Environmental and Social Impact Assessment of the Proposed Zima Homes Affordable Housing Development in Kibiku, Kiambu County

ESIA Study Report

Zima Homes Limited

29 June 2021

Notice

This document and its contents have been prepared and are intended solely as information for use in relation to the ESIA Study for the proposed Zima Homes Affordable Housing Development.

This document has 237 pages including the cover.

Document history

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Declarations

Expert signoff

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Job number	202101
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Abbreviations

AOI	Area of Influence
BAU	Business as Usual
bgl	Below ground level
BS	British Standard
CEMP	Construction Environmental Management Plan
CGK	County Government of Kiambu
COVID-19	Coronavirus disease-19
CP-ESMP	Construction Phase Environmental & Social Management Plan
CRVA	Climate Risk and Vulnerability Assessment
DEMP	Decommissioning Environmental Management Plan
EIA	Environmental Impact Assessment
EMC	Estate Management Company
EMCA	Environmental Management and Coordination Act
ENSO	El Niño Southern Oscillation
ESHS	Environmental, Social, Health & Safety
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FOG	Fats Oil and Grease
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GoK	Government of Kenya
GC	Ground Coverage
GIIP	Good International industry Practice
IAP	Interested and Affected Parties
KVA	Kilovolt Amperes
Lat	Latitude
Long	Longitude
MAM	March-April-May
masl	Meters Above Sea Level
NCA	National Construction Authority
NDC	Nationally Determined Contribution
OND	October – November – December
OP-ESMP	Operations Phase Environmental & Social Management Plan
OSHA	Occupational Safety and Health Act
PMC	Project Management Company
PPE	Personal Protective Equipment
PR	Plot Ratio
PVC	Polyvinyl Chloride
RLC	Reconnaissance Level Characterization
RLCR	Reconnaissance Level Characterization Report
STD	Sexually Transmitted Disease
SWH	Solar Water Heater
TMP	Traffic Management Plan
ToR	Terms of Reference
WRA	Water Resources Authority
WSP	Water Service Provider

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Executive Summary

Zima Homes Limited, a company incorporated in Kenya intends to construct 143No. affordable housing units in Kibiku – Ngababa area along Gitaru Road, Kabete Constituency, Kiambu County. The proposed housing units are comprised of 34No. Studio, 69No. One-Bedroom, and 40No. Two-bedroom apartments on a 0.504-acre parcel of land Plot LR No KABETE/KARURA/3979. Majority (109No.) will be for sale, while 34No will be owned by the developer as rental units.

The proposed site is developed with a block of 8No. residential houses which will be demolished to pave way for the proposed apartments. Also found on site is a tin-structure ablution facility and a well, both of which will be demolished/filled during site preparation.

The new development will host a resident population of approximately 347 people who will consume about 35m^3/d of water, generate about 28m^3/d of sewage, and about 165 kgs of solid waste per day. To meet the residents' water demand, an onsite borehole is proposed, while a septic tank and soak pit will be constructed to dispose the sewage generated. Provisions have also been made to temporarily store the solid waste generated by households at a designated location awaiting collection by a solid waste handler for final disposal.

The Environmental Management and Coordination Act (EMCA) 1999 provides for a full Environmental Impact Assessment study of a new housing estate development exceeding 100No. housing units in order to identify the potential adverse impacts of the development and provide for adequate mitigation measures. An Environmental and Social Impact Assessment (ESIA) of the proposed housing project was conducted in line with the Act and following a conventional approach in the assessment.

