** Single-deck containers will be used (matching the current Mombasa-Nairobi operations).
  - **Future Phase:** As volumes increase and the Naivasha-Malaba connection is fully realized, operations will transition to **double-deck container** transport to maximize efficiency.
- **Volume Capacity:** The system is designed to handle a long-term freight volume of **23**

million tons per year.

- **Speed:** Designed for a maximum operating speed of **80 km/h** for freight trains.

3. Station Operations

- **Station Distribution:** A total of **9 stations** are planned.
  - **Opening Initially (6 Stations):** Kisian West, Yala, Mumias, Amakura, Malaba, and Manyulia.
  - **Reserved for Future (3 Stations):** Ramula, Musanda, and Mungatsi.
- **Key Hubs**
  - **Passenger & Freight Handling:** Yala and Mumias stations will serve as intermediate stations handling both passengers and freight.
  - **Border Operations: Malaba Station** will function as a major intermediate station and border crossing point, featuring a **Logistics Hub** and facilities for train inspection and repair.

4. Maintenance and Technical Facilities

- **Maintenance Strategy:** A **Train Inspection and Repair Point** will be established at **Malaba Station** to handle line maintenance and rolling stock checks.
- **Traction:** The line will initially operate using **Diesel (Internal Combustion)** locomotives (such as the DF8B freight locomotive). The design preserves technical conditions (like clearances) to allow for **future electrification**.

5. Financial Viability of Operations

- **Sustainability:** The financial analysis indicates that the project requires government support to be viable. It is estimated that a **Government subsidy (approx. USD 135 million/year)** will be needed during the 2027–2031 period to ensure healthy continuous operation, raising the Financial Internal Rate of Return (FIRR) from 1.21% to a feasible 5.57%.

2.3 The Project Implementation Activities

For the purposes of this ESIA, the SGR project implementation activities can be split into three key phases as outlined below:

i. **Construction Phase**

- Site preparation & earthworks; clearing and grading land /site clearance
- Track laying & Infrastructure Development
- Drilling of wells, water and sanitation treatment systems
- Construction of burrow pits
- Temporary materials storage yard
- Establishment of campsites
- Construction of stations, sub stations and passing stations.
- Construction of bridges, viaducts and other related infrastructure.

ii **Operations Phase**

- Regular inspections and preventive maintenance
- Track repairs and system upgrades
- Materials and waste handling

iii **Decommissioning Phase**

- Dismantling and removal of equipment and temporary infrastructure
- Restoration of site vegetation
- Refiling of burrow pits
- Decommissioning of camp sites and yards

2.4 Railway development phases

Railway construction involves several key activities comprising of the following:

- **Planning and Feasibility Study** – Conducting feasibility studies, environmental and social impact assessments, and route selection;
- **Land Acquisition & Site Preparation** –Land acquisition & stakeholder consultations and relocating utilities;
- **Design & Engineering-** Detailed engineering designs for stations, tracks, bridges, and tunnels; selection of materials and construction methodologies; integration of signaling and communication systems;
- **Earthworks & Grading** – Excavation, embankment construction and soil stabilization and drainage system installation;
- **Track Laying & Infrastructure Development** – Installing sleepers, ballast, and rails to form the railway line; construction of bridges, tunnels, and stations; electrical and signaling system setup – implementing modern railway control systems for efficient train operations;
- **Stations & Depots Development** – Constructing passenger stations, freight terminals, and maintenance depots;
- **Testing & Commissioning-** Trial runs to assess track integrity and operational efficiency; Safety inspections and regulatory approvals;
- **Operations & Maintenance** - Regular inspections and preventive maintenance; Track repairs and system upgrades; Passenger and freight service optimization.

2.5 Project timelines

The anticipated construction period of 36 months. Figure 12 below outlines the indicative overall the project schedule.

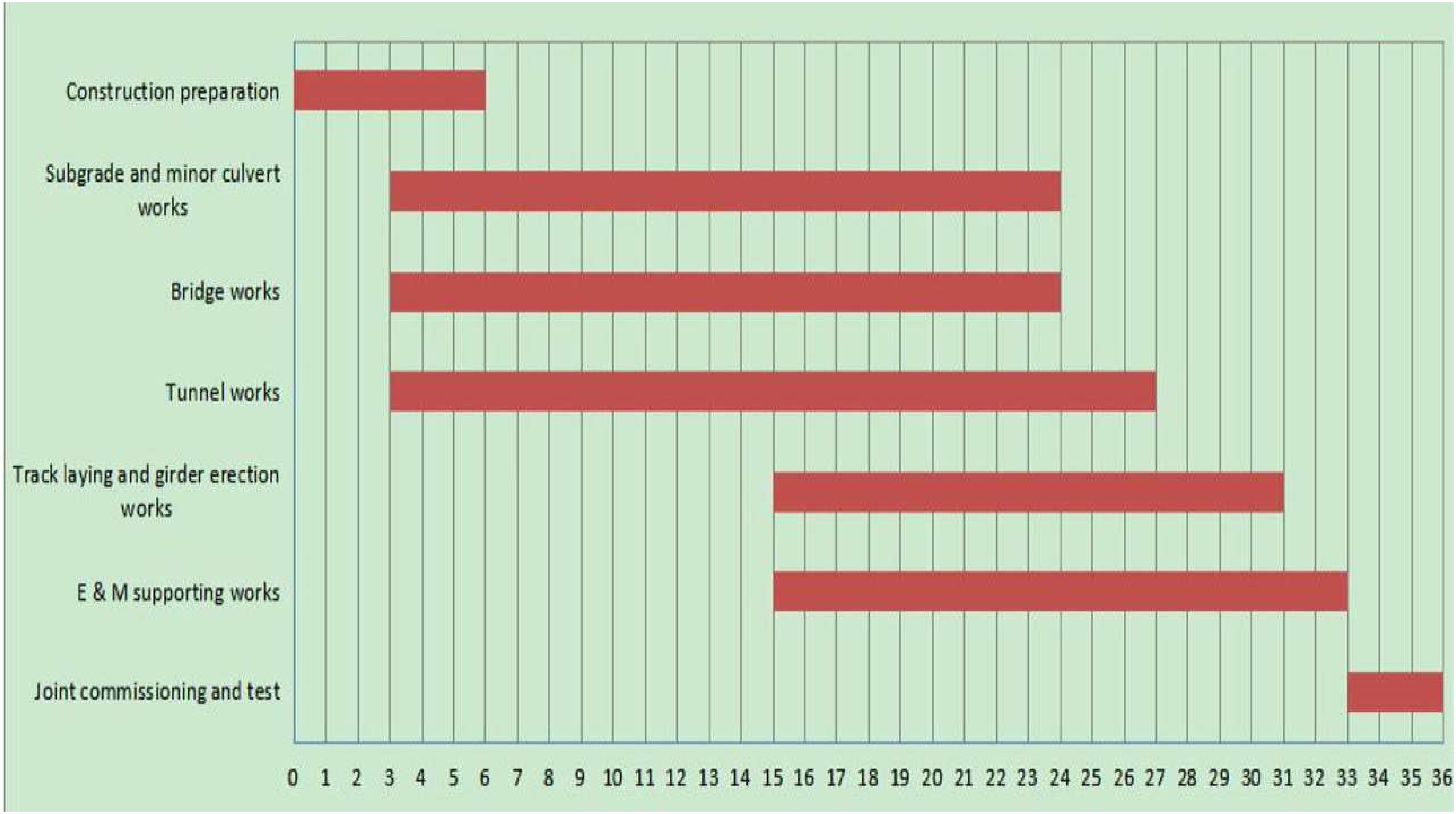

Figure 14: Project activities

Source: KRC

CHAPTER 3.0 ANALYSIS OF PROJECT ALTERNATIVES

3.1 Introduction

This chapter presents the assessment of alternatives considered for the proposed Standard Gauge Railway (SGR) Project, including the "No Project" option, route alternatives, technological options, and locomotive configurations. The analysis aims to identify the most environmentally, socially, and economically feasible alternative in line with Kenya's development priorities and regional transport objectives.

3.2 Analysis of alternatives

3.2.1 No Project Alternative

Under the No Project scenario, the existing transport challenges road congestion, high accident rates, increased emissions, and rising logistics costs would persist or worsen. The alternative would also limit regional integration, economic growth, and job creation opportunities associated with the SGR. The scenario offers minimal long-term environmental or socio-economic benefits and would constrain

Kenya's ability to meet national infrastructure and development goals.

Conclusion: The No Project alternative is not viable.

3.2.2 Alternative – Option of Main Passage Routes

Three broad route corridors were comparatively evaluated based on engineering feasibility, environmental and social considerations, cost implications, and alignment with national development strategies.

3.2.2.1 Nairobi - Nakuru - Eldoret - Malaba Option (Northern Route Option)

The Nairobi–Nakuru–Eldoret–Malaba route option, combined with a proposed Eldoret–Kisumu branch line, forms the Northern Corridor alternative. The mainline from Nairobi to Malaba is 505.2 km, with the Eldoret–Kisumu branch adding 133.2 km, resulting in a total length of 638.2 km—making it the longest and most costly of the assessed options. Although the route connects major economic centres such as Nakuru and Kisumu, it requires significantly higher construction and operational investment, follows the old metre-gauge corridor which does not align with Kenya's current development strategy, and passes through geologically complex Rift Valley sections with dense fault lines. Overall, this option is longer, more expensive, and more technically challenging compared to the southern route.

3.2.2.2 Nairobi - Nakuru - Kisumu - Malaba Option (Middle Route Option)

The Nairobi–Naivasha–Nakuru–Nandi–Kericho–Kisumu–Malaba route option has a total length of 525.2 km. It passes through major economic hubs in northern Kenya, offering strong potential for passenger and freight transport. However, a significant section—approximately 233 km—lies within a high seismic hazard zone (Intensity VIII–IX), where ground instability poses risks such as structural damage, track distortion, and alignment failures, making this route less suitable from an engineering and safety perspective.

3.2.2.3 Option of Nairobi - Naivasha - Kisumu - Malaba (Southern Route Option)

The Nairobi – Ngong – Kiambu – Mai Mahiu – Suswa – Narok – Bomet – Sondu – Ahero – Kisumu Malaba route option covers 489.57 km. Although its operating costs are similar to the central route, comparison focuses on economic hubs, engineering geology, and investment requirements. The route has several advantages: it crosses only 133 km of high seismic intensity zones 80 km less than the middle route—encounters fewer fault-affected areas in the Rift Valley, is 31 km shorter, and requires approximately USD 772.7 million less investment. Its main limitation is that while it connects key towns such as Narok and Kisumu, its economic centres are slightly smaller in scale compared to those along the middle route.

3.2.2.4 Analysis of option of retaining/ refurbishing the existing railway line

An alternative to constructing a new Standard Gauge Railway (SGR) line is to maintain operations on the existing metre-gauge railway. However, the current system is highly inefficient and has driven an increase in heavy-truck movements along the Nairobi–Nakuru–Malaba corridor, resulting in elevated road maintenance costs, higher emissions, and persistent road-accident fatalities involving humans, livestock, and wildlife.

While this option presents some advantages including reduced environmental disturbance, quicker implementation, and limited displacement of communities or economic activities—it also has significant drawbacks. The ageing metre-gauge infrastructure cannot support modern high-speed or high-capacity railway operations, is technologically outdated and incompatible with SGR infrastructure, and would require ongoing and costly maintenance, making it unsustainable in the long term.

In comparing route alternatives, the southern alignment although bypassing major towns such as Nakuru and Eldoret offers more favorable topographic and engineering conditions than the middle route. Additionally, it provides an opportunity to stimulate economic growth in the southwestern region by opening a new development corridor. For these reasons, the southern route option (Nairobi–Naivasha–Kisumu–Malaba) is recommended as the preferred alignment.

3.2.3 Technology Alternatives

The Project evaluated several alternative technology and design options to ensure efficiency, safety, and cost-effectiveness. Key technical considerations included: number of main-line tracks, traction type (electric vs. internal combustion), locomotive type, traction tonnage, reception track length, blocking system, construction clearance, train operating system, and coupler type.

Main Line Configuration - The railway is designed as a Class I standard line, suitable for high-speed and heavy-freight operations. Based on projected traffic 4 passenger train pairs daily and 17.75 million tonnes of freight per year a single-track main line is sufficient to meet long-term transport demand.

Maximum Running Speed - Two design speeds were assessed: 120 km/h and 160 km/h. While 160 km/h offers higher passenger performance, it requires extensive engineering upgrades, especially in hilly terrain, significantly increasing project costs. Given the line's Grade I classification, mixed freight-passenger operations, and economic considerations, a design speed of 120 km/h is recommended.

Traction System Options

Two traction options were considered:

Electric Traction - Offers energy efficiency, lower emissions, reduced noise, and better acceleration. However, it requires high initial investment and substantial external power infrastructure.

Internal Combustion Traction:

- Lower upfront cost and minimal reliance on external infrastructure.
- Choosing this system reduces investment risk and financing pressure.

Electric traction would increase project costs by approximately USD 299.95 million (excluding transmission line costs). Considering Kenya's current power supply capacity, operational needs, investment constraints, and future flexibility, internal combustion traction is recommended, with the option for future electrification preserved. Electricity demand estimates for a potential electrified system were generated for planning purposes, including projected power consumption for 2030, 2035, and 2045.

3.2.4 Locomotive Type

Locomotive type and traction tonnage were assessed together, with altitude, gradients, and engine performance influencing hauling capacity. A 12‰ ruling gradient and 4,000-tonne traction tonnage were found adequate and economical for projected traffic. DF8B was selected as the preferred freight locomotive due to better speed and operational efficiency, while DF11 was chosen for passenger services for its superior performance and compatibility with the existing SGR fleet. An 880 m effective reception-track length (with provision for 1,050 m) was recommended to maintain system consistency and avoid costly upgrades. The line will apply Class I standards, including single-track design, diesel traction with provision for electrification, automatic inter-station block control, and clearance for future double-deck container operations.

3.2.5 Alternative Construction Materials

When selecting construction materials for the SGR, options were evaluated for cost, durability, environmental impact, and suitability to local conditions.

Sleepers: Concrete sleepers are preferred for their strength, durability, and stability, supporting heavy freight and passenger loads, and can be locally produced, creating jobs. Steel sleepers are lighter and cheaper initially but are prone to corrosion in Kenya's humid or saline environments, increasing long-term maintenance.

Track Type: Ballasted track is cost-effective, flexible, and uses locally available materials, but requires regular maintenance, especially in high-rainfall areas. Ballastless (slab) track offers superior stability, lower maintenance, and longer service life, making it suitable for steep gradients, tunnels, bridges, and heavy freight/high-speed corridors, though construction costs are higher.

Eco-Friendly Cement Alternatives: Blended cements using fly ash, slag, or natural pozzolana can reduce carbon emissions while maintaining strength. Emerging technologies like geopolymer concrete and recycled aggregates further reduce environmental impact and can be applied in non-critical structures, supporting green infrastructure and local technical capacity development.

3.2.6 Conclusion

Based on the comprehensive assessment of environmental, social, engineering, and economic parameters, the preferred project configuration consists of:

- Southern Route Alignment (Nairobi–Naivasha–Bomet–Kisumu–Malaba)
- Class 1 single-track standard gauge line
- Design speed of 120 km/h for passenger trains
- Diesel traction system (future-ready for electrification)
- DF8B freight locomotives and DF11 passenger locomotives
- Reception track length of 880 m

This configuration offers the most sustainable, cost-effective, and operationally efficient option, while minimizing adverse environmental and social impacts.

CHAPTER 4.0 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

4.1 Introduction

This chapter presents both the national and international legal framework for planning and environmental and social protection in Kenya, applicable to a railway construction project. In addition, reference has been made to relevant international standards, in this instance namely the International Finance Corporation's (IFC) Performance Standards (PS), associated PS Guidance Notes, and the World Bank Group Environmental Health and Safety (EHS) Guidelines (2007). Generally, where national legal standards are not as stringent as international requirements or vice versa, the Project will be required to defer to the most stringent requirement except in cases where national law or regulations have been explicitly identified as taking precedence for the Project.

4.2 National Policy Framework

4.2.1 National Environment Policy

The National Environment Policy (NEP) was officially adopted in 2013 to provide a comprehensive framework for environmental management in line with Sustainable Development Goals. Its main aim is to ensure a clean, healthy, and sustainable environment for all Kenyans, as guaranteed under Article 42 of the Constitution of Kenya (2010). The broad objectives of the national environmental policy in Kenya are:

- Provide a framework for an integrated approach to planning and sustainable management of Kenya's environment and natural resources.
- Strengthen the legal and institutional framework for good governance, effective coordination and management of the environment and natural resources.
- Ensure sustainable management of the environment and natural resources, such as unique terrestrial and aquatic ecosystems, for national economic growth and improved livelihoods.
- Promote and support research and capacity development as well as use of innovative environmental management tools such as incentives, disincentives, total economic valuation, indicators of sustainable development, Strategic Environmental Assessments (SEAs), Environmental Impact Assessments (EIAs), Environmental Audits (EA) and Payment for Environmental Services (PES).
- Promote and enhance cooperation, collaboration, synergy, partnerships and participation in the protection, conservation, sustainable management of the environment and natural resources.
- Ensure inclusion of cross-cutting and emerging issues such as poverty reduction, gender, disability, HIV&AIDS and other diseases in the management of the environment and natural resources.
- Promote domestication, coordination and maximization of benefit from Strategic Multilateral Environmental Agreements (MEAs).

i. NEP Guiding principles

Implementation of NEP is guided by the following principles:

a) **Environmental Right**: Every person in Kenya has a right to a clean and healthy environment and a duty to safeguard and enhance the environment.
b) **Right to Development**: The right to development will be exercised taking into

consideration sustainability, resource efficiency and economic, social and environmental needs.

c) **Ecosystem Approach**: An integrated ecosystem approach to conserving environmental resources will be adopted and enhanced to ensure that all ecosystems are managed in an integrated manner while also providing a range of benefits to the citizenry.
d) **Total Economic Value**: The benefits that ecosystems generate will be integrated into the national accounting system, programmes and projects.
e) **Sustainable Resource Use**: Environmental resources will be utilized in a manner that does not compromise the quality and value of the resource or decrease the carrying capacity of supporting ecosystems.
f) **Equity:** The management of the environment and natural resources will ensure equitable access to resources for present and future generations.
g) **Public Participation**: A coordinated and participatory approach to environmental protection and management will be enhanced to ensure that the relevant government agencies, county governments, private sector, civil society and communities are involved in planning, implementation and decision-making processes.
h) **Subsidiarity:** The management of the environment and natural resources will be through decentralization and devolution of authority and responsibilities to the lowest level possible.
i) **Precautionary Principle**: Where there are credible threats of serious or irreversible damage to key environmental resources, lack of full scientific certainty will not be used as a reason for postponing cost-effective measures to prevent environmental degradation.
j) **Polluter Pays Principle**: The polluter and users of environmental and natural resources shall bear the full environmental and social costs of their activities.
k) **International Cooperation**: MEAs and regional instruments will be domesticated and implemented cooperatively for better environmental management of shared resources.
l) **Good Governance**: Rule of law, effective institutions, transparency and accountability, respect for human rights and the meaningful participation of citizens will be integrated in environmental management.
m) **Benefit sharing:** Where benefits will accrue from utilization of biodiversity, these will be shared in order to promote conservation and sustainable use of biodiversity.
n) **Community Empowerment:** Communities will be involved in decision making and empowered in the implementation of such decisions.

To achieve the above policy objectives, it is a policy directive that appropriate reviews and evaluations of all forms of developmental project plans and operations are carried out to ensure compliance with the environmental policy and legal frameworks.

4.2.2 Environment and Development (Sessional Paper No. 6 of 1999)

Sessional Paper No. 6 of 1999 on Environment and Development was Kenya's first comprehensive policy framework aimed at integrating environmental management with development planning. It laid the foundation for the country's environmental governance system and influenced future environmental legislation, including the Environmental Management and Coordination Act (EMCA), 1999(Amendment 2015).

The policy defined approaches that will be pursued by the Government in mainstreaming environment into development. The policy harmonized environmental and developmental objectives with the broad goal of achieving sustainable development. The policy paper also provided guidelines and strategies for government action regarding environment and development.

Relevance:

This policy is relevant to the proposed project in view of the potential impacts on the environment and involvement of the public in project planning including ensuring long-term environmental sustainability alongside economic growth and balancing infrastructure needs with ecological preservation (e.g., wildlife corridors and fencing to prevent animal-train collisions).

4.2.3 Forest Policy (2014)

The Forest Policy of 2014 in Kenya provides the framework for sustainable forest management, conservation, and utilization of forest resources.

Its relevance to infrastructure projects like the Standard Gauge Railway (SGR) lies in ensuring that such developments do not degrade forest ecosystems, and that any necessary forest land use is sustainable, mitigated, and compensated.

Relevance

The proposed project may intersect forested areas, including riparian forests and wildlife corridors. The policy requires environmental assessments to minimize impacts on any indigenous forests, water catchment areas and protected forest reserves.

4.2.4 Wildlife Policy of 2011

The Kenya Wildlife Policy provides a framework for the conservation and management of wildlife resources in Kenya. It plays a crucial role in ensuring that projects are developed in a way that respects wildlife habitats, promotes ecological integrity, and balances development with biodiversity conservation.

Relevance

The Wildlife Policy mandates that development projects must avoid or minimize disruption of wildlife habitats and migration routes. The SGR design should include elevated sections and underpasses to allow safe wildlife movement, especially in their natural habitats, corridors, migratory routes and dispersal areas.

4.2.5 National Environmental Policy, 2014

This policy aims to guide sustainable environmental management and ensure that environmental considerations are mainstreamed into all development sectors and levels of government.

The National Environmental Policy is an outcome of the Sessional Paper No. 10 of 2014.The overall goal of the policy is better quality of life for present and future generations through sustainable management and use of the environment and natural resources. One of the objectives of the policy is to promote and support research and capacity development as well as use of innovative environmental management tools such as Environmental Impact Assessments (EIAs) and Environmental Audits that is necessary to ensure environmental quality and resource productivity on long term basis.

The policy among other important objectives calls for promotion of domestication, coordination and maximization of benefits from Strategic Multilateral Environmental Agreements (MEAs). The policy further calls for integration of environmental concerns into development policies, plans and activities.

The National Environmental Policy proposes a broad range of measures and actions responding to key environmental issues and challenges. It seeks to provide the framework for an integrated approach to planning and sustainable management of natural resources in the country. It recognizes the various vulnerable ecosystems and proposes various policy measures not only to mainstream sound environmental management practices in all sectors of society throughout the country but also recommends strong institutional and governance measures to support the achievement of the desired objectives and goal.

Relevance

The policy requires that projects such as this one, which are likely to have significant environmental and social impacts should be undertaken with sound environmental management plan.

4.2.6 The Kenya National Biodiversity Strategy and Action Plan of 2000

The Kenya National Biodiversity Strategy and Action Plan (NBSAP) of 2000 was developed in line with the country's commitments under the Convention on Biological Diversity (CBD). Its purpose is to conserve biodiversity, promote its sustainable use, and ensure equitable sharing of benefits from genetic resources

The strategy is a national framework of action for ensuring that the present rate of biodiversity loss is reversed, and present levels of biological resources are maintained at sustainable levels for posterity. The general objectives of the strategy are to conserve Kenya's biodiversity; to sustainably use its components; to share the benefits arising fairly and equitably from the utilization of biological resources among the stakeholders; and to enhance technical and scientific cooperation nationally and internationally, including the exchange of information in support of biological conservation.

Relevance:

The proposed project may impact biodiversity through land use, habitat fragmentation, and ecosystem disturbance.

4.2.7 Kenya Vision 2030

The Vision 2030 is based on 3 key pillars; Economic Pillar, Social Pillar, and Political Pillar. The economic, social and political pillars of Kenya Vision 2030 are anchored on the following foundations: macroeconomic stability; continuity in governance reforms; enhanced equity and wealth creation opportunities for the poor; infrastructure; energy; science, technology and innovation, land reform; human resources development; security and public-sector reforms. According to the vision, the country aims at enhancing and diversifying national power generation and supply by identifying new generation and supply sources through exploitation of geothermal power, coal, renewable energy sources, and connecting Kenya to energy-surplus countries in the region.

In terms of environment, one of the aims is to make Kenya to be a nation that has a clean, secure and sustainable environment by 2030. This will be achieved through promoting environmental conservation for better support the economic pillar flagship projects.

Relevance

Vision 2030 is a long-term development blueprint aiming to transform Kenya into a middle-income, industrializing country that provides a high quality of life to all its citizens by 2030. The SGR is one of the flagship infrastructure projects under Vision 2030 which directly supports multiple pillars and objectives of the Vision.

4.2.8 National Land Policy 2023

The Land Policy in Kenya is guided by the environmental management principles which are aimed at restoring the environmental integrity through introduction of incentives and encouragement of use of technology and scientific methods for soil conservation, among others. The policy further requires fragile ecosystems to be managed and protected by developing a comprehensive land use policy bearing in mind the needs of the surrounding communities. The policy also requires zoning of catchment areas to protect them from degradation and establishment of participatory mechanisms for sustainable management of fragile ecosystems. The policy also called for development of procedures for co-management and rehabilitation of forest resources while recognizing traditional management systems and sharing of benefits with contiguous communities and individuals. Lastly, all national parks, game reserves, islands, front row beaches and all areas hosting fragile biodiversity are declared as fragile ecosystems under the policy.

The policy recognizes that sustainable management of land based natural resources depends largely on the governance system that defines the relationships between people, and between people and resources. To achieve an integrated approach to management of land-based natural resources, all policies, regulations, and laws dealing with these resources need to be harmonized with the framework established by the Environmental Management and Coordination Act (EMCA), 1999

The policy also addresses land management on ecosystem protection (including wetlands). Measures for protection are required for fragile ecosystems. The policy also calls for the protection of watersheds, lakes, drainage basins and wetlands. The policy prohibits settlement and agricultural activities in water catchment areas and calls for identification, delineation and gazettement of all water courses and wetlands.

Relevance;

The proposed project shall intersect different aspects concerning land use, environmental conservation, and community rights ensuring adherence to the principles outlined in the policy including contributing positively to Kenya's socio-economic development while safeguarding the rights of affected communities and preserving the environment.

4.2.9 Physical Planning Policy

The Physical Planning Policy of Kenya provides a strategic framework for land use planning, infrastructure development, and spatial organization across urban and rural areas. It plays a critical role in guiding sustainable development, including the planning and implementation of projects. Its main objectives include promotion of **Sustainable** Land Use, coordination of Infrastructure Development, enhancement of Environmental Protection, guide urbanization and Settlement Patterns, Strengthen Institutional Frameworks and Facilitate Public Participation in Planning.

Relevance.

The policy is essential since it shall ensure the proposed project aligns with national and county land use plans, minimizes environmental and social impacts and supports long-term economic growth through planned urban and regional development.

4.2.10 HIV/AIDS Policy of 2009

The HIV and AIDS Policy of 2009 in Kenya provides a comprehensive framework for the prevention, treatment, care, and mitigation of HIV/AIDS. Although primarily a health-focused policy.

Relevance:

The proposed project shall involve a mobile and concentrated workforce, often working for extended periods. Workers may be at higher risk of engaging in risky behaviors due to isolation, limited recreation, or separation from families. The proponent shall create HIV/AIDS awareness among staff, provide condoms in dispensers and discourage *against any form of discrimination against any would be HIV/AIDS patient.*

4.2.11 Kenya National Gender and development Policy of 2011

The Kenya National Gender and Development Policy (2011) aims to mainstream gender considerations into all sectors of development and ensure equality, equity, and empowerment for both women and men.

Relevance:

It ensures that projects promote inclusive development, protects the rights and safety of women and marginalized groups and integrate gender equality into all stages of project planning and execution. This contributes to Kenya's broader goals of social justice, equity, and sustainable development. The proponent shall ensure equal employment opportunities to both gender and discourage any form of discrimination based on gender.

4.2.12 The Kenya National Climate Change Response Strategy of 2010

The Kenya National Climate Change Response Strategy of 2010 was the first comprehensive policy document to guide the country's response to the challenges posed by climate change. It laid the groundwork for climate-resilient development, aiming to integrate climate considerations into all sectors, including transport infrastructure.

Relevance:

The policy will guide on how the proposed project mitigates and assesses climate risks e.g. flooding, heat stress, landslides, promotes resilience, emissions are reduced through sustainable transport and promote economic sustainability.

4.2.13 The Kenya Environmental Sanitation and Hygiene Policy of 2016-2030

The Kenya Environmental Sanitation and Hygiene Policy (KESHP) 2016-2030 provides broad guidelines to both state and non-state actors at all levels to work towards universal access to improved sanitation leading to improved quality of life for the people. Primarily, the KESHP policy aims to increase the proportion of the population with access to improved sanitation to 100 percent by 2030 and ensure a clean and healthy environment for all in Kenya. The development of KESHP 2016-2030 is a result of extensive policy review and participatory stakeholder consultations and validation meetings held throughout the country.

The policy sets Kenya on the trajectory of ensuring that all Kenyans have sustainable access to improved sanitation and a clean and healthy environment by 2030. The policy therefore sets the following targets:

- Achieve and sustain 100 percent Open Defecation Free (ODF) Kenya by 2030;
- Achieve and sustain 100 percent access to improved sanitation in rural and urban areas by 2030.

Policy Objectives

- To scale up rural and urban sanitation towards an ODF Kenya and universal access to improved sanitation by 2030;
- To assure a clean and healthy environment for all Kenyans through appropriate technology choices for waste management and pollution control;
- To foster strong private sector participation and investment in creating sanitation demand and increasing uptake of appropriate products and services.
- To establish an enabling legal and regulatory environment for sanitation at both national

and county levels;
- To strengthen institutional and human resource capacity of the environmental sanitation sector for efficient and effective provision of sanitation and hygiene services;
- To establish an effective research and development framework for sanitation to improve appropriate technology choices and promote evidence-informed sector decision-making;
- To establish a functionally effective monitoring and evaluation framework for the sanitation sector to ensure maximum accountability in policy implementation at all levels.

Relevance;

The project will engage a number of workers, construction camps, and impacts on surrounding communities. The policy will ensure public health, environmental protection, and sustainable development. The proponent and the contractor will seek to comply with the provision of this policy to achieve 100% ODF at the project area during construction period.

4.2.14 Kenya National Adaptation Plan (2015-2030)

The plan envisions enhanced climate resilience towards the attainment of Vision 2030 including strong economic growth, resilient ecosystems, and sustainable livelihoods for Kenyans. It also results in reduced climate-induced loss and damage, mainstreamed disaster risk reduction approaches in various sectors, reduced costs of humanitarian aid, and improved knowledge and learning for adaptation and the future protection of the country.

The objectives of the NAP are to:

- Highlight the importance of adaptation and resilience building actions in development;
- Integrate climate change adaptation into national and county level development planning and budgeting processes;
- Enhance the resilience of public and private sector investment in the national transformation, economic and social and pillars of Vision 2030 to climate shocks;
- Enhance synergies between adaptation and mitigation actions in order to attain a low carbon climate resilient economy; and
- Enhance resilience of vulnerable populations to climate shocks through adaptation and disaster risk reduction strategies

Relevance

The SGR project will be designed and constructed to withstand climate risks like flooding, soil erosion, landslides and extreme heat (affecting rails or structures).

4.2.15 Green Economy Strategy and Implementation Plan 2016 – 2030

The Green Economy Strategy is geared towards enabling Kenya to attain a higher economic growth rate consistent with the Vision 2030, which firmly embeds the principles of sustainable development in the overall national growth strategy. This strategy builds on the achievements realized during the implementation of the first Medium Term Plan (MTP I 2008-2012) and implementation of MTP II (2013-2017) for Vision 2030. The policy framework for Green Economy (GE) is designed to support a globally competitive low carbon development path through promoting economic resilience and resource efficiency, sustainable management of natural resources, development of sustainable infrastructure and providing support for social inclusion.

Relevance

The SGR project touches on economy, environment, and communities hence GESIP provides guidance on how to make the project sustainable, efficient, and climate-smart by designing infrastructure that is low carbon, resource efficient and resilient to climate risks.

4.3 National Environmental Legal and Regulatory Framework

The Republic of Kenya has numerous statutes that guides environmental management and conservation. Most of these statutes are sector specific and cover a wide range of issues including public health, soil conservation, protected areas conservation, endangered species, public participation, water rights, water quality, air quality, excessive noise control, vibration control, land use, among others.

4.3.1 Relevant National Environmental Legislations and Regulations

The proposed project is governed by a wide range of national environmental laws and regulations designed to ensure that projects are planned, executed, and operated in a manner that promotes sustainable development, protects the environment, and safeguards the rights and well-being of affected communities.

- **The Constitution of Kenya 2010**: It onboards various issues that are related to environmental management. Article 42 of the Bill of Rights provides that 'every Kenyan has the right to a clean and healthy environment, which includes the right to have the environment protected for the benefit of present and future generations through legislative and other measures.
- **The Environment Management and Co-ordination (EMCA), 1999(Revised 2015**): The legislation advocates for environmental protection during project implementation and restoration of impacted environment. EMCA is the framework law on environment, which was enacted on the 14th of January 1999 and commenced in January 2002 and further amended in 2015 to be in line with the new constitution. The Act mandates NEMA to exercise general supervision and coordination over all matters relating to the environment and to be the principal instrument of the Government in the implementation of all policies. Following the introduction of EIA and Audit Regulations, (2003) issued through Kenya Gazette Supplement No. 56 of 13 June 2003, the submission of environmental reports became mandatory. According to these regulations no proponent shall implement a project likely to have a negative environmental impact or for which an ESIA has not been concluded and approved in accordance with this regulation. The proposed project is categorized as high risk under Legal Notice number 31 Second Schedule, Environmental Management and Coordination Act No. 8 of 1999 as amended on 30th April 2019. Proponent has commissioned the ESIA study in compliance with the Act.
- **The Environment (Impact Assessment and Audit) Regulations, 2003**: Provides guidelines that have been established to govern the conduct of environmental assessments and environmental audits in Kenya. The legislation provides guidance on project impact categorization into low, medium and high risks and implementation of appropriate environmental and social impact assessments.
- **Environmental Management and Co-ordination (Water Quality) Regulations, 2024**: Observes that, every person shall refrain from any act which directly or indirectly causes, or may cause immediate or subsequent water pollution, and it shall be immaterial whether the water resource was polluted before the enactment of the Act.

- **Environmental Management and Co-ordination (Waste management) Regulations, 2024**: Defines rules for the management of waste in general and for the management of solid waste, industrial waste, hazardous waste, pesticides and toxic substances, biomedical waste and radioactive substances in particular.
- **Environmental Management and Co-ordination (Noise and Excessive Vibration Pollution Control) Regulations, 2009**: Observes that, except as otherwise provided in the Regulations, no person shall make or cause to be made any loud, unreasonable, unnecessary, or unusual noise which annoys, disturbs, injures, or endangers the comfort, repose, health or safety of others and the environment,
- **Environmental Management and Co-ordination (Air Quality) Regulations, 2024**: Aimed at providing for prevention, control and abatement of air pollution to ensure clean and healthy ambient air.
- **Environmental Management and Coordination (Conservation of Biological Diversity and Resources, Access to Genetic Resources, and Benefit Sharing) Regulations, 2006**: Aims at enhancing the preservation of biodiversity as well as safeguarding the endangered and rare species of plants and animals existing within a project area. Part II stipulates the prohibitions on the extraction and use of biological resources
- **The Occupational Safety and Health Act, No. 15 of 2007**: Provides for the safety, health and welfare of workers and all persons lawfully present at workplaces, to provide for the establishment of the National Council for Occupational Safety and Health and for connected purposes.
- **Work Injury Benefit Act 2007(Revised 2010)**: Provides for compensation for employees on work related injuries and diseases contacted in the course of employment and for connected purposes. The act includes compulsory insurance for employees. The act defines an employee as any worker on contract of service with employer will be relevant during construction.
- **The Energy Act 2019:** Consolidates the laws relating to energy, provides for National and County Government functions in relation to energy, provides for the establishment, powers and functions of the energy sector entities; promotion of renewable energy; exploration, recovery and commercial utilization of geothermal energy; regulation of midstream and downstream petroleum and coal activities; regulation, production, supply and use of electricity and other energy forms; and for connected purposes.
- **The Wildlife Conservation and Management Act No. 47 of 2013 (Revised 2014**): Provides for the protection, conservation, sustainable use and management of wildlife in Kenya. Section 19 elaborates on the functions of the County Wildlife Conservation and Compensation Committees that includes undertaking education, extension services and public awareness.
- **Forest Conservation and Management Act No. 34 of 2016(Revised 2018):** Gives effect to Article 69 of the Constitution with regard to forest resources; to provide for the development and sustainable management, including conservation and rational utilization of all forest resources for the socioeconomic development of the country and for connected purposes. The Act applies to all forests on public, community and private lands.
- **National Land Commission Act, 2012:** Makes further provision as to the functions and powers of the National Land Commission, qualifications and procedures for appointments to

the Commission; to give effect to the objects and principles of devolved government in land management and administration, and for connected purposes.

- **Land Act 2012(Revised 2019):** Gives effect to Article 68 of the Constitution, to revise, consolidate and rationalize land laws; to provide for the sustainable administration and management of land and land-based resources, and for connected purposes
- **Water Act No. 43 of 2016(Revised in 2023):** Provides for the regulation, management and development of water resources, water and sewerage service, and for other connected purposes. Further provides for the regulation, management and development of water resources and water and sewerage services in line with the Constitution.
- **The Physical Planning and Land Use Act 2019:** Provides for the preparation and implementation of physical development plans and for connected purposes. The Act provides for implementation of regulated development through preparation of physical development plans while considering potential environmental impacts.
- **Employment Act No 11 of 2007 (Amendment 2022)**: Declares and defines the fundamental rights of employees, to provide basic conditions of employment of employees, to regulate employment of children and to provide for matters connected with the foregoing.
- **HIV and AIDS Prevention and Control Act No. 14 of 2006 Revised in 2012**: Provides for measures for the prevention, management and control of HIV and AIDS, to provide for the protection and promotion of public health and for the appropriate treatment, counselling, support and care of persons infected or at risk of HIV and AIDS infection
- **Public Health Act, Cap 242 (Revised in 2012)**: Regulates activities detrimental to human health. An environmental nuisance is one that causes danger, discomfort or annoyance to the local inhabitants or which is hazardous to human health. The Act prohibits activities (nuisances) that may be injurious to health.
- **The Climate Change Act, 2016**: Provides for a regulatory framework for enhanced response to climate change; to provide for mechanism and measures to achieve low carbon climate development.
- **National Gender and Equality Commission Act, 2011 (Revised 2012 and 2023)**: An Act of Parliament to establish the National Gender and Equality Commission as a successor to the Kenya National Human Rights and Equality Commission pursuant to Article 59(4) of the Constitution; to provide for the membership, powers and functions of the Commission, and for connected purposes.
- **The Valuers Act cap 532 (Revised 2012)**: The Act Cap makes provisions for the relevant charges and conducts of valuers in relation to valuation of assets
- **County Government Act No. 17 of 2012**: The Act is intended to provide powers, functions and responsibilities to deliver services to the Counties under the devolved government.
- **The Sexual Offences Act, 2006 and its amendment 2012**: Makes provision about sexual offences, their definition, prevention and the protection of all persons from harm from unlawful sexual acts, and for connected purposes.
- **The Environment and Land Court Act, 2012 (Revised 2015)**: Plays a crucial role in providing legal and institutional framework for resolving disputes and enforcing environmental and land laws.

- **Traffic Act Cap 403(Revised 2024)**: Supports the safe and lawful transport and logistics operations which is also essential to the proposed project since it will involve transport of machinery and construction materials.
- **The Penal Code, Cap 63**; This is crucial to preventing and addressing any criminal offenses that may arise during project planning, construction, and operation. The Penal Code covers a wide range of offenses including corruption, property damage, public safety, and environmental harm.
- **The National Museums and Heritage Act (2006) (Revised 2012):** This is crucial in protecting cultural, historical, and archaeological heritage. The Act governs the conservation of sites and objects of historical or cultural significance and is enforced by the National Museums of Kenya (NMK)
- **National Construction Authority Act, 2011(Revised 2012,2017,2019,2020)**: The Act provides that civil works such as construction of bridges, access roads and tunnels must be undertaken by NCA-registered contractors
- **Community Land Act, 2016(Revised 2022):** The Act provides a legal framework governing how community land is managed, accessed, and utilized
- **The Labour Relations Act 2007(Revised 2022)**: The Act governs the rights, duties, and mechanisms for resolving disputes between employers and employees. It is a foundational law ensuring fair labor practices, collective bargaining, and industrial harmony.
- **Building Code**; The Building Code provides a set of regulations governing the design, construction, alteration, and maintenance of buildings across the country.
- **Social Health Insurance Act, No. 16 of 2023 ("SHIFA")**: The Constitution of Kenya in the Bill of Rights assures every person in Kenya to the highest standard of health which includes the right to health care services. Towards this end, the Government, through the Ministry of Health, embarked on the creation of a fund to ensure lower cost of health since many Kenyans will have access to affordable health care.
- **The Urban Areas and Cities Act, 2011 (Revised 2019)**: The Act provides a legal framework for the classification, governance, and management of urban areas and cities and plays a key role in guiding how the project interacts with urban development, land use, and governance structures in cities and towns along its route.
- **Kenya Railways Corporation Act (Cap. 397**): This is the primary legislation governing the establishment and operations of the Kenya Railways Corporation (KRC) and provides a comprehensive legal framework for the management of railway services.
- **Sustainable Waste Management Act ,2022:** The Act establishes the legal and institutional framework for the sustainable management of waste; ensure the realization of the constitutional provision on the right to a clean and healthy environment and for connected purposes
- **Persons with Disabilities Act, 2015**: The Persons with Disabilities Act, 2015 was enacted to operationalize the provisions of Article 54 of the Kenyan Constitution (2010), which guarantees the rights of Persons With Disabilities (PWDs). It aims to eliminate discrimination on the basis of disability, promote equal opportunities in education, employment, health, and public life, ensure accessibility of services, infrastructure, and communication, guarantee legal capacity, autonomy, and protection of human rights and encourage inclusion and participation in

decision-making at all levels. The relevance of the cited legal frameworks are shown in **Table 11** below;

Table 11: Legal Frameworks and their relevance

Legal Framework	Relevant environmental obligations
Kenya Railways Corporation Act (Cap. 397), 1979	The overall mandate of the Corporation is to provide a coordinated and integrated system within Kenya for rail and inland waterways transport services and inland port facilities.
Standard Gauge Railway Protocol, 2014	**Article 2** - Stipulates the overall objective of the SGR which is to jointly develop and operate a modem, fast, reliable, efficient and high capacity railway transport system as a seamless single railway operation among the Parties with the specific objectives of the SGR project.
Environmental Management and Coordination Act (EMCA) No. 8 of 1999.	**Section 42** – Supporting the protection of rivers and wetlands **Section 50** – Supporting the conservation of biological diversity **Section 51** – Supporting the conservation of biological resources *in situ* **Specific compliance obligations** • Prohibiting and controlling the introduction of alien species into natural habitats • Controlling and prevention of environmental pollution • Carrying out ESIA for all proposed projects with a potential for adverse impacts • Carrying out environmental audit and monitoring of all activities that are likely to have significant effect on the environment • Ensuring compliance with all other relevant EMCA (1999) Regulations including the following: - Environmental Impact Assessment and Audit Regulations, 2003 o The Environmental management and coordination (Noise and Excessive vibration Pollution Control) Regulation, 2009 o Water Quality Regulations, 2006 (Legal Notice No. 121) o Waste Management Regulations, 2006 (Legal Notice No.121) o Air Quality, Regulations, 2024 o Controlled Substances Regulations, 2007 (Legal Notice No.73 of 2007) o Fossil Fuel Emission Control Regulations (2006) o Conservation of Biodiversity Regulations 2006 Wetlands, River Banks, Lake Shores and Sea Shore Management Regulation, 2009. The EMCA Section 68 and 69 also states that the proponent must submit an ESIA Report to be reviewed by NEMA. We intend to comply fully with the requirements of EMCA.
Wildlife Conservation and Management Act, 2013	**33 (c)**: Supporting the establishment of wildlife Development Fund for development of conservation areas. **68:(4)**: Preventing development in a National Park without approved management plans. **Section 30 of part VI:** Prevention of adverse effects on the environment, including the seepage of toxic waste into streams, rivers, lakes and wetlands.

Legal Framework	Relevant environmental obligations
Way Leaves Act (Cap. 292)	The Act provides for certain undertakings to be constructed e.g. rail lines transmission lines, pipelines, canals, pathways etc., though, over or under any lands. **Section 3**: Allows the Government may carry any works through, over or under any land whatsoever provided it shall not interfere with any existing building or structures of an ongoing activity.
Physical Planning and Land Use Act, 2019	**Section 29**: Ensuring that developers to ensure proper execution and implementation of approved physical development plans **Other legal obligations:** • Ensuring that subsidiary area plans are recognized and integrated in the Regional Physical Development Plans • The local authority concerned shall require the developer to restore the land on which such development has taken place to its original condition within a period of not more than ninety days.
The Land Act, 2012	**Part viii:** Provides procedures for compulsory acquisition of interests in land. **Section 111 (1)**: States that if land is acquired compulsorily under this Act, just compensation shall be paid promptly in full to all persons whose interests in the land have been determined. The Act also provides for settlement programmes.
Land Adjudication Act, 2010	Act applies to any area of Trust land where the County Council in whom the land is vested so requests; and the Minister considers it expedient that the rights and interests of persons in the land should be ascertained and registered.
Forest Conservation and Management Act, 2016	Highlights the integration of the community on the management, utilization and conservation of forests and its resources. It prohibits wanton destruction of the forests.
Water Act, 2016	**Article 20.** (1) Ensuring that state schemes shall take precedence over all other schemes for the use of water or the drainage of land **Part IV**: Addresses the issues of water supply and sewerage **Other legal obligations** • Promoting the conservation and proper use of water resources • Protection of any water resource, its source or catchment.
Public Health Act, Cap 242	**Article 129:** Supporting the protection of public water supplies. **Article 117:** Supporting the prevention or remedy danger to health from unsuitable activities including dust and noise.
Occupational Safety and Health Act, 2007.	This Act applies to all workplaces where any person is at work, whether temporarily or permanently. The purpose of this Act is to secure the safety, health and welfare of persons at work, and protect persons other than persons at work against risks to safety and health arising out of, or in connection with, the activities of persons at work
The Agriculture Act	The Agricultural Land-Use Rules under Cap 318 are clear on activities proscribed in riparian areas and it's essential that the proposed construction of transmission lines does not contradict requirements of this Act.
Antiquities and Monuments Act, 1983, Cap	The Act aims to preserve Kenya 's national heritage. Kenya is rich in its antiquities, monuments and cultural and natural sites which are spread all over the country. The National Museums of Kenya is the custodian of the

Legal Framework	Relevant environmental obligations
215	country 's cultural heritage
Mining and Minerals Act, Cap 3016	The Mining and Minerals Act administered by the Department of Mines and Geology in the Ministry of Mining requires that the resulting open pits be rehabilitated appropriately, so that the natural environment is protected.
Explosives Act Cap 115	**Section 7(1)** - Stipulates that No person shall keep, store or be in possession of any unauthorized explosive in or on any premises except in an explosives factory or explosives magazine or unless the explosive is kept for private use, and not for sale or other disposal, and in accordance with rules or unless the explosive is kept for use in the construction of railway, road or other public work, in quantities not exceeding two thousand five hundred kilograms in weight and is stored in a temporary magazine approved by an inspector and under conditions specified in writing by an inspector. **7(2) -** Stipulates that any person who contravenes the provisions of this section or any condition imposed or prescribed thereunder or mentioned therein shall be guilty of an offence and liable to a fine not exceeding three thousand shillings or in default of payment to imprisonment for a term not exceeding one year.
The Standards Act Cap 496	The Act is meant to promote the standardization of the specification of commodities, and to provide for the standardization of commodities and codes of practice; to establish a Kenya Bureau of Standards, to define its functions and provide for its management and control.
National Land Commission Act, 2012 (No. 5 of 2012)	**Section 5**: Mandates the Commission to: - *a)* Initiate investigations, on its own initiative. or on a complaint, into present or historical land injustices, and recommend appropriate redress; *b)* Encourage the application of traditional dispute resolution mechanisms in land conflicts; Assess tax on land and premiums on immovable property in any area designated by law.
The Kenya Civil Aviation Act, Cap 394	The Act mandates the KCAA to authorize and approve the usage of the flight for the purpose of ensuring the safety of flying aircraft over the proposed SGR project area.
Building Code 2024	The Act mandates the Municipalities or County Governments the powers to approve building plans.
Penal Code Cap 63	**Section 191** - States that if any person or institution that voluntarily corrupts or foils water from public springs or reservoirs, rendering it less fit for its ordinary use is guilty of an offence **Section 192** – States that a person who makes or vitiates the atmosphere in any place to make it noxious to health of persons /institution, dwelling or business premises in the neighbourhood or those passing along public way, commit an offence.

Legal Framework	Relevant environmental obligations
Public Participation Bill, 2024	provide conduct of public participation; to give effect to the constitutional principles of democracy and participation of the people under Articles 10(2), 69(1)(d), 118, 184(1)(c), 196, 201(a) and 232(1)(d) of the Constitution.
The Climate Change Act, 2016	The ACT provide for a regulatory framework for enhanced response to climate change; to provide for mechanism and measures to achieve low carbon climate development.
County Integrated Development Plans	County Integrated Development Plan (CIDP) is a plan that guides development within a county, integrating national and county government initiatives. SGR project transverse through the counties.

4.5 Development Partners Regulations on Environmental and Social Management

i. International Finance Corporation.

The International Finance Corporation (IFC) part of the World Bank Group has a well-defined set of environmental and social regulations, standards, and procedures designed to ensure that the projects are environmentally sound, socially responsible, and sustainable.

Table 12 below outlines the various performance standards, their objectives, relevance and applicability to the proposed project.

Table 12: Relevant IFC performance standards

PS	Performance Standard	Objectives	Relevance to the proposed railway transport project	Remarks
PS1	Assessment and Management of Environmental and Social Risks and Impacts.	• To identify and evaluate projects environmental and social risks and impacts. • To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts • To promote improved environmental and social performance of clients through the effective use of management systems. • To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately. • To promote and provide means for adequate engagement with Affected Communities throughout the project cycle.	Underscores the importance of managing environmental and social performance throughout the life of a project. It requires the proponent to conduct ESIA to establish and maintain an Environmental and Social Management System (ESMS), appropriate to the nature and scale of the project and commensurate with the level of its environmental and social risks and impacts. The concept of mitigation hierarchy is central to PS1, whereas it requires projects to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, Affected Communities, and the environment.	***Applicable*** There are Environmental and Social risks that will arise during construction and operational phases of the project.
PS 2	Labour and Working Conditions	• To promote the fair treatment, nondiscrimination, and equal opportunity of workers. • To establish, maintain, and improve the worker-management relationship. • To promote compliance with national employment and labor laws. • To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain.	Recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers ensuring proper health and safety, e proper labor conditions, and addressing concerns related to work place environment.	***Applicable*** The proposed project shall engage both skilled and unskilled workers to offer services in the project and their welfare will need to be taken care of.

PS	Performance Standard	Objectives	Relevance to the proposed railway transport project	Remarks
		• To promote safe and healthy working conditions, and the health of workers. • To avoid the use of forced labor.		
PS 3	Resource Efficiency and Pollution Prevention	• To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities. • To promote more sustainable use of resources, including energy and water. • To reduce project-related GHG emissions.	Recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels.	***Applicable*** There are project activities like maintenance of vehicles and machines, dust and exhaust emissions that have the potential to cause pollution.
PS 4	Community Health, Safety, and Security	• To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life. • To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles.	Recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. It calls for establishing procedures for local safety protocols, and emergency response plans for potential accidents.	***Applicable*** Community members will be employed in the project. Project vehicles will also be transporting equipment, materials and waste outside the project area exposing community members to safety risks
PS 5	Land Acquisition and Involuntary resettlement	• To avoid and/or minimize displacement by exploring alternative project designs. • To avoid forced eviction. • To anticipate and/ or void/minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost4 and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. • To improve, or restore, the livelihoods and standards of living of displaced persons.	It recognizes that project related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use the land. Ensures that land acquisition processes are fair and transparent, and that communities are not involuntarily displaced due to the project operations.	***Applicable*** PS5 recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land.

PS	Performance Standard	Objectives	Relevance to the proposed railway transport project	Remarks
		• To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure5at resettlement sites.		
PS 6	Biodiversity Conservation and Sustainable Management of Living Natural Resources	• To protect and conserve biodiversity. • To maintain the benefits from ecosystem services. • To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.	Recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainable management of living natural resources are fundamental to sustainable development. It further addresses impact on local biodiversity and ecosystems, especially in sensitive areas, and ensures sustainable management of natural resources (e.g., water bodies, local habitats).	***Applicable*** PS6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development.
PS 7	Indigenous Peoples	• To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples. • To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts. • To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner. • To establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project's life-cycle.	Seeks to ensure project activities minimize negative impacts, foster respect for human rights, dignity, and culture of indigenous populations, and promote development benefits in culturally appropriate ways. Ensures that Indigenous Peoples' rights and cultures are respected during the project planning, implementation and decommissioning phases. Free, Prior, and Informed Consent (FPIC) is required for projects that affect indigenous territories or practices.	***Applicable*** The local communities i.e. the Luo and the Luhya, who neighbor the proposed project area is not regarded indigenous peoples.

PS	Performance Standard	Objectives	Relevance to the proposed railway transport project	Remarks
		• To ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present. • To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.		
PS 8	Cultural Heritage	• To protect cultural heritage from the adverse impacts of project activities and support its preservation. • To promote the equitable sharing of benefits from the use of cultural heritage	It recognizes the importance of cultural heritage for current and future generations. Ensures that any cultural or archaeological sites along the railway line are identified and preserved, respecting the cultural heritage of local communities during operations.	***Applicable*** Before project commencement, survey to ascertain the presence of any archaeological or cultural sites to avoid disturbance will be conducted.

4.6 World Bank Group Environmental and Social Framework (ESF)

The ESF supports green, resilient and inclusive development by strengthening protections for people and the environment and making important advances in areas such as labor, inclusion and non-discrimination, gender, climate change, biodiversity, community health and safety, and stakeholder engagement. It uses a risk-based and proportionate approach that applies increased oversight and resources to complex projects and allows for greater responsiveness to changes in project circumstances through adaptive risk management and stakeholder engagement. It also promotes integrated environmental and social risk management.

The ESF places an emphasis on strengthening national environmental and social management systems and institutions, and supporting proponent's capacity building. It promotes enhanced transparency and stakeholder engagement through timely information disclosure, meaningful and ongoing consultations throughout the project life cycle, and responsive grievance mechanisms to facilitate resolution of concerns and grievances of project-affected parties.

The Environmental and Social Standards (ESS) are part of the World Bank's Environmental and Social Framework (ESF) for new investment projects helps in ensuring that World Bank-financed projects are environmentally and socially sustainable. **Table 13** below summarizes the triggered ESS and their relevance to the project.

Table 13: Relevant ESS and their relevance to the project

Standard	Purpose	Relevance to the project
ESS1 - Assessment and Management of Environmental and Social Risks and Impacts	Establishes the foundation for identifying, evaluating, and managing environmental and social risks. Requires Environmental and Social Impact Assessment (ESIA) and Environmental and Social management Plan (ESMP) to be put in place	The proponent has commissioned a full Environmental and Social Impact Assessment (ESIA) for the proposed project including construction, implementation and decommissioning phases.
ESS2 - Labor and Working Conditions	Protects workers' rights and ensures fair and safe labor practices, including for contractors and subcontractors.	The proposed project will engage both skilled and unskilled workers at different phases of the project. The proponent and contractor will promote sound worker-management relationships and enhance the development benefits of a project by treating workers in the project fairly and providing safe and healthy working conditions
ESS3 - Resource Efficiency	Promotes sustainable use of resources (energy, water) and	The economic activities and urbanization which will result

Standard	Purpose	Relevance to the project
and Pollution Prevention	reduces pollution and GHG emissions.	from the project often generate pollution to air, water, and land, and consume finite resources that may threaten people, ecosystem services and the environment at the local, regional, and global levels. The proponent will put in measures to address resource efficiency, pollution prevention and management throughout the project life-cycle.
ESS4 - Community Health and Safety	Addresses project impacts on community health, safety, and security (e.g. traffic, hazardous materials, emergency response	The proponent shall ensure community safety (e.g., rail crossings, vibrations, noise) and put in place emergency response and security plans to reduce any negative impacts on project-affected communities.
ESS5 - Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	Minimizes displacement, ensures fair compensation, and requires Resettlement Action Plans (RAPs)	The project will acquire land across different counties to lay the railway line. It should be ensured that the land acquisition process and any resettlement is managed fairly well.
ESS6 - Biodiversity Conservation	Protects habitats, species, and promotes sustainable land use practices.	The project will traverse some sensitive ecosystems hence strong biodiversity management measures will be required. It will also recognize the need to consider the livelihood of project-affected parties, whose access to, or use of, biodiversity or living natural resources may be affected by a project.
ESS7 - Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities	Ensures respect for Indigenous Peoples' rights, culture, and Free, Prior, and Informed Consent (FPIC).	The report shall not impact any indigenous people.
ESS8 - Cultural Heritage	Protects tangible and intangible cultural heritage and requires Chance-find procedures	Before project commencement, survey for any archaeological or cultural sites will be conducted to avoid disturbance. An elaborate Chance find procedures will be included in the ESIA report.
ESS10: Stakeholder Engagement and Information	Requires early and ongoing stakeholder engagement and an accessible grievance mechanism.	Strengthens stakeholder dialogue and transparency between the proponent, County Governments, Community and other

Standard	Purpose	Relevance to the project
Disclosure		stakeholders. Elaborate stakeholder management process shall be carried out during the ESIA process.

4.7 International Environmental Agreements Relevant to Kenya

Kenya is involved in numerous international environmental agreements to address global challenges covering diverse areas like climate change, biodiversity, ozone layer protection, and trade in endangered species amongst others. Some of the agreements are included in the **Table 14** below

Table 14: International agreements relevant to Kenya

Theme	Convention objective	Summary
Biodiversity	International Plant Protection Convention -new revised text approved by Resolution 12/97 of the 29th Session of the FAO Conference in November 1997 – Declaration	To prevent the spread and introduction of pests of plants and plant products and to promote measures for their control.
	Convention on Biological Diversity	To ensure the conservation of biological diversity; the sustainable use of its components and the fair and equitable sharing of the benefits.
	Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)	To protect migratory species of wild animals and their habitat
	Convention on International Trade in Endangered Species of Wild Flora and Fauna	To ensure that international trade in specimens of wild animals and plants does not threaten their survival.
Climate change	Kyoto Protocol to the United Nations Framework Convention on Climate Change	To reduce or limit the emission of gases contributing to the "greenhouse effect" and causing climate change in the industrialized countries
	United Nations Framework Convention on Climate Change (UNFCCC)	To achieve stabilization of greenhouse gas concentrations
	The Paris climate change agreement-UNFCCC	Its goal is to limit global warming to well below 2^{o}C, preferably to 1.5^{o}C, compared to pre-industrial levels
Cultural Heritage	UNESCO Convention concerning the Protection of the World Cultural and Natural Heritage	To ensure that effective and active measures are taken for the protection, conservation and presentation of the "cultural and natural heritage" on its territories.
	UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage	To safeguard and ensure respect for the world's Intangible Cultural Heritage, including raising awareness of the importance of intangible heritage and encouraging international cooperation and assistance.
Democracy	Partnership agreement between the members of the African, Caribbean and Pacific Group of States of the one part, and the European Community and its Member States, of the other part, signed on 23 June 2000 - Protocols- Final Act - Declarations	To promote and expedite economic growth with a view to contributing to peace and security and to promoting a stable and democratic political environment
Desertification	United Nations Convention to Combat Desertification in Countries Experiencing	To combat desertification and mitigate the effects of drought with a view to achieving

Theme	Convention objective	Summary
	Serious Drought and/or Desertification, Particularly in Africa	sustainable development
Ozone Layer Depletion	Amendment to the Montreal Protocol on substances that deplete the ozone layer, adopted at the ninth meeting of the Parties	To ensure effective protection of the ozone layer by regulating trade in substances that deplete it.
Waste Management	Basel Convention on the control of trans boundary movements of hazardous wastes and their disposal	To lay down obligations with regard to ensuring that the trans-boundary movement of wastes is reduced to the minimum consistent with the environmentally sound and efficient management of such wastes

4.7.1 International Labour Organization Fundamentals and Other Conventions

Table 15 below indicates the standards aimed to promote rights at work, encourage decent employment opportunities, enhance social protection, and strengthen dialogue on work-related issues.

Table 15: ILO standards and other conventions

Theme	Convention	Summary	Application in Kenya
Women rights	International labour organization Convention No. 89 on Women's Rights and working conditions	These conventions set our basic principles and rights at work in regards to gender equity	The principles and rights set out in these conventions are generally adopted in the 2010 constitution and in Kenya's Employment Law,2007 plus the Industrial Relations Act, 2007, the Workers Injury benefit Act, 2007 and the Occupational Safety and Health Act, 2007
	ILO Discrimination (Employment and Occupation Convention 1958(No.111)		
	United Nations Convention on the Elimination of all Forms of Discrimination Against Women.		
	ILO Worst Forms of Child Labour Convention, 1999 (No. 182)		
	ILO Child Rights and Working Conditions Convention No. 90		
	ILO Forced Labour Convention, 1930 (no. 29		
	ILO Abolition of Forced Labour Convention, 1957 (No. 105)		
Labour Rights	ILO Right to Organize and Collective Bargaining Convention, 1949 (No. 98	These conventions set out basic principles and rights at work in regard to representation	
	ILO Freedom of Association and Protection of the Right to Organize Convention, 1948 (no. 87)		
Occupational Health and Safety	ILO Occupational Safety and Health Convention, 1981 (No. 155)	This convention sets out basic principles and rights at work in regard to workplace	

Theme	Convention	Summary	Application in Kenya
		health and safety management	

CHAPTER 5.0 ESIA APPROACH AND METHODOLOGY

5.1 Introduction

This chapter outlines the stakeholder engagement (consultation, participation and disclosure) process and methodology used during data and information collection. The different methodologies were applied to collect and analyze data relevant to social-economic environment, physical environment and biodiversity. These methodologies are expounded in the foregoing sections,

5.2 Socio Economic Data Collection Methodology

5.2.1 Desktop Study Studies

Desktop study entailed an office-based exercise during which available existing information (such as available aerial imagery, mapping and published literature) was undertaken prior to undertaking field work, to describe the existing environment. Relevant literature and available project documents were reviewed to help in describing the biophysical and social settings of the project's area of influence. The documents reviewed included but not limited to the following:

- Relevant Acts of parliament,
- Kisumu County Integrated Development Plan 2023 - 2027
- Busia County Intergrated Development Plan 2023 – 2027
- Vihiga County Intergrated Development Plan 2023 – 2027
- Feasibility Study Report-Naivasha–Kisumu Standard Gauge Railway Project in Kenya, June 2023.
- Kenya Railways Strategic Plan 2023-2027
- Siaya County Intergrated Development Plan 2023 – 2027
- Kakamega County Intergrated Development Plan 2023 – 2027
- KNBS Kenya Population and Housing Census Report-2019.
- The Railways Bill,2024
- Feasibility Study report for New Railway Kisumu–Malaba Standard Gauge Railway Project
- World Bank Group Enivronmental,Health And Safety Guidelines (Ehs Guidelines)
- Convention on Biological Diversity website (http://www.cbd.int/)
- UNESCO database on World Heritage Sites (http://whc.unesco.org/en/interactive-map/)

5.2.2 Stakeholder Engagement and Public Participation

The core stakeholders of the project include Project Affected Persons (PAPs), local residents, motorists, businesses, and service providers along the SGR corridor individuals and groups who may either benefit from or be impacted by the development. The primary objective of stakeholder consultation is to ensure that their views and concerns are incorporated into the Environmental and Social Impact Assessment (ESIA), thereby supporting a transparent, inclusive, and robust evaluation process.

Stakeholders are categorized as either directly affected or indirectly involved, such as regulatory agencies, interest groups, and other institutions with a stake in the project's outcomes. Engagement activities commenced during the scoping phase and continued throughout the project lifecycle, in accordance with national legislation, IFC Performance Standards, and the World Bank Environmental and Social Framework.

Stakeholder engagement and consultations were undertaken in order to determine and capture all the key areas of potential environmental impact, namely: a) physical environment, b) biological environment, c) social-cultural environment, d) economic issues, e) political issues, f) institutional issues, g) international implications, and h) any other issues.

5.2.2.1 Stakeholder Identification

The following list outlines the parties to be consulted, they will likely be affected or have interest in the proposed railway corridor.

1. Government Institutions officials including, Kenya Pipeline Company (KPC), Kenya Civil Aviation Authority (KCAA), Kenya Power Company, Kenya Airports Authority (KAA), Kenya Wildlife Service (KWS), Kenya Ports Authority (KPA), Kenya Railway Corporation (KRC), Kenya Highways Authority (KENHA), Kenya Urban Roads Authority (KURA), Kenya Rural Roads Authority (KeRRA), Kenya Electricity Generating Company (KenGen), Kenya Electricity Transmission Company (KETRACO), Kenya Forest Service (KFS), Water Resource Authority (WRA), Ministry of Mining, Relevant ministries in the County governments of Kisumu, Siaya, Kakamega, Vihiga and Busia such as Environment, Transport, National Transport Safety Authority (NTSA), National lands Commission (NLC), Academia, Youth among others.
2. Long Distance Truck Drivers Union.
3. Kenya Association of Transporters.
4. Kenya Association of Manufacturers (KAM).
5. Kenya Association of Tour Operators.
6. Kenya Chamber of Commerce.
7. Local community representatives (Local political and Community leaders).
8. Local community members along the proposed railway line.
9. Business operators – Hotel owners, shop owners, service stations, freight terminal owners, truck owners among others.
10. Truck drivers, turn boys, mechanics, puncture repairers.
11. Residents Associations along the proposed alignment
12. Conservation NGOs – Conservation alliance, Nature Kenya,
13. Local administration in the SGR route for the five counties – Kisumu, Siaya, Vihiga, Kakamega and Busia.

5.2.2.2 Stakeholder Mapping and Analysis

Stakeholder mapping seeks to understand stakeholders' level of interest in the Project and influence in decision making as well as on other Project stakeholders, and will continue throughout the Project lifecycle. It is also important to note that stakeholder interests and level of influence is dynamic and changes over time; hence the need to periodically update the stakeholder map as well as the wider SEP. Mapping will also help identify stakeholders who may find it more difficult to participate in consultation activities and are affected by or interested in the proposed Project because of their marginalized or vulnerable status.

Stakeholder mapping considers:

- Who is affected by the Project and how;
- Who the formal and informal community leaders are and to what degree they are seen as representative;
- Whether the stakeholder supports, is neutral towards, or is opposed to the Project;
- Each stakeholder's interests and concerns in relation to the Project; and
- How different stakeholders can influence the Project and what risks or opportunities this presents.

According to each stakeholder's levels of interest or impact on the proposed Project, different levels of engagement intensity will be employed. Stakeholders will be mapped using the matrix presented below.

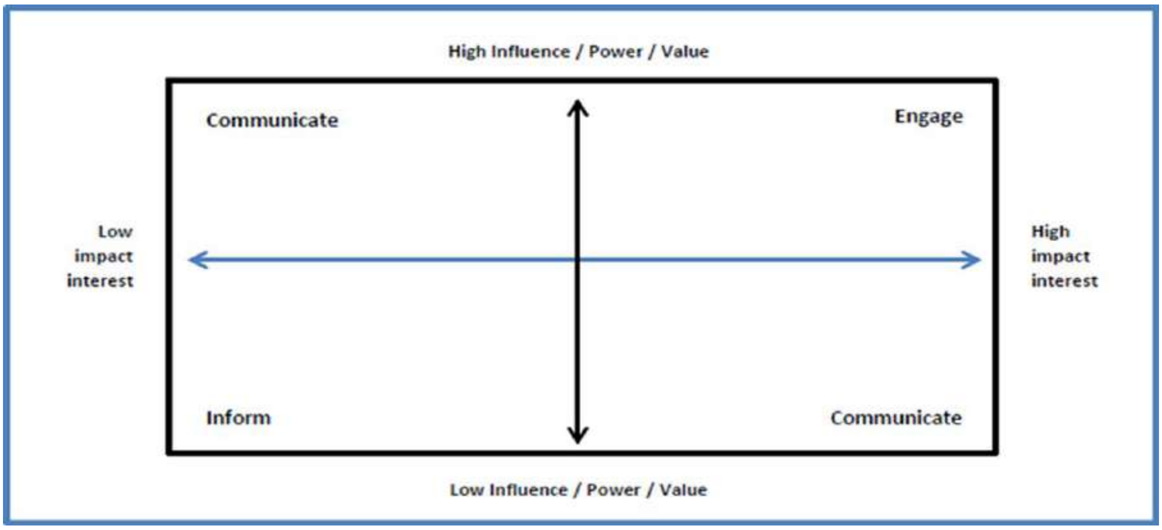

Figure 15: Stakeholder analysis

In addition to the stakeholder mapping analysis presented above, the dimensions of stakeholder interest and influence were also considered, as summarized in the table below. This analysis categorizes stakeholders based on their level of interest in, and influence over, the project. The identification process began with a brainstorming exercise to determine which stakeholders may be affected by the project and the extent of their influence. The expert team then classified the stakeholders into four distinct groups based on their respective levels of interest and influence:

- Low interest, low influence
- Low interest, high influence
- High interest, low influence
- High interest, high influence

The **Table 16** below presents the identified stakeholder groups, their roles, interests, and levels of influence.

Table 16: Stakeholders Mapping

Category	Stakeholder	Role	Interest	Influence	Strategy
National Government	Districts County Commissioners (DCC) Assistant County Commissioners (ACCs), Area Chiefs, Assistant Chiefs	• Smooth implementation of the Project • PAPs are informed about the project • PAPs are compensated • The project is done within the law	**High**	**High**	**Engage**
County Governments	Busia	• Providing information to the consultants in regards to the public land where the project is being undertaken. • Providing necessary information in respect to community, • Participate in validating the project outputs.	**High**	**Medium**	**Communicate**
	Siaya	• Providing information to the consultants in regards to the public land where the project is being undertaken. • Providing necessary information in respect to community, • Participate in validating the project outputs.	**High**	**Medium**	**Communicate**
	Kakamega	• Providing information to the consultants in regards to the public land where the project is being undertaken. • Providing necessary information in respect to community, • Participate in validating the project outputs.	**High**	**Medium**	**Communicate**
	Vihiga	• Providing information to the consultants in regards to the public land where the project is being undertaken. • Providing necessary information in respect to community,	**High**	**Medium**	**Communicate**

Category	Stakeholder	Role	Interest	Influence	Strategy
		• Participate in validating the project outputs.			
	Kisumu	• Providing information to the consultants in regards to the public land where the project is being undertaken. • Providing necessary information in respect to community, • Participate in validating the project outputs.	**High**	**Medium**	**Communicate**
Government Institutions	KRC	• Project Proponent (Project implementation (Timely and efficient implementation of the project)	**High**	**High**	**Engage**
	NEMA	• Environmental regulating agency	**High**	**Medium**	**Communicate**
	KFS	• Providing information in regards to forestry	**Low**	**Low**	**Inform**
	KWS	• Providing information in regards to wildlife	**Moderate**	**Low**	**Inform**
	KMFRI	• Providing information in regards to marine and fisheries	**Moderate**	**High**	**Engage**
	Water Resources Authority (WRA)	• Providing information in regards to water management and conservation.	**Moderate**	**Medium**	**Communicate**
	KPLC, KETRACO and other related Institutions	• Providing information in regards their existing infrastructures. • Relocation of their infrastructures where necessary for the project	**Moderate**	**Low**	**Inform**
Project Affected Persons (PAPs)	Individual Land Owners along the ROW	• Providing the required information for preparation of the Resettlement Action Plan. • Participate in decision making.	**High**	**High**	**Engage**
Transport Operators	Bodaboda, Lorries, Matatus, Trucks Operators	• Information on the expectation of the SGR project	**Moderate**	**Moderate**	**Inform**
Business Communities	Traders	• Information on the expectation of the SGR project	**Moderate**	**Moderate**	**Inform**
Local Communities	Communities group and members	• Involvement in public participation	**Low**	**Low**	**Inform**

Category	Stakeholder	Role	Interest	Influence	Strategy
Trade/ Manufacturers Associations	KAM KNCCI	• Information on the expectation of the SGR project	**Low**	**Low**	**Inform**
Others	• Religious groups representative, • Community Based • Organizations (CBO) • Non-Governmental Organizations (NGO) • Youth and Women groups • People with disability • Vulnerable groups	• Participate in providing local information. • Providing the required information for project execution and consideration.	**Low**	**Low**	**Inform**

5.2.2.3 Stakeholder and Public Consultation Methods

The consultation methods that will be used to engage the stakeholders in the specific projects will include:

- High-Level Introduction to County Leadership – already done during 3rd – 7th March 2025.
- One- to-one meetings with Key Informants
- Community/ Public Meetings

The **Table 17** below outlines the stakeholder and public consultations methods.

Table 17: Stakeholder and public consultation methods

Method of Consultation	Purpose	Justification	Target Audience
Public Meetings	• Share information about the project • Provide a forum for the community to raise issues and concerns about the proposed project • Allow issues to be verified and solutions formulated • Document stakeholders' comments and concerns for consideration during the subsequent studies • Provide response to the project related questions	• Allows wider consultation and discussion on issues and relevant topics • Increased ownership by the participants	Local communities, PAPs, National and County Government officers and others Stakeholders
Focus Group Discussions	• Provide information about the project to the key informants and stakeholders • To verify the information provided by the community • Gather data on specialized/thematic areas issues	• Allows wider consultation and discussion on issues and relevant topics • Increased ownership by the participants	• Women • Youths • Persons with Disabilities

Method of Consultation	Purpose	Justification	Target Audience
One to One Interviews	• Provide information about the project to the key informants and stakeholders • To verify the information provided by the community • Gather data on specialized/thematic areas issues	• Allows for follow up on issues and gather detailed further information.	• Government Institutional Representatives, • County Government Representatives, • Academia, professions
Administration of Questionnaires	• Provide information about the project to the key informants and stakeholders • Gather data on specialized/thematic areas issues	• Allows wider consultation and collect relevant data	• Government Institutional Representatives, • County Government Representatives, • Academia, professions • Community Members

5.2.2.4 Stakeholder Engagement Plan

The **Table 18** below presents stakeholder plan outlining strategies to be used, timing and frequencies throughout project life cycle.

Table 18: Stakeholder Engagement plan

Stakeholder category	Specific needs/role	Means of communication	Timing
Ministry of Interior and Coordination of National Government	• Information dissemination and outreach • Facilitate public participation	Correspondence by phone/email, Meetings	During implementation – input into all project activities
County Governments (Kisumu, Vihiga, Siaya, Kakamega & Busia)	• Information dissemination and outreach • Facilitate public participation	Correspondence through letters, Email, meetings	During implementation of the project Lifecyle
Government Institutions and Lead agencies	• Issuing of permit, guidelines • Provision of Technical support	Correspondence by phone/email, Roundtable discussions, website link.	Throughout the project life cycle
Project Affected Persons (PAPs)	• Provision of Right of Way and to be Compensated	Meetings and Focus group discussions	During compensation process, Land acquisition
Business Communities	• Partnership and collaboration	Meetings and Focus group meeting	Entire project cycle
Other Stakeholders	• Partnership and collaboration	Meetings and Focus group meeting	Entire project cycle

NB: *Kindly note that a detailed Stakeholder Engagement Plan is annexed to this report.*

5.2.2.5 Grievance Redress Mechanism (GRM)

A user-friendly Grievance Redress Mechanism is in place to allow stakeholders to submit any concerns or complaints throughout the project lifecycle. The GRM aims to resolve issues promptly and openly, encouraging community participation in finding solutions.

Information on how to file and monitor grievances will be shared widely, and the process will be promoted during all community engagement activities. Local-language explanations and visual aids such as posters, leaflets, and flowcharts will be displayed in public institutions including chiefs' offices, schools, health facilities, markets, and places of worship.

Other modes of communication, including WhatsApp and text messaging, will also be used whenever a grievance arises whether from the community to the project team or internally between the contractor and employees. The grievances are in three levels as illustrated below;

Level 1 Grievances: Resolved at Field Level

These grievances relate to matters that can typically be addressed at the field level. The expected resolution period is 14 days; however, until the full procedure is fully implemented, claimants will be notified within 30 days. Addressing these grievances may involve engaging relevant stakeholders in the field, sharing necessary information, negotiating compensation with the affected parties, issuing an apology, or applying any other appropriate remedy within the abilities and resources of the field staff and their local networks.

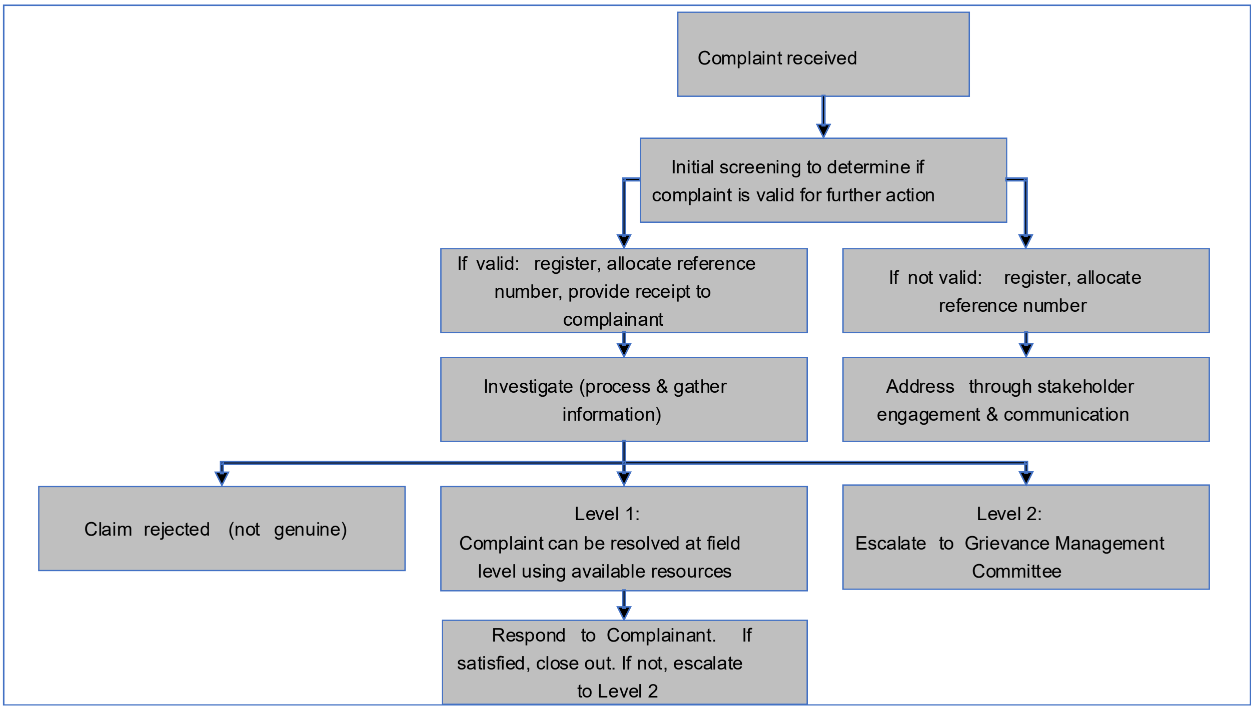

Figure 16: Level 1 Grievance Process

If all resources and options have been totally exhausted at field level and the claimant still appeals the resolutions proposed by KRC, the case needs to be escalated to level 2.

Level 2 Grievances: Resolved through a Grievance Management Committee

These are complex claims usually related to project aspects that could have adverse impacts on the claimant's livelihood, health and safety and cultural norms and traditions.

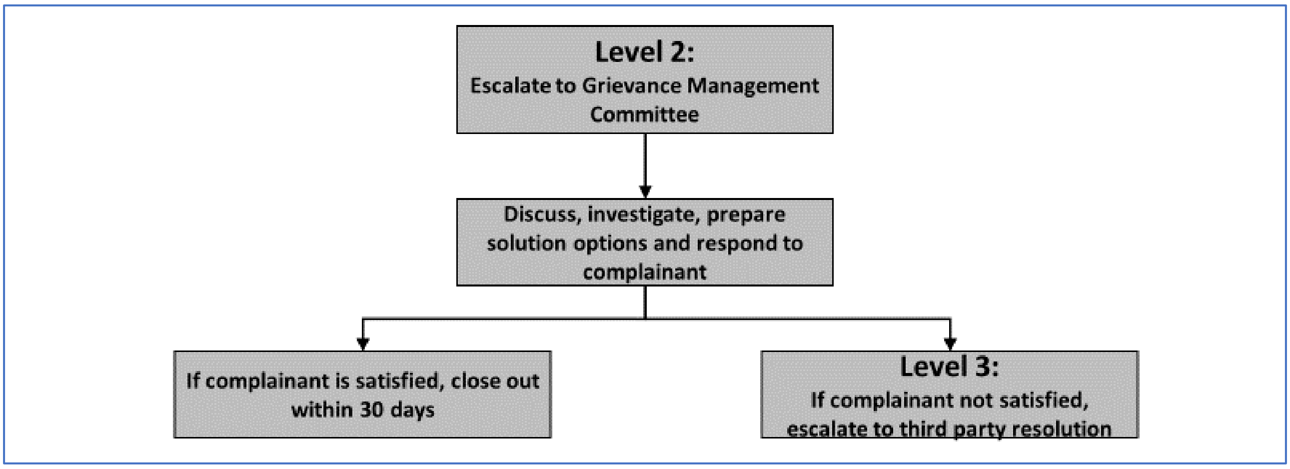

Figure 17: Level 2 Grievance Process

<u>Level 3 Grievances: Referred to Third Party</u>

A grievance that remains unresolved despite following all available avenues to resolve it through first and second levels grievance resolution will become a Level 3 Grievance. KRC will comply with all legal requirements and will follow up regularly to assess the status of all such outstanding cases.

NB: ***Kindly note that a detailed Grievance Redress Mechanisms is annexed to this report.***

5.3 Biodiversity Data Collection Methodology

The biodiversity data collection was done to assess the project's environmental footprint, identify potential ecological impacts on habitats and species, inform mitigation and conservation efforts, ensure compliance with environmental regulations, and predict long-term effects on biodiversity within the standard gauge railway corridor. The assessment focused on the distribution and status of flora and fauna, the sensitivity of habitats, and the presence of any species of conservation concern.

5.3.1 Biodiversity Assessments

The study adopted a purposive sampling design where wetlands and immediate surrounding were targeted. This was informed by the observation that the area traversed by the railway is already disturbed by human activities through establishment of farms and human settlement. The only natural habitats that remain are thus flowing rivers and streams as most marshes have been converted into sugarcane plantations. The other rationale was that since the areas around wetlands are less disturbed, they would form refuge habitats for the remnants of the original biota which increases the likelihood of getting them.

The study was carried out in the counties of Busia, Kakamega, Vihiga, Siaya and Kisumu. The sampling points were concerted around wetlands which included major rivers like river Nzoia and Yala, smaller ones like rover Malaba, Malakisi, Lusubu, Kisian as well as streams interacting with the railway line. These are shown in Table below. The sampled points are presented in **Table 19** below. The biodiversity sample points are also shown in figure 18 below.

Table 19: Sampled points along the SGR Phase 2C corridor

County	Wetland	Latitude	Longitude
Busia	River Malaba/Lwakhaka	0.6337944	34.26096
	River Kajei	0.5919639	34.27047
	River Malakisi	0.6190806	34.28258
	Kamolo Stream	0.6094583	34.29155833

County	Wetland	Latitude	Longitude
	Sokomoko Market	0.529	34.31874
	River Walatsi/Siyo	0.48918	34.3413
Kakamega	River Nzoia	0.3016778	34.420431
	River Lusumu	0.3011944	34.422444
Kakamega/Siaya boundary	River Faratsi/Murumba	0.2037694134	34.45131666
Siaya	Yala Town	0.0976139	34.53656389
	River Yala	0.0840028	34.538555
Siaya/Vihiga boundary	Epuche	0.01307	34.54898
Siaya	River Awach	-0.00694	34.54211
Vihiga	Ochuore Village	-0.0183056	34.5214966
	Sinongo Stream	-0.0211	34.54472
	Alukucha stream	-0.0167	34.54467
Kisumu	Miranga area	-0.08445	34.58102
	River Kisian	-0.070911	34.666972
	Kasuna Stream	-0.068	34.655
	River Awach	-0.069	34.638
	Karamilo area-	-0.6711	34.68642

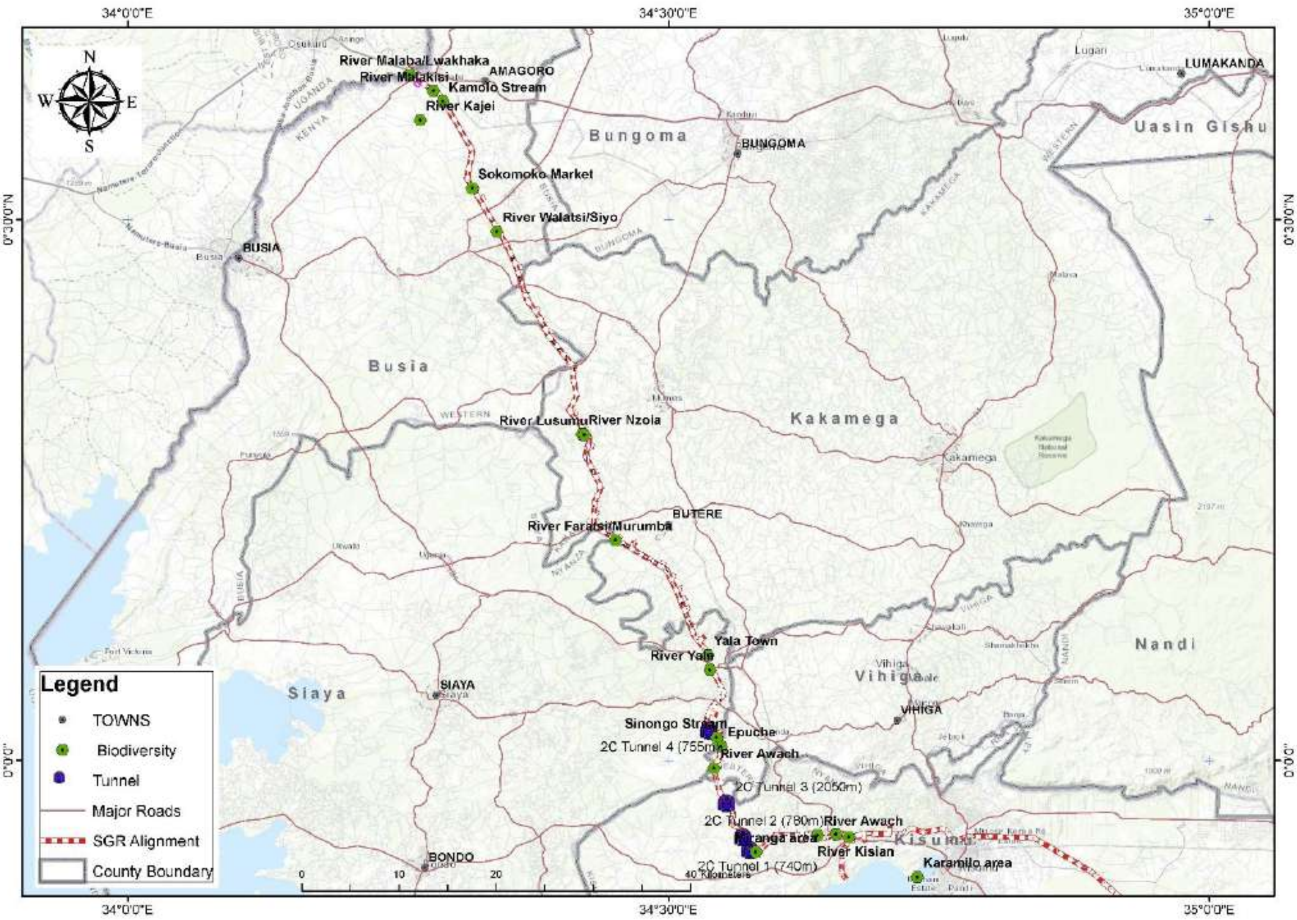

Figure 18: Biodiversity Assessment sampling points

The approach adopted for each taxonomic group during the biodiversity assessment is outlined below. For each taxa, specific survey methods and tools were applied to ensure accurate data collection and representation. By using methodologies specific to each taxa, the study ensured that the biodiversity along the Right of Way was comprehensively evaluated and that both common and conservation-sensitive species were adequately considered.

5.3.2 Mammal Survey Methodology

Different sampling methods were employed based on the size of the mammal targeted along the sampling points indicated in **Figure 17** above.

- **Small sized crawling mammals;** For small mammals, Sherman traps and pitfall traps were employed in the study area. Appropriate baits used were oatmeal and groundnut butter and laid set in paceline transect established within identified study sites. Ten (10) Sherman traps were placed in a straight line with a space of 10m between consecutive traps covering a radius of 100m for each of the sampling points. This targeted shrews, mice and rats.
- **Small sized flying mammals;** these are the bats, a unique group of mammals with the ability to fly and echo communicate through the use of high frequency sounds. Acoustic device, SM4 was used to record bat activities around the sampling sites. Since bats are nocturnal, the devices were left at the sampling points overnight and collected the following morning. The records were later analyzed using computer software to identify the bats present in a given locality.
- **Medium sized mammals**: Tomahawk cages were employed as shown in **Figure 19** (b) below to target the medium sized mammals averaging the size of the mongoose and civets. These were baited with fish and laid in appropriate vintage points where the animals are likely to encounter them. Such include the riparian vegetation, bushes and plantations where human activities were minimal.

(Key = a – Camera trap, b – Tomahawk, c – SM4, d – Sherman Trap)

Figure 19: Tomahawk cage, camera trap and Acoustic device (SM4) used in mammal survey

Source: Ecoscience Engineering Biodiversity Assessment report-May 2025

- **Large sized mammals**; A combination of Camera traps, direct observation, signs and tracks were used to survey presence of large mammals within study sites. Captured individuals were identified to species level with help of field guide.

5.3.4 Bird Survey Methodology

Vantage point and spot surveys, as well as walked transects in each study area were used to mark the spot and identify birds within the study area. Binoculars were employed to increase visibility of distant birds. Identification was based on calls and physical observation.

5.3.5 Herpetofauna Survey Methodology

Different sampling methods were employed to complement each other and maximize chances of species observation.

- **Pitfall traps associated with drift fences (Corn, 1994).**

The drift fences as shown in **Figure 20** below were either laid in an X or cross formation to trap animals moving from all direction. Also laid in a strain line. The choice is influenced by the topography of the sampling site. The traps were laid at intervals of approximately 5km all along the transect/ wayleave

Figure 20: Drift fences

Source: Ecoscience Engineering Biodiversity Assessment report-May 2025

- **Time Limited Searches (Karns, 1986).**
  This involved actively seeking the herps from their possible cover within a restricted time frame of on hour and recording the observation. The searches involved digging up soil, moving leaf litter, turning rocks, logs and inspecting tree barks for the animals.
- Acoustic surveys for the amphibians and is targeted at their calling behavior in wetlands especially at night as some species are able to call even during the day. This was nested within the Time Limited searches and was done from late evening into the early hours of the night as these are the hours when the amphibians and other crepuscular reptiles are active. Some species such as *Phrynobatrachus spp.* can call during the day as well and this method was used to locate them.
- Opportunistic encounters during other field activities and observations recorded and reported by other members of the team and the community. The identification was based on the description given and the expert knowledge of the possible species in the region.
- Interviews done with the locals provided more species. This was used to enrich the inventory but only took to account well described species and those that are within the distribution range based on the expert's knowledge

5.3.5 Fish Surveys Methodology

Fish data was obtained from unpublished report from recent studies in the study area which covered the river systems captured in the present study.

5.3.6 Invertebrate Survey Methodology

Different methods were employed as informed by the behavior of the targeted invertebrates. Pitfall traps were used for crawling species as shown in **Figure 21** below. These were dug to flash with the ground and filled halfway with water. Pantraps were used were used for flying butterflies seeking flowers, aerial nets for butterflies seeking rotting fruits and sweep nets for flying species.

Figure 21: Pitfall traps

Source: Ecoscience Engineering Biodiversity Assessment report-May 2025

5.4. Physical Environment Data Collection Methodology

5.4.1 Air Quality Assessment Methodology

Air quality monitoring was carried out using Aeroqual Monitor and sensors that meets Monitoring Certification Scheme (MCERTS) standards that are compliant with ISO/IEC 17000 series of conformity assessment standards. The methods are in line with the following standard methods;

- KS ISO 8672: Air quality - Determination of the number concentration of airborne inorganic fibres by phase contrast optical microscopy - Membrane filter method was for inhalable and respirable particulate matter;
- KS ISO 7996: Ambient air - Determination of the mass concentration of nitrogen oxides -- Chemiluminescence method for nitrogen oxide;
- KS ISO 4224: Ambient air - Determination of carbon monoxide non-dispersive infrared spectrometric method for carbon dioxide; and
- KS ISO 14965: Air quality - Determination of total non-methane organic compounds -- Cryogenic pre-concentration and direct flame ionization detection method for total volatile

organic compounds.

The Aeroqual sensor heads used feature an active fan sampling, which ensures a representative sample is taken and therefore increases measurement accuracy. The sensor heads used (H_2S and PM_{10}& $PM_{2.5}$) are duly calibrated with their calibration certificates annexed in the report. The monitors were elevated at a height of approximately 1.5m using a tripod stand as illustrated in **Figure 22** below. The monitor was set to log the pollutant data every minute. They were then placed in an area free of any obstruction during the monitoring period to allow free air circulation.

Data was the analysed using Microsoft Excel with the results compared with EMC (Air Quality) Regulations, 2014. The logged data was then downloaded Aeroqual S500 V6 software in the computer whereby the data was analyzed using Microsoft Excel software.

Figure 22: Air quality analysis at the proposed Malaba Marshalling Yard

Source: Ecoscience Engineering Air quality Assessment report-May 2025

5.4.2 Soil Quality Assessment Methodology

ISO 18400-104:2018 Soil quality — Sampling Part 104: Strategies was adopted in soil sampling.

Soil samples were obtained for between 15-30 cm above the surface as shown in **Figure 23** below. Composite samples were obtained from each site in weighing approximately 500g. The soil samples were stored in air-tight plastic containers in readiness for transportation and analysis. The samples were stored in a cooler park ensuring a temperature of below 4^0C was maintained.

Figure 23: Soil sample collection

5.4.3 Water Quality Assessment Methodology

ISO 5667-1:2023 Water quality — Sampling Part 1: Guidance on the design of sampling programmes and sampling techniques was adopted in water sampling from all the sources. **Figure 24** and **Figure 25** below shows some of the rivers where water samples were obtained from rivers and shallow well.

Figure 24: Water sample collection from a shallow well

Figure 25: Water sample collection at R. Malaba

Source: Ecoscience Engineering Water quality Assessment report-May 2025

5.4.4 Noise and vibration assessment methodology

Noise measurement methodology

ISO 1996, Acoustics – Description and Measurement of Environmental Noise was applied in the noise assessment. Measurement was carried out with the use of a duly calibrated SVAN 971 Type 1 (Serial Number 82474) sound level meter. Monitoring locations were based on prevalent wind direction south west to north east and the two sensitive receptors located in the vicinity of the facility. Four sampling locations were, however selected with their geo-location identified using a Global Positioning System (GPS).

Field calibration checks was done before and after measurement using a duly calibrated sound level calibrator (Type SV36- Serial Number 112554). Sound level meter was positioned in unobstructed location and elevated with a tripod stand during measurement. This is as illustrated on **Figures 26 - 28** below.

Figure 26: A view of the Sound Level Calibrator used

Figure 27: A view of the Sound Level Meter used

Figure 28: Noise measurement at the proposed Yala Railway Station

Source: Ecoscience Engineering Noise and Vibration Assessment report-May 2025

Ground Vibration Methodology

ISO 4866: 2010 'Mechanical vibration and shock-Vibration of fixed structures - Guidelines for the measurement of vibrations and evaluation of their effects on structures' was applied in monitoring. The Instantel Micromate; Serial Number UM152275 that is duly calibrated; a 4-channel unit, is designed to monitor and transmit event data with one triaxial geophone and one air overpressure microphone, was used for the vibration monitoring exercise. The vibration monitoring equipment had a frequency response is within the recommended range of between 1 Hz to 80 Hz for accurate readings.

Ground vibration was measured on a tri-axial arrangement of velocity transducers and air blast by means of air blast microphone. Set-up of the monitor include times when the unit is active, set trigger levels for ground vibration and air blast as well as general information about the location and client. Trigger levels are those levels that are pre-programmed in the system to start the recording if any event is greater than those set levels. Normally the system is to trigger on ground vibration and/or air blast. Set levels are such to minimize the possibility of false triggers due to noise/vibration generated in the vicinity of the monitor and ensure accurate and effective monitoring of any blast related event. The vibration measurement is as illustrated on **Figure 29 and 30** below.

Figure 29: Vibration measurement at the proposed Kisumu Station

Figure 30: Ground vibration monitoring equipment

5.5 Impact Analysis and Evaluation Methodology

This exercise is intended to give an analysis of possible impacts of the project. The analysis and evaluation of potential impacts associated with all the project phases has been undertaken the project based on site surveys, available secondary information, professional knowledge and judgment drawn from similar projects. The methodology applied in this ESIA to assess impacts is as follows:

- Each receptor is analyzed to understand how sensitive it is to a change in its external environment as indicated in **Table 20** below.
- Each potential change which will be caused by the project is analyzed to understand the extent to which it might impact the receptors in the project area.
- The two factors (sensitivity of a receptor and change parameter) are combined to estimate the significance of each impact to the receptors. The method used is described below.

5.5.1 Sensitivity of a Receptor

The sensitivity of each group of receptors has been estimated based on the understanding of their potential status, using the criteria and scoring system set out the table below. It is important to note that the way in which sensitivity is assessed varies from receptor to receptor so the criteria is only used as a guide.

Table 20: Criteria and scoring system for determining sensitivity of a receptor Category

Criteria	Score	Description
Negligible	1	Receptor with good capacity to absorb proposed changes or good opportunities for mitigation.
Low	2	Receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation.
Medium	3	Receptor with little capacity to absorb proposed changes or limited opportunities for mitigation.
High	4	Receptor (human, physical or biological) with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.

5.2.2 Change Parameter

Each potential change describes various parameters of the change and considers how each change could affect each receptor applying a scoring system. To describe the change, we used the parameters set out in **Table 21** below.

Table 21: Change receptors

Parameter	Score	Description
Nature	Positive Negative (scoring system not applicable)	The nature of the change that is being considered may be positive, neutral or negative. For example, a gain in available habitat area for a key species would be classed as positive, whereas a habitat loss would be considered negative.
Magnitude	1 Negligible 2 Minor 3 Moderate 4 Major	The magnitude of change is a measure of the degree of change that will be incurred as a result of the proposed development. The categorization of magnitude is based on a set of criteria that is specific to the discipline area being considered. For example, in the case of surface water, the magnitude may be defined as the extent to which the water quality (for example, suspended solids) exceeds the adopted national criteria.
Duration	1-Short term(0-6months) 2-Medium term (7-18 months) 3-Longterm (19-36 months 4 Permanent	The duration of change refers to the length of time over which an environmental impact may occur.
Scale	1 Local 2 Regional 3 National 4 International	The change may happen at a local, regional, national or international level
Probability	1 Low (Unlikely) 2 Medium (as likely as not) 3 High (likely) 4 Certain	How likely is it that the change will happen

5.5.3 Significance of Impact

Having assessed the sensitivity of a receptor and change parameters set out in **Table 21 and 22** above, an estimation of the significance of the change by combining the parameters of change with the sensitivity of the receptor was conducted using the following formulae; **SP (Significance points) = (Magnitude + Duration + Scale + Probability) x Sensitivity.**

Based on the result of the calculation (the significance point), the relative significance of the impact is classified as set out in **Table 22** below.

Table 22: Guidance to significance points

Significance points	Significance	Description
Between 48- 64	Major	The degree of impact that the project may have upon the

Significance points	Significance	Description
		environment and/or the community(s) is unacceptably high. It is unlikely that an impact of this magnitude can be satisfactorily mitigated. If this impact cannot be avoided, the project is unlikely to be permitted for development.
Between 32-47	Moderate	The degree of impact that the project may have upon the environment and/or the community(s) is high. The project may be compromised if this impact cannot be avoided or mitigated (i.e. to reduce the significance of the impact).
Between 16-31	Minor	The degree of impact that the project may have upon the environment and/or the community(s) is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.
<16	Negligible	No noticeable impact on the environment and/or the community(s). No mitigation is required.

The methodology chosen for this ESIA aims to provide a reasoned determination of significance, which demonstrates how the impacts have been assessed whether significant effect will occur, indicating how the scores are applied to different parameters to easily understand the rationale for the assessment based on the magnitude of the change, duration, scale and probability.

5.5.4 Mitigation and Enhancement Measures

Mitigation measures are identified through the ESIA process in order to reduce the level of adverse impact upon a receptor. The following hierarchy of mitigation measures is applied:

- Avoid and reduce impacts through design (embedded mitigation)
- Abate impacts at source or at receptor
- Repair, restore or reinstate to address temporary construction impacts
- Compensation for loss or damage

In addition to the above, community engagement and disclosure activities have played a key role in managing the extent of impacts and consideration has also been given to the identification of enhancement measures. Enhancement measures are actions and processes that:

- Create new positive impacts or benefits
- Increase the reach or number of positive impacts or benefits
- Distribute positive impacts or benefits more equitably

5.6 ESIA Study Area / Area of Influence

The project Area of Influence (AOI) is the area over which the impacts of the project are likely to be felt including all its related facilities such as the construction of access roads, as well as any reasonably foreseen unplanned developments induced by the project or cumulative impacts.
The project AOI is comprised of areas of direct impacts and indirect impacts which will inform the impact assessment.

● Direct area of influence: considers the physical footprint of the project such as the construction sites, work staging area and area affected during project works
● Indirect area of influence: includes the area which may experience project related changes in combination with activities not under the direct control of the project.

The project direct AOI often varies depending on the specific environmental or social aspect considered based on the extent an impact may be affected and can be influenced on a spatial and temporal level. The temporal influence of the project has been assessed by comparing the existing baseline conditions (social, biodiversity, hydrological and other) with the change expected over time as a result of the project activities as listed below phases:

- Site preparation/Construction phase
- Operation phase
- Decommissioning phase

CHAPTER 6.0 ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS OF THE PROJECT AREA

6.1 Introduction

This section provides the baseline state of the environment covering biophysical, social, and economic prior to commencement of the project. The section is significant in undertaking the project's impact prediction and analysis. The proposed project traversed through 5 counties namely Kisumu, Siaya, Vihiga, Kakamega, and Busia.

6.2 Physical Environment

Taking of baseline conditions and measurements is essential to provide an understand existing environmental and social dynamics, predict and manage project impacts, comply with local and international legislations, enables monitoring the effectiveness of mitigation measures. Under this section physical conditions relating to Hydrology, Water Quality, Air Quality, Soil Quality are discussed.

6.2.1 Hydrology

6.2.1.1 Drainage

The Phase 2C SGR corridor runs from Kisian in Kisumu County to Malaba at the Kenya–Uganda border, traversing Kisumu, Vihiga, Siaya, Kakamega, and Busia counties. The alignment intersects major river basins that drain into Lake Victoria, including the Malaba River, the Sio–Malaba–Malakisi system, and tributaries linked to the Yala and Nzoia catchments. The corridor's drainage environment varies from moderately sloped terrain in Kisumu to flat low-lying plains and wetlands toward Busia, increasing risks of slow drainage, ponding, and floodplain flooding. Seasonal rainfall significantly increases river flows and surface runoff. Extensive wetlands, swamps, and floodplains along the route act as natural flood buffers, groundwater recharge areas, and sediment retention zones, with the Sio–Malaba–Malakisi catchment exhibiting both steep, erosion-prone upstream sections and flat downstream wetland areas.

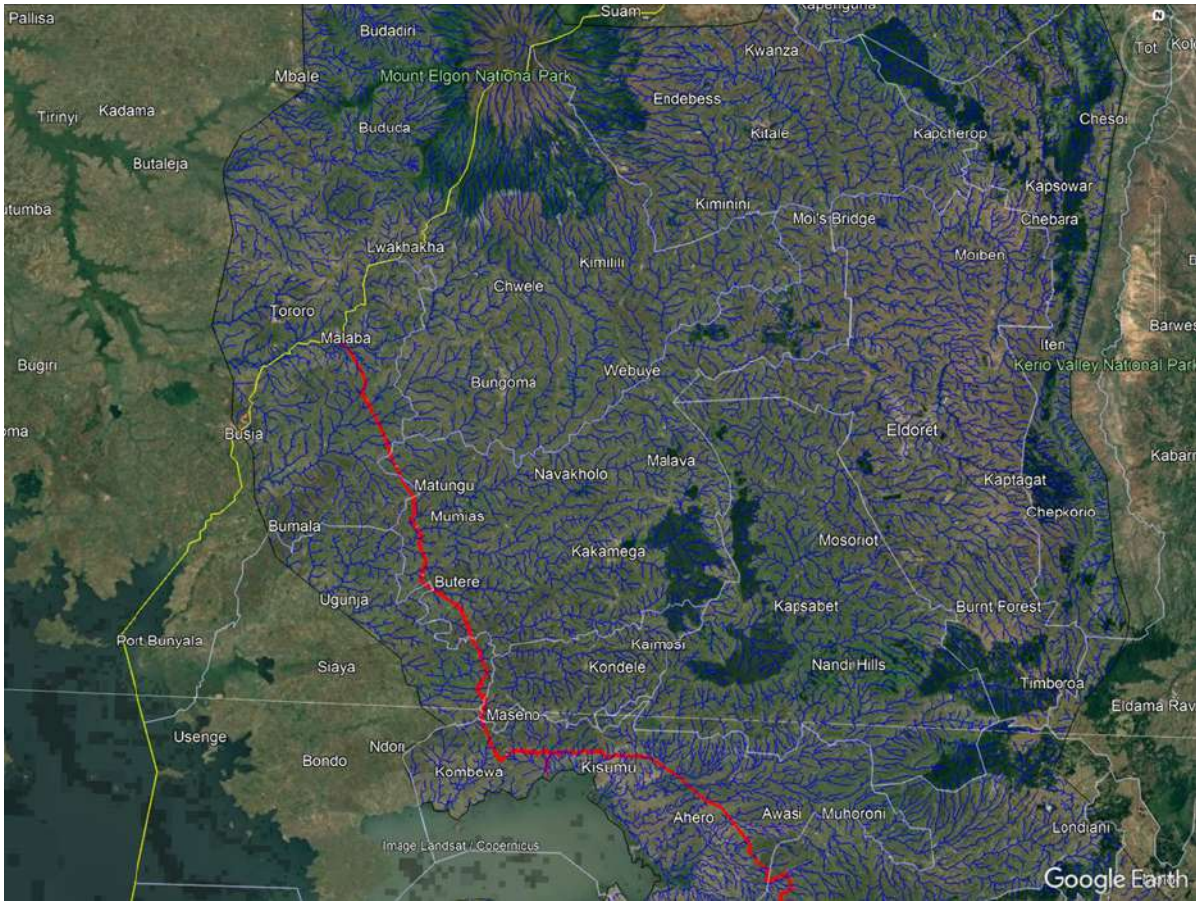

Figure 31: A map showing the project area and the broader hydrological catchment area

6.2.1.2 Topography/ Climate and Vegetation

- **Climate**

Kisumu, Siaya, Kakamega, Vihiga, and Busia counties lie within the Lake Victoria Basin and experience a tropical climate shaped by altitude and proximity to the lake. Kisumu is hot and humid year-round, receiving 1,000–1,800 mm of rainfall. Siaya has similar warm, humid conditions with 1,200–1,800 mm of rainfall. Kakamega and Vihiga, located in the higher inland areas, are cooler and wetter, receiving 1,500–2,000 mm and over 1,800 mm of rainfall respectively. Busia experiences warm tropical conditions with 1,200–1,800 mm of annual rainfall. Overall, the region has high rainfall, warm temperatures, and distinct rainy seasons, supporting agriculture and diverse ecosystems.

- **Topography**

The topography along the Phase 2C alignment is diverse. Kisumu County lies on the low-lying Lake Victoria plains with gently undulating terrain that rises gradually inland. Siaya County is marked by flat to gently rolling landforms with occasional isolated hills that support both agriculture and settlement. Kakamega County presents a more rugged landscape of hills, ridges and valleys that reflect its highland setting. Vihiga County is strongly dissected with steep slopes, hills and valleys that are often terraced for farming. Busia County has predominantly flat to gently undulating land with low ridges and river valleys that support agriculture and settlement. The variation in topography, from low-lying lake plains to elevated highlands, strongly influences drainage behavior, land use and ecological distribution across the corridor.

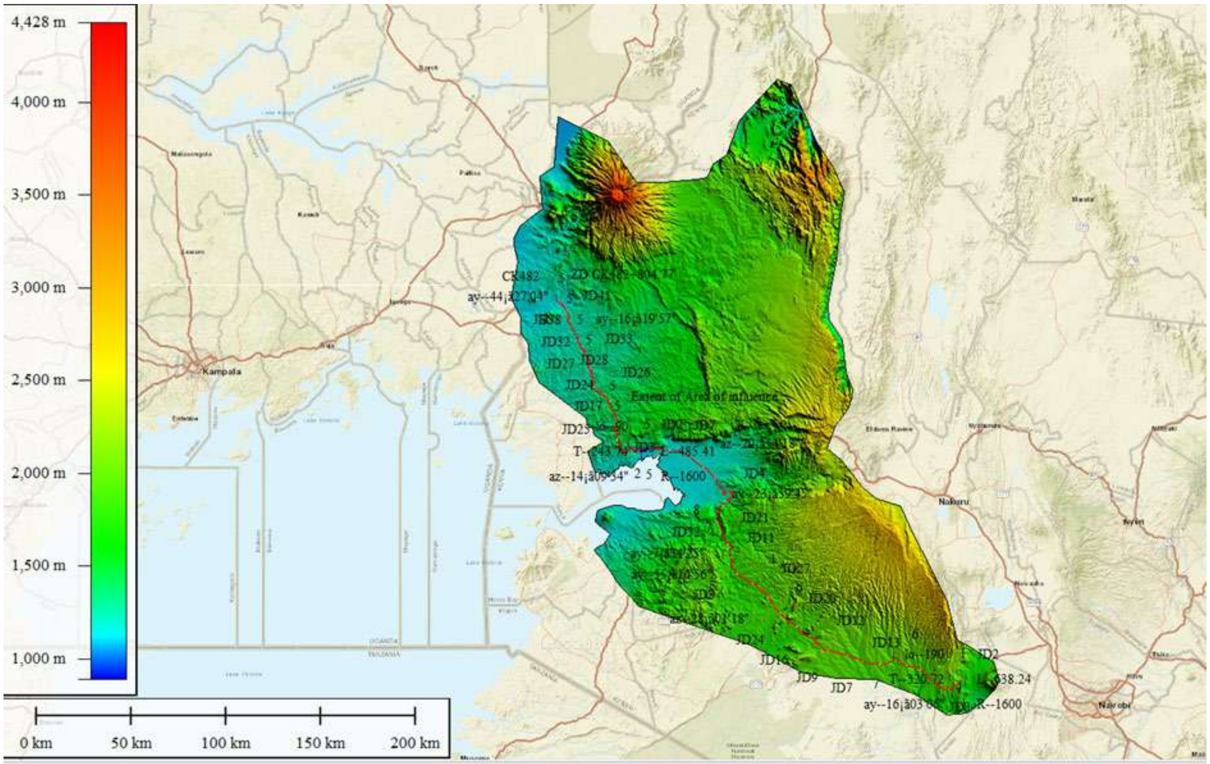

Figure 32: Delineation of Catchment's outer boundary based on topography

- **Vegetation**

Land use along the Phase 2C corridor is shaped by variations in soils, climate, and terrain. Kisumu County is dominated by agriculture maize, sugarcane, rice, and horticulture alongside fishing and aquaculture near Lake Victoria. Siaya features smallholder farming of maize, beans, cassava, and sorghum, with grazing areas and riparian vegetation. Kakamega mixes food crops with tea and sugarcane and retains patches of tropical rainforest. Vihiga is densely cultivated with terraced farms producing maize, bananas, beans, and vegetables, with forest remnants on hills and riverbanks. Busia's flat plains support sugarcane, maize, rice, livestock, and wetland-based fishing and irrigation. Overall, agriculture dominates land use, supported by forestry, fishing, and expanding urban settlements, while natural landscapes play key roles in soil conservation, biodiversity, and water regulation.

6.2.1.3 Soils and Geology

Soils and geology along the corridor vary widely. Kisumu's lowlands contain black cotton soils prone to waterlogging and shrink–swell behaviour, while higher areas have better-drained sandy loams. Siaya has clay and loamy soils with fertile alluvial deposits along rivers. Kakamega and Vihiga feature deep, weathered nitisols and ferralsols derived from igneous and metamorphic rocks, which are productive but erosion-prone on slopes; Vihiga also has pockets of black cotton soils in valley bottoms. Busia and areas near Mount Elgon contain volcanic and sedimentary soils fertile but acidic volcanic soils and poorly drained alluvial sediments. Geologically, the alignment transitions from sedimentary formations near Lake Victoria to highland metamorphic rocks and volcanic deposits toward Mount Elgon, resulting in varied soil fertility, depth, and erosion risks.

6.2.1.4 Catchments Characteristics

The hydrological behavior of the Kisumu–Malaba corridor is shaped by the size, shape, slope, land use, and storage capacity of the major catchments it crosses. Catchment boundaries were mapped using satellite imagery, DEMs, and topographic data, with field verification in flat areas where interpretation was difficult.

The Phase 2C corridor spans both low-lying plains near Lake Victoria and higher inland terrain, with most surface runoff flowing west and southwest toward the lake. In addition to the four main catchments, the alignment crosses numerous small tributaries and seasonal streams that intensify storm runoff, sediment transport, and localized flooding.

Extensive wetlands including the Yala Swamp, Sio Wetland, and Maungo Wetland provide natural flood regulation by storing runoff and delaying peak flows. Overall, the interaction of perennial rivers, seasonal waterways, and wetland systems creates a complex and dynamic hydrological environment along the railway route.

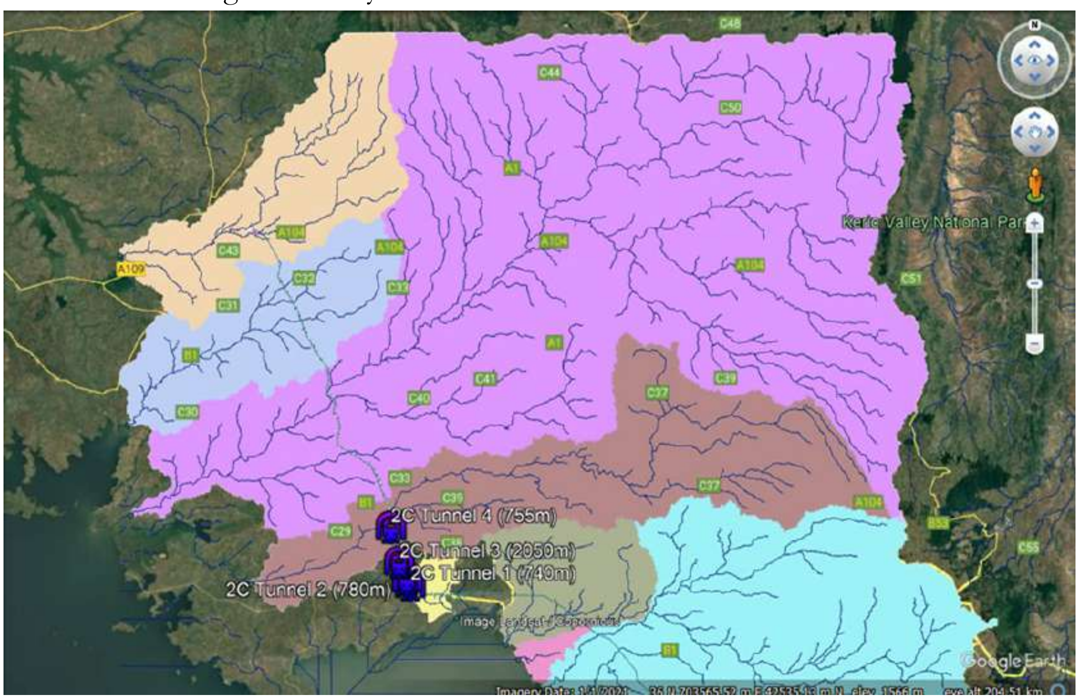

Figure 33: A map showing the 4 Major Catchment areas the railway is proposed to cut through A. Yala Catchment B. Nzoia Catchment C. Sio Catchment D. Malaba Catchment

Table 23 below outlines the hydrological characteristics of the entire catchments along the SGR Phase 2C corridor.

Table 23: Major Catchments

Catchment	Size & Origin	Key Hydrological Features	Ecological & Socio-Economic Importance	Main Challenges
Yala River Catchment	~3,351 km²; rises from Nandi Escarpment	Over 200 km long; drains into Lake Victoria via the 200 km² Yala Swamp	Supports rare fauna (e.g., Sitatunga), diverse birdlife, endemic fish;	Wetland drainage for agriculture reducing ecological connectivity and

Catchment	Size & Origin	Key Hydrological Features	Ecological & Socio-Economic Importance	Main Challenges
			supports highland agriculture; proposed Yala railway station	weakening flood-buffering capacity
Nzoia River Catchment	~12,950 km²; originates from Cherangani Hills & Mt. Elgon	High rainfall (1,076–2,200 mm); major flooding in Budalang'i; mean discharge ~118 m^3/s, peaks >1,100 m^3/s	Kenya's largest Lake Victoria tributary; key food-production zone (maize, wheat, sugarcane, rice); includes Kakamega Forest biodiversity	Recurrent floods; deforestation; land-use changes; agricultural & industrial pollution; climate variability
Sio River Catchment	Small catchment within the Sio–Malaba–Malakisi system; shared with Uganda	Seasonal flows with high wet–dry variability	Supports dense rural populations; small-scale farming; fishing; key for domestic and livestock water	Riparian encroachment; erosion; sedimentation; poor water quality from agriculture & inadequate sanitation
Malaba River Catchment	Transboundary; originates on Mt. Elgon	Hydrology altered by land-use change & deforestation; increased runoff and sediment loads	Vital for border communities; sustains twin towns of Malaba (major Kenya–Uganda trade hub); supports smallholder farming	Pollution from growing settlements; weak waste management; erosion; sedimentation; degraded riverine ecosystems

Source- *Ministry of Water and Irrigation*

6.2.1.5 Subsurface hydrology

Subsurface hydrology along the SGR Phase 2C corridor is shaped by varying soils and geology, with black cotton soils limiting infiltration in low-lying areas, alluvial deposits enhancing recharge, and fractured metamorphic, igneous, and volcanic rocks storing groundwater in highland zones. Groundwater levels fluctuate seasonally and are widely used for domestic and agricultural needs, while expanding urban and agricultural land use is increasing runoff and reducing natural recharge. Borehole data from Emululu Primary School—representative of the Lower Nzoia–Yala hydrogeological zone—indicate shallow, rapidly recharging aquifers within fractured volcanic formations, though water quality requires treatment. These hydrological conditions have significant implications for SGR engineering, including risks of groundwater inflow into tunnels and deep excavations, the need for robust waterproofing, and careful timing of construction. Adequate water supply is feasible through similar boreholes, but continued groundwater monitoring is recommended near sensitive sections.

6.2.2 Baseline Air Quality

Baseline air quality assessment was undertaken in accordance with Environmental Management and Co-ordination (Air Quality) Regulations, 2024. Air quality measurements were undertaken between 26th May to 4th June 2025 and a comprehensive report is attached to this report. (*See Annex 1 – Air Quality Report*)

The objectives of baseline air quality measurements include;

- Establish Baseline Air Quality Levels: Document existing concentrations of key air pollutants (e.g., $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, and O_3) in the project area prior to the proposed development.
- Support Environmental and Social Impact Assessment (ESIA): Provide scientifically credible data to evaluate how the project may influence local and regional air quality.
- Identify Sensitive Receptors: Determine the presence and proximity of communities, schools, hospitals, and ecological zones that may be affected by changes in air quality.
- Inform Mitigation Measures: Guide the development of targeted air pollution control and mitigation strategies during construction and operation phases.
- Ensure Compliance with Regulations: Ensure that the project adheres to national and international air quality standards and guidelines including EMCA (Air Quality) Regulations, 2024.
- Enable Long-Term Monitoring: Establish a reference point for future air quality monitoring to track changes and verify the effectiveness of implemented mitigation measures.

The proposed SGR project traverses' different counties including Busia, Kakamega, Vihiga, Siaya and Kisumu counties. The proposed project alignment main land uses include agricultural, residential and commercial. Among key areas of interest proposed in the project include the proposed Malaba Marshaling Yard, railway stations, passing stations and bridges.

Table 24 below is an excerpt from EMC (Air Quality) Regulations, 2024 First Schedule showing the limits for air quality.

Table 24: Tolerance limits for air quality

Pollutant	Residential Rural & Other Areas Tolerance Limits
Inhalable Particulate Matter (PM_{10})	100.00 $\mu g/m^3$
Respirable Particulate Matter ($PM_{2.5}$)	75.00 $\mu g/m^3$
Nitrogen Dioxide (NO_2)	410.00 $\mu g/m^3$
Total Volatile Organic Compounds (TVOC)	600 $\mu g/m^3$
Carbon Dioxide (CO_2)	4.0 mg/m^3

The **Table 25** below shows the different areas where the air samples were collected from.

Table 25: Different areas where air samples were collected from

Location	Location Description	Sub County	Coordinates	Pollutants Monitored	Altitude (in m)
SP 1	Proposed Malaba Marshalling Yard	Teso North	0°38'1.66"N, 34°15'39.47"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1135
SP 2	Proposed Kanjei Bridge		0°37'21.17"N, 34°16'39.44"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1128
SP 3	Proposed Malakisi Bridge		0°37'11.95"N, 34°16'58.37"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1134
SP 4	Proposed Kamolo Bridge		0°36'34.11"N, 34°17'32.06"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1140
SP 5	St. Leo Kamolo Comprehensive School		0°36'18.19"N, 34°17'36.35"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1151
SP 6	Proposed Soko Moko Station		0°31'44.74"N, 34°19'6.02"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1225
SP 7	Proposed Bakamoyo Station		0°24'53.25"N, 34°22'38.64"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1258
SP 8	Proposed Nzoia/ Musonga Station		0°18'55.69"N, 34°24'50.51"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1241
SP 9	Proposed Nzoia/ Musonga Station		0°19'2.72"N, 34°24'45.40"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1248
SP 10	St. Mary's Yala School	Gem	0° 5'47.72"N, 34°32'5.83"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1403
SP 11	Proposed Yala Station	Gem	0° 5'51.41"N, 34°32'11.63"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1391
SP 12	Proposed Luanda Station	Luanda	0°1'5.90"S, 34°32'41.88"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1384
SP 13	Simba Geru Primary School		0° 4'51.09"S, 34°35'14.09"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1293
SP 14	Proposed Kisumu Station	Kisumu West	0° 4'37.66"S, 34°35'24.36"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1287
SP 15	Kisian River Bridge	Kisumu West	0° 4'10.18"S, 34°39'59.95"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	1169
SP 16	Karombo Village		0° 4'1.35"S, 34°41'11.48"E	PM_{10} and $PM_{2.5}$, NO_2, TVOC & CO_2	

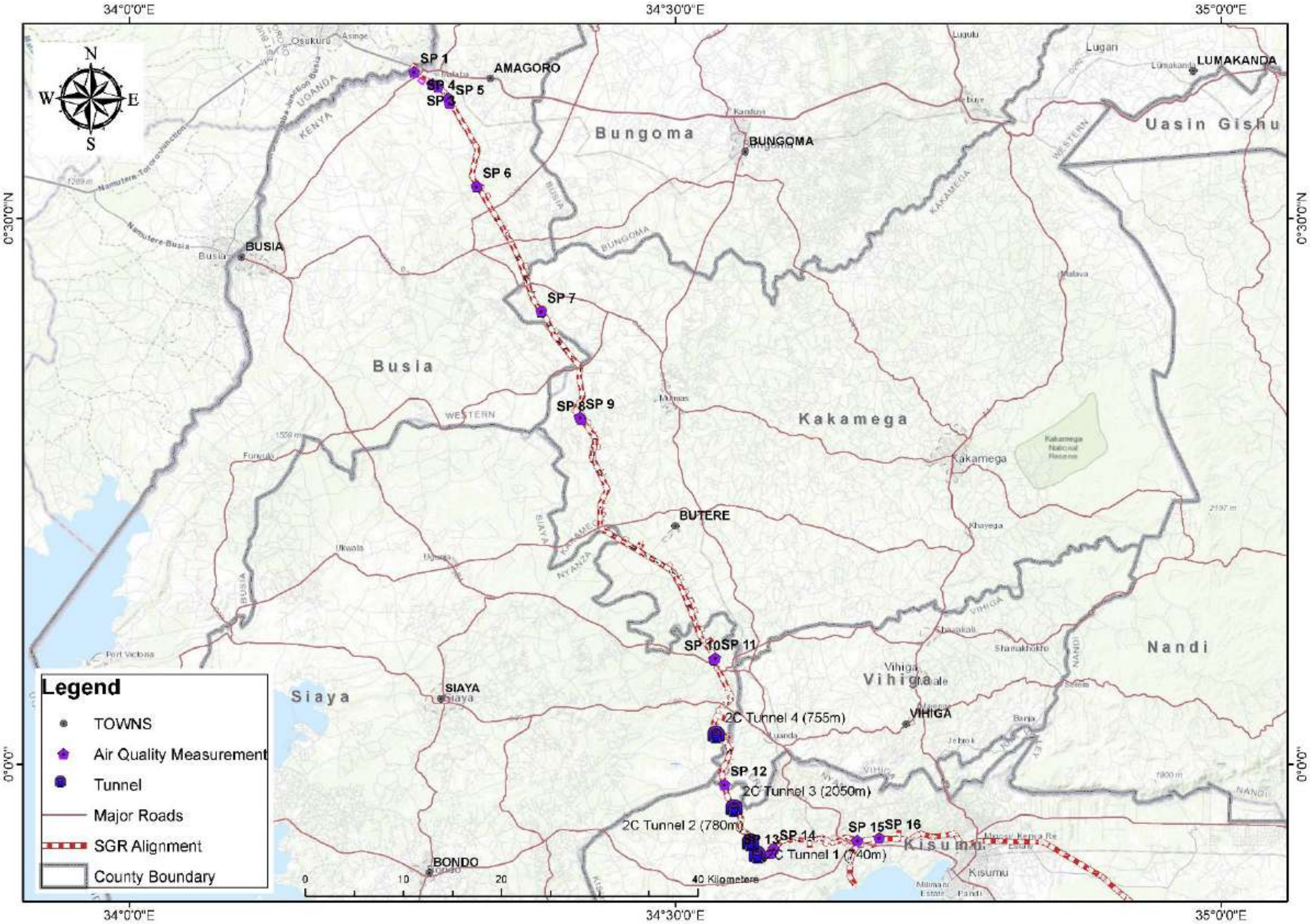

Figure 34: Mapped areas where air samples were collected

6.2.2.1 Inhalable and Respirable Particulate Matter Results

Inhalable particulate matter (PM_{10}) from all assesses areas ranged between **19.0-41.2 µg/m³** with Proposed Nzoia/ Musonga Station Location 1 and Proposed Nzoia/ Musonga Station Location 2 having the lowest and highest concentrations respectively. Similarly, respirable particulate matter ($PM_{2.5}$) concentration ranged between **8.0-21.6µg/m³** with Proposed Nzoia/ Musonga Station Location 1 and Proposed Nzoia/ Musonga Station Location 2 having the lowest and highest concentrations respectively.

A summary of the results is presented in **Table 26** below. Logger results for some areas are also as presented on the figures below. From the results, it is evident that all sampling locations had their inhalable and respirable particulate matter results within EMC, 2014 Tolerance Limit.

Table 26: Respirable and Inhalable Particulate Matter Results

Location	PM_{10} Results (µg/m³)	PM_{10} Tolerance Limit (µg/m³)	$PM_{2.5}$ Results (µg/m³)	$PM_{2.5}$ Tolerance Limit (µg/m³)
Proposed Malaba Marshalling Yard	37.0	**100.0**	18.0	**75.0**
Proposed Kanjei Bridge	33.8		13.2	
Proposed Malakisi Bridge	31.0		12.0	
Proposed Kamolo Bridge	30.6		12.3	
St. Leo Kamolo Comprehensive School	26.8		11.1	
Proposed Soko Moko Station	26.0		9.0	
Proposed Bakamoyo Station	29.0		10.0	
Proposed Nzoia/ Musonga Station Location 1	19.0		8.0	
Proposed Nzoia/ Musonga Station Location 1	41.2		21.6	
St. Mary's Yala School	25.0		9.0	
Proposed Yala Station	35.0		17.0	
Proposed Luanda Station	23.0		8.7	
Simba Geru Primary School	36.0		14.0	
Proposed Kisumu Station	30.0		12.0	
Kisian River Bridge	30.0		13.0	
Karombo Village	31.0		13.0	

6.2.2.2 Carbon dioxide

From the monitoring, carbon dioxide concentration ranged between **371.93 - 872.20 mg/m³** with the Proposed Luanda Station and the Proposed Kamolo Bridge having the lowest and highest concentrations respectively. A summary of the results is as presented in **Table 27** below. Logger results for some locations assessed are as shown in figures below. From the results, it is evident that carbon dioxide concentrations were above EMC Tolerance Limit. This is however characteristic of most areas in the country especially along highways

Table 27: Carbon dioxide results

Location	Carbon Dioxide Results (mg/m³)	Carbon Dioxide Tolerance Limit (mg/m³)
Proposed Malaba Marshalling Yard	457.78	**4.00**
Proposed Kanjei Bridge	400.26	
Proposed Malakisi Bridge	782.00	
Proposed Kamolo Bridge	872.20	
St. Leo Kamolo Comprehensive School	394.58	
Proposed Soko Moko Station	679.00	
Proposed Bakamoyo Station	799.00	
Proposed Nzoia/ Musonga Station	695.00	
Proposed Nzoia/ Musonga Station	451.00	
St. Mary's Yala School	701.00	
Proposed Yala Station	804.00	
Proposed Luanda Station	371.93	
Simba Geru Primary School	690.00	
Proposed Kisumu Station	666.00	
Kisian River Bridge	761.00	
Karombo Village	680.00	

6.2.2.3 Nitrogen Dioxide Results

Nitrogen dioxide results from the assessed areas ranged between **0.21 - 131.20 µg/m³** with St. Leo Kamolo Comprehensive School and Proposed Malaba Marshalling Yard having the lowest and highest concentrations respectively. The results are as presented in **Table 28** below with logger results of some locations assessed also presented in the figures below. It is evident from the results that nitrogen dioxide concentrations in all locations assessed were within EMC, 2024 Tolerance Limit.

Table 28: Nitrogen Dioxide results

Location	Nitrogen Dioxide Results (µg/m³)	Nitrogen Dioxide Tolerance Limit (µg/m³)
Proposed Malaba Marshalling Yard	131.20	410.00
Proposed Kanjei Bridge	102.50	
Proposed Malakisi Bridge	17.08	
Proposed Kamolo Bridge	34.34	
St. Leo Kamolo Comprehensive School	0.21	
Proposed Soko Moko Station	4.10	
Proposed Bakamoyo Station	3.56	
Proposed Nzoia/ Musonga Station	55.35	
Proposed Nzoia/ Musonga	100.45	

Location	Nitrogen Dioxide Results ($\mu g/m^3$)	Nitrogen Dioxide Tolerance Limit ($\mu g/m^3$)
Station		
St. Mary's Yala School	2.05	
Proposed Yala Station	2.05	
Proposed Luanda Station	36.90	
Simba Geru Primary School	6.15	
Proposed Kisumu Station	30.75	
Kisian River Bridge	45.10	
Karombo Village	6.15	

6.2.2.4 Total Volatile Organic Compounds Results

Total volatile organic compounds in the assessed areas ranged between **286.84-730.00 $\mu g/m^3$** with the Proposed Malakisi Bridge and the Proposed Kanjei Bridge having the lowest and highest concentrations respectively. A summary of the results is as presented in **Table 29** below with logger results for some locations assessed also presented below. From the results, only two areas; the Proposed Kanjei Bridge and the Proposed Bakamoyo Station had their results above the EMC, 2024 Tolerance Limit of 600 $\mu g/m^3$

Table 29: Total Volatile Organic Compounds Results

Location	TVOC Results ($\mu g/m^3$)	TVOC Tolerance Limit ($\mu g/m^3$)
Proposed Malaba Marshalling Yard	410.00	
Proposed Kanjei Bridge	730.00	
Proposed Malakisi Bridge	286.84	
Proposed Kamolo Bridge	474.62	
St. Leo Kamolo Comprehensive School	420.83	
Proposed Soko Moko Station	390.00	
Proposed Bakamoyo Station	625.56	
Proposed Nzoia/ Musonga Station	451.07	**600.00**
Proposed Nzoia/ Musonga Station	470.00	
St. Mary's Yala School	460.00	
Proposed Yala Station	370.00	
Proposed Luanda Station	580.00	
Simba Geru Primary School	430.00	
Proposed Kisumu Station	390.00	
Kisian River Bridge	510.00	
Karombo Village	370.00	

6.2.2.5 Discussions

Sixteen sampling locations were identified whereby measurement was carried out to assess for nitrogen dioxide, Inhalable Particulate Matter (PM_{10}), Respirable Particulate Matter ($PM_{2.5}$), total volatile organic compounds and carbon dioxide concentration in air. Based on the monitoring, below is a summary;

- Inhalable particulate matter (PM_{10}) ranged between 19.0-41.2 $\mu g/m^3$ against the stipulate limit of 150 $\mu g/m^3$
- Respirable particulate matter ($PM_{2.5}$) concentration ranged between 8.0-21.6$\mu g/m^3$ against the stipulate limit of 75 $\mu g/m^3$
- Carbon dioxide concentration ranged between 371.93-872.20 mg/m^3 against the stipulate limit of 4.0 mg/m^3
- Nitrogen dioxide results ranged between 0.21-131.20 $\mu g/m^3$ against the stipulate limit of 410 $\mu g/m^3$
- Total volatile organic compounds concentration ranged between 286.84-730.00 $\mu g/m^3$ against the stipulate limit of 600 $\mu g/m^3$

It is, therefore, evident from the results that inhalable and respirable particulate matter and nitrogen dioxide concentration from all sampling locations were within Environmental Management and Coordination (Air Quality) Regulations, 2024 tolerance limits. Carbon dioxide concentrations in all the locations were above EMC, 2024 Tolerance Limit. This is however characteristic of most areas, especially along roads. Additionally, two areas; the Proposed Kanjei Bridge and the Proposed Bakamoyo Station had their total volatile organic compounds concentration above Regulatory Tolerance Limit.

The proposed project will involve excavation works, concrete works, and the use of heavy machinery. Consequently, there is a likelihood of increased air pollutants if appropriate mitigation measures are not implemented across all phases of the project. To minimize potential impacts, the following recommendations are proposed:

- Implement dust suppression measures, particularly during the dry season, for all earth-moving operations.
- Cover transit vehicles transporting dry soil and other loose materials to prevent fugitive dust emissions.
- Regularly sprinkle water on earth roads serving as transit routes during dry seasons.
- Restrict material batching operations to designated and well-managed areas.
- Ensure all machinery and equipment used in the project are regularly serviced and maintained.
- Provide continuous training for all project workers on air pollution prevention and control measures.
- Ensure timely servicing and maintenance of all locomotives used in the project.
- Undertake annual ambient air quality monitoring in line with the Environmental Management and Coordination (Air Quality) Regulations, 2024.

6.2.3 Noise Measurements

Baseline ambient noise and ground vibration assessment was undertaken between 26th May to 4th June 2025 in accordance with Environmental Management and Coordination (EMC) (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 Legal Notice No. 61. The report is attached as Baseline Noise and

The objectives of noise and vibration measurements include:

- Assess current environmental conditions: Document existing ambient noise and vibration levels to understand the pre-project acoustic and vibrational environment.
- Support Environmental and Social Impact Assessment (ESIA): Provide essential data for evaluating the potential impacts of construction and operational phases on nearby communities and sensitive receptors.
- Inform mitigation strategies: Aid in the development of effective noise and vibration mitigation measures by identifying high-risk zones and sensitive areas.
- Ensure regulatory compliance: Ensure adherence to national and international environmental standards and guidelines regarding noise and vibration including EMCA (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 and international guidelines
- Enable future monitoring and comparison: Establish a baseline for future monitoring, allowing for the assessment of actual project impacts during and after construction by comparison with baseline data.

Permissible noise limits as provided by the First Schedule of EMC (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 are as presented in **Table 30** below.

Table 30: Noise and Excessive Vibrations Pollution Regulations

Zone		Sound Level Limits dB(A)		Noise Rating Level (NR)	
		Day	Night	Day	Night
A.	Silent Zone	40	35	30	25
B.	Places of worship	40	35	30	25
C.	Residential: Indoor	45	35	35	25
	Residential: Outdoor	50	35	40	25
D.	Mixed residential (with some commercial and places of entertainment)	55	35	50	25
E.	Commercial	60	35	55	25

EMCA (Noise and Excessive Vibration Pollution (Control) Regulations, 2009 (Legal Notice No. 61) further is aimed at ensuring vibration levels from a facility does not exceed stipulated limits. Regulations 4 stipulates that exceed vibration levels does not exceed 0.5 cm/second (cm/s) or 5.000 mm/s beyond any source property boundary or 30 metres from any moving source.

6.2.3.1 Site Location and Sampling Locations

The proposed SGR project is situated within Busia, Siaya, Kakamega, Vihiga and Kisumu counties. The proposed project alignment main land uses include agricultural, residential and commercial.

The table below presents a summary of all key areas of interest and sensitive receptors where sampling and measurements were carried including education facilities, proposed railway stations and bridges sampling locations with the figures below showing locations of respective sampling locations.

Table 31 and **Figure 35** below presents a summary of all sampling locations.

Table 31: Noise and Ground Vibration Measurements Locations

Location	Location Description	Coordinates	Measurement Undertaken	Altitude (in m)
SP 1	Proposed Malaba Marshalling Yard	0°38'1.66"N, 34°15'39.47"E	Noise and Ground Vibration	1135
SP 2	Proposed Kanjei Bridge	0°37'21.17"N, 34°16'39.44"E	Noise and Ground Vibration	1128
SP 3	Proposed Malakisi Bridge	0°37'11.95"N, 34°16'58.37"E	Noise and Ground Vibration	1134
SP 4	Proposed Kamolo Bridge	0°36'34.11"N, 34°17'32.06"E	Noise and Ground Vibration	1140
SP 5	St. Leo Kamolo Comprehensive School	0°36'18.19"N, 34°17'36.35"E	Noise and Ground Vibration	1151
SP 6	Proposed Soko Moko Station	0°31'44.74"N, 34°19'6.02"E	Noise and Ground Vibration	1225
SP 7	Proposed Bakamoyo Station	0°24'53.25"N, 34°22'38.64"E	Noise and Ground Vibration	1258
SP 8	Proposed Nzoia/ Musonga Station	0°18'55.69"N, 34°24'50.51"E	Noise and Ground Vibration	1241
SP 9	Proposed Nzoia/ Musonga Station	0°19'2.72"N, 34°24'45.40"E	Noise and Ground Vibration	1248
SP 10	St. Mary's Yala School	0° 5'47.72"N, 34°32'5.83"E	Noise and Ground Vibration	1403
SP 11	Proposed Yala Station	0° 5'51.41"N, 34°32'11.63"E	Noise and Ground Vibration	1391
SP 12	Proposed Luanda Station	0°1'5.90"S, 34°32'41.88"E	Noise and Ground Vibration	1384
SP 13	Simba Geru Primary School	0° 4'51.09"S, 34°35'14.09"E	Noise and Ground Vibration	1293
SP 14	Proposed Kisumu Station	0° 4'37.66"S, 34°35'24.36"E	Noise and Ground Vibration	1287
SP 15	Kisian River Bridge	0° 4'10.18"S, 34°39'59.95"E	Noise and Ground Vibration	1169
SP 16	Karombo Village	0° 4'1.35"S, 34°41'11.48"E	Noise and Ground Vibration	1178

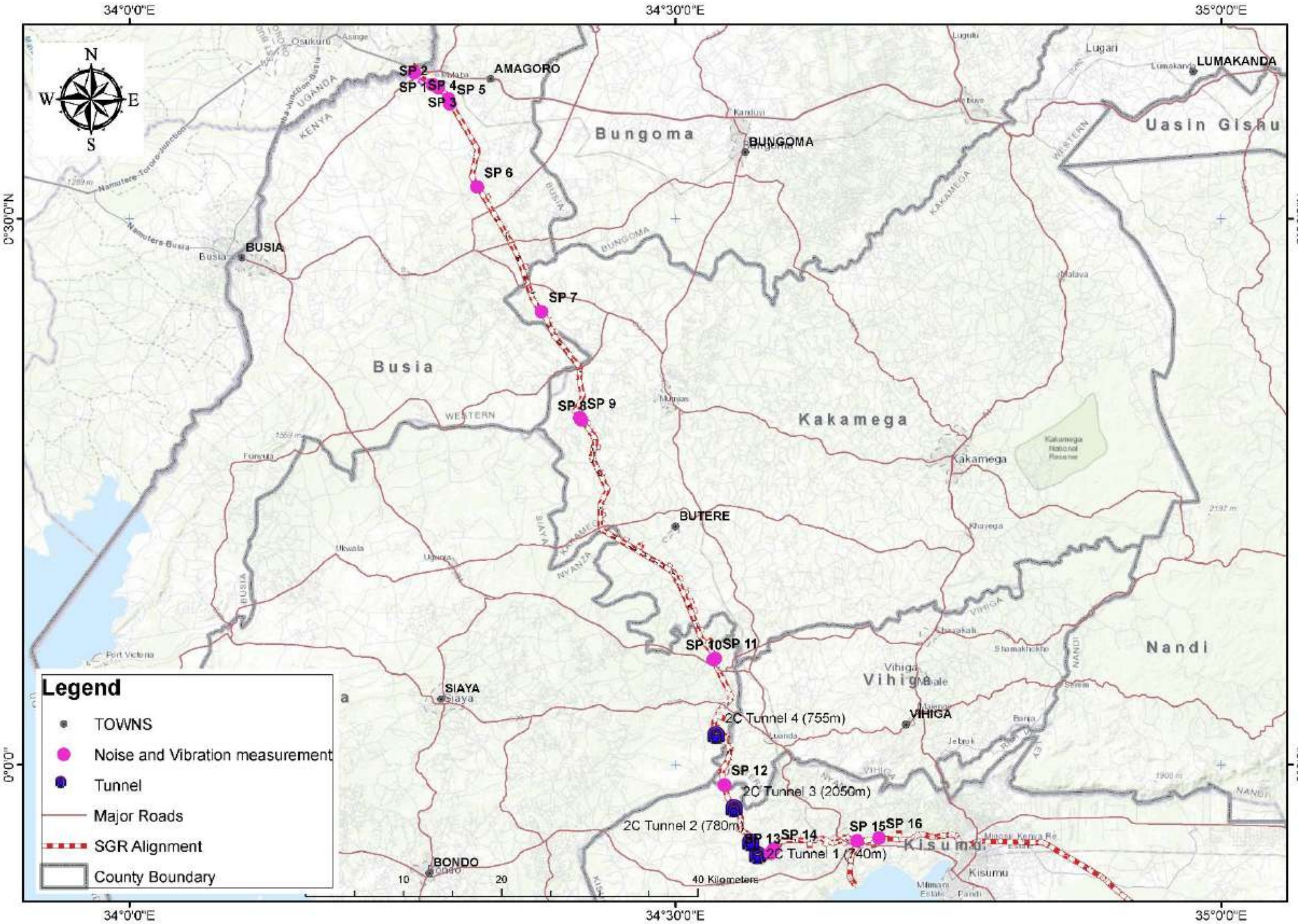

Figure 35: Location of Noise and vibration mapped areas

6.2.3.2 Baseline Noise Measurement Results

The measurement results are expressed as follows:

- L_{eq}: Value of A-weighted sound pressure level of a continuous steady sound that, within a specified interval, has the same mean square sound pressure as a sound under consideration whose level varies with time.
- L_{10}: Value is the level just exceeded for 10% of the time.
- L_{50}: Value is the level just exceeded for 50% of the time.
- L_{90}: Value is the level just exceeded for 90% of the time (Background noise).

Baseline environmental noise equivalent noise results from all the sampling locations ranged between 44.4-60.0 dB(A) with Proposed Malaba Marshalling Yard and Kisian River Bridge having the lowest and highest noise levels respectively. Similarly, background noise (L_{90}) levels result from all the measurement locations ranged between 32.9-57.1 dB(A) with Proposed Kisumu Station Proposed Kisian Bridge having the lowest and highest noise levels respectively. A summary of the noise measurement results is provided in **Table 32** below. Third octave logger data for some areas are as shown on the **Figure 36** below.

From **Table 32** below, it is evident that most sampling locations had their noise levels within EMC, WHO and IFC recommended limits. However, Proposed Malakisi Bridge, Proposed Kamolo Bridge, St. Leo Kamolo Comprehensive School, Proposed Bakamoyo Station, Proposed Nzoia/ Musonga Station (Point 1), St. Mary's Yala School and Proposed Kisian Bridge had their noise levels above the EMC limit.

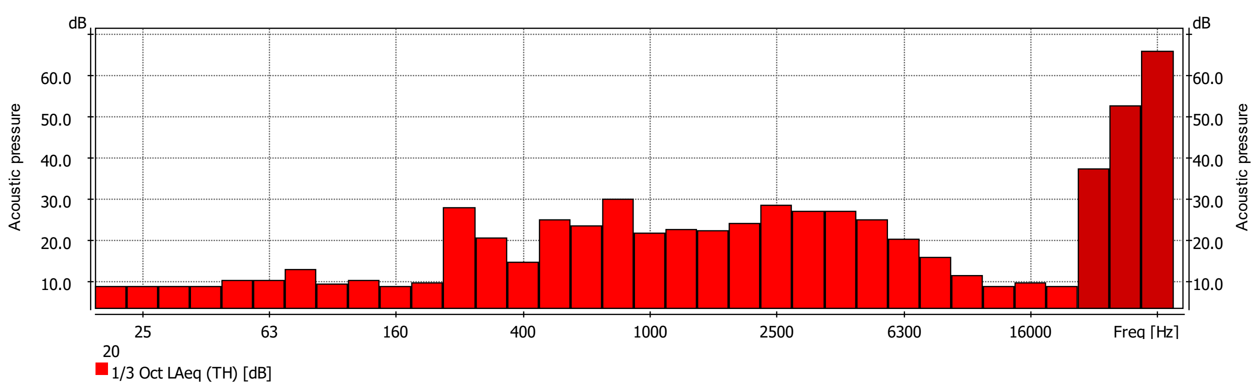

Figure 36: Proposed Kisumu Station 1/3 Octave Logger Results

Table 32: Noise measurement results

Location	Measurement Date and Time	L_{eq} (dBA)	EMC Limit (dBA)	L_{90} (dB)	L_{50} (dB)	L_{10} (dB)
Proposed Malaba Marshalling Yard	5/27/2025 8:39	44.4	**50.0**	34.4	37.8	44.8
Proposed Kanjei Bridge	5/27/2025 12:26	49.7		39.0	41.3	47.8
Proposed Malakisi Bridge	5/27/2025 13:55	51.4		40.8	43.6	51.1
Proposed Kamolo Bridge	5/28/2025 9:19	52.4		43.3	44.8	53.1
St. Leo Kamolo Comprehensive School	5/28/2025 10:18	54.8		43.1	50.6	57.7
Proposed Soko Moko Station	5/28/2025 14:30	49.8		38.7	44.1	52.0
Proposed Bakamoyo Station	5/29/2025 13:47	59.4		47.9	58.4	61.8
Proposed Nzoia/ Musonga Station (Point 1)	5/30/2025 10:10	50.3		39.9	45.1	53.3
Proposed Nzoia/ Musonga Station (Point 2)	5/31/2025 8:07	45.3		38.2	40.9	47.2
St. Mary's Yala School	5/31/2025 12:21	50.5		39.0	44.3	53.8
Proposed Yala Station	5/31/2025 13:16	47.5		36.6	40.4	49.3
Proposed Luanda Station	6/2/2025 9:50	48.7		34.4	39.8	50.3
Simba Geru Primary School	6/2/2025 12:30	47.9		35.0	39.8	47.9
Proposed Kisumu Station	6/2/2025 13:22	49.8		32.9	37.9	55.2
Proposed Kisian Bridge	6/4/2025 12:18	60.0		57.1	58.0	60.9
Karombo Village	6/4/2025 14:27	48.3		39.5	42.8	49.3
Key:		(red)	Above EMC Limit			
			Within EMC Limit			

6.2.3.3 Ground Vibration Measurement Results

Based on the assessment, ground vibration; Peak Particle Velocity (PPV) results from all sampling locations ranged between 0.110-0.717mm/s as shown in **Table 33** below. Proposed Kamolo Bridge and Proposed Nzoia/ Musonga Station (Point 1) had the lowest and highest vibration levels respectively. All the locations assessed had their peak particle velocity results within EMC Limit of 5.000mm/s.

Table 33: Ground Vibration Measurement Results

Location Description	PPV Results (mm/s)	Threshold Limit (in mm/s)
Proposed Malaba Marshalling Yard	0.290	**5.000**
Proposed Kanjei Bridge	0.345	
Proposed Malakisi Bridge	0.544	
Proposed Kamolo Bridge	0.110	
St. Leo Kamolo Comprehensive School	0.465	
Proposed Soko Moko Station	0.213	
Proposed Bakamoyo Station	0.497	
Proposed Nzoia/ Musonga Station (Point 1)	0.717	
Proposed Nzoia/ Musonga Station (Point 2)	0.166	
St. Mary's Yala School	0.189	
Proposed Yala Station	0.394	
Proposed Luanda Station	0.163	
Simba Geru Primary School	0.280	
Proposed Kisumu Station	0.278	
Proposed Kisian Bridge	0.390	
Karombo Village	0.376	

6.2.3.4 Discussion of the Results

Sixteen sampling locations were identified whereby baseline noise and ground vibration measurements were undertaken.

Based on the measurements, baseline environmental noise equivalent noise results from all the sampling locations ranged between 44.4-60.0 dB(A). Background noise (L_{90}) levels result from all the measurement locations, on the other hand, ranged between 32.9-57.1 dB(A). The proposed Malakisi Bridge, Proposed Kamolo Bridge, St. Leo Kamolo Comprehensive School, Proposed Bakamoyo Station, Proposed Nzoia/ Musonga Station (Point 1), St. Mary's Yala School and Proposed Kisian Bridge had their noise levels above the EMC limit. However, background noise levels from these areas apart from the proposed Kisian Bridge was within EMC Limit.

Additionally, ground vibration; Peak Particle Velocity (PPV) results from all sampling locations ranged between 0.110-0.717mm/s. Proposed Kamolo Bridge and Proposed Nzoia/ Musonga Station (Point 1) had the lowest and highest vibration levels respectively. All the locations assessed had their peak particle velocity results within EMC Limit of 5.000mm/s.

The proposed project is anticipated to generate increased environmental noise and ground vibration levels. This will primarily result from machinery operations, earth-moving activities, and locomotive movement during the operational phases of the project. Nonetheless, these impacts can be minimized and maintained within acceptable limits if appropriate mitigation measures are implemented. The recommended measures include:

- Regular servicing and maintenance of all machinery used in the project.
- Ensuring that all locomotives operating during the project's lifespan are timely serviced and well-maintained.
- Avoiding high-noise and high-vibration activities within or near residential and institutional areas.
- Providing adequate public notices prior to activities likely to generate elevated noise or vibration levels.
- Conducting prior assessments in areas where high-vibration operations (e.g., blasting) are anticipated.
- Undertaking continuous environmental noise and vibration monitoring throughout the project's lifespan to ensure compliance with regulatory standards.

6.2.4 Soil Measurements

Soil sampling was undertaken between 26t[h] May to 4[th] June 2025, 2025.The soil analysis report is annexed to this Report. The objective of the assessment was to establish baseline soil quality in the proposed project for the purpose of future monitoring during project implementation. Parameters analyzed were limited to Polycyclic Aromatic Hydrocarbons (PAHs) and Oil & Grease The samples were the taken to CSI International Limited, an ISO/ ICE 17025 Accredited Laboratory for analysis for Total Petroleum Hydrocarbons (TPH) and Oil and Grease. The soil samples were collected from seven (7) sampling areas as shown in Table 34 and **Figure 37** below

Table 34: Soil sample collection sites and results

Location	Oil & Grease (mg/Kg)	TPH C5-C12 (mg/Kg)	TPH C12-C28 (mg/Kg)	TPH C28-C44 (mg/Kg)
Proposed Bakamoyo Station	0.015	0.0014	0.0037	0.0049
Proposed Marshalling Yard	0.0145	0.001	0.0034	0.0051
Proposed Yala Station	0.0086	0.0016	0.0011	0.0009
Proposed Luanda Station	0.0123	0.0015	0.0021	0.0037
Proposed Kisumu Station	0.0125	0.0018	0.0024	0.0033
Proposed Sokomoko Station	0.0155	0.0024	0.0037	0.0044

Location	Oil & Grease (mg/Kg)	TPH C5-C12 (mg/Kg)	TPH C12-C28 (mg/Kg)	TPH C28-C44 (mg/Kg)
Proposed Nzoia Station	0.0121	0.0011	0.0027	0.0033

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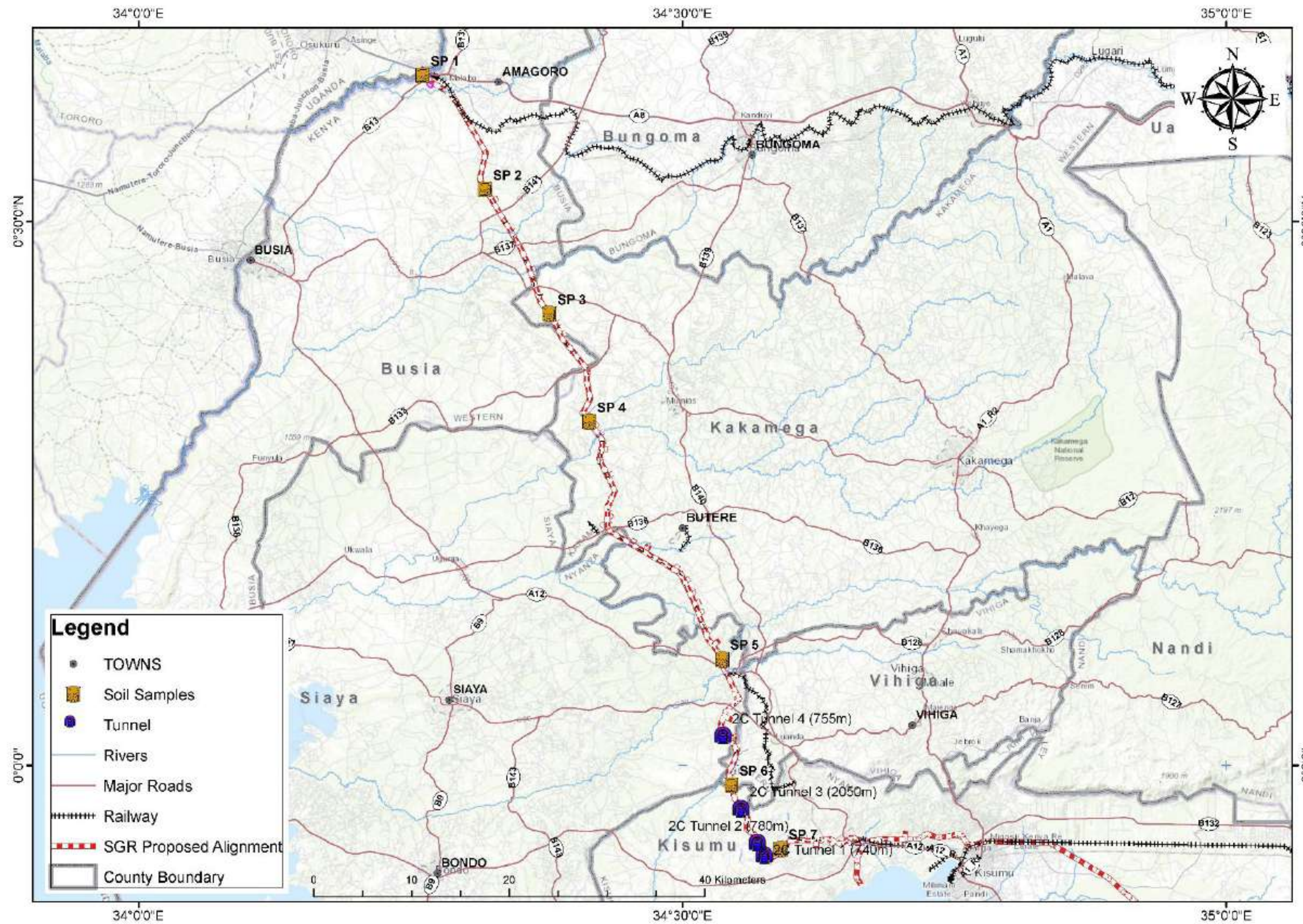


Figure 37: Mapped soil sampled areas

6.2.3.1 Soil Assessment Results

Seven (7) soil samples were collected from different sites and taken to CSI International Limited, an ISO/ ICE 17025 Accredited Laboratory for analysis for Total Petroleum Hydrocarbons (TPH) and Oil and Grease. Below is a summary of soil analysis as summarized in **Table 34** above,

- Oil and Grease results ranged between 0.0086-0.0155 mg/Kg with Proposed Yala Station and Proposed Sokomoko Station having the lowest and highest concentrations respectively.

- TPH C5-C12 (gasoline) concentration in the soil ranged between 0.001-0.0024 mg/Kg with Proposed Marshalling Yard and Proposed Sokomoko Station having the lowest and highest concentrations respectively.

- TPH C12-C28 (diesel) concentration ranged between 0.0011-0.0037 mg/Kg with Proposed Yala Station and Proposed Bakamoyo Station/Proposed Sokomoko Station having the highest and lowest concentrations respectively.

- TPH C28-C44 (oils) results ranged between 0.0009-0.0049 mg/Kg with the Proposed Bakamoyo Station and Proposed Yala Station having the lowest and highest results respectively. Detailed laboratory results are annexed in the report in Appendix 1.

6.2.3.2 Discussions

The proposed development is anticipated to lead to an increase in concentration of the analysed parameters in the soil if measures are not put in place. Such activities will entail oil or fuel spillage either through accidental spillages, malfunctioning machineries, vehicles or locomotives or poor management of used oils. In view of this a number of mitigation measures are proposed in minimizing this and include;

- All spillages to be immediately collected in avoidance of water pollution;
- All machineries and locomotives to be timely serviced in minimizing oil spillages;
- Machineries cleaning to be undertaken in designated areas;
- Machineries servicing to be carried out within designated areas.;
- The proponent to ensure periodic soil analysis.

6.2.4 Water Quality Measurements

Water sampling was undertaken between 26th May to 4th June 2025 from (20) water points including rivers, springs and boreholes/ wells as shown in the **Table 35** below.

The objectives of water quality measurements include;

- Establish Existing Water Quality Status: Determine the chemical, physical, and biological characteristics of surface and groundwater resources.
- Establish baseline values for ongoing water quality monitoring during construction and operation project phases and enable future comparison to detect changes and evaluate the effectiveness of mitigation actions.

The parameters analyzed included pH, Total Dissolved Solids (TDS), Turbidity, Total Suspended Solids (TSS) and Oil and Grease.

Table 35: Water sampling locations

Location Description	Coordinate	Parameters Analysed
Kajei River	0°35'31.07"N, 34°16'13.68"E	pH, Total Suspended solids, Total Dissolved Solids, Turbidity, Oil & Grease
Malakisi River	0°37'8.69"N, 34°16'57.28"E	
Kamolo River	0°36'34.05"N, 34°17'29.61"E	
Otengo Market/Sokomoko Well	0°31'42.84"N, 34°19'5.30"E	
Kamsogon/ Msokoto River	0°30'58.60"N, 34°19'20.25"E	
Kakolite River	0°32'47.15"N, 34°18'42.46"E	
River Walatsi/Sio	0°29'20.45"N, 34°20'28.44"E	
Suo River	0°27'7.54"N, 34°20'59.38"E	
Bakamoyo Borehole	0°24'49.43"N, 34°22'42.54"E	
Fratatsi River	0°12'13.57"N, 34°27'4.74"E	
Kamimo Spring	0° 4'58.41"N, 34°32'27.33"E	
Awach (Ramula) River	0°0'26.26"S, 34°32'30.41"E	
Alukucha Stream	0°1'0.37"S, 34°32'36.65"E	
Ogongo Stream	0°4'23.46"S, 34°35'42.06"E	
Kisian River	0°4'15.28"S, 34°40'1.10"E	
Kasuna Stream	0°4'9.24"S, 34°39'16.54"E	
Awach (Kisumu) River	0° 4'10.10"S, 34°38'16.40"E	
Yala River	0°5'2.41"N, 34°32'18.80"E	
Nzoia River	0°18'6.04"N, 34°25'13.55"E	
Malaba River	0°38'5.20"N, 34°15'33.98"E	

Source: Ecoscience Engineering Limited Baseline water quality report-June 2025

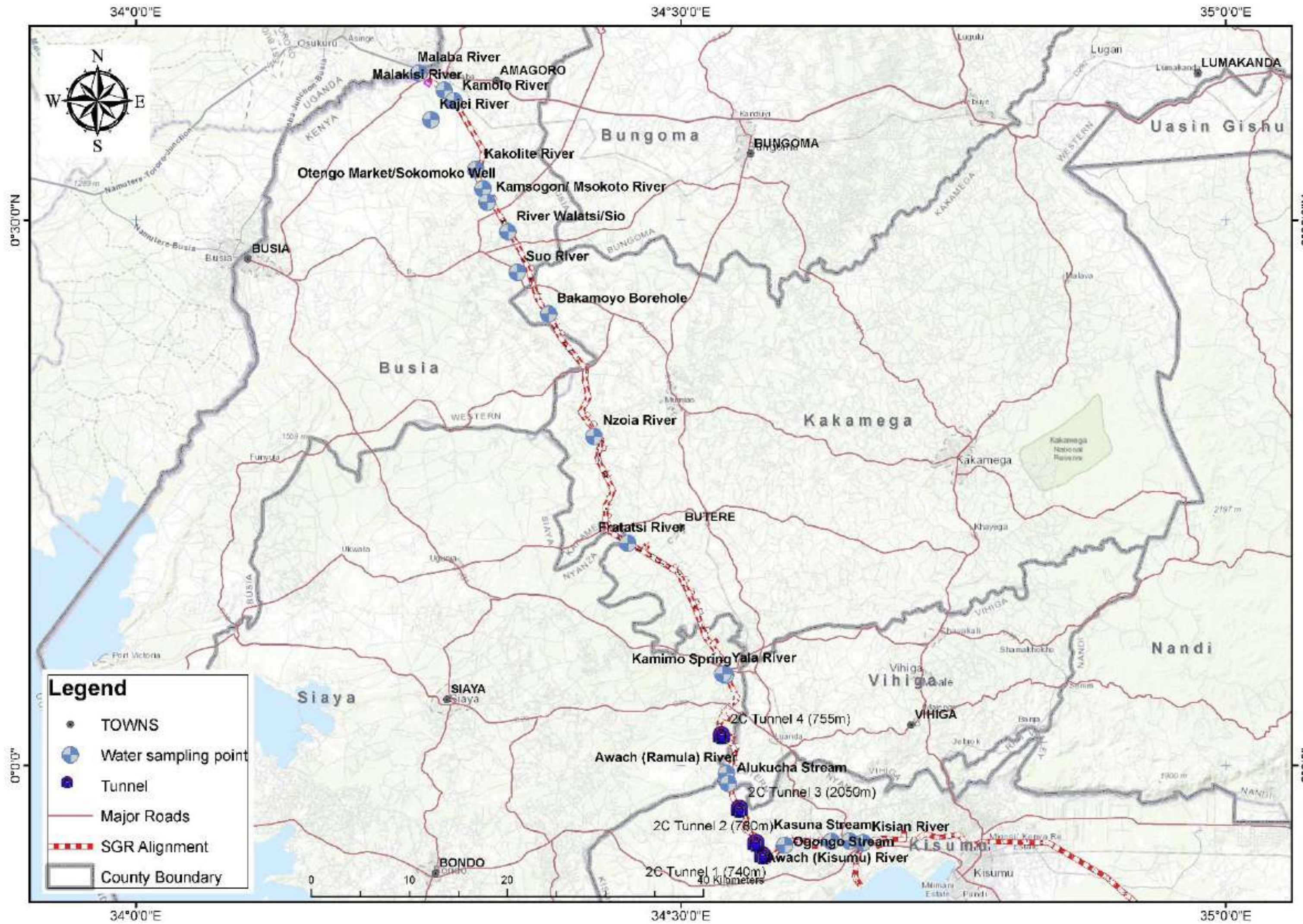


Figure 38: Water sampling locations on google map

Source: Ecoscience Engineering Limited Baseline water quality report-June 2025

Table 36 below is an excerpt the First Schedule of the Water Quality Regulations, 2006.