Both positive and negative construction phase and operation phase impacts were identified in the assessment, and mitigation measures developed for the adverse impacts. These are summarized in the Table below:

Construction phase Impacts		
Aspect	**Potential Impacts**	**Potential mitigation measures**
Business opportunities and employment creation	• Expected creation of job opportunities for local communities during construction; • Creation of business and job opportunities in the housing value chains (for suppliers, transporters and other service providers); • Increased revenue for the exchequer through taxes	
Physical attributes and landscape	• Loss of vegetation, mainly trees and grass cover at the site; • Disturbance and loss of topsoil during excavation works; • Soil compaction and sealing which may lead to increased surface runoff and soil erosion from the site; and • Loss of serenity and aesthetic value	• Construction works should not hinder drainage, or introduce physical changes that are not in harmony with the physical setting of the Project area • Buildings to be developed should be aesthetically acceptable to blend in with the surrounding • Complete the works in such a way that natural aesthetics are retained at the site • Landscaping activities to include planting of indigenous trees and shrubs
Noise and vibrations levels	• Increased noise and vibrations from construction vehicles and other construction machinery;	• Install portable hoods to shield compressors and other small stationary equipment where necessary; • Use equipment installed with noise abatement devices as much as practicable; • Idling time on trucks and other noisy equipment should be limited to a minimum;

Construction phase Impacts		
Aspect	**Potential Impacts**	**Potential mitigation measures**
		• Personal protective equipment such as ear muffs to be provided to workers at the site as necessary; and • Construction work to be carried out during the day only
Local air quality	• Reduced ambient air quality during construction due to emissions of exhaust fumes from vehicles and equipment and dust from earth works, vehicular movements along loose surface roads, stockpiles etc;	• Sprinkling of all active demolition sites and construction areas as and when necessary; • Install dust screens and maintain them on the buildings as construction progresses above the ground level; • Maintain equipment and machinery to manufacturers' specifications by regular servicing to maintain efficiency in combustion and reduce carbon emissions; • Use environmentally friendly fuels such as low sulphur diesel; • Minimize the idling of machinery; • Ensure that no burning of waste is done on site; • Provide appropriate Personnel Protective Equipment such as dust masks to site workers
Water resources	• Increased demand for construction water; • Potential for pollution of ground and surface water resources from spillage or mismanagement of hazardous materials and wastes at the site including construction wastewater; • Potential pollution of the neighboring Thigii stream during construction by silt, hydrocarbons and other hazardous substances and waste discharges from construction sites, camp and equipment	• Ensure that water is used efficiently at the site through worker sensitization programmes; • Storm water harvesting wherever possible to complement other sources of water. • Recycling and reuse of construction wastewater wherever possible; • A concrete washout pit to be used to contain wash water;
Local biodiversity	• Loss of vegetation cover (mostly trees and shrubs) at the site will lead to a loss of habitat and forage grounds for birds and other small mammals	Planting of indigenous trees and shrubs and if necessary, exotic trees and shrubs
Other natural resources	• Potential for unsustainable extraction of construction materials at sources, causing environmental damage	Source construction materials such as sand ballast, quarry stones, and hard core from registered and approved quarries
Occupational and public health, safety and security	• Potential increase in safety hazards during demolition and construction activities resulting in increase in accidents involving workers and/or the general public; • Potential increase in STDs such as HIV/AIDS from influx of people particularly the workforce during project construction; • Potential increase in respiratory and eye infections from increased dust emissions during construction; • Traffic nuisance from increase in construction vehicle movements	• Adherence to site occupational health and safety rules and regulations as stipulated in the Occupational Safety and Health Act, 2007 • Provide all workers on site with the necessary Personal Protective Equipment • Mitigate accidents by enforcing adherence to safety procedures and preparing contingency plans for accident response;

Construction phase Impacts		
Aspect	**Potential Impacts**	**Potential mitigation measures**
		• Carry out safety education and training including HIV/AIDS awareness • Avail adequate sanitary facilities such as toilets and potable water to maintain high health standards at the construction site • Prepare and implement a Traffic Management Plan (TMP)
Waste generation	• Potential environmental pollution from mismanagement of wastes including demolition wastes, spoils, cleared vegetation, packaging wastes, reject materials etc	• Salvage fixtures and building components as much as possible for reuse elsewhere; • Recycle or reuse construction waste as much as possible • Ensure that construction materials left over at the end of construction are used in other projects rather than their disposal; • Ensure that construction material requirements are carefully budgeted to minimize leftovers • Use of durable, long-lasting materials that would not need to be replaced often