Table 36: Quality Standards for Sources of Domestic Water

Parameter	Guide Value (max allowable)
pH	6.5 – 8.5
Suspended solids	30 (mg/L)
Nitrate-NO_3	10 (mg/L)
Ammonia –NH_3	0.5 (mg/L)
Nitrite –NO_2	3 (mg/L)
Total Dissolved Solids	1200 (mg/L)
Scientific name *(E. coli)*	Nil/100 ml
Fluoride	1.5 (mg/L)
Phenols	Nil (mg/L)
Arsenic	0.01 (mg/L)
Cadmium	0.01 (mg/L)
Lead	0.05 (mg/L)
Selenium	0.01 (mg/L)
Copper	0.05 (mg/L)
Zinc	1.5 (mg/L)
Alkyl benzyl sulphonates	0.5 (mg/L)
Permanganate value (PV)	1.0 (mg/L)

Source: Environmental Management and Coordination Act, (Water Quality Regulations), 2006

6.2.4.1 Summary of results

Table below presents a summary of the water analysis results. Detailed laboratory results are presented on the annexed Water analysis report. Based on the laboratory analysis below is the summary.

- PH results ranged between 6.09-7.91 with Soko Moko Well and Ogongo Stream having the lowest and highest concentrations respectively. Based on the results, only water sample from Soko Moko Well had its results below Regulatory Limit.
- Total Dissolved Solids (TDS) results ranged between 40.0-187.0 ppm with River Kakolait and River Kasuna having the lowest and highest concentrations respectively. However, all the water samples had their TDS results below the Regulatory Limit.
- Turbidity results ranged between 0.36-748 NTU with Bakamoyo Borehole and River Awach (Ramula) having the lowest and highest concentrations respectively. Only two water samples; from Soko Moko Well and Bakamoyo Borehole had their turbidity results

within Regulatory Limit. High turbidity results from the samples can mainly be attributed to the fact that samples were collected during a rainy season whereby soil erosion is high.

- Total Suspended Solids (TSS) results ranged between 1.00-658 ppm with Soko Moko Well and River Awach (Ramula) having the lowest and highest concentrations respectively. Only four water samples; from Soko Moko Well, River Kakolait, Bakamoyo Borehole, Aora Kamimo Spring and River Alukucha had their TSS results within Regulatory Limit. High TSS results from the samples can mainly be attributed to the fact that samples were collected during a rainy season whereby soil erosion is high.

- Oil and Grease results ranged between 0.004 - 0.016 ppm with River Malakisi/ River Suo/ River Kasuna and River Alukucha having the lowest and highest concentrations respectively. All the water samples from sampled sources had their Oil and Grease results within Regulatory Limit.

Table 37: Summarized results of different parameter

Source: Ecoscience Engineering Limited Baseline water quality report-June 2025

Water Source	pH	pH Limit	TDS (ppm)	TDS Limit (ppm)	TUB (NTU)	TUB Limit (NTU)	TSS (ppm)	TSS Limit (ppm)	OG (ppm)	OG Limit (ppm)
River Malakisi	7.82		96.0		229		178		0.016	
River Kamolo	7.53		66.0		166		124		0.008	
Soko Moko Well	6.09		62.0		1.56		1.00		0.008	
Kamsogon Stream	7.45		50.0		53.5		54.0		0.008	
River Kakolait	7.40		40.0		50.5		19.0		0.008	
River Walatsi	7.49		73.0		55.0		47.0		0.008	
River Suo	7.54		63.0		59.8		42.0		0.004	
Bakamoyo Borehole	6.74		69.0		0.36		ND		0.008	
River Firatsi	7.14		46.0		83.5		50.0		0.008	
River Awach (Ramula)	7.52		67.0		748		658		0.008	
Ogongo Stream	7.91	**6.50-8.50**	125.0	**< 1000**	59.7	**< 5.00**	56.0	**< 25.0**	0.008	**0.00-0.05**
River Kasuna	7.68		187.0		59.6		62.0		0.004	
River Awach (Kisumu)	7.82		57.0		59.8		51.0		0.008	
River Kisian	7.82		58.0		56.9		67.0		0.008	
River Kajei	7.69		85.0		89.2		99.0		0.008	
Aora Kamimo Spring	6.65		53.0		2.47		3.00		0.008	
River Alukucha	7.67		98.0		37.0		20.0		0.004	
River Yala	7.50		47.0		229		214		0.008	
River Nzoia	7.61		63.0		454		404		0.008	
River Malaba	7.78		97.0		255		290		0.008	
Key:		Denotes Above; TDS – Total Dissolved Solids; TUB – Turbidity; TSS – Total Suspended Solids; OG – Oil and Grease								

6.2.4.2 Discussions

High turbidity and Total Suspended Solids (TSS) from the water samples can mainly be attributed to the fact that samples were collected during a rainy season whereby soil erosion is high affecting most surface water sources.

The proposed development is anticipated to lead to an increase in concentration of the analysed parameters if measures are not put in place. This will mainly entail activities within the revers; particularly bridges construction leading to increased soil erosion and pollution of the water. In view of this a number of mitigation measures are proposed in minimizing this and include;

- Soil and loose material stock piling to be avoided along rivers;
- Concrete mixing operations to be avoided in close proximity to rivers;
- All spillages to be immediately collected in avoidance of water pollution;
- All machineries and locomotives to be timely serviced in minimizing oil spillages;
- Machineries cleaning to be prohibited along all rivers;
- Machineries servicing to be carried out within designated areas.;
- The proponent to ensure periodic water analysis.

6.3 Biodiversity Baseline

6.4.1 Introduction

Satellite imagery and field reconnaissance indicate that much of the area along the proposed railway has been heavily modified by human settlements and agriculture. Traditional bushland is now scarce, with wetlands converted to sugarcane fields or used for livestock grazing, leading to significant changes in local biodiversity. Lotic wetlands and streams, despite being disturbed, remain important refuges for displaced species and serve as the most reliable sites for biodiversity sampling.

- **Internationally Recognized Areas**

Key Biodiversity Areas (KBAs) are critical sites for the survival of globally threatened species, while Important Bird Areas (IBAs) are recognized for their significance in conserving bird populations, often overlapping with KBAs. The Lake Victoria Basin is a KBA for the endangered crowned crane, whose population is declining due to habitat loss, fragmentation, and human disturbance. The study recorded the species at three locations: two in marshes along the Yala and Nzoia rivers and one along the smaller Firatsi/Murumba River, with at least one confirmed nest, highlighting the importance of these wetlands for breeding and conservation.

- **Nationally Protected Areas**

Five Nationally protected areas are found in the western region of the country. However, none of them are found near the project area of influence at small scale. However, they lie in the Regional Area of Influence. These are provided in the **Table 38** below.

Table 38: Nationally protected areas

Protected Area	Type	Key Biodiversity Features
Kakamega Forest NR	National Reserve	Guineo-Congolian rainforest, birds, primates
Saiwa Swamp NP	National Park	Sitatunga, wetland birds
Mt. Elgon NR	National Reserve	Montane flora & fauna
Yala Swamp	Wetland (partly protected)	Birds, fish, wetland mammals

The findings on the taxa studied are summarized in the following sections, highlighting the species identified, their distribution, abundance, ecological significance, and any notable conservation concerns observed during the assessment.

6.4.2 Flora of the Project Area

The entire Biodiversity Sensitive Area is classified as disturbed due to the immense human activities observed across the entire landscape. Plantations of cash crops like sugarcane cover most of what used to be marshlands while maize farming is done at different scales depending on the land available for the farmer. Small pockets of land not covered by crops are used to graze animals. The species have been categorized into 5 groups based on the life form and the representations presented in Figure 39 below:

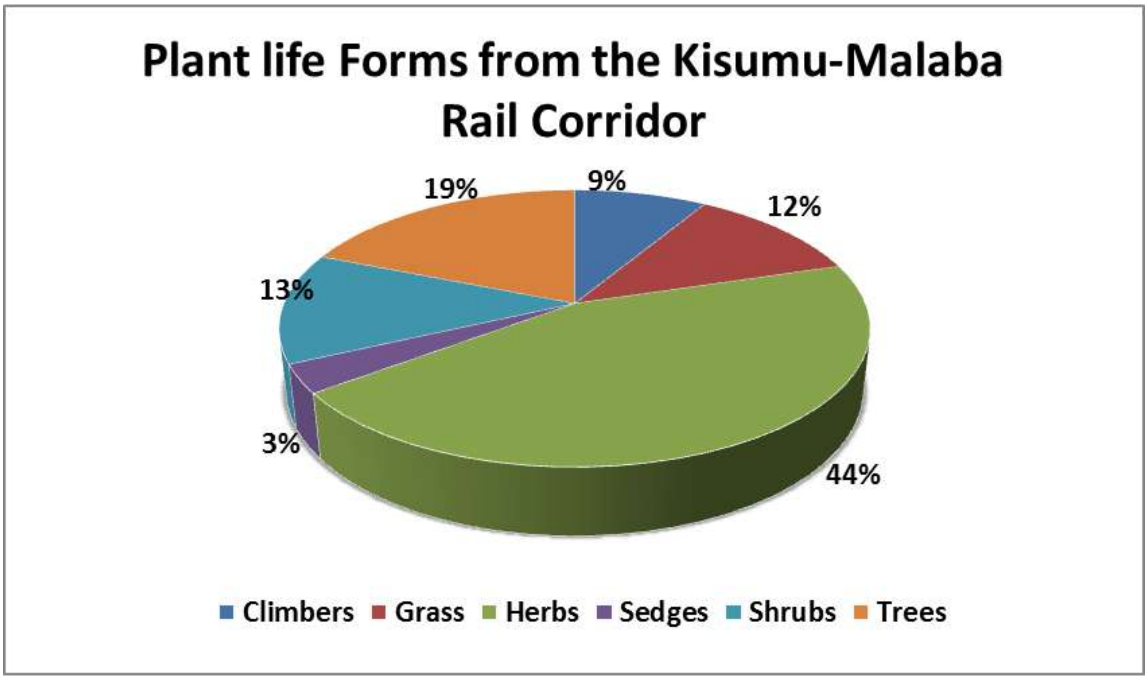


Figure 39: Plant life within the AoI

Due to establishment of homesteads, the floral composition has seen introduced species in many parts of the landscape. Some of the species include *Eucalyptus species, Delonix regia, Grivellia robusta, Pinus spp, Cupressus lustanica, Bischovia javonica, Casuarina equisetofolia and Jacaranda mimosifolia. Indigenous trees are few and dot the area with species such as Spathodea campanulata, Albizia spp, Ficus natalensis, Ficus luscchnathiana, Makhamia lutea, Zanthoxylum gilleti, Melia azedarach, Azadirachta indica Croton macrostachyus and Croton megalocarpus , Cordia africana and Acacia polycantha.* Fruit trees common in the area include*; Mangifera indica, Persea americana, Artocarpus heterophyllus, Syzygium cumini, Aleurites moluccana* and *Carica papaya.*

Figure 40: Some of the tree ecosystem in the project areas

The shrub community is also made of both indigenous and introduced species. Common species include *Lantana camara*, *Lantana trifolia*, *Solanum mauritanium, Psidium guajava* all of which have invasive characteristics. Othe native species are *Tithonia diversifolia, Dracaena spp, Luceana leucocephala, Ceasalpinia decapitala, Acanthus polystachyus, Senna spectabilis, Senna siamea, Senna obtusifolia, Harungana madagascarensis, Cascabelia theretia, Euphorbia candelabrum and Euphorbia tirucalli.*

The herb community is composed of majorly of farm weeds such as *Bidens pilosa, Ageratum conyzoides, Crosophylum spp, Aspilia spp, Guizotia abyssinica, Centella asiatica, Phyllanthus tenellus, Alysicarpus vaginalis, Grona triflora, Cyathillium cenereum, Sida tenuicarpa, Mimisa pudica, Ocimum gratissimum, Galinsoga, Dichondra micrantha, Oxalis stricta, Alternathera sessilis, Erigeron floribundus, Sida acutus, Urena lobata, Desmodium incanum, Ipomea spp.* and the invasive *Parthenium hysterophorus* and *Cuscuta spp*

Species associated with wetlands include *Papyrus cyperuss, Tristemum mauritenum, Afromomum alboridaceum, Tavenna pavettoides, Fiurenna umbellate, Bambusa spp.*

The grass community on the other hand is composed of *Cyperus richandi, Cypruss brevifolius, Cyperuss cyperoides, Setaria barbata, Axonopus compressus, Setaria geminate, Paspalum dilatanum, Paspalum conjugatum, Paspalum compressus, Digitaria verutina, Cynodon dactylon, Enteropogon macrostachyus, Pennisetum clandestinum.*

The succulent species present are the *Opuntia spp*, *Aloe spp*, *Euphorbia candelabrum* and *Euphorbia tirucalli* and *Agave sisalana.*

Food crops and fodder plants in the area include *Zea mays, Phaseolus vulgaris,* Cassava (*Manihot esculenta*), Sweet potatoes (*Ipomoea batatas*), Tomatoes (*Solanum lycopersicum*), *Cenchrus purpureus and* Coffee arabica.

Only one species, *Jacaranda mimosifolia* is threatened under the Vulnerable category of the IUCN but since it is away from its natural range, it is considered introduced and thus can't be a trigger to the critical habitat.

6.4.3 Invasive species

Due to the disturbed nature across the study area, several invasive species were observed, all plants. These include *Solanum mauritanium*, *Parthenium hysterophorus*, *Psidium guajava*, *Lantana camara* and *Cuscuta spp.*, Senna didymobotrya. These are profiled in tables below;

1. *Solanum Mauritianum* (Bugweed, Woolly nightshade)

- Origin: South America

a) Ecological Characteristics

Trait	Description
Growth Form	Evergreen shrub/small tree (up to 5 m tall)
Reproduction	Produces berries with hundreds of seeds
Habitats Invaded	Forests, riparian zones, disturbed lands
Dispersal Vectors	Birds, mammals, water
Special Traits	Allelopathic effects
Toxicity	Leaves and fruits toxic to livestock

Key Impacts

- Displaces native flora, affects forest regeneration
- Toxic to livestock and affects biodiversity

2. *Lantana camara* (Lantana)

- Origin: Central and South America

b) Ecological Characteristics

Trait	Description
Growth Form	Woody shrub or scrambling climber
Reproduction	Abundant berries with bird dispersal
Habitats Invaded	Grasslands, forests, pastures
Dispersal Vectors	Birds, livestock, water
Special Traits	Allelopathy, fire promotion
Toxicity	Toxic to livestock

Key Impacts

- Forms impenetrable thickets, outcompetes native species
- Reduces pasture quality and biodiversity

3. Parthenium hysterophorus (Parthenium weed, Congress grass)

- Origin: North and Central America

c) Ecological Characteristics

Trait	Description
Growth Form	Annual herb
Reproduction	Produces thousands of seeds
Habitats Invaded	Roadsides, farmlands, wetlands
Dispersal Vectors	Wind, water, machinery
Special Traits	Strong allergen and phytotoxin
Toxicity	Causes dermatitis and respiratory issues

Key Impacts

- Suppresses crop yields, triggers allergies
- Reduces grazing land quality

4.***Psidium guajava (Guava)***

- Origin: Central America and the Caribbean

d) Ecological Characteristics

Trait	Description

Growth Form	Evergreen tree
Reproduction	Fruits with many seeds dispersed by animals
Habitats Invaded	Forests, abandoned farmland
Dispersal Vectors	Monkeys, birds, livestock
Special Traits	Highly competitive
Toxicity	Not toxic but ecologically invasive

Key Impacts

- Outcompetes indigenous forest species
- Changes forest composition and regeneration

5. *Opuntia spp.* (Prickly pear)

- Origin: Americas

e) Ecological Characteristics

Trait	Description
Growth Form	Succulent cactus
Reproduction	Pads/root segments and seeds
Habitats Invaded	Drylands, rangelands, rocky slopes
Dispersal Vectors	Animals, humans, water
Special Traits	Drought tolerant, spiny
Toxicity	Causes injury to livestock and humans

Key Impacts

- Degrades grazing lands and injures animals
- Alters soil and native plant communities

6.Cuscuta spp. (Dodder)

- Origin; Cosmopolitan

f) Ecological Characteristics

Trait	Description
Growth Form	Parasitic vine
Reproduction	Tiny seeds and stem fragments
Habitats Invaded	Crops, grasslands, forest edges
Dispersal Vectors	Wind, water, contaminated seed
Special Traits	Obligate parasite
Toxicity	Weakens host plants

Key Impacts

- Reduces host plant growth and yields
- Damages biodiversity and agricultural output

***7. Senna didymobotrya* (Peanut Butter Cassia)**
Origin; Native to Eastern and Central Africa

g) Ecological Characteristics

Trait	Description
Growth Form	Shrub
Reproduction	Seeds, Root suckers

Trait	Description
Habitats Invaded	Disturbed soils, riparian zones, roadsides, and abandoned farmlands
Dispersal Vectors	Explosive mechanism of the pods
Special Traits	Ability to recoppice after being cut
Toxicity	Not toxic but ecologically invasive

Key impacts

- Displaces native vegetation by forming dense stands that inhibit natural regeneration.
- Alters habitat structure, reducing plant and invertebrate diversity.
- Not palatable to livestock; reduces pasture productivity.
- Rapid colonizer of construction footprints and road reserves.
- Limits revegetation in restoration areas post-construction.

6.4.3 Herpetofauna

- **Reptiles**

There are 5 species of reptiles in the study area (see Table 39) that are of conservation concern namely *Bitis gabonica*, *Bitis narsiconis* and *Ancylodactylus elgonensis* are categorized as Vulnerable (VU), *Python sebae* are are is is Near Threatened (NT) while *Leptotyphlops howelii* is Data Defficient (DD). *Python sebae* is associated with the wetlands and even though *Bitis narsicornisos* and Ancylodactylus *elgonensis* a forest species, there is a historical record for River Yala.

Table 39: Reptiles within the Study area

Common name	Species name	Restricted Range/ Endemic	IUCN threat category
Reptiles			
Gaboon Viper	*Bitis gabonica*	No	VU
Nose-horned viper	*Bitis narsiconis*	No	VU
Mt. Elgon Forest Gecko	*Ancylodactylus elgonensis*	Yes	VU
Central African Rock python	*Python sebae*	No	NT
Kakamega Puddle frog	*Phrynobatrachus kakamikro*	Yes	DD

- **Amphibians**

A trigger amphibian species is the endemic Kakamega puddle frog, *Phrynobatrachus kakamikro* which is endemic to Kakamega and Mt. Elgon. (Malonza and Bwong' 2023).

6.4.4 Fish

The field survey and desktop study revealed a total of 16 fish species from all the wetlands and the river systems in the study area (Majorly Yala and Nzoia). These are distributed in 6 families dominated by Cyprinidae as shown in **Table 40** below, none of the species is of serious conservation status. 5 are not yet assessed and these include; *Enteromius alberti, Enteromius jacksonii, Haplochromis sp, Oreochromis sp, Pseudocrenilabrus multocolor victoria. 2* of the species not assessed by the IUCN (*Haplochromis sp, Oreochromis sp)* are yet to be determined while 1 species, *Zaireichthys rotundiceps* is in the Data Deficient category.

Table 40: Fish species within the study area

Family	Common Name	Species	IUCN Status
Amphiliidae	Catfish	Amphilius lujani	LC
Mochokidae	Someren's suckermouth	Chiloglanis somereni	LC
Clariidae	African sharptooth catfish	Clarias gariepinus	LC
Cyprinidae	Luambwa barb	Enteromius alberti	NE
Cyprinidae	East African red-finned barb	Enteromius apleurogramma	LC
Cyprinidae	Jackson's barb	Enteromius jacksonii	NE
Cyprinidae	Redspot barb	Enteromius kerstenii	LC
Cyprinidae	Neumayer's barb	Enteromius neumayeri	LC
Cyprinidae	straightfin barb	Enteromius paludinosus	LC
Cichlididae		Haplochromis sp	NE
Cyprinidae	Ripon barbel	Labeobarbus altianalis	LC
Cyprinidae	African big barb	Labeobarbus intermedius	LC
Cichlididae		Oreochromis sp	NE
Poeciliidae	Guppy	Poecilia reticulata	LC
Cichlididae	Small mouthbrooder	Pseudocrenilabrus multocolor victoriae	NE
Amphiliidae	Spotted sand catlet	Zaireichthys rotundiceps	DD

6.4.5 Terrestrial Invertebrates

The AoI is rich in invertebrate species. However, only 3 are of conservation concern as indicated in the **Table 41** below. These are are *Notogomphus maathaiae endangered (EN), Platycypha amboniensis Critically endangered (CR)* and the Vulnerable (VU) *Pseudagrion bicoerulans.* All these species are associated with wetlands as breeding grounds. Members of damselfly and dragonfly species deposit their eggs in water and their larvae are among the key indicators of water quality.

Table 41: Terrestrial invertebrates within the study area

Common name	Species name	Restricted Range / Endemic Status	IUCN threat category (IUCN, 2025)
Maathai's Longleg	*Notogomphus maathaiae*	Yes	EN
Kenya Jewel	*Platycypha amboniensis*	No	CR
Painted lady	*Pseudagrion bicoerulans*	No	VU

Members of the order Hymenoptera dominates the invert assemblage in the study area followed by *Coleopteran* and *Diptera* as shown in the **Figure 41** below:

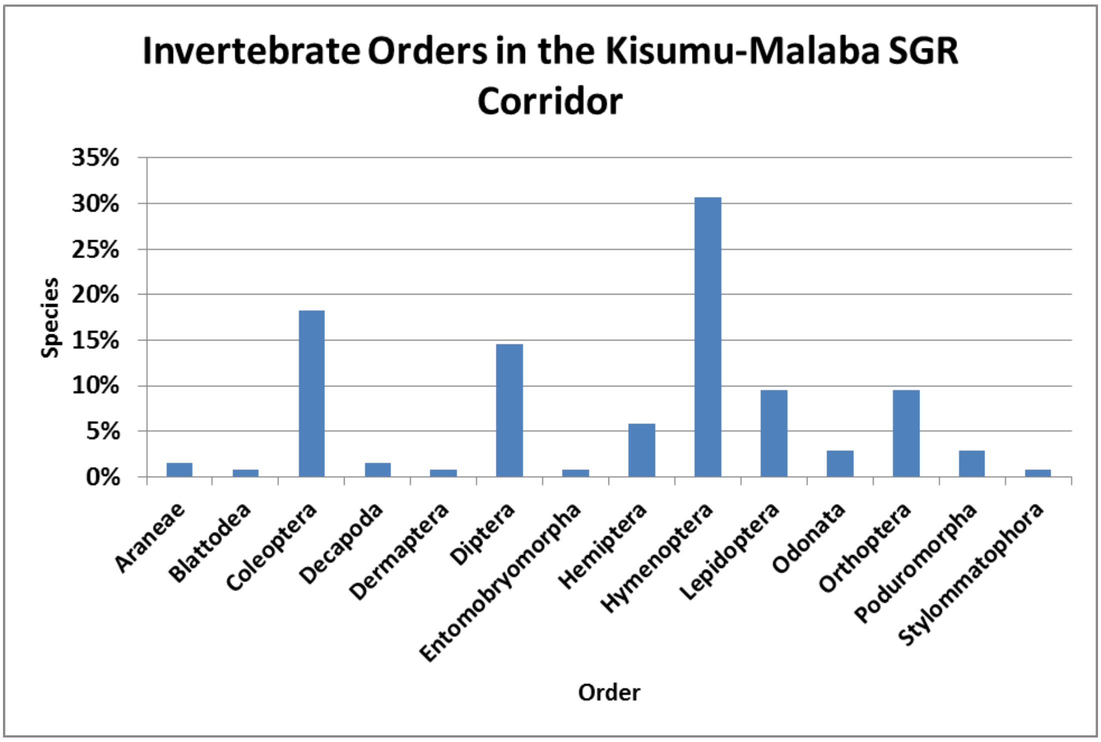


Figure 41: Invertebrate orders within the project area.

6.4.6 Mammals

The mammalian community in the Area of influence is made up of 41 species in 19 families. The bat family (Chiroptera) had the highest number of species compared to the terrestrial groups. The mammalian family is indicated in **Table 42** below.

Table 42: Mammalian family members

Common name	Species name	Restricted Range / Endemic Status	IUCN treat category (IUCN, 2025)	Nationally Protected (KWS Act and Schedules)	National Status	Present in BSA and/ or AoI
Straw-coloured fruit bat	*Eidolon helvum*	No	VU	No	VU	Yes
Hippo	*Hippopotamus amphibius*	No	VU	Yes	VU	Yes

- **Bats**

The bat assemblage was made up of 12 species in 5 families. The family Vespertilionid had 5 species which was the largest while Nycteridae and Molossidae each had a single species thus the lowest represented. However, only one species from the Family Pteropodidae, Straw-coloured fruit bat (*Eidolon helvum)* is a critical habitat trigger as it is Vulnerable and has a migratory life history.

- **Terrestrial Mammals**

Only the semi-aquatic Hippopotamus amphibious is a Threatened species under the Vulnerable (VU) category of the IUCN among the terrestrial mammals. This species was however not recorded from the BSA but is found in the AoI. Other mammal species in the area include; Common Duiker (*Sylvicapra grimmia*), Giant otter shrew (*Potamogale velox*), Spotted hyena (*Crocuta crocuta*) and the White-tailed mongoose (*Ichneumia albicauda*)

6.4.7 Birds

One avian species , Grey Crowned Crane (*Balearica regulorum*)is endangered as per the IUCN threat categories while 6 namely Green Sandpiper (*Tringa ochropus*), Common Sandpiper (*Actitis hypoleucos*), Eurasian Bee-eater (*Merops apiaster*), Barn Swallow (*Hirundo rustica*), Marsh Warbler (*Acrocephalus palustris*) and Red-chested Cuckoo (*Cuculus solitarius*)are migrants and protected under the Agreement on the Conservation of African-Eurasian Migratory Waterbirds AEWA treaty to which Kenya is a signatory. These are presented **Table 43** below.

Additionally, a nest of the endangered bird was spotted within the AoI as shown in **Figure 42** below.

Table 43: Birds within the project area

Common name	Species name	Restricted Range / Endemic status	Migratory Species	IUCN treat category (IUCN 2025)	Nationally Protected (AEWA/KWS Act)	National Status
Gruidae: cranes						
Grey Crowned Crane	*Balearica regulorum*	No	No	EN	Yes	EN
Scolopacidae: sandpipers and relatives						
Green Sandpiper	*Tringa ochropus*	No	Yes	LC	Yes	LC
Common Sandpiper	*Actitis hypoleucos*	No	Yes	LC	Yes	LC
Meropidae: bee-eaters						
Eurasian Bee-eater	*Merops apiaster*	No	Yes	LC	Yes	LC
Hirundinidae: saw-wings, swallows and martins						
Barn Swallow	*Hirundo rustica*	No	Yes	LC	Yes	LC
Sylviidae: Old World warblers						
Marsh Warbler	*Acrocephalus palustris*	No	Yes	LC	Yes	LC
Cuculidae: cuckoos and coucals						
Red-chested Cuckoo	*Cuculus solitarius*	No	Yes	LC	Yes	LC

Figure 42: Nest of the Endangered Crowned crane

6.5 Social Economic Baseline

6.5.1 Introduction

This socio-economic baseline outlines the prevailing social and economic conditions within the project area. It examines key socio-economic dimensions, including administrative structures, demographic characteristics, economic activities, health and education services, land use and land tenure systems, among others.

Purpose of a Socio-Economic Baseline

- To understand who lives in the project area, their livelihoods, wellbeing, and vulnerabilities.
- To provide evidence for predicting social impacts, designing mitigation measures, and informing stakeholder engagement.
- To provide a baseline on which project socio-economic impacts can be evaluated and monitored.

Projected Affected Persons

An estimated 5,800 PAPs are expected to be displaced with the number broken down as follows;

County	Number of Persons Affected
Kisumu	1,205
Vihiga	377
Siaya	928
Kakamega	1,780
Busia	1,510

Source: RAP Study Report, June 2025

The subsequent sections present the socio-economic profiles for each of the five counties traversed by the project, namely Kisumu, Vihiga, Kakamega, Siaya, and Busia.

6.5.2 Kisumu County

6.5.2.1 Overview

Kisumu County, located in western Kenya along Lake Victoria, has a population of about 1.16 million people and is predominantly inhabited by the Luo community. Its economy is diverse, driven by agriculture (including sugarcane and rice), fishing, tourism, manufacturing, and a vibrant informal sector. Kisumu City serves as a major regional hub with key infrastructure such as an international airport, port facilities, major roads, and numerous educational and health institutions. The county covers approximately 2,086 km² of land and 567 km² of water, and is bordered by Homa Bay, Nandi, Kericho, Vihiga, and Siaya counties. The proposed railway line traverses Kisumu West and Seme Sub-counties.

6.5.2.2 Administrative Units

Kisumu County comprises seven sub-counties. Muhoroni is the largest, covering 658 km², and consists of two divisions, 10 locations, and 35 sub-locations. Nyakach, the second largest sub-county, has the highest number of divisions (4) and locations (23). Kisumu East, Kisumu Central, and Seme each have one division, with Kisumu Central having the fewest locations (3) and sub-locations (9). Nyando, the third largest in area, has the most sub-locations (36).

The proposed SGR Phase 2C project traverses two of the seven sub-counties—Kisumu West and Seme. In Kisumu West, the alignment passes through West Kisumu, South West Kisumu, and Central Kisumu Locations. In Seme Sub-County, it runs across Otuenya and East Seme Locations. At the sub-location level, the project route covers Newa, Upper Kagongo, Ojolla, and Korando B (Kisumu West), as well as North Rata, West Kolunje, East Kolunje, and Kaila (Seme).

The **Figure 43** below depicts the Sub – Counties administrative units of Kisumu County.

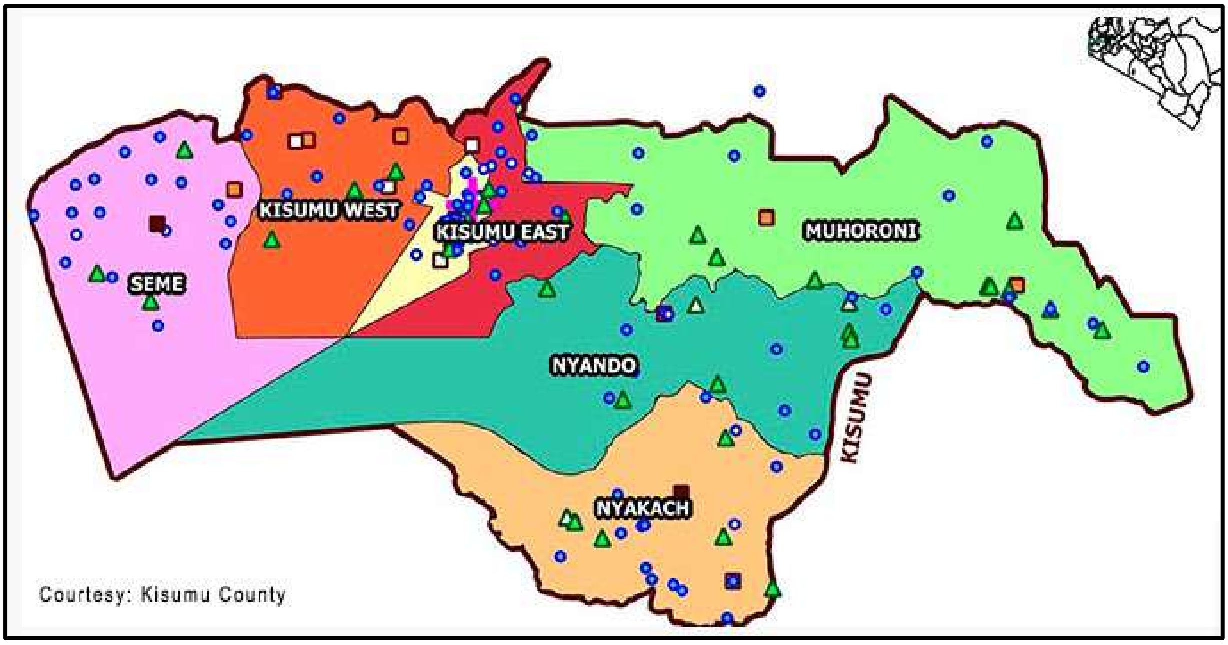


Figure 43: Kisumu County Administrative Units

Source, Kisumu County CIDP, 2023-2027

6.5.2.3 Demographic Profile

According to the 2019 census, Kisumu County had a population of 1,155,574, comprising 560,942 males, 594,609 females, and 23 intersex persons. The population is projected to rise to 1,290,016 in

2025 and 1,329,805 by 2027 (Kisumu CIDP 2022–2027). This rapid growth underscores the need for increased investment in essential social infrastructure and services, including schools, health facilities, water supply, sanitation, and other utilities. The to Sub Counties traversed by the project are Kisumu West and Seme have their demographic profiles presented below.

Seme Sub-County recorded a population of 121,667 in 2019, with 57,685 males and 64,007 females. Covering 267.7 km², it has a population density of 454.5 persons per km². By 2027, the population is projected to increase to 67,689 males and 72,260 females. Population density is a key factor influencing economic and administrative planning, urban and spatial planning, land use, housing demand, infrastructure development, agriculture, health services, and environmental and climate change programs.

Kisumu West Sub-County had a population of 172,821 in 2019, with projections indicating growth to 198,402 by 2027.

Table 44 provides current and projected population figures for Kisumu West and Seme Sub-Counties.

Table 44: Population projection for various sub counties

Sub-County	Location	Sub-Location	Population Projections		
			2019	2025	2030
Kisumu West	West Kisumu	Newa	4,325	5,202	6,081
		Upper Kadongo	5,312	6,389	7,469
	South West Kisumu	Ojolla	12,491	15,024	17,563
	Central Kisumu	Karando B	9,268	11,148	13,031
Seme	Otuenya	North Rata	8,325	10,013	11,706
		West Kolunje	3,477	4,182	4,889
		East Kolunje	4,719	5,676	6,635
	East Seme	Kaila	4,681	5,630	6,582

Source: KNBS Population and Household Census 2019

Vulnerable Groups

According to the 2019 Census, PWDs represent 2.2% of Kenya's population. Kisumu County recorded 39,868 PWDs, consisting of 16,311 males and 23,557 females across all seven sub-counties. The most prevalent disability types were visual impairments (17,606) and physical/mobility impairments (16,196), followed by hearing (7,291), cognition (7,922), self-care (4,288), and speech/communication disabilities (3,409). The 55+ age group registered the highest disability prevalence due to age-related factors.

In the two project-affected sub-counties:

- Kisumu West has a total of 9,901 PWDs, with visual and mobility disabilities being most common.
- Seme Sub-County has 8,719 PWDs, also dominated by visual, mobility, and cognitive impairments.

6.5.2.4 Economic Profile

Economy

Kisumu County functions as the primary commercial and transport hub for western Kenya and the wider East African region. The county's major economic activities include subsistence farming, livestock keeping, fishing, rice cultivation, sugarcane farming, and small-scale trading. Its economy is largely driven by micro, small, and medium enterprises (SMEs), which face various challenges such as limited economies of scale, restricted access to credit, a small skilled labour pool, and inadequate marketing structures and infrastructure.

Industrial activities also play a significant role in the county's economic growth. Kisumu County hosts three state-owned sugar mills Chemelil, Muhoroni, and Miwani and one private mill, Kibos. It is also home to Kenya Breweries, which supports sorghum production by creating market opportunities for local farmers. In addition, Equator Bottlers, a major Coca-Cola franchise, operates in the county, supplying the entire western region. Other notable industries include ballast production plants, paint manufacturers, and steel and cement factories.

Kisumu West and Seme Sub Counties

Livelihoods in Kisumu West and Seme Sub-Counties are diverse, including small and micro-enterprises (such as retail shops, motorcycle transport, brick making, and quarrying), formal employment, farming, livestock rearing, aquaculture, fishing, and irrigation-based activities.

Agriculture is a key source of income and employment in both sub-counties, with crop production particularly sugarcane, rice, and cotton being significant due to the support of local sugar factories.

Kisumu West Sub-County: About 23,207 residents engage in agriculture. Main subsistence crops include maize, sorghum, rice, beans, cassava, and sweet potatoes, while cash crops comprise sugarcane, rice, and cotton. Other crops grown include groundnuts, kale, and bananas, with crop patterns varying across different areas.

Seme Sub-County: Approximately 23,014 residents practice agriculture, cultivating maize, sorghum, soybeans, watermelons, tomatoes, millet, cowpeas, and assorted vegetables and fruits. Emphasis is also placed on resilient and traditional crops such as finger millet, beans, and leafy vegetables to support climate change adaptation and seed conservation initiatives.

Fishing along Lake Victoria is another vital economic activity, particularly in Seme Sub-County, which records the highest number of fishermen, providing livelihoods for many households. **Table 45** below shows the livelihood distribution within Kisumu West and Seme Sub Counties of Kisumu County.

Table 45: Livelihood distribution within Kisumu West and Seme Sub Counties

Sub County	Farming	Crop production	Livestock production	Aquaculture	Fishing	Irrigation
Kisumu West	23,207	21,018	15,276	99	1,009	538
Seme	24,014	22,896	16,524	91	1,634	459

Source: KNBS Kenya Population and Housing Census, 2019.


Figure 44: Maize farm within Seme Sub County

6.5.2.5 Land Tenure and Use

Land Tenure

In Kisumu County, land tenure systems are mainly public, and individual tenure, with leaseholds and freeholds also prevalent in the peri-urban fringe. Urbanization and population growth put pressure on land, leading to challenges in land use planning and security of tenure. Kisumu County is classified into public land owned by the County Government, while communal land is traditionally held by local communities. Individual tenure, including leaseholds and freeholds, is also common, particularly in urban areas and peri-urban fringes.

Land Use

Kisumu County's land uses include a variety of agricultural practices, urban development, and areas designated for specific purposes like urban renewal and infrastructure. The county also has areas with forest cover, shrubs, herbaceous vegetation, wetlands, and bare/sparse vegetation.

a) **Agricultural Land Uses**

- Crop Farming: Kisumu County supports various crops, including sugar cane, maize, potatoes, fruits, vegetables, flowers, and seeds.
- Livestock Farming: Dairy farming, beekeeping, and breeding livestock are also common. Game Ranching and Cropping: The county also utilizes land for game ranching, game cropping, and the conservation of game animals and birds. Other Uses include grazing, market gardening, and nursery grounds.

b) **Urban Development**

- Urban Core and Lakefront: Kisumu City's urban core, including the lakefront, is a designated area for physical and land use development plans.
- Urban Renewal and Regeneration: The city also has areas designated for urban renewal and regeneration, including informal settlements and Auji Creek.

- Eastern and Northern Extensions: The city is expanding into the eastern and northern extensions, with designated land use plans for these areas.
-

c) **Other Land Uses**

- Forest Cover and Vegetation: Kisumu County has areas with varying types of vegetation, including forest cover, shrubs, herbaceous vegetation, and bare/sparse vegetation.
- Wetlands: Wetlands are also present in the county.
- Permanent Water Bodies: Permanent water bodies, such as Lake Victoria, are a significant part of the landscape.
- Urban and Built-Up Areas: The county also has urban areas and built-up zones.

Source: Land use/Land cover in Kisumu County (2022)/https/www/Kisumu.go.ke

Issues in Land Use and Tenure

In Kisumu County, women in particular face significant challenges in accessing and inheriting land due to cultural and legal frameworks that often prioritize men. While legal provisions exist to ensure equal access to land and property, societal norms and traditional practices frequently undermine these rights, particularly for women. Women face the following challenges:

- Cultural Norms: Traditional customs and practices, especially regarding inheritance, often favor male family members, leaving women with limited or no land ownership.
- Legal Frameworks: While the Kenyan constitution and various laws aim to protect women's land rights, enforcement and implementation can be weak, and cultural norms often override legal provisions.
- Limited Awareness: Many women lack awareness about their land rights and the legal frameworks available to protect them.
- Inheritance Issues: Women can face challenges in inheriting land, especially after the death of their husbands or fathers, with in-laws sometimes taking over property.
- Displacement and Fraud: Women can also be victims of land displacement and fraud, further hindering their access to and control over land

6.5.2.6 Education

Kisumu's education infrastructure is focused on providing foundational education, vocational training, and supporting social services. The county government aims to improve access to quality education, including early childhood development (ECD) and vocational training. Significant investments are being made in ECD centers, including construction and capacity building for teachers.
A total of 77.7% of the population has completed either primary or secondary education. According to 2019 KNPHS, Kisumu County has 504, 312 school going population at different levels distributed as shown in **Table 46** below.

Table 46: Number of learning institutions and teacher in Kisumu County

Number of schools	Public	Private
ECD centres	657	550
Primary schools	615	206
Secondary schools	226	26

No. of teachers	Public	Private
ECD centres	1688	1627
Primary schools	6174	1554
Secondary schools	2895	288
Pupils Teacher Ratio	**Public**	**Private**
ECD centres	29	18
Primary schools	41	21
Secondary schools	31	11

Source: CRA County Data Sheet, 2023

- **Seme and Kisumu West Sub Counties**

The information on the number of schools, teachers and Pupils Teacher Ratio for the County is provided in **Table 47** below.

Table 47: Distribution of student population

Sub County	ECD	Primary	Secondary	TVET	University
Kisumu West	13,371	40,444	13,930	2,316	5,027
Seme	10,567	33,461	10,618	915	734

Source: Kenya Population and Housing Census, 2019

Some learning institutions within Kisumu West and Seme Sub-Counties are: -

- **Kisumu West:** Some learning institutions in Kisumu West subcounty are Bishop Okoth Ojolla (Secondary), Muslim Secondary School (Extra County), Kotetni Primary School, New Kisumu Secondary (Private), and Obede Secondary (County).
- **Seme sub-county:** Some learning institutions within the subcounty are Alungo Primary School and Pap-Konaam Agricultural Training College.
- The learning institutions within Kisumu West and Seme Sub-counties which are within the 70m wayleave corridor, will be displaced and reinstituted are Kisian Primary School and Kadongo Vacational Training Centre, Simba Gero primary school Kaila and Church of Christ in Africa St. James Orando. A parcel of land should be acquired within the vicinity to ensure students do not walk long distances to school, temporary structures should be put in place while constructing permanent structures to ensure learning is not disrupted.

6.5.2.7 Health

According to an assessment conducted by labflow.com in Kisumu County has a total of 353 health facilities of different levels spread across the 7 sub-counties. Out of these, 5.4% are faith-based facilities (19) while 41.6% owned by the Ministry of Health (147). This leaves 7.9% under NGO's (28) and 45% listed as private facilities (159).

Kisumu West sub-county has a total of 35 health facilities, translating to 10% of the health facilities in Kisumu County.

Seme sub-county has a total of 29 health facilities making up to 8% of the health facilities in Kisumu County.

Some of the key heath facilities within Kisumu County offering specialist services e.g. Diagnostic Imaging, Surgical Services, Maternity Services, Tuberculosis Treatment, dental care and youth-Friendly Services amongst others include friendly health services include

- Kisumu County Referral Hospital (KMHFR): A major public hospital with services like youth-friendly services, X-ray, vaccination, ultrasound, tuberculosis treatment, surgical outpatient clinics, and specialized X-ray.
- Kisumu Specialists Hospital (KSH): A 50-bed hospital with emergency services, diagnostic imaging (including MRI, CT scan, X-ray), and a range of clinical care specialties.
- Avenue Healthcare Kisumu Hospital: A hospital with a range of services, including general medical and surgical wards, maternity, pediatric, burns and isolation units, dialysis, private rooms, ICU, operating theaters, outpatient services, pharmacy, laboratory, and CT scan/X-ray.
- The Aga Khan Hospital, Kisumu: Provides a range of medical services, including general medicine and surgery, women's health, and other specialized areas.
- Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH): A national teaching and referral hospital with various specialized services.

Kisumu West and Seme Sub Counties

a) Health facilities

The various health facilities are distributed in the two sub counties as indicated in **Table 48** below.

Table 48: Distribution of health facilities within Kisumu West and Seme Sub Counties

Health facility	Kisumu West	Seme
Ministry of Health	23	22
Faith Based Organization	1	1
NGOs	0	0
Private practice	11	6
Total	35	29

Source: (Assessment report by labflow.org)

Some of the health facilities within Kisumu West Sub-County include Nyahera Sub County Hospital, Kodiaga Prison Health Centre, Maseno University Health Centre, Mainga Health Centre, Siriba Dispensary, Good Neighbour Clinic, Amani Medical Clinic and Benec Medical Centre amongst others

Some of the health facilities within Seme Sub-County include Kolenyo Dispensary, Rodi Dispensary, Arito Langi Health Centre, Asat Beach Dispensary, Bodi Health Centre, Ratta Health Centre, and Manyuanda Sub-County Hospital.

No health facility in Kisumu West and Seme Sub Counties are within the SGR wayleave corridor. Health facilities within 2-10 km radius from the wayleave corridor such as Ojola Health Center and Masaba hospital.

b) Common Diseases and Ailments

Kisumu West and Seme Sub Counties recorded different conditions and diseases as indicated in the **Table 49** below.

Table 49: Dominant ailments for under 5s in the project areas

Ailment/condition	Kisumu West	Seme
	Numbers	
Accidents (Fractures, injuries.)	2758	1539
Clinical malaria	21,466	24,877
Confirmed Malaria	38,902	36,187

Diarrhoea	4,723	3,906
Sexually Transmitted Infections	1,257	495
New AIDS Cases	110	204
Pneumonia	1,451	1,370
Typhoid fever	2,995	1,565
Malnutrition	42	110
Tuberculosis	129	32
Urinary Tract Infection	3,091	1,949

Source: (KNBS Kisumu County Statistical abstract, 2015)

6.5.2.8 Water

The main water sources in Kisumu are L. Victoria, shallow wells, unprotected springs, boreholes and roof catchment systems and bottled water. During the dry season, some of the water sources run dry forcing people to take longer time to fetch water. Women and children specially spend more time in search of water than men and boys. Kisumu Water and Sanitation Company (KIWASCO) provides water and sanitation services in Kisumu town and its environs County, according to KIWASCO's website. KIWASCO operates two water treatment plants, Dunga (44,000 m^3), which produces 40% of Kisumu's water through pumping and Kajulu (36,000 m^3), with a total capacity of 80,000 m^3 and produces 60% of Kisumu's water via gravity.

Seme and Kisumu West Sub Counties

From **Table 50** below, majority of households from Seme and Kisumu West sub counties rely on water from Streams/River, springs and well.

Table 50: Sources of water within the County

Sub County	Percentage of HHs							
	No. of HHS	Pond	Dam/lake	Stream/River	Spring	Well	Borehole	Others (piped, bottled, rain water)
Kisumu West	42,785	0.3	2.4	15.1	8.5	7.9	10.1	55.7
Seme	29,404	0.8	6.0	32.8	4.4	12.1	20.7	23.2

Source: Kenya Population and Housing Census, 2019

The contractor will be required to obtain water abstraction permit from Water Resources Authority to draw water for construction and other uses from surface water bodies. In the event that contractor may need to drill boreholes, necessary permits shall be obtained in compliance with the WRA requirements.

Access to Safe Drinking Water

According to Commission for Revenue Allocation (CRA) County Data Sheet, 2023, only 2.3% Household in Seme Sub County and 17.6% household in Kisumu West Sub County have access to safe drinking water as shown in **Figure 45** below.

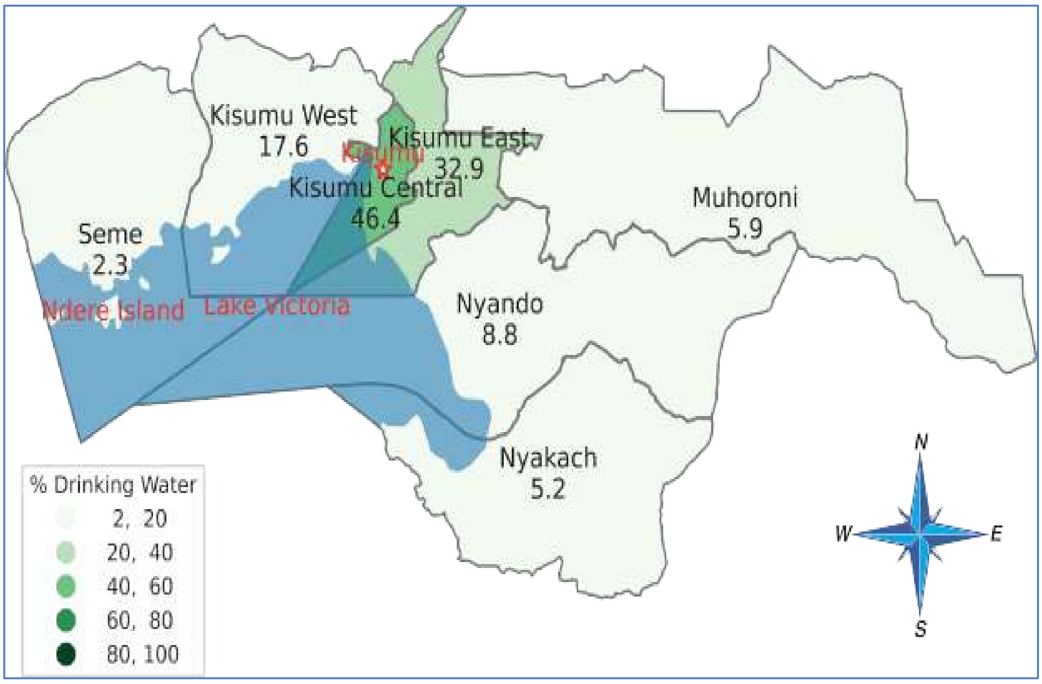


Figure 45: Percentage of HHs accessing Safe Drinking Water

Source: CRA Kisumu County Data Sheet, 2023

6.5.2.9 Transport and Communication Network

Kisumu County has a mix of transportation facilities including roads, public transport (buses and matatus), a railway line, and air and water transport.

i) Road Transportation

- Matatus (minibuses) and buses: These are the primary modes of public transport within the city and to other areas.
- Boda-boda**:** Motorcycles (boda-boda) are also a common mode of transport, especially for quick access.
- Taxis and Tuk tuk: Mainly plies town to peri urban areas.

The SGR Phase 2C crosses Kisumu-Maseno road at Ojola area close to Kenyeree SDA church and several other murram roads the major one being Holo-Lela murram road close to Nyakune Catholic Church.

ii) Other Transportation Facilities:

- **Air Transport:** Kisumu International Airport offers daily flights to other parts of the country.
- **Railway:** A railway line connects Nairobi and Kisumu, offering a scenic journey through the Kenyan landscape.
- **Ferry Service:** Traditional steam and diesel-powered ferries operate on Lake Victoria, connecting Kisumu with other ports in Uganda and Tanzania.

6.5.2.10 Recreation and Tourism

Kisumu offers a variety of recreational activities and attractions. These include exploring the Kisumu Impala Sanctuary, enjoying the vibrant Dunga Beach and wetlands, visiting the Kisumu Museum, and experiencing the unique rock formation of Kit Mikayi (see **Figure 46** below). Visitors can also enjoy boat trips on Lake Victoria, explore the West End Shopping Mall, and discover local markets like Kibuye and Oile. Below are some of the recreational sites within the county

i) Nature and Wildlife

- **Kisumu Impala Sanctuary:** This sanctuary is home to impalas, the rare Sitatunga antelope, and various other animals, including lions, leopards, and giraffes. Visitors can enjoy nature walks, bird watching, and boat rides.
- **Dunga Beach and Wetlands:** A unique ecological area with rich biodiversity, including over 800 bird species. Activities include bird watching, kayaking, and boat rides.
- **Ndere Island National Park:** Located on an island in Lake Victoria, offering opportunities for wildlife viewing and scenic views.
- **Hippo Point:** A popular spot near Dunga, offering views of Lake Victoria and the chance to see hippos.
- **Kit Mikayi:** A large rock formation with cultural and historical significance, offering scenic views and a place for picnics and other activities
- These nature and wildlife sites are more than 10kms from SGR wayleave corridor.

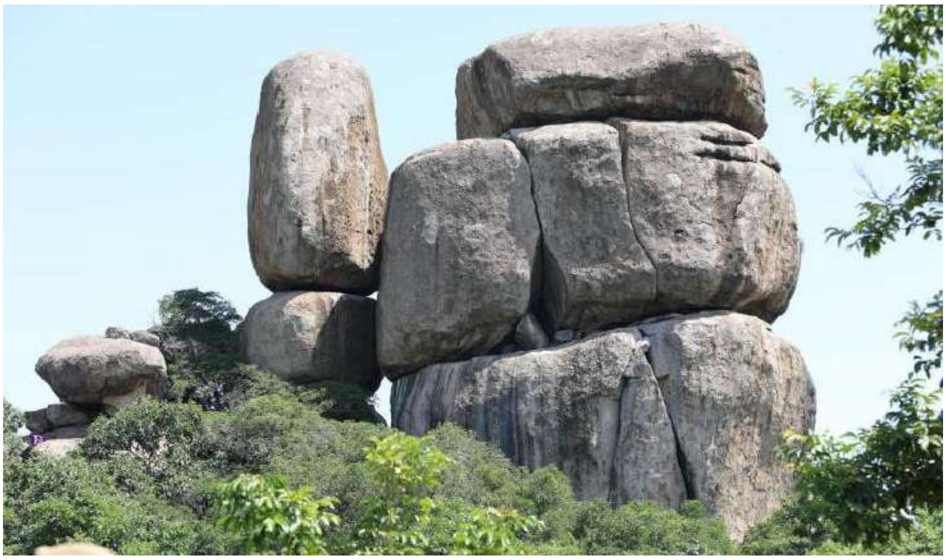


Figure 46: Kit Mikayi which has been named a world heritage site by UNESCO

Source: Ecoscience Baseline survey

ii) Historical Sites

Kisumu County has a number of cultural and historical sites namely;

- **Kisumu Museum:** Features displays of local artifacts and cultural exhibits.
- **Kibuye Market and Oile Market:** Bustling local markets where visitors can experience the local culture and find a variety of goods.
- **Seme-Kaila:** Consists of six stone-walled enclosures used by early Luo ancestors for defense and settlement, offering insights into their cosmology and communal lifestyle.

There is no cultural heritage site within the proposed SGR wayleave corridor. Abindu caves and cultural sites are more than 1km away from the SGR corridor while Kit Mikayi is about 7kms from the proposed SGR corridor.

iii) Other Recreational Activities

- **Boat Trips on Lake Victoria:** Enjoy scenic views of the lake and the city from a boat or canoe.
- **Bike ventures:** Offers bicycle tours and rentals for exploring the city and surrounding areas.
- **Sports:** Kisumu also has sporting venues like Oile Park, Jamhuri Park, and Jaramogi Oginga Sports Ground, which provide opportunities for active recreation.

iv) Cultural Practices and Expressions

- **Ramogi and Dodo Dances:** Kisumu is known for its unique and vibrant cultural dance performances.
- **Oral Traditions:** Oral traditions are an important part of the cultural heritage of the region, and efforts are underway to document and preserve them.
- **Religious Diversity:** The city's diverse religious landscape, including Christian churches, Sikh temples, Muslim mosques, and Hindu temples, reflects the varied cultural backgrounds of its inhabitants.

These cultural sites and practices attract tourists hence a justification for the SGR project i.e. ease of transport for tourists.

6.5.2.11 Energy

Kisumu County's energy consumption for household needs primarily revolves around paraffin gas, Biogas, firewood, charcoal and solar mainly for cooking and lighting.

Urban–rural disparities are significant since most household in town centres use LPG gas as compared to firewood in rural areas.

From **Figure 47** below, majority of households in Seme use firewood (89.2%) and charcoal (13%) while in Kisumu West, majority of households use firewood (55.1%), Charcoal (20.9%) and LPG gas (16.1%).

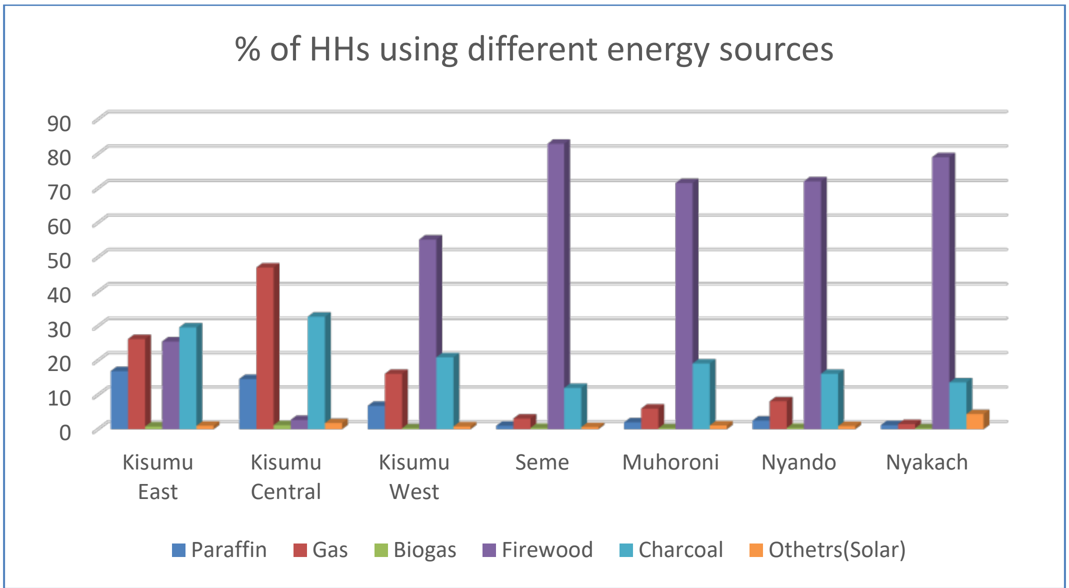


Figure 47: Distribution of Households by energy sources

Source: Kenya Population and Housing Census, 2019

Access to Electricity

Household electricity connection within Kisumu County stands at 52.8%. The county hosts three major energy sources including Hydro: Sondu Mirui (60 MW), Sango'ro (21 MW), Thermal: Muhoroni GT1 (28 MW), Muhoroni GT2 (28 MW) and Biomass from sugar factories (own consumption), 21 MW. Electivity connectivity in Seme sub County stand at 19.2% while Kisumu West is 55% as shown **Figure**

48 below.

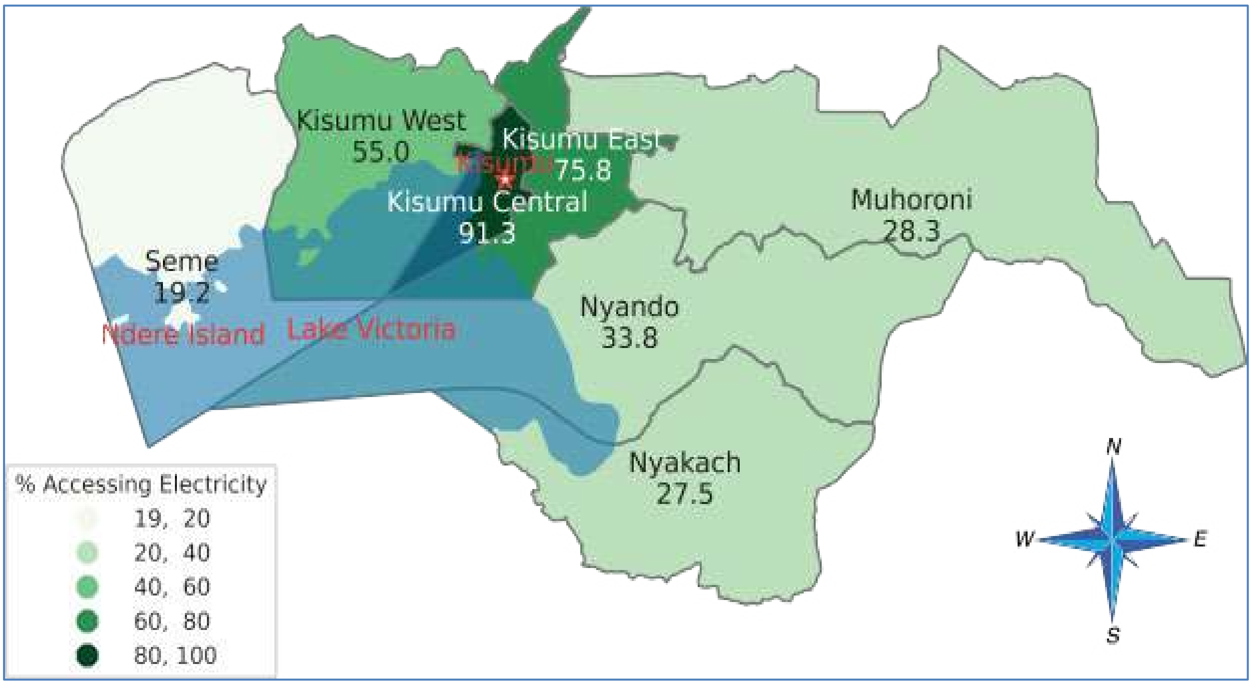


Figure 48: Percentage of HHs with access to electricity

Source: CRA Kisumu County Data Facts, 2023

6.5.2.12 Cross-cutting issues

Cross-cutting issues along the SGR corridor in Kisumu West and Seme sub county include poverty, unemployment (especially among youth), environmental degradation, climate change, understaffing and underfunding in health facilities, erratic drug supplies, and the increasing pressure on natural resources and employment due to population growth. Other challenges involve implementing gender equality initiatives and ensuring access to basic services like clean water and proper sanitation. Below are the issues in brief:

<u>Socio-Economic Challenges</u>

- Poverty - A prevalent issue with consequences for nutrition, health, education, and access to services.
- Unemployment - A major challenge, particularly for the youth, as the growing population increases the demand for limited job opportunities.
- Youth and Population Growth - A large youth population puts pressure on employment and natural resources, requiring proactive strategies.

<u>Health Sector Challenges</u>

- Understaffing **-** Health facilities, including those in Seme sub-county, face a shortage of adequate staff to meet community needs.
- Underfunding and Erratic Supplies **-** Severe underfunding leads to delayed payments for utilities and casual workers, as well as inconsistent supplies of essential drugs and medical reagents.

<u>Environmental and Climate-Related Issues</u>

- Environmental Degradation - Livelihoods are threatened by the degradation of land, freshwaters, and biodiversity, driven by activities like fishing, transport, and agriculture.
- Climate Change - A significant factor influencing the county, with impacts seen in rising costs for water treatment, food, and health services.

Infrastructure and Basic Services

- Access to Basic Services - Many residents lack access to essential services, which is directly linked to poverty.
- Resource Management - There is a need for better management of natural resources like land and water to prevent further degradation and support the environment's natural functions.

Governance and Social Issues

- Gender Equality - While policies are in place, the challenges of achieving women's socio-economic empowerment, participation in leadership, and preventing gender-based violence remain significant.
- Civic Education - There's a need to educate citizens on governance, their rights, and opportunities for collaboration

6.5.3 Vihiga County

Vihiga County is located in the Lake Victoria Basin of Western Kenya, lying between longitudes 34°30' and 35°0' E and latitudes 0° and 0°15' N. It is bordered by Nandi County to the east, Kisumu County to the south, Siaya County to the west, and Kakamega County to the north, covering an area of approximately 563.7 km².

The county's administrative headquarters is Mbale Town, and it is the smallest devolved unit in Western Kenya. Vihiga County is divided into five sub-counties: Emuhaya, Hamisi, Sabatia, Vihiga, and Luanda. The proposed project passes through about 3.45 km at the eastern edge of Luanda Sub-County, specifically within Emasaba and Maseno Divisions, covering Ebutsimi and Emasaba Sub-Locations.

The county is home to four major indigenous sub-tribes: Maragoli, Banyore, Tiriki, and Terik. The Maragoli, the largest sub-tribe, primarily reside in Sabatia, Vihiga, and Hamisi sub-counties. The Tiriki community is found mainly in Hamisi sub-county. The Terik, an agro-pastoralist minority of the Kalenjin group, occupy their ancestral lands in Hamisi and parts of Sabatia. The Banyore predominantly reside in Luanda and Emuhaya sub-counties.

6.5.3.1 Administrative Units

The County consists of five Sub-Counties (as shown in **Table 51** and **Figure 49** and below) namely; Hamisi, Emuhaya, Luanda, Sabatia and Vihiga. The county is further subdivided into 13 divisions, 41 locations, and 140 sub-locations. Hamisi Sub-county is the most expansive with an area of 188.9 Km², Sabatia 110.9 km², Vihiga 90.2Km², Emuhaya 89.5Km² and Luanda 84 Km².

The proposed SGR Phase 2C project will only traverse through Luanda Sub County in Vihiga. It will pass through Ekwanda in Ochwore location.

Table 51: Administrative units

Sub-County/Constituency	No of Divisions	No of Locations	No of Sub-Locations	Area (Km2)
Sabatia	2	8	31	110.9
Vihiga	2	5	18	90.2
Hamisi	5	11	37	188.9
Emuhaya	2	7	25	89.5
Luanda	2	10	29	84
Total	13	41	140	563.7

Source: Vihiga County CIDP 2023-2027

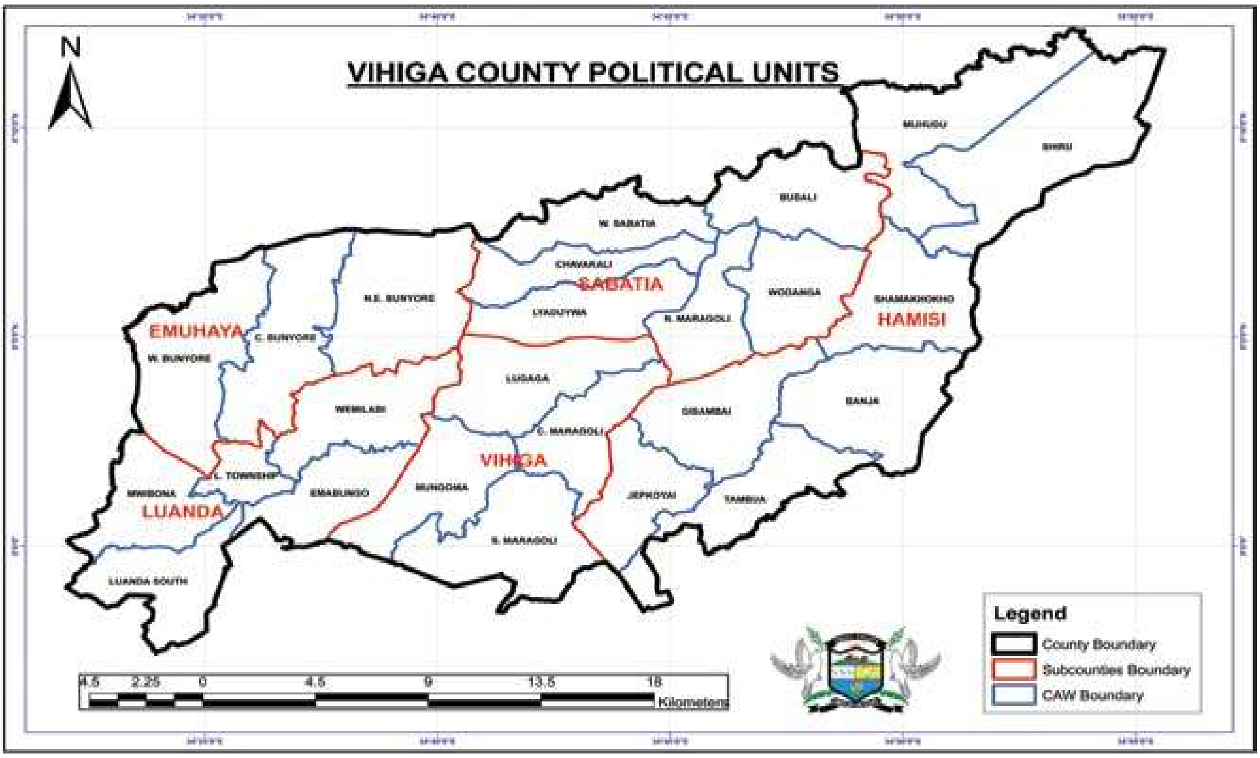


Figure 49: Political and administrative units

6.5.3.2 Demographic Profile

Vihiga County population count in 2019 was 590,013 with a density of 1047 persons/Km^2 (KNBS Census 2019). Approximately 48% of the population were male while 52 % were female. The population is estimated to grow to 634,074 (304,869 male, 329,205 female) with a density of 1125 persons/Km^2 by 2027 as shown in **Table 52** below.

Table 52: Population Projections (by Sub-County)

Sub-County	Location	Sub-Location	Population Projections		
			2019	2025	2030
Luanda	Emasaba	Ebutsimi	3,390	3,899	4,386
	Maseno	Emasaba	1,706	1,962	2,207

Source: KNBS Population and Household Census 2019

<u>**Vulnerable Groups within Vihiga County**</u>

Vulnerable groups in the county include widows and widowers, orphans and at-risk children, persons with disabilities (PWDs), and the poorest members of the community. The county implements a Cash Transfer Programme targeting orphans and vulnerable children (OVCs), the elderly, and PWDs. Additionally, the county government supports health insurance programs for expectant women, children, and the elderly, and provides braille materials and wheelchairs to PWDs. Funds are also allocated for scholarships and bursaries benefiting learners from low-income households.

Efforts have been made to mainstream disability in county government programs, including a target of at least 5% representation in employment, although this target has not yet been fully achieved. Furthermore, various policies and regulations have been developed to address the needs of PWDs, youth, and vulnerable children.

Luanda Sub County

Luanda Sub-County is predominantly inhabited by the Banyore people, a subgroup of the larger Luhya community. Luanda town serves as the central hub of the sub-county, shaping community interactions and trade. Its proximity to Lake Victoria influences local fishing activities, which are important for the economy and community livelihoods.

According to the Vihiga County CIDP 2022–2027, Luanda Sub-County had a population of 106,694, comprising 51,525 males, 55,165 females, and 4 intersex persons, with projections indicating growth to 114,664 by 2027 (see **Table 53**: Population Projections per Ward).

Historically, the Banyore practiced a decentralized leadership system, organized around age-sets and clan elders, with no single paramount chief. Decisions were guided by a council of elders who advised clan leaders. With the introduction of Kenya's modern political system, the community now elects leaders for local and national representation. Traditional leadership structures, however, remain significant, and some elected officials maintain strong ties to the clan elder system.

Within a 2 km radius of the SGR centreline are Emmaloba, Otwero, Marende, and Ebusyubi Primary Schools, Ebusyubi General Hospital, and St. Peter Coptic Orthodox Church, while Luanda Market is approximately 4.2 km away. The project area of influence affects private homes, parcels of land, trees, and crops.

Table 53: Population projections per Ward

Ward	Census (2019)	Projection (2022)	Projection (2025)	Projection (2027)
Luanda township	17148	17618	18100	18429
Luanda South	21681	22275	22589	23301
Emabungo	23275	23913	24252	25014
Wemilabi	24922	24958	25315	26107
Mwibona	20298	20854	21146	21814
TOTAL	107324	109617	111402	114664

6.5.3.3 Economic Profile

According to the Kenya Institute for Public Policy Research and Analysis (KIPPRA) Policy Brief No. 60/2023–2024, Vihiga County contributes an average of 0.3% to the National Gross Value Added (GVA), amounting to approximately Ksh 57,774.7 million. The GVA per capita stands at Ksh 97,923, with an average population growth rate of 3.7% and an overall poverty level of 48.8%. From 2013 to 2022, Vihiga County's GVA grew at an average rate of 3.5%, slightly below the national average of 4.37%, with the highest growth recorded in 2018 and the lowest in 2014.

The county's economy is predominantly agriculture-based, with over 85% of the population relying on farming for their livelihoods. Despite this, poverty remains a significant challenge, with a poverty index of 38.6%.

Luanda Sub-County's economy is primarily driven by subsistence farming, while Luanda town serves as a key business hub with vibrant commercial activity extending into the night. Agriculture is the dominant sector, contributing 37.4% to the GVA, and approximately 90% of the population is engaged in farming (see Figure 43: Agricultural Practices in Luanda Sub-County). Key crops include tea and coffee, alongside a mixed crop-livestock farming system. Common subsistence crops are maize (often intercropped with beans), bananas, soybeans, and sweet potatoes, while a variety of traditional leafy vegetables, such as cowpea, jute mallow, slender leaf, and spider plant, are also cultivated.

The proposed SGR line traverses Luanda Sub-County, an area characterized by this diverse and predominantly smallholder agricultural system. **Figure 50** below Agriculture practices in Luanda County.

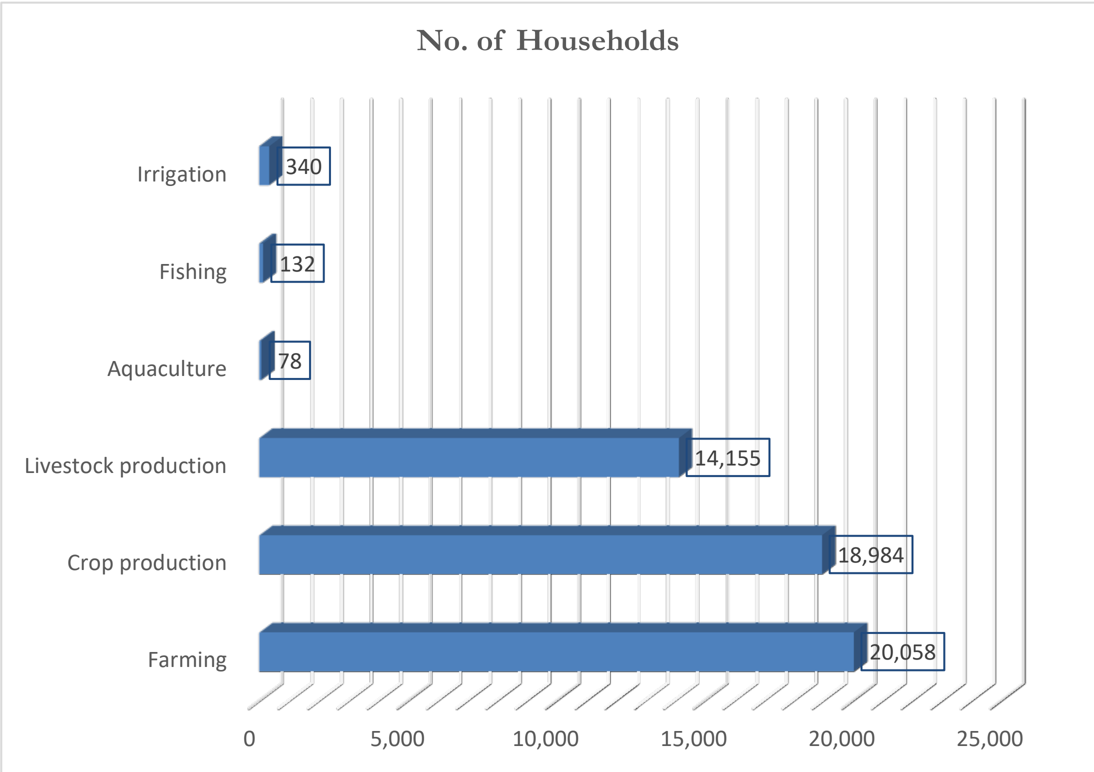


Figure 50: Agriculture practices in Luanda Sub County

Source: KNBS Kenya Population and Housing Census-2019

Employment and Livelihoods

The agriculture sector is the highest employer in Vihiga County at 76.42 per cent followed by the industry sector at 18.81 per cent. The services sector including boda-boda and small-scale trading is third at 17.23 per cent as shown in **Figure 51** below.

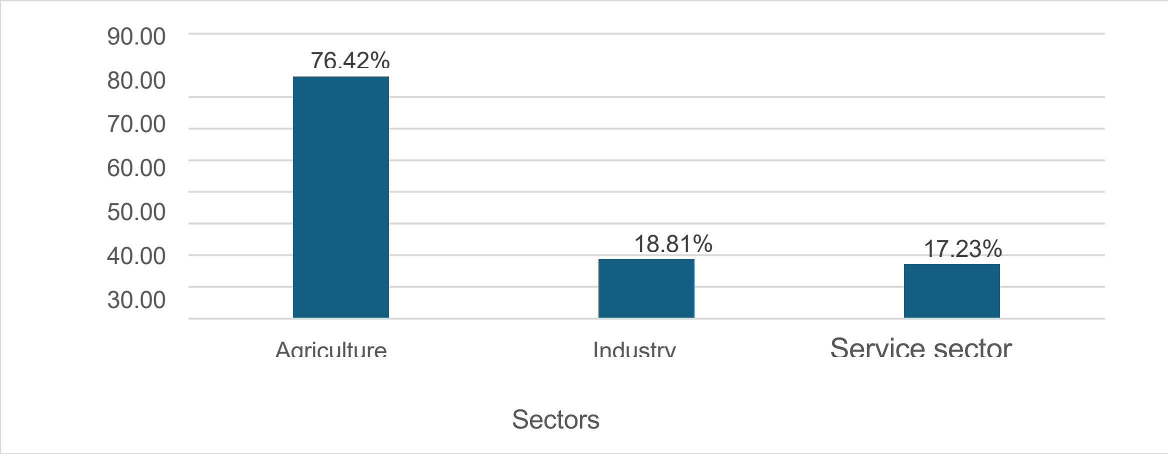


Figure 51: Percentage of people employed in broad sectors

Source: KNBS 2021- Kenya Continuous Household Survey

Boda-boda (Motorcycles)

The Boda -boda sub-sector in Luanda Sub County, is a vital part of the local economy (see **Figure 52**), supporting livelihoods through transport services and forming the basis for various Savings and Credit Cooperative Societies (SACCOs), such as the Vihiga County Boda-boda Sacco.

Figure 52: Boda boda operators in Luanda town

Small Scale Trading

Small scale traders in Luanda Sub-County is are primarily involved in small-scale and micro-businesses, with the sub-county serving as a major business hub within Vihiga County. The **Figure 53** indicates an example of small-scale trading in Luanda town.


Figure 53: A small scale banana trader

6.5.3.4 Land Tenure and Land Use

Land Tenure

In Vihiga County, the land tenure system, while evolving, is characterized by a blend of customary land rights and formal legal structures. The County land ownership is classified into public land owned by the County Government, while communal land is traditionally held by local communities. Individual tenure, including leaseholds and freeholds, is also common, particularly in urban and peri-urban areas.

Land Uses

Land tenure in Luanda Sub-County consists of freehold, leasehold, and customary systems. Freehold offers permanent ownership, leasehold provides time-bound rights, while customary tenure is based on traditional family or community inheritance, often without formal documentation. Although Kenyan law grants women equal rights to land and inheritance, patriarchal cultural practices continue to limit women's access in the sub-county.

Some land uses include;

- **Agriculture:** Vihiga County is heavily reliant on agriculture, with a significant portion of the population directly or indirectly involved in farming, including crop, livestock, and tea farming.
- **Residential**: Residential areas are a major component of land use, supporting both rural and urban settlements.
- **Commercial**: Commercial activities, including markets, wholesale and retail trade, and cottage industries, also contribute to land use patterns in Vihiga county.
- **Infrastructure:** Land is allocated for essential infrastructure like roads, telecommunication networks, power lines, and hospitals.
- **Education**: Education facilities are also significant land use, supporting the development of human resources.

- **Zoning and Regulations**: The county has implemented zoning regulations that categorize land into various zones, including residential, commercial, industrial, recreational, open spaces, institutional, and agricultural.

Informal Land Users

Vihiga County is addressing informal land users through several initiatives, including land tenure regularization, the development of a County Spatial Plan, and efforts to improve housing and urban development. These efforts aim to provide secure land tenure, guide sustainable development, and enhance the quality of life for residents in urban and rural areas.

6.5.3.5 Education

According to CRA Data facts, Vihiga County 2023, the County has a literacy level of 88.50. Some of the notable secondary schools in the county include Bunyore Girls High School, Ebubayi Secondary, Ekwanda High School, and Ebusakami Secondary. There is no public institution within the 70m SGR wayleave corridor. Schools within the 1.5km radius from the wayleave corridor are Marende Primary and Emaloba Primary schools. **Table 54** below shows the distribution of learning institutions in Vihiga County.

Table 54: Distribution of education infrastructure and resources

School Infrastructure		
No of schools	**Public**	**Private**
ECDE centres	407	140
Primary schools	383	69
Secondary schools	158	4
No. of teachers	**Public**	**Private**
ECDE centres	1,606	412
Primary schools	4,180	613
Secondary schools	2,107	39
Pupils Teachers Ratio (PTR)	**Public**	**Private**
ECDE centres	22	21
Primary schools	38	17
Secondary schools	32	9

Source: CRA Data facts, Vihiga County 2023

6.3.2.7 Health

Vihiga County's health system includes a number of health facilities as shown **Table 55** below. The county has one referral hospital, the Vihiga County Referral Hospital, which is a Level 5 referral hospital, along with numerous sub-county hospitals, health centers, and dispensaries. There is no health facility within the SGR wayleave corridor or passing station.

The Level 5 Referral Hospital acts as a county referral hospital, a teaching hospital, and a center for specialized healthcare. It offers various services including:

- Internal medicine, general surgery, pediatrics, obstetrics and gynecology, dental services.
- Psychiatry, ophthalmology, pharmaceutical services, ambulatory and emergency services.
- Laboratory services, rehabilitative care, counseling, physiotherapy, nutritional services, radiological imaging services, and oncology services.

- Specialized clinics, including Diabetic Outpatient Clinic, Mental Health Clinic, Orthopedic Consultant Clinic, and Oncology Clinic.
- Inpatient services, accident and emergency (A&E), orthopedic services, nursing services, and ophthalmic services.

Some of the health facilities within Luanda Sub-County include Luanda Wayside Clinic (medical clinic), Coptic Nursing Home, Equator Nursing and Maternity Home, Emanaka Dispensary, Epang'a Health Centre, Across Western Medical Center and Pharmaceuticals Ltd and Great Lakes Medical Centre Luanda among others

Table 55: Distribution of health facilities in Vihiga County

Sub County	Ministry of health	NGOs	Faith based organization	Private organization
Emuhaya	10	1	0	10
Hamisi	26	1	3	19
Luanda	13	0	2	7
Sabatia	9	0	4	12
Vihiga	17	1	0	9

Source: Labflow.com

Patient Mobility

Luanda sub county records different ailments as shown in the **Table 56** below.

Table 56: Outpatient Morbidity for Patients above 5 years in Luanda Sub County

Cause	Numbers
Accidents - Fractures, injuries.	1,295
Brucellosis	117
Bites - Animal, Snake, etc	311
Confirmed Malaria	21,140
Diarrhoea	1,425
Dysentery	90
Eye Infections	1,129
Sexually Transmitted Infections	358

Source: County Statistical Abstract, Vihiga County

6.5.3.7 Utility Facilities

Key areas of focus include water and sanitation, energy, and ICT infrastructure. This includes the Kaimosi Water Project, which utilizes solar energy to reduce electricity costs and improve water quality.

Water Supply

As indicated in the **Figure 54** below, majority of residents in Luanda Sub County fetch water from both protected and unprotected spring (61.4%), while 21.9% fetches water from rivers and streams.

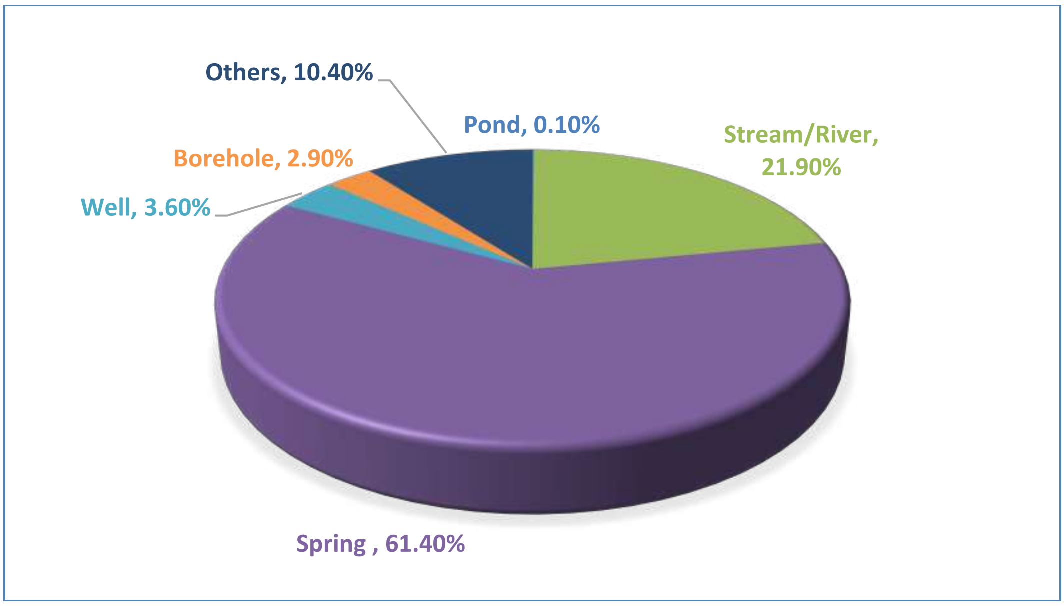


Figure 54: Sources of water

Source: KNBS Kenya Population and Housing Census-2019

Access to safe drinking water in Vihiga County is still a challenge since majority of the households draw water from springs. Only 4.2% of household in Luanda Sub County have access to safe drinking water, as shown in **Figure 55** below. This may lead to prevalence of water borne diseases.

Figure 55: Percentage of households with access to clean drinking water

Source: CRA Vihiga County Fact sheet-2023

Energy

Vihiga County's energy landscape reflects a strong shift toward clean and locally generated power, with notable strides in solar adoption, rural electrification, and climate-smart initiatives. The table below indicates the percentage use of different power sources at household level within Luanda Sub County. Most of the households use firewood (80.9%) as the main source of energy for food preparation a shown in **Figure 56** below.

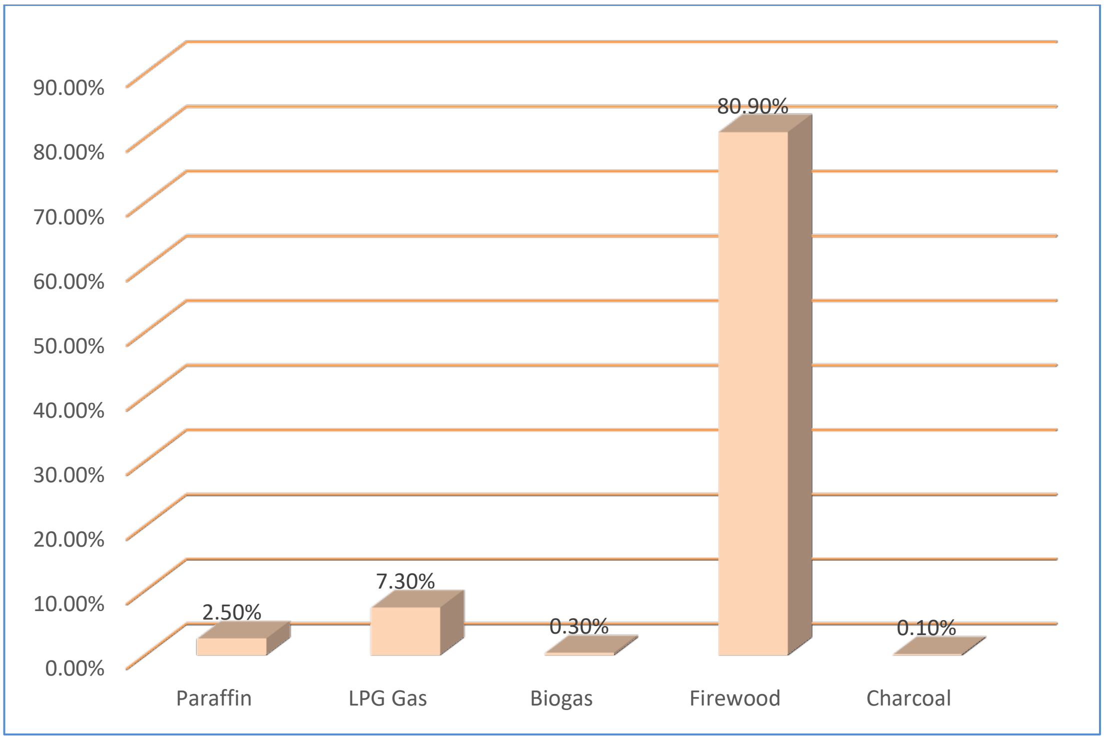


Figure 56: Types of energy sources used by households

Source: KNBS Kenya Population and Housing Census-2019

Households with access to electricity in Luanda County stands at 36.8% as indicated in the **Figure 57** below.

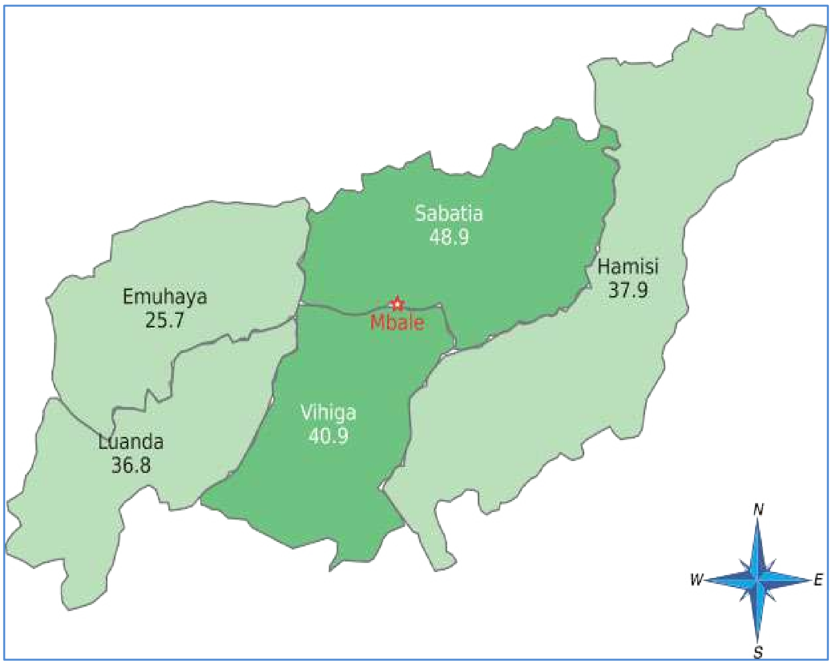


Figure 57: Households with access to electricity

Source: CRA Vihiga County Fact sheet-2023

ICT Infrastructure

From mobile phones and computers to the internet and digital platforms, ICT enables people to communicate, access information, and improve productivity. The percentage of population with access to the internet is shown in **Figure 58** below.

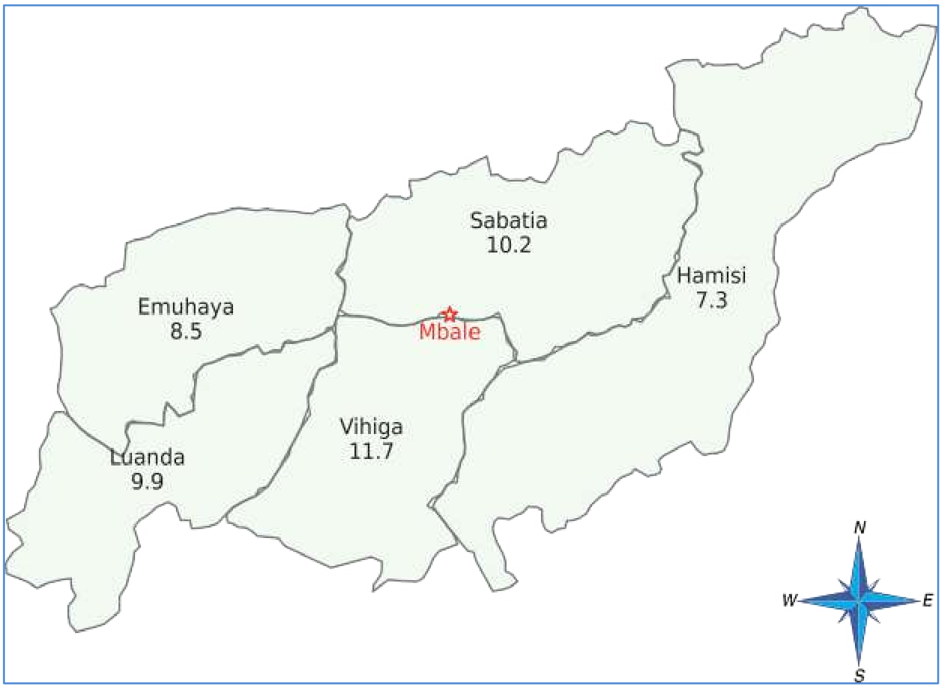


Figure 58: Percentage (%) of population Accessing Internet

Source: CRA Vihiga County Fact sheet-2023

6.5.3.8 Transport and Communication Network

Vihiga County has a road network primarily consisting of unpaved roads, with a smaller portion of paved roads. The county is actively working to improve its road infrastructure through maintenance, rehabilitation, and expansion of paved roads. They are also focused on improving road safety and efficiency by addressing issues like overloaded roads and implementing regulations.

- **Predominantly unpaved:** The majority of the county's road network (862km) is unpaved.
- **Paved roads:** Vihiga has 157km of paved roads, including Kisumu-Busia highway under currently under maintenance by KeNHA.

The SGR project passes through several rural murram roads like Maseno-Ratta road, Lwanda-Ekwanda road and the tarmacked Ramula-Lwanda road.

6.5.3.9 Recreation

Vihiga County offers various recreational activities and has initiatives to promote sports and cultural events. The County is known for its unique cultural practices and has initiatives to promote tourism through events like the "Festival of the Hills".

6.5.3.10 Culture and Tourism

Vihiga County is known for various cultures and tourism attraction sites; most notably;

- Rain making activities of the Nganyi clan.
- Festival of the Hills**:** This annual event, which includes fireworks, is aimed at attracting tourists and investors.
- Cultural Preservation**:** Vihiga County is known for its well-preserved cultural practices and has a vision to promote cultural diversity and social empowerment. It also hosts various cultural festivals to celebrate and preserve its diverse heritage, including the Vihiga Cultural and Tourism Festival and the Maragoli Cultural Festival.
- Tourist Destinations**:** The has attraction sites notably e g Malondole e Hills (where rainmakers are said to reside), Mungoma Caves (the origin of the Maragoli community), and Kibiri Forest (where the Tirikis conduct circumcision ceremonies), making it a potential tourist destination.
- Subtribes**:** Maragoli, Banyore, Tiriki, and Terik are the main subtribes that call Vihiga home, each with its own unique traditions and cultural practices. Archaeological sites including Kitigu site in South Maragoli, Maganyi site in Busali Ward, and Jamulongoi site in Shiru Ward offer insights into the past.

There are no cultural heritage sites within the SGR 70m wayleave corridor**.**

6.5.3.11 Luanda Gem Ramula Gold Mining on the Proposed SGR Phase 2C Project

The proposed Luanda Ramula gold mine and the SGR Phase 2C project have significant potential negative impacts on each other and the environment, including land acquisition conflicts, displacement of communities, social unrest, economic disruptions, and potential environmental contamination from mining operations like heavy metal release and increased arsenic and lead pollution in water and soil.

6.5.3.12 Housing and Settlement Characteristics

The project area, Luanda subcounty, experiences housing and settlement characteristics influenced by a predominantly rural setting, with firewood being the primary cooking fuel and low access to electricity. The project area needs improved rural electrification, clean energy, and the potential for informal settlement development driven by economic opportunities.

6.5.3.13 Cross-Cutting issues

Cross-cutting issues in Luanda subcounty include climate change, environmental degradation, disaster risk reduction, HIV/AIDS, gender equality, youth engagement, and the inclusion of Persons with Disabilities (PWDs). These are factors that affect multiple areas of development and must be considered across various sectors to ensure inclusive and sustainable growth in Vihiga County, where Luanda is located. Below is a brief on the cross-cutting issues within the SGR project area in subcounty.

6.5.4 Siaya County

6.5.4.1 Overview

The county is divided into six sub-counties: Ugunja, Gem, Rarieda, Ugenya, Alego Usonga, and Bondo as shown in **Figure 59** below. Bondo is the largest administrative unit. The county headquarters is in Siaya. The Kisumu- Malaba SGR line is proposed to pass through Ugunja and Gem, with a intermediate station proposed to be in Yala town of Gem Sub county.

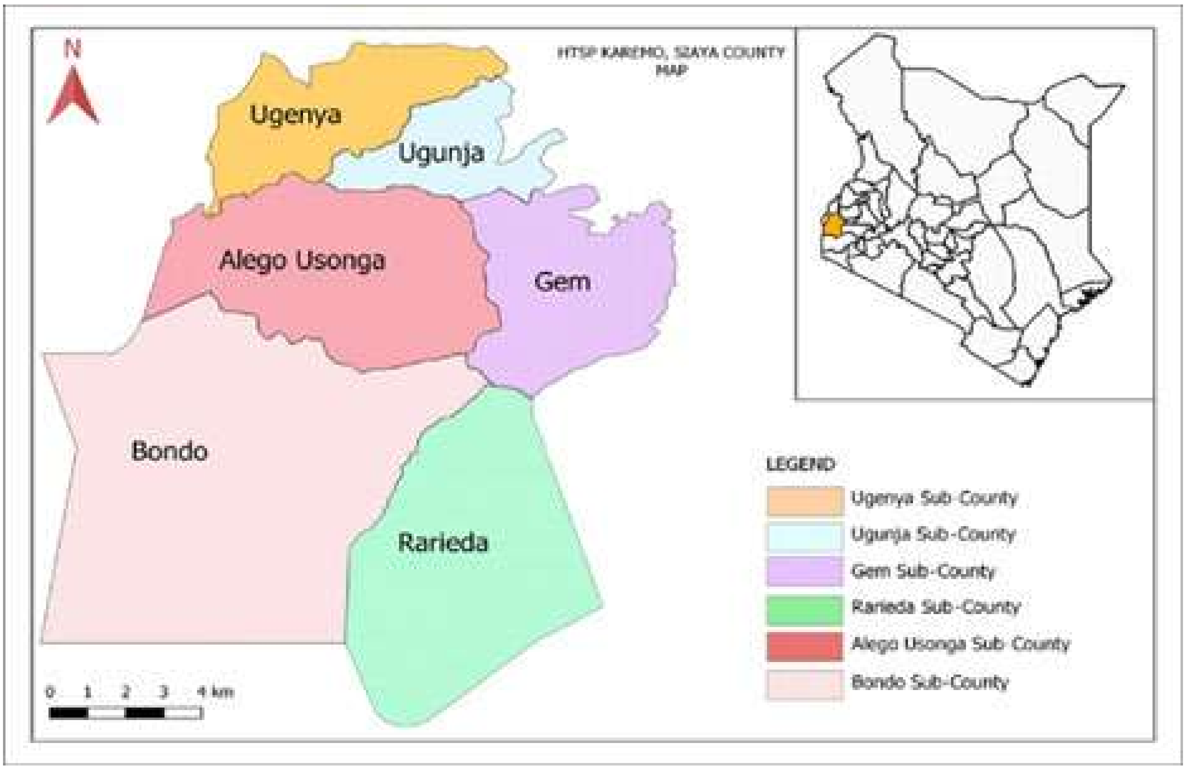


Figure 59: Map showing location of sub counties within Siaya County

Source: Siaya County CIDP, 2023-2027

The proposed SGR Phase 2C alignment traverses Yala and Ugunja Sub-Counties. In Gem Sub-County, it passes through North East Gem Location (Jina Sublocation) and Yala Township Location (Anyiko, Sauri, and Nyamninia Sublocations). Within a 1.5 km radius in Gem Yala Sub-County, the alignment passes near several institutions and community facilities, including Maungo Assembly African Israel Nineveh Church, Marenyo Health Centre, Mindhine Dispensary, Karogo Hospital, Sinaga School, Nomiya Church, Sagam Mixed Secondary School, Ahono Primary School, Jina Church, St. Paul's Jina Secondary School, Yala Trinity Education Centre, Yala Town Main Altar, Yala Tree Nursery, Gem Yala

Assembly Nineveh, Yala Sub-County Hospital, and Bar Sauri Health Centre.

Maseno University's Odera Akang'o Campus and the Church of Christ in Africa (CCA) Yala fall within the 70-metre SGR wayleave corridor and will therefore require reinstatement or relocation.

Figure 60: Odera Akango Campus

In Ugunja subcounty, within a radius of 1.5km the SGR project passes in close proximity to Amburuni Waterfalls Conservancy and Uhuyi Dispensary.

6.5.4.2 Demographic Profile

This section gives information on population size and composition; population density and distribution, population projection for special age groups and demographic dividend potential as shown in **Table 57** below.

Table 57: Population Projections (by Sub-County and Sex)

Sub County	Census (2019)			Population (2025)		
	Male	Female	Total	Male	Female	Total
Gem (Wagai & Yala)	66,142	71,619	138,031	74,430	80,897	155,327
Ugunja	80,484	87,630	168,114	90,568	98,610	189,178
Ugenya	52,900	58,732	111,632	59,530	66,092	125,622
Alego/ Usonga	65,136	75,195	140,331	73,298	84,617	157,915
Rarieda	50,821	56,341	107,162	57,195	63.408	120,603
Bondo	41,465	44,511	85,976	46,660	50,088	96,748

Source: KNBS Kenya Demographic and Household census-2019

Population distribution in the areas traversed by the SGR in Gem Yala and Ugunja Sub-Counties is shaped by factors such as resource availability, existing infrastructure, economic opportunities, and migration patterns within and outside the county. These drivers create variations in population density across the sub-counties.

The SGR project is expected to influence settlement patterns by stimulating commercial and industrial growth around station areas, attracting new investments, and increasing population density. Improved connectivity and job creation will likely boost land values and support the development of new commercial hubs, better social amenities, and enhanced access to services.

However, potential negative impacts such as displacement, noise, visual intrusion, and environmental concerns may alter traditional settlement structures and social dynamics. Careful planning and mitigation will be necessary to manage these risks.

Population by Urban Areas

The most populous urban centers are Siaya, Bondo, Usenge and Ugunja. The demographic data will assist in urban planning and investment in housing development, health care services, employment creation, water and sanitation, social amenities and utilities expansion of road network and other related infrastructure. **Table 58** below gives population projections for urban centers in Siaya County.

Table 58: Population Projections by Urban Centre

Urban Area	Census (2019)	2022 (Projection)	Projection (2025)	Projection (2027)
Siaya	33,133	34,714	36,600	37,915
Bondo	22,694	23,777	25,069	25,969
Usenge	7,975	8,355	8,809	9,126
Ugunja	7,060	7,396	7,798	8,079
Sega	4,172	4,371	4,608	4,774
Nyandiwa Beach	4,033	4,225	4,455	4,615
Ndori	3,770	3,949	4,164	4,314
Yala	3,237	3,391	3,575	3,704
Sigomere	1,527	1,599	1,686	1,747
Ukwala	1,346	1,410	1,486	1,540
Ragengni	457	478	504	522

(Source: KNBS)

The dominant community in Gem and Ugunja Sub-Counties is the Luo. Minority Luhya populations are present near the Vihiga and Kakamega borders, though their numbers remain small in Gem Yala and Ugunja. There are no displaced persons reported in either sub-county.

6.5.4.3 Economic Profile

Siaya County's economy is largely supported by subsistence agriculture and fishing, which remain the main sources of income and employment for most households. Although the county's industrial and service sectors are gradually expanding, climate change and environmental degradation continue to threaten these traditional livelihood systems.

In Gem Yala and Ugunja Sub-Counties, a substantial portion of the population works in the informal sector particularly in trade, micro-enterprises, and small businesses. These opportunities, while essential for youth and low-income earners, often provide low wages and limited formal support. Casual farm laborers earn about Ksh 300 per day. To strengthen the informal sector, ongoing efforts focus on skills training and facilitating access to mobile-based pension and savings platforms.

In Gem Yala, key livelihood activities include livestock keeping (dairy, poultry, goats, and sheep), subsistence crop farming, fishing along the Yala River, and small-scale trade. Ugunja Sub-County similarly depends on rain-fed agriculture and mixed farming, with common crops such as maize, sorghum, beans, bananas, and potatoes. Other important activities include boda boda transport, brick making, and informal trading.

Fishing

Fishing is an important source of livelihood as the county is among those along the Lake Victoria riparian. Available statistics on fisheries showed that Siaya County accounted for the second highest total weight of fish caught in Lake Victoria at 32.32 per cent as shown in **Figure 61** below.

Gem and Ugunya Sub Counties does not boarder Lake Victoria but residents are engaged in fish farming. There is no fish farm within the 70m SGR wayleave corridor.

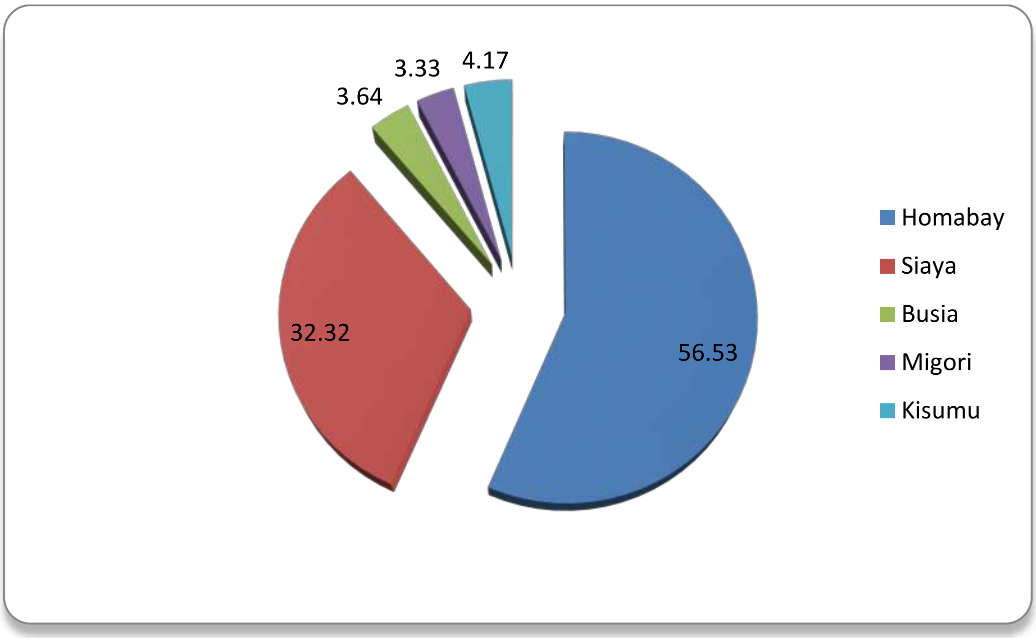


Figure 61: Percentage of fish from Lake Victoria for different counties

Source: State Department for Fisheries (2024)

Agriculture

About 60% of household income and 61% of employment opportunities come from subsistence farming. This includes crops like maize, rice, cotton, coffee, and various vegetables. Gem Yala and Ugunja Sub-Counties are traversed by the proposed SGR line and are known for their diverse agricultural activities. Maize is the most dominant crop, serving as the staple food for households. Other crops grown include beans, groundnuts, bananas, and various agro-forestry trees. Farmers are also adopting climate-smart agriculture practices like mulching and composting to improve soil health and crop yields, particularly in response to climate change impacts.

Livestock and poultry farming are significant economic activities in GemYala and Ugunja Sub counties with a focus on dairy cattle, local poultry (especially indigenous chicken), and small livestock like sheep and goats. There is a growing commercial interest in indigenous poultry, leading to changes in farming practices such as improved housing, increased use of commercial feed, and the rise of local hatcheries. County efforts, including extension support and seed funding, aim to professionalize the sector, empower farmers, increase flock sizes, and transform poultry farming into a scalable, profitable enterprise that enhances household incomes and nutrition.

6.5.4.4 Land tenure and land use

Siaya County's land tenure and land use are governed by a combination of customary practices, statutory laws, and county-level development plans.

Land Tenure

The County's land tenure system combines customary land rights with formal legal structures, including public, communal, and individual ownership (freehold and leasehold), especially in urban areas. In the SGR corridors of Gem Yala and Ugunja, women face major barriers to land ownership due to cultural practices, resulting in extremely low title registration—only about 3% of land titles in Siaya County were held by women in 2018. Despite legal provisions for equal property rights, discriminatory norms, particularly affecting widows, limit women's access to and control over land. Ongoing initiatives by local organizations and the County Assembly aim to address these inequalities through legal education, advocacy, and gender-responsive reforms.

Land Use

Land use in Siaya County is predominantly agricultural, supported by various other uses such as urban development, vegetation cover, wetlands, and water bodies like Lake Victoria and River Nzoia. Within the 70m SGR wayleave corridor, only Maseno University's Odera Akang'o Campus and the Church of Christ in Africa (CCA) Yala fall inside the project footprint, with no other settlements affected.

Key county-wide land uses include crop farming, livestock keeping, urban growth (residential, commercial, and institutional areas), forest and shrubland cover, wetlands such as Yala Swamp, and major water bodies.

In the project areas:

- Gem Subcounty: Land use is mainly subsistence farming, livestock keeping, fishing, small-scale trading, and localized gold mining in Ramula. Transport infrastructure such as roads and the meter-gauge railway is also present.
- Ugunja Subcounty: Land use is primarily agricultural and residential, largely on communal land, consistent with typical rural land use patterns. Roads constitute the main transport infrastructure.

Additional land uses across both sub-counties include mixed residential commercial zones and recreational spaces such as sports fields and playgrounds. **Figure 62** below shows Siaya County land use classification.

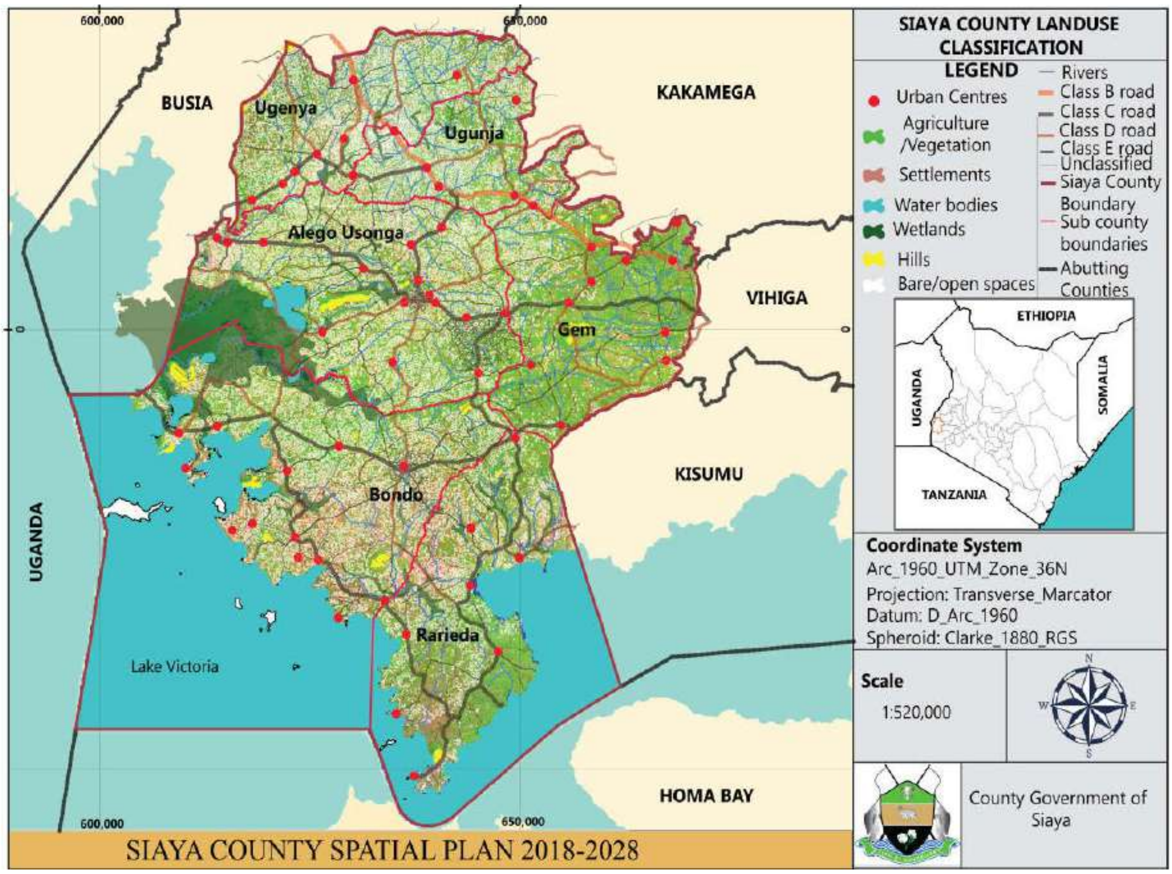


Figure 62: Siaya County land use classification

Women's Access to Land and Inheritance

In the two sub-counties, just like in other parts of the country, women face significant challenges in accessing and inheriting land and property due to deeply entrenched patriarchal customs and practices. While legal frameworks exist to protect women's land rights, including the Constitution, National Land Policy, and various land laws, discriminatory customary practices often undermine these protections. This leads to women having limited ownership and control over land, impacting their economic empowerment and livelihoods.

6.5.4.5 Education

Siaya County had a number of educational facilities both public and private. The institutions comprise of pre-primary, primary, secondary and tertiary institutions. The major type of school within is mixed school followed by boys' school and girls' school the least. The average maximum distance to educational facilities is 5km with a majority of the facilities located at an average of 2 km.

Some schools within Gem Yala subcounty where children of the SGR workers may attend include Yala Township Primary, Anyiko Primary, Sagam Primary, Jina Primary, Bar Turo Primary, Gogo Primary, Got Kokwirii Primary, and Ndere Primary among others. Secondary schools the children of SGR workers may attend include Inuka Mixed Boarding Secondary Academy, St.Mary's Yala, Nyamninia Secondary, Sagam Mixed Secondary, Sinaga Girls Secondary, Nyawara Girls Secondary school among others.

The public schools and the facilities affected by the proposed SGR Phase 2C project are Maseno University's Odera Akang'o Campus, ACK Diocese St. Marys Girls School, Yala and Gok, ACC's Office, Yala.

Table 59 Below shows learning institutions that are within 1.5km from the proposed SGR wayleave corridor.

Table 59: Learning Institutions within 1.5km from the wayleave corridor

S/NO	Learning Institution
1	Ahono Primary School
2	Sagam Mixed Secondary School
3	Sinaga Girls Secondary School
4	Jina Seconadry School
5	Mindhine Primary
6	Jina Primary School
7	Odera Akang'o University Campus (is within the wayleave corridor)
8	Yala Township Primary
9	St. Mary's School Yala
10	Anyiko Primary School
11	St. Teresa Primary School
12	Yala Trinity Education Centre
13	Bar Sauri Primary School
14	Makwara Primary School

6.5.4.6 Health

Siaya County offers a range of medical services and health facilities, including hospitals, health centers, and dispensaries. These facilities provide a variety of services, from basic outpatient care to specialized procedures like surgery and radiology. The county also focuses on preventative and promotive health interventions, including immunization and maternal health services.

Key Health Facilities in Siaya County

- Siaya County Referral Hospital: A major referral hospital providing a wide range of medical services.
- Bondo County Referral Hospital: Another major referral hospital serving the region.
- Yala Sub-District Hospital: A key sub-county hospital providing essential services.
- Various Health Centers and Dispensaries: Located throughout the county, providing basic healthcare services at the local level.

In Gem Yala Subcounty, major health facilities include Yala Subcounty Hospital, Malanga Health Centre, Nyawara Health Centre, and Sagam Community Hospital. No health facilities fall within the 70m SGR wayleave corridor. According to the Siaya County CIDP (2023–2027), the doctor–patient ratio is 1:68,126 in Gem and 1:118,315 in Ugunja, indicating limited access to medical personnel.

Along the SGR project corridor, the key health facilities are Sagam Community Hospital and Yala Subcounty Hospital.

Both Gem Yala and Ugunja experience significant public health challenges, with common diseases including malaria, tuberculosis, HIV/AIDS, and neglected tropical diseases such as lymphatic filariasis, trachoma, and schistosomiasis. These health issues are linked to factors like poor sanitation, waterborne parasites, and socio-economic vulnerabilities tied to agriculture and fishing livelihoods. **Table 60** below depicts the prevalent diseases and causes.

Table 60: Prevalent diseases and causes

Diseases	Cause
Lymphatic Filariasis	Parasitic worms transmitted by mosquitoes, leading to chronic inflammation and swelling
Trachoma:	A bacterial eye infection spread through contact with infected secretions, which can cause blindness.
Schistosomiasis	A parasitic disease transmitted by snails in freshwater, which can lead to serious complications.
Waterborne diseases	Poor sanitation, contaminated water, inadequate water treatment and poor hygiene.

Source: Ecoscience & Engineering Ltd ESIA Team Field Data, 2025

6.5.4.7 Utilities Facilities

Some of the facilities within the County include;

Water Infrastructure

According to the CRA Siaya County Data Sheet Report 2023 (**Figure 63**), only 5.5% of Ugunja Sub-County and 4.2% of Gem Sub-County populations have access to safe drinking water. Common water sources in the area include boreholes, protected wells, springs, rainwater harvesting systems, improved piped water supply, and Lake Victoria.

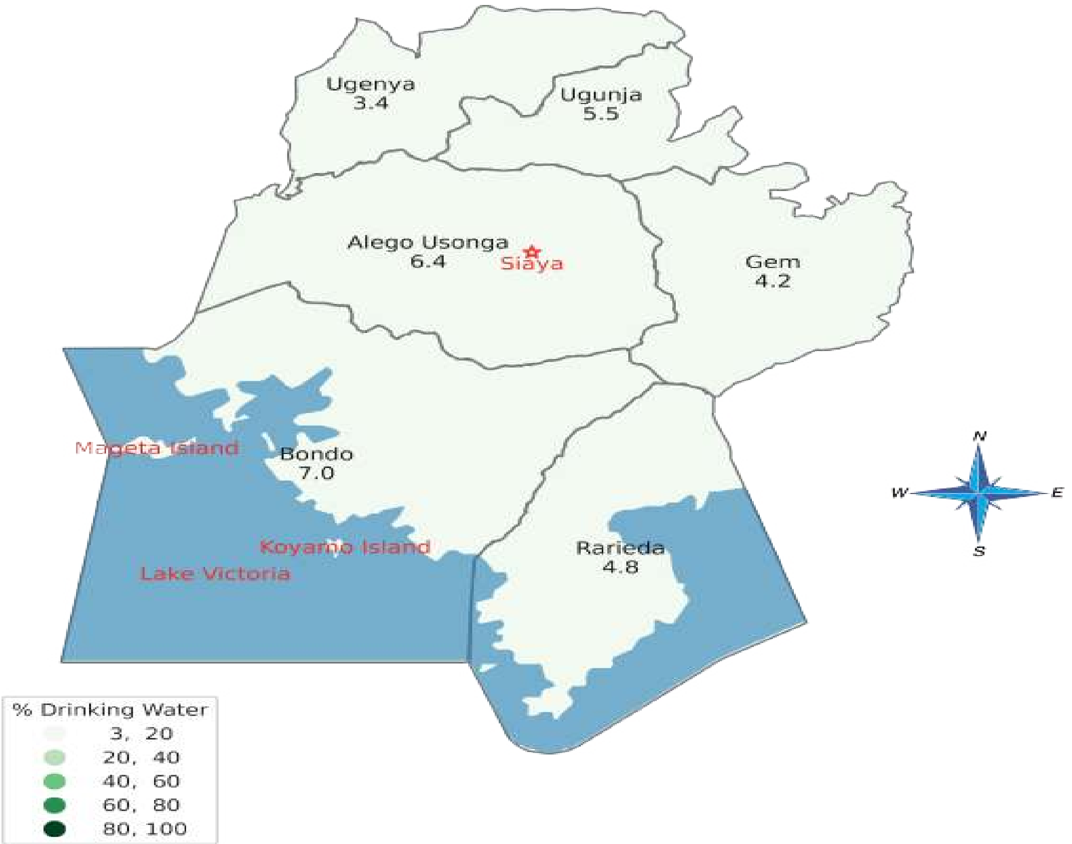


Figure 63: Households Accessing Safe Drinking Water 2019 (%)

Source: CRA Siaya County data sheet report 2023

Energy Infrastructure

According to Siaya County data sheet report 2023, the County has average of 19.6% of its total population accessing electricity, while Ugenya and Gem Sub Counties have a total of 15.5% and 19.5% of their population accessing electricity respectively. Some other sources of energy include solar power and kerosene.

Recreation Facilities and Tourism

Siaya County offers a variety of recreational activities and attractions, including natural sites like Lake Kanyaboli and Got Ramogi, Yala swamp, Usenge beach and Ndanu falls. Cultural sites like the Jaramogi Oginga Odinga Mausoleum, and opportunities for sports and community events

Other recreational activities and tourist attraction sites include:

- Boat trips and fishing on Lake Victoria
- Hiking trails and bird watching: Explore the county's natural beauty through hiking.
- Nature and wildlife areas including endangered Sitatunga antelope and diverse flora and fauna of Siaya.
- Open spaces as rehearsal grounds: Utilizing open spaces for artistic expression and community gatherings.

There is no cultural and heritage site within the SGR project wayleave corridor or station within Gem and Uguja sub-counties.

Cultural Heritage and Archaeology

Siaya County's culture and heritage are deeply intertwined with the Luo community, a prominent group in the area. The county preserves its rich cultural traditions through festivals, artifacts, and heritage sites like the Jaramogi Oginga Odinga Mausoleum. Additionally, the county actively works to promote its cultural heritage through initiatives like the Piny Luo Cultural Festival and public participation meetings on heritage sites.

Key Aspects of Siaya County's Culture and Heritage:

- Luo Community: Most of the Siaya County's population is comprised of members of the Luo community, a strong cultural influence on the region.
- Cultural Festivals: The Piny Luo Cultural Festival showcases the county's cultural heritage through various displays and performances.
- Notable People: Jaramogi Oginga Odinga, a prominent figure in Kenyan politics, is associated with Siaya County, and his mausoleum is a key heritage site.
- Artifacts and Traditions: Traditional Luo weapons, like spears and shields, and personal artifacts of figures like Jaramogi Oginga Odinga are displayed to highlight the community's history and craftsmanship.

The proposed SGR project passes very far away from these sites except Ndanu Water falls which is 600m away.

6.5.4.8 Housing and Settlement Characteristics

The project area of Gem Yala and Ugunja are characterized by their reliance on subsistence farming, livestock keeping, and fishing. Housing and settlements likely consist of traditional structures and agricultural-focused layouts, influenced by the regions warm, rainy climate and seasonal rainfall patterns.

The areas housing and settlement Characteristics are:

- Agricultural Focus - Settlements are integrated with agricultural activities, with homes often surrounded by farms.
- Traditional Materials - Housing consist of traditional materials and structures common in rural Kenya, reflecting the local environment and economy.
- Climate Influence - The warm climate with distinct wet and dry seasons has influenced housing design and the type of agricultural activities that can be sustained.

6.5.4.9 Cross cutting issues

Cross-cutting issues in Gem and Ugunja sub counties include the environmental impact of unsustainable fishing practices like harvesting fingerlings, which threatens biodiversity and the wetland food chain; the need for climate-resilient development across all sectors; managing resource dependency on the River Yala and River Nzoia for subsistence farming, livestock; and addressing the complex relationship between these economic activities and their ecological consequences.

6.5.5 Kakamega County

Overview

Kakamega County is the largest devolved unit in Western Kenya, consisting of 12 sub-counties: Butere, Kakamega Central, Kakamega East, Kakamega North, Kakamega South, Khwisero, Lugari, Lurambi, Likuyani, Malava, Matungu, Mumias East, and Mumias West. It shares borders with Vihiga County to the south, Siaya County to the west, Bungoma and Trans Nzoia Counties to the north, and Nandi and Uasin Gishu Counties to the east.

The County covers an area of 3,051.3 km^2. The proposed SGR Phase 2C project passes through Butere, Khwisero, Mumias West, and Matungu Sub-Counties. In Butere Sub-County, it traverses Malama South and Shainda Locations; in Khwisero Sub-County, Kisa Central and Shirombe Locations; in Mumias West Sub-County, Lureko, Masinjira, Buchifi, Bukaya, and Musanda Locations; and in Matungu Sub-County, Lunganyiro, Koyonzo, Nanyeni, and Indangalasia Locations. At the sub-location level, the alignment touches Masaba, Shibembe, and Bubala in Butere; Lureko, Matawa, Masinjira, Buchifi, Bukaya, Musanda, and Bungasi in Mumias West; Mundeku and Ikomero in Khwisero; as well as Lunganyiro, Koyonzo, Nanyeni, and Indangalasia in Matungu. The administrative units are shown in

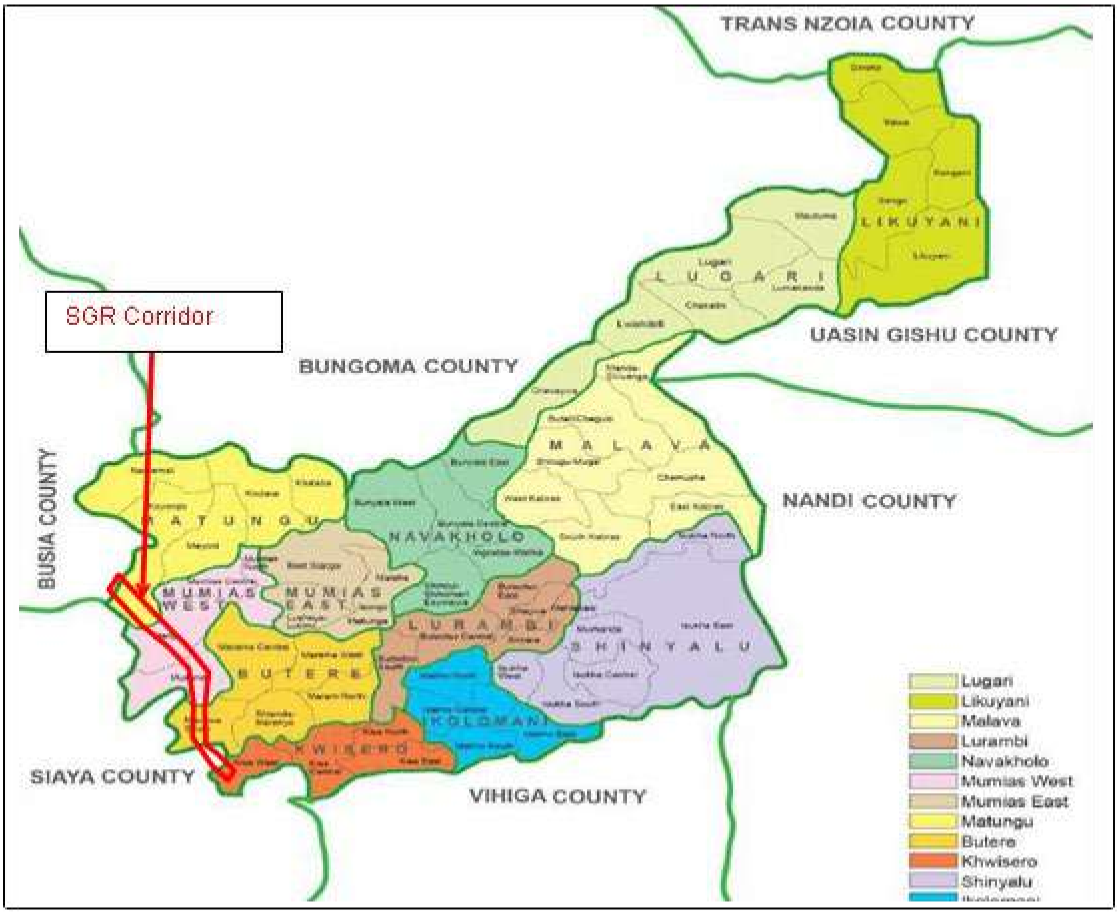


Figure 64: Administrative units of Kakamega County

6.5.5.1 Administrative Profile

The county is divided into thirteen (13) Sub Counties, one hundred and six (106) divisions, two hundred and seventy-four (274) sub-locations as indicated in the **Table 61** below. The proposed SGR project passes through 4 Sub Counties namely Khwisero, Butere, Mumias West and Matungu Sub Counties.

Table 61: Sub counties within Kakamega County

S/ No	Sub County	No. of divisions	No. of locations	No. of sub locations	Area (Km)^2
1	Likuyani	2	4	13	302
2	Lugari	2	6	10	265.8
3	Matete	2	4	8	101.2
4	Malava	5	16	56	427.2
5	Navakholo	4	12	24	258
6	Lurambi	2	5	15	161.7
7	Ikolomani	2	10	25	142.6
8	Shinyalu	2	6	23	445.5
9	Mumias east	2	9	19	149.2
10	Mumias west	2	6	11	165.3
11	Matungu	2	9	20	275.8
12	Butere	3	12	30	210.4
13	Khwisero	2	7	20	145.6
	Total	**32**	**106**	**274**	**3051.30**

Source: Kakamega County CIDP 2023-2027

6.5.5.2 Demographic Profile

According to the 2019 Kenya Population and Housing Census, Kakamega County had a population of 1,867,579 (48% male, 52% female). Malava Sub-County had the highest population (238,330), while Shinyalu had the lowest (111,743). With an intercensal growth rate of 1.2%, below the national average, the population is projected to reach 1,967,370 in 2022, 2,072,565 in 2025, and 2,138,415 by 2027. The county is predominantly inhabited by Luhya ethnic groups, including Batsotso, Wanga, Idakho, Isukha, Kabras, Kisa, Marama, Banyala, Bukusu, Maragoli, Banyole, and Tachoni.

The SGR Phase 2C project traverses Khwisero, Butere, Mumias West, and Matungu Sub-Counties, passing near several schools, health centers, and churches, with only Emuberi Primary School located within the 70m wayleave corridor.

Population distribution in these sub-counties is influenced by agricultural opportunities (particularly sugarcane farming), access to education, employment, housing, infrastructure, topography, climate, and cultural factors. The SGR project is expected to influence settlements through economic growth, improved infrastructure, and job creation during its construction phase. **Table 62** depicts the population distribution within project area.

Table 62: Population distribution within project area

Sub-County	Location	Sub-Location	Population Projections		
			2019	2025	2030
Butere	Malama South	Masaba	4,823	5,344	5,825
		Shibembe	5,299	5,871	6,400
	Shianda	Ebubala	3,417	3,786	4,127
Khwisero	Kisa Central	Mundeku	5,298	5,870	6,399
	Eshirombe	Ikomero	5,525	6,122	6,673
Mumias West	Lureko	Lureko	5,914	6,553	7,143
		Matawa	11,077	12,273	13,378
	Masinjira	Masinjira	8,996	9,968	10,865
	Buchifi	Buchifi	10,572	11,714	12,768
	Bukaya	Bukaya	5,721	6,339	6,909
	Musanda	Musanda	10,190	11,291	12,307
		Bungasi	7,815	8,659	9,438
Matungu	Lunganyiro	Lunganyiro	8,616	9,547	10,406
	Koyonzo	Koyonzo	11,871	13,153	14,337
	Nanyeni	Nanyeni	7,068	7,831	8,536.
	Indangalasia	Indangalasia	7,122	7,891	8,601

Source: KNBS Population and Housing Census 2019

Vulnerable Groups

Vulnerable groups in the county include those experiencing poverty, young girls, women, individuals with disabilities, the elderly, widows, child-headed households, and those affected by HIV/AIDS. Additionally, adolescents and youth, particularly those transitioning from education to the workforce, are also considered vulnerable due to potential challenges in accessing employment and income opportunities

6.5.5.3 Economic Profile

Kakamega County's economy is heavily reliant on agriculture, with over 80% of the population engaged in farming and related activities. The county's Gross County Product (GCP) is also significantly influenced by agriculture, accounting for over 52%. Key agricultural products include sugarcane, maize, beans, cassava, and bananas, with sugarcane being a major cash crop. The county also has a significant livestock sector, with cattle being the most population.

According to Kenya Institute for Public Policy Research and Analysis (KIPRA) Policy Brief No. 42/2023-2024, Kakamega County contributes on average 2.2 per cent of the National Gross Value added with an average GVA of Ksh. 160,8925 million. The GVA per capita for Kakamega. County is Ksh. 86,152.15 with an average population growth of 1.8 per cent and overall poverty levels at 39.6 per cent. Kakamega County has shown a steady growth in GVA with an average growth rate of 4.32 per cent from 2013-2022 which is slightly lower than the national average growth of 4.37 per cent. The highest growth rate was experienced in 2021. The lowest growth rate was experienced in 2017.

The economy of the sub counties traversed by SGR project (Khwisero, Butere, Mumias West and Matungu) are driven by agriculture, livestock farming, and trade. Agriculture, particularly maize and sugarcane farming, is the main economic activity, with over 80% of the population engaged in it, according to the Kakamega County Directorate of Agriculture. Micro, Small, and Medium Enterprises (MSMEs) also play a significant role, and access to microfinance credit has been shown to positively impact their incomes and livelihoods.

Agriculture

Kakamega County's economy is largely driven by agriculture, particularly crop farming, which employs over 80% of the population and contributes significantly to the Gross County Product. While livestock farming is also present, it plays a smaller but important role in livelihoods, with many farmers practicing mixed crop-livestock systems.

Crop farming is the most prevalent type of agriculture, with a focus on maize and other cash crops. Livestock farming, including sheep, beef cattle, and poultry, is also important, especially for dairy production and eggs.

Khwisero, Butere, Mumias West and Matungu Sub Counties actively involved in agricultural production, with a focus on maize, bananas and other food crops, as well as some cash crops like coffee and Sugar cane.

Table 63 below indicates the number of households practicing different agricultural income generating activities.

Table 63: Households practicing different income streams

Sub County	Farming	Crop production	Livestock production	Aquaculture	Fishing	Irrigation
Butere	29,189	27,903	20,417	145	210	300
Khwisero	23,443	22,413	16,873	134	157	341
Matungu	30,321	29,385	20,844	269	257	440
Mumias West	19,375	18,603	12,604	114	177	215

Source: KNBS Kenya Population and Housing census, 2019

6.5.5.4 Land tenure and land use

Kakamega County operates under both freehold and leasehold systems, with most rural households relying on smallholder farms.
Land subdivision through inheritance has led to fragmentation, with many families farming on less than 0.5 acres. This limits agricultural productivity, reduces economies of scale, and undermines food security, especially in high-density areas like Mumias West where sugarcane farming competes with food crops.
Agriculture remains the county's main land use, with maize, beans, sugarcane, and groundnuts as key crops. Despite fertile soils, yields remain low due to declining soil fertility, continuous cultivation, limited inputs, and weak extension services.
Other land uses include settlements, businesses, infrastructure, and conservation areas such as the Kakamega Forest. However, deforestation, riparian encroachment, and unsustainable practices threaten ecosystems. Climate change through erratic rainfall, floods, and droughts further compounds these challenges, with smallholder farmers being most affected due to limited adaptive capacity.

Key Challenges in Land Tenure and Use

- Land fragmentation and diminishing farm sizes, limiting economies of scale and mechanization.
- Insecure land rights for vulnerable groups, especially women, youth, and persons with disabilities (PWDs), who often face barriers in inheritance, ownership, and decision-making.
- Encroachment on forest and riparian ecosystems, threatening biodiversity, water sources, and climate regulation.
- Declining soil fertility due to overuse, poor farming practices, and limited investment in soil conservation.
- Conflicts over inheritance, succession, and boundary disputes, which undermine social cohesion and delay productive land use.

6.5.5.5 Education

Table 64 below indicates the number of schools at different levels for the county.

Table 64: Distribution of schools and teachers

No. of Schools	Public	Private
ECDE centres	334	262
Primary schools	908	212
Secondary schools	420	23
No. of teachers	**Public**	**Private**

ECDE centres	1,886	841
Primary schools	10,664	1,825
Secondary schools	4,625	269
Pupils Teachers Ratio (PTR)	**Public**	**Private**
ECDE centres	63	34
Primary schools	49	19
Secondary schools	35	14

Source-CRA Kakamega County Data Sheet-2023

Learning institutions within 1.5km radius from the SGR wayleave corridor include Ebukutenga Primary, Namasoli Secondary, Shianda Primary, Boston School Butere, Eshikhungula Primary, Ebutsetse Primary School, Emauko Primary, Butobe Primary, Matawa Polytechnic, Ihonje Primary, Ebubaka Primary and Eshirumbe Primary. Emuberi Primary School and Masaba Primary are within the 70m SGR wayleave corridor.

6.5.5.6 Heath

Kakamega County provides a wide range of medical services and health facilities, including the level 5 Kakamega County General Hospital and a network of community health units.
The County has 374 health facilities spread across the 12 sub-counties. 7.2% of these are faith-based facilities (27) while 51.9% belong to the ministry of health (194). This leaves 1.3% under NGO's (5) and 39.6% listed as private facilities (148). **Table 65** below indicates the number of health facilities in sub counties to be traversed by the proposed project.

Table 65: Spread and management of health facilities within project area

Sub County	Ministry of Health	NGOs	Faith based organizations	Private organization
Butere	17	0	2	11
Khwisero	15	0	4	11
Matungu	12	1	1	13
Mumias East	13	0	1	10

Source: Labflow.com report

Common ailments

Some of the common ailments reported in the sub counties to be traversed by the proposed project is shown in the **Table 66** below. Malaria, diarrheal diseases, and respiratory tract infections. These are largely caused by poor sanitation and hygiene, contaminated water sources, poverty, and inadequate waste management, which foster the spread of infectious agents

Table 66: Some common ailments

Ailment	Butere	Khwisero	Matungu	Mumias West
Accidents	2,304	2,018	2,333	2,389
Confirmed Malaria	31,346	22,922	20,957	23,009
Diarrhoea	2,089	2,298	2,530	2,962
Disease of the skin	9,731	7,472	11,247	9,650
Dysentery	140	58	179	98
Malaria in pregnant woman	867	1,038	1,421	659

Malnutrition	100	81	155	13
Sexually Transmitted Infections	1,258	480	812	1,118
Urinary Tract Infection	1,907	1,822	1,384	1,587

Source: KNBS Kakamega County Statistical abstract

Health Facilities within the sub counties traversed by the SGR project include

- Khwisero Subcounty: Khwisero Level IV Hospital; Shamberere Health Centre, Shivanga Health Centre, Kuvasali Health Centre, Chombeli Health Centre, and Inyuu Health Centre. Dispensaries include Nyabikaye Dispensary, Muhaka Dispensary and Kanduti Dispensary. Medical centres include Bulimbo Medical Centre and Eliss Medical Centres. Mwihila Mission Hospital is a Faith-Based Hospital within the subcounty.
- Butere sub-county has several health facilities, including Butere Sub County Hospital and other public and private clinics and hospitals, as well as faith-based facilities.
- Mumias West subcounty health facilities where SGR workers and their families can seek medical services are Health Centres such as Mumias Model Health Centre and Bukaya Health Centre. Dispensaries include Eshikalame, Eshikulu and Nyapeta Dispensary. The sub-County has Mumias Level IV County Hospital.
- Matungu Sub-County has a network of 27 health facilities, including Matungu Sub-County Hospital, Mung'ungu Dispensary, and Namulungu Dispensary. Community Health Units include Matungu A, Matungu B, and Mayoni Community Health Unit, providing healthcare at the community level.

There is no health facility within the SGR wayleave corridor within Khwisero, Butere, Matungu and Mumias sub counties. The doctor to patient ration in the county is 6: 10,000. The health facilities within a radius of 1.5ksm from the SGR project corridor include Uhuyi, Buyemi and Vikunga Dispensaries.

6.5.5.7 Other Services

Energy

According to CRA Factsheet 2023, Kakamega County, the number of households accessing electricity in Kakamega County stands at 25.2% with Lurambi Sub County leading at 62.5% because uit hosts Kakamega Town, the county headquarters.

Other sub counties where the proposed project passes have different coverage include. Matungu(11.1%),Mumias West(29.6%),Khwisero(16.6%) and Butere(17%).

In the SGR project areas of Khwisero, Butere, Mumias West, and Matungu, sources of energy primarily revolve around traditional biomass, particularly wood fuel and other forms of biomass, due to widespread poverty and limited access to modern energy. Contributing factors to this reliance include high poverty rates, inadequate access to electricity from the national grid, increasing energy demand outpacing generation capacity, and the resulting deforestation due to intense biomass pressure, as noted in general Kenyan energy trends and Kakamega's challenges.

Water supply

Kakamega County's water supply is managed by the Kakamega County Water and Sanitation Company (KACWASCO), an agency of the County Government. KACWASCO extracts, produces, transmits, and distributes water to residents, and also manages wastewater treatment. The main water source for Kakamega Municipality is River Isiukhu, with both old and new intake systems, along with groundwater from boreholes.

Figure 65 below indicates percentage of households accessing safe drinking water. Amongst the Sub Counties where the proposed project will traverse, Mumias West has the highest percentage (11.9%), followed by Butere (4%), Khwisero (2.8%) then Matungu (1.2%)

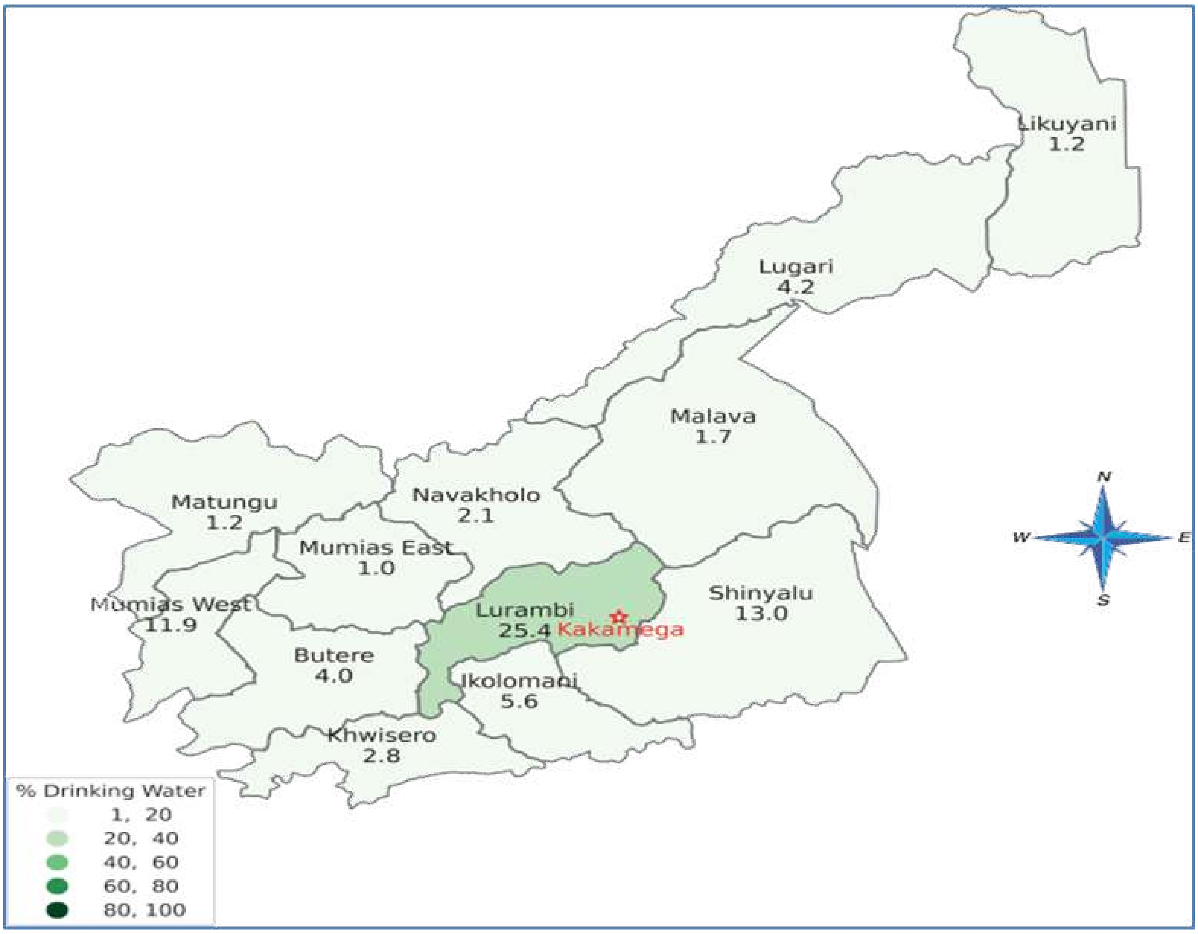


Figure 65: Percentage of Households with access to clean drinking water

Source: CRA Kakamega County Data sheet-2023

Water supplies in the SGR project areas of Khwisero, Butere, Mumias West, and Matungu regions primarily rely on surface water from rivers and groundwater from boreholes, with the River Lusumu serving as a major source for Mumias and environs. A joint Bukura-Butere-Khwisero Water Supply Project is also proposed to improve access in those areas. In Mumias West, a significant portion of residents already use improved sources, but the overall infrastructure, particularly in Matungu, requires further development and public awareness for water quality and sanitation.

- **Challenges in Accessing the Water**

Challenges in accessing water in Khwisero, Butere, Mumias West, and Matungu include poor sanitation and lack of access to safe drinking water, often attributed to inadequate infrastructure, the presence of unreliable water sources, and the impact of environmental factors such as droughts and deforestation.

- **Water Related Diseases**

Water-related diseases are a significant issue within the SGR project areas of Khwisero, Butere,Mumias West, and Matungu, due to poor access to potable water and inadequate sanitation. The common diseases include diarrhoea, cholera, typhoid, dysentery, and hepatitis A. These illnesses are spread through contaminated water, with studies showing E. coli and total coliforms in local water sources, often exceeding safe limits.

Transport and Communication Network

Kakamega County's transportation network includes a mix of road and railway infrastructure. The county has a road network, including national trunk roads and county roads, with ongoing maintenance and construction projects. Additionally, there are two airstrips, one in Kakamega and another in Mumias, and a railway line, though it is currently underutilized due to vandalism.

Road Infrastructure

- **Road Network:** Kakamega County has a mix of well-maintained and poorly maintained roads. Efforts are underway to improve the overall road network.
- **Road Construction:** Several road construction projects are ongoing, including the Lumakanda–Mwamba Road, Ebukwala–Khukolomani Road, and others across different sub-counties.
- **National Trunk Roads:** The county is served by national trunk roads maintained by national road agencies.
- **County Roads:** County roads are developed and maintained by the respective county governments.

Other Transportation Facilities

- **Railway:** Kakamega County has a 30 km railway line with two stations, but it is rarely used due to vandalism.
- **Airstrips:** The county has two airstrips, one in Kakamega and another in Mumias, which could be upgraded and expanded.
- **Public Transportation:** The county has a system of public transportation, including bus services and shuttles.

Transport scenarios in Khiwisero, Butere, Mumias West and Matungu involve limited road infrastructure in some areas, reliance on public transport (matatus and bodabodas), increasing private vehicle ownership, and specific challenges related to rural accessibility and connection to larger urban centers like Kakamega Town and Kisumu.

These areas transport scenario involves long-distance bus travel to and from major cities like Nairobi and Kisumu, with journeys taking several hours depending on traffic and road conditions, and local transport dominated by buses and private vehicles, connecting Mumias, Matungu, Butere and Khwisero to surrounding areas.

Communication Services

Communication services within the SGR project areas of Khwisero, Butere, Mumias, and Matungu subcounties are generally provided by telecommunication companies for mobile and internet services such as Safaricom and airtel.

iv) Housing and Settlement Characteristics

Housing and settlement in Khwisero, Butere, Mumias, and Matungu are characterized by a rural-to-urban shift, agricultural-dominated economies, and a mix of formal and informal settlements, with Mjini in Mumias being an example of a high-density informal settlement. Sugarcane farming is a major economic activity influencing settlement patterns, while the urban center of Butere serves as a former district capital with a significant urban population. Settlements vary from agricultural homesteads to informal urban areas with challenges in housing and infrastructure.

Settlement Characteristics

- Rural and Agricultural Focus: A significant portion of the population lives in rural areas, relying on agriculture, especially sugarcane production, for their livelihoods.
- Informal Settlements: Urban areas, like Mjini in Mumias, feature informal settlements characterized by high population densities and dense, often sub-standard, housing conditions.
- Mixed Housing Types: Settlements include agricultural homesteads, commercial centers, and urban residential areas, with varying housing quality.

Housing Characteristics

- Agricultural Dwellings: Many households in rural areas are traditional homesteads, often with surrounding land for farming activities.
- Informal Urban Housing: In areas like Mjini, informal settlements consist of dense housing, typically constructed from affordable and often impermanent materials, to accommodate the high population density.
- Formal Urban Housing: Butere, as a former district capital, has a greater concentration of formal residential housing in its urban core and surrounding areas, in addition to the informal settlements.

6.5.5.8 Crossing Issues

Cross-cutting issues in the SGR project areas of Khwisero, Butere, Mumias, and Matungu sub counties include Gender based violence, PWDs, Climate change, high poverty rates, food insecurity, which affect the region's agricultural landscape and overall development. Below are some of the common Challenges:

- **Gender Based Violence** - Kakamega has high incidences of Gender-Based Violence (GBV). For example, between January and April 2022, the county recorded about 4,426 GBV cases, with Shinyalu Sub-County leading. Teenage pregnancy has been a major concern. But there has been progress: teen pregnancies dropped by ~38.7% from 2020 (14,768 cases) to 2023 (9,048 cases). The County Government has taken legal and institutional steps: MoUs to combat GBV and teenage pregnancy, free legal services for GBV survivors, rescue centres and shelters, and efforts to fast-track relevant policy bills.
- **Persons with Disabilities (PWDs)** - A baseline survey in 2018/19 showed ~19,000 PWDs identified (in terms of household count etc.), with many households having at least one

PWD. County has allocated significant funding: e.g. KSh 60 million to support PWDs (wheelchairs, crutches, assistive support, etc.). Over 49,000 beneficiaries in 12 sub-counties identified. There are outreach programs to assess, register, and issue disability certificates for PWDs in rural / hard-to-reach areas. The county also offers waivers for licence fees for trade activities for PWDs, and there are plans to ensure health facilities have sign language interpreters.

- **HIV/AIDS** - Prevalence & Trend: As of 2018, Kakamega's HIV prevalence was ~4.5% (female ~5.6%, male ~3.4%). New infections have dropped: e.g., from ~6.6% in 2021 to ~3.2% in 2022 for new HIV infections among youth etc. But youth (especially ages 15-24) remain a high-risk group in terms of new infections. County has a policy framework: Kakamega HIV/AIDS & STI Control Policy 2020-2030. It aims to reduce new infections, HIV-related mortality, stigma, and mother-to-child transmission, among other goals.
- **Climate Change** - Signs of climate impacts: seasonal agricultural drought in Kakamega South; erratic weather patterns, reduced rainfall in some seasons, flooding in others; declining water levels in springs/streams; loss of soil fertility.
- **Food Security** - Approximately 33% of households in Kakamega County face food insecurity. Around 60% of households are unable to access minimally diverse diets. Challenges affecting food security include small land holdings (often ≤ 0.5 acres), low yields, overreliance on staple crops, limited non-food crop income, and market dependency for food staples.
- **Poverty Levels** - Kakamega is among the counties with the highest poverty incidence in Kenya. At about 49.2% of the population lives below the poverty line. More than 809,500 people in the county are estimated to be living in poverty under that measure. In Mumias West sub-county, a survey found that ~16% of households did not have enough income even for basic food energy requirement; an additional ~5% met the food energy requirement but were too poor to afford essential non-food items (education, clothing, etc.). (*Sourced from Kakamega county website*)

6.5.5.9 Cultural Heritage and Archaeology

Kakamega County's cultural heritage includes designated heritage sites like Nabongo Shrines/ cultural centre (see **Figure 66** below), Mawe Tatu Hills, Misango Hills, and Lugai stones and caves, as well as traditions like Isukuti dance and music, and Isikuti ceremonies. The county government is working to document and preserve these sites and traditions for future generations.

a) Heritage Sites

- Nabongo Shrines: These shrines, located in Matungu and Mumias East, are important cultural and religious sites.
- Mawe Tatu Hills: These hills, located in Likuyani, are a designated heritage site.
- Misango Hills: Located in Khwisero, these hills are another important heritage location.
- Lugai stones and Caves: Located in Malava, these are significant sites for their natural and cultural features.
- Kambiri Hills: Located in Shinyalu, this is another designated heritage site.

Figure 66: Nabongo Cultural Centre, Eshiembekho-Matungu

Misango Hills and Nabongo shrines are 5kms and 9kms from the SGR project wayleave corridor respectively. Mawe Tatu Hils, Kambiri Hills and Lugai caves are not with the subcounties traversed by the SGR project.

b) Cultural Traditions

- **Isukuti:** This is a vibrant traditional music and dance form, often performed at celebrations and ceremonies.
- **Isikuti ceremonies:** These are important rituals and events that reflect traditional beliefs and practices.
- **Other traditions:** Kakamega also has a rich tapestry of other cultural practices, including bullfighting, pottery, and circumcision, which are important for passing down traditions to future generations.
- **Traditional cuisine:** The county is known for its unique and flavorful traditional dishes.

c) Tourism

Kakamega, Kenya, offers diverse tourist attractions, including the unique Kakamega Forest, a tropical rainforest ith rich biodiversity. Other notable sites include the Crying Stone of Ilesi, cultural centers like the Nabongo Cultural Center, and opportunities for ecotourism, bird watching, and cultural tours. None of these are within the Sub Counties traversed by the proposed SGR project.

6.5.6 Busia County

6.5.6.1 Overview

Busia County has a population of 893,681, comprising 426,252 males and 467,401 females. The sub-county populations are: Teso North – 138,034, Teso Central – 168,116, Nambale – 111,636, and Butula – 140,334. With an annual growth rate of 2.2%, the county's population is projected to reach 1,090,290 by 2030, with Teso North at 168,401, Teso Central at 205,102, Nambale at 136,196, and Butula at 171,207. Covering a total area of 1,048 km², the county has an average population density of 570 persons per km².

Busia County holds strategic importance nationally and regionally due to its transboundary position, with key entry points including Busia Town (county headquarters), Sio Port, Port Victoria, Malaba Town (SGR corridor termini), and Lwakhakha at the northern border. Agriculture remains the main economic activity, dominated by sugarcane, bananas, maize, sorghum, groundnuts, and other food crops. The county is also a hub for cross-border trade, attracting large populations to border towns like Busia and Malaba. Limited rural economic opportunities have led to increased migration toward urban centers within and outside the county.

6.5.6.2 Administrative Profile

These sub-counties are further broken down into 10 divisions, 60 locations, 181 sub-locations, and 120 villages.Teso South is the largest administrative unit at 299.6 sq. km. The county headquarters are in Busia Town, Matayos Sub-County.

Busia is diverse county, primarily inhabited by the Luhya (Abakhayo, Abamarachi, Abasamia, Abanyala sub-tribes) and Teso communities, alongside other groups like the Luo, Somali, Kisii, and Kikuyu.

The county's economy mainly relies on agriculture, fishing, and trade. Small-scale agriculture is prevalent, with sugarcane cultivated for commercial purposes and cotton and tobacco as cash crops. Subsistence crops include maize, beans, sweet potatoes, millet, and cassava. Livestock farming is also practiced. Fishing, primarily for Nile perch and tilapia, thrives along Lake Victoria in the county's southern part. Busia also engages in cross-border trade at the Busia and Malaba borders, supported by its agricultural and fishing produce and a transshipment market. **Figure 67** shows the administrative units of Busia County.

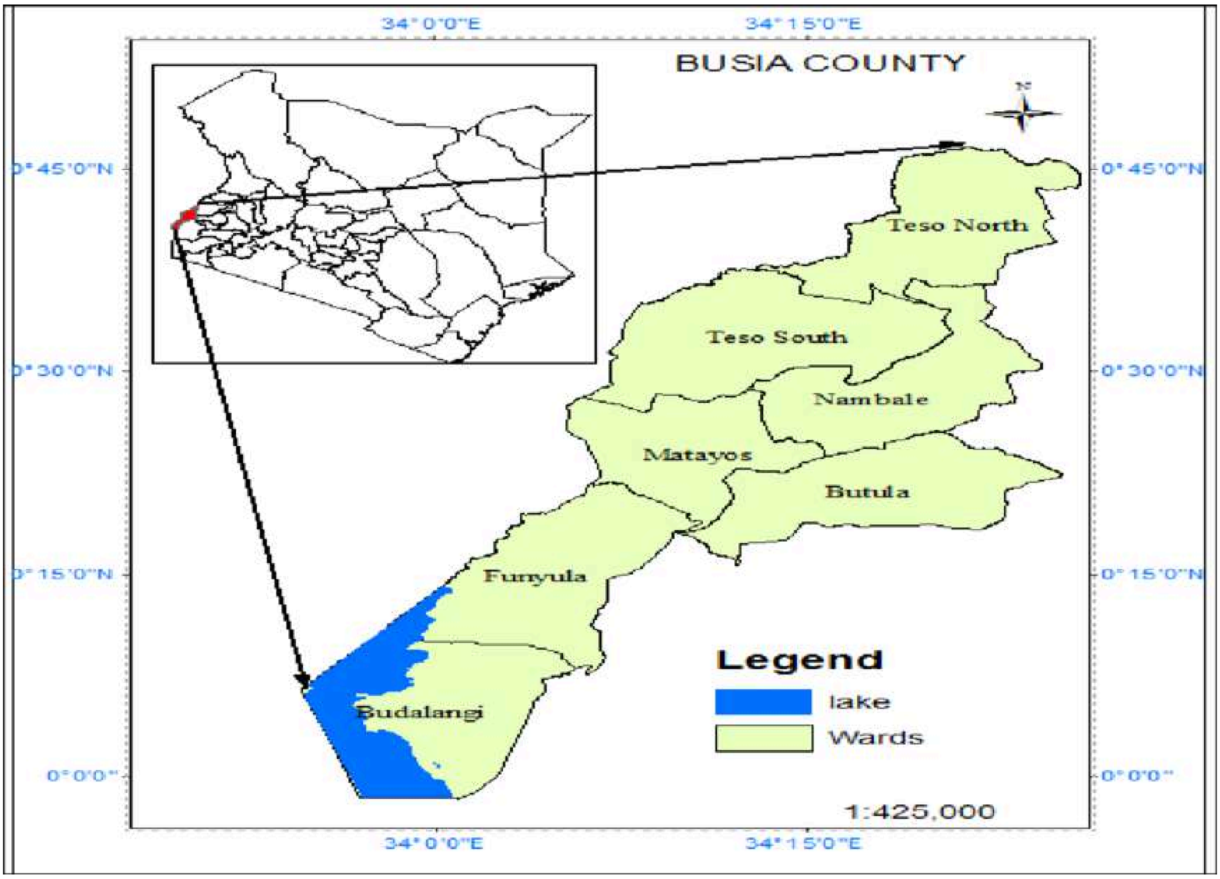


Figure 67: Administrative units of Busia County

6.5.6.3 Economic Profile

Busia County's main economic activities are agriculture, fishing, and trade, supported by a favorable climate. Key crops include maize, cassava, finger millet, beans, sorghum, rice, sweet potatoes, cowpeas, groundnuts, bananas, green grams, sesame, soya beans, cotton, tobacco, sugarcane, oil palm, and pepper. The county also produces horticultural crops such as pineapples, tomatoes, kale, cabbage, watermelon, local vegetables, papaya, amaranth, onions, and mangoes.

Fishing is significant due to proximity to Lake Victoria, which sustains species like Nile Perch and Tilapia. Being a key entry point between Kenya and Uganda, Busia and Malaba towns are major trade hubs for livestock, agricultural produce, and manufactured goods. The county has over 80 trading centers, including urban centers at Busia, Nambale, Malaba, Bumala, Funyula, Amagoro, Sio Port, Port Victoria, Butula, and Ang'urai, where most markets are open-air and largely unplanned, focusing on agricultural produce.

In Teso Central, Teso North, Nambale, and Butula, major crops are sugarcane, maize, groundnuts, sorghum, sesame, millet, and cassava. Livelihoods are supplemented by small-scale trading, quarrying, brick making, retail shops, boda boda transport, livestock farming, and cross-border trade due to proximity to Uganda.

6.5.6.4 Land Tenure and Land Use

Land in Busia County is predominantly under smallholder agriculture, with average farm sizes of about two hectares. The main food crops include maize, beans, cassava, millet, and sweet potatoes, while sugarcane, cotton, and tobacco serve as key cash crops. Livestock rearing and horticulture further supplement household incomes. Despite the county's strong agricultural potential, challenges such as land fragmentation, encroachment on wetlands, and growing pressure for settlement and non-agricultural use particularly around expanding market centres and border towns continue to strain land resources.

In Nambale Sub-County, the fertile dark clay soils support sugarcane, groundnuts, maize, sorghum, and cassava. Land is primarily under smallholder ownership with a mix of freehold and customary tenure. However, the declining profitability of sugarcane has driven farmers to diversify into food and horticultural crops. Persistent land subdivision and limited security of title have discouraged large-scale investment.

Teso North Sub-County relies heavily on rain-fed agriculture, with maize and beans as the main staples. Most land is held under customary tenure, though titling is increasingly common in peri-urban areas. The area faces tenure challenges such as boundary disputes, shrinking farm sizes, and limited access to land for youth.

In Teso South, farming remains the backbone of livelihoods, with households cultivating maize, sugarcane, and vegetables. Mechanized ploughing has been promoted to boost yields. While customary tenure still dominates, more land in market centres and along major roads has been registered. However, the rising demand for land for housing and trade is steadily reducing land available for farming.

Teso Central Sub-County follows a mixed farming system, with maize, cassava, and beans being the main crops. Land is largely held under customary arrangements, and fragmentation is widespread due to repeated subdivision through inheritance. Growing population pressure and rising settlement needs are placing additional strain on agricultural land.

In Butula Sub-County, flat plains and fertile soils support both subsistence and cash crop farming. Sugarcane, maize, and beans dominate production, with potential for horticultural expansion. Land tenure systems are mixed, but challenges persist, including small farm sizes, disputes over public land, and excessive subdivision. Encroachment into wetlands for cultivation has also emerged as a pressing concern, threatening land sustainability and ecosystem health.

6.5.6.5 Education

Busia County had a number of educational facilities both public and private. The institutions comprise of pre-primary, primary, secondary and tertiary institutions as shown in **Table 67** below. The major type of school within is mixed school followed by boys' school and girls' school the least. The average maximum distance to educational facilities is 5km with a majority of the facilities located at an average of 2 km.