Operation Phase Impacts		
Aspect	**Potential Impacts**	**Potential mitigation measures**
Business opportunities and employment creation	• Growth of business opportunities in the locality from an increase in resident population	
Energy resources	• Increased demand on energy resources, especially grid electricity	• Incorporate energy conservation measures in building designs and fixtures; • Install solar water heating systems to meet household hot water requirements
Water resources	• Increased demand on water resources for household use	• Monitor water resource use at the premises through water meters; • Harvest rain water from roof catchments for outdoor water requirements; • Install low volume fixtures and fittings such as taps, and cisterns
Liquid and solid waste generation	• Increased quantities of liquid and solid wastes from households • Potential contamination of groundwater resources in disposal of effluent through a soak pit	• Procure services of registered waste management companies to ensure appropriate disposal of the generated solid and effluent wastes; • Install and maintain grease traps to remove fats, oil and grease in grey water from kitchens and maintain effectiveness of bio-treatment in the septic tank
Vehicular and pedestrian traffic	• Slight increase in vehicular and pedestrian traffic in the area	• Adequately size the driveway and access road to limit pedestrian and vehicular interactions

Although potential adverse impacts were identified in the construction of the housing project, various opportunities were also identified for the mitigation of these impacts. It is considered that with good construction, environmental and social practices and procedures, the project has potential to enhance benefits while avoiding environmental degradation. The requirements identified for the contractor in this Report will ensure environmental protection, health and safety of the workers and the general public and social acceptance of the proposed project.

1. Introduction

1.1. The Proposed Project

Zima Homes Limited, a company incorporated in Kenya intends to construct 143No. affordable housing units in Kibiku – Ngababa area along Gitaru Road, Kabete Constituency, Kiambu County. The proposed housing units are comprised of 34 No. Studio, 69No. One-Bedroom, and 40No. Two-bedroom apartments on a 0.504-acre parcel of land Plot LR No KABETE/KARURA/3979. Majority (109No.) will be for sale, while 34No will be owned by the developer as rental units.

A Change of User approval has been obtained from the County Government of Kiambu for the proposed change of use from agricultural to multi-dwelling residential units (Flats). A copy of the approval is included in **Appendix C** of this Report.

1.2. Project justification

One of the Government of Kenya's (GoK) strategy to promote long-term economic development for its citizens is to catalyze affordable housing. Housing is a basic need besides food and clothing, and its availability for all is an indicator of the state of socioeconomic development of a society. Apart from addressing the basic need for majority of the population, affordable housing (including its value chains) will support economic growth, create jobs, and deepen the financial sector[1].

The housing sector in Kenya is characterized by inadequate affordable and decent housing, low-level of urban home ownership, extensive and inappropriate dwelling units including slums and squatter settlements[2]. Research shows that Kenya has a housing deficit of over 2 million homes, which increases by approximately 200,000 per annum.

The Government launched an affordable housing programme in 2017 with the goal of providing 500,000 homes over a five-year period as part of the Big Four Agenda[3]. However, about 50,000 new houses are being constructed annually, falling far short of the demand. An estimated 61% of Kenya's 50 million residents live in slums – mainly because of limited supply and unaffordability. Additionally, over 90% of Kenya's urban households live in rental properties[4]. It has also been established that only 2% of the formally constructed houses target lower-income families[5] whereas more than 80% of supply is for upper middle income (48%) and high income (35%).

Kenya's urban population is growing at a rate of 4.4% per year, compared to 3.6% across sub-Saharan Africa. Given this growth and urbanization rate, the housing problem in Kenya is destined to worsen over the next decades if no interventions are made. Additional research has also shown an increase in the number of households coupled with a decrease in the average household size, particularly in Nairobi. Between 2013 and 2019, the total number of households increased from 1.14M to 1.51M, while the household size decreased from an average of 3.2 persons per household to 2.9. These trends are indicative of a sustained and growing demand for smaller sized residential units within the city[6].