Table 67: Schools within Busia County

Sub County	ECD	Primary	Secondary
Nambale	56	110	30
Malaba	47	94	28
Teso north	70	98	32

Teso south	51	88	27
Butula	49	89	25
Samia	38	79	31
Bunyala	56	81	28

Source: Busia County CIDP 2023-2027

There are two learning institutions which lie within the proposed SGR wayleave namely Machakusi Secondary School and Vision Hill Academy.

Other schools which are within 2kms radius from the SGR corridor are Kwangamor Primary School, Bukhuyi Secondary School, Makwara Primary School, Namaindi Primary School, Onunyur Primary School, Kosera Primary School, Papa Primary school, Musokoto Primary School, Mungatsi Technical Training Institute, Esidende Primary School, Kaludeka Primary School and Kamolo Primary School.

Gross enrollment in Vocational training centers increased from 3328 students in year 2018 to 4171 students in the year 2022 against the target of 3379 students, this increment from the baseline can be attributed to subsidized tuition fees to trainees, enhancement of Busia County Education Support Scheme and subsidized vocational training support grant that was disbursed to 24 public vocational training centers across the county to support the purchase of learning materials, tools and equipment.

In 2018, the Teacher-student ratio in the county's vocational training centers was 1:60. At the end of plan period, the ratio stood at 1:30 against a target ratio of 1:40. This can be attributed to the recruitment of 142 instructors to bridge the training gap and boost service delivery and quality of training in the VTCs. The table below shows the learning institutions with potential interaction with the SGR Phase 2C project. The **Table 68** below outlines the educational facilities that may potentially interact with the SGR Phase C project within Busia County.

Table 68: Educational facilities with potential interaction with the SGR project

S/NO	Educational Facility
1.	Kaludeka Primary School
2.	Kwangamor Primary School
3.	Kotur Primary School
4.	Gara Primary School
5.	Akapijan School
6.	Kamolo Primary School
7.	Akulony Primary School
8.	Tasosa School
9.	Kajei Secondary School
10.	Elwanikha Primary

6.5.6.6 Health

Busia County in Kenya offers a range of medical services and health facilities, including primary healthcare, clinical services, and specialized treatments. The county has a network of health facilities, including dispensaries, health centers, and a referral hospital, catering to diverse medical needs. Busia County has a network of 193 health facilities. There is no health facility within the SGR wayleave corridor in Busia County

Key Medical Services

- Primary Healthcare: Basic medical care, preventative health services, and management of common illnesses.
- Specialized Services: Includes specialized ANC (Antenatal Care), ophthalmology, orthopedics, and renal services.
- Inpatient and Outpatient Care: Provides both inpatient and outpatient services, including general outpatient, pediatric outpatient, and surgical outpatient clinics.
- Diagnostic Services: Includes radiology, laboratory services, and specialized imaging services like CT scans and ultrasounds.
- Maternal and Child Health: Offers antenatal care, postnatal care, newborn care, and services related to elimination of mother-to-child transmission of HIV (EMTCT).
- HIV/AIDS Services: Provides HIV counseling and testing, treatment, and risk reduction services.
- Rehabilitative Services: Includes physiotherapy and occupational therapy.
- Blood Transfusion Services: Offers blood transfusion services, including a satellite blood transfusion service.
- Family Planning Services: Provides various family planning methods.

Health Facilities

Busia County has a number of health facilities spread across the different sub counties as indicated in **Table 69** below.

Table 69: Number of health facilities within Busia County

Sub County	GOK	FBO	NGO	Private
Teso North	11	3	3	15
Teso central	18	1	3	12
Nambale	13	1	0	4
Butula	18	2	4	5
Matayos	17	0	0	34
Samia	12	3	1	2
Bunyala	9	0	1	1

Source (Labflow website, 2025)

Some of the notably hospitals include;

- Busia County Referral Hospital: A major referral hospital offering a wide range of medical services.
- Sub-county Hospitals: Provide a hub and spoke model for healthcare services, with sub-county hospitals serving as hubs for satellite health centers and dispensaries.
- Health Centers: Offer a range of services including primary healthcare, antenatal care, and family planning.
- Dispensaries: Provide basic healthcare services, often in rural areas.
- Community Health Units: Provide basic healthcare services at the community level.

- Faith-Based Facilities: A small percentage of health facilities are run by religious organizations.
- Private Facilities: A significant number of health facilities are private clinics and hospitals.

Some of the health facilities within the proposed project sub counties include;

- Butula Subcounty Health facilities: Butula Mission Health Centre, Khunyangu Sub County Hospital, Igula Dispensary, Mafubu Dispensary, Masendebale Dispensary, Buyingi Dispensary and Bwaliro Dispensary.
- Nambale Subcounty has health facilities: Nambale Sub-County hospital, Lupida, Syekunya, Nambale B, Nambale A and Nambale C.
- Teso Central Sub-County health facilities: Angurai Subcounty Hospital; Changara (GoK) Health Centre, Malaga Health Centre, Moding Health Center, Alupe Subcounty Referral Hospital,Ochude Dispensary, Obekai Health Centre and Katelenyang Community Health Unit.
- Teso North Subcounty Health facilities: Teso North Sub County Hospital, St. Mary's Health Unit Chelelemuk, Moding Health Centre and Kadinda Health Centre among others.
- Community Units include Koteko, Kengatunyi, Kiriko, Kokare, Kocholya, and Amagoro Community Health Units.

6.5.6.7 Utilities facilities

Busia County's utility facilities encompass various services and infrastructure aimed at improving the quality of life for its residents. These include water and sanitation, electricity, and transportation infrastructure.

Energy

In the SGR project area of Butula, Nambale, Teso Central, and Teso North sub-counties, the primary energy sources are biomass (especially firewood and agricultural residues for cooking) and grid electricity for households and businesses. Solar energy is also increasingly adopted for lighting and power, particularly in rural areas. The main contributing factors to these energy sources are the abundance of biomass from agriculture and forests, the availability of grid electricity in trading centers, and the promotion of renewable energy through solar technologies.

- Biomass (Firewood & Agricultural Residues): This is a major energy source, particularly for households, due to its availability in the agricultural landscape of Busia County.
- Grid Electricity: Grid electricity is the primary source of energy in urban and commercial centers and is expanding to more rural areas.
- Solar Energy: Solar energy, through panels and systems, is a growing renewable source, especially for lighting and small-scale power needs in off-grid and rural households.
- Kerosene/Paraffin: Kerosene is still a significant energy source for lighting in many households, especially where grid electricity is unavailable.

Water and Sanitation

Residents of Busia County rely on a variety of water sources, including piped water, protected wells, boreholes, kiosks, and rivers. While piped water is common in urban centers, households also use improved sources like boreholes and protected wells, as well as less reliable sources such as rivers.

In Butula, Nambale, Teso Central, and Teso North Sub-Counties, water primarily comes from surface water (e.g., the Sio and Malaba Rivers) and groundwater from boreholes. Efforts to improve access include the development of new water supplies and the expansion of existing systems, with the Lake Victoria North Water Service Board (LVNWSB) and the Busia County Government playing key roles.

- Surface Water: The Sio River flows through Nambale and other sub-counties, serving as a major water source.

- Groundwater: High-yielding boreholes are being developed to increase water access for residents.

Challenges in these sub-counties include prolonged dry spells that reduce water availability, waterborne diseases, and inadequate infrastructure, such as limited piped schemes and poorly functioning boreholes. Additional issues include poor management of water catchments and riparian zones, which further constrain water access for communities.

Transport and Communication Network

Busia County's transportation system primarily relies on road networks, with ongoing efforts to improve road quality and infrastructure, including upgrading roads to bitumen standards and maintaining existing ones. The County is an important corridor to Uganda where lots of trucks transport goods to and from Uganda as indicated in **Figure 68** below.

Road Network **-** Busia County has a network of both paved and unpaved road. The proposed SGR project will cross Bumala-Mayoni road, Busia-Nambale road and Busia-Malaba road among other murram roads.

Communication services within Teso North, Teso Central, Nambale and Butula sub-counties are provided through mobile network providers and internet services, with residents relying on national Kenyan operators like Safaricom, Airtel Kenya, and Telkom Kenya for calls, data, and other telecommunications

Figure 68: A fleet of trailers at Malaba boarder

Cultural, Recreation and Tourism

Busia County offers a variety of recreational activities and tourist attractions, including cultural centers, natural landscapes, and sports facilities. Key highlights include:

- Kakapel National Monument: This site is known for its historical significance and also offers hiking opportunities with views of Mt. Elgon, Tororo rocks in Uganda, and Siaya plains.
- Museum of Teso Culture - Located in Amagoro Town, this museum is dedicated to preserving and showcasing Teso culture.
- Mauko Cultural Centre - This center focuses on promoting and preserving the local culture. These cultural and historical sites are more than 10kms from the SGR wayleave corridor.
- Lake Victoria Beaches - The county's location on Lake Victoria offers opportunities for enjoying the shoreline and water activities.
- Samia Hills - These hills are known for their scenic views and are a popular destination for hiking.
- Hiking - The Chelelemuk hills offer hiking with views of Mt. Elgon and Siaya plains.
- River Sio - This river provides another natural attraction and recreational area.
- All these natural attractions are more than 15kms from the SGR wayleave corridor**.**

All the above Busia cultural heritage sites are more than 10kms from the SGR wayleave corridor.

6.5.6.8 Housing and Settlement characteristics

Butula, Nambale, Teso Central, and Teso North sub-counties in Busia County exhibit varied settlement characteristics, with Butula and Nambale being more central, flatter, and showing urban expansion around their respective towns, while the Teso sub-counties are characterized by sparser distribution and more rural settlement patterns. Housing often consists of agricultural-based dwellings, with growth in Nambale influenced by potential factory development, and Teso sub-counties showing a relatively lower concentration of permanent settlements. Common characteristics across the Sub-Counties

- **Agricultural Economy:** The predominant economic activity in these areas is agriculture, with crops like sugarcane, maize, and other food crops being grown. This significantly influences the settlement pattern, as people often live on or near their agricultural lands.
- **Luhya and Teso Influence:** The Luhya community primarily inhabits Butula and Nambale, while the Teso community dominates in the Teso North and Teso Central sub-counties, influencing the cultural aspects of settlements and housing.
- **Riverine Influence:** Nambale sub-county is characterized by river valleys and plains, notably around the River Sio, which impacts the types of settlements and the availability of water.

Characteristics by Sub-County

- **Butula and Nambale**

These areas have a relatively higher density of population compared to the Teso regions, especially in the central parts of Busia County. Nambale town is identified as a growing urban establishment with a fair concentration of people, influenced by agricultural activities and potential future factory development. Topography: The topography in this central region is marked by low, flat divides.

- **Teso Central and Teso North**

These sub-counties exhibit a sparser distribution of population. While permanent settlements are present, there's a general lack of dense, organized settlements compared to the areas around the main urban hubs. The housing style is often less permanent and depends on local building materials, which are easily accessible within the agricultural and semi-arid conditions of Teso.

6.5.6.9 Cross-cutting issues

Butula, Nambale, Teso Central, and Teso North sub-counties in Busia County, Kenya, share common demographic and developmental challenges related to Gender, People with Disabilities (PWDs), HIV/AIDS, and Climate Change. While specific detailed data for each sub-county requires access to the Busia County Integrated Development Plan, general county themes suggest these issues are prevalent, with agriculture and trade being primary economic activities, and the presence of Luhya and Teso ethnic communities influencing social structures and needs.
Key Considerations for Butula, Nambale, Teso Central and Teso North Sub-counties:

- Gender roles: Both Luhya and Teso communities have distinct cultural norms regarding gender roles, which affect access to education, healthcare, and economic opportunities for women and men.
- Persons with Disabilities (PWDs): As with many regions in Kenya, PWDs in these sub-counties likely face challenges related to accessibility, education, and employment.
- Climate Change: Butula, Namabale, Teso Central and Teso North Sub-counties face climate-related challenges such as changing rainfall patterns and temperature fluctuations, which can significantly impact the predominantly agrarian economies of these sub-counties.

CHAPTER 7.0. CLIMATE CHANGE RISK AND VULNERABILITY ASSESSMENT

7.1 Background

The Kisumu–Malaba SGR Phase 2C section traverses a climate-sensitive region of western Kenya characterized by high rainfall variability, increasing temperatures, recurrent flooding, and localized drought conditions. These changes pose direct and indirect risks to rail infrastructure, rolling stock, maintenance operations, workers, and surrounding communities.

The assessment below outlines the key climate hazards, exposure, sensitivity, and overall vulnerability of the corridor.

Since the SGR Phase 2C corridor spans a wide variety of landscapes, the team introduced spatial assessment of key indicators to take a much closer look at the leading indicators (precipitation) and hazards by using high-resolution spatial modeling with a 0.05degree pixel-level focus. We used the GFDL-ESM4 Earth System Model, to capture the specific weather patterns and land features of the Lake Victoria Basin and the Western Highlands. This approach allowed us team to find specific hazard hotspots at exact points along the railway track where steep hills, easily eroded soil, and heavy rain come together. This gives the engineers the precise data they need to build a railway that can withstand the unique environmental pressures of Western Kenya.

7.2 Purpose of the Climate Risk and Vulnerability assessment

The objectives of climate risk and vulnerability assessment for the proposed Kisumu Malaba SGR project are as under listed:

- To assess potential climate-induced impacts on structural integrity, operational continuity, safety, and maintenance needs of the SGR Project.
- To analyze the key climate-related hazards such as extreme rainfall, flooding, drought, temperature increases, storms, and erosion likely to affect the Kisumu–Malaba SGR section during construction and operation.
- To examine how susceptible the SGR infrastructure, operations, workers, and adjacent communities are to climate stresses, considering design standards, site conditions, and socio-economic factors.
- To determine which project components (tracks, bridges, culverts, embankments, work camps) and which surrounding communities are located in climate-sensitive or hazard-prone areas.
- To guide the integration of climate-resilient design measures such as improved drainage, slope stabilization, flood-proofing, and material selection into project plans and technical specifications.
- To minimize climate-related risks to nearby settlements, floodplains, wetlands, agricultural land, and ecosystems that may be affected by SGR development.
- To ensure that the SGR remains safe, functional, and reliable under future climate scenarios, reducing potential disruptions and increasing asset longevity.

7.3 Study Methodology

The climate impact assessment for the proposed railway project in Kenya used internationally recognized methods combining CMIP5 global climate models and CORDEX-Africa regional models, supported by historical data from KMD, CHIRPS (rainfall), and CHIRTS (temperature). The analysis examined key climate variables—temperature, rainfall, and extreme precipitation—alongside secondary risks such as flooding, soil moisture changes, and erosion. Model outputs were bias-corrected and ensemble statistics applied to manage uncertainty.

Climate results were aggregated at county and corridor levels to align directly with the railway route. Projections were integrated with engineering design standards to identify vulnerabilities in structures such as bridges, culverts, and embankments. Threshold analysis helped highlight areas requiring climate adaptation.

High-resolution satellite datasets provided a strong historical baseline, while future climate projections were generated from two GCMs (CESM1-CAM5 and MPI-ESM-MR) under RCP2.6, RCP4.5, and RCP8.5 scenarios. Monthly trends for temperature and rainfall were computed after bias correction to ensure consistency with observed conditions. Multi-model means were used to produce more reliable ensemble projections. The followings methods were used;

1. **Resampling/ Regridding**

Climate datasets from CHIRPS, CHIRTS, ERA5, and CMIP6 were processed to ensure consistency for project analysis. Coarser-resolution datasets (ERA5 and CMIP6) were regridded to match the high-resolution CHIRPS/CHIRTS grid (~5 km), using conservative methods for precipitation and bilinear interpolation for temperature and related variables. All data were standardized to daily values, ensuring spatially and temporally aligned climate information for accurate assessment of climate impacts and project planning.

2. **Bias correction**

To ensure that the climate projections used in this study are realistic and relevant for local decision-making, we applied a bias-correction process. Because climate models can over- or underestimate rainfall, temperature, and other variables, we compared model outputs with trusted historical datasets (CHIRPS, CHIRTS, and ERA5) and used quantile mapping, a statistical method, to align the projections with observed patterns. This adjusts the full range of values, including averages and extremes, so projections better reflect the climate experienced on the ground.

3. **Trend and Variability Analysis**

After resampling and bias correction, the climate datasets were analyzed to identify trends and variability over the project corridor. Historical and projected time series were evaluated to detect long-term changes in temperature, precipitation, and other key variables, as well as interannual and seasonal variability.

4. **Geospatial Modeling and Extreme Value Analysis**

Finally, to make sure the SGR Phase 2C is built with the best possible safeguards, we developed three specialized spatial models. First, we used Extreme Value Theory to look at the annual maximum rainfall over three-day periods. By fitting this data to a Gumbel Distribution, we calculated return levels for periods ranging from 2 to 50 years. This gives engineers the stress-test numbers they need to size culverts and bridges correctly. Second, we created a Flood Risk Index that shows the percentage shift in seasonal rain compared to the past. Finally, we modeled soil erosivity (the R-Factor) to see which hills in Vihiga and Kakamega are most likely to suffer from landslides or washouts.

7.3.1 Shared Socioeconomic Pathways (SSPs) and Planning Horizons

We used daily CMIP6 outputs for historical, SSP1-2.6, SSP2-4.5, and SSP5-8.5 scenarios (1983–2099) to assess climate risks. CMIP6, from IPCC AR6 (2021), builds on and supersedes CMIP5 (AR5), which used RCPs to project warming (Siabi et al., 2023). Unlike CMIP5, CMIP6 couples' socio-economic pathways (SSPs) with forcing scenarios, enabling analysis of emissions, land use, and adaptation storylines from sustainability (SSP1-2.6) to high-emission development (SSP5-8.5). The IPCC recommends AR6 CMIP6 scenarios as the basis for climate impact assessments. The 1983–2099 period ensures overlap with CHIRTS data, allowing consistent bias correction and high-resolution historical-to-future climate analysis.

The assessment relies on daily CMIP6 outputs (1983–2100) under three Shared Socioeconomic Pathways (SSPs):

Table 70: AR6 scenarios and project planning horizons

Scenario	Description	Planning Horizon Alignment
Historical	Baseline (1983–2014)	Construction phase and Immediate Operations
SSP1-2.6	Sustainability / Low emissions	Long-term operations (2070s)
SSP2-4.5	Middle-of-the-road	Mid-century maintenance (2050s)
SSP5-8.5	High-emission development	Early operations / construction impacts (2030s)

We used MPI-ESM1-2-LR and CanESM5 from the CMIP6 ensemble to project future climate over Kenya. MPI-ESM1-2-LR performs well in reproducing East African temperature and rainfall patterns, while CanESM5 adds structural diversity to capture uncertainties in climate projections (Hirons et al., 2021; Gleckler et al., 2025). Together, these models provide a balanced representation of plausible future climate conditions for regional impact assessment.

Overall, the approach delivers robust, county-specific climate projections that support risk-informed planning for railway infrastructure and broader sectors such as agriculture, water resources, and disaster management. **Table 71** below outlines summary of data set.

Table 71: Summary of data set used

Dataset	Source	Years	Spatial resolution	Temporal resolution	Variables	Use
CHIRPS	Climate Hazards Center	1981–2014	0.05^0(~5 km)	Hourly	Precipitation used for downscaling	Bias correcting CMIP6 precipitation
CHIRTS	Climate Hazards Center	1983–2014	0.05^0(~5 km)	Daily	Minimum & maximum temperatures	Downscaling and bias correcting CMIP6
ERA5	ECMWF - Climate Data Store	1983–2014	0.25^0(~ 28 km)	Daily	Temperature; dew point temperature, maximum temperature, u wind, v wind, relative humidity	Bias correcting corresponding CMIP6 variables
CMIP6	ECMWF - Climate Data Store	1983–2100	~25 km	Daily	Mean temperature, minimum temperature, maximum temperature, precipitation, specific humidity, pressure	Baseline and future scenarios

Unit conversions

Table 72: Unit Conversions for CMIP6 Variables

Variable	Original Units	New Units	Formula / Conversion
tas (Near-surface air temperature)	K	°C	°C = K − 273.15
tasmax (Daily maximum near-surface air temperature)	K	°C	°C = K − 273.15
tasmin (Daily minimum near-surface air temperature)	K	°C	°C = K − 273.15
pr (Precipitation)	$kg\ m^{-2}\ s^{-1}$	mm/day	mm/day = ($kg\ m^{-2}\ s^{-1}$) × 86400
huss (Near-surface specific humidity)	Dimensionless	kg/kg	No conversion needed
psl (Surface air pressure / Sea level pressure)	Pa	Pa	No conversion needed

Computation of Climate Indices Relevant to the SGR Project and Surrounding Areas

To support risk assessment and adaptation planning, a suite of climate indices was calculated from the processed datasets.

Assumptions and uncertainties

- Bias-corrected CMIP6 outputs accurately represent local climate conditions.

- Thresholds for heat/cold stress follow FAO (2018), Thornton et al. (2021), and Steadman (1979).
- Uncertainty arises from multi-model spread, scenario variability, and bias-correction/regridding methods.
- Confidence levels (IPCC AR6 guidance): High for temperature trends, Medium for extreme precipitation, Low–Medium for combined hazards (heat + dust, cold + rainfall).

References (for data sources)

- Funk, C., Peterson, P., Shukla, S., et al. (2019). *A high-resolution 1983–2016 Tmax climate data record based on infrared temperatures and stations by the Climate Hazard Center*. Journal of Climate, 32(17), 5639–5658. https://doi.org/10.1175/JCLI-D-18-0698.1

- Copernicus Climate Change Service (2018). *CMIP5 monthly data on single levels*. CDS. DOI: 10.24381/cds.9d44a987 (Accessed on 27-Nov-2025)

7.4 Climatic Conditions

Table 73 below present the summary of weather elements for the five counties traversed by the SGR Phase 2C project.

Table 73: Weather elements

County	Mean Annual Rainfall (mm)	Rainfall Pattern	Mean Temperature (°C)	Temperature Range (°C)	Extreme Weather Events	Seasonality
Busia	1,200 – 1,800	Bimodal	23 – 31	16 – 34	Flooding, lightning, storms	Long rains Mar–May; short rains Oct–Dec
Siaya	1,200 – 1,600	Bimodal	22 – 30	15 – 33	Floods, lake-enhanced storms	Long rains Mar–May; short rains Oct–Dec High rainfall along Yala & Nzoia floodplains
Kakamega	1,500 – 2,200	High rainfall zone	18 – 28	14 – 30	Thunderstorms, floods	Long rains Mar–May; short rains Oct–Dec One of Kenya's wettest areas
Vihiga	1,400 – 2,000	High altitude rainfall	16 – 26	12 – 28	Landslides, heavy storms	Long rains Mar–May; short rains

County	Mean Annual Rainfall (mm)	Rainfall Pattern	Mean Temperature (°C)	Temperature Range (°C)	Extreme Weather Events	Seasonality
						Oct–Dec Rainfall influenced by highlands
Kisumu	900 – 1,400	Bimodal	23 – 32	18 – 35	Flash floods, heatwaves	Long rains Mar–May; short rains Oct–Dec Lake Victoria basin effects; convective storms

7.5 Climatic Projections

7.5.1 County summaries of rainfall trends

This section presents the projected climatic conditions for the five counties traversed by the SGR Phase 2C corridor.

1. Kisumu: Rainfall in Kisumu increases by ~155 mm in the early century (RCP4.5 2030s), dips by -162 mm mid-century under RCP8.5, and ends with a late-century increase of ~543 mm (RCP8.5 2070s). This variability points to potential periods of water scarcity followed by heavy rainfall, impacting embankments and drainage systems**.**

2. Siaya: Early-century increases are moderate (~98 mm, RCP4.5 2030s), with mid-century declines of -148 mm (RCP8.5 2050s) and late-century rises of ~277 mm (RCP8.5 2070s). Overall, rainfall intensification is moderate but should still inform culvert sizing and embankment planning.

3. Vihiga: Vihiga sees a ~187 mm increase in the RCP4.5 2030s, a mid-century dip of -210 mm (RCP8.5 2050s), and a late-century rise of ~681 mm (RCP8.5 2070s). Being the wettest county, such large increases elevate the risk of flooding and slope instability, making drainage and slope protection critical along the railway route.

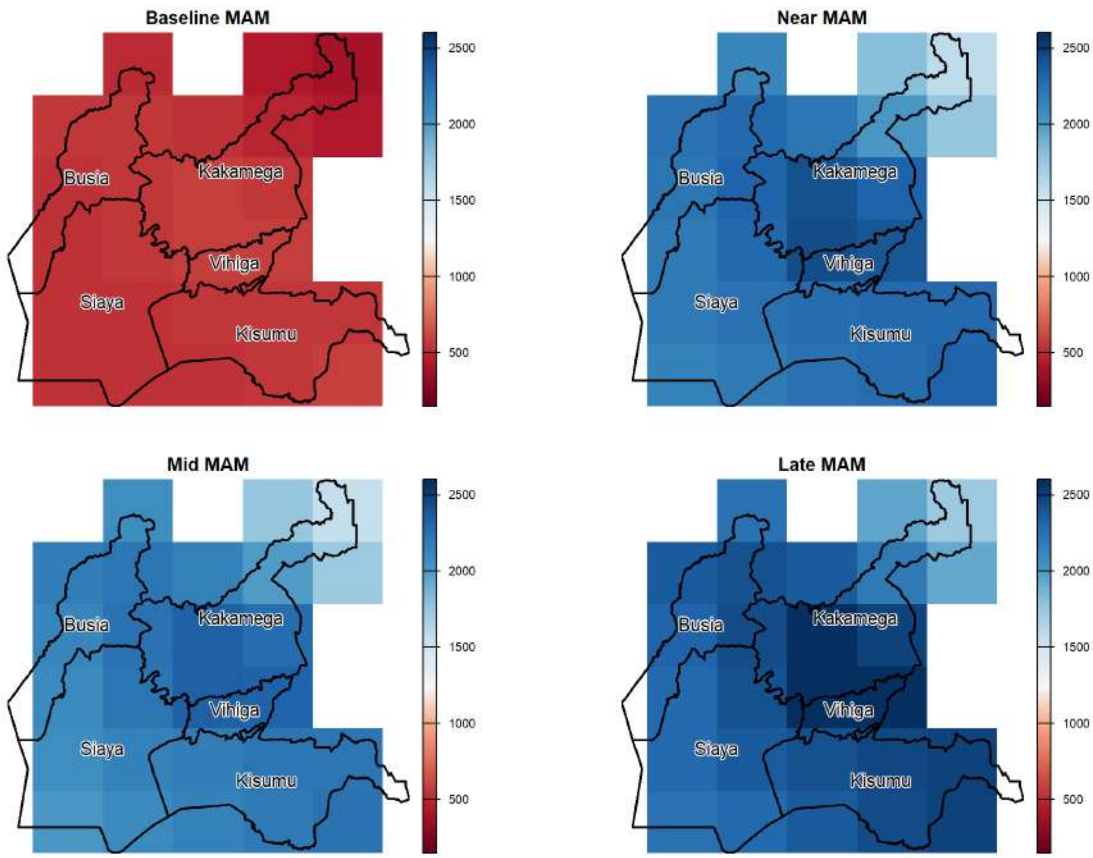
4. Kakamega: Kakamega shows early-century increases of ~115 mm (RCP4.5 2030s) and mid-century decreases of -195 mm (RCP8.5 2050s), culminating in a late-century increase of ~297 mm (RCP8.5 2070s). Significant late-century increases may amplify erosion and landslide risks along sloped railway segments.

5. Busia: Busia experiences modest early-century increases (~98 mm, RCP4.5 2030s) and a slight mid-century decrease (-165 mm, RCP8.5 2050s), before ending with a late-century increase of ~244 mm (RCP8.5 2070s). These variations suggest periods of both drier and wetter conditions, highlighting the need for adaptable drainage infrastructure.

The figure below shows annual rainfall and temperature for the five counties traversed by SGR Phase 2C project.

7.5.2 Seasonal Rainfall Trends: Project Counties Maps

While the annual charts show us the long-term trends, the project counties maps for the MAM and OND seasons show us exactly where the risk is highest.



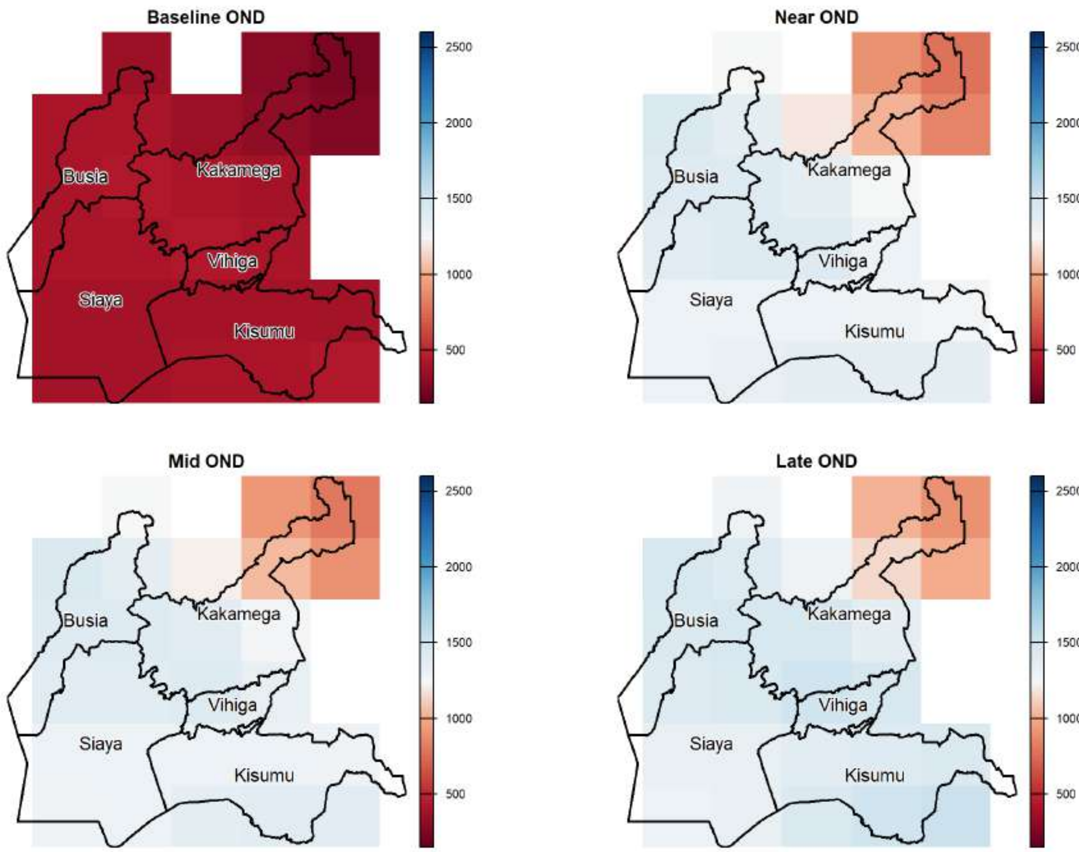
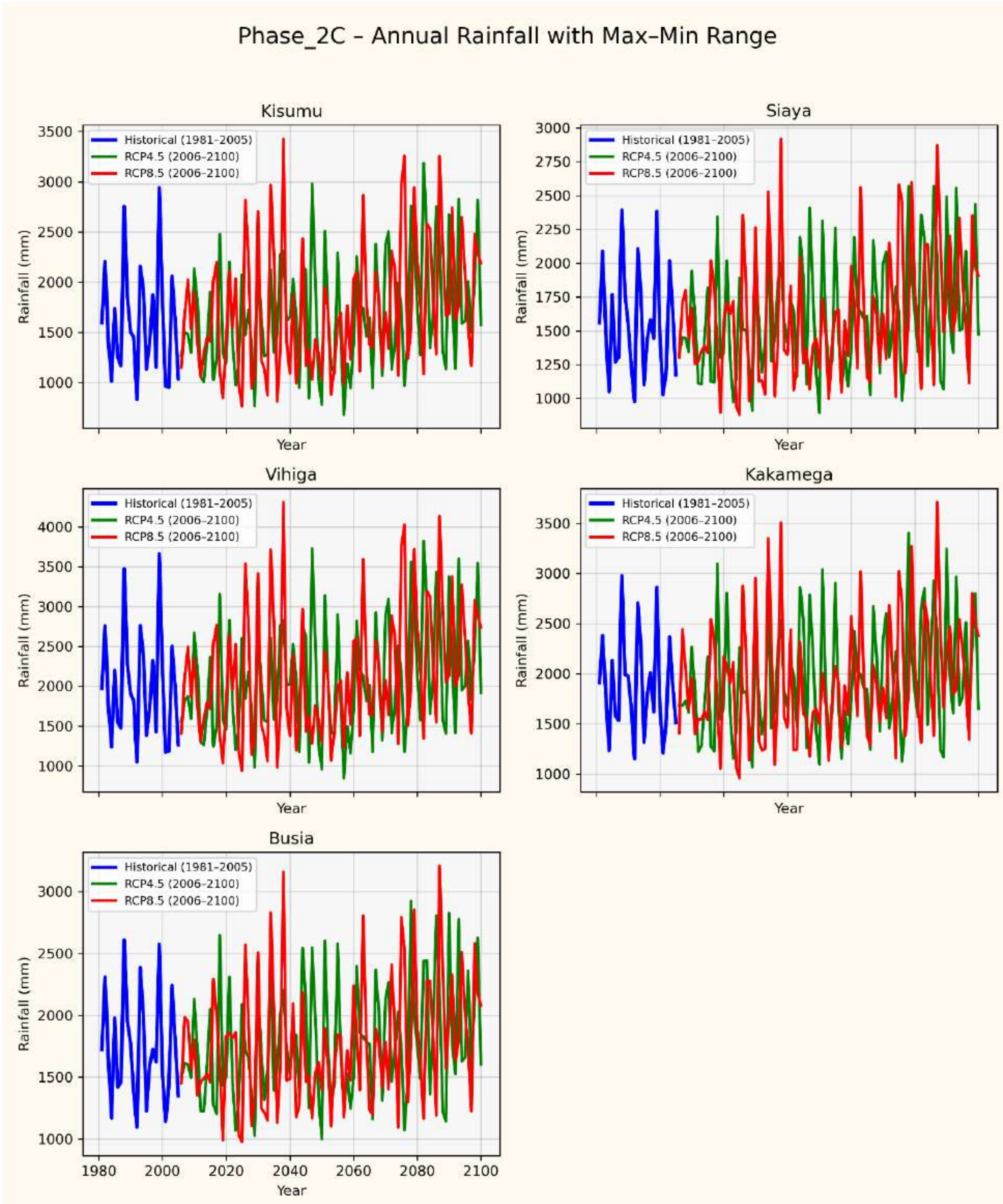


Figure 69: Projected changes in average seasonal rainfall for the MAM and OND seasons across the project counties

The spatial data shows that Western Kenya is moving toward a more unpredictable weather system. Under the GFDL-ESM4 model, the *Short Rains* in the OND season show a very strong increase by the end of the century, especially in the lowlands of Siaya and Busia. These maps show that sections of the railway crossing the Nzoia and Yala floodplains will deal with much more water than in the past. This shift means a higher risk of the ground becoming saturated and the track base becoming unstable, so maintenance plans will need to be adjusted for these wetter seasons. The following time series graphs shows the broader county summaries for overview.



Phase_2C – Annual Rainfall with Max–Min Range
Kisumu
Siaya
Vihiga
Kakamega
Busia
Historical (1981–2005)
RCP4.5 (2006–2100)
RCP8.5 (2006–2100)
Rainfall (mm)
Year

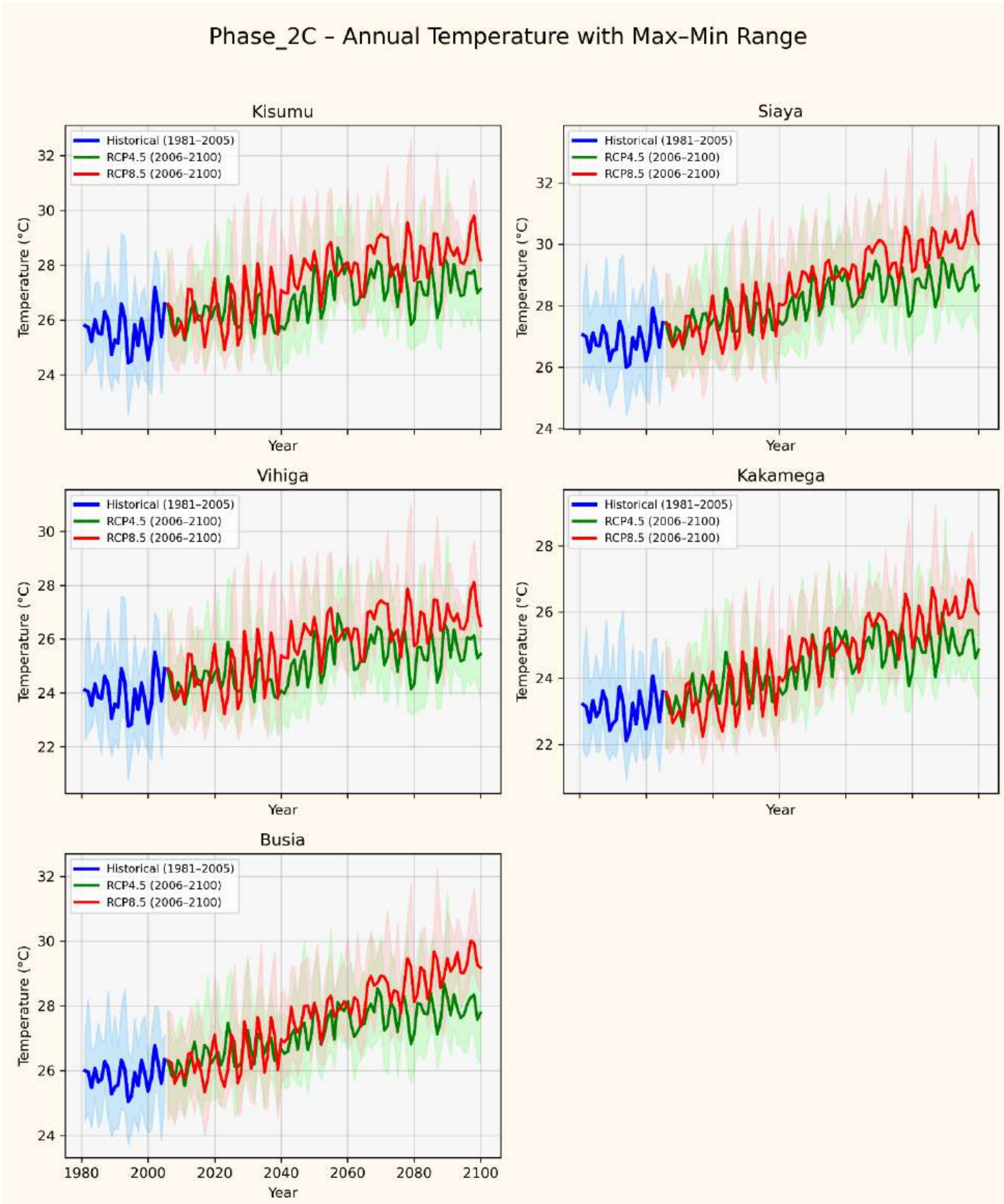

Phase_2C - Annual Temperature with Max-Min Range
Kisumu
Siaya
Vihiga
Kakamega
Busia
Historical (1981-2005)
RCP4.5 (2006-2100)
RCP8.5 (2006-2100)
Temperature (°C)
Year
1980
2000
2020
2040
2060
2080
2100

Table 74 below shows the temperature projections (2030, 2050 and 2070) for the five counties traversed by SGR Phase 2C project.

Table 74: Temperature projections (2030, 2050 and 2070) for the five counties

County	RCP 4.5 2030s	RCP 4.5 2050s	RCP 4.5 2070s	RCP 8.5 2030s	RCP 8.5 2050s	RCP 8.5 2070s
Busia	98.08	1715.41	1876.7	1689.85	-164.5	243.82
Kakamega	115.43	1851.28	2030.48	1831.62	-194.94	297.36
Kisumu	155.09	1508.08	1900.07	1602.03	-161.94	543.38
Siaya	97.89	1534.65	1720.1	1530.14	-147.88	276.79
Vihiga	186.73	1867.93	2353.19	1987.64	-209.8	680.89

Table 75 below shows the rainfall projections (2030, 2050 and 2070) for the five counties traversed by SGR Phase 2C project.

Table 75: Rainfall Projections (2030, 2050 and 2070) for the five Counties

	RCP 4.5			RCP 8.5		
County	2030s	2050s	2070s	2030s	2050s	2070s
Busia	98.08	-10.84	150.45	-36.4	-66.42	232.98
Kakamega	115.43	-32.85	146.35	-52.52	-79.5	264.51
Kisumu	155.1	-85.72	306.26	8.22	-6.85	457.65
Siaya	97.89	-18.42	167.04	-22.92	-49.99	258.38
Vihiga	186.73	-113.52	371.74	6.19	-23.07	567.37

Across the western counties, early-century projections (2030s) under RCP4.5 show modest increases in rainfall relative to historical values, with Busia (+98 mm), Kakamega (+115 mm), Kisumu (+155 mm), Siaya (+98 mm), and Vihiga (+187 mm).

Mid-century (2050s) projections under RCP8.5 indicate moderate decreases in most counties, including Busia (-165 mm), Kakamega (-195 mm), Kisumu (-162 mm), Siaya (-148 mm), and Vihiga (-210 mm). These fluctuations suggest that the mid-century period may experience temporary drier conditions, potentially impacting water availability for construction and operation activities along the railway corridor.

By the late century (2070s), most counties are projected to experience substantial rainfall increases under RCP8.5, with Busia (+244 mm), Kakamega (+297 mm), Kisumu (+543 mm), Siaya (+277 mm), and Vihiga (+681 mm).

These pronounced increases highlight a significant risk of flooding, soil erosion, and slope instability, particularly in Vihiga. The variability in rainfall, combined with these projected surges, emphasizes the need for robust drainage, embankment stabilization, and flood management measures in the railway's design to ensure resilience against future climatic extremes.

7.6 Climatic Change Impact on SGR Infrastructure

Railway infrastructure including tracks, bridges, catenary systems, and embankments is highly sensitive to extreme weather events such as high/low temperatures and heavy precipitation. These conditions can disrupt operations, damage infrastructure, and reduce the lifespan of assets. Understanding weather patterns during planning, design, operation, and maintenance is essential to ensure safety and reliability.

Depending on the severity of weather events, impacts may require increased inspections, reduced train speeds, and proactive climate risk assessments. If not addressed, failures can lead to operational disruptions, economic losses, higher emissions from alternative transport, and in severe cases, derailments or threats to human life. **Table 76** below outlines the incidence of weather elements on various infrastructure.

Table 76: Impact Matrix of extreme weather events on vulnerable assets

Vulnerable infrastructure	Bridges/ Viaducts	Tunnels	Drainage systems	Railway tracks	Culverts	Slip slopes
Temperature	X	X		X		
Rainfall	X	X	X	X	X	X
Wind	X					

Table 77 below outlines the effects of climatic change elements identified above on SGR infrastructures.

Table 77: Effects of climate change on the SGR

Climate change effect category	Risk ranking	Vulnerable asset
Rainfall (including high amount falls, variations to mean rainfall, groundwater content, and soil moisture)	High	Track movement Line closure Reduced operating speeds
Extreme high temperature (including air and ground temperature)	High	Track buckling Line closure Reduced operating speeds
Flooding (including river and surface flooding)	High	Track washout Line closure Reduced operating speeds
Inland erosion and instability	High	Disruptions from blockages Decrease in track condition
High winds	High	Rolling stock stability Modest risk of railway equipment and destruction Decreased operating speeds
Lightning	High	Risk to line workers Outages of power Destruction to infrastructure

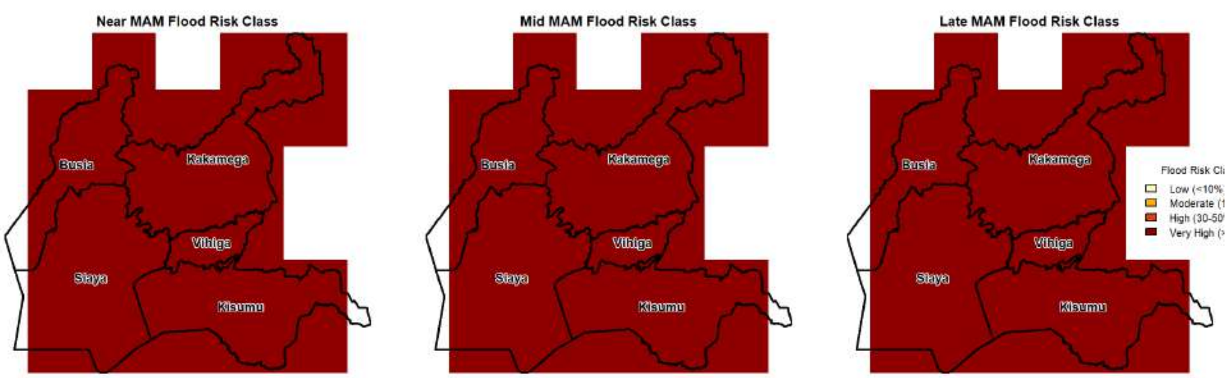
7.7 Climatic Hazards Assessment

All climate hazard indicators for the SGR corridor are derived from bias-corrected CMIP6 outputs (tas, tasmax, tasmin, pr, huss, psl), with additional stresses computed using proxies such as soil water stress (NDWS) and THI (from tasmax and RH). Cold stress affects workers, livestock, and crops (tea, maize, wheat, sugarcane) in highland zones, while livestock thresholds follow Thornton et al. (2021) and human heat stress thresholds follow Steadman (1979) and Stull (2011). Flood and waterlogging hazards are derived from precipitation combined with simple soil moisture proxies, and aquaculture/fish cold stress uses tas as a proxy for water temperature. All indicators are ESMP-relevant, guiding worker and passenger safety, livestock and crop adaptation, and the resilience of railway infrastructure, embankments, bridges, drainage, and construction sites. Thresholds in the table below were locally adjusted to observed SGR corridor conditions (min 11–18°C, max 25–30°C) to ensure realistic worker, crop, livestock, and passenger hazard assessment for planning and interventions.

To provide analytical outlook for these thresholds, we have included spatial modelling to show exactly how these risks are distributed across the project counties. This ensures that the mitigation measures are targeted at the areas with the highest physical exposure.

1. Spatial Analysis of Flood and Waterlogging Risk

The flood and waterlogging hazards described in the assessment are supported by our Flood Risk Class modelling. These maps identify the specific geographic zones where the projected increase in rainfall is most likely to exceed drainage capacity.



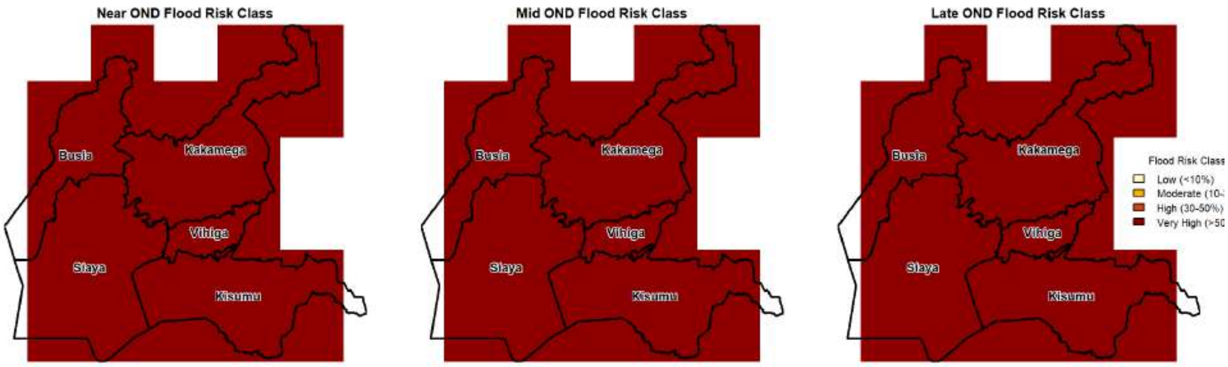
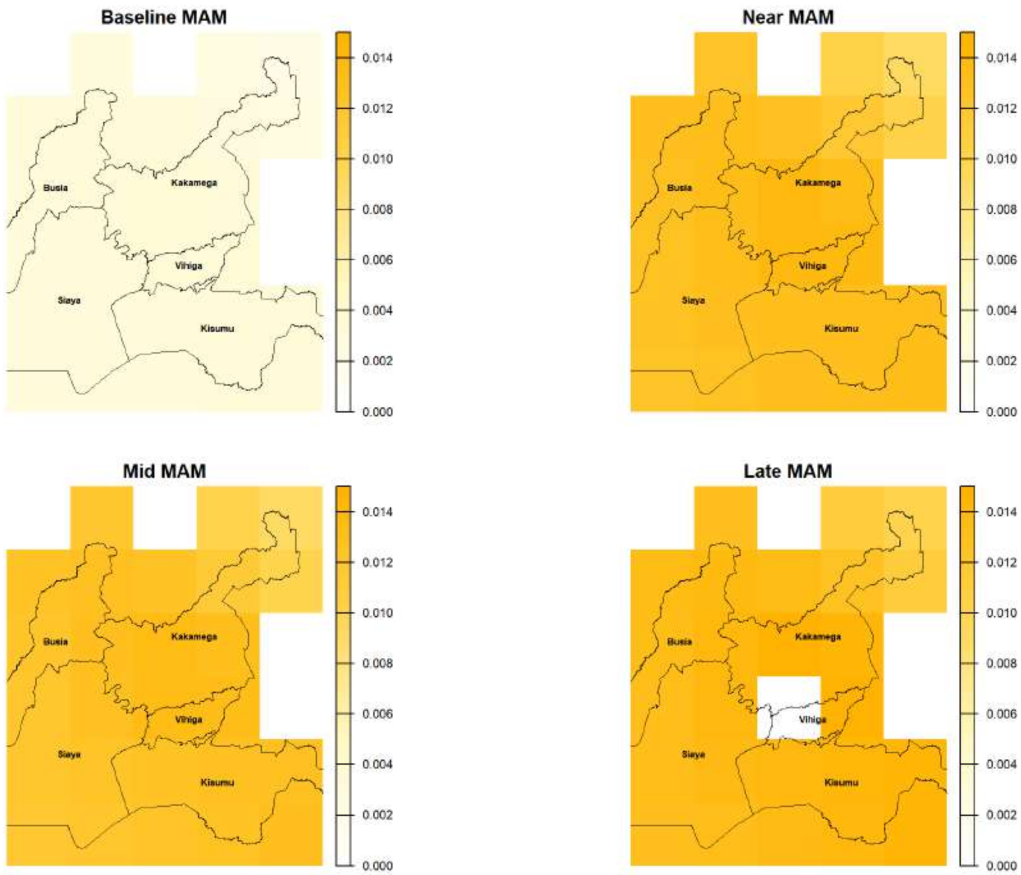


Figure 70: Categorized flood risk levels showing areas with the highest projected increases in seasonal precipitation

The spatial analysis shows that the most vulnerable areas, shown in dark red, are concentrated spread across the entire project area. In these specific locations, seasonal rainfall is projected to increase by more than 30 percent. This provides the direct evidence for the Heavy rain and flood indicators used in the hazard table 78.

2. Spatial Analysis of Soil Erosivity and Landslide Risk

The risks related to landslides and slope failure are validated by our Rainfall Erosivity (R-Factor) modeling. This part of the study measures the kinetic power of the projected rainfall and its ability to wash away soil and destabilize railway embankments.



Baseline MAM
Near MAM
Mid MAM
Late MAM
Busia
Kakamega
Vihiga
Siaya
Kisumu
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000

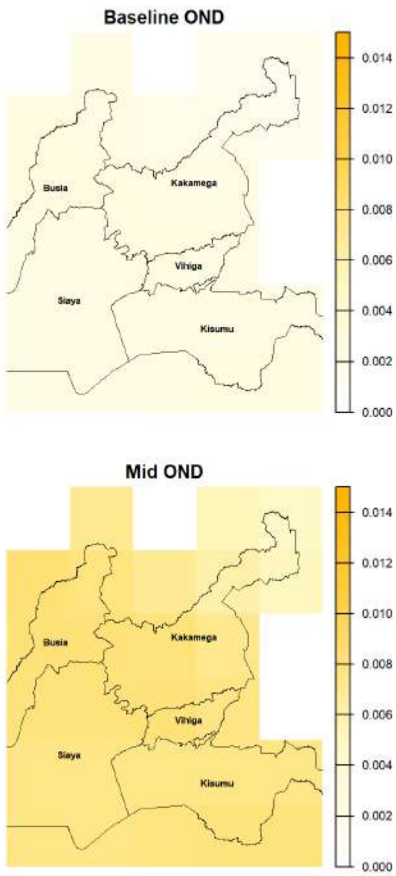


Figure 71: Unified Rainfall erosivity index (R-Factor) for MAM and OND seasons

The extremely spatial data reveals that the R-factor across the five counties remains within **a** low-to-moderate range, with values peaking between 0.002 and 0.014. These extremely low values are a reflection of the regional pedology, specifically the dominance of well-aggregated volcanic soils in the highlands and clay-rich soils in the basin, both of which possess strong structural stability.

However, the distribution of this erosive power is closely tied to the regional topography, Highland Sensitivity (Vihiga and Kakamega), The MAM maps exhibit a noticeable amber intensification (peaking at 0.014) in the high-altitude zones. While the volcanic soils here are naturally stable, the steep topographic gradients of the Western Highlands mean that even low erosivity levels can become problematic. When these values coincide with the projected 30% increase in intense 3-day rainfall events, the kinetic energy of the runoff can overcome soil aggregation, leading to localized gullying and embankment failure.

In the flatter lowlands of Siaya, Busia, and the Kisumu shoreline, the R-factor remains at the lower end of the scale (**0.002–0.008**, shown in pale yellow). In these areas, the heavy clay soils are less prone to high-velocity erosion due to the gentle slopes. However, the projected increase in 3-day rainfall extremes poses a different risk: waterlogging. The structural stability of SGR embankments in these counties will depend more on drainage capacity than on slope reinforcement. As mentioned earlier, other important hazards and indicators are summarized in Table 78.

Table 78: Hazard indicators and thresholds

Hazard / Stress	Indicator	CMIP 6 Variables	Formula / Computation	Original Thresholds / Categories (Source)	Local Adjustment / Justification	Relevance for SGR Corridor / ESMP
Cold stress (workers)	Cold stress days (field/rail)	tasmin	Count days tasmin < threshold	Moderate: 5–10°C, Severe: <5°C, Extreme: <0°C (FAO, 2018)	Adjusted to Mild: 13°C, Moderate: 11°C, Severe: 9°C, Extreme: 7°C to reflect local min temps (11–18°C) in highland and midland counties	Worker safety on rail/construction/farm sites; protective gear, rotation planning
Heat stress (workers)	Heat stress days (field/rail)	tas, huss	Count days tas > threshold or HI > threshold	Moderate: 35–38°C, Severe: 38–41°C, Extreme: >41°C (Steadman, 1979; Stull, 2011)	Adjusted to Mild: 28°C, Moderate: 30°C, Severe: 32°C, Extreme: 34°C to reflect observed max temps 25–30°C	Worker safety; heat alerts, rotation, hydration, PPE
Cold stress (crops)	Cold stress – crop risk	tasmin	Count days tasmin < species threshold	Maize <10°C, Wheat <5°C, Tea <8°C, Sugarcane <12°C, Bananas <15°C (FAO, 2018)	Adjusted per crop and local temps: Maize Mild:14, Mod:12, Sev:10, Ext:8; Tea Mild:14, Mod:12, Sev:10, Ext:8; Sugarcane Mild:17, Mod:15, Sev:13, Ext:10; Bananas Mild:17, Mod:15, Sev:13, Ext:10	Crop growth delay, frost-sensitive crop protection, irrigation adjustments
Crop extreme heat	Flowering /fruiting heat stress	tasmax	Count days tasmax > species flowering threshold	Maize/Wheat/Tea Severe>35°C (Sacks et al., 2010)	Adjusted to Mild:30, Moderate:32, Severe:34, Extreme:36°C to match local peak temps 25–30°C	Yield reduction, planting/harvesting adjustments, labor planning
Cold stress (livestock)	THI cold / minimum temp	tasmin	Count days below species thresholds	Cattle <2°C severe; Sheep/Goats <2°C severe; Poultry <5°C severe; Bees <10°C moderate (FAO, 2018; Thornton et al., 2021)	Adjusted for local temps: Cattle Mild:10, Mod:9, Sev:8, Ext:6; Sheep/Goats Mild:9, Mod:8, Sev:7, Ext:6; Poultry Mild:12, Mod:10, Sev:9, Ext:7; Bees Mild:12, Mod:10, Sev:8, Ext:6	Livestock sheltering, feed adjustments, mortality risk, veterinary interventions
Heat stress (livestock)	THI heat / max temp	tas, huss	Count days THI > species thresholds	Cattle: 94, Goats: 94, Sheep: 93, Pigs: 92, Poultry: 92 (Thornton et al., 2021)	Same as original; thresholds already meaningful for local climate	Shelter, water supply, veterinary planning,

Hazard / Stress	Indicator	CMIP 6 Variables	Formula / Computation	Original Thresholds / Categories (Source)	Local Adjustment / Justification	Relevance for SGR Corridor / ESMP
						grazing schedule adjustment
Cold stress (aquaculture/fish)	Water temperature proxy	tas	Count days water temp < species thresholds	Lake fish <18°C moderate, <15°C severe; Pond <16°C moderate, <13°C severe (FAO, 2018)	No change; thresholds already appropriate for Kenyan lakes and ponds	Fish growth, pond management, aquaculture survival, harvest timing
Heat stress (fish)	Water temperature proxy	tas	Count days water temp > species thresholds	Lake fish >28°C, Pond >30°C (FAO, 2018)	No change; reflects local maximum water temperatures	Fish growth, survival, pond/aquaculture management
Dust / Air quality stress	Dust risk days	tas, pr, NDWS	Count days NDWS >15 AND pr <1mm	Low <5, Moderate 5–10, High 10–20, Extreme >20 (Morton, 2017)	No change; thresholds reasonable for SGR corridor	Worker health (rail/field), passenger exposure, livestock respiratory risk, crop deposition
Wind-exacerbated dust	Dust-Wind risk	psl, tas, pr	Days with low pr + high wind (estimated from daily pressure gradients)	Moderate / High / Extreme (Morton, 2017)	No change	Construction site mitigation, vegetation buffers, PPE for workers, dust exposure control along railway corridor
Flood / Landslide risk	Heavy rain/flood events	pr, slope, soil	Count days pr>50mm/day; combine with slope & soil data	Moderate: 5–10 days/year, Severe: >10 days/year (Roco et al., 2017)	No change; rainfall thresholds appropriate	Embankment stability, bridge safety, drainage design, flood emergency preparedness
Occupational multi-stress	Multi-stress days (heat/cold/drought/dust)	tasmax, tasmin, pr, NDWS, RH	Count days exceeding extreme thresholds for multiple hazards	Extreme per literature (Steadman, 1979; Stull, 2011; Thornton et al., 2021; FAO, 2018; Morton, 2017)	Adjusted cold/heat thresholds applied locally (see above)	Labor rotation, rest breaks, PPE, emergency health response

Hazard / Stress	Indicator	CMIP 6 Variables	Formula / Computation	Original Thresholds / Categories (Source)	Local Adjustment / Justification	Relevance for SGR Corridor / ESMP
Crop/livestock compound stress	Heat + Drought	tasmax, pr, NDWS	Count days NTx35>20 AND NDWS>20	Severe: >20 days (Sacks et al., 2010; ENVIREM R Package)	Thresholds maintained; local climatology supports this	Crop yield reduction, livestock mortality, irrigation/feeding adjustments
Occupational heat/dust stress (rail/construction)	HI + Dust days	tasmax, tasmin, pr, huss	Count days HI>41 OR Dust risk >10 days/year	Severe / Extreme (Steadman, 1979; Morton, 2017)	Adjust HI threshold using local climatology: Extreme rarely >34°C	Worker safety, health alerts, ESMP planning, PPE requirements
Human thermal stress – passengers	Heat Index / Wet-bulb temp	tas, huss	Compute HI and Tw as above	Same categories as heat stress humans (Steadman, 1979; Stull, 2011)	Apply locally adjusted HI/thresholds	Passenger comfort, station design, shelter, scheduling impacts
Seasonal risk indicators	Dry spells, NDWS seasonal count	pr, tas, soil proxy	Seasonal sum of dry days and NDWS	High risk: NDWS>20 days, consecutive dry days>15 (ENVIREM R Package; CHIRPS/CHIRTS)	No change	Planning for water supply, irrigation, ESMP mitigation for crop/livestock/farm workers
Dust-Heat compound stress	Heat + Dust	tasmax, tasmin, pr, huss	Count days exceeding thresholds for HI and dust	Severe / Extreme (Steadman, 1979; Morton, 2017)	Use locally adjusted HI/heat thresholds + dust thresholds	Worker safety, ESMP planning, PPE, scheduling adjustments

7.8 Climatic Risk Assessment Matrix

The potential impacts emanating from the climate related hazards observed in the five counties traversed by the SGR Phase 2C is analysed in the risk assessment matrix (see **Table 79 below**). The matrix systematically combines information on the likelihood of specific climate events such as flooding, storms, drought, extreme temperatures, or landslides with the exposure and sensitivity of assets and populations along the SGR corridor. By assigning risk levels (e.g., low, medium, high, or very high) to each hazard, the matrix prioritizes critical areas requiring attention and guides the development of adaptation and mitigation strategies. It also facilitates decision-making for climate-resilient design, operational planning, and emergency preparedness, while providing a clear framework for communicating risks to stakeholders.

To help prioritize where to spend money on climate protection, we combined different threats into one Multi-Hazard Index. This index brings together temperature changes, heavy rain, the steepness of the land, and how easily the soil erodes. We mapped this on a scale from 0.00 up to 1.00, where 0.00 is stable and 1.00 (deep red) represents highest risk.

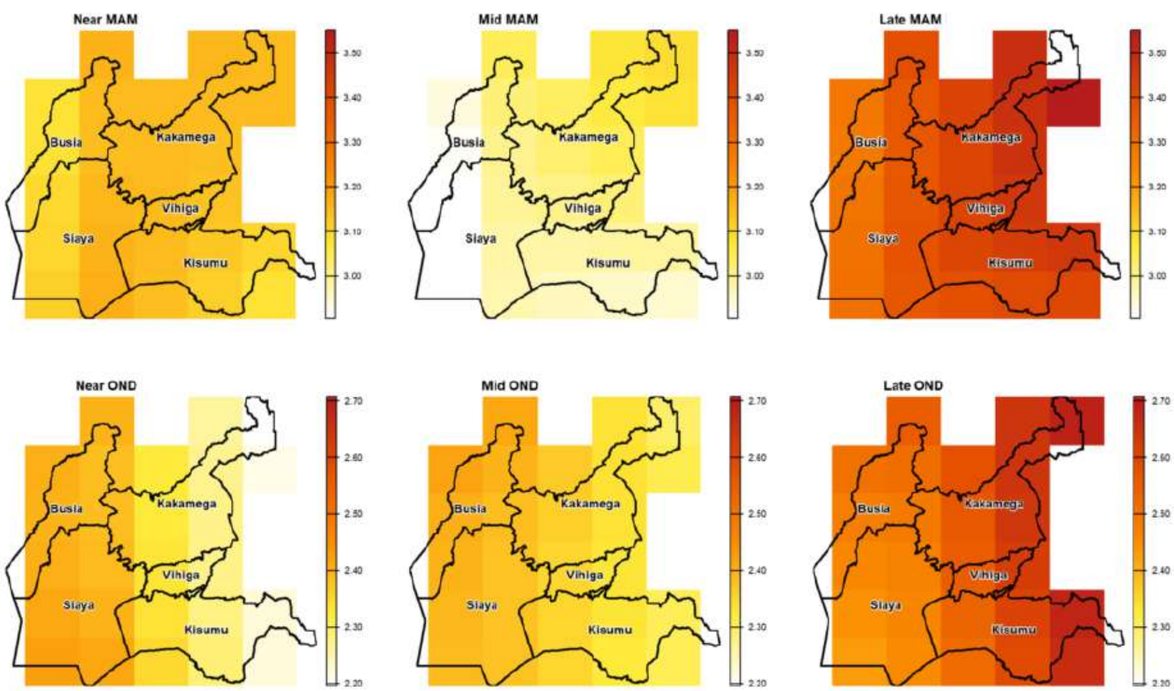


Figure 72: Integrated Multi-Hazard Index (MHI) showing the combined impact of climate, soil and terrain factors on a 0 to 1 scale

The MHI maps show that the risk is not spread evenly across the region. The *hot* zones are mostly concentrated where the rugged Western Highlands of Vihiga and Kakamega meet the Lake Victoria lowlands of Kisumu, Siaya, and Busia. This geographic transition is critical because it represents a *convergence zone* where multiple climate problems happen at the same time. In the higher altitudes of Vihiga and Kakamega, the primary drivers of the MHI are steep slopes and high soil erosivity. Even though the volcanic soils are structurally stable, the projected 30 percent increase in intense rainfall events means these slopes will face much higher physical stress. When the railway passes through these hilly sections, the MHI identifies a combined risk of slope failure and rapid runoff that can overwhelm trackside drains.

As the corridor moves into the flatter plains of Kisumu, Siaya, and Busia, the nature of the risk changes. In these areas, the *red* zones on the map are driven by a combination of high temperature stress and flood accumulation. Because these counties sit at the bottom of the drainage basin, they must handle not only the rain that falls locally but also the high-velocity runoff coming from the Kakamega highlands.

This mapping gives us the numeric proof for the risk ratings seen in Table 79. The analysis has identified these specific orange and red hotspots, the ESMP can focus on the segments where the railway is most vulnerable. Instead of applying the same design everywhere, we recommend that the project can use this data to target specific interventions, such as reinforced embankments in the highland transitions and extra-capacity culverts in the lowland flood zones. This ensures the SGR is built to handle the compounding pressures of topography and climate change simultaneously.

Table 79: Climate change risk assessment matrix

Climate Hazard	County Hotspots	Exposure	Severity	Risk Rating	Potential Impacts on SGR	Recommended Adaptation / Mitigation Measures
Extreme Rainfall & Flooding	Siaya (Yala Swamp), Busia lowlands	Tracks, culverts, bridges, embankments, work camps	High	High	Flooding of tracks, ballast washout, erosion, construction delays	• Construct enlarged culverts & flood-resistant bridges • Reinforce embankments with gabions & rip-rap • Install high-capacity drainage channels • Design with 50–100-year flood return periods
Soil Erosion & Landslides	Vihiga highlands, Kakamega hills, parts of Siaya	Slopes, cut/fill areas, borrow pits, surface drains	High	High	Slopes failure, sedimentation, instability of rail foundation	• Slope reinforcement (retaining walls, geogrids) • Vegetative stabilization • Controlled excavation sequencing • Erosion control bunds & sediment traps
Rising Temperatures	Busia, Kisumu, parts of Siaya	Rails, sleepers, machinery, labour force	Medium	Moderate	Rail expansion, material fatigue, worker heat stress	• Use heat-resistant rail steel • Continuous welded rail with expansion monitoring • Adjust work hours to avoid mid-day heat • Provide cooling shelters & hydration points
Drought & Water Scarcity	Busia, Siaya, Kakamega dry pockets	Earthworks, concrete works, worker camps	Medium	Moderate	Insufficient water for construction & domestic use; conflict with communities	• Drill boreholes with county permits • Rainwater harvesting tanks at camps • Water-efficient construction technology • Community water-sharing agreements

Climate Hazard	County Hotspots	Exposure	Severity	Risk Rating	Potential Impacts on SGR	Recommended Adaptation / Mitigation Measures
Storms, Lightning & Strong Winds	Kisumu (Lake Victoria), Siaya shoreline	Signalling systems, power lines, tall structures, cranes	Medium	Moderate to High	Equipment damage, construction hazards, power surges	• Lightning arrestors on all tall structures • Surge protectors for signalling • Secure cranes & scaffolding during storms • Weather monitoring alerts
High Humidity & Corrosion Risk	Kisumu, Siaya (lake-influenced zones)	Steel structures, bridges, equipment	Medium	Moderate	Accelerated corrosion of metals, higher maintenance	• Use corrosion-resistant coatings • Regular anti-rust inspections • Elevated concrete covers on structures
Increased Pest & Disease Incidence	All counties (malaria-prone), especially Kisumu & Busia	Workforce health, productivity	Medium	Moderate	Worker absenteeism, medical costs, reduced productivity	• Provide treated mosquito nets • On-site health clinics and preventive treatment • Water drainage around camps
Changing Hydrology	Kisumu shoreline, wetlands	Rail structures near floodplains, culverts	High	Moderate to High	Long-term waterlogging, scouring of foundations	• Elevate track levels near wetlands • Use deep pile foundations • Wetland buffers & monitoring
Air Quality Stress During Heat/Dry Seasons	Busia, Kakamega, Kisumu	Workers, nearby communities, earthworks zones	Medium	Low to Moderate	More dust emissions affecting visibility & health	• Water sprinkling (efficient use) • PPE for workers • Vegetative buffers
Strong Lake Wind Gusts	Kisumu, parts of Siaya	Temporary structures, cranes, materials	Low	Low to Moderate	Risk of toppling scaffolding & equipment	• Enforce wind-speed shutdown thresholds • Secure loose materials • Weather monitoring systems

7.9 Infrastructure Climate Vulnerabilities

Extreme precipitation undermines railway infrastructure through flooding, erosion, and slope instability, leading to operational shutdowns, safety hazards, and costly repairs. With climate change amplifying these events, resilience planning such as improved drainage, slope stabilization, and predictive monitoring is becoming essential for railway systems worldwide. **Table 80** below outlines impacts, risks and mitigation/ adaptation measures.

Table 80: Impacts, Risk and Mitigations

Impact	Risk/Consequence	Mitigation/Adaptation
Flooding of tracks & stations	Service interruptions, electrical failures, passenger safety hazards	Elevate track beds, install flood-resistant electrical systems, improve drainage capacity
Erosion & washouts	Track instability, derailment risk, costly repairs	Reinforce ballast/subgrade, use geotextiles, regular inspection after heavy rainfall
Bridge & culvert overload	Structural collapse or blockage, long-term service disruption	Upgrade culverts/bridges for higher flow capacity, implement debris screens, proactive maintenance
Landslides & debris flows	Track blockage, derailments, passenger injury	Slope stabilization, vegetation management, early-warning monitoring systems
Signal & power system damage	Communication failures, unsafe train operations	Waterproof enclosures, redundant power supplies, real-time monitoring
Reduced operational speeds	Delays, economic losses, cascading supply chain disruption	Adaptive scheduling, predictive weather monitoring, contingency routing
Rising maintenance costs	Increased O&M budgets, insurance claims, regulatory scrutiny	Long-term resilience planning, climate-proof design standards, risk-sharing mechanisms

7.10 Railway Infrastructure Heat Stress Vulnerability

Extreme temperatures both heat and cold can warp tracks, degrade materials, disrupt operations, and pose serious safety risks across railway systems. These impacts are intensifying with climate change and require proactive adaptation.

Railway systems are highly sensitive to ambient temperature extremes due to the thermal properties of steel, concrete, and electrical components. With climate change increasing the frequency and intensity of heatwaves and cold spells, railway infrastructure faces heightened exposure to thermal stress, material degradation, and operational disruptions. This section outlines the physical, operational, and safety-related impacts of extreme temperature events, along with mitigation strategies relevant to infrastructure planning and climate resilience.

1. Track Buckling (Sun Kinks) - Steel rails expand under high temperatures. Without adequate expansion joints or stress management, this thermal expansion leads to lateral deformation known as "sun kinks," which pose derailment risks. Buckling is most prevalent in continuously welded rail (CWR) systems and is exacerbated by poor ballast conditions or inadequate anchoring.

2. Electrical and Signaling Failures - Overheating of trackside electrical systems, including signal relays, transformers, and power cabling, can result in system outages. Thermal stress may degrade insulation and reduce the reliability of control systems, compromising operational safety.

3. Speed Restrictions and Service Delays - To mitigate derailment risks during heatwaves, operators often impose speed restrictions. These reduce dynamic loads on heat-stressed tracks but result in cascading delays across the network, affecting both passenger and freight services.

4. **Passenger Comfort and HVAC Stress -** Rolling stock HVAC systems may be undersized for extreme heat conditions, leading to passenger discomfort and potential health risks. Thermal loading on carriages also increases energy demand and maintenance frequency.

5. **Extreme Events and Design -** One of the biggest risks to the SGR is the increase in the intensity of *Design Storms*. The following 5-page series of maps show how much rain is expected in 3-day extreme events for periods ranging from 2 to 50 years.