Zima Homes Limited believes that the low-income market is ready for housing that is affordable and dignified, and that offers unique design and environmental benefits, hence the development proposal.

1.3. ESIA rationale

Section 58 of the Environmental Management and Coordination Act (EMCA) 1999 provides for a full Environmental Impact Assessment study of a new housing estate development exceeding 100No. housing units. This scale of development is categorized as 'High-Risk' in the Second Schedule of the Act such that a full study is mandated at the planning stages of the proposed undertaking to ensure that significant impacts on the environment are taken into consideration during the design, construction, operation and decommissioning stages of the Project.

[1] World Bank Group (2017). Kenya Economic Update. Housing: Unavailable and Unaffordable

[2] Sessional Paper No 3. April 2016: National Housing Policy for Kenya

[3] Kenya Affordable Housing Programme Development Framework Guidelines

[4] https://www.reall.net/data-dashboard/kenya/

[5] https://www.habitat.org/where-we-build/kenya

[6] BuildX Studio/Reall (2020). Market Study for Zima Homes Affordable Housing Development

1.4. Objectives of the ESIA

The overall aim and purpose of the study was to assess environmental and social impacts that are likely to arise from implementation of the proposed housing project. Specific objectives of the ESIA were to:

- Collect and analyze baseline environmental and socioeconomic data in the study area;
- Identify and assess potential environmental impacts in the design, construction and operation of the proposed project;
- Liaise with interested and affected parties in the area to seek their views on pertinent issues related to the proposed project;
- Identify mitigation measures for the actual and potential adverse impacts; and
- Develop environmental and social management plans suitable for the proposed works, activities and anticipated environmental impacts.

1.5. The ESIA Terms of Reference

The ESIA Terms of Reference (ToRs) are a requirement of the Regulations and are developed following a scoping exercise to determine the range of issues to be addressed in the ESIA study. The ToRs focus on key issues of concern including, but not limited to:

- Proposed project activities during construction, operations and decommissioning;
- Relevant policies, legislation and institutional framework to the proposed project;
- Identification of significant impacts on biological, physical, social, economic and cultural aspects or the project area;
- Possible mitigation measures for adverse impacts;
- The proposed environmental and social management plan;
- Outline modalities for environmental audit and monitoring;
- Details of the experts who will carry out the ESIA Study and study schedules;
- Details of the total project implementation costs; and
- Identification of sources of baseline information and information gaps.

The ESIA ToRs for Zima Homes Affordable Housing Development were prepared and submitted to NEMA on 13th April 2021, and an approval received on 20th April 2021. A copy of the Approval is attached in **Appendix D** of this Report.

1.6. Approach to the ESIA

To identify the potential environmental and social impacts and mitigation measures for the Project, conventional and participatory approaches were be used. This entailed a review of the designs for the proposed Project to identify elements that are of environmental and/or social significance; Collection of biophysical, socioeconomic and cultural information on the project area to identify aspects that could be impacted by the proposed development; evaluation of the significance of identified impacts using a set of criteria; and development of mitigation measures and management plans for the identified adverse impacts. The surrounding community and other interested stakeholders were also consulted to provide insights into the ESIA.

1.6.1. Scoping

A scoping exercise was carried out in March 2021 to determine the range of issues to be addressed in the ESIA, the significant issues that would need detailed study and those that were not significant, and the stakeholders to be consulted in the ESIA. The exercise established the following issues to be investigated in the study:

- General environmental, health and safety considerations in relation to construction sites waste generation; Soil erosion and sediment control; Fugitive dust and other emissions; Noise from heavy equipment and construction traffic; hazardous materials and hydrocarbons spillages;
- Housing-specific considerations including population changes; demand on natural resources – materials, energy, water; visual impacts; vehicular and pedestrian traffic; waste generation; noise impact