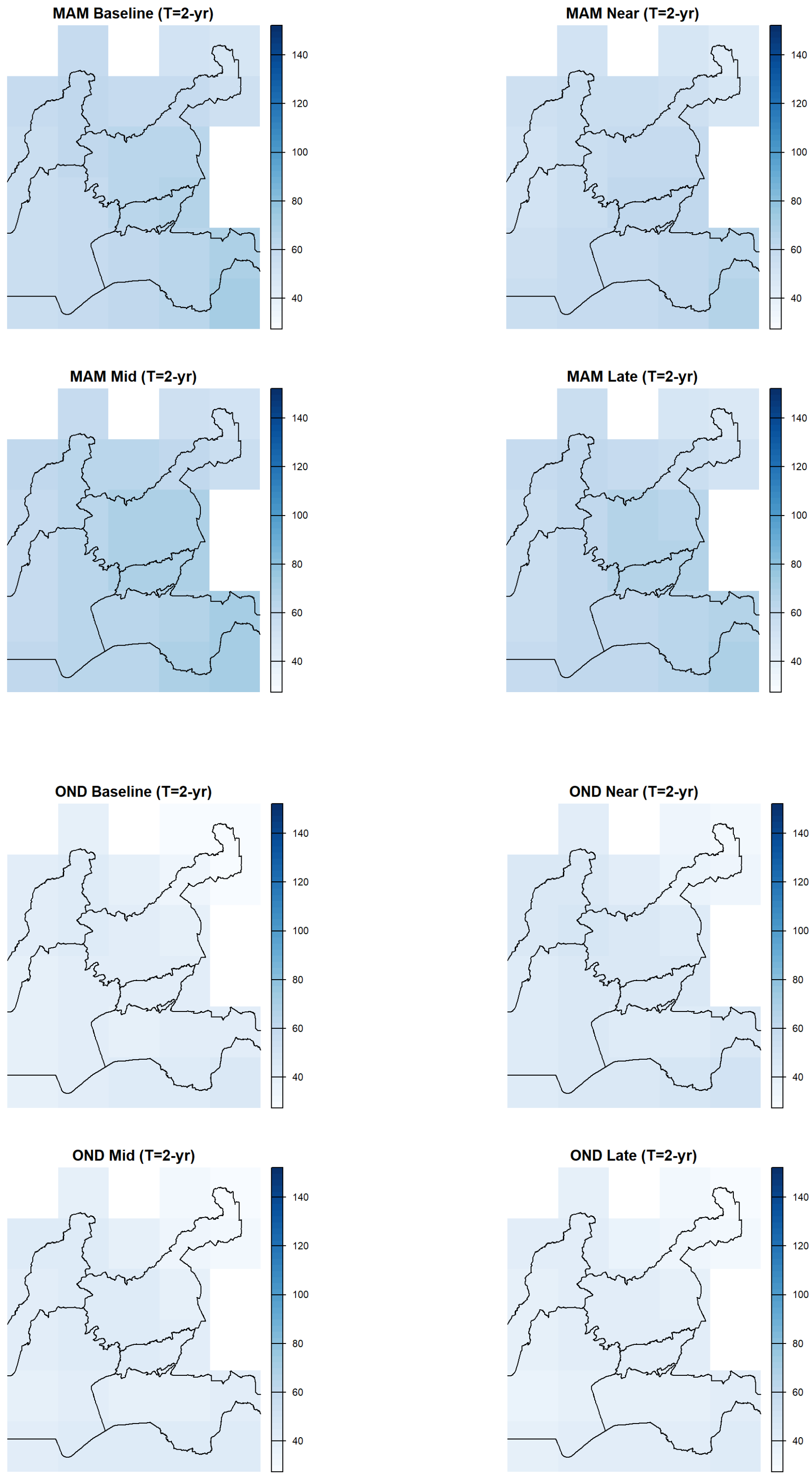


Figure 73: Projected rainfall intensities for the 2-year return period 3-day extreme storm event

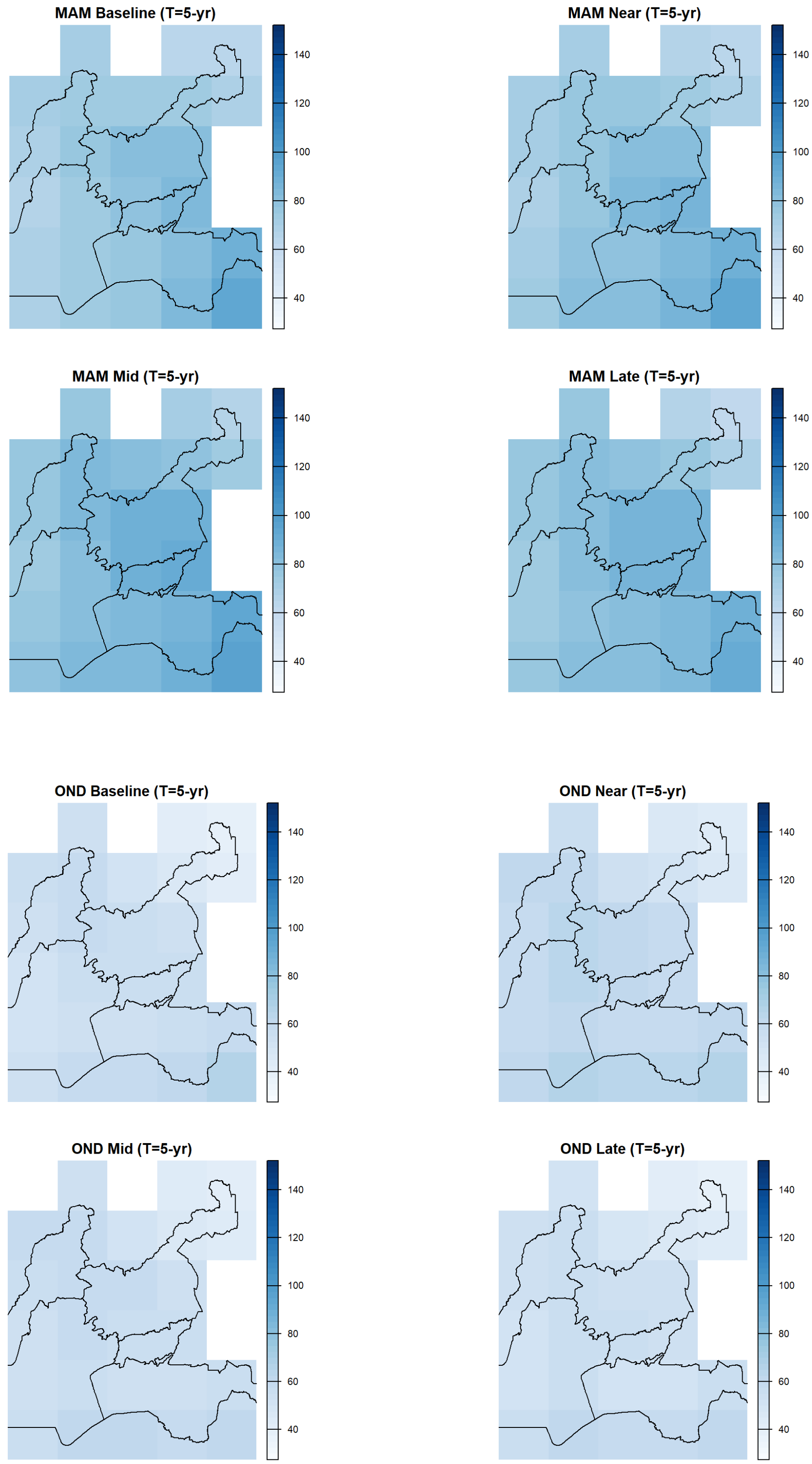


Figure 74: Projected rainfall intensities for the 5-year return period 3-day extreme storm event

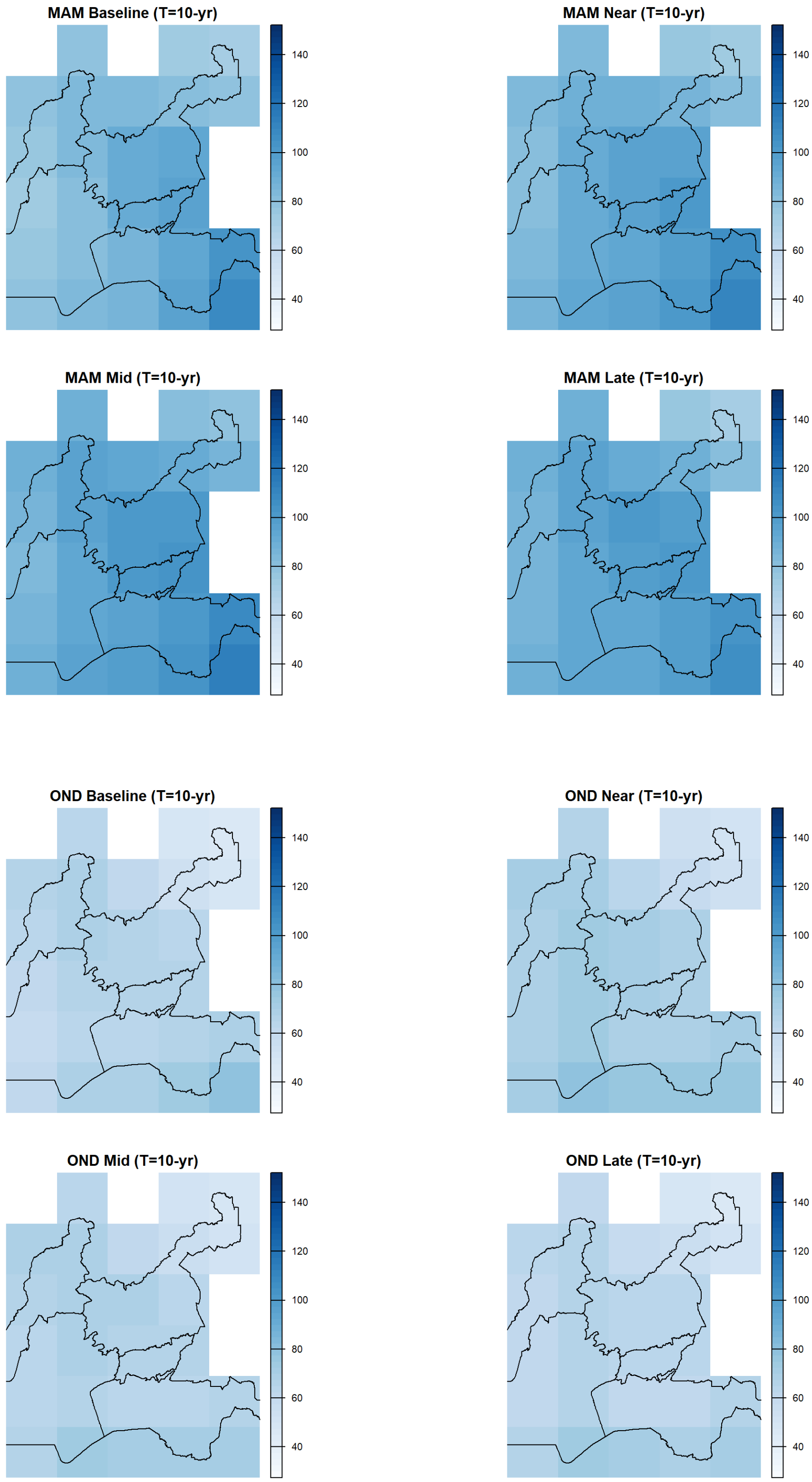


Figure 75: Projected rainfall intensities for the 10-year return period 3-day extreme storm event

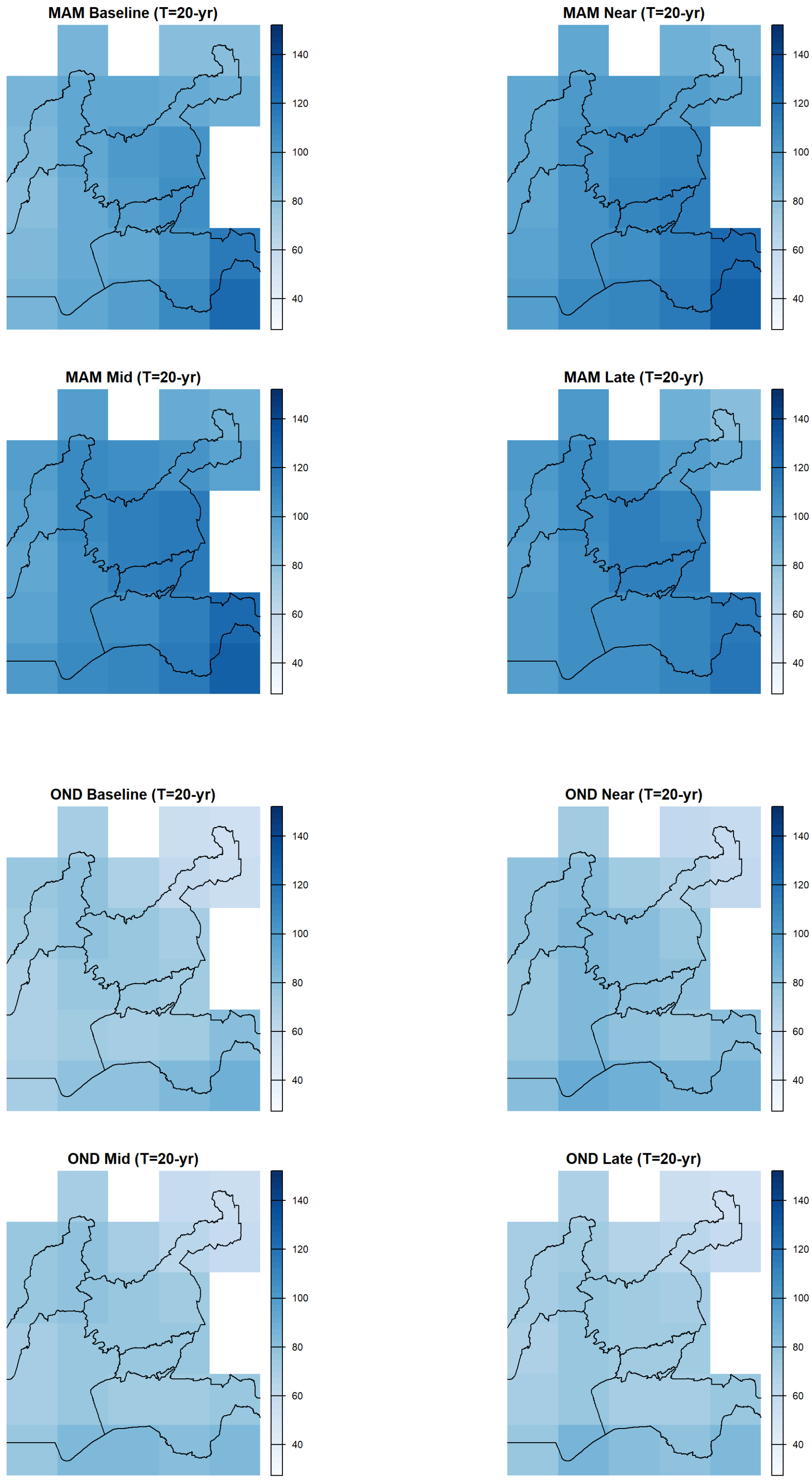
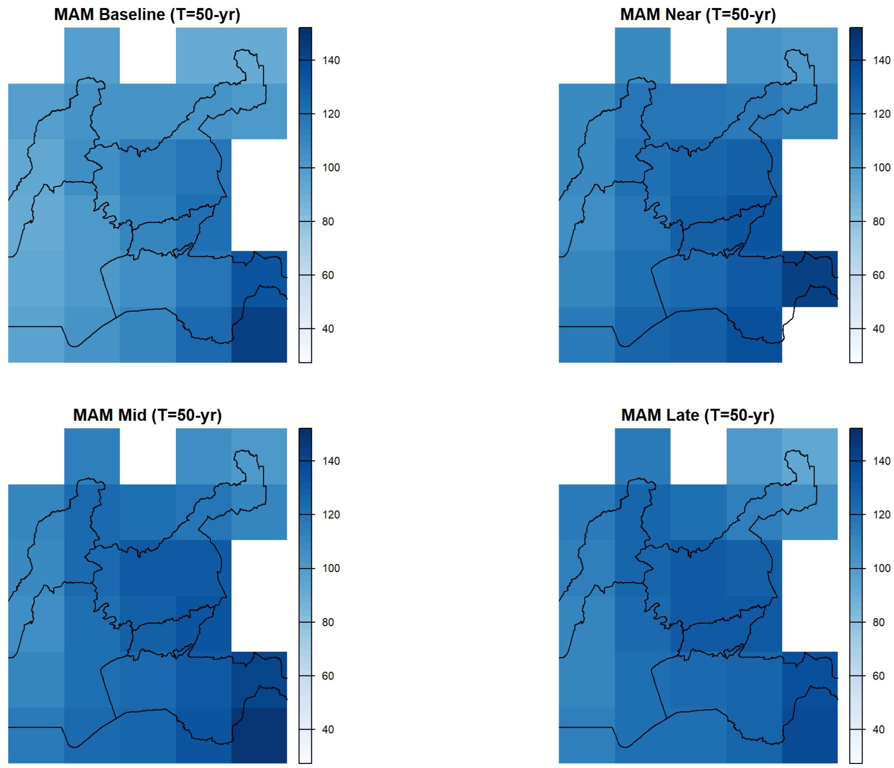


Figure 76: Projected rainfall intensities for the 20-year return period 3-day extreme storm event


MAM Baseline (T=50-yr)
MAM Near (T=50-yr)
MAM Mid (T=50-yr)
MAM Late (T=50-yr)
140
120
100
80
60
40

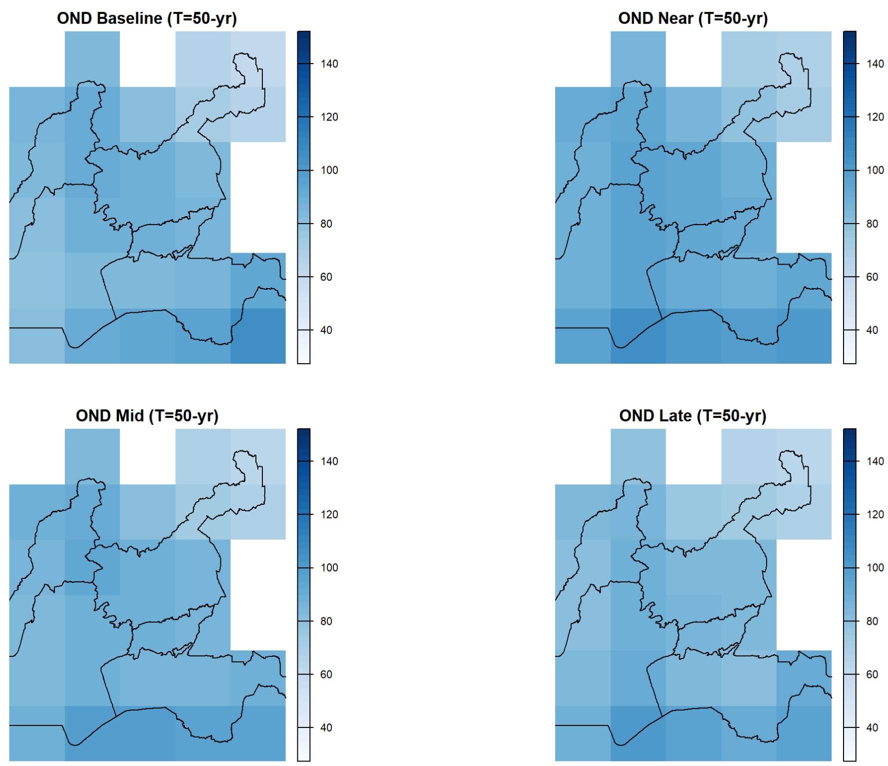

OND Baseline (T=50-yr)
OND Near (T=50-yr)
OND Mid (T=50-yr)
OND Late (T=50-yr)
140
120
100
80
60
40

Figure 77: Projected rainfall intensities for the 50-year return period 3-day extreme storm event

One of the biggest risks to the SGR is the increase in the intensity of what we call Design Storms. The following five-page series of maps shows how much rain is expected during three-day extreme events for return periods ranging from 2 to 50 years.

When we look across the different scenarios and seasons, the MAM season consistently shows the highest rainfall intensity, which is represented by the deep blue colors on the maps. While the total amount of water naturally increases as we move toward the 50-year event, the maps for the 10-year and 20-year MAM return periods show a very significant surge in blue intensity compared to the historical records. These high-intensity areas are most prominent in the highlands of Kakamega and Vihiga, as well as the low-lying basin areas of Kisumu and Busia.

The fact that the 10-year and 20-year storms are showing such high levels of intensity is a major concern for the project. It indicates that *mid-range* storms, which happen more frequently than the 50-year extremes, are now carrying much more water than they used to. For the SGR infrastructure, this means that even a 10-year storm could now bring enough rainfall to cause serious scouring or track flooding. These maps provide the scientific proof that drainage systems must be built to handle these intensity levels to avoid the track being overwhelmed by water during the operational life of the railway.

7.11 Climate Change Adaptation plan

Table 81 below outlines the climate change adaption plan for the SGR Phase 2C project.

Table 81: Climate Change Adaptation plan

Climate Risk	Adaptation Measures	Resilience Outcome	Responsibility	Monitoring Indicators
Extreme Rainfall & Flooding	• For sizing of culverts 1 in 100 years designed will be adopted • Flood-resistant bridges • Embankment reinforcement	Rail infrastructure withstands heavy rains and floods	Contractor / KRC	• Drainage flow check • Inspection after rainfall
Soil Erosion & Landslides	• Bioengineering (grass and bamboo) • Terracing and geotextiles on slopes • Sediment traps and silt fences	Reduced erosion and slope stability	Contractor	• Slope stability monitoring • Sediment load measurements
Water Scarcity & Drought	• Rainwater harvesting at camps • Boreholes with permits • Water-efficient construction (e.g.,	Stable water supply with reduced conflict	Contractor	• Water abstraction volume • Borehole output logs

Climate Risk	Adaptation Measures	Resilience Outcome	Responsibility	Monitoring Indicators
	batching plants)			
High Temperatures & Heatwaves	• Heat-resistant rail steel • Expansion joints monitored • Worker heat stress protocols (shaded rest areas, hydration)	Reduced thermal stress on tracks & workers	Contractor / KRC	• Worker H&S logs • Rail temperature records
Storms, Wind Gusts & Lightning	• Lightning arrestors on tall structures • Anchoring cranes and scaffolding • Weather alert systems at construction sites	Lower risk of equipment failure & accidents	Contractor	• Lightning protection tests • Incident reports
High Humidity & Corrosion	• Anti-corrosion coatings • Regular maintenance & inspections • Use of stainless steel where necessary	Prolonged lifespan of steel structures	Contractor / KRC	• Corrosion inspection logs
Floodplain & Wetland Sensitivity	• Elevated rail sections near wetlands (use of Viaducts) • Controlled construction access in Yala Swamp & Nyando Wetland • Wetland buffer zones	Reduced ecological and structural vulnerability	KRC / Contractor	• Wetland monitoring reports
Public Health Risks (Malaria, Waterborne Diseases)	• Camp drainage improvements • Mosquito nets & fumigation • On-site medical facilities	Healthy workforce and reduced downtime	Contractor	• Clinic records • Malaria incidence trends

7.12 Greenhouse Gas (GHG) Emissions and Climate Mitigation Strategy

The Standard Gauge Railway (SGR) Phase 2C project, which runs for 107 kilometers from Kisumu to Malaba, is a major part of Kenya's plan for low-carbon regional transport. As the corridor passes through Kisumu, Siaya, Vihiga, Kakamega, and Busia Counties, it will change the regional carbon footprint in different ways during its construction and its decades of use. This section looks at the

Greenhouse Gas (GHG) impact by calculating the *Carbon Debt* created during building and the "Net Carbon Benefit" it provides once it is running.

7.12.1 The Construction Phase: The initial Carbon Debt

Building a railway is carbon-heavy. This initial debt comes from the energy used to make building materials, the clearing of land, and the diesel used by heavy construction equipment.

1. <u>Embodied Carbon in Construction Materials</u>

Embodied carbon is the sum of all emissions from the mining, processing, and making of materials like cement and steel. For the Phase 2C line, we use a specific formula to estimate this total embodied carbon (*EC*):

$$EC = \sum(Q_m \times L \times C_f)$$

In this formula:

- *Qm* is the amount of material used for every kilometer.
- *L* is the length of the project (107 km).
- *Cf* is the carbon factor (how many tonnes of *CO2e* are produced per tonne of material).

A. Cement Consumption

Based on data from the Mombasa to Nairobi SGR, we estimate that 318 tonnes of cement are used for every kilometer of track.

- **Total Amount:** 107 km×318 t/km=34,026 tonnes107 km×318 t/km=34,026 tonnes.
- **Carbon Factor:** $0.912t^2CO_2e/t$ (based on the Inventory of Carbon and Energy - ICE Database).
- **Total Cement Impact:**

  34,026×0.912=31,032 tonnes of CO2e34,026×0.912=**31,032** tonnes of **CO2e**.

B. Steel Consumption

Because Phase 2C requires many bridges and viaducts to cross rivers and wetlands, we estimate steel use at 70 tonnes per kilometer.

- **Total Amount:** 107 km×70 t/km=7,490 tonnes107 km×70 t/km=7,490 tonnes.
- **Carbon Factor:** $1.85t^2CO_2e/t$ (based on the World Steel Association global average).
- **Total Steel Impact:** 7,490×1.85=13,856 tonnes of CO2e7,490×1.85=**13,856** tonnes of **CO2 e**.

Combined, the cement and steel for this project create an initial carbon debt of **44,888 tonnes of *CO2 e*.**

2. <u>Land Use Change and Sequestration Loss</u>

Clearing the 107 km path for the railway involves removing trees and plants, especially in the green hills of Vihiga and Kakamega. This causes an immediate release of carbon and stops that land from absorbing CO2 in the future. We calculate this loss of sequestration potential (*SP*) as:

$$SP = \text{Area} \times \text{ACSR}$$

In this equation, *ACSR* is the Annual Carbon Sequestration Rate. To balance this out, the project includes a reforestation plan to plant new trees along the corridor.

3. <u>Construction Logistics and Machinery</u>

The heavy diesel machines used for digging tunnels in Vihiga and building embankments in Busia also emit GHGs. We calculate these logistics emissions (*Elog*) using the total fuel used:

$$E_{log} = \text{Total Fuel (L)} \times 2.68(\text{kgCOC}_2/\text{L})$$

The number 2.68 is the standard coefficient used by the IPCC for burning diesel in mobile machinery.

7.12.2 The Operational Phase: Direct and Indirect Emissions

Once the trains start running, the emissions become more predictable. They depend on how many trips are made and the type of locomotives used.

1. <u>Direct Locomotive Emissions (Scope 1)</u>

For the current diesel-electric locomotives, we calculate direct emissions (*Eops*) this way:

$$E_{ops} = \text{Trips} \times \text{Distance} \times \text{Fuel Economy} \times \text{Emission Factor}$$

With 2,920 trips per year over 107 km, the railway produces emissions, but it is much more efficient than using hundreds of trucks to move the same weight.

2. <u>Station Operations and Auxiliary Power (Scope 2)</u>

These are indirect emissions from the electricity used for station lights, signals, and offices. Since most of Kenya's power comes from green sources like geothermal and wind, this footprint is very small, using a factor of about $0.40\text{kgCO}_2/\text{kWh}$.

3. <u>Efficiency Gains through Operational Design</u>

The SGR is built to save energy. The tracks are laid with gentle slopes to reduce the fuel needed for heavy climbs. Also, the trains use regenerative braking, which turns the energy of the train slowing down into electricity, further reducing the total power needed.

7.12.3 The Net Carbon Benefit: Avoided Emissions and Payback Analysis

The biggest climate win for Phase 2C is the Modal Shift, where cargo moves from polluting trucks to the efficient railway.

Table 82: Summary of Projected Operational GHG Emissions (Annual)

Parameter	Diesel Traction (Current)	Electric Traction (Potential)
Fuel or Energy per one-way trip	428.0 Litres	856.0 kWh
CO2CO_2 per one-way trip	1,147.0 kg	342.4 kg
CO2CO_2 per train-kilometer	10.72 kg	3.20 kg
Annual CO2CO_2 (2,920 trips)	3,349.4 tonnes	999.8 tonnes
Annual CO2eCO_2e (Total Operational)	3,550.3 tonnes	1,059.8 tonnes

To see when the project becomes Carbon Neutral, we look at the Avoided Road Emissions. A standard heavy truck emits about 1.1 kg of CO_2 for every kilometer. When the SGR replaces these trucks, it saves about 17,185 tonnes of CO_2e every year.

Table 83: Carbon Payback and Net Impact Timeline

Phase / Year	Cumulative Project Emissions (tCO2etCO_2e)	Annual Avoided Road Emissions (tCO2etCO_2e)	Net Project Carbon Impact
Construction (Year 0)	44,888 (Debt)	0	-44,888 (Debt)
Operation Year 1	48,438	17,185	-31,253
Operation Year 2	51,988	34,370	-17,618
Operation Year 3	55,538	51,555	-3,983
Operation Year 4	59,088	68,740	+9,652 (Net Zero Reached)
Operation Year 10	80,388	171,850	+91,462 (Net Positive)

The project is expected to reach the net carbon point in 3.3 years of operation.

7.12.4 Conclusions on GHG Mitigation

This analysis proves that while SGR Phase 2C starts with a carbon debt from construction, its high operational efficiency allows it to pay back that debt in just over three years. After that, it becomes a major benefit for Kenya's goal of reducing transport emissions. To maximize this, the Kenya Railways Corporation should continue to plan for full electrification and implement tree-planting programs in Vihiga and Kakamega to replace the vegetation lost during construction. This will ensure the Kisumu-Malaba line is a leader in sustainable infrastructure for East Africa.

7.13 Conclusions

Railway infrastructure along the Kisumu–Malaba SGR corridor including tracks, bridges, culverts, embankments, signaling systems, and power components is highly sensitive to extreme weather conditions. Rising temperatures, intense rainfall, flooding, and occasional cold spells can cause track deformation, ballast washouts, reduced visibility, and operational delays. Without proper climate-responsive planning, these hazards may disrupt train operations, damage infrastructure, and shorten asset lifespan.

The railway infrastructure along the Kisumu to Malaba SGR corridor, including the tracks, bridges, signaling systems, and power components, is highly sensitive to the extreme weather conditions characteristic of Western Kenya. While rising temperatures and intense rainfall can cause track deformation and operational delays, our high-resolution modeling with the GFDL-ESM4 model proves that these risks are not spread evenly across the five counties. By moving beyond regional averages, this assessment has successfully identified the specific locations where the infrastructure is most likely to face structural or operational stress.

The integration of the Multi-Hazard Index and Soil Erosivity modeling identifies the Vihiga and Kakamega highlands, alongside the Kisumu and Busia lowlands, as the primary climate hotspots. Although the volcanic and clay-rich soils in these regions are naturally well-aggregated and stable, they become susceptible to gullying and embankment failure under the projected 30 percent increase in intense 3-day rainfall events. With erosivity values peaking at 0.014, both the MAM and OND seasons will put significant pressure on the railway's subgrade and drainage networks.

A critical finding of this study is the projected compression of return periods for extreme storms. Storm intensities that were historically considered rare 50-year events are becoming more frequent, which greatly increases the risk of hydraulic overtopping. If historical data alone is used to size culverts and bridge freeboards, there is a high probability that future runoff will exceed drainage capacity, leading to ballast scouring or catastrophic washouts.

To maintain safety and service reliability, climate factors must be integrated into every stage of the planning, design, and maintenance of the SGR. This includes adopting a Climate-Plus design philosophy for all hydrological infrastructure and implementing targeted bio-engineering, such as bamboo terracing, in the identified high-erosivity zones. Enhanced inspections during extreme weather and proactive risk assessments are essential to prevent the social and economic consequences of infrastructure failure. By following the spatial hazard profiles and return-period models provided in this assessment, the Kenya Railways Corporation can ensure that Phase 2C remains a resilient and dependable asset for the region throughout the 21st century.

CHAPTER 8.0 STAKEHOLDER AND PUBLIC PARTICIPATION

8.1 Introduction

This chapter presents the approach, process, and outcomes of the Stakeholder and Community Consultation conducted as part of the ESIA process. Stakeholder engagement is a critical component of the ESIA process, ensuring that the views, concerns, and knowledge of affected and interested parties are considered in project planning and decision-making.

Public participation is an essential and legislative requirement for environmental authorization. The Firm of Experts undertook the public stakeholder consultation (PSC) with regard to the proposed project. The public consultation was undertaken between 26th May 2025 to 6th June 2025 to obtain information from interested and affected parties (stakeholders), solicit their views and consult on sensitive issues by completing a set of questionnaires. The output is incorporated in the development of mitigation measures.

8.2 Objectives of Stakeholder Engagement

Stakeholder engagement for the proposed project was undertaken to:

a) Inform key stakeholders of the proposed project and create public awareness on environmental and social risks associated with the project.
b) Identify opportunities and risks from and to the project: By anticipating a project's potential problems, consultations can help reduce the risk profile (delays, legal disputes, and negative publicity), lead to cost savings, and enhance the social benefits to local communities.
c) Explicitly address stakeholders' comments and concerns, in the project's decision-making process.
d) Achieve a transparent decision-making process with greater input from stakeholders and their support of the decisions that are taken.
e) To enhance the project to support the aspirations and needs of the local communities, including the vulnerable marginalized groups (VMGs) living within the project area.
f) To build local capacities and foster ownership, which are crucial elements of project sustainability.

The consultation process enabled the establishment of a communication channel between the Public and the ESIA Consultants, KRC and the Government (through the Local Administration), and ensured that concerns of the stakeholders were known to the decision-making bodies at an early phase of project development.

8.3 Stakeholder Consulted

Table 84 below summarize the stakeholder consulted that will be affected or have an interest in the proposed Kisumu Malaba SGR Project and are therefore expected to have an influence on its implementation in one way or another.

Table 84: List of stakeholders consulted

Category	Stakeholders Consulted
National Government	County Commissioner Busia, Siaya, Kakamega, Vihiga and Kisumu
	DCC, s for each Sub County traversed by the SGR
	ACC, s for each division traversed

Category	**Stakeholders Consulted**
	Chiefs for each location
County Governments	County governments of Busia, Siaya, Kakamega, Vihiga and Kisumu Sub Counties administrators
Government Institutions	KRC
	NEMA at the County levels
	KFS at the county levels
	KWS at the county levels
	KMFRI Kisumu Office
	Water Resources Authority (WRA) at regional levels
	KPLC, KETRACO and other related Institutions at Regional levels
Project Affected Persons (PAPs)	All
Transport Operators	Representatives
Business Communities	Representatives
Local Communities	Communities group and members
Trade/ Manufacturers Associations	KAM KNCCI
Others	• Religious groups representative, • Community Based • Organizations (CBO) • Non-Governmental Organizations (NGO) • Youth and Women groups • People with disability • Vulnerable groups

8.4 Stakeholder Response Matrix

Table 85 below summarizes the stakeholder outcomes during consultation.

Table 85: Stakeholder Response Matrix

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
1	Nyaoke Alex, Kisumu Museums, Admin|HR	• Natural habitats for living creatures will be affected. • Snakes, fish, birds and rare mongoose are endangered. • KRC should find alternative measures that are friendly to nature during implementation. • KRC should put into consideration climate change and its effects. • KRC should observe policies that ensure balanced ecosystem.	• Cheap and reliable means of transport. • Widespread distribution of resources.	• Interference of natural habitats of wildlife. • Displacement of human population.	• Proper relocation of wildlife. • Proper relocation of human settlements.
2	James Nyangweso Water Resources Authority Regional Manager	• KRC should comply with all regulations before implementation.	• Creation of employment • Ease of transport. • Enhanced development growth.	• Displacement of people. • Loss of ancestral land. • Culture change. • Disruption of water sources. • Water pollution.	• Develop and implement recovery/rehabilitation plans. • Sensitize the community. • Compensation.
3	Lorrine Otieno KFS Forester II	• KRC should sensitize the communities on where to get the correct species of trees for afforestation i.e. KEFRI and KFS. • KRC should have more stations for easier access.	•	• Soil erosion. • Migration of some birds from the affected areas • Deforestation	• KRC can sponsor tree planting • Create awareness to the communities affected on environment conservation.
4	George Otieno Kenya Fisheries Service Senior Fisheries Officer	• KRC should share study reports. • KRC should have a one-on-one stakeholder's consultation on the recommendations made by the public.	• Employment creation. • Economic growth	• Displacement of people • Possible loss of lives.	• KRC should compensate the affected persons promptly. • Proper protection of site during implementation phase.
5	Beatrice E. Amollo NGAO Ass. Chief	• KRC should prioritize the affected people on employment during implementation.	• Business improvement • Growth of urban areas. • Job creation	• Displacement of schools and other learning institutions.	• KRC and National Lands should consider a better way of relocating and

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
				• Increased transmission of STIs and HIV/ AIDS.	compensating vulnerable people who would have not processed their succession for land • Moving schools to other places.
6	Joel Otieno Otiang' KOBAT CBO Director KOBAT	• KRC should conduct regular consultation with the communities and stakeholders. • KRC provide media briefs on the progress. • KRC should have community ambassadors.	• Job creation • Promotes economic development. • Ease of transport in terms of speed and cost. • Cash crop farming enhancements.	• Displacement of the inhabitants. • Power disruption. • Vibration and noise. • Waste disposal	• Compensation and advance notices. • Waste management and rehabilitation.
7	Lucas Ong'are Small Scale Farmer Retired Civil Servant	• KRC should be cooperative with the community during implementation.	• Urbanization of tows along the line	• Displacement of people • Separation of families.	•
8	Austin Obiero NGAO Assistant Chief	• KRC should be informing the communities on the progress of the project. • KRC should conduct sensitization and financial literacy education to the community.	• Creation of job opportunities • Growth of centers and towns along the railway line.	• Displacement of public institutions. • Misuse of compensation funds by affected people • Displacement of people	• Compensation be done in time to the affected people. • Affected people be given ample time to acquire land and settle.
9	S.M. Mashobo Assistant County Commissioner – Yala	•	• Creation of job. • Faster transportation of goods.	• Displacement of people. • Disruption of way of life of the displaced communities. • Destruction of environment	• KRC should conduct public participation. • Involvement of key stakeholders in the processes to be undertaken.
10	Edwin B. Shikuku Sub County Water Officer-Teso South	• KRC should incorporate Water Expert to handle the water and sanitation aspects.	• Urbanization	• Destruction of water infrastructure. • Pollution of water	• Use greener energy and plant climate resilient vegetation to avoid soil degradation

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
11	Ruth N. Social Development Officer.	• The implementing company to establish an office to deal with the social issues arising.	• Job creation • Improve living standards for locals • Growth of businesses	• Spread of STIs and HIV • Defilement cases • Gender based violence. • Early pregnancies. • Family wrangles and breakdown over the compensation	• Sensitization of the communities on the risks • Project implementors to work closely with relevant departments to address emerging issues
12	Amina Jamal Ward Administrator County Govt. of Kakamega	• KRC to conduct public participation.	• Increased land value. • Job creation • Improved security	• Soil erosion. • Noise and Air pollution	• Minimize air pollution • Reduce oil usage
13	Lydiah Khata PSA Kakamega County Administrator	• Training of residents through public participation prior to the project commencement.	• Creation of employment • Enhance regional trade • Faster and safe means of transport. • Attracting investors. • Increased land value and security	• Displacement of families • Environmental pollution • Deforestation • Reduced farming /food production • Shut down of small transport companies	• Identify land and resettle the displaced. • Afforestation. • Ensure proper disposal of excavated waste.
14	Linet Odinga Administrator	• The contractor should work with the residents and other stakeholder in a friendly manner.	• Faster and safer means of transport. • Increase employment • opportunities. • Attraction of investors	• Displacement of residents and public institutions. • Family conflicts because of compensation • Sexual harassments. • Environmental hazards.	• Sensitization be done to affected residents.
15	Emily Asiko County Govt of Kakamega Ward Administrator	• The administrators should be involved in sensitization of residents, • Ensure rehabilitation of areas where excavation has been done.	• Employment opportunities • Faster means of transport.	• Conflict between kins. • Spread of diseases i.e. HIV/AIDS, STIs • Displacement of families.	• Sensitize members of the public in advance for those who will be affected and compensated. • Provide protective measures e.g. sexual education and condoms provision.

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
16	Amos Barasa Administrator	•	• Job creation. • Improved socio economic • Faster means of transport. • Increase in regional trade.	• Displacement of people. • Misuse of compensation • Increased HIV infections. • Displacement of public utilities. • Risk of accidents.	• Protection of water and soil from pollution. • Protection of railway lines
17	Fridah Bwoga Business Woman	• KRC should keep educating the affected people on how to use the compensation.	• Ease of movement. • Job creation.	• Families will be separated. • Affected members will be displaced.	•
18	Pius N.Wesonga Wakhutu	• Resettlement should be done as per the law.	• Development within the region. • Employment opportunities. • Enhanced transport.	• Displacement of residents.	• Follow the laid down procedure on the resettlement of people. • Compensation of the affected land owners.
19	Lilian Getlight Andako Saloonist Ikomero Kisa West	• Residents should be considered for employment.	• Promoting socio-economic development	• Displacement of people	•
20	Charles Wesonga Makokha Farmer. Emulaka SubLocation	• This is a great project since it creates jobs and open up markets for their products.	• Job creation • Improved security • Business growth in the region • Ease of transport	• Loss of land • Separation of families.	• Enough Compensation to the affected people
21	Erasmo Omurunga Nandwa CGK-PSA Department Ward Administrator	• The study team should keep involving the local community in the project. • The project should set up other community projects e.g. schools, hospitals and major, markets as part of the community social responsibility.	• Creation of employment opportunities for the locals. • Enhance local economy by attracting investors • Promote integration of local communities.		
22	Elvis Opicho Nurse	• Timely payment of the displaced persons • Job creation for locally unskilled and semi-skilled persons • Dispute resolutions for affected persons be done outside courts	• Business growth • Faster transport means • Ease of traffic/congestion in roads • Economic growth		

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
23	Beatrice Adhiambo Bolere Peasant Farmer Arwatat village	• Let the government enhance peace, support youths and vulnerable persons	• Easy transportation of people and goods • Employment • Improved connectivity		
24	Charles Inyang Orone Farmer Opare Village	• The government could sensitize people compensated on financial literacy • The government should protect locals against land brokers and fake documents • The government should resolve all related disputes outside courts.	• Enhance drainage particularly in swampy areas and flood prone areas. • The project will sensitize locals on the importance of acquiring title deeds. • Growth of local towns.		
25	Blaise Ekakol Teacher Amoni	• KRC should consider the safety of those people affected by the SGR.	• It will lead to development of the area and improved infrastructure.	• Displacement of people	• the displaced people should be compensated by concerned department for resettlement
26	Dr. Anthony Opacha Ekakol IBOM Church Planting Ministry of Kenya. Amoni	• The affected people should be relocated to safe places. • KRC should consider the safety of those people affected by the SGR.	• Development of infrastructure and improvement of people's lives around the area.	• Displacement of residents	• the displaced people should be compensated by concerned department for resettlement
27	Francis Etori Okisah Peasant Farmer Township A	• The government should compensate the affected people promptly to help in acquisition of new land • The government should do away with land brokers.	• It will create employment • It will boost lifestyles • Ease transport	• Displacement of community	• By properly compensating the victims • The affected persons be given civic education. • The persons to be compensated lumpsum and also be given enough time to relocate
28	Mustafa Wanga Wesonga Farmer Kolemu B	• It's not easy to get new land • The government will pay little compensation • The government should pay people on time • The government to provide more civic education • The government to consider locals for employment.		• Relocation of people • People will be forced to relocate to new settlements thus facing new challenges	• Quick and good compensations • People to accept changes associated with relocations

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
29	Kenanzi Karani Etiang Peasant Farmer Township A	• The project will facelift the town • The government should compensate people well and do away with brokers.	• Easy means of transport • Will create job opportunities • Will enhance drainage	• Displacement of people • Environmental change	• Good compensation • People should embrace tree planting
30	Solomon C.Kitai DCC Teso North Sub County	• They should understand and be willing to interact with locals well in case of dispute.	• Improve trade • Creation of employments • Cheap means of transport	• Accidents	
31	Ismael Anekeya Ongaya Medic (Med-Lab tech)	• The team to enhance communication and coordination with the community. • Request for fairness and just ways of compensation.	• Growth of business. • Improved communication. • The land values will increase. • Improved lifestyles.	• Separation of families. • Displacement of people.	• Fair and prompt compensation • Counselling and sensitization of the affected people to make good use of the compensation.
32	Dorothy Adongo Muhola NGAO Chief	• Compensation to be done to the rightful owners. • Ensure the community gets proper awareness of the project.	• Emergence of market centers • Reduced transport cost • Reduced accidents in roads • Creation of employment (unskilled labor) • Reduction in pollution	• Displacement of people • Interference /destruction of cultural heritage centers • Markets and learning institutions will be displaced.	• Re-routing
33	Livingstone Wetende Namayi Firatsi WRUA/Water Resource Authority Chairman.	• Implementing contractors to work closely with WRUA for mitigation measures to restore water catchment ecosystems • The community main source of water are springs, boreholes, shallow wells, community water projects and river Firatsi.		• Water projects will be affected as well as water sources e.g. springs. • Deforestation • Soil erosions during construction • Community and institutions e.g. schools will be displaced during construction of the rail.	• Resettlement and compensation of affected communities. • Planting of indigenous trees, drilling of boreholes to communities whose water source will be interfered with.
34.	Kemia Emmanuel Interior Assistant County Commissioner	• KRC should form a financial literacy program for beneficiaries. • Life skill capacity building on health and disease control egg HIV/AIDS	• Improved transportation of locally produced goods to markets. • Job creation		

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
		• KRC should sponsor programs for the community e.g. construction of markets, schools and abolition blocks.	• Opening up of the sub county for development.		
35	Daniel Owino Wamukuwa Teacher/Education	• Ensure electricity supply to nearby corridors for the residents.	• Employment both skilled and unskilled labor force. • Cheap and faster transportation.	• Displacement of former land owners.	• Fair, just and prompt compensation to the affected land owners to find alternative land to resettle. • Adequate notice time to move to alternative places after compensation.
37.	Timothy Achungo Okumu Westland's Constituency (P.S.C)	• KRC should establish clear communication channel to those affected by the project	• Job creation to the community • Transport made easy • Promotion of businesses	• Relocation from ancestral land. • Disruption of access to social amenities to those affected • Settlement inconvenience.	• On-time compensation to the affected • Proper human relocation methods.
38	Elizabeth Interior DCC	• KRC should take keen consideration of the inputs from the community.	• Opening up of the area for development. • Cultural growth. • Employment opportunities	• Blocking quick access for the neighboring community members. • Emotional effects where graves are affected.	• Putting up sufficient underpasses. • Counselling of the affected families
39	Ochieng' Otieno SCHRMO-NGAO HRMO	• KRC should reduce the distance from one underpass to the other for easier movement of locals	• Efficient means of transport • Increased economic activities • Enlarged business enterprises.	• Displacement of persons • Pollution of environment • Land disputes	• Land compensations • Put measures to reduce pollution.
40	Julius Kanganya N.P.S DAP	• KRC should consider putting up more stopovers			
41	Jared Magara MOE SCQASO-Seme	• The project is very important for transportation and time management because of the speed of SGR • The government should think of addressing land succession issues and timely compensation.	• Employments to locals • Reduced congestion in roads especially in December holidays		

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
			• Mushrooming of the businesses because of the ongoing construction		
42	Tom O. Otieno Self Employed Manager		• Enhancing business • Increased land value • Travel time made short		• Sensitizing the stakeholders on the bigger picture.
43	Peter Ouko R.E. Africa Western Sales Manager	• The processing of land documentation should be made fair and cheaper to the affected. • KRC to promptly compensate the affected persons.	• Enhancing regional trade • Job creation for the community • Faster means of transport • Growth of local businesses	• Displacement of family members. • Destruction of natural infrastructure along the line	• Proper and prompt compensation to enable resettlement. • KRC should build better /proper social institutions for the communities e.g. hospitals and schools
44	Benard Otieno Otiende Korando Opinion Leader Chairman	• The team explained the project very well to the people	• Trading will be positively up-lifted	• Farm land will be reduced especially where the stations will be located.	
45	Tobias M. Olweru Department of Agriculture, Livestock Assistant Director of Agriculture	• KRC should do phase uplift of the social amenities and infrastructure within the project areas e.g. schools, hospitals, markets, roads • The project has more positive than negative impacts.	• Emergence of new markets • More trees planted	• Crop damage • Increased soil erosion • New flood cases • Deforestation • Loss of other livelihood means.	• Crop damage compensation • Soil conservation • Planting trees • Drainage systems, canals, diversion channels to be put in place.
46	Peter Okoth Hongo Veterinary Officer	• Recommend payment of non-evictees living along the proposed railway line		• Noise levels from the SGR will disrupt farming and rearing of some animal species e.g. poultry and bees	• Payment of people ling along the line.
47	Josphat Mayanja Office of WREP Field Officer	• KRC should consider request od providing a station in the region	• Improved economy of the region	• Vibration and noise pollution • Involuntary land acquisition	
48	Carren Atieno Omondi Kenya Forest Service Forester	• KRC should create positive work environment b enhancing feedback and evaluations, foster collaboration among stakeholders		• Noise will cause distress on wildlife • Fragmentation and degradation of land after deforestation	• Proper control on the emissions of greenhouse gases.

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
		• Optimization of workload management by preparing detailed workplans.		• Loss of vegetation cover hence an imbalance in ecosystem. • Disruption of water bodies	• Well established environment management plan. • Public education to raise public awareness within the affected communities • Proper inspection of construction materials and equipment. • Detailed research on the SGR route in order to come up with reasonable management plans.
49	Charles Apudo Gem Constituency CDF Manager	• KRC should state how soon will the project start and if the affected members will be fair compensated.	• Youth employment • Business will grow	• Insecurity in some areas • Land disputes • Displacement of people • Separation of communities • Destruction of other facilities and buildings.	• Fair compensation to the affected
50	Peter Omondi Orinda Education Youth Affairs, Gender and Social Services Sub -County Co-ord for PWD	• The study team to have a sign language interpreter during public participation to enable those with hearing impairment participate • The community is worried about less compensations, hazardous substances e.g. smoke, fuel spills	• Employment creation • It will improve businesses	• Interfere with social amenities and residentials • Relocation of people	• Compensation to the affected people • Affected persons to be involved in the project management cycle.
51	Edwin Maxwell KYDPU Co-Ordinator	• There should be effective involvement of beneficiaries, timely valuation and compensations, effective communication between KRC and affected people and the involvement of the community in the study team.	• Creation of job opportunities • Improved businesses • Efficient and effective means of transport • Networking and collaborations		

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
52	Benard Omondi Omongo Businessman	• The affected persons should be handled professionally in the project • Water issues to be addressed	• Improve the lives of locals	• Displacement of persons • Environmental change	• KRC to work with the local administrators the opinions of the people
53	Peter Ayila Wadegu Ministry of Education School Principal	• Establish more railway stations • Sensitize railway builders to be in harmony with the community. • Put into consideration future development of the environment.	• Employment • Faster means of transport. • Boost trade • Increased tourism • Reduced congestion in roads	• Immorality • Noise pollution • Soil erosion • Dust may cause respiratory diseases • May cause climate change • Animal migration	• Fencing to be done • Compensated people to plant more trees • Take care of animals by giving them pathways
54	Thomas Achuke Politician	• Make sure the interests of vulnerable people are considered. • Put up a station in Seme Sub-County	• Decongestion of roads • Cheap and safe means of transport • It will improve the economy.	• Environmental pollution • Water points will be contaminated	• Properly compensate the affected. • Make sure our people and animal use safe water. • Measure should be taken by contractors to safeguard the environment.
55	Robert Odondo Businessman Director	• KRC should speed up the process	• There will be employment to the people. • Reduced travelling cost		• The resettlement and compensation should be clear and wider.
56	Jared Oketch CGK-Livestock	• KRC should consider stakeholders welfare.	• Increased employment • Reduced poverty • Attraction of investment • Reduction in accidents	• Displaced and reduced grazing fields for free range. • Disrupted water points for animals. • Possible disease outbreaks in confined areas • Disruption and change of livelihoods • Potential increase in crime rate	• Continuous public participation and awareness creation • Construct side institutes for the said affected. • Partner with county government in opening up new sale yards. • Construct water paths for selected water sources
57	County Government of Kisumu Ward Administrator.	• KRC should consider doing other social responsibility projects to benefit the community members	• It will reduce pressure on roads • Creation of jobs • Emergence of new market	• Disruption of livelihoods • Family conflicts	• Creating /training the community members on other sources of livelihood. • Training on HIV/AIDS

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
			• Increased business	• Sexual harassment by the workers • Increased HIV spread • Misuse of compensation money • Increased crime	• Putting rules on workers e.g. whoever breaks the law will be prosecuted
58	Joan Kevin Barasa Ministry of Agriculture Agricultural Officer	• The government should pay real people • The government should close all possible avenues for brokers to capture the good project. • Government should consider paying the people small left-over lands that are not of importance. • The government to pay workers on time • The government of Kenya could have improved M.G.R to S.G. R	• Enhanced marketing of farm produce • Improved infrastructure	• Relocation of people • Small left-over land is not economically viable. • Relocation of affected people • People won't access water incase rivers are blocked by the SGR	• The government should consider buying the small left-over lands • The government to offer good compensation • Contractors to excavate the river for people to access water.
59	Lawrence Ikiro Eyang	• Rehabilitate existing roads along the rail • Drill water for general use for employees and affected locals • Employ locals	• Will create employment • Will ease transportation	• Displacement of locals	• Compensate people fully on time
60	Mourine Murega Peasant Farmer Kodedema B vilage	• The government should consider dualling the SGR and bring other projects related to the project.	• it will provide enhanced trade • it will ease transportation • it will act as a landmark • it will facelift affected areas		
61	Omondi Oliech Lamech Farmer	• Conduct more sensitization programs (door to door)	• Job creation • Businesses improvements.	• Relocation. • Barrier to social amenities. • Difficulty in acquiring fertile land. • Family disagreement.	• Providing financial awareness to affected individuals. • Providing a legal framework. • Thorough awareness on social and environmental impacts.

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
				• Pressure in handling large sum of money that you have never had. • Conmen and conwomen	
62	Jenipher Awuor Farmer	• The training was adequate although needs more time.	• Job opportunities. • Source of revenue. • New centers and towns emerging. • Growth of businesses.	•	• Relocation to new homes. • Preparation of tittle deeds
63	James Otieno	• Include sign language during public participations	• Improve transportation • Economic growth	• Displacement of communities. • Separation of families	• Early relocation to the affected families. • Compensation should be fair.
64	Electrical engineer	• Observe high discipline during the construction work.	• Increase in trade. • Construction of infrastructure • Increase in goods and services	• Displacement • Noise pollution • Insecurity • Cultural exchange	• Use machines that produces less noise.
65	Aggrey Ongaya Agriculture Farmer	• The team to enhance communication and have the best co-ordination.	• Improved lifestyle. • The land value will increase • Businesses will come up	• Families will be separated.	• Fair and prompt compensation to enable affected people relocate
66	Imelda Naliaka Business woman Bubala Sub-Location	• The study team should educate people on how to use money being compensated.	• Tourism attraction • Improve business in the society • Fare transportation	• Displacement of people.	
67	Wilberforce Buluma NPS/KPS	• Ensure the right people should be compensated	• Creation of employment • Fast means of transport • Increased trade	• Relocation of people from their homes • Loss of employment for those working in PSV	
68	Patricia Kokoi Civil Registration Department	• Conduct proper public participation to ensure a seamless consensus as built before commencing of project.	• Creation of new employment	• Displacement of families • Loss of jobs for some sectors • Increased crime	• Compensation in full to enable affected people recover lost properties.

INDEX	STAKEHOLDER	COMMENTS GIVEN	POSITIVE IMPACTS	NEGATIVE IMPACTS	PROPOSED MITIGATION MEASURES
				• Loss of property	
69	Eld. Kochila	• Make sure people are paid by KRC and the Kenyan government in lumpsum and fairly • The society will be affected culturally and economically.	• Job opportunities	• Community breakage • Poverty to those whose land will be affected. • Environmental disasters	• Prompt compensations. • Land be provided by government resettle people.
70	John Oluoch Ochiel SIBO-WASCO HR	• The team should have the interpretation for those that do not understand the used language for the local and illiterate people.	• Improved infrastructure and enhanced transportation of both goods and people.	• Relocation of people	• They should use sound control. • Government should help those unable to process the titles
71	Eric Omondi KPLF Supply Chain Officer	• Cooperate social responsibilities.	• Job creation	• Separation of communities	• Building underpasses
72	Adamson Akendo Pastor	• It is healthy to have censored public consultation	• Easy and quick transportation • Reduction of road congestion • Opening up of the interior areas	• Displacement of people • Agriculture land will reduce • Deforestation • Land will be expensive to buy	• Fair compensation • Sponsored afforestation • Excavated land be rehabilitated • Dust be controlled during construction
73	Jorum O.Nyamor Farmer	•	• Fast transportation • Employment of locals • Business to locals	• Noise to environment • Dust • Blocked access to amenities e.g. water and hospitals	• Construction of walls • Watering the dust • Several Underpasses

8.5 Analysis of the Stakeholder Questionnaire Responses

The stakeholder consultations demonstrated broad awareness of, and general support for, the proposed SGR project, with most participants acknowledging its substantial socio-economic benefits. However, the consultations also underscore significant environmental, social, and livelihood-related concerns that will require careful and proactive management.

Across the 73 stakeholders consulted representing government agencies, community leaders, farmers, businesspersons, civil servants, and special interest groups there is a strong consensus that the SGR project is a transformative development initiative. Stakeholders widely recognize its potential to stimulate regional economic growth, enhance connectivity, and improve access to markets and social services. Nevertheless, stakeholder support is largely conditional on the provision of fair and timely compensation, transparent and continuous communication, and the effective mitigation of adverse impacts. Presented below is a tabulated thematic analysis that synthesizes stakeholder.

Table 86: Analysis of the stakeholder questionnaire responses

Theme	Key Issues Raised by Stakeholders	Perceived Positive Impacts	Key Risks / Negative Impacts	Recommended Mitigation & Enhancement Measures
Land Acquisition, Displacement & Resettlement	• Fairness and timeliness of compensation • Loss of ancestral land • Land succession issues and lack of title deeds • Influence of land brokers • Residual uneconomical land parcels	• Increased land value in some areas • Formalization of land ownership	• Physical and economic displacement • Family separation and conflicts • Displacement of schools, markets, utilities	• Fair, prompt, and transparent compensation • Resettlement in line with the law • Adequate notice periods • Compensation to rightful owners • Financial literacy and legal support
Livelihoods & Economic Impacts	• Employment for locals • Protection of farmers, pastoralists, and traders • Loss of farmland and grazing areas	• Job creation (skilled and unskilled) • Growth of businesses and markets • Enhanced regional trade • Improved access to markets	• Loss of agricultural land • Reduced grazing areas • Disruption of existing livelihoods • Closure of small transport businesses	• Local employment prioritization • Livelihood restoration programs • Support for alternative income activities • County partnerships for market development
Social Risks & Community Well-being	• Labor influx management • Protection of vulnerable groups • Community cohesion	• Improved living standards • Urban growth and improved services	• Spread of HIV/AIDS and STIs • Gender-based violence and sexual harassment • Early pregnancies • Increased crime and insecurity • Misuse of compensation funds	• HIV/AIDS and GBV awareness programs • Codes of conduct for workers • Collaboration with health and social departments • Financial literacy and counselling
Environmental Impacts & Biodiversity	• Protection of forests, wetlands, wildlife, and fisheries • Climate change considerations	• Opportunity for afforestation • Improved environmental planning	• Deforestation and habitat loss • Wildlife displacement and migration • Soil erosion	• Implement ESMP measures • Afforestation and rehabilitation • Wildlife corridors and crossings

Theme	Key Issues Raised by Stakeholders	Perceived Positive Impacts	Key Risks / Negative Impacts	Recommended Mitigation & Enhancement Measures
			• Dust, noise, and vibration • Air and water pollution	• Dust, noise, and emissions control • Climate-resilient vegetation
Water Resources & Sanitation	• Protection of rivers, springs, boreholes, and community water projects • Involvement of water experts	• Improved drainage in flood-prone areas	• Pollution of water sources • Destruction of water infrastructure • Restricted access to water	• Work with WRUAs and Water Authorities • Protect and rehabilitate water sources • Provide alternative water supply (boreholes, diversions)
Community Access, Safety & Mobility	• Need for underpasses and crossings • Safety during construction and operation	• Faster and safer transport • Reduced road congestion and accidents	• Blocked access to social amenities • Accidents involving people and livestock • Noise impacts on settlements	• Adequate underpasses and crossings • Traffic and safety management plans • Fencing and signage
Cultural Heritage & Social Institutions	• Protection of graves and cultural sites • Relocation of public institutions	• Cultural integration and regional growth	• Disturbance of graves and heritage sites • Displacement of schools, churches, and markets	• Chance finds procedures • Rerouting where feasible • Relocation and reconstruction of institutions
Stakeholder Engagement & Communication	• Continuous consultation • Clear communication channels • Inclusive participation	• Improved trust and project ownership	• Misinformation and disputes • Exclusion of vulnerable groups (PWDs, illiterate persons)	• Regular public participation • Use of local languages and sign language • Community liaison officers and feedback mechanisms
Governance & Institutional Coordination	• Compliance with laws and regulations • Role of national and county governments	• Improved coordination and service delivery	• Delays due to weak coordination • Disputes and grievances	• Strong GRM • Inter-agency collaboration • Transparent disclosure of project information
Corporate Social Responsibility (CSR)	• Demand for community development projects	• Schools, hospitals, markets, water projects	• Unrealistic expectations if unmanaged	• Clearly defined CSR programs aligned with community priorities

8.5 Public Consultation Meetings

The ESIA Public Consultation Meetings were held between 26th May 2025 to 6th June 2025 at various locations as shown in Figures 22-25 below. The meetings were carried out in a language that was appropriate to the different audience i.e. English, Swahili and Luo. While the local project affected people, meeting was organized at location level with support of the respective DCCs. The public consultation meetings provided a wide platform for all the relevant stakeholders to raise their concerns, highlight the project related environmental, social, economic, cultural and risk impacts and issues of significant. The total of 2,506 persons attended the consultative meeting, among them 1,739(61%) were males and 767(31%) were females as indicated in **Table 87** below which also indicates meeting schedule. Issues and concerns articulated during the stakeholder meetings. The summary of minutes from the public meetings are attached in this report.

Table 87: Meeting schedule

Date	County	Venue per Sub County	Attendance	Gender	
				Male	Female
26/05/2025	Busia	Baptist Church (Malaba, Teso North)	287	223	64
27/05/2025		DCC's office Teso Central	30	21	9
		Kotur Location Chief's office (Teso Central)	77	64	13
		Kwangamor Location, Sokomoko/Koteng'o (Teso Central)	94	67	27
29/05/2025		Mauko Market, Butula sub-county Apostle Restoration Ministries Church	157	113	44
28/05/2025		DCC's office, Butula sub-county	10	7	3
		DCC's office, Nambale sub-county	144	101	43
29/05/2025	Siaya	Ugunja DCC's office, New Life Prayer Centre	86	62	24
		Gem Yala sub-county Office	21	16	5
30/05/2025		Yaw Pachi Sagam Marenyo sub-location (Gem Yala Subcounty)	179	114	65
30/05/2025	Kakamega	DCC office, Matungu sub-county	12	10	2
		Esiala Catholic church Matungu subcounty	111	73	38
03/06/2025		DCC Office, Mumias	20	11	9

Date	County	Venue per Sub County	Attendance	Gender	
				Male	Female
		West Sub-County)			
		Masinjira sub-location	152	112	40
		Eshirombe location	188	128	60
04/06/2025		DCC Office, Butere Sub-County	163	119	44
04/06/2025	Vihiga	Luanda Sub-County (Ochwore Centre)	150	87	63
05/06/2025	Kisumu	Kisumu West DCC office	11	9	2
		Korando B/Kisian Railaway Station (Kisumu West)	453	278	175
		DCC Office, Seme Sub-County	11	7	4
06/05/2025		Siala Ka-Aila Primary School, Seme Sub-County	150	117	33
Total			**2,506**	**1,736**	**767**

Public participation meetings attracted 2506 participants across the 5 counties traversed by the proposed Kisumu Malaba SGR line. Of the participants 1736 were male while 767 were female.

Figure 78 and 79 below provides a comparative analysis of participants by county and gender.

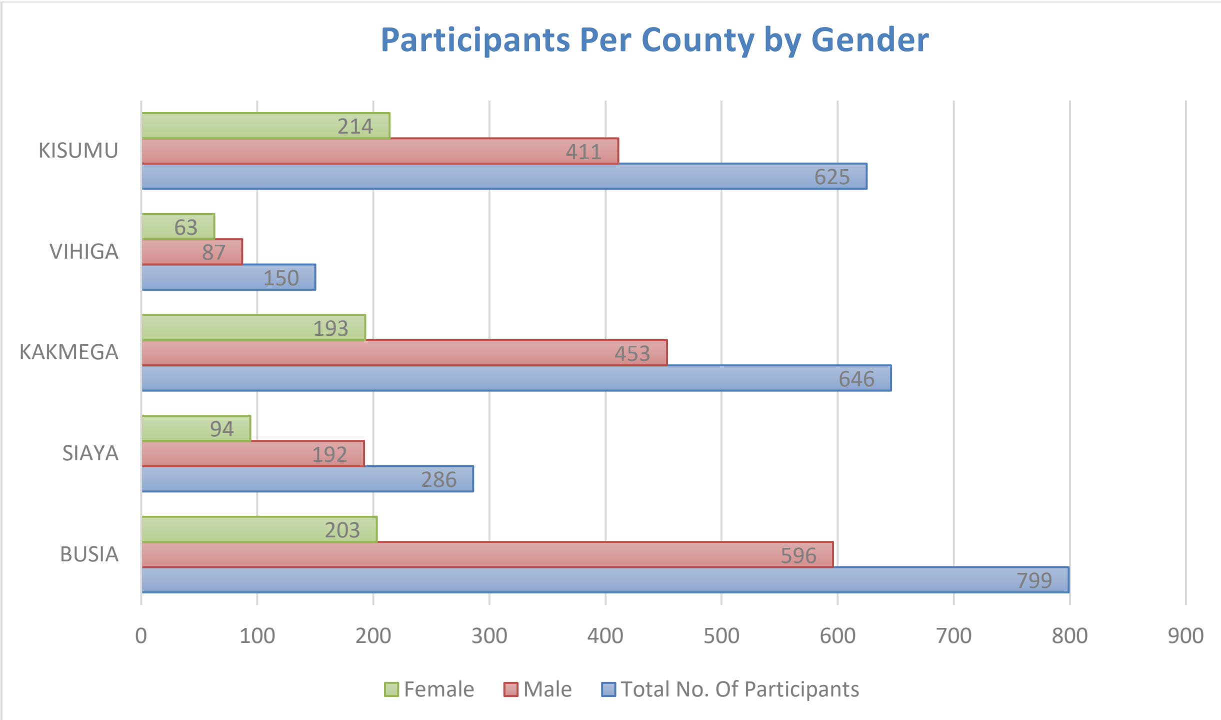


Figure 78: Participants per county by gender

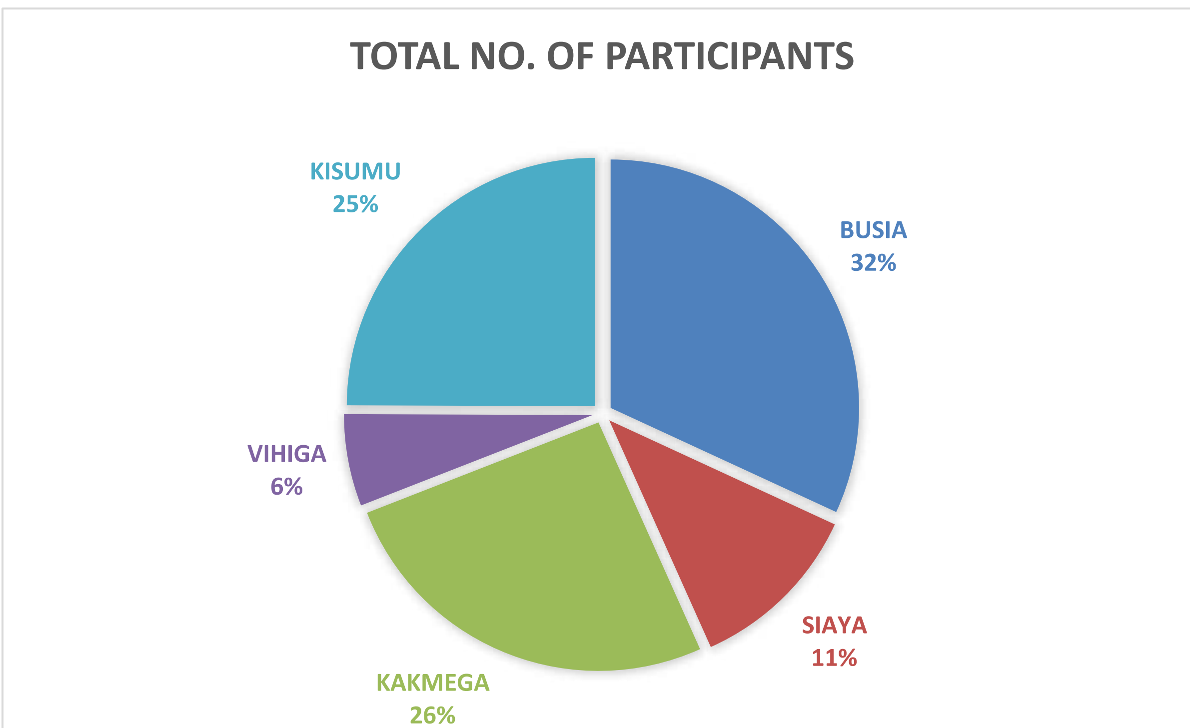


Figure 79: Total number of Participants for the five counties

The figures below show the images during the public participation forums held in Busia County.

Baptist Church (Malaba, Teso North)

Kotur Location Chief's office (Teso Central)

At the Butula DCC office

DCC's office, Nambale sub-county

The figures below show the images during the public participation forums held in Siaya County.

 Ugunja DCC's office, New Life Prayer Centre	 Ugunja DCC's office, New Life Prayer Centre
 Sagam Marenyo sub-location (Gem Yala Subcounty	 Sagam Marenyo sub-location (Gem Yala Subcounty

The figures below show the images during the public participation forums held in Kakamega County.


At Esiala Catholic church Matungu subcounty


At Masinjira sub-location


At Eshirombe Location


DCC Office, Mumias West Sub-County)

The figures below show the images during the public participation forums held in Vihiga County.


Luanda Sub-County (Ochwore Centre)


Luanda Sub-County (Ochwore Centre)

The figures below show the images during the public participation forums held in Kisumu County.

 Korando B/Kisian Railaway Station (Kisumu West)	 Korando B/Kisian Railaway Station (Kisumu West)
 DCC Office, Seme Sub-County	 Siala Ka-Aila Primary School, Seme Sub-County

The public engagement meetings revealed that most stakeholders were already informed about the proposed project. During these sessions, the consultant and the proponent provided detailed briefings to the community and relevant stakeholders on the planned Standard Gauge Railway line from Kisumu to Malaba. Questions and concerns raised by participants were also responded to their satisfaction.

Stakeholders had varied perspectives to the project, with residents expressing both support and apprehension due to the potential positive and negative impacts. Stakeholders and local communities openly shared their views, opinions, and suggestions based on their interests and the circumstances influencing their livelihoods and institutions.

The meetings created an opportunity for those who would be directly affected to voice their concerns. These contributions played a key role in identifying issues that guided the ESIA process. It was noted that some project-affected persons expressed a sense of entitlement, believing that the proposed project passes through their parcels of land.

All environmental issues raised are to be addressed through the mitigation measures outlined in the subsequent chapter of this report. Other project-related concerns were also clarified and resolved during the meetings with support from the proponent's representatives, who provided further explanations where necessary.

8.6 Validation Workshops

8.6.1 Introduction

The draft ESIA report and its findings were subjected to a validation workshop attended by regulators, lead agencies, national and county government officials, representatives of affected communities, and technical experts, in line with NEMA guidelines and international best practices.

The purpose of the validation workshop was to ensure that the findings of the Environmental and Social Impact Assessment (ESIA) accurately reflected the realities, views, and concerns of stakeholders consulted during the fieldwork.

8.6.2 Objective of a Validation Workshop

The objectives are:

- Present the ESIA findings including identified impacts, baseline conditions, and proposed mitigation and management measures.
- Receive stakeholder feedback to verify the accuracy and completeness of the information documented during the ESIA process.
- Ensure stakeholder ownership of the results by providing a platform for meaningful participation and dialogue.
- Confirm that community concerns were correctly captured and reflected in the ESIA report.
- Enhance transparency and accountability by involving stakeholders in reviewing and validating project impacts and proposed actions.

Notice letters were issued seven days prior to the workshops to the respective County Commissioners (CCs), Deputy County Commissioners (DCCs), County Government offices, and relevant government agencies as per the NEMA guidelines.

Table 88 below presents the meetings of the validation workshops for the Kisumu–Malaba SGR Phase 2C.

Table 88: Validation Workshop Meetings

County	Busia County	Siaya County	Kakamega County	Vihiga County	Kisumu County
Date	6th October, 2025	7th October, 2025	8th October, 2025	9th October, 2025	13th October, 2025
Venue	Kokodrilla Hotel, Malaba	VIP Madeya Hotel	Garden Park - Mumias	Vihiga Triple T	Alabama County Lodge

The output during the validation workshop have been incorporated in this final report.

The figures below illustrate the ongoing validation workshop sessions.

At Alabama Hotel, Kisumu County

At VIP Madeya, Siaya County

At Garden Park Hotel, Kakamega County

At Triple T Hotel, Vihiga County

At Kokodrilla Hotel, Busia County

Figure 80: Ongoing meetings during validation workshop

The validation workshop confirmed that the findings of the draft ESIA report reflected the environmental and social baseline conditions, as well as the key issues raised during earlier consultations.

Participants including regulators, government representatives, technical experts, and representatives of the affected community members verified that their concerns had been correctly captured and highlighted any additional issues that needed inclusion.

The proposed mitigation and enhancement measures were reviewed, with stakeholders offering further recommendations to strengthen the Environmental and Social Management Plan (ESMP).

The workshop provided an opportunity to clarify outstanding questions related to project design, anticipated impacts, and institutional responsibilities.

Any gaps identified in the ESIA process were noted, and follow-up actions were agreed upon. Overall, the workshop facilitated consensus-building on the ESIA findings, with stakeholders acknowledging the inclusiveness and transparency of the consultation process. A record of participants, key contributions, and deliberations was documented to meet NEMA requirements.

The outcome of the deliberation from the validation workshops, attendance sheets are annexed in this report.

CHAPTER 9.0. ENVIRONMENTAL IMPACTS IDENTIFICATION, ANALYSIS AND EVALUATION

9.1 Introduction

This chapter presents the systematic identification, evaluation, and analysis of potential environmental and social impacts associated with the proposed project the objective is to determine the likely positive and negative effects of project activities across all phases and to assess their significance in order to inform decision-making and the design of appropriate mitigation measures.

9.2 Impact Identification

This forms the foundation upon which mitigation, management, and monitoring plans are built. It helps in identifying potential environmental and social impacts (positive and negative) helps decision-makers assess the feasibility, acceptability, and sustainability of the proposed project.
Impact identification was conducted through project screening and scoping, baseline data collection, stakeholder engagement,) GIS and Spatial analysis, Use of impact identification tools e.g. checklists and expert judgements from past similar projects.

During the site preparation and clearance phase of the proposed project, several negative environmental and social impacts may arise if the right mitigation measures are not put in place. This phase typically involves vegetation clearing, land leveling, excavation, and relocation activities — all of which can disrupt ecosystems and communities.

During the construction phase, several negative environmental and social impacts may occur if proper mitigation measures are not implemented. This phase involves intensive activities such as earthworks, bridge and tunnel construction, material transport and infrastructure installation.

The operation phase of a Standard Gauge Railway (SGR) project brings significant long-term benefits like efficient transportation and economic growth. However, it can also lead to negative environmental, social, and economic impacts if not properly managed. These impacts typically arise from train operations, maintenance activities, and associated infrastructure use.

The decommissioning phase may involve dismantling railway infrastructure and restoring the site to its original or another agreed-upon state. This phase may have significant negative environmental and social impacts if not properly managed including waste generation, soil disturbance and erosion, air and noise pollution amongst others.

Table 89 and 90 below provides the scoping matrix for environmental and social aspects respectively.

Table 89: Scoping Matrix - Environmental aspects identification of the potential interactions between project actions and environmental aspects

	Project Activities	**Soil quality**	**Topsoil**	**Soil erosion**	**Surface water**	**Surface water flow patterns**	**Sediments**	**Groundwater**	**Hydrogeological flow patterns**	**Air quality**	**Noise and**	**Landscape**	**Flora**	**Fauna**	**Habitats**	**Ecosystem Services**	**Protected and Designated sites**	**Cultural Heritage**
1	*Clearance of existing land, vegetation and buildings*	X	X	X	X		X			X	X	X	X	X	X	X	X	X
2	*Temporary sites used for construction works (material storage and equipment maintenance camps, concrete batching plants, crushing plants) and housing of construction workers)*	X	X		X			X		X	X	X	X	X	X	X	X	X
3	*Above ground construction, earthworks, cut and fill or excavations, building of linear structures and stations*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	*Underground works including mining / tunneling*							X	X	X	X	X			X	X	X	X
5	*Haulage roads*	X	X	X						X	X	X	X	X	X	X	X	X
6	*Construction traffic and machinery movement*	X	X	X			X			X	X	X	X	X	X	X	X	
7	*Inert waste landfills*	X	X	X	X		X			X	X	X	X	X	X	X	X	
8	*Borrow pits*	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X
9	*Impoundment, realignment or other changes to the hydrology of watercourses or aquifers*	X	X	X	X	X	X	X	X				X	X	X	X		X
10	*Rivers/Stream crossings (building the bridges)*	X	X	X	X	X	X						X	X	X	X		
11	*Usage, storage, transport, handling or production of hazardous substances*	X	X	X	X	X	X	X		X		X	X	X	X	X	X	

12	*Trains passing*				X			X		X	X		X	X	X	X	X	X
13	*Presence of permanent way, bridges, tunnels and stations*			X		X	X	X	X	X	X	X	X	X	X	X	X	X
14	*Passengers/loads in/out the trains and at stations*				X					X	X							X
15	*Maintenance of railway track*	X	X		X			X		X	X		X	X	X			
16	*Overhead power lines*												X	X	X	X	X	X

Table 90: Scoping Matrix – Social aspects identification of the potential interactions between project actions and social aspects

		Project Activities	Land and Property	Community Health and safety	Community tensions	Access & Severance	Disruption of utilities	Economy	Employment	Education and Training	Vulnerable groups	Workforce Related impacts	Communities " Quality of Life"
Construction phase	*1*	*Above ground construction, earthworks, cut and fill or excavations, and building of linear structures and stations*	X	X	X	X	X	X	X	X	X	X	X
	2	*Temporary sites used for construction works (material storage and equipment maintenance camps, concrete batching plants, crushing plants) and housing of construction workers, placement of borrow pits and landfill*	X		X	X	X	X	X	X		X	
	3	*Haulage roads*	X	X		X							X
	4	*Construction traffic and machinery movement*		X	X	X						X	X
	5	*Manipulation with hazardous materials during construction and transport of raw materials and finished materials*		X								X	
Operational phases													
	1	*Presence of permanent way, bridges, tunnels and stations, passenger and freight traffic*	X	X		X		X	X	X	X	X	X
	2	*Passengers/loads in/out the trains and at stations*		X								X	
	3	*Maintenance of railway track*										X	

	4	*Trains passing*		X								X	X
	5	*Overhead power lines*		X			X					X	

Summarized impacts are indicated in **Table 91** below.

Table 91: Impact identification

PHASE 1: SITE PREPARATION	
Impact category	**Impacts**
Flora and Fauna	• Clearing and de-vegetation, levelling of land surface; excavated materials, drainage requirements. • Traffic affecting wildlife by driving them away from their natural habitat leading to increased stress and displacement. • Introduction of invasive species through machinery used at different sites may carrying soil, seeds, or plant material stuck to tires, tracks, or undercarriages. • Vegetation clearing, grading land, building access roads, and mobilizing equipment may contribute to the breaking up of continuous natural habitats into smaller, isolated patches. • Fencing off areas results into barriers, preventing animals from accessing feeding areas, water sources, breeding grounds, or migration routes.
Clearance of existing land vegetation and buildings	• Removal of portions of existing tree cover found both on farms and in urban areas may lead to altered temperature patterns, shifts in light exposure, changes in soil moisture and nutrient content, and modifications to the natural landscape. • The loss of vegetation in urban areas and residential zones will leave communities more vulnerable to harsh winds, which can cause increased soil erosion and environmental degradation. • May also result in the loss of valuable resources such as cash crops, natural shade, windbreaks, animal fodder, fruits, timber, medicinal plants, and firewood—resources that many local households depend on for both economic and daily living needs.
Air quality / general site	• Earthmoving, stockpiling, land clearance and excavation activities have the potential to create

establishment works and access road	air quality impacts. Different activities will create different levels of dust, so the magnitude of change will vary throughout the site clearance phase.
Increase in noise and vibration from establishment works and access road upgrade	• These may cause excessive noise to the human and ecological receptors. The nearby properties could be adversely affected from a small number of movements or even the passage of a single heavy vehicle in close proximity to receptors at a sensitive time of the day • Noise generated from machinery for construction of road, water storage facilities, vehicular transport of equipment to the project sites
Water quality	• Water required for reducing dust during site clearance and establishment • There is potential for pollution of surface water courses from fuel or chemical spillages (if poorly managed) and spoil materials generated during site clearance, particularly during heavy rainfall.
Reduced Surface Water Quantity	• Water will be sourced from different water sources for dust suppression and access road construction which can lead to reduction of water quantity. However, this is not expected to be significant considering water shall be drawn from different water sources.
Soils and geology	• Extensive bush clearing to give way for railway line and other related infrastructure, levelling of land, construction of buildings causing soil compaction, soil exposure to wind/water erosion, and dust pollution. • Repeated movement of trucks and equipment along undesignated routes may compress the soil resulting in reduced porosity and permeability, poor water infiltration and drainage. • Excavation activities along landscapes and hillsides have the potential to destabilize slopes, increasing the risk of erosion and slope failures.
Improved access due to upgrades to existing access road network	• Potential impacts on local road users and local people due to increased project traffic and upgrades
Impact on grazing land and other livelihood sources	• Potential disruption to traditional grazing patterns as a result of the proposed infrastructure development due to restricted access to established grazing routes and communal pasturelands.

	• Displacement of small businesses and farmlands traversed by railway line.
Oil spillage	• Risk of oil spillages occurring due to leaks of petroleum products and routine dripping and leaking of oil, grease, and solvents from machinery and vehicles leading to soil and water contamination.
Project influx/induced in-migration	• Due to availability of both skilled and casual work opportunities, a number of jobseekers will be attracted to the area looking for employment opportunities. This will result in a temporary increase in population in the project areas. This increase is also not expected to result in increased pressure on local services or markets for local goods and services although it could contribute to perceptions that local people are not sufficiently benefiting from employment opportunities and create conflict between the local community and non-local workers.
Land acquisition and economic displacement	• Physical displacement is expected for residential structures have been identified to be closer to the proposed railway infrastructure. The project is expected to result in loss of land and access to land for landowners and livestock farmers along the railway line. The proponent commissioned a Resettlement Action Plan which outlines how affected individuals and communities will be identified, consulted, compensated, relocated, and supported to restore or improve their livelihoods and living standards. In total, the following categories of potentially economically displaced Project Affected Person (PAPs) have been identified: 1. Legal landowners and legal tenants 2. Informal land landowners and informal land users 3. Ecosystem services users (restricted access to farming lands, grazing areas, disruption of wildlife habitat,)
Cultural Heritage/known and unknown archaeological sites	• There are no known archaeological sites located within the site/ or footprints of the project but the presence of as yet unidentified artifacts or sites of archaeological and/or historical importance cannot be ruled out that could be accidentally damaged during site preparation activities.
Health, safety and security risks to workers	The key OHS risks for the site establishment phase, include: • Exposure to physical hazards from use of heavy equipment • Trip and fall hazards

	• Exposure to dust, noise and vibrations • Falling objects • Exposure to hazardous materials; and exposure to electrical hazards from the use of tools and machinery • Environmental hazards adverse weather conditions, such as working in extreme heat, heavy rainfall • Psychological hazards including high-stress work environments or fatigue • Risks specific to the project location include exposure to extreme heat and hazards associated with working on or near roads. • Workers involved in vegetation clearance are at greater risk of snake bites.
Health, safety and security risks to the local community	• The project creates potential risks of incidences, accidents and transmission of disease to the community members. These risks and associated hazards require management measures. • During site establishment, if not mitigated the following activities could cause disturbance or impact the health safety and security of land users, neighboring villages and local community members: • Truck and vehicle movements will increase existing traffic volumes. Nuisance impacts from increased noise, vibration and dust related to site clearance activities. Potential diseases and infections passed from workers to local community, in particular HIV/AIDS and other sexually transmitted infections as a result of the influx of labour force population from other areas.
Waste from excavated materials and obsolete equipment	• Some excavation tools and equipment used may become worn out or obsolete hence there will be need for them to be discarded. • Additionally, soil and rock materials excavated from the site may be unsuitable for reuse once the excavation is complete. • If not properly managed, the materials can cause negative environmental impacts, such as soil contamination or disruption of local ecosystems.
Movement of vehicles and mobilization of the materials and other associated equipment	• Injury and killing of species through project activities e.g vehicle movement can cause degradation of terrestrial habitats. There is also potential for injury/ death of terrestrial fauna due to collisions with vehicles.

	• Incidents and accidents caused by vehicles transporting equipment to and from the site. • Emissions from vehicles and pollution from operational vehicles
PHASE II: CONSTRUCTION PHASE	
Flora and Fauna	• Splitting ecosystems into smaller, disconnected patches, making it harder for certain plant species to propagate Disturbance of soil and transport of materials from other areas to the project sites may lead to the spread of invasive alien plant species. These species can outcompete and displace native plants, disrupting the local ecosystem. • Heavy machinery may compact the soil, reducing its ability to support plant growth. • Constant noise and vibration from construction disturb some mammals, birds and some herpetofauna species, affecting their feeding, mating, nesting, and migration. • Nighttime lighting may disorient nocturnal animals and migratory birds. • Dust particles generated by vehicle movements on dusty roads may adhere to leaves, impeding photosynthesis and plant growth
Blasting and rock excavation	• Blasting activities generate significant quantities of dust and fine particulate matter which pose respiratory risks to workers and nearby communities • Detonation of explosives produces high-intensity impulsive noise and ground vibrations causing human discomfort, disturbance of wildlife, and structural damage to nearby buildings. • Improperly controlled blasting can result in the ejection of rock fragments at high velocities which poses serious safety hazards to workers, nearby residents, livestock, and infrastructure.
Occupational Health, safety and security risks to workers	• Exposure to physical hazards from use of heavy equipment • Trip and fall hazards • Exposure to dust, noise, vibrations and falling objects • Exposure to hazardous materials; and exposure to electrical hazards from the use of tools and machinery • Environmental hazards adverse weather conditions, such as working in extreme heat, heavy rainfall • Psychological hazards including high-stress work environments or fatigue

	• Risks specific to the project location include exposure to extreme heat and hazards associated with working on or near roads.
Impact on existing public utilities	• Existing community service utilities located within the designated railway corridor including domestic water supply lines, sewerage systems, electrical transmission and distribution networks, and optical fiber communication cables may require relocation as part of the project's easement and right-of-way acquisition process. • End-users and customers connected to the affected utility networks may experience temporary, short-term disruptions or service outages.
Water quality	Impacts especially in areas where the railway corridor crosses rivers, wetlands, or groundwater recharge zones. These impacts can be temporary or long-term, and often result from land disturbance, machinery use, and poor construction practices. • Soil disturbance during excavation, grading, and clearing leading to erosion and runoff into nearby water bodies • Increased turbidity, which reduces sunlight penetration and affects aquatic ecosystems. • Contamination from construction materials e.g. accidental spills of fuel, oil, lubricants, and cement slurry from machinery and storage areas can pollute surface/ groundwater and harm aquatic life. • Groundwater Contamination due to deep excavation near water tables ma introduce pollutants from surface runoff into aquifers.
Water Quantity	• Construction of railway embankments, bridges, and culverts can redirect or block natural water flow, leading to alteration of natural drainage patterns. This can result to flooding or reduced water flow to downstream users or ecosystems. • Soil compaction from machinery reduces infiltration and increases surface runoff which may lead to decreased groundwater recharge.
Flooding and drainage	• The project may encounter significant challenges related to local flooding, primarily due to surface runoff influenced by the existing land topography, the configuration of outfall linkages, and the absence or inadequacy of efficient drainage infrastructure.

	• The areas that are likely to prone to flooding include; Kamolo area in Busia, Wet lands including the Yala swamp, Sio Wetland and Maungo Wetland.
Soils and geology	• Soil compaction from heavy machinery and construction traffic compact the soil, especially in access roads and embankments. • Soil Contamination resulting from spillage of fuels, lubricants, cement, and chemicals can lead to soil pollution, negative impacts on microorganisms and soil fertility.
Influx/induced in- migration	• The proposed project is likely to attract people looking for employment opportunities from different areas leading to temporary increase in population in the areas. This may result to; • Reduced access or quality of services for the host community by putting strain on local services and resources e.g. health facilities, water supplies, sanitation infrastructure and waste management systems • Increased Risk of Gender-Based Violence (GBV) and Exploitation through Sexual exploitation and harassment, increased cases of teen pregnancies or transactional sex and higher incidence of STIs, including HIV/AIDS. • Increased demand for housing and goods may cause inflated prices of goods services that locals may not afford. • Tensions or protests by locals due to exclusion from employment opportunities.
Damage to Cultural Heritage/known and unknown archaeological sites	There are no known archaeological sites located within areas earmarked for the railway line but the presence of as yet unidentified artifacts of archaeological and/or historical importance cannot be ruled out that could be accidentally damaged during construction activities.
Increased traffic to and from the construction sites	• Heavy trucks carrying construction materials to the site may cause traffic jams on highways and access roads. • The weight and volume of construction vehicles may accelerate wear and tear on roads. • Mixing heavy-duty vehicles with regular traffic may lead to a rise in accidents, including injuries and fatalities. • Constant movement of trucks and machinery causes dust pollution, affecting visibility and respiratory health.

	• Noise from traffic if not managed may disrupt daily life, especially in sensitive receptors e.g. residential houses, schools and hospitals.
Impacts on local communities	• Relocation of families may lead to inadequate housing alternatives • Splitting of communities who have been staying together may weaken social support systems and cultural ties. • Displacement sometimes may result to reduced access to facilities e.g schools, clinics, and clean water.
Impact on livelihoods	• Destruction of farmlands and livestock grazing areas • Loss of informal employment e.g. roadside vendors, artisans, or service providers lose income as work areas are taken over.
Sourcing of construction materials from the locality e.g. sand, hardcore and ballast	• The construction activities will require substantial quantities of raw materials including sand, ballast and murram, which are likely to be sourced from off-site borrow pits and quarry locations. • These may lead to over exploitation of the natural resources, burrow pits
PHASE III: OPERATION	
Impacts on Flora and Fauna	• Regular vegetation clearance due to routine maintenance leads to damage to surrounding plant communities and soil degradation. • The railway creates a physical barrier for wildlife movement which may lead to disruption of migration routes, breeding patterns and access to feeding and watering sites. • High-speed trains may pose a significant collision risk to animals crossing tracks leading to injury or death. • Operational noise and vibration from trains and stations causes may cause chronic stress in wildlife disrupting mating calls, communication, and predator-prey dynamics. • Diesel-powered trains emit NOx, PM, and CO_2, which may affect air quality leading to foliar damage in nearby plants and cause respiratory issues in small mammals and birds.
Impacts on local community	• The railway line may act as a physical barrier, cutting off shorter access to schools, markets, health facilities.

	• Increased risk of accidents and injuries from high-speed trains from collision risks at uncontrolled crossings or near settlements. • Noise and vibration from constant train movements causing noise pollution and affecting nearby structures.
Impacts on soil and geology	• Inadequate or clogged drainage channels can lead to waterlogging causing weakening of railway embankments which triggers local landslides. • Ongoing use of fuels, lubricants and waste materials near rail yards and stations may spill into surrounding soil leading to reduction of soil fertility and affecting nearby agricultural productivity. • Long-term vibrations from frequent train operations can destabilize weak rock formations near tunnels or steep cuts and exacerbate micro-cracking or slope movements in geologically sensitive areas.
Impact on the environment	• Waste from stations, train cabins, and maintenance yards includes e.g. plastics, oil, used lubricants, and chemicals when not well managed can lead to littering, soil and water pollution.
Visual intrusion arising from lighting at night	• Lighting at night from bulbs installed at railway stations, tunnels and bridges can cause visual intrusion, disrupting the natural landscape and affecting the aesthetic value of the area. • It can disturb local communities, wildlife, and sensitive ecosystems by altering natural light patterns, potentially leading to disorientation in nocturnal animals and sleep disturbances for nearby residents.
PHASE IV: DECOMISSIONING	
Impacts on Flora & fauna	• Re-disturbance of restored or natural Vegetation including areas previously revegetated during operation may be cleared or damaged again during the removal of tracks, embankments, and infrastructure. This can result to loss of native plant cover, increased risk of erosion and invasive species colonization. • Leakage of fuels, oils, or chemical residues during dismantling can result to harming of root systems inhibiting natural regrowth and regeneration. • Mechanical removal of structures and vegetation can lead to creation of new barriers or clearings in previously connected plant communities. This can disrupt successional stages and

	slow down ecological restoration • Some animal species may have adapted to railway embankments or buffer zones as habitats or movement corridors. Decommissioning activities may lead to their displacement and reduced available foraging or breeding grounds.
Impacts on local community	• Dismantling activities may release dust and particulate matter from heavy machinery affecting nearby residents and wildlife. • Noise and vibration from the decommissioning activities. • Potential diseases and infections passed from workers to local community, in particular HIV/AIDS and other sexually transmitted infections as a result of decommissioning labour force population
Impact on workers	• The key OHS risks for the site decommissioning phase, include: • Exposure to physical hazards from use of heavy equipment • Trip and fall hazards • Exposure to dust, noise, vibrations and falling objects. • Exposure to electrical hazards from the use of tools and machinery • Environmental hazards adverse weather conditions, such as working in extreme heat, heavy rainfall • Psychological hazards including high-stress work environments or fatigue • Risks specific to the project location include exposure to extreme heat and hazards associated with working on or near roads. Workers involved in vegetation clearance are at greater risk of snake bites
Water Quality	• There is potential for pollution of surface watercourses from fuel or chemical spillages (if poorly managed) and spoil materials generated during decommissioning, particularly if heavy rainfall occurs.
Soils and geology	• Soil disturbance and erosion from removal of rail tracks, embankments, and foundations. • Increased risk of soil erosion, especially on slopes or loose soils. • Heavy machinery used in dismantling and transportation can compact soil, reducing

	Infiltration, drainage and soil aeration when designated routes are not followed.
Land acquisition and economic displacement	• Further impacts on land acquisition and economic displacement are not expected during decommissioning phase. • Once the project has been decommissioned it is expected that most land will be rehabilitated and returned to the existing land uses. The land required for the upgraded roads and new access roads will not be rehabilitated and so the land loss will be permanent.
Damage to Cultural Heritage/known and unknown archaeological sites	• There is a possibility that during the decommissioning activities hitherto undiscovered artefacts or sites may be discovered although the likelihood of this is low given that no new areas of land take is expected.

9.3 Significance and impact analysis

Significance and impact analysis matrix have been used purposely to evaluate the importance and severity of predicted impacts on the environment and local communities. The matrix combines several criteria to determine which impacts are most significant and therefore require focused mitigation and monitoring. It also ensures that predicted negative impacts are evaluated objectively, forming the basis for effective mitigation planning, stakeholder engagement, and environmental management throughout the project lifecycle.

The following tables below indicate the significance of the evaluated impacts;

i. Noise and vibration

Table 92: Evaluation of Noise and vibration

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	3(Moderate)	2(Minor)	2(minor)
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	2(Regional)	1(Local)	1(Local)
Probability	4(Certain)	3(Likely)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	36(Moderate)	30(minor)	21(Minor)
Implication	The degree of impact that the project may have upon the Community is high. The project may be compromised if this impact cannot be avoided or mitigated.	The degree of impact that the project may have upon the community during operation and decommissioning is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project	
Discussion	Noise and vibrations levels is expected to increase mainly due to blasting during site preparation. Baseline environmental noise equivalent noise results from all the sampling locations ranged between 44.4-60.0 dB(A) which is within EMC, WHO and IFC recommended limits. Ground vibration levels ranged between 0.011 and 0.49mm/s which is within EMC Limit of 5.000mm/s.		

ii. Air pollution- Gaseous emissions

Table 93: Evaluation of Air pollution – Gaseous emissions

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	3(Moderate)	3 (Moderate)	2 (Minor)
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	3(Likely)	2(Medium (as likely as not)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	30(Minor)	30(Minor)	21(Minor)
Implication	The degree of impact that the project may have upon the environment and community during the 3 phases is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.		
Discussion	Emissions during the construction and operation phases may be relatively higher as compared to decommissioning phase due to extensive machinery and materials usage. By adopting modern emission controls and use of clean energy sources, the project will be able to sufficiently mitigate the impacts.		

iii. Air pollution- Dust generation

Table 94: Evaluation of Air pollution – Dust Generation

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	4(Major)	1(Negligible)	3(Moderate)
Duration	3(Long term)	4(Permanent)	2(Medium term)
Scale	1(Local)	1(Local)	1(Local)
Probability	4(Certain)	1(Low)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	36(Moderate)	21(Minor)	18(Minor)
Implication	The degree of impact that the project may have upon the environment and community is high. The project may be compromised if this impact cannot be avoided or	The degree of impact that the project may have upon the environment and community during operation and decommissioning is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.	

	mitigated	
Discussion	This will be relatively high during site preparation/construction phase generated through vegetation clearing, earthworks disturbing the soil surface and making fine particles airborne. Access roads used by trucks and equipment may also raise large amounts of dust.	

iv. Impact due to vegetation clearance

Table 95: Evaluation of impact due to vegetation clearance

	Site Preparation/Construction	Operation	Decommissioning
Magnitude	4(Major)	2(Minor)	2(Minor)
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	2(Regional)	1(Local)	1(Local)
Probability	4(Certain)	2 Medium (as likely as not)	2(Medium (as likely as not)
Sensitivity	3(High)	2(Low)	2(Low)
Significant points	39(Moderate)	18(minor)	14(negligible)
Implication	The degree of impact that the project may have upon the environment is high. The project may be compromised if this impact cannot be avoided or mitigated.	The degree of impact is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project	No noticeable impact on the environment and community. Little or no mitigation is required
Discussion	Site preparation/construction phase has a relative impact on vegetation due to expected extensive land clearing for rail corridors and embankments, station infrastructure, construction camps, burrow pits and access road.		

v. Health and safety of workers

Table 96: Evaluation of Health and Safety of workers

	Site Preparation/Construction	Operation	Decommissioning
Magnitude	4(Major)	4(Major)	4(Major)
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	1(Local)	1(Local)	1(Local)
Probability	3(High)	3(High)	3(High)

Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant	33(Moderate)	36(Moderate)	30(Minor)
Implication	The degree of impact that the project may have upon the workers during construction and operation phases is high. The project may be compromised if this impact cannot be avoided or mitigated.		The degree of impact that the project may have upon the workers is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.
Discussion	The project may expose workers to significant occupational risks. Relatively high impacts is expected to be experienced in construction and operation phases due to exposure to sharp tools, snake/insect bites, falls into trenches, dust inhalation, accidents during routine operation and maintenance activities, noise pollution from heavy machinery and heat stress due to prolonged outdoor exposure amongst others.		

vi. Community health and safety

Table 97: Evaluation of Community Health and Safety

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	4(Major)	3(Moderate)	3(Moderate)
Duration	3(Long-term)	4(Permanent)	3(Medium term)
Scale	1(Local)	1(Local)	1(Local)
Probability	3(High)	3(High)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	33(Moderate)	33(Moderate)	27(Minor)
Implication	The degree of impact that the project may have upon the community during construction and operation is high. The project may be compromised if this impact cannot be avoided or mitigated.		The degree of impact that the project may have upon the community is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project
Discussion	The project can significantly affect the health and safety of surrounding communities through exposure to physical, environmental, and social risks throughout construction and operation. Identifying and addressing these risks is essential to ensuring sustainable and inclusive development.		

vii. Solid and liquid waste generation

Table 98: Evaluation of Solid and liquid waste generation

PHASE	Site Preparation/construction	Operation phase	Decommissioning
Magnitude	4(Major)	4(Major)	4(Major)
Duration	2(Medium term)	2(Medium term)	2(Medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	4(Certain)	4(Certain)	4(Certain)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	33(Moderate)	33(Moderate)	33(Moderate)
Implication	The degree of impact that the project may have upon the environment and community during the three project phases is high. The project may be compromised if this impact cannot be avoided or mitigated effectively.		
Discussion	Significant quantities of solid waste are expected to be generated throughout the project, primarily from soil excavation activities, leftover construction materials, and associated packaging waste. Additionally, municipal and domestic waste produced at labor camps and train stations presents a substantial risk of contributing to land pollution if not properly managed. Improper disposal or uncontrolled dumping of these waste streams can lead to the leaching of contaminants into the soil, subsequently posing risks to both surface and groundwater quality through infiltration and runoff pathways.		

viii. Soil erosion

Table 99: Evaluation of Soil erosion

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	3(Moderate)	1(Negligible)	2(Minor)
Duration	3(Long term)	0	2(Medium term)
Scale	1(Local)	0	1(Local)
Probability	3(High)	0	2(Likely)
Sensitivity	3(Medium)	0	3(Medium)
Significant points	30(Medium)	0	21(negligible)
Implication	The degree of impact that the project may have upon the environment is relatively low. Opportunities to avoid	No noticeable impact.	The degree of impact that the project may have upon the environment is relatively low. Opportunities to avoid

	or mitigate the impact should be considered; however, this should not compromise the viability of the project.		or mitigate the impact should be considered; however, this should not compromise the viability of the project.
Discussion	Excavation and construction activities may loosen soil particles, increasing their vulnerability to erosion. This may be significant when the topsoil is left exposed without protective vegetation or ground cover, allowing natural erosion agents like wind and water to actively displace the soil.		

ix. Influx of workers leading to increased HIV/Aids prevalence and moral decay

Table 100: Evaluation of Influx of Workers leading to increased HIV prevalence and moral decay

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	4(Major)	3(Moderate)	3(Moderate)
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	2(Local)	1(Local)	1(Local)
Probability	3(Likely)	3(Likely)	3(Likely)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	36(Moderate)	33(Moderate)	27(Minor)
Implication	The degree of impact that the project during construction and operation phases may have upon the community during construction and operation phases is high. The project may be compromised if this impact cannot be avoided or mitigated		The degree of impact that the project may have upon the community is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project
Discussion	Influx of workers during the three phases in search of job and business opportunities has the potential of creating social vices like spread of communicable diseases and promotion of crime incidents. Communicable or infectious diseases that may be of major concern include HIV/AIDS and other sexually transmitted infections.		

x. Pollution from oil spills

Table 101: Evaluation of Pollution from oil spills

PHASE	Site Preparation/Construction	Operation phase	Decommissioning
Magnitude	3(Moderate)	3(Moderate)	3(Moderate)
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	2(Regional)	2(Regional)	2(Regional)
Probability	3 (Likely)	2(Likely)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	33(Moderate)	33(Moderate)	27(Moderate)
Implication	The degree of impact that the project may have upon the environment during construction and operation phases is high. The project may be compromised if this impact cannot be avoided or mitigated.		The degree of impact that the project may have upon the environment during decommissioning phase is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project
Discussion	Significant oil spillage may occur during site preparation /construction due to leaks from petroleum products, as well as the routine dripping and leaking of oil, grease, and solvents from machinery and vehicles transporting materials to the site. Additionally, oil spills may occur when conducting routine operation and maintenance of coaches.		

xi. Slope Destabilization

Table 102: Evaluation of Slope Destabilization

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	4(Major)	3(Moderate)	3(Moderate)
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	1(Local)	1(Local)	1(Local)
Probability	3(Likely)	2(Medium (as likely as not)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	2(Low)
Significant points	33(negligible)	30(minor)	16(negligible)

Implication	The degree of impact that the project may have upon the environment is high. The project may be compromised if this impact cannot be avoided or mitigated (i.e. to reduce the significance of the impact	The degree of impact that the project may have upon the environment during operation and decommissioning phases is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project
Discussion	Excavation activities along landscapes and hillsides during the construction of the rail track have the potential to destabilize slopes, increasing the risk of erosion and slope failures. Vibration during operation phase may also lead to destabilization. Mitigation measures have been suggested in	

xii. Impacts associated with depletion of local natural resources-sand, ballast, murram, hardcore

Table 103: Evaluation of Impacts associated with depletion of Local natural resources (sand, ballast, murram and hardcore)

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	4(Major)	1(Negligible))	1(Negligible)
Duration	3(Long-term)	0	0
Scale	1(Regional)	0	0
Probability	4(Certain))	0	0
Sensitivity	3(Medium)	0	0
Significant points	36(negligible)		0
Implication	The degree of impact that the project may have upon the environment and community is high. The project may be compromised if this impact cannot be avoided or mitigated.	No noticeable impact on the environment and community during operation and decommissioning phases. No mitigation is required	
Discussion	The construction of the railway line will necessitate substantial quantities of raw materials, particularly aggregates and lateritic soil (murram), which are essential for forming embankments, subgrades, and ballast layers. These materials are likely to be sourced from off-site borrow pits and quarry locations identified and operated by the contractor.		

xiii. Traffic accidents

Table 104: Evaluation of Traffic accidents

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	3(Moderate)	3(Moderate)	2(Minor)
Duration	3(Long term)	4(Permanent)	2(Medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	2Medium (as likely as not)	2(Medium (as likely as not)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	27(Minor)	27(Minor)	21(Minor)
Implication	The degree of impact that the project may have upon the community during construction, operation and decommissioning is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.		
Discussion	Traffic accidents may occur during the 3 phases, mainly caused by over speeding of vehicles, use of undesignated routes, absence of road traffic marshals amongst others causes.		

xiv. Hydrology and water quality degradation

Table 105: Evaluation of Hydrology and water quality degradation

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	3 (Moderate)	2(Minor)	2(Minor)
Duration	3(Long-term)	4(Permanent	2(Medium term)
Scale	2(Regional)	2(Regional)	2(Regional)
Probability	3(Likely)	2 Medium (as likely as not	2 Medium (as likely as not
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	33(Moderate)	30(Minor)	24(Minor)
Implication	The degree of impact that the project may have upon the environment is high. The project may be compromised if this impact cannot be avoided or	The degree of impact that the project may have upon the dam is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.	

	mitigated.	
Discussion	Excavation activities have the potential to impact groundwater quality. Disturbance of contaminated soils or previously polluted groundwater along the excavation path can mobilize pollutants, leading to their migration into adjacent aquifers. Additionally, accidental spills of hazardous substances such as fuels, lubricants, or chemical additives during construction within excavated areas pose a significant risk of leaching into the subsurface environment, further compromising groundwater integrity. Water quality results were as follow • PH results ranged between 6.09-7.91 against a limit of 6.5-8.5 • Total Dissolved Solids results ranged between 40.0-187.0 ppm against a limit of 1200 (mg/L) • Total Suspended Solids (TSS) results ranged between 1.00-658 ppm against a limit of 30 (mg/L)	

xv. Contribution to climate change

Table 106: Evaluation of Contribution to climate change

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	3(Moderate)	2(Minor)	2(Minor)
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	3(Likely)	3(Likely)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	30(Moderate)	30(Minor)	21(Minor)
Implication	The degree of impact that the project may have upon the environment during the three phases is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.		
Discussion	Vegetation clearance may result in a corresponding reduction in terrestrial carbon sequestration capacity, contributing to a net increase in atmospheric CO_2 levels. This loss of carbon sink function represents a minor but relevant factor in the context of cumulative greenhouse gas (GHG) emissions. Construction-phase activities may contribute directly to atmospheric carbon through the combustion of fossil fuels in heavy machinery, transport coaches, vehicles, and generators. These operations emit CO_2 and NO_x and particulate matter, which collectively exacerbate climate change and local air quality degradation.		

xvi. Wildlife and Livestock accidents

Table 107: Evaluation of wildlife and livestock accidents

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	3(Moderate)	2(Minor)	2(Minor)
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	3(Likely)	2(Medium (as likely as not)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	27(Moderate)	27(Minor)	21(Minor)
Implication	The degree of impact that the project may have upon the environment and/or the community(s) during the three phases is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.		
Discussion	Wildlife and wildlife injury and mortality may occur resulting from collisions as animals attempt to cross the tracks and falls in burrow pits. The installation of fencing along the railway corridor and barriers around burrow pits is a critical safety measure aimed at minimizing these incidents by restricting animal access to the track area.		

xvii. Disruption of existing public utilities

Table 108: Evaluation of disruption of existing public utilities

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	4(Major)	1(Negligible)	2(Minor)
Duration	3(Long-term)	0	2(Medium term)
Scale	1(Local)	0	1(local)
Probability	3(Likely)	0	2(Medium (as likely as not)
Sensitivity	3(Medium)	0	3(Medium)
Significant points	33(Moderate)	0	21(Minor)
Implication	The degree of impact that the project may have upon the environment and/or the community(s) is high. The project may be compromised if this impact cannot be avoided or	No impact	The degree of impact that the project may have upon the environment and/or the community(s) is relatively low. Opportunities to avoid or mitigate the impact should be considered;

	mitigated.		however, this should not compromise the viability of the project.
Discussion	Existing community service utilities located within the designated railway corridor—including domestic water supply lines, sewerage systems, electrical transmission and distribution networks, and optical fiber communication cables—will require relocation as part of the project's easement and right-of-way acquisition process. However, during the relocation phase, end-users and customers connected to the affected utility networks may experience service outages.		

xviii. Disputes over employment

Table 109: Evaluation of Disputes over employment

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	3(Moderate)	3(Moderate	3(Moderate
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	3(Likely)	3(Likely)	3(Likely)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	30(Moderate)	30(Moderate)	30(Moderate)
Implication	The degree of impact that the project may have upon the community during the three phases is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.		
Discussion	Recruitment of unskilled workers from local communities can result in conflicts due lack of proper stakeholder engagement. Protection of vulnerable and marginalized groups such as youth and women within the project's labour force may also require especial measures		

xix. Loss of grazing land and livelihoods

Table 110: Evaluation of loss of grazing land and livelihoods

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	4(Major)	2(Minor)	2(Minor)
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	4(Certain)	2(Medium (as likely as not)	2(Medium (as likely as not)
Sensitivity	3(Medium)	3(Medium)	3(Medium)

Significant points	36(Moderate)	30(Minor)	21(Minor)
Implication	The degree of impact that the project may have upon the Community and their livestock are high. The project may be compromised if this impact cannot be avoided or mitigated.	The degree of impact that the project may have upon the community and their livestock is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.	
Discussion	Potential disruption to traditional grazing lands and patterns as a result of the proposed infrastructure development may affect livestock, which is a key livelihood source for some households.		

xx. Habitat loss and fragmentation

Table 111: Evaluation of Habitat loss and fragmentation

PHASE	Site Preparation/Construction	Operation	Decommissioning
Magnitude	4(Major)	3(Moderate)	2(Minor)
Duration	3(Long-term)	4(Permanent)	2(Medium term)
Scale	1(Local)	1(Local)	1(local)
Probability	4(Certain)	4(Certain)	3(Likely)
Sensitivity	3(Medium)	3(Medium)	3(Medium)
Significant points	36(Moderate)	33(Moderate)	24(Moderate)
Implication	The degree of impact that the project may have upon the wildlife and other small animals is high. The project may be compromised if this impact cannot be avoided or mitigated.		The degree of impact that the project may have upon the wildlife and other small animals is relatively low. Opportunities to avoid or mitigate the impact should be considered; however, this should not compromise the viability of the project.
Discussion	The proposed project will lead to habitat destruction and fragmented wildlife dispersal areas, impacting wildlife movements and breeding patterns.		

9.3 Potential Impacts

9.3.1 Anticipated positive social and economic impacts during site preparation, construction, operation and decommissioning phases

- **Employment Opportunities**

The proposed project during different phases will create different job opportunities, both casual, skilled and unskilled. Employment opportunities are of benefit both economically and socially. Several workers including casual laborer's, masons, carpenters, joiners, electricians, and plumbers are expected to work along the railway alignment site during the construction phase. Apart from casual labour, semi-skilled, unskilled labour and formal employees are also expected to obtain gainful employment during the period of construction. Generally, employment during the site preparation, construction and operation phases will lead to multidimensional development in the area and improve several people's living standards.

- **Economic Growth**

Through the use of locally available materials during the construction phase e.g. cement, steel metals and others; the project will contribute towards growth of the country's economy by contributing to the gross domestic product. The consumption of these materials, oil, fuel and others will attract taxes including VAT which will be payable to both national and county governments hence increasing government revenue while the cost of these raw materials will be payable directly to the producers.

- **Reduced Transport Cost of Goods**

The transport costs of passengers and goods like petroleum products, building materials, cereals and food stuffs, minerals, e.t.c. are expected to reduce and this will greatly improve regional trade by making the country's goods and services competitive.

- **Reduced Road Congestion and Improved Safety**

Significant reduction of volumes of cargo and passengers from roads to rail shall be realized, reducing wear and tear on highways. It will further lead to a decrease in the number of road accidents and fatalities caused by heavy trucks and buses.

- **Increased local incomes**

The local community may get extra income from the sale of construction materials from their farms and also renting spaces for company sites, borrow pits, dumping sites, lease of ground for yards and temporary passage to pick materials.
It will also spur economic activity along the transport corridor by attracting investments in logistics hubs, dry ports, and industrial parks and increase market access for agricultural and other produce.

- **Improved Community and road Infrastructure**

Implementation of the proposed project will require a road network to facilitate ferrying of materials and equipment to the construction sites. A favorable road network will be developed to allow for easy movement of machinery and construction materials. The proponent will rehabilitate existing roads and create new access roads which in the long run will be used by the residents. Additionally, the proposed project will improve existing community facilities including schools and healthcare facilities as part of corporate social responsibility initiatives or government partnerships.

- **Promotion of education skill and knowledge transfer**

By hiring labor for the project, workers will gain a range of skills related to railway construction, maintenance, and environmental and social governance (ESG). This is considered a significant positive impact, as it equips individuals with experience that can be applied to similar projects in the future.

9.3.2. Positive Environmental Impacts during site preparation, construction, operation and decommissioning phases

- **Reduction in greenhouse gases**

Rail transport produces significantly lower greenhouse gas emissions per ton-km compared to trucks. This reduces air and noise pollution in urban centers caused by heavy commercial vehicles and helps in achieving Kenya's commitments under climate change frameworks such as the Paris Agreement and its Nationally Determined Contributions (NDCs).

- **Improved Land Use Efficiency**

Proposed railway line uses less land area per unit of transport capacity compared to roads, especially for bulk cargo transport. Concentrating freight movement on railways helps preserve land for agriculture, forestry, conservation and other users.

- **Reduced noise pollution**

Modern train transport produces less cumulative noise compared to the combined impact of many individual vehicles on highways. Modern rail infrastructure includes **noise control measures**, especially near residential and sensitive areas.

- **Reduced Pressure on Natural Resources**

More efficient railway transport leads to lower fuel consumption per ton of cargo. This minimizes pressure on non-renewable fossil fuels and supports energy-efficient logistics.

- **Reclamation of Disturbed land**

Borrow pits and unproductive land can be used as disposal areas for the topsoil excavated during construction activities. The developer is responsible for restoring any sites that are disturbed during the construction process. Because rehabilitation and watershed protection efforts will extend beyond the immediate project area, the developer must also provide seedlings to state agencies and local communities to support these initiatives.

- **Reduced Carbon Emissions**

The proposed project is expected to reduce greenhouse gas emissions currently associated with the heavy vehicular traffic along the Kisumu to Busia Road. Compared to road transport, rail transport produces significantly lower emissions. Therefore, the development of a reliable and efficient rail network is likely to attract more passengers, resulting in decreased traffic volumes on the Kisumu to Busia Road. Consequently, this reduction in vehicle usage will lead to lower emission levels and a smaller carbon footprint.

- **Reduced littering along the Highway**

A decrease in vehicular traffic particularly private and commercial road transport within and around protected areas is expected to result in a corresponding reduction in anthropogenic solid waste deposition. This includes commonly discarded items such as used vehicle tyres, single-use food packaging, cigarette filters, and other non-biodegradable materials. Such forms of litter not only degrade the aesthetic and ecological integrity of conservation zones but also pose direct threats to wildlife through ingestion or entanglement.

Furthermore, leveraging mass transit systems, particularly railway networks, presents a more scalable and controlled platform for environmental education and awareness campaigns. Unlike the dispersed and often informal nature of road-based transit, trains offer centralized points of engagement (e.g., stations, compartments) and extended travel durations, allowing for targeted dissemination of conservation messaging. Educational content related to proper waste disposal and ecosystem preservation can be integrated into on-board announcements, digital displays, brochures, and interactive media. This approach enables broader outreach across demographic groups, enhancing public participation in minimizing environmental degradation in protected areas

- **Landscaping and improvement of aesthetic value**

Alongside the proposed construction activities, the developer will implement landscaping measures not only within the railway corridor but also in areas designated for station offices and staff residences. These efforts aim to improve the visual appeal of the surroundings, particularly in locations that are currently degraded or lack proper vegetation. By introducing greenery, organizing open spaces, and possibly incorporating decorative elements, the landscaping will contribute to environmental restoration and enhance the overall aesthetic value of the project area. In the long term, this can also foster a more pleasant and welcoming environment for both staff and the public.

9.3.3 Negative Environmental Impacts During Site Preparation and Construction Phases

- **Clearance of Vegetation**

The construction process will necessitate the removal of portions of existing tree cover found both on farms and in urban areas at the project sites. Some of the trees to be affected include include *Eucalyptus species, Delonix regia, Grivellia robusta, Pinus spp, Cupressus lustanica, Bischovia javonica, Casuarina equisetofolia and Jacaranda mimosifolia*. Indigenous trees are few and dot the area with species such as *Spathodea campanulata, Albizia spp, Ficus natalensis, Ficus luscchnathiana, Makhamia lutea, Zanthoxylum gilleti, Melia azedarach, Azadirachta indica Croton macrostachyus and Croton megalocarpus, Cordia africana and Acacia polycantha*. Some of the fruit trees along the alignment include; *Mangifera indica, Persea americana, Artocarpus heterophyllus, Syzygium cumini, Aleurites moluccana and Carica papaya*.This deforestation will lead to environmental changes, including altered temperature patterns, shifts in light exposure, changes in soil moisture and nutrient content, and modifications to the natural landscape. The loss of vegetation in urban areas and residential zones will leave communities more vulnerable to harsh winds, which can cause increased soil erosion and environmental degradation. Additionally, the removal of trees will result in the loss of valuable resources such as cash crops, natural shade, windbreaks, animal fodder, fruits, timber, medicinal plants, and firewood—resources that many local households depend on for both economic and daily living needs.

Mitigation

1. Establishment of woodlots on affected farms to help restore tree cover, support local ecosystems, and ensure continued access to these essential natural resources.
2. Clearing Minimization: Limit clearing to the smallest area necessary for the project to reduce habitat loss and soil exposure.
3. Buffer Zones: Establish protective buffers around sensitive habitats, water bodies, and remnant vegetation to maintain ecological connectivity.
4. Compensatory Planting: Implement tree planting programs to replace cleared trees, using native and fast-growing species to restore ecosystem functions.
5. Agroforestry Practices: On farms, integrate trees with crops to maintain biodiversity, improve soil health, and provide economic benefits.

- **Disturbance of indigenous forests**

Declining forest cover, driven by land degradation and rapid climate change, has led to immediate impacts such as the extinction and migration of native vegetation, plants, and animal species, along with the spread of invasive species like striga weed, *cascuta dodder, Psidium guajava,* and *Lantana camara* The project will involve clearing sections of forested areas, resulting in the permanent loss of indigenous vegetation. It is worth noting that the project will not traverse any major forests. However, the alignment will be through areas with significant concentrations of trees such as Kamolo, Kotur, Mosokoto, Elukongo, Masinjira, Uhuyi, Masaba and Jina These forests play a crucial role as catchment zones for streams and springs, so their removal could negatively impact water quality and reduce water flow. The disturbance caused by construction activities will alter the forest's structure, species composition, and overall biodiversity. If such disturbances occur frequently or over short periods, there is a risk that the forest ecosystem could shift to an alternative, less desirable state, which would harm the plants and animals that depend on it.

Mitigation

1. Minimization of forest clearance during the construction phase to preserve the ecological integrity and sustainability of these vital habitats.
2. Micro-siting: Align project elements (e.g. access roads, utility corridors) along disturbed or degraded areas rather than intact forest patches to minimize fragmentation.
3. Ecological Buffer Zones: Establish and maintain buffer zones around high-value conservation areas, riparian zones, and wetlands.
4. Fauna Translocation and Rescue Plans: Safely relocate fauna from the project area in coordination with wildlife authorities, especially for species with limited mobility or breeding grounds.
5. Reforestation and Assisted Natural Regeneration (ANR): Restore disturbed areas using native species that match the original forest composition. Employ ANR techniques where natural seed banks exist.
6. Participatory Forest Management (PFM): Involve local communities in forest protection, replanting, and monitoring initiatives to enhance stewardship.
7. Alternative Livelihood Programs: Provide support for non-forest-based income activities (e.g., beekeeping, agroforestry, eco-tourism) to reduce pressure on forest resources.

- **Impact of oil Spillage**

There is a significant risk of oil spillages occurring during construction due to leaks from petroleum products, as well as the routine dripping and leaking of oil, grease, and solvents from machinery and vehicles transporting materials to the site. These oil spills pose a serious threat to the environment by contaminating the soil, which can lead to long-term degradation of the land. It is further noting that the rock beneath East Seme is the Kavirondian basement system is porous and more permeable leading to further degradation Furthermore, if substances like oil, diesel, and solvents stored on-site accidentally enter nearby water bodies, they could severely impact water quality and harm wildlife habitats, particularly in conservation areas close to the construction zones. Based on the baseline survey, the rivers along the alignment had their Oil and Grease results within Regulatory Limit with rivers Malakisi, Suo and Kasuna having significantly low concentrations (0.004 ppm). However, there was a risk of cumulative impact on River Alukucha which had a concentration of 0.016 ppm.To mitigate these risks, it is crucial that the contractor implements stringent oil spill containment and management measures, including regular equipment maintenance, proper storage of hazardous liquids, and immediate response plans in the event of a spill to protect both the environment and local ecosystems.

Mitigation

1. Spill Prevention, Control, and Countermeasure (SPCC) Plan: Develop a site-specific SPCC plan that outlines procedures for handling, storage, and spill response.
2. Risk Assessment: Identify high-risk areas (fueling stations, equipment storage zones, vehicle maintenance areas) and assess potential spill scenarios.
3. Secondary Containment Systems: Store oil and fuel in tanks or containers with bunds or drip trays capable of holding 110% of the container's volume.
4. Impermeable Surfaces: Conduct fuel transfer and storage activities on concrete or other impermeable surfaces to prevent infiltration into the soil.
5. Routine Inspection: Regularly inspect construction machinery for leaks in hydraulic systems, fuel tanks, and lubrication lines.
6. Preventive Maintenance: Ensure that all construction equipment is well-maintained to prevent accidental leaks.
7. Spill Kits: Provide and strategically locate oil spill response kits (absorbents, pads, booms, PPE) on-site and in vehicles.
8. Training: Train workers on proper fuel handling and spill response procedures, including use of spill kits and emergency reporting protocols.
9. Sediment and Oil Traps: Use grit chambers, silt fences, and retention ponds to control runoff and filter out pollutants
10. Designated Waste Oil Tanks: Collect used oil, grease, and contaminated materials in clearly labeled, sealed containers.
11. Licensed Disposal: Dispose of used oil and oily waste through licensed hazardous waste handlers

- **Impacts associated with sourcing of construction materials from the locality**

The construction of the railway line will necessitate substantial quantities of raw materials, particularly aggregates and lateritic soil (murram), which are essential for forming embankments, subgrades, and ballast layers. These materials are likely to be sourced from off-site borrow pits and quarry locations identified and operated by the contractor. While essential for construction, quarrying and borrow pit excavation activities can have considerable environmental and socio-economic impacts if not properly managed.

Key environmental impacts include:

1. Loss of Vegetation and Topsoil: Vegetation clearance and the stripping of topsoil disturb local ecosystems, reduce biodiversity, and degrade soil quality, making the land less suitable for future agricultural or ecological use.
2. Visual Intrusion and Landscape Alteration: Unrehabilitated quarries and borrow pits can become permanent eyesores, negatively affecting the visual aesthetics of the surrounding landscape.
3. Air and Noise Pollution: Operations involving blasting, crushing, and hauling of materials generate significant dust (particulate matter), as well as high noise and vibration levels, which can adversely affect both workers and nearby communities.
4. Hydrological and Public Health Impacts: Abandoned and unrehabilitated pits can collect rainwater, leading to the formation of stagnant water bodies that serve as breeding grounds for disease vectors such as mosquitoes, posing serious public health risks (e.g., malaria, dengue). Additionally, if such water is used by local populations, there is a risk of contamination and waterborne diseases.
5. Safety Hazards: Steep, unsecured pit walls pose fall and drowning risks, particularly for children, livestock, and other vulnerable populations. Without fencing or signage, these sites can become hazardous zones.

Mitigation

1. Development and implementation of rehabilitation plans including backfilling, contouring, topsoil replacement, and re-vegetation of borrow sites.
2. Adoption of dust suppression techniques (e.g., water spraying, windbreaks) and noise control measures (e.g., sound barriers, regulated blasting times).
3. Installation of drainage controls to prevent water stagnation, and sites should be securely fenced with warning signage.
4. Monitoring and enforcement by regulatory agencies e.g. NEMA must be strengthened to ensure contractors comply with restoration obligations post-excavation.

- **Blasting and rock excavation**

Blasting is a controlled use of explosives to fracture and dislodge rock material, primarily employed during the excavation of bedrock or in quarrying operations to facilitate material extraction. While blasting is an effective technique for breaking hard rock, it is associated with several potential environmental and safety impacts, particularly in areas in proximity to active blasting zones.

Key environmental and occupational health and safety concerns include:

1. Air Quality Degradation: Blasting activities generate significant quantities of dust and fine particulate matter (PM_{10} and $PM_{2.5}$), which can be suspended in the atmosphere and transported over considerable distances. These particulates pose respiratory health risks to

workers and nearby communities and may degrade local air quality.

2. Noise Pollution and Ground Vibrations: The detonation of explosives produces high-intensity impulsive noise and ground vibrations. These can lead to human discomfort, disturbance of wildlife, and structural damage to nearby buildings—especially those not engineered to withstand such vibrations.
3. Flyrock and Debris Projection: Improperly controlled blasting can result in flyrock—the ejection of rock fragments at high velocities—which poses serious safety hazards to workers, nearby residents, livestock, and infrastructure. This risk is exacerbated in densely populated or poorly demarcated blasting zones.
4. Safety Hazards to Workers: Workers face direct risks from premature detonations, misfires, and flyrock. Strict adherence to occupational health and safety protocols—including the use of Personal Protective Equipment (PPE), blast zone clearance procedures, and proper training—is essential.
5. Water and Soil Contamination: If explosive materials, oils, or other chemical residues are spilled or improperly handled, they may leach into the soil and surface water, causing contamination. Additionally, the disruption of natural ground surfaces can accelerate sedimentation in nearby water bodies, impacting aquatic ecosystems.
6. Localized Impact Zone: The negative effects of blasting—especially noise, dust, and flyrock—are typically concentrated in areas surrounding the quarry or blasting site. However, depending on geological conditions and blast intensity, these impacts can extend beyond anticipated buffer zones.

Mitigation and Control Measures:

1. Blasting should be carried out in accordance with a site-specific Blast Management Plan (BMP), which includes pre-blast surveys, vibration and air overpressure monitoring, and risk assessments.
2. Use of modern blasting techniques, such as electronic detonators and controlled delay sequences, can reduce vibration and flyrock.
3. Establishment of blast exclusion zones with proper signage and fencing to restrict access during detonation.
4. Real-time monitoring of vibration and air overpressure levels.
5. Dust suppression strategies, such as water spraying and wind barriers, should be implemented before and after blasting.

In summary, while blasting is essential for efficient rock excavation, its associated risks demand rigorous planning, engineering controls, and regulatory compliance to ensure environmental protection and the safety of both workers and surrounding communities.

- **Waste from excavated materials and obsolete equipment**

Some excavation tools and equipment used during the project will become worn out or obsolete hence there will be need for them to be discarded. Similarly, certain soil and rock materials excavated from the site may be unsuitable for reuse once the excavation is complete. Furthermore, site excavations must meet established standard specifications, meaning that some materials will inevitably be rejected and classified as waste requiring proper disposal. If not managed correctly, the improper disposal of these materials could cause negative environmental impacts, such as soil contamination or disruption of local ecosystems. Therefore, it is essential that all waste materials—whether tools, equipment, or excavated soil and rocks—are carefully collected, transported, and either recycled or disposed of in designated, environmentally approved locations. Additionally, efforts should be made to explore alternative uses for these materials to transform potential waste into valuable resources, contributing to economic benefits and reducing environmental harm.

Mitigation:

1. Material Segregation: Separate excavated materials into reusable (e.g., topsoil, gravel) and non-reusable/spoiled materials (e.g., contaminated or mixed debris).
2. Backfilling and Embankment Construction: Use inert excavated materials for backfilling, slope stabilization, or forming embankments where geotechnically suitable.
3. Construction Use: Crushed rock and clean fill can be reused in subgrade or roadbed layers
4. Designated Disposal Sites: Transport non-reusable materials to approved dumping sites.
5. Fluids Draining: Drain fuel, lubricants, coolant, and hydraulic fluids from decommissioned equipment prior to disposal.
6. Scrap Recovery: Salvage metals, rubber parts, and electronics for recycling through licensed waste handlers.

- **Impacts of Soil Erosion**

From East Kombewa, stretching toward the shores of Lake Victoria and into parts of Kaila Sub-Location, the dominant topsoil is composed of orthic Ferralsols, partly in the petroferric phase, interspersed with pockets of orthic Acrisols. These soils are often strewn with boulders and stones, while certain slope areas reveal cracking clays of dark grey to black hues—firm to very firm in texture, exceptionally deep, yet imperfectly drained. Their physical characteristics play a pivotal role in determining how rainwater infiltrates, how much moisture the soil can store, and how effectively it recharges groundwater through percolation into underlying aquifers. This stored moisture forms the critical baseline for deep chemical weathering processes, while surface runoff, driven by these same properties, sets the stage for water erosion to shape the land over time. This will be further exacerbated by the project activities.

Excavation and construction activities tend to loosen soil particles, increasing their vulnerability to erosion. This issue becomes particularly severe when the topsoil is left exposed without protective vegetation or ground cover, allowing natural erosion agents like wind and water to actively displace the soil. Additionally, the creation of open quarries at sites used for extracting building materials can further exacerbate soil instability. Runoff from these unprotected and excavated areas can cause significant soil erosion, especially in regions where the soil is highly erodible. The displaced soil doesn't simply disappear; it is carried downstream and deposited elsewhere, which can significantly alter local hydrological patterns. This sedimentation can degrade water quality by causing siltation in rivers, streams, and reservoirs. Moreover, contaminants attached to soil particles—such as chemicals, heavy metals, or nutrients—may be introduced into aquatic ecosystems, leading to further environmental harm. To prevent these adverse effects, it is critical to implement effective erosion control measures, such as stabilizing exposed soils, managing runoff, and rehabilitating disturbed areas promptly.

Mitigation:

1. Soil and Terrain Survey: Conduct geotechnical and hydrological assessments to identify erosion-prone zones (e.g., steep slopes, loose soils).
2. Erosion Risk Mapping: Develop erosion susceptibility maps to inform alignment design, cut-and-fill balances, and drainage planning.
3. Construction Phasing: Schedule earthworks during dry seasons where possible to minimize rainfall-induced erosion
4. Minimal Clearance: Clear only the areas necessary for construction to preserve natural ground cover and reduce exposure.
5. Topsoil Stripping and Storage: Remove and store topsoil separately for reuse in site restoration and landscaping.
6. Rapid Revegetation: Replant native grasses, shrubs, or fast-growing groundcover species as soon as construction is complete in each section.
7. Retaining Structures: Construct gabions, rock bunds, or retaining walls on high embankments and cut slopes.
8. Proper Drainage Design: Construct lined channels, culverts, cross-drains, and side drains to manage surface runoff efficiently.
9. Check Dams and Sediment Traps: Install temporary sediment traps or check dams to capture soil before it enters watercourses.
10. Stormwater Detention Basins: Create holding ponds to allow sediment to settle before water is released downstream.
11. Compaction of Fills: Compact loose fill and embankments to reduce susceptibility to erosion by water and wind.
12. Minimize Disturbance: Confine heavy equipment movement to designated paths to avoid unnecessary soil compaction and disturbance.

- **Slope Destabilization**

Excavation activities along landscapes and hillsides during the construction of the rail track have the potential to destabilize slopes, increasing the risk of erosion and slope failures. To mitigate these risks, it is essential to design and implement appropriate slope gradients for cuttings, as well as to apply protective measures—either through natural methods like vegetation planting or artificial solutions such as retaining walls. The destabilizing impact is particularly significant in hilly areas where the railway line crosses steep terrain. Historical evidence shows that landslides in such regions often result from a combination of steep slopes, heavy rainfall, and soil conditions—especially where high clay content leads to increased water absorption, and where fractured metamorphic rocks create zones of weakness in the ground. Therefore, careful geotechnical assessment and slope stabilization measures are critical during construction to ensure the safety and stability of the railway infrastructure as well as the surrounding environment

Mitigation

1. Cut and Fill Balancing: Minimize the number of cut-and-fill earthworks by optimizing rail alignment and grading plans.
2. Reinforced Earth Structures: Use mechanically stabilized earth (MSE), geogrids, and retaining walls to support cut slopes and embankments.

3. Slope Reinforcement: Employ soil nails, rock bolts, or micropiles to provide deep anchoring in unstable slopes.
4. Drainage Control: Install subsurface and surface drainage (e.g., French drains, interceptor ditches, and weep holes in retaining walls) to prevent water accumulation that weakens soil.

- **Impacts of generated exhaust emissions**

During the construction phase, various machinery and equipment are expected to generate exhaust emissions, contributing to atmospheric pollutant loads. The operation of diesel- and petrol -powered construction equipment, including excavators, loaders, and generators, will release combustion by-products such as nitrogen oxides (NOx), carbon monoxide (CO), particulate matter (PM), and volatile organic compounds (VOCs). Additionally, motor vehicles responsible for transporting the workforce and construction materials to and from the site will further exacerbate air quality degradation by emitting similar exhaust pollutants. These emissions have the potential to create localized increases in ambient concentrations of air contaminants, thereby posing significant environmental and public health concerns if not properly managed. . Baseline conditions indicate the alignment areas enjoy good air quality with areas like the Proposed Launda Station having the lowest carbon dioxide concentration and St. Leo Kamolo Comprehensive School having the lowest Nitrogen dioxide concentration.
Cumulative impacts may be experienced in areas such as Proposed Kamolo Bridge and the Proposed Malaba Marshalling Yard which had the highest concentration of Carbon dioxide and Nitrogen dioxide respectively. Implementation of emission control strategies, such as the use of well-maintained equipment, adoption of low-emission vehicles, and scheduling to minimize peak traffic, is essential to mitigate these impacts.

Mitigation

1. Retrofitting: Retrofit older machinery with emission control technologies such as Diesel Particulate Filters (DPFs) and oxidation catalysts.
2. Electric or Hybrid Alternatives: Use electric, hybrid, or compressed natural gas (CNG)-powered equipment where feasible, particularly in enclosed or urban areas.
3. Use of Clean Fuels: Utilize ultra-low sulfur diesel to reduce sulfur dioxide and particulate emissions.
4. Fuel Storage Practices: Store fuels in sealed, labeled tanks to prevent evaporation losses and reduce fugitive emissions
5. Preventive Maintenance: Implement a strict maintenance schedule to ensure that engines operate at optimal efficiency and with minimal emissions.
6. Idle Reduction: Enforce anti-idling policies for machinery and vehicles (e.g., limit idling to 3–5 minutes) to reduce unnecessary fuel combustion.
7. Load Optimization: Avoid engine overloading by matching the size and capacity of machinery to the task, ensuring efficient operation.
8. Phased Construction: Implement phased construction to limit the number of machines operating simultaneously and reduce peak emissions.
9. Material Sourcing: Source materials (e.g., ballast, sand, steel) locally to reduce long-distance transport and associated emissions.
10. Traffic Management: Use efficient routing and scheduling for material delivery to avoid

congestion and repeated trips.

11. Air Quality Monitoring: Establish ambient air monitoring stations near sensitive areas to track PM_{10}, $PM_{2.5}$, and NOx levels during construction.
12. Emission Tracking: Keep records of equipment types, fuel use, and hours operated to estimate and report construction-phase emissions.

- **Contribution to climate change**

Kakamega's dependence on rain-fed agriculture makes it highly susceptible to the effects of climate change, with shifts in rainfall patterns and temperatures contributing to declining crop yields and increasing food insecurity. Therefore, climate change will be a cumulative impact. The implementation of the railway infrastructure project is anticipated to involve limited but necessary vegetation clearance along the designated construction corridor. While minimal in scope, the removal of vegetation—particularly woody biomass—will result in a corresponding reduction in terrestrial carbon sequestration capacity, contributing to a net increase in atmospheric carbon dioxide (CO_2) levels. This loss of carbon sink function, even on a localized scale, represents a minor but relevant factor in the context of cumulative greenhouse gas (GHG) emissions.

In addition to land-use change emissions, construction-phase activities are expected to contribute directly to atmospheric carbon through the combustion of fossil fuels in heavy machinery, vehicles, and generators. These operations emit a mix of greenhouse gases, primarily CO_2, as well as nitrogen oxides (NO_x) and particulate matter, which collectively exacerbate climate change and local air quality degradation.

Technical Recommendations and Mitigation Measures

1. Minimize vegetation clearance by optimizing the construction corridor and integrating natural landscape features into the design where possible.
2. Implement carbon offset measures, such as reforestation or afforestation programs in nearby areas to compensate for lost carbon sinks.
3. Ensure all construction equipment meets emission standards (Euro Stage V should be a good reference), and promote the use of low-emission fuels or electric-powered machinery where feasible.
4. Develop integrated waste management plans in collaboration with local authorities, emphasizing waste minimization, segregation, recycling, and safe disposal practices.
5. Incorporate climate resilience and low-carbon strategies into regional development planning to ensure that induced growth does not exacerbate environmental degradation.

- **Air quality impacts due to dust generation**

Cumulative impact of Inhalable particulate matter (PM_{10}) and respirable particulate matter ($PM_{2.5}$) are likely to be experienced at the Nzoia/ Musonga Station Location 2. Air pollution during the site preparation and construction phase will primarily result from fugitive dust emissions generated by various site activities. These activities include site clearance, demolition, excavation, loading, and the transportation of construction materials and excavated earth. Dust emissions are expected to originate not only from the main construction areas but also from diversion roads and blasting sites associated with the project. The predominant air pollutant anticipated is Suspended Particulate Matter (SPM), which encompasses a range of airborne particles capable of penetrating respiratory systems and contributing to adverse health effects. The generation of SPM is directly linked to earthmoving operations and material handling processes, which disturb soil surfaces and liberate fine particulate matter into the atmosphere. Effective dust control measures, such as water spraying, use of dust suppressants, covering of transported materials, and maintaining vegetation buffers, are critical to minimizing airborne particulate concentrations and mitigating impacts on air quality and public health.

Mitigation

1. Progressive Land Clearing: Clear only the areas required for immediate work to reduce the amount of exposed, dust-prone soil.
2. Moisture Conditioning: Apply water to lose soil prior to and during earthworks (excavation, grading, backfilling) to suppress dust at the source.
3. Water Spraying: Regularly spray water or non-toxic dust suppressants (e.g., calcium chloride or magnesium chloride solutions) on access and haul roads, especially during dry or windy conditions.
4. Speed Limits: Enforce low speed limits (e.g., <20 km/h) for construction vehicles on unpaved surfaces to minimize dust uplift.
5. Paved Access Routes: Where feasible, pave or gravel main site access roads to reduce dust from vehicle movement.
6. Dust-Controlled Loading/Unloading: Minimize drop heights when loading or unloading fine materials like sand or ballast, and use enclosed conveyors or hoppers when available.
7. Covered Storage: Store loose construction materials such as cement, sand, and aggregates in enclosed or covered facilities.
8. Transport Covering: Use tarpaulins or fitted covers on trucks transporting dusty materials.
9. Wet Methods: Apply water spray during demolition, concrete cutting, and rock drilling to suppress dust at the point of generation.
10. Dust Extraction Systems: Equip drilling and grinding equipment with vacuum or extraction systems to capture fine particles.
11. Dust Monitoring Stations: Install PM_{10} and $PM_{2.5}$ monitors at sensitive locations (e.g., residential areas, schools, hospitals) to track ambient dust levels.

- **Impacts on hydrology and water quality**

Based on our baseline tests the rivers traversing the project alignment were within acceptable standards in terms of water quality with good examples being rivers kakolait, Bakamoyo borehole and Soko Moko Well. Cumulative impacts were likely to be experienced on rivers kasuna and Awach.Excavation activities associated with the project have the potential to adversely impact groundwater quality. Disturbance of contaminated soils or previously polluted groundwater along the excavation path can mobilize pollutants, leading to their migration into adjacent aquifers. Linear excavations, such as trenches for pipelines or rail foundations, may act as preferential pathways, facilitating the lateral and vertical spread of contaminants to previously unaffected groundwater zones. Additionally, accidental spills of hazardous substances—such as fuels, lubricants, or chemical additives during construction within excavated areas pose a significant risk of leaching into the subsurface environment, further compromising groundwater integrity. To mitigate these risks, it is imperative to implement comprehensive site assessment protocols prior to excavation, establish containment measures to prevent spillages, and conduct continuous groundwater monitoring to detect any early signs of contamination migration.

Mitigation

1. Silt Fences and Sediment Barriers: Install geotextile silt fences or sediment traps around exposed soils, stockpiles, and drainage paths to intercept suspended solids.
2. Sedimentation Ponds/Basins: Construct temporary settling basins to capture and treat stormwater runoff from construction areas before discharge into natural water bodies
3. Stormwater Diversion Channels: Build lined or vegetated swales and diversion ditches to redirect clean runoff away from construction zones.
4. Check Dams and Contour Trenches: Install check dams along drainage channels on slopes to reduce flow velocity and trap sediments.
5. Grading and Drainage Planning: Design site grading to control surface runoff direction and volume to avoid erosion and water body contamination.
6. Designated Refueling and Maintenance Areas: Locate fuel and maintenance areas at least 50 m away from watercourses and provide impervious, bunded surfaces with oil-water separators.
7. Secondary Containment: Store fuels, lubricants, and chemicals in leak-proof containers within secondary containment systems.
8. Spill Response Plan: Maintain spill kits on-site and train personnel in emergency spill response. Implement a Spill Prevention and Control Plan (SPCC).
9. Worker Sanitation Facilities: Provide portable toilets or biodigester toilets for workers, located away from water bodies and serviced regularly.
10. Construction Wastewater Treatment: Treat wastewater from concrete batching, equipment washing, or drilling using sediment traps or pH neutralization before discharge.
11. No Direct Discharge: Prohibit direct discharge of untreated wastewater or sewage into rivers, lakes, wetlands, or groundwater.
12. Material Storage on Impervious Surfaces: Store construction materials (e.g. cement, lime, paint) on impervious surfaces under cover to prevent contact with rainwater.
13. Stockpile Management: Cover soil and spoil stockpiles with tarpaulin and place them away from drainage paths and watercourses.
14. Riparian Buffer Zones: Maintain buffer zones (e.g., 30 meters) along rivers and streams to act as natural filters.
15. Wetland Avoidance: Avoid construction in or near wetlands; where unavoidable, apply wetland restoration and compensation measures.
16. Water Quality Monitoring: Regularly test parameters such as turbidity, pH, oil & grease, BOD/COD, nitrates, and coliforms in nearby surface and groundwater.

- **Flooding and water logging risks**

The SGR route, especially in regions such as the Nzoia River Basin, is prone to flooding, which can damage tracks and bridges and, in some cases, trigger landslides, leading to disruptions in rail operations. Moreover, Luanda Sub-County is witnessing shifts in its usual rainfall patterns, resulting in periods of flooding as well as extended dry seasons. Siaya County is highly exposed to the effects of climate change because it relies heavily on climate-sensitive sectors such as agriculture, fisheries, and agricultural trade. The region faces challenges like more frequent droughts, floods, and extreme weather events, which disrupt livelihoods and damage infrastructure. The central region of Kakamega County, especially Butula and Nambale Sub-Counties, features low, flat divides of nearly uniform elevation, often topped with laterite and characterized by a shallow, swampy drainage network.

The construction phase of the project may encounter significant challenges related to local flooding, primarily due to surface runoff influenced by the existing land topography, the configuration of outfall linkages, and the absence or inadequacy of efficient drainage infrastructure. These hydrological factors can adversely impact construction quality and cause delays if not effectively managed. Furthermore, the long-term structural integrity and operational reliability of the railway track are highly dependent on the proper design and implementation of drainage channels and outfall connections, necessitating careful consideration during both the design and construction stages.

Anticipated drainage-related impacts include:

1. Localized flooding resulting from temporary blockages or disruptions to surface drainage systems, particularly in areas designated for spoil management where accumulated debris or excavated material may obstruct water flow.
2. Increased potential for soil erosion caused by uncontrolled runoff, which can degrade soil stability around the construction site and contribute to sedimentation in adjacent water bodies.
3. Concentration and channeling of stormwater into roadside drains, cross culverts, and downstream drainage outfalls, which can lead to siltation and structural damage to these drainage components, further exacerbating flood risks downstream.

Mitigation

1. Development of a comprehensive stormwater management plan that incorporates proper grading, installation of appropriately sized and aligned drainage infrastructure, regular maintenance of drainage pathways during construction, and erosion control measures such as sediment traps, silt fences, and vegetative buffers.
2. Integrate hydrological modeling in the design phase will optimize drainage capacity and ensure resilience against varying rainfall events, thereby safeguarding both construction progress and the long-term functionality of the railway system.

- **Solid Waste Generation**

Significant quantities of solid waste are expected to be generated throughout the project, primarily from soil excavation activities, leftover construction materials, and associated packaging waste. Additionally, municipal and domestic waste produced at labor camps presents a substantial risk of contributing to land pollution if not properly managed. Improper disposal or uncontrolled dumping of these waste streams can lead to the leaching of contaminants into the soil, subsequently posing risks to both surface and groundwater quality through infiltration and runoff pathways.

Mitigation

1. Implement an integrated waste management plan that includes waste segregation, collection, and disposal in accordance with NEMA guidelines.
2. Implementing measures including designated landfill sites, recycling of construction debris,

and effective sanitation systems at labor camps should be enforced to prevent pollution and safeguard surrounding ecosystems.

3. Provision of sanitation facilities to workers to prevent open defecation.
4. Prioritize options of waste reduction, reuse and recycling, particularly papers, polythene bags and plastic wrappers and containers and other materials that can possibly be recycled.
5. Sensitize site workers and frequent visitors (especially those operating food catering services) to the work sites on proper waste management practices.
6. Use of durable, long-lasting materials that will not need to be replaced as often, thereby reducing the amount of waste generated over time.
7. Donate recyclable/reusable or residual materials to local community groups, institutions and individual local residents or homeowners.
8. Reuse packaging materials such as cartons, cement bags, empty metal and plastic containers to reduce waste at the site.
9. Waste collection bins to be provided at designated points on site and contract a NEMA Licensed waste handlers to be contracted to transport and dispose the solid waste from site

- **Noise and vibrations impacts**

The project areas had low baseline noise levels with the Proposed Malaba Marshalling Yard having the lowest levels. The project will, however, contribute to cumulative noise impact at the Kisian River Bridge

Construction activities, including the operation of heavy machinery, blasting, and quarrying, are expected to generate elevated noise levels that may adversely impact nearby communities. Noise propagation could become particularly problematic when construction-related diversions route traffic or equipment closer to residential areas, educational institutions, and commercial establishments, thereby increasing exposure to high decibel levels. Additionally, vibrations produced by the movement of heavy equipment, excavation processes, and blasting operations pose a risk to the structural integrity of adjacent buildings and infrastructure. These vibrations can induce ground-borne oscillations that may lead to the destabilization, cracking, or other forms of physical damage to foundations, walls, and other structural components, especially in older or poorly maintained structures.

Mitigation

1. Implement engineering controls such as vibration dampening and noise barriers, and establish monitoring programs. Moreover, communication with affected communities and stakeholders should be maintained throughout the construction period to manage expectations and address concerns related to noise and vibration exposure.
2. Construction Scheduling: Plan high-noise activities during daytime hours (e.g. 08:00–17:00) to minimize impact on nearby communities
3. Modern Equipment: Use new or well-maintained machinery designed with noise-reducing features (e.g. mufflers, silencers, acoustic enclosures).
4. Electric or Hydraulic Equipment: Use electric or hydraulic-powered tools instead of pneumatic tools to reduce noise and vibration
5. Temporary Acoustic Barriers: Erect movable noise barriers (e.g. acoustic curtains, sound-insulating panels) around high-noise equipment like generators and compressors.

6. Enclosures for Fixed Equipment: Install acoustic enclosures for stationary noise sources such as concrete mixers, batching plants, and power units.
7. Earth Berms or Gabions: Use constructed embankments or gabion walls along site perimeters to attenuate sound propagation.
8. Limit Simultaneous Operations: Avoid operating multiple high-noise machines simultaneously near sensitive areas.
9. Relocation of Noisy Equipment: Position equipment and haul roads away from populated areas whenever possible.
10. Vehicle Movement Control: Implement traffic management plans to reduce vehicle idling and control speeds on site to reduce noise and vibration from transport.
11. Vibration Dampening Systems: Use vibration isolation pads, trench barriers, or matting under machinery to reduce transmission.
12. Controlled Blasting: If blasting is necessary, use controlled methods (e.g., pre-split or cushion blasting) and time it to avoid peak community activity.
13. Noise and Vibration Monitoring Stations: Install real-time monitoring devices at key sensitive locations to measure dB(A) levels and vibration (PPV – Peak Particle Velocity).
14. Spoil soil emanating from excavations will be reused for landscaping followed by revegetation of the landscaped areas.
15. Implementing procurement measures that ensure ordering the correct amount of materials when needed to reduce chances of unused materials being abandoned at the site.

9.3.4 Predicted negative social and economic impacts during site preparation and construction phases.

- **Loss of grazing land**

Livestock rearing constitutes a key livelihood activity within the project area, providing both subsistence and economic benefits to local communities. During stakeholder engagement sessions, including public consultation meetings, the communities expressed concerns regarding the potential disruption to traditional grazing patterns as a result of the proposed infrastructure development.
Specifically, the construction and eventual operation of the railway corridor may:

1. Restrict access to established grazing routes and communal pasturelands due to the erection of physical barriers such as fencing, embankments, or culverts.
2. Reduce available grazing land through land acquisition and site occupation for railway infrastructure (e.g., tracks, access roads).
3. Limit livestock mobility, which is critical in dryland areas where herders rely on seasonal movement to access water and forage resources.
4. Exacerbate resource pressure on remaining communal lands, leading to overgrazing, land degradation, and reduced pasture productivity.
5. Increase the risk of livestock accidents or fatalities due to proximity to active construction zones or operational rail lines.

Mitigation

1. Designing livestock underpasses or overpasses at strategic locations to facilitate safe crossing and maintain grazing continuity.
2. Incorporating community grazing access corridors in the railway layout to minimize disruption to migratory routes.
3. Establishing participatory rangeland management plans with local stakeholders to ensure sustainable pasture use during and after construction.
4. Implementing fencing safety protocols and clear signage to reduce the likelihood of livestock-train collisions.
5. Engaging with livestock keepers throughout the project lifecycle—from planning to implementation and post-construction—is critical to minimizing adverse socio-economic impacts and maintaining community support for the project.

- **Disruption of existing public utilities**

To facilitate the construction of the railway infrastructure, existing community service utilities located within the designated railway corridor—including domestic water supply lines, sewerage systems, electrical transmission and distribution networks, and optical fiber communication cables—will require relocation as part of the project's easement and right-of-way acquisition process.

This utility relocation is a critical pre-construction activity designed to ensure unimpeded access to the construction site and to safeguard these essential services from damage during construction operations. However, during the relocation phase, end-users and customers connected to the affected utility networks may experience temporary, short-term disruptions or service outages. These interruptions could impact domestic water availability, sanitation services, electricity supply, and telecommunications connectivity, necessitating the development and implementation of contingency plans to minimize inconvenience and ensure rapid restoration of services.

The sequencing of utility relocation is expected to precede the commencement of major construction activities to avoid concurrent disruptions and to maintain project timelines.

It is important to note that certain infrastructure components, such as sewerage systems, may not be relocated due to their dependence on natural topography and gravitational flow regimes, which limit flexibility in alignment adjustments without incurring significant technical and financial costs. In such cases, protective measures will be necessary to safeguard these systems during construction.

Additionally, the current railway design incorporates multiple level crossings and underpass crossings. These intersections with existing access roads pose potential points of disruption to local traffic flow and access, both during construction and operational phases. Effective traffic management plans, stakeholder engagement, and engineering solutions—such as temporary detours, traffic signal controls, and phased construction—will be essential to mitigate impacts on mobility and ensure safety for road users and the general public.

Mitigation

1. Coordination with utility service providers and local authorities to map existing underground and overhead infrastructure accurately to avoid service interruptions, and adhere to safety and

regulatory standards during relocation activities.

2. Integrating comprehensive surveys and utility mapping, coupled with robust monitoring frameworks into the project management plans to manage risks associated with utility relocations and traffic disruptions.
3. Engage utility agencies early in the planning phase to identify vulnerable infrastructure and agree on protocols for relocation or protection.
4. Where relocation is unavoidable, prepare detailed relocation plans approved by utility providers and schedule works during off-peak hours or planned outages.
5. Install protective barriers, sleeves, or encasements around utilities that are close to excavation or piling activities.
6. Clearly mark utility corridors on the ground and in site drawings to prevent accidental damage by construction crews.
7. Set up a system to receive, document, and resolve complaints regarding service disruptions quickly.

- **Influx of Workers to the proposed project areas leading to increased HIV/Aids prevalence and moral decay.**

Influx of workers during site preparation, construction and operation phases in search of job and business opportunities has the potential of creating social vices like spread of communicable diseases and promotion of crime incidents. Communicable or infectious diseases that will be of major concern include HIV/AIDS and other sexually transmitted infections. Crime incidents likely to be encountered will comprise of, fraud, burglary, theft and vandalism of property. The location of the project greatly affects both the amount and type of crime that occurs. Increase in crime cases when working in or around cities urban and peri urban centres, and the nature of crime tends to vary in different regions.
Mitigation measures;

1. Prioritize recruitment of local workers for unskilled labour through job fairs, community hiring agreements and consider partnerships with local vocational training centers for skilled labour.
2. Restrict site access to only essential staff, especially during high-impact activities.
3. Develop shared strategies for mitigation (e.g., zoning and curfews)
4. Require incoming workers to follow a code of behavior that respects local cultures and laws.
5. Incorporate STD/HIV/AIDS awareness and prevention programmes into the training Programme for all project workers

- **Impacts on Slope Instability**

Excavation works along sloped landscapes and hilly terrain during the railway construction pose a significant geotechnical challenge, with the potential to destabilize slopes and trigger soil erosion, landslides, and catastrophic slope failures. The risks escalate sharply in steep-gradient zones, where hillside tunneling, controlled blasting, and deep cuttings are unavoidable to achieve the required rail alignment. Without proper engineering controls, poorly designed or inadequately supported cut slopes can undermine the structural integrity of entire landforms, endangering both the railway infrastructure and nearby communities.

Key tunneling activities are anticipated at North Rata, Ebutanyi and Yala, areas characterized by fragile geological conditions. In high-rainfall zones with clay-rich soils and fractured metamorphic rock formations, the susceptibility to landslides is particularly acute. Clay soils absorb water rapidly, lose shear strength when saturated, and become highly prone to mass movements. Similarly, fractured rock masses introduce natural planes of weakness, which can be activated by excavation vibrations, blasting operations, or excessive loading. Historical evidence from comparable terrains highlights that landslides typically emerge from a dangerous combination of steep gradients, unstable geology, and inadequate drainage systems.

- **Mitigation**

To mitigate the risk of slope instability, soil erosion, and landslides during railway construction, a combination of preventive engineering measures and proactive environmental management should be adopted. This begins with detailed geotechnical and hydrological investigations to identify vulnerable zones and determine appropriate slope stabilization methods. Engineering solutions may include the design of stable cut angles, installation of retaining walls, soil nailing, and rock bolting to reinforce weak formations, as well as controlled blasting techniques to minimize vibrations. Proper drainage systems such as culverts, sub-surface drains, and catchwater ditches should be constructed to manage surface runoff and reduce water infiltration into clay-rich soils and fractured rocks. In addition, bioengineering approaches like vegetation cover, grassing, and terracing can further stabilize slopes and reduce erosion. Continuous monitoring through slope sensors, visual inspections, and early warning systems is also essential to detect movement or stress build-up, ensuring timely interventions. Together, these measures not only safeguard the railway infrastructure but also protect nearby communities and ecosystems from landslide hazards.

- **Interruptions of the existing railway operations**

During the construction phase, there is potential for operational interference with the existing meter gauge railway line, particularly at crossing points, shared yards, and depots. Such disruptions may arise from the necessity to relocate utilities and services, the temporary occupation of rail infrastructure for construction purposes, and the implementation of traffic diversions to accommodate work activities. These interruptions could adversely affect the regular functioning and efficiency of the meter gauge railway operations, potentially leading to delays and reduced service reliability.

Mitigation

1. Engage in extensive stakeholder consultations involving railway operators, service providers, and other affected parties
2. Conduct comprehensive planning and scheduling of construction activities to coordinate works in a manner that minimizes operational disruptions.
3. Employing phased construction approaches, optimizing work windows, and establishing clear communication channels will help ensure that business operations on the existing meter gauge line are maintained as effectively as possible throughout the project lifecycle.

- **Wildlife and Livestock accidents due to breached fence**

Wildlife mortality and livestock casualties have been reported along the existing railway corridor, primarily resulting from collisions as animals attempt to cross the tracks. The installation of fencing along the railway corridor is a critical safety measure aimed at minimizing these incidents by restricting animal access to the track area. These animals include Common Duiker (Sylvicapra grimmia), Giant otter shrew (Potamogale velox), Spotted hyena (Crocuta crocuta) and the White-tailed mongoose (Ichneumia albicauda).

However, larger animals, and occasionally humans, may attempt to breach or damage fencing infrastructure, potentially compromising its integrity and effectiveness. To mitigate these challenges, the design and construction of the fence must consider both durability and deterrence capabilities. Options include the construction of robust earth embankments paired with high-tensile wire fences, or the installation of electrically charged fencing systems, which provide an effective physical and psychological barrier to prevent crossing attempts by large animals and unauthorized human access.

Additionally, the incorporation of wildlife underpasses or culverts at strategic crossing points enables safe passage of animals beneath the railway line without interfering with rail operations. These structures facilitate wildlife movement and habitat connectivity, reducing ecological fragmentation while simultaneously enhancing safety.

The implementation of these combined measures will not only reduce the frequency of animal-train collisions, thus preserving wildlife and livestock populations, but also enhance the safety of rail operations by preventing accidents that can result in significant damage to rolling stock and freight vehicles. This reduction in collision-related incidents also contributes to lower operational disruptions and associated economic losses.

Recommendations for Effective Fence and Crossing Design:

1. Conduct wildlife movement and behavior studies to identify high-crossing zones and optimize the placement of underpasses.
2. Utilize fencing materials that balance strength, flexibility, and visibility to reduce damage by animals and humans.
3. Design underpasses with appropriate dimensions, lighting, and natural substrate to encourage regular animal use.
4. Implement regular fence inspection and maintenance schedules to promptly repair breaches and maintain barrier effectiveness.
5. Engage local communities and stakeholders in awareness programs to minimize human interference with fencing infrastructure.

- **Disputes over employment**

Recruitment of labour from the local communities can result in conflicts. These would result in need for proper stakeholder engagement in line with the requirements of the standards on labour and working conditions for smooth operation of activities that rely on local labour. Protection of vulnerable and marginalized groups such as youth and women within the project's labour force may also require especial measures.

Proposed Mitigation Measures

1. The proponent shall develop a grievance management system to manage grievances arising from the local labour force.
2. The proponent shall develop a Stakeholder Engagement and Community Development Plans.
3. The proponent shall develop local labour recruitment plans, including disclosure of opportunities and partnership building with local support agencies / institutions.

- **Loss of livelihood**

Land will be required for construction of the new railway project. This will require acquisition of public, community and private lands, and will involve social issues such as resettlement of quite a number of families. The project is likely to affect various households, business enterprises among others. Moreover, there is possibility of adverse effects on the quality of life of affected community members. There will be loss of land and crops as well as houses and other properties such as businesses, churches, institutions among others. The land will be acquired and the properties destroyed to pave way for construction of the railway line and the respective stations. The identified line route will lead to physical displacement of people, loss of shelter, assets, income sources and livelihood, and restriction of access to economic resources

Mitigation measures

1. Conduct detailed socio-economic baseline surveys to understand the livelihoods at risk.
2. Develop a Livelihood Restoration Plan (LRP) alongside the Resettlement Action Plan (RAP).
3. Ensure the LRP includes short-term compensation and long-term recovery support.
4. Promote income diversification e.g. bee keeping to the affected communities.
5. Offer support for transitioning to new livelihoods through: Skills training, micro-financing and job placement in the project or related services
6. Prioritize affected persons for construction and support employment opportunities in the SGR project.

9.3.5 Negative Environmental Impacts During Operation Phase

- **Loss of vegetation during wayleave maintenance**

Effective and routine vegetation management along railway corridors (track alignments and associated wayleaves) is essential to ensure the safe and efficient operation of train services, as well as to facilitate proper maintenance of railway infrastructure.

Unchecked growth of vegetation, including trees, shrubs, and grasses, poses multiple operational hazards. Overgrown trees may obstruct visibility of trackside signaling equipment, encroach on overhead electrification lines, or even collapse onto the track during adverse weather conditions, causing service disruptions or derailments. Dense undergrowth can also impede access to emergency egress zones or maintenance pathways, potentially compromising the safety of personnel during routine operations or emergencies.

Vegetation Management Techniques

Vegetation control within the rail corridor should employ an integrated management strategy that includes the following methods:

1. Mechanical Methods

   These involve the use of equipment such as rotary mowers, brush cutters, and flail mowers to control grass and shrub growth. Mechanical cutting is effective for large areas but may require frequent application due to regrowth.

2. Manual Methods
   Manual techniques such as hand pruning and selective cutting are suitable for sensitive areas or where precision is needed, for example near infrastructure or ecologically sensitive zones.

3. Chemical Methods (Herbicide Application)
   The use of approved herbicides can provide long-term control of invasive or fast-growing species. However, chemical use must be carefully managed to minimize off-target impacts, soil contamination, and exposure risks to non-target species, including humans.

Ecological Considerations and Potential Impacts

Vegetation maintenance must be balanced to meet both operational requirements and environmental sustainability. Excessive or indiscriminate clearing can disrupt local ecosystems by continually removing successional species, reducing biodiversity, and exposing the area to colonization by invasive or opportunistic plant species including Solanum mauritanium, Parthenium hysterophorus, Psidium guajava, Lantana camara and Cuscuta spp.

Long-term ecological consequences may include:

1. Loss of native habitat for pollinators, birds, and small mammals;
2. Soil destabilization and increased erosion, especially on embankments;
3. Reduction in carbon sequestration potential due to removal of plant biomass.

Best Practices and Mitigation Measures

1. Vegetation Management Planning: Develop a site-specific Vegetation Management Plan (VMP) that incorporates biodiversity conservation objectives, prioritizes native species, and outlines treatment thresholds.
2. Buffer Zones: Establish vegetative buffer zones using low-growing, native plant species that do not interfere with infrastructure but support ecological functions.
3. Integrated Pest Management (IPM): Use herbicides as a last resort, incorporating monitoring and mechanical/manual methods first to minimize chemical dependency.
4. Monitoring and Adaptive Management: Regular ecological assessments should be conducted to track the effectiveness of vegetation control measures and adapt strategies to evolving site conditions.

- **Liquid Waste Generation**

The operation of sanitation facilities at train stations will inevitably result in the generation of liquid waste, primarily consisting of greywater and blackwater from toilets, handwashing stations, and other hygiene-related infrastructure. Effective management of this wastewater is critical to maintaining public health standards and ensuring environmental protection.

In instances where train stations are not connected to a centralized or conventional municipal sewerage network, on-site wastewater treatment solutions must be employed. A common approach involves the construction of septic tank systems in conjunction with soak away pits (also known as infiltration or percolation pits).

Mitigation measures

1. Construction of septic tanks in areas not served by sewer lines. The septic tank serves as a primary treatment unit where solids settle, and anaerobic digestion reduces the organic load of the wastewater. The effluent, while partially treated, is then discharged to a soak away pit—a subsurface structure designed to allow gradual infiltration of liquid into the surrounding soil. The soil acts as a secondary filtration medium, facilitating further biodegradation and pathogen removal through natural processes.
2. Proper design, sizing, and maintenance of liquid waste management systems to ensure their effectiveness and to prevent contamination of groundwater resources. Factors such as soil permeability, water table levels, projected usage volumes must be considered in the engineering of these facilities. In areas with high water tables or impermeable soils, alternative technologies such as constructed wetlands or bio-digesters may be more appropriate.
3. Periodic monitoring and desludging schedules should be established as part of a comprehensive wastewater management plan.

- **Oil Spillage**

Petroleum hydrocarbon contamination is a significant environmental risk associated with the operation and maintenance of railway infrastructure, particularly during activities such as lubricant changes, cleaning, and mechanical repairs of rolling stock. Uncontrolled oil spillages are frequently observed in maintenance yards due to operational practices, equipment wear, and poor containment measures. In addition to acute spill events, chronic pollution can occur through persistent leaks and drips of lubricants, hydraulic fluids, solvents, and grease from locomotives and auxiliary machinery.

Railway yards, particularly fueling and servicing zones, are high-risk areas for such contamination. Spilled oil and related substances have the potential to infiltrate the surrounding soil matrix, leading to long-term degradation of soil quality and posing serious risks to terrestrial and aquatic ecosystems. Moreover, surface runoff, especially during rainfall events, can mobilize these pollutants, enabling their transport to adjacent agricultural lands and ecologically sensitive areas such as wildlife conservation zones. This runoff may also contain residues from incidental spills that are not effectively managed by containment infrastructure.

Stormwater falling on exposed maintenance areas, fuel storage zones, and washing bays can become contaminated with hydrocarbons. If not properly managed, this stormwater can act as a conduit for non-point source pollution

Recommended Mitigation Measures

1. Primary Containment: All maintenance and fueling activities should be conducted on impermeable, bunded surfaces equipped with oil-water separators to prevent direct infiltration and runoff.
2. Secondary Containment Systems: Drip trays, catchment basins, and covered storage should be employed to collect incidental leaks and spills, particularly in high-risk areas.
3. Spill Interception and Treatment: A grit chamber system should be installed to facilitate the settling of suspended solids and initial separation of hydrocarbons from wash water and stormwater runoff. These chambers should be regularly monitored and cleaned to maintain operational efficiency.

4. Oil Recovery and Disposal: Recovered oil and oily residues should be handled as hazardous waste. Appropriate disposal methods include:
    - Auctioning the waste oil to licensed recyclers or re-refiners.
    - High-temperature incineration in approved facilities, which ensures complete combustion of organic compounds and prevents groundwater contamination.
5. Monitoring and Environmental Safeguards: Regular environmental audits, soil and water quality assessments, and hydrocarbon concentration monitoring should be conducted, particularly in drainage pathways leading from the rail yard.
6. Emergency Response Planning: Personnel should be trained in spill response protocols, and spill kits must be readily accessible at all maintenance and fueling stations.

- **Pollution on Vegetation**

The operation of diesel-powered locomotives is expected to generate exhaust emissions comprising various air pollutants, including particulate matter (PM), nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), and unburned hydrocarbons (HC). These emissions contribute to both local air quality degradation and broader atmospheric environmental concerns.

Impacts on Vegetation and Ecosystems:

1. Deposition of Particulate Matter and Soot - When particulate-laden exhaust settles on plant foliage, it creates a physical barrier that obstructs light absorption and gas exchange through stomata, thereby disrupting the process of photosynthesis. This reduction in photosynthetic efficiency can lead to stunted growth, reduced crop yields, and overall decline in plant health, particularly in areas adjacent to the rail corridor.
2. Formation of Acid Rain - Nitrogen oxides (NO_x) and sulfur dioxide (SO_2) emitted from locomotive exhaust can undergo atmospheric chemical transformations, forming nitric and sulfuric acids. These acids are deposited on terrestrial and aquatic ecosystems through precipitation—a phenomenon known as acid rain. Acid rain leads to soil acidification, nutrient leaching, and direct damage to leaf surfaces, which collectively impair vegetation growth and biodiversity.

Mitigation Measures to Minimize Emissions

To reduce the environmental footprint of locomotive operations, the project will implement a comprehensive emissions reduction strategy, including:

1. Adoption of low-emission or hybrid locomotives, and where feasible, electrification of rail lines, will significantly reduce combustion-related pollutants.
2. Routine inspection and maintenance of engines will ensure optimal combustion efficiency, thereby minimizing the release of incomplete combustion products such as soot and carbon monoxide.
3. Utilizing ultra-low sulfur diesel (ULSD) will directly reduce sulfur dioxide emissions, thereby decreasing the risk of acid rain formation.
4. Implementation of after-treatment systems such as diesel oxidation catalysts (DOCs), particulate filters, and selective catalytic reduction (SCR) units can substantially reduce NO_x and PM emissions from diesel engines.
5. Establishment of green buffers along the railway corridor can serve as biofilters for airborne

pollutants, while also providing aesthetic and ecological benefits.

6. Continuous ambient air quality monitoring stations will be installed near sensitive ecological zones to track pollutant levels and assess the effectiveness of mitigation measures.

- **Air Emissions**

Locomotive engines, particularly diesel-powered units, represent a notable source of air pollutant emissions, with heightened concentrations commonly observed in and around rail yard facilities. The combustion of diesel fuel in these engines generates several key pollutants, including nitrogen oxides (NO_x) and particulate matter (PM). Both NO_x and PM are well-documented contributors to adverse public health outcomes, such as respiratory and cardiovascular diseases, due to their capacity to penetrate deep into the respiratory tract and induce inflammatory responses.

Additionally, diesel locomotives emit carbon dioxide (CO_2), a principal greenhouse gas, thereby contributing to anthropogenic climate change through the enhancement of the atmospheric greenhouse effect.

Beyond exhaust emissions, ancillary operations associated with rail transport also present air quality challenges. The handling and transportation of dry granular materials—such as minerals, grains, or construction aggregates can generate fugitive dust emissions, which may degrade local air quality and visibility if not properly controlled.

Furthermore, the storage, transfer, and handling of fuels, lubricants, and volatile chemicals at rail yards carry the risk of fugitive emissions unintended releases of volatile organic compounds (VOCs) and other hazardous air pollutants (HAPs) into the atmosphere. These fugitive emissions can contribute to ground-level ozone formation, exacerbate smog conditions, and pose toxicological risks to nearby communities and ecosystems.

Mitigation and Control Strategies

1. Employing advanced engine technologies with diesel particulate filters (DPFs), and selective catalytic reduction (SCR) systems to reduce NO_x and PM emissions.
2. Application of water sprays, chemical suppressants, and use of covered conveyors or enclosed handling facilities to reduce particulate matter during material transport and transfer operations.
3. Implementing leak detection and repair (LDAR) programs, utilizing vapor recovery systems during fuel storage and transfer, and maintaining sealed containment areas to limit VOC releases.
4. Continuous ambient air quality monitoring near sensitive receptors and rail yard boundaries should be conducted to inform adaptive management.

- **Solid Waste Generation**

The volume and composition of solid waste generated by passenger trains and train terminals largely depend on passenger throughput and the range of services offered on-site. Common waste streams include non-hazardous organic waste such as food residues from onboard catering services and station-based food vendors. Additionally, packaging materials from retail outlets, paper products including newspapers, disposable food containers, and other single-use items contribute significantly to the waste profile in passenger areas.

Rail infrastructure maintenance and upgrades introduce further waste streams, comprising both non-hazardous and hazardous materials. Non-hazardous waste typically consists of scrap steel, wooden sleepers (rail ties), and other construction debris. Hazardous wastes arise primarily from the use and disposal of lubricants, solvents, and other chemical substances employed in field maintenance equipment and refurbishment activities.

Waste generation from railway operations is predominantly associated with the maintenance and overhaul of locomotives and rolling stock, with track maintenance activities contributing to a lesser extent. Typical waste types from these operations include:

- Solid residues from mechanical cleaning processes of railcars (e.g., accumulated dirt and debris);
- Paint chips and abrasive blasting media such as sandblast grit used during surface preparation;
- Residual and waste paint materials;
- Spent solvents and solvent sludges resulting from painting and cleaning operations;
- Sludge generated from wastewater treatment systems related to cleaning activities;
- Waste oils, hydraulic fluids, and other petroleum-based lubricants;
- Petroleum-contaminated solids such as used oil filters and absorbent materials saturated with spills;
- Spent engine coolants and antifreeze solutions;
- Metal shavings, scrap components, and worn mechanical parts;
- Depleted locomotive and signaling batteries containing heavy metals and acids;
- Spent brake shoes containing metallic components and potential hazardous residues.

At passenger stations, refuse primarily includes general garbage, rubbish, and floor sweepings. Efficient and sanitary collection and disposal of this waste are critical for vector control, minimizing odor and pest infestations, improving the aesthetic environment, and preventing pollution. Modernization efforts aim to digitize most station transactions and communications, thereby reducing reliance on paper-based materials and consequently lowering the proportion of paper waste generated during operations.

To maintain sanitary conditions, appropriately designed waste containers and collection bins will be strategically installed across all railway facilities. These receptacles will facilitate segregation where possible and support regular waste collection schedules to prevent accumulation and overflow.

Environmental Considerations:

The potential for increased littering, particularly within environmentally sensitive or protected areas adjacent to rail corridors, poses a risk to the visual amenity and ecological integrity of these zones. Littering by passengers and rail-line users can introduce non-biodegradable pollutants and wildlife hazards, thereby degrading habitat quality and the protected area's aesthetic value.

Recommendations for Waste Management

1. Implementation of a comprehensive Waste Management Plan (WMP) encompassing waste minimization, segregation, and recycling strategies;
2. Training of staff and public awareness campaigns to reduce littering and promote responsible waste disposal;
3. Regular monitoring and cleanup operations within and around rail facilities and protected areas;

4. Provision of adequate infrastructure for waste containment and environmentally sound disposal or recycling of hazardous materials;
5. Engagement with licensed waste handlers for safe disposal of hazardous wastes such as oils, solvents, and batteries in compliance with local regulations and international best practices.

- **Hazardous Materials**

Maintenance operations on locomotives and rolling stock frequently involve the use of hazardous materials, including chemical agents such as solvents, coolants, acids, and alkalis. These substances are essential for tasks such as degreasing, cooling system management, cleaning, and corrosion control. However, improper handling, storage, or disposal of these hazardous chemicals poses significant risks to worker safety, public health, and the environment, including soil and water contamination.

Risk Mitigation and Management Measures

1. Establish and enforce standard operating procedures (SOPs) for the safe storage, handling, and disposal of solvents, coolants, acids, and alkalis to minimize exposure risks and environmental release.
2. Identification and Inventory of Legacy Hazardous Substances: Conduct thorough inspections and material audits to identify equipment containing PCBs and asbestos. Maintain an updated inventory to support risk assessment and management planning.
3. Specialized Removal and Disposal Procedures: Engage licensed hazardous waste contractors for the safe removal, transport, and disposal of PCBs and asbestos-containing materials.
4. Personal Protective Equipment (PPE) and Training: Ensure maintenance personnel are equipped with appropriate PPE, such as respirators and protective clothing, and are trained in handling hazardous substances and emergency response protocols.

Noise and Vibration

Railway operations are associated with multiple sources of noise pollution, which can have significant impacts on human health, wildlife, and the general acoustic environment, particularly in densely populated or environmentally sensitive areas. The primary contributors to railway-related noise emissions include:

1. Rolling Noise: This is the predominant noise source during train operation and is generated by the interaction between the steel wheels and the rail track. Rolling noise results from surface roughness, wheel and rail irregularities, and vibrations induced in the rail structure. It becomes more pronounced at higher speeds and varies depending on the condition of the track and wheel surfaces, track stiffness, and maintenance practices.
2. Braking Noise: During deceleration, especially with mechanical (friction-based) braking systems, additional high-frequency noise is produced. This is typically more pronounced in freight trains and older rolling stock, where braking involves significant contact forces between brake shoes and wheels or discs.
3. Aerodynamic Noise: Aerodynamic noise becomes significant at higher operating speeds and is generated by the displacement of air as the train moves. This includes turbulence created around the nose of the train, pantographs, and undercarriage, as well as pressure fluctuations that can lead to transient noise events (e.g., when trains enter tunnels).

4. Traction and Mechanical Noise: Noise from the propulsion system, particularly in diesel-electric locomotives, includes emissions from internal combustion engines, turbochargers, and associated mechanical systems. In electric trains, traction noise originates from electric motors, gearboxes, and auxiliary systems such as compressors and inverters. Cooling fans and ventilation units also contribute significantly to overall noise levels, especially at low speeds or when idling.

Technical Considerations and Mitigation Measures

- Track and Wheel Maintenance: Regular grinding of rails and re-profiling of wheels to maintain smooth contact surfaces and reduce vibrational noise.
- Use of Noise Barriers: Installation of physical barriers such as acoustic walls, earth berms, or vegetation screens along sections of track adjacent to noise-sensitive receptors (e.g., residential areas, schools, hospitals).
- Low-Noise Rail and Wheel Technologies: Adoption of damped wheel designs, resilient rail fasteners, and rail web dampers can effectively reduce noise at the source.
- Aerodynamic Design Optimization: Streamlining train profiles, optimizing pantograph geometry, and enclosing undercarriage components can significantly reduce aerodynamic noise for high-speed trains.
- Quiet Braking Systems: Transition to disc brakes or composite brake blocks which generate less noise than traditional cast-iron blocks.
- Engine Enclosures and Acoustic Insulation: Incorporating soundproofing materials around engines and mechanical compartments, as well as using vibration isolation mounts.
- Operational Controls: Imposing speed restrictions in urban and noise-sensitive areas, and scheduling train operations to avoid nighttime disturbances.

The movement of trains along railway tracks results in the generation of ground-borne vibrations. These vibrations originate primarily from dynamic interactions between the train wheels and the rail, particularly during high-speed travel, at track joints, switches, or in areas with structural discontinuities or poor subgrade conditions.

While these vibrations are typically perceptible to humans, their magnitude is generally localized and tends to attenuate rapidly with distance from the source. In most cases, significant ground vibration levels are confined to areas immediately adjacent to the railway corridor, typically within 30 to 100 meters, depending on soil type, train speed, axle load, and track condition.

The primary mechanisms contributing to railway-induced vibration include:

- Quasi-static loads due to the weight of the train moving over the track;
- Dynamic loads from wheel-rail irregularities (e.g., out-of-round wheels, rail joints, or track defects);
- Impact loads at rail discontinuities or crossings.

Potential Impacts of Ground Vibration

- Structural vibrations: Repeated exposure may affect the integrity of nearby buildings, particularly older or poorly constructed structures.
- Human comfort: Vibrations can cause annoyance or sleep disturbances for residents near the railway, even at low frequencies.

- Sensitive equipment interference: Facilities with vibration-sensitive instruments (e.g., hospitals, laboratories) may be affected.

Mitigation and Control Measures

1. Track Maintenance and Upgrades:
    - Ensuring smooth rail surfaces through regular grinding and alignment reduces dynamic impacts.
    - Use of continuously welded rail (CWR) instead of jointed track minimizes impact vibrations.
2. Track Design Solutions:
    - Ballast mats, under-sleeper pads, or floating slab track systems can absorb and dissipate vibration energy before it transmits to the ground.
    - Resilient track fasteners reduce the stiffness of the rail-to-tie connection and mitigate high-frequency vibration.
3. Operational Adjustments:
    - Speed limits in vibration-sensitive zones can significantly reduce both the amplitude and frequency of vibration.
    - Scheduling freight or heavy trains during daytime hours may help reduce nighttime disturbance.
4. Buffer Zones and Land Use Planning:
    - Maintaining appropriate setback distances between the railway and residential or sensitive land uses can prevent significant impacts.
5. Monitoring and Baseline Studies:
    - Conducting pre-construction and operational vibration monitoring helps establish baseline levels and assess the effectiveness of mitigation measures.

- **Climate change**

Much of the area along the proposed railroad route is heavily altered by human settlements and activities. The bushland that once dominated the region's vegetation has become rare, having been cleared to make way for agriculture and habitation. Therefore, climate change impact is likely to be a cumulative impact.

The proposed railway project has several potential linkages to climate change, particularly during its operational phase. These linkages primarily stem from greenhouse gas (GHG) emissions and land-use changes, which can directly and indirectly contribute to atmospheric warming and environmental degradation.

1. Direct Greenhouse Gas Emissions from Rail Operations: During operation, the project will result in emissions of carbon dioxide (CO_2) and other GHGs due to the combustion of diesel fuel in train engines, especially where electrification is absent or partial. In addition, stationary sources—such as backup generators, HVAC systems, and maintenance equipment at stations and rail yards—will contribute further emissions. These activities will increase the project's carbon footprint, thereby contributing to global climate change and potentially affecting national emission inventories.

2. Indirect Emissions from Induced Socioeconomic Activities: The railway project is expected to stimulate economic development and urbanization along the corridor. While these outcomes are

beneficial from a development perspective, they introduce secondary climate risks through:

- Increased organic waste generation, which if not managed properly can result in the release of methane (CH_4), a potent GHG, particularly from anaerobic decomposition in unmanaged landfills.
- Increased wastewater production, which, in the absence of proper treatment infrastructure, contributes to GHG emissions (e.g., CH_4 and nitrous oxide, N_2O) and can contaminate water bodies.
- Vegetation clearing and land-use change for new settlements, roads, or amenities can lead to the loss of carbon sinks and soil carbon stocks, contributing to long-term net carbon emissions.

3. Climate Change Feedback and Vulnerability: In addition to contributing to climate change, the project area may itself become vulnerable to climate-related impacts. For instance, increased GHG concentrations may exacerbate local temperature extremes, alter precipitation patterns, and increase the frequency of extreme weather events, all of which could affect the structural integrity and operational efficiency of the railway system.

Mitigation and Climate-Resilient Recommendations:

- Adoption of low-emission locomotives, including electrified rail systems or hybrid alternatives to diesel engines.
- Energy-efficient station infrastructure, powered by renewable energy sources (e.g., solar PV systems).
- Implementation of solid and liquid waste management systems, including biogas digesters, composting units, and wastewater treatment plants to reduce methane and nutrient emissions.
- Afforestation or reforestation programs to offset unavoidable emissions and enhance carbon sequestration.
- Integration of climate risk assessments into infrastructure design to ensure climate-resilient development and reduce vulnerability to climate variability.

- **Water Ponding**

This is the accumulation of water in unwanted or low-lying areas, usually due to poor drainage. The construction of railway embankments, especially in low-lying and flood-prone regions, can significantly alter natural surface water flow patterns. Embankments, by their design, act as linear barriers across the landscape. When constructed without adequate hydraulic considerations such as culverts, bridges, or drainage channels they can impede the natural flow of water across floodplains, wetlands, or seasonal drainage paths.

This obstruction leads to a ponding or impoundment effect on the upstream (water-receiving) side of the embankment. The accumulation of water results in a damming effect, increasing hydrostatic pressure and potentially causing localized flooding. Such flooding may submerge adjacent land, disrupt agricultural activities, damage ecosystems, and negatively impact nearby communities.

Furthermore, if the embankment is not engineered to withstand sustained or high-pressure water exposure, the increased saturation and hydraulic force can lead to soil erosion, scouring, or even structural failure of the embankment. Erosive forces may undermine the track bed, destabilize slopes, and result in track deformation, posing safety hazards and increasing maintenance costs.

Mitigation

- Hydrological Impact Assessment:
  - ✓ Conduct detailed hydrological and hydraulic modeling of the project area to identify all-natural drainage pathways, seasonal water flows, and potential flood zones.
- Drainage and Water Conveyance Infrastructure:
  - ✓ Integrate appropriately sized and strategically placed culverts, box drains, or small bridges along the embankment to allow unimpeded flow of water.
  - ✓ Ensure these drainage structures are designed to handle peak flows based on historical flood data and climate change projections.
- Embankment Design Reinforcement:
  - ✓ Use erosion-resistant materials such as riprap or geotextiles on embankment slopes to prevent soil loss due to water action.
  - ✓ Consider vegetative stabilization techniques to improve slope integrity and absorb runoff.
- Regular Inspection and Maintenance:
  - ✓ Implement a maintenance schedule to inspect drainage structures for blockages or sedimentation and monitor embankment stability, especially during and after heavy rainfall events.
- Environmental Flow Management:
  - ✓ Ensure that natural flow regimes are maintained to protect downstream ecosystems and avoid waterlogging upstream agricultural or residential areas.

9.3.6 Negative environmental impacts during decommissioning phase

- **Solid Waste Generation**

The demolition of the buildings and their associated infrastructure will generate substantial volumes of solid waste. This waste stream is expected to comprise various construction materials including concrete, metals, drywall, timber, glass, paints, adhesives, sealants, and fastening components. While demolition waste is predominantly regarded as inert and thus less environmentally harmful, recent studies indicate that the accumulation of large quantities of such materials can potentially result in the release of hazardous substances into the environment.

Specifically, chemical constituents embedded in construction materials such as additives in paints, adhesives, and sealants may leach out over time, leading to soil and water contamination. Moreover, even substances traditionally considered non-toxic, such as chloride (Cl^-), sodium (Na^+), sulfate (SO_4^{2-}), and ammonia (NH_3), can be mobilized through leaching processes associated with demolition debris. These ions have the potential to significantly degrade groundwater quality by increasing salinity, altering pH balance, and elevating total dissolved solids, which can adversely affect human health, agricultural productivity, and local ecosystems.

Mitigation measures.

1. Waste Characterization and Hazard Assessment: Prior to demolition, a thorough waste audit and hazardous materials survey should be conducted to identify potential sources of contaminants and ensure proper segregation of hazardous and non-hazardous materials.
2. Leachate Management: Effective containment and management strategies for demolition waste stockpiles should be implemented to minimize leachate generation. This may include

the use of impermeable liners, runoff diversion systems, and controlled drainage infrastructure.

3. Groundwater Protection Measures: Buffer zones around water bodies and groundwater extraction points should be established to prevent contamination. Regular groundwater monitoring programs should be instituted to detect early signs of pollution.
4. Material Recycling and Reuse: Emphasizing the recycling and repurposing of inert materials such as concrete and metals can reduce the volume of waste requiring disposal and mitigate environmental impacts.

- **Dust pollution**

Demolition activities are anticipated to produce substantial volumes of airborne particulate matter (dust), which can have significant occupational health and environmental implications. The generation of dust during demolition results primarily from the mechanical disruption of building materials such as concrete, drywall, wood, and other construction debris.

Exposure to elevated dust concentrations poses respiratory health risks to demolition workers, including the potential development of conditions such as silicosis, chronic obstructive pulmonary disease (COPD), and other respiratory irritations or allergies. Additionally, nearby residents and sensitive receptors, including schools, hospitals, and community centers, may experience reduced air quality, leading to nuisance complaints and potential exacerbation of pre-existing health conditions such as asthma.

Mitigation and Management Measures:

- Dust Suppression Techniques:
- ✓ Application of water sprays or misting systems at active demolition sites to suppress dust generation.
- ✓ Use of dust extraction or vacuum systems where feasible.
- Personal Protective Equipment (PPE):
- ✓ Provision of appropriate respiratory protective equipment (e.g., N95 masks) to workers.
- ✓ Implementation of occupational health protocols including training and health surveillance.
- Site Management Practices:
- ✓ Scheduling demolition during favorable meteorological conditions to minimize dust dispersion (e.g., avoiding high winds).
- ✓ Installation of physical barriers such as screens or fencing to contain dust within the demolition zone.
- Air Quality Monitoring:
- ✓ Deployment of particulate matter (PM10 and PM2.5) monitoring stations around the demolition site to assess dust levels.
- Community Engagement:
- ✓ Informing and coordinating with neighboring residents and businesses regarding demolition schedules and mitigation efforts to manage expectations and minimize disruption.

- **Noise and Vibration**

Demolition activities are expected to cause a substantial degradation of the acoustic environment both within the project site and in adjacent areas. This deterioration is primarily attributed to the elevated noise levels and ground-borne vibrations generated by heavy machinery, mechanical demolition processes, and material handling operations.

The noise generated during demolition can exceed typical ambient sound levels significantly, potentially causing disturbances to nearby residents, commercial establishments, and sensitive receptors such as schools and healthcare facilities. Prolonged exposure to high noise levels may result in adverse health effects including hearing impairment, increased stress levels, and sleep disturbances. Simultaneously, vibrations produced by demolition equipment and impact activities can propagate through the ground, potentially causing structural vibrations that may affect neighboring buildings and infrastructure. These vibrations can also contribute to discomfort for people in proximity to the site and may interfere with the operation of sensitive equipment in adjacent facilities.

Mitigation and Control Measures

- o Noise Control Strategies:
- ✓ Utilize modern, well-maintained demolition equipment equipped with noise reduction features such as mufflers and silencers.
- ✓ Implement time restrictions to limit demolition activities to daytime hours, minimizing disturbance during early mornings, evenings, and nighttime.
- ✓ Employ physical noise barriers or acoustic screens around the demolition site to reduce sound propagation.
- o Vibration Monitoring and Management:
- ✓ Conduct pre-demolition structural assessments of nearby buildings to identify vulnerabilities.
- ✓ Install vibration monitoring devices during demolition to ensure levels remain within acceptable limits.
- ✓ Adjust demolition techniques or equipment usage if vibration thresholds are exceeded.
- o Community Communication:
- ✓ Inform local communities and stakeholders in advance about demolition schedules and expected noise levels.
- ✓ Establish a grievance mechanism to address concerns promptly.

- **Visual intrusion arising from lighting at night**

Lighting at night from bulbs installed at railway stations, tunnels and bridges can cause visual intrusion, disrupting the natural landscape and affecting the aesthetic value of the area. It can disturb local communities, wildlife, and sensitive ecosystems by altering natural light patterns, potentially leading to disorientation in nocturnal animals and sleep disturbances for nearby residents.

Mitigation measures

1. Use downward-facing, shielded lighting to minimize light spill and glare.
2. Install motion-sensor or timer-controlled lights to limit usage to when necessary.
3. Choose low-intensity, warm-colored lights to reduce visual impact.
4. Position lights strategically to minimize exposure to nearby communities and natural habitats.
5. Conduct regular assessments to ensure lighting remains appropriate and causes minimal disturbance.

9.4 Cumulative Impacts Assessment (CIA)

The project is likely to have cumulative impacts when considered together with other existing, ongoing, or planned developments along the Kisumu Malaba corridor. These impacts may be additive, synergistic, or incremental over time.

9.4.1 Objectives CIA

The objectives of CIA include;

- To assess the combined effects of the project alongside other developments.
- To identify Valued Environmental and Social Components (VECs) that could be significantly affected.
- To recommend mitigation and management measures for sustainable development.

9.4.2 Key Projects/Activities for Cumulative Impact Assessment (CIA)

Along the Kisumu–Malaba corridor, the SGR project interacts with several other developments that may create cumulative effects: **Table 112** highlight such projects.

Table 112: Projects/ Activities for cumulative impacts

Activities	Examples
Existing Infrastructure	• Meter Gauge Railway (MGR) line rehabilitation • Road networks (A1, B1 and associated bypasses), managed by either KeNHA, KURA and KeRRA • KPA - Kisumu Port Operations • KPLC, KETRACO powerlines • Malaba border facilities and customs operation
Planned or Ongoing Projects	• Urban expansion in Kisumu, Butere, Mumias, Yala, Sondu, Malaba • Inland container depots or freight logistics hubs • Utilities: electricity transmission lines, water projects, fibre optic lines • Industrial zones and agro-processing facilities
Environmental Baseline Conditions	• Wetlands (e.g., Lake Victoria catchment areas, Nzoia and Yala wetlands) • Forested or agricultural landscapes • Densely settled areas with existing transportation pressures

9.4.3 Impacts Identification

Cumulative impacts are heighted in the **Table 113** below.

Table 113: Impacts Identification

Category	Cumulative Impact	Description of Potential Cumulative Impact
Environmental	**Habitat Loss & Fragmentation**	Combined land-take from SGR, roads, power lines, and urban expansion may reduce wildlife movement corridors and affect wetlands, riparian areas, and agricultural biodiversity.
	Increased Soil Erosion & Sedimentation	Concurrent construction activities (SGR, road upgrades, urban development) can accelerate erosion and increase sediment loads in rivers flowing into Lake Victoria.
	Water Resource Pressure	Water demand from construction camps, agriculture, and municipal supply may cumulatively stress rivers, springs, and groundwater sources.
	Noise & Vibration Levels	SGR operations combined with road traffic, industry, and urban noise may increase overall noise affecting communities along the corridor.
	Air Quality Deterioration	Dust and emissions from construction machinery, vehicles, and industries may jointly degrade air quality, especially in Kisumu, Mumias, Bungoma, and Malaba.
	Cumulative Waste Generation	Waste from multiple infrastructure projects may exceed county waste management capacity, leading to illegal dumping or pollution.
Social	**Land Acquisition Pressure**	Sequential land demands from roads, utilities, and SGR may increase displacement risks in densely populated villages.
	Influx of Workers	Worker influx from multiple projects may strain housing, water supply, sanitation, and social amenities, potentially causing conflicts.
	Community Health & Safety Risks	Increased traffic from SGR, trucks, boda bodas, and urban growth may raise accident risks and contribute to health/safety concerns.
	Pressure on Public Services	An expanding project-related population may overwhelm schools, health centres, and county administrative services.
	Cross-Border Impacts (Malaba)	Freight congestion and customs operations combined with SGR/road activities may cause delays, pollution, and social/economic pressure on border communities.
	Synergistic Economic Growth	Interaction of SGR operations, logistics hubs, and agriculture value chains may stimulate broader

Economic		regional trade and investment.
	Impacts on Small Businesses	Rising land prices and competition for commercial spaces due to multiple projects may displace small-scale traders and farmers.
	Employment Effects	Overlapping project activities may create job opportunities but also expose workers to cumulative risks such as safety hazards or labour disputes.

9.4.4 Cumulative Impact Matrix

Cumulative impacts are classified as **additive**, **synergistic**, or **incremental**. Additive impacts occur when the identified projects, independently combine, resulting in a total effect equal to the sum of individual impacts. Synergistic impacts arise when project interactions amplify the overall effect beyond a simple sum. Incremental impacts are small, gradual changes that, over time, contribute to long-term cumulative effects.

Table 114 below depicts the identified cumulative impacts, SGR and other projects contributions, type of cumulative impacts and the overall significance of each receptor/ impact area.

Table 114: Cumulative Impact Matrix

Receptor / Impact Area	SGR Contribution	Other Projects	Type of Cumulative	Cumulative Significance
Land Use & Land Acquisition	M	H	Additive	**High**
Habitat Loss & Fragmentation (Wetlands, riparian areas, agricultural landscape)	M	M–H	Synergistic	**High**
Soil Erosion & Sedimentation (rivers draining to Lake Victoria)	M	M	Additive	**Medium–High**
Water Resource Stress (surface & groundwater)	L–M	M–H	Incremental	**Medium–High**
Surface Water Quality (runoff, sediment loads)	M	M	Additive	**Medium–High**
Air Quality (dust, emissions)	M	H	Additive	**High** in urban centers
Noise & Vibration (settlements along corridor)	M	M	Additive	**Medium–High**
Waste Generation (solid waste from construction, camps, towns)	M	H	Additive	**High**
Biodiversity (flora & fauna)	M	M	Synergistic	**High**
Climate Change Contribution (GHG emissions)	L–M	M	Additive	**Medium**
Traffic Safety Risks (SGR + roads + port + border freight)	M	H	Synergistic	**High**
Community Health & Safety (disease exposure, accidents, dust, noise)	M	H	Synergistic	**High**
Worker Influx & Social Pressure	M	M	Incremental	**Medium–High**
Pressure on Public Services (schools, health centres, housing)	M	H	Incremental	**High**
Livelihood Disruption (farmers, traders, artisanal activities)	M	M	Additive	**Medium–High**
Economic Opportunities (trade, logistics, jobs)	H	H	Synergistic (positive)	**High Positive**
Cross-Border Impacts (Malaba congestion, freight handling)	M	H	Synergistic	**High**
Cultural Heritage Sites & Community Areas	L–M	M	Incremental	**Medium**

9.4.5 Cumulative Impact Mitigation and Monitoring Matrix

Table 115 below depicts the identified cumulative impacts, mitigation, Monitoring indicator, frequency and responsibility

Table 115: Cumulative Impact Mitigation and Monitoring Matrix

Cumulative Impact	Mitigation Measures	Monitoring Indicators	Frequency	Responsibility
Habitat Loss & Fragmentation	• Maintain ecological buffer zones and riparian reserves. • Avoid sensitive wetlands and forests through design refinement. • Rehabilitate disturbed areas and implement biodiversity offsets. • Coordinate with county environment offices on land-use planning.	• Number of hectares restored. • Compliance with buffer zone requirements. • Species diversity in restored areas.	Periodic	Contractor, Supervising Engineer, County Environment Depts., KWS
Soil Erosion & Sedimentation	• Joint erosion-control plans with road/utility contractors. • Install silt traps, gabions, and contouring structures. • Phase construction to avoid rainy seasons.	• Suspended solids in rivers. • Condition of sediment traps. • Stabilization of embankments.	Frequent	Contractor, Supervising Engineer, WRMA, County Depts.
Water Resource Pressure	• Regulate water abstraction with WRMA permits. • Promote water-saving technologies at camps. • Coordinate abstraction schedules with nearby projects.	• Abstraction volumes vs. permit. • Water levels in rivers/boreholes.	Periodic	Contractor, WRMA, County Water Dept.
Surface Water Quality Degradation	• Implement wastewater management plans. • Use retention ponds for runoff. • Integrate waste controls with nearby industries and projects.	• pH, turbidity, BOD/COD indicators. • Visible pollution incidents.	Frequent	Contractor, NEMA, WRMA
Air Quality	• Wetting of haul roads.	• Dust levels	Frequent	Contractor, Supervising

Cumulative Impact	Mitigation Measures	Monitoring Indicators	Frequency	Responsibility
Deterioration (Dust, Emissions)	• Limit vehicle speeds. • Maintain machinery. • Coordinate haulage routes with KeNHA/KURA.	(PM10/PM2.5). • Complaints recorded.		Engineer, County Public Health
Noise & Vibration	• Restrict construction to daytime. • Install noise barriers in urban areas. • Coordinate blasting/rail operations with other projects.	• dB(A) levels near settlements. • Complaints logged.	Frequent	Contractor, Supervising Engineer
Cumulative Waste Generation	• Develop integrated waste management plans with counties. • Use licensed waste collectors. • Reuse/recycle materials where possible.	• Waste volumes generated. • Disposal manifests.	Frequent	Contractor, County Governments, NEMA
Biodiversity Loss	• Implement reforestation/afforestation programs. • Avoid key wildlife crossing points. • Collaborate with KWS on conservation corridors.	• Number of trees planted/surviving. • Wildlife sightings/roadkill incidents.	Periodic	Contractor, KWS, County Environment Dept.

CHAPTER 10.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

10.1 Overview

Environmental and Social Management Plan (ESMP) for development projects provides a logical framework within which identified negative environmental impacts can be mitigated and monitored. In addition, the ESMP assigns responsibilities of actions to various actors and provides a timeframe within which mitigation measures and monitoring can be done. ESMP is a vital output of an ESIA as it provides a checklist for project monitoring and evaluation.

10.2 Purpose and Objectives of ESMP

The purpose of ESMP is to ensure that the environmental and social impacts identified during the ESIA process are effectively managed, mitigated, or enhanced throughout the project lifecycle**.**

It specifically;

- Outlines specific measures to prevent or reduce possible negative impacts on the environment.
- Ensures the project adheres to Kenyan and international environmental law
- Assigns responsibilities, timelines, and resources for environmental and social risk management.
- Sets out how environmental and social impacts will be tracked, measured, and reported.

10.3 Auditing of the ESMP

Auditing the ESMP critical in ensuring the environmental and social commitments made during project planning and licensing are actually being implemented, and that they are effective in managing impacts throughout the project's lifecycle.

ESMP audit is crucial in;

- Verifying compliance with the ESMP and regulatory conditions as indicated in the NEMA license).
- Assessing effectiveness of mitigation measures, identify any gaps, non-compliance, or new risks.
- Recommending corrective and preventive actions.

10.4 Responsibilities of the ESMP

ESMP assigns clear responsibilities to various actors to ensure effective implementation, monitoring, and compliance with environmental and social safeguards as shown in the **Table 116** below**.**

Table 116: Actors and tasks in ESMP implementation

Actor	Responsibility
KRC	• Overall accountability for ESMP implementation. • Allocation of budget and resources for mitigation measures. • Ensuring all project phases (design, construction, operation) follow the ESMP. • Submitting compliance reports to NEMA and other regulators.
Environmental and Social (E&S) Officer /Manager	• Coordinating daily implementation of the ESMP. • Monitoring environmental indicators (dust, noise, waste) and social aspects (grievances, local engagement). • Conducting site inspections, train staff on environmental and safety practices. • Preparing ESMP compliance reports and recommend corrective action
Community Liaison Officer / Social Specialist	• Leading stakeholder engagement and public communication. • Operating the Grievance Redress Mechanism (GRM). • Monitoring and report on any community issues, land access, and cultural concerns.
National Environment Management Authority (NEMA)	• Approving the ESIA/ESMP. • Conducting environmental audits and inspections. • Enforcing compliance with environmental laws and license conditions.
County Governments of Kisumu, Vihiga, Kakamega, Siaya and Busia	• Reviewing and supporting land use approvals, local compliance, and permitting. • Participating in community consultations and conflict resolution where necessary.
Independent Environmental Auditor (if engaged)	• Conducting annual Environmental audits guided by the ESMP. • Providing objective evaluation of the environmental performance of the project and give recommendations.

ESMP outlined in **Table 117** below considers mitigation measures for impacts during site preparation, construction, operation and decommissioning phases of the project respectively.

Table 117: Environnemental Social Management Plan (ESMP)

Phase 1: Site preparation and Construction					
Expected Negative Impacts	**Recommended Mitigation Measures**	**Goal**	**Responsibility for implementation**	**Time Frame**	**Cost (KShs)**
Loss of land	• Documentation of the land acquisition/transfer agreements for the identified pieces of Land.	To ensure that the rightful owners are identified.	Proponent	Before acquisition of the identified land	To be determined from the RAP documentations
	• Any new land requirements for the project as well as arising grievances shall be handled in line with the Resettlement Action Plan (RAP).	To ensure grievances are identified and adequately addressed.	Proponent	Land take process to be completed before project construction commences.	
Vegetation Clearance/ Clearance of urban and farm trees	• Equipment and tools brought in for reuse from other project sites should be screened and cleaned of alien / invasive propagules to avoid introduction in the project area • Borrow sites should be inspected for invasive and colonizer propagules • Restrict vegetation clearing to demarcated project site boundaries. • Establishment of woodlots on affected farms to help restore tree cover. • Limiting clearing to the smallest area necessary for the project to reduce habitat loss and soil exposure. • Establishment of protective buffers around sensitive habitats. • Implement tree planting programs to replace	To minimize ecological disruption and biodiversity loss.	Proponent & Contractor	Continuous	400,000

	Phase 1: Site preparation and Construction				
	cleared trees. • Work with farmers to promote agro forestry initiatives.				
Disturbance of indigenous forests	• Minimize the extent of forest clearance. • Align project elements (e.g. access roads, utility corridors) along disturbed or degraded areas. • Establish and maintain buffer zones around high-value conservation areas, riparian zones, and wetlands. • Safely relocate fauna from the project area in coordination with wildlife authorities, especially for species with limited mobility or breeding grounds. • Restore disturbed areas using native species that match the original forest composition. • Involve local communities in forest protection, replanting, and monitoring initiatives. • Provide support for non-forest-based income activities (e.g., beekeeping, agroforestry, eco-tourism) to reduce pressure on forest resources.	To minimize ecological disruption and biodiversity loss	Proponent & Contractor	Continuous	500,000
Loss of pasture for livestock and wildlife	• Avoid key grazing areas and wildlife habitats during route planning. • Incorporate wildlife corridors and livestock crossings (underpasses and overpasses) to ensure safe and uninterrupted movement to pasture areas.	Reduce negative impacts on rangeland ecosystems, local livelihoods while ensuring the sustainability of the project.	Proponent and contractor	Continuous	1,000,000

	Phase 1: Site preparation and Construction				
	• Ensure transparent and timely disclosure of all relevant project information, particularly concerning activities that may affect local communities' rights, land use, and livelihoods. • Support development of fodder banks and irrigated pasture fields for livestock keepers. • Provide advance notice to local farmers, allowing sufficient time for the harvesting of grass. • Compensation where grasslands are unavoidably destroyed due to project activities.				
Oil Spillage	• Develop a site-specific SPCC plan. • Identify high-risk areas and assess potential spill scenarios. • Store oil and fuel in tanks or containers with bunds or drip trays capable. • Conduct fuel transfer and storage activities on concrete or other impermeable surfaces to prevent infiltration into the soil. • Regularly inspect construction machinery for leaks in hydraulic systems, fuel tanks, and lubrication lines. • Ensure that all construction equipment is well-maintained to prevent accidental leaks.	To protect soil, water resources, human health, and ecosystems.	Proponent and contractor	Continuous	300,000

	Phase 1: Site preparation and Construction				
	• Provide and strategically locate oil spill response kits on-site and in vehicles. • Train workers on proper fuel handling and spill response procedures. • Use grit chambers, silt fences, and retention ponds to control runoff and filter out pollutants • Collect used oil, grease, and contaminated materials in clearly labeled, sealed containers. • Dispose of used oil and oily waste through licensed hazardous waste handlers				
Environmental degradation of areas where construction materials are sourced.	• Development and implementation of site rehabilitation plans. • Installation of controls to prevent water stagnation, and sites should be securely fenced with warning signage. • Strengthening monitoring and enforcement to ensure contractors comply with restoration obligations post-excavation.	Prevent long-term environmental degradation and supporting post-project land use.	Contractor and NEMA	Continuous	2,000,000
Blasting and rock excavation	• Blasting should be carried out in accordance with a site-specific Blast Management Plan (BMP). • Use of modern blasting techniques to reduce vibration and flyrock.	To minimize the environmental, structural, and social impacts ensuring safety, protecting ecosystems, and reducing disturbances to nearby communities.	Contractor	Continuous	500,000

	Phase 1: Site preparation and Construction				
	• Establishment of blast exclusion zones with proper signage and fencing to restrict access during detonation. • Real-time monitoring of vibration and air overpressure levels. • Implementing dust suppression strategies, such as water spraying and wind barriers, should be implemented before and after blasting.				
Poor disposal of excavated materials and equipment	• Separate excavated materials into reusable and non-reusable/spoiled materials. • Use inert excavated materials for backfilling, slope stabilization, or forming embankments. • Use crushed rock and clean fill in subgrade or roadbed layers. • Transport non-reusable materials to approved dumping sites. • Drain fuel, lubricants, coolant, and hydraulic fluids from decommissioned equipment prior to disposal. • Salvage metals, rubber parts, and electronics for recycling through licensed waste handlers.	To ensure the environmentally responsible and safe disposal, reuse, or management of excavated materials and decommissioned equipment, thereby minimizing environmental degradation, visual pollution, and public health risks.	Contractor	Continuous	800,000
Soil Erosion	• Conduct geotechnical and hydrological assessments to identify erosion-prone zones. • Develop erosion susceptibility maps to inform alignment design, cut-and-fill balances, and drainage planning. • Schedule earthworks during dry seasons to	To prevent, control, and minimize soil erosion, thereby protecting land productivity, water quality, and surrounding ecosystems.	Contractor	Continuous	400,000

	Phase 1: Site preparation and Construction				
	minimize rainfall-induced erosion. • Clear only the areas necessary for construction to preserve natural ground cover and reduce exposure. • Remove and store topsoil separately for reuse in site restoration and landscaping. • Replant native grasses, shrubs, or fast-growing groundcover species as soon as construction is complete in each section. • Construct gabions, rock bunds, or retaining walls on high embankments and cut slopes. • Construct lined channels, culverts, cross-drains, and side drains to manage surface runoff efficiently. • Install temporary sediment traps or check dams to capture soil before it enters watercourses. • Create holding ponds to allow sediment to settle before water is released downstream. • Compact loose fill and embankments to reduce susceptibility to erosion by water and wind. • Confine heavy equipment movement to designated paths to avoid unnecessary soil compaction and disturbance.				
Slope Destabilization	• Minimize the number of cut-and-fill earthworks by optimizing rail alignment and grading plans. • Use mechanically stabilized earth (MSE), geogrids, and retaining walls to support cut	To prevent and manage slope destabilization in order to ensure structural safety, protect the environment, and minimize risks to	Contractor	Continuous	500,000

	Phase 1: Site preparation and Construction				
	slopes and embankments. • Employ soil nails, rock bolts, or micropiles to provide deep anchoring in unstable slopes. • Install subsurface and surface drainage (e.g., French drains, interceptor ditches, and weep holes in retaining walls) to prevent water accumulation that weakens soil.	human life and property.			
Generation of exhaust emissions	• Retrofit older machinery with emission control technologies such as diesel particulate filters (DPFs) and oxidation catalysts. • Use electric, hybrid, or Compressed Natural Gas (CNG)-powered equipment where feasible, particularly in enclosed or urban areas. • Utilize ultra-low sulfur diesel to reduce sulfur dioxide and particulate emissions. • Store fuels in sealed, labeled tanks to prevent evaporation losses and reduce fugitive emissions • Implement a strict maintenance schedule to ensure that engines operate at optimal efficiency and with minimal emissions. • Enforce anti-idling policies for machinery and vehicles (e.g., limit idling to 3–5 minutes) to reduce unnecessary fuel combustion. • Avoid engine overloading by matching the size and capacity of machinery to the task, ensuring efficient operation. • Implement phased construction to limit the number of machines operating simultaneously	To minimize the generation and impact of exhaust emissions from machinery, vehicles, and equipment in order to protect air quality, human health, and the environment.	Contractor	Continuous	450,000

	Phase 1: Site preparation and Construction				
	and reduce peak emissions. • Source materials (e.g., ballast, sand, steel) locally to reduce long-distance transport and associated emissions. • Use efficient routing and scheduling for material delivery to avoid congestion and repeated trips. • Establish ambient air monitoring stations near sensitive areas to track PM_{10}, $PM_{2.5}$, and NOx levels during construction. • Keep records of equipment types, fuel use, and hours operated to estimate and report construction-phase emissions				
Climate change	• Minimize vegetation clearance by optimizing the construction corridor and integrating natural landscape features into the design where possible. • Implement carbon offset measures, such as reforestation or afforestation programs. • Ensure all construction equipment meets emission standards and promote the use of low-emission fuels or electric-powered machinery where feasible. • Develop integrated waste management plans in collaboration with local authorities. • Incorporate climate resilience and low-carbon strategies into regional development planning	To reduce the contribution of the project to climate change and enhance its resilience to climate-related impacts by minimizing greenhouse gas (GHG) emissions, promoting sustainable practices, and integrating climate adaptation strategies.	Contractor	Continuous	550,000

	Phase 1: Site preparation and Construction				
	to ensure that induced growth does not exacerbate environmental degradation				
Dust Emission	• Clear only the areas required for immediate work to reduce the amount of exposed, dust-prone soil. • Apply water to lose soil prior to and during earthworks (excavation, grading, backfilling) to suppress dust at the source. • Regularly spray water or non-toxic dust suppressants on access and haul roads, especially during dry or windy conditions. • Enforce low speed limits (e.g., <20 km/h) for construction vehicles on unpaved surfaces to minimize dust uplift. • Where feasible, pave or gravel main site access roads to reduce dust from vehicle movement. • Minimize drop heights when loading or unloading fine materials like sand or ballast, and use enclosed conveyors or hoppers when available. • Store loose construction materials such as cement, sand, and aggregates in enclosed or covered facilities. • Use tarpaulins or fitted covers on trucks transporting dusty materials. • Apply water spray during demolition, concrete cutting, and rock drilling to suppress dust at the point of generation. • Equip drilling and grinding equipment with vacuum or extraction systems to capture fine	To protect human health, reduce environmental degradation, and ensure regulatory compliance.	Proponent and Contractor	Continuous	400,000

	Phase 1: Site preparation and Construction				
	particles. • Install PM_{10} and $PM_{2.5}$ monitors at sensitive locations (e.g., residential areas, schools, hospitals) to track ambient dust levels.				
Hydrology and water quality degradation	• Install geotextile silt fences or sediment traps around exposed soils, stockpiles, and drainage paths to intercept suspended solids. • Construct temporary settling basins to capture and treat stormwater runoff from construction areas before discharge into natural water bodies • Build lined and diversion ditches to redirect clean runoff away from construction zones. • Install check dams along drainage channels on slopes to reduce flow velocity and trap sediments. • Design site grading to control surface runoff direction and volume to avoid erosion and water body contamination. • Locate fuel and maintenance areas at least 50 m away from watercourses and provide impervious, bunded surfaces with oil-water separators. • Store fuels, lubricants, and chemicals in leak-proof containers within secondary containment systems. • Maintain spill kits on-site and train personnel in emergency spill response. • Provide portable sanitation facilities for	To preserve natural hydrological systems and prevent the degradation of surface and groundwater quality during and after the implementation of the project, ensuring the sustainability of water resources for ecosystems and communities.	Proponent	Continuous	400,000

	Phase 1: Site preparation and Construction				
	workers, located away from water bodies and serviced regularly. • Treat wastewater from concrete batching, equipment washing, or drilling using sediment traps or pH neutralization before discharge. • Prohibit direct discharge of untreated wastewater or sewage into rivers, lakes, wetlands, or groundwater. • Store construction materials on impervious surfaces under cover to prevent contact with rainwater. • Cover soil and spoil stockpiles with tarpaulin and place them away from drainage paths and watercourses. • Maintain buffer zones (e.g., 30 meters) along rivers and streams to act as natural filters. • Avoid construction in or near wetlands; where unavoidable, apply wetland restoration and compensation measures. • Regularly test parameters such as turbidity, pH, oil & grease, BOD/COD, nitrates, and coliforms in nearby surface and groundwater.				
Storm water drainage management	• Develop a comprehensive stormwater management plan that incorporates proper grading. • Install appropriately sized and aligned drainage infrastructure. • Regular maintenance of drainage pathways during construction, and erosion control measures.	To manage stormwater effectively during and after the construction phases in order to prevent flooding, erosion, waterlogging, and pollution, thereby protecting infrastructure, ecosystems, and community health.	Contractor	Continuous	300,000

	Phase 1: Site preparation and Construction				
	• Integrate hydrological modeling in the design phase.				
Solid Waste Generation	• Prioritize options of waste reduction, reuse and recycling. • Soil emanating from excavations will be reused for landscaping followed by revegetation of the landscaped areas. • Food waste can be disposed in a composite pit as it can degrade and enrich the soil. • No burning of waste onsite • Contract a NEMA certified waste collection firm to collect solid waste for disposal	To minimize the amount of waste produced, ensure safe handling, storage, disposal, and prevent health hazards	Proponent and Contractor	Continuous	300,000
Noise and vibrations	• Plan high-noise activities during daytime hours (e.g. 08:00–17:00) to minimize impact on nearby communities • Use new or well-maintained machinery designed with noise-reducing features (e.g. mufflers, silencers, acoustic enclosures). • Use electric or hydraulic-powered tools instead of pneumatic tools to reduce noise and vibration • Erect movable noise barriers (e.g. acoustic curtains, sound-insulating panels) around high-noise equipment like generators and compressors. • Install acoustic enclosures for stationary noise sources such as concrete mixers, batching plants, and power units.	To manage and reduce noise and vibration impacts, safeguard public health, ensure a safe working environment and maintain regulatory compliance.	Proponent and Contractor	Continuous	530,000

Phase 1: Site preparation and Construction					
	• Avoid operating multiple high-noise machines simultaneously near sensitive areas. • Position equipment and haul roads away from populated areas whenever possible. • Implement traffic management plans to reduce vehicle idling and control speeds on site to reduce noise and vibration from transport. • Use vibration isolation pads, trench barriers, or matting under machinery to reduce transmission. • If blasting is necessary, use controlled methods (e.g., pre-split or cushion blasting) and time it to avoid peak community activity. • Install real-time monitoring devices at key sensitive locations to measure dB(A) levels and vibration (PPV – Peak Particle Velocity).				
Loss of Grazing Land	• Designing livestock underpasses or overpasses at strategic locations to facilitate safe crossing and maintain grazing continuity. • Incorporating community grazing access corridors in the railway layout to minimize disruption to migratory routes. • Establishing participatory rangeland management plans with local stakeholders to ensure sustainable pasture use during and after construction.	To minimize the adverse impacts of the on grazing land by preserving access to rangelands, restoring disturbed areas, and supporting the livelihoods of affected livestock-keeping communities	Proponent and Contractor	Continuous	300,000

Phase 1: Site preparation and Construction					
	• Implementing fencing safety protocols and clear signage to reduce the likelihood of livestock-train collisions.				
Disruption of Public Utilities	• Coordinate with utility service providers and local authorities to map existing underground and overhead infrastructure accurately, • Avoid service interruptions, and adhere to safety and regulatory standards during relocation activities. • Integrated comprehensive surveys and utility mapping, coupled with robust monitoring frameworks. • Engage utility agencies early in the planning phase to identify vulnerable infrastructure and agree on protocols for relocation or protection. • Prepare detailed relocation plans approved by utility providers and schedule works during off-peak hours or planned outages. • Install protective barriers, sleeves, or encasements around utilities that are close to excavation or piling activities. • Clearly mark utility corridors on the ground and in site drawings to prevent accidental damage by construction crews.	To prevent, minimize, and promptly address disruptions to public utilities (such as water supply, electricity, telecommunications, and sewerage systems), ensuring continued access to essential services for communities and businesses.	Proponent and Contractor	Continuous	600,000

	Phase 1: Site preparation and Construction				
	• Set up a system to receive, document, and resolve complaints regarding service disruptions quickly.				
Poor site management and control leading to accidents and incidences	• Nominate persons with defined responsibility for EHS • Through relevant training, ensure everyone on site is aware of their responsibilities and liabilities with respect to the environment. • Through site induction, make staff and visitors aware of Project environmental issues and environmental standards. • Display warning signs at key work sites prominently. • Avail environmental policy at the site • Provide adequate security at the site to protect primary work sites against vandalism, theft and breakage.	To ensure the operations are safe, environmentally responsible, efficient, and compliant with regulatory standards.	Proponent	Continuous	200,000
Road Accidents	• Any abnormal loads for the project must be transported in line with the traffic rules, including public notification and use of escort cars. • Sensitize project staff on risks of over speeding while on site • Erect warning signs for approaching drivers at the points of entry to the project site	To safeguard lives and ensure safe transport operations.	Proponent and Contractor	Continuous	100,000
Disputes over employment	• Develop a grievance management system to manage grievances arising from the local labour force	**To** prevent conflicts, foster community trust, and ensure compliance with labor laws.	Proponent	One -Off	300,000

	Phase 1: Site preparation and Construction				
	• Develop local labour recruitment plans, including disclosure of opportunities and partnership building with local support agencies / institutions.				
Phase 2: Operations Phase					
Expected Negative Impacts	• **Recommended Mitigation Measures**	**Goal**	**Responsibility for implementation**	**Time Frame**	**Cost (KShs)**
Liquid Waste Generation	• Construction of septic tanks in areas not served by sewer lines to serve as a primary treatment unit. • Proper design, sizing, and maintenance of liquid waste management systems to ensure their effectiveness and to prevent contamination of groundwater resources. • Periodic monitoring and desludging schedules should be established as part of a comprehensive wastewater management plan. • Regularly inspecting drainage systems, separators, and treatment facilities.	To ensure safe, compliant, and environmentally sustainable handling, treatment, and disposal of all liquid waste generated.	Proponent	Continuous	1,000,000
Oil Spillage	• All maintenance and fueling activities should be conducted on impermeable, bunded surfaces equipped with oil-water	To prevent, control, and effectively respond to oil spills in order to protect soil, water resources, ecosystems, and public	Proponent	Continuous	900,000

Phase 1: Site preparation and Construction					
	separators to prevent direct infiltration and runoff. • Drip trays, catchment basins, and covered storage should be employed to collect incidental leaks and spills, particularly in high-risk areas. • A grit chamber/pretreatment system should be installed to facilitate the settling of suspended solids and initial separation of hydrocarbons from wash water and stormwater runoff. These chambers should be regularly monitored and cleaned to maintain operational efficiency. • Recovered oil and oily residues should be handled as hazardous waste and appropriate disposal methods used including selling the waste oil to licensed recyclers or re-refiners. • Install high-temperature incineration in approved facilities, which ensures complete combustion of organic	health.			

Phase 1: Site preparation and Construction					
	compounds and prevents groundwater contamination • Conduct regular environmental audits, soil and water quality assessments, and hydrocarbon concentration monitoring, particularly in drainage pathways leading from the rail yard. • Personnel should be trained in spill response protocols, and spill kits must be readily accessible at all maintenance and fueling stations.				
Pollution of Vegetation	• Adopt low-emission or hybrid locomotives to significantly reduce combustion-related pollutants. • Routine inspection and maintenance of engines to ensure optimal combustion efficiency. • Utilize Ultra-Low Sulfur Diesel (ULSD) to directly reduce sulfur dioxide emissions, thereby decreasing the risk of acid rain formation. • Implementation of after-treatment systems such as diesel	To prevent and minimize the degradation, contamination, or destruction of vegetation, ensuring the preservation of biodiversity, ecosystem functions, and community resources.	Proponent	Continuous	800,000

Phase 1: Site preparation and Construction					
	oxidation catalysts (DOCs), particulate filters, and selective catalytic reduction (SCR) units to substantially reduce NO_x and PM emissions from diesel engines. • Establishment of green buffers along the railway corridor to serve as biofilters for airborne pollutants, while also providing aesthetic and ecological benefits. • Conduct continuous ambient air quality monitoring near sensitive ecological zones to track pollutant levels and assess the effectiveness of mitigation measures.				

	Phase 1: Site preparation and Construction				
Loss of vegetation during wayleave maintenance	• Develop a site-specific Vegetation Management Plan (VMP) that incorporates biodiversity conservation objectives, prioritizes native species, and outlines treatment thresholds. • Establish vegetative buffer zones using low-growing, native plant species that do not interfere with infrastructure but support ecological functions. • Regular ecological assessments should be conducted to track the effectiveness of vegetation control measures and adapt strategies to evolving site conditions.	To minimize the loss of vegetation during the maintenance of wayleaves (railway corridors), while promoting ecological integrity, preventing land degradation, and supporting sustainable land use.	Proponent	Continuous	800,000

	Phase 1: Site preparation and Construction				
Air Emissions	• Employ advanced engine technologies with Diesel Particulate Filters (DPFs), and selective catalytic reduction (SCR) systems to reduce NO_x and PM emissions. • Application of water sprays, chemical suppressants, and use of covered conveyors or enclosed handling facilities to reduce particulate matter during material transport and transfer operations. • Implementing leak detection and repair (LDAR) programs, utilizing vapor recovery systems during fuel storage and transfer, and maintaining sealed containment areas to limit VOC releases. • Continuous ambient air quality monitoring near sensitive receptors and rail yard boundaries should be conducted to inform adaptive management	To reduce and manage air emissions generated in order to protect air quality, safeguard public health, and contribute to climate change mitigation efforts.	Proponent	Continuous	800,000

	Phase 1: Site preparation and Construction				
Solid Waste Generation	• Implement a comprehensive Waste Management Plan (WMP) encompassing waste minimization, segregation, and recycling strategies; • Training of staff and public awareness campaigns to reduce littering and promote responsible waste disposal; • Regular monitoring and cleanup operations within and around rail facilities and protected areas; • Provision of adequate infrastructure for waste containment and environmentally sound disposal or recycling of hazardous materials; • Engagement with licensed waste handlers for safe disposal of hazardous wastes such as oils, solvents, and batteries in compliance with local regulations and international best practices.	To ensure the effective management, reduction, and safe disposal of solid waste generated, in order to protect public health, the environment, and maintain cleanliness along the railway corridor and facilities.	Proponent	Continuous	700,000
Hazardous Materials	• Establish and enforce standard operating procedures (SOPs) for the safe storage, handling, and disposal of solvents, coolants,	To ensure the safe handling, storage, transportation, and disposal of hazardous waste generated in order to protect	Proponent	Continuous	1,000,000

	Phase 1: Site preparation and Construction				
	acids, and alkalis to minimize exposure risks and environmental release. • Conduct thorough inspections and material audits to identify equipment containing PCBs and asbestos. Maintain an updated inventory to support risk assessment and management planning. • Engage licensed hazardous waste contractors for the safe removal, transport, and disposal of PCBs • Ensure maintenance personnel are equipped with appropriate PPE and are trained in handling hazardous substances and emergency response protocols	human health, the environment, and comply with regulatory requirements.			
Wildlife and Livestock accidents due to breached fence	• Conduct wildlife movement and behavior studies to identify high-crossing zones and optimize the placement of underpasses. • Utilize fencing materials that balance strength, flexibility, and visibility to reduce damage by animals and humans. • Design underpasses with appropriate dimensions, lighting,	To prevent and minimize accidents involving wildlife and livestock along the SGR corridor caused by breaches or failures in fencing, thereby protecting animal life, enhancing railway safety, and supporting coexistence with surrounding communities and ecosystems.	Proponent	Continuous	900,000

Phase 1: Site preparation and Construction					
	and natural substrate to encourage regular animal use. • Implement regular fence inspection and maintenance schedules to promptly repair breaches and maintain barrier effectiveness. • Engage local communities and stakeholders in awareness programs to minimize human interference with fencing infrastructure.				
Noise and Vibration	• Ensure smooth rail surfaces through regular grinding and alignment to reduce dynamic impacts. • Use of continuously welded rail (CWR) instead of jointed track minimizes impact vibrations. • Use ballast mats, under-sleeper pads, or floating slab track systems to absorb and dissipate vibration energy before it transmits to the ground. • Use resilient track fasteners reduce the stiffness of the rail-	To minimize the impact of noise and vibration generated on nearby communities, wildlife, and infrastructure, ensuring environmental compliance, public comfort, and structural integrity.	Proponent	Continuous	900,000

Phase 1: Site preparation and Construction					
	to-tie connection and mitigate high-frequency vibration. • Set speed limits in vibration-sensitive zones to significantly reduce both the amplitude and frequency of vibration. • Schedule freight or heavy trains during daytime hours to help reduce nighttime disturbance. • Maintain appropriate setback distances between the railway and residential or sensitive land uses to prevent significant impacts. • Conduct noise and vibration monitoring to establish baseline levels and assess the effectiveness of mitigation measures as per EMCA (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009. • Workers performing in noisy working environment shall be provided with suitable ear protectors based on the expected noise levels				

Phase 1: Site preparation and Construction					
	• Undertake pre-employment and periodic audiometric testing for staff exposed to occupational noise risks to monitor the sharpness and acuity of an employee's hearing over time. This will be in line with OSHA (Medical Examination) Rules, 2005; • Servicing of stand by generators and other equipment to ensure they are maintained at optimal working conditions to minimize the noise that will be generated.				
Climate change	• Adoption of low-emission locomotives, including electrified rail systems or hybrid alternatives to diesel engines. • Energy-efficient station infrastructure, powered by renewable energy sources (e.g., solar PV systems). • Implementation of solid and liquid waste management systems, including biogas digesters, composting units, and wastewater treatment plants to	To reduce greenhouse gas emissions and enhance climate resilience, contributing to national and global efforts to combat climate change while ensuring the sustainability of railway services.	Proponent	Continuous	700,000

	Phase 1: Site preparation and Construction				
	reduce methane and nutrient emissions. • Afforestation or reforestation programs to offset unavoidable emissions and enhance carbon sequestration. • Integration of climate risk assessments into infrastructure design to ensure climate-resilient development and reduce vulnerability to climate variability.				
Impacts on water quantity	• Ensure that water is used efficiently at the railway stations by sensitizing staff to use water efficiently and avoid irresponsible water wastage. • Install water-conserving automatic taps and toilets • Any water leaks through damaged pipes and faulty taps shall be fixed promptly. • Employ water recycling and re-use, explore rain water harvesting at railway stations.	To ensure efficient use, management, and protection of water resources, reducing wastage and preserving water availability for ecosystems, communities, and future use.	Proponent	Continuous	700,000

	Phase 1: Site preparation and Construction				
Flooding/water ponding	• Conduct detailed hydrological and hydraulic modeling to identify all-natural drainage pathways, seasonal water flows, and potential flood zones. • Integrate appropriately sized and strategically placed culverts, box drains, or small bridges along the embankment to allow unimpeded flow of water. • Ensure drainage structures are designed to handle peak flows based on historical flood data and climate change projections. • Use erosion-resistant materials such as riprap or geotextiles on embankment slopes to prevent soil loss due to water action. • Consider vegetative stabilization techniques to improve slope integrity and absorb runoff. • Implement a maintenance schedule to inspect drainage structures for blockages or sedimentation and monitor embankment stability, especially during and after heavy rainfall.	To prevent and reduce the risk of flooding in order to protect infrastructure, ensure passenger and worker safety, and safeguard surrounding communities and ecosystems.	Proponent	Continuous	800,000

	Phase 1: Site preparation and Construction				
	• Ensure that natural flow regimes are maintained to protect downstream ecosystems and avoid waterlogging upstream agricultural or residential areas.				
Ground and surface water contamination	• Install septic tanks or sewage treatment systems at stations and staff facilities. • Ensure treated effluent meets NEMA discharge standards before release into the environment. • Regularly maintain wastewater systems to prevent overflows and leakages. • Construct stormwater drains that direct runoff away from sensitive areas. • Monitor surface and groundwater quality near stations and yards for signs of contamination (e.g., oil, heavy metals, pH, nitrates). • Refueling and maintenance of wagons, vehicles and equipment in designated bunded areas. • Use of drip trays, bunded storage, and spill kits on site, to minimize the potential for	To protect surface and underground water resources from pollutants that may be introduced during railway operations.	Proponent	Continuous	500,000

	Phase 1: Site preparation and Construction				
	releases and spills of oils and other liquids. • Use of silt traps and other measures to control silt laden run off from sites, especially during the rainy season.				
Visual Impacts from Night time Lighting	• Night lighting should be shielded or designed to prevent any adverse impacts of offsite glare. • Use low-pressure sodium lights/lighting • Minimize light trespass and over illumination by limiting lighting to only those areas necessary • Use light activation mechanism (or assign as a responsibility to project staff) to ensure that lights are on only when needed • Use shrouds, low brightness fixtures with optical controls and other methods of shielding to control direct and stray lighting effects.	To reduce visual impact while maintaining safety and compliance.	Proponent and Contractor	Continuous	300,000

	Phase 1: Site preparation and Construction				
Energy Consumption	• Use energy-efficient lighting (e.g., LED) in stations, offices, and maintenance yards. • Install motion sensors and automatic timers for lighting and air conditioning in low-traffic areas. • Equip buildings with insulation and passive design features to reduce heating and cooling needs. • Regularly maintain locomotives and equipment to ensure fuel and energy efficiency. • Install solar panels at stations, signal systems, and maintenance yards for lighting and low-load applications. • Introduce or upgrade to electric or hybrid locomotives, where infrastructure allows.	To make project operations more efficient, cost-effective, and environmentally sustainable.	Proponent	Continuous	2,000,000
Occupational Health & Safety of workers and visitors	• Ensure compliance with all standards and legally required health and safety regulations as per OSHA, 2007 revised in 2010. • Attach a full-time qualified safety and Health Officer • Provision of a standard First Aid kit and serviced Fire extinguishers at the railway	To protect the health, safety, and well-being of workers, prevent accidents and injuries.	Proponent	Continuous	1,500,000

Phase 1: Site preparation and Construction					
	stations at all times and train first aiders • Establish Occupational Health and Safety Committee • Undertake fire drills and statutory safety inspections and audits. • Develop specific emergency response plan and procedures • Proper servicing of the generators and other mechanical equipment • Maintain an accident register and carry out accident and incidents investigations and implement corrective actions, • Installation and maintenance of warning signage and emergency contacts at appropriate locations depending on the hazards.				
Phase 3: Decommissioning					
Expected Negative Impacts	**Recommended Mitigation Measures**	**Goal**	**Responsibility**	**Time Frame**	**Cost (KShs)**
Solid Waste Generation	• Conduct a waste audit and hazardous material survey prior to demolition to identify potential sources and ensure proper waste segregation.	To minimize the generation and environmental impact of solid waste by promoting safe removal, reuse, recycling, and responsible disposal of materials.	Proponent Contractor	During decommissioning	1,200,000

Phase 1: Site preparation and Construction					
	• Implement an effective containment and management strategies for demolition waste stockpiles to minimize leachate generation. • Establish buffer zones around any water bodies and groundwater extraction points to close to the site to prevent contamination. • Emphasize the recycling and repurposing of inert materials such as concrete and metals to reduce the volume of waste requiring disposal and mitigate environmental impacts.				
Air Pollution from dust generation	• Apply dust suppression techniques e.g., application of water sprays at active demolition sites. • Use of Personal Protective Equipment. • Site Management Practices e.g. scheduling demolition during favorable conditions to minimize dust dispersion (e.g., avoiding high winds).	To minimize the release of harmful airborne pollutants.	Contractor	During decommissioning	600,000

Phase 1: Site preparation and Construction					
	• Installation of physical barriers such as screens or fencing to contain dust within the demolition zone. • Deployment of particulate matter (PM10 and PM2.5) monitoring stations around the demolition site to assess dust levels. • Informing and coordinating with neighboring residents and businesses regarding demolition schedules and mitigation efforts to manage expectations and minimize disruption. • Comply with the provisions of Environmental Management and Coordination (Air Quality) Regulations, 2024				
Oil Spills	• Prepare plans and procedures for proper storage and handling of any waste oil. • Comply with the provisions of EMCA (Waste Management) Regulations, 2024	To prevent environmental contamination from oil spills.	Contractor	During decommissioning	200,000
Noise Pollution	• Comply with the provisions of EMCA (Noise and Excessive Vibration Pollution) (Control)	To reduce noise disturbances and uphold legal compliance.	Contractor	During decommissioning	500,000

Phase 1: Site preparation and Construction					
	Regulations, 2009 regarding noise limits. • Utilize modern, well-maintained demolition equipment equipped with noise reduction features such as mufflers and silencers. • Implement time restrictions to limit demolition activities to daytime hours, minimizing disturbance during early mornings, evenings, and nighttime. • Conduct pre-demolition structural assessments of any nearby buildings to identify vulnerabilities. • Inform local communities and stakeholders in advance about demolition schedules and expected noise levels. • Establish a grievance mechanism to address concerns promptly.				
Site degradation	• Implement an appropriate landscaping and re-vegetation programme to restore the site to its original status. Consider use of indigenous plant species in re-vegetation.	To prevent and minimize environmental degradation through sustainable land restoration, pollution control, and landscape rehabilitation, ensuring the land is safe, stable, and	Proponent and Contractor	One -Off	700,000

Phase 1: Site preparation and Construction					
		suitable for future use.			

10.5 Chance Find procedures for Archaeological and Cultural Heritage

Chance Find Procedures (CFP**)** are essential protocols designed to protect archaeological and cultural heritage that may be unexpectedly discovered during different activities within the railway project corridor, mainly during excavation.

The main purpose is to establish a systematic procedure for handling unexpected discoveries of cultural heritage, including artifacts, fossils, human remains, or structures, during site preparation, construction or decommissioning activities.

Chance find may include any previously unknown:

- Human remains or burial sites
- Stone tools, pottery, or ceramics
- Fossils or bones
- Structures (e.g., foundations, walls, wells)
- Sacred or ceremonial objects

Responsibility and Training

- The Contractor is responsible for enforcing the CFP through training of site workers on:
    - What constitutes a chance find
    - Steps to take if one is discovered
    - Reporting lines and documentation

Table 118 below indicates procedures to be undertaken in case of a chance find during project activities**.**

Table 118: Step-by-Step Procedure for a Chance Find

Step	Action
Stop Work Immediately	All activities must cease in the immediate area of the find. Secure the area to prevent further disturbance.
Notify Supervisor	The discoverer must inform their immediate supervisor and the Environmental/Social Officer.
Record the Find	Document the location using GPS, take photographs, and describe the find (type, size, condition).
Report to Authorities	The Site Manager must notify the relevant national heritage authority within 24–48 hours.
Protect the Site	Establish a buffer zone (e.g., 10–30 m radius) with visible markers or fencing and prevent unauthorized access.
Assessment by Experts	Authorities or appointed archaeologists will inspect and assess the find.
Decision and Clearance	Based on the assessment:

10.6 Responsibility and Accountability for ESMP

The Environmental and Social Management Plan (ESMP) contains the schedule for implementing the mitigation measures for impacts identified for the proposed project. It includes the identified environmental and social parameters, indicators, monitoring frequency, assigns monitoring responsibility and associated costs.

The Proponent will utilize the existing arrangements in the implementation of the ESMP during planning and design, construction, operation and decommissioning phases. The Proponent is accountable for ensuring that resources are made available to effectively implement the ESMP and necessary environmental management measures arising from the proposed project. The contractor will oversee and take responsibility of the day to day running of the project while the EHS Manager will oversee the detail of implementation of the ESMP for the project phases. Environmental monitoring will be undertaken by the EHS specialists and independent audits of environmental performance will be conducted from time to time by independent NEMA approved environmental experts. **Table 119** below provides details on the functions of each staff member.

Table 119: Responsibilities of various staff Implementing the Project ESMP

Position	Responsibility
Proponent	• Overall, in charge of the project. • Schedule preparation and resource forecasting for both technical non-technical activities relating to the project.
Environmental Specialists	• Conducting environmental monitoring, preparation of environmental monitoring reports and any permit applications (if any) • Running of day-to-day requirements for EMP implementation • Supervising monitoring and review of EMP implementation by contractors.
Health and Safety Expert	• Monitor and promote HSE work practices within all the operational sites • Monitor HSE process and equipment availability and safe operations. • Safety and Environmental awareness creation to all workers within the project.
Community Liaison Officer	• Implementing community engagement strategies and overseeing all community liaison related matters • Management of emerging community matters • Liaison with the appropriate company personnel to ensure that community grievances are tracked, reported and responded to accordingly as necessary
Contractor	• Undertake development of project activities in accordance with contract signed with the Proponent • Ensure strict adherence to the project ESMP requirements, • HSE policies/procedures and other legal requirements in regard to the project

10.7 Training, Awareness and Capacity Building

The Proponent will ensure that project supervisors, managers, general staff, contractors and community surrounding the project are inducted on health, safety, environmental and emergency response procedures. The Proponent will use written (EHS code of conduct/newsletter/posters/toolbox talks/ brochures) and verbal (as part of routine briefings) communication methods to raise awareness on a range of health, safety and environmental issues. This will be done in both Kiswahili and English languages (as appropriate) to ensure that all members of the workforce are made aware of the aspects of the ESMP.

The training components shall include but not limited to:

- Operational legislative frameworks detailing all applicable laws, regulations, standards and technical guidelines in work aspects that will affect environmental compliance
- Policies and procedures to be followed by the proponent and contractors applicable to the project
- ESMP as the tool and key document for project environmental compliance and associated documents including EHS and ERP among others
- Environmental monitoring and surveillance for ESMP implementation
- Documentation, record keeping and reporting procedures for ESMP related aspects
- Awareness creation methods, information packaging and communication procedures for ESMP purposes
- Complaints handling and good relationship nurturing with other stakeholders' local communities
- The economic and social cultural contexts and behavior of local communities in the within the project area.

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CHAPTER 11.0 ENVIRONMENTAL AND SOCIAL MONITORING PLAN

Environmental and social monitoring is key in any project implementation for it ensures that project activities comply and adhere to environmental laws/standards provisions. Environmental and social monitoring also ensures that mitigation measures are implemented and that they are effective. New and developing issues of concern are also addressed during the Environmental and social monitoring. The activities and indicators that have been recommended for monitoring are presented in the **Table 120** below.

The environmental monitoring program will operate during all the project phases and will include visual observations, selection of environmental parameters, sampling and regular testing of environmental parameters.

It facilitates and ensures the follow-up of the implementation of the proposed mitigation measures proposed in the EMP. The parameters of the proposed railway project identified for monitoring include; vegetation, water quality, air quality, solid waste generation, occupational health and safety risks, wildlife/livestock/human accidents, AIDS/HIV incidence, Soil erosion, resettlement and livelihood and environmental risks/ hazards.

11.1 Internal Monitoring

It is the responsibility of the proponent to conduct regular internal monitoring of the project to verify the results of the Contractor and to audit direct implementation of environmental mitigation measures contained in the ESMMP and construction contract clauses for the Project.

The proponent also has direct responsibility to implement and monitor land acquisition and compensation issues arising from project. The monitoring should be a systematic evaluation of the activities of the operation in relation to the specified criteria of the conditions of approval.

The objective of internal monitoring and audit will be:

- To find out any significant environmental hazards and their existing control systems in place.
- Meeting the legal requirements as stipulated in EMCA and international standards.
- To come up with corrective actions to identified non-conformities to ensure adherence to the Environmental Management Plan

11.2 External Monitoring and Evaluation

NEMA has the overall responsibility for issuing approval for the Project and ensuring that their environmental guidelines are followed during Project implementation. Its role therefore is to review environmental monitoring and environmental compliance documentation submitted by the implementing authorities and they would not normally be directly involved in monitoring the Project unless some specific major environmental issue arose.

Table 120: Environmental Social Monitoring plan (ESMP) of the Proposed Project

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
Land acquisition	Land take for railway line construction.	Land size taken	Compensation documents	Inventory of PAPs	Quarterly	KRC
Livestock accidents	Habitat fragmentation, broken fences, proximity to feeding and watering areas	Number of animals knocked down by the trains, type of animals knocked, locations where they are knocked	Frequency/number of accidents reported.	Reports and complains raised.	Continuous during the project cycle	KRC
Soil Erosion	Vegetation clearance, delayed rehabilitation,	Soils eroded, Turbidity in storm water, sources and causes, e.t.c	Evidenced eroded areas	Reports and observed eroded areas	Continuous	KRC
Vegetation Disturbance Visual intrusion; Insecurity and Illegal Harvesting of Wild Products	Vegetation clearance, excessive harvesting of sand and other resources	% cover Vegetation cover and wildlife habitat.	No. of Trees felled; Areas of land cleared; Identified invasive species Number of seedlings replanted.	Inventory of vegetation baseline	Weekly	KRC
Noise and Vibration Impacts	Heavy construction machinery, blasting, delivery vehicles, trains wagons	dB and m/s	Noise levels monitoring data & Complaints log	Noise leve l measuring	Continuous	KRC

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
Air pollution	Different machinery, backup generators, open burning,	TSP, NOx, SO2, CO, Dust particles, particulate matter, e.t.c	Daily water uses for dust sprinkling; Safety induction records. Air Quality records Records on issuance and use of PPEs	Measure concentrations of particulate matter, TSP, NOx, SO_2 and CO_2	Continuous	KRC
Generation of Waste	Wrappings, excavated soil, cement bags,	Spoils, domestic refuse, scrap metal	Disposal sites	Site inspections / observations	Quarterly	KRC
Increased Demand for Water	Construction, cleaning of premises, dust suppression,	Rate of consumption	Consumption records Complains from other water users	Inspection of meter readings Observation of water levels	Continuous	KRC
Occupational and Public Health and Safety Impacts	Accidents from general works, site clearance, train accidents, oil spillage, hazardous waste handling	Job safety analysis	JSA Report by a qualified OSH Advisor		Once contractor takes possession of the site	KRC
		Health and safety action plan	Community sensitization and participation in Community health and safety	Consultations of sample of the Project area communities	Quarterly	KRC

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
			Health and Safety Personnel	One on One Interview with the H&S Personnel	Once contractor takes possession of the sites	KRC
		Emergency Preparedness and Response Plan (EPRP)	EPRP as approved by the RE	Inspection of records	After conduct of a JSA	KRC
			Community awareness posters/ warnings Participation of response activities by the community	Community sensitization in their participation in community health and safety	Quarterly	KRC
		Registration of the workplace	Work place registration permit	Inspection of records	After conduct of a JSA	KRC
		Accidents and incidents	Number of accidents and incidents register	Inspection of incident reports	Quarterly	KRC
			Community complaints related to road accidents and incidents	Consultations of sample of the project area	Quarterly	KRC /DOSHS

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
				communities		
		Safety training for workers	Training plans, Training Reports, Attendance list	Inspection of records	Quarterly	KRC
			Feedback Reports on Training from staff Attendance sheets	Inspection of records	Quarterly	KRC
			Staff awareness on health and safety issues Staff use of appropriate PPE Reduced accidents and incidents on site	Observation and interviews with a sample group of staff	Quarterly	KRC
		Awareness posters on identified risks and responses in case of emergency	Physical posters	Observation	Quarterly	KRC /DOSHS
			Physical posters for the community	Observation	Quarterly	KRC/DOSHS

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
		Emergency drills	Records of drills	Inspection of record.	Quarterly	KRC /DOSHS
		Safety and health committee for a contractor with more than 20 staff on site	Safety and Health Committee Minutes of meetings	One on One Interview with the committee	Quarterly	KRC
		OSHA required Reports to DOSHS	Copies of Reports submitted to DOSHS	Inspection of record	Quarterly	KRC /DOSHS
				Community Baraza with sample community	Quarterly	KRC
		Handling, storage and use of hazardous materials	Presence of Material Safety Data Sheet (MSDS)	Inspection of Material Safety Data sheets Incidence reports resulting from improper handling of	Quarterly	Health and safety Officer

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
				hazardous materials.		
HIV/AIDs and STIs program	In-migration of labour from other areas, moral decay,	Education and sensitization of workers on HIV/AIDs Management Program.	Training plans, Training Reports	Inspection records	Quarterly	KRC
			Feedback Reports on Training from staff Attendance sheets.	Inspection of records	Quarterly	KRC
			Formation of counselling Peer grou	Interviews with staff	Semi-Annually	KRC
				Records of Training of trainers for peer counsellors	Quarterly	KRC
			Physical posters on appropriate locations within the worksite.	Observations	Monthly	KRC

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
			Staff awareness on HIV/AIDS and STI Causative agents, prevention, diagnosis and management.	Knowledge, Attitudes and Practices (KAP) Survey of a stratified sample group of staff, prior to Commencement Of the sensitization program and periodically every six months	Semi-Annually	KRC
Enhancement of project benefits-employment	Different employment opportunities	Equitable distribution of employment opportunities	Community complaints	Inspection of grievance logs	Monthly	KRC

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
			Gender mainstreaming strategies within the HR recruitment policies.	Inspection of Relevant HR policy procedures and records.	Once contractor takes possession of the site and every quarter after that	KRC
			Gender balance among project staff to a minimum proportion of 2/3 of men or women	Number of employees segregated by age and gender	Monthly	KRC
		Compliance with labor laws and labor standards	Availability of Human Resource Policy that includes a recruitment strategy (including a local staff recruitment strategy), non-discrimination procedures and practices as well as a retrenchment policy.	Inspection of records	Once contractor takes possession of the site	KRC

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
			Availability of employment record	Inspection of employment records	Monthly	KRC
	Grievances resulting from community including noise, soil erosion, lack of equity in employment opportunities,	Mechanism for managing staff grievances	Establishment grievance mechanism Of staff redress	Inspection of records established under the grievance redress mechanism	Once contractor takes possession of the site and every quarter	KRC
			Policy and practice by the contractor that does not prohibit staff from joining workers associations.	Inspection relevant policy procedures records of HR	Once contractor takes possession of the site and every quarter after that	KRC
	Child labour and exploitation	Child protection	Compliance with child protection requirements by Kenyan law and ILO standards.	Inspection relevant policy procedures records of HR	Once contractor takes possession of the site and every quarter after that	KRC

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
Vandalism	Retaliation over land, jobs, or exclusion, Unregulated demand for stolen metal parts,	Destruction of railway associated infrastructure	Losses incurred	Inspection of railway infrastructure	Monthly	KRC
Stakeholder engagement during monitoring and evaluation of the implementation and efficacy of project environmental and social management plans and mitigation		Awareness on the project ESMPs and management plan that affect the various stakeholder	Increased ownership of project's ESMPs and management plans	Interviews with sample groups of stakeholders	Quarterly	KRC
		Stakeholder participation in decisions that affect them	Maintenance of social license	Interviews with sample groups of stakeholders	Quarterly	KRC
		Record of as felt benefits or negative impacts to improve the ESMP and Management Plan	Records of as felt benefits or negative impacts Revision and updates of ESMP and management plans based on recommendations from stakeholder	Inspection of records	Quarterly	KRC

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
			engagements			
Natural Resource use Conflicts		Maintenance of Project social license	Complaints by the communities	Inspection of community feedback records. Grievance logs	Quarterly	KRC
				Consultations of sample of the project area communities	Quarterly	KRC
Ground water Quality	Oil spollage, vegetation clearance,	pH, Salinity (EC), Nitrates Phosphorous, Pesticide residues	WRA Guidelines	Inspection of hydrological reports; Consultations with WRA for area data	6 months	KRC
Surface water quality – intakes and receiving waters	Soil erosion, surface run off,	pH, Salinity (EC), Nitrates, Phosphorous, Pesticide residues, Coliforms BOD and COD	EMCA and WRA Guidelines	Water analysis of collected water samples	Yearly	KRC

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
Disputes over employment	Inequity in hiring, lack of transparent recruitment processes, poor grievance management mechanisms	A formal recruitment process to be adhered to Clearly explain to all job- seekers the terms and conditions of their respective employment contract.	Recruitment policy Copies of signed contracts for each employee filed	Inspection of records	Monthly	KRC
Interference with cultural sites	Inadequate cultural heritage surveys, lack of community consultation and disclosure and lack of cultural awareness among workers	Destruction of features or areas of cultural interest.	Registered cases	Inspection of records	Quarterly	Contractor/ KRC
Grievance Manageme nt	Land acquisition and compensation issues, lack of community engagement and lack of consultation and broken promises	Resolve of grievances	Review of complaints logbook and the response and handling of the complaints.	Inspection of records	Entire duration of works	Contractor/ KRC
		Meetings held with the stakeholders	Reports shared with the community	Inspection of records	Quarterly	KRC

Monitoring Scope	Source of the impact	Parameter	Indicators	Activity	Frequency	Responsibility
Excessive water usage	Leaky plumbing systems, Train washing and maintenance, lack of water meters or control systems	Water meter readings Reduced water level in the dams	Complaints by other water users. Reduction of water quantity for project activities	Feedback from other water users. Grievance logs	Entire duration of works	KRC
Excessive energy usage	Poor servicing of equipment, poor lighting systems, idle vehicles and equipment	Total energy used over time.	Energy efficiency reports	Review of energy reports	Entire duration of works	KRC

CHAPTER 12.0 CONCLUSIONS AND RECOMMENDATIONS

12.1 Conclusions

The proposed Kisumu–Malaba Standard Gauge Railway (SGR) Project represents a transformative infrastructure investment with the potential to significantly enhance Kenya's national transport system and regional connectivity. The project is aligned with Kenya Vision 2030, the Bottom-Up Economic Transformation Agenda (BETA), and key regional and international frameworks such as the EAC Vision 2050, AU Agenda 2063, and the UN Sustainable Development Goals. By providing a modern, efficient, and reliable transport corridor, the project will unlock opportunities for trade facilitation, tourism, industrial growth, and agricultural commercialization across western Kenya and the wider East African region.

The Environmental and Social Impact Assessment (ESIA) has established that while the project will generate notable positive socio-economic and environmental benefits, it also carries potential adverse impacts relating to land acquisition, displacement, livelihood disruption, and environmental sensitivities. However, with the proposed mitigation measures including a robust Environmental and Social Management Plan (ESMP), a professional Resettlement Action Plan (RAP), and livelihood restoration strategies these impacts can be effectively managed to ensure sustainable outcomes.

In light of its strategic importance, socio-economic benefits, and the commitment of Kenya Railways Corporation (KRC) to implement environmental and social safeguards, the Kisumu–Malaba SGR Project is considered viable and necessary. It is therefore recommended for approval by the National Environment Management Authority (NEMA) subject to strict adherence to all proposed mitigation measures and continuous stakeholder engagement. Successful implementation of the project will not only strengthen Kenya's railway infrastructure but also serve as a catalyst for regional integration, sustainable development, and long-term economic transformation.

12.2 Recommendations

The SGR Phase 2C ESIA recommendations focuses on mitigating adverse environmental and social impacts through measures like effective soil erosion control, proper waste management, careful sourcing of materials from environmentally responsible suppliers, and establishing culturally appropriate grievance redress mechanisms. The recommendations also emphasize the need for continuous monitoring, robust public consultation and participation to inform decision-making, and the creation of a comprehensive environmental management plan to be implemented throughout the project's lifecycle.

The main recommendations for SGR Phase 2C project are:

Environmental Management

- Soil and Water Protection - Implement soil erosion control measures such as silt traps and drainage systems to manage run-off and minimize soil loss.
- Waste Management - Develop responsible strategies for waste management, including reusing construction materials and disposing of waste at designated sites.
- Resource Management - Prioritize the use of raw materials from suppliers with environmentally friendly processes and minimize losses during storage and use.

Social Management

- Stakeholder Engagement - Ensure open and comprehensive public information and consultation processes to identify and address potential negative impacts and enhance positive ones.
- Grievance Redress Mechanism (GRM) - Establish a culturally appropriate and accessible GRM to handle concerns from affected stakeholders.
- Involuntary Resettlement - Implement measures for fair compensation and relocation since the SGR project will trigger involuntary resettlement.

Implementation and Monitoring

- Environmental Management Plans - The developed ESMPs should be implemented. The proponent should put in place monitoring mechanisms to be used during both the construction and operation phases of the project.
- Climate Change Risk - Assess likely risks related to climate change and recommend specific mitigation measures for the project.
- Monitoring Mechanisms - Incorporate robust monitoring systems to track the implementation of mitigation measures and ensure compliance with environmental and social standards

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LIST OF ANNEXES

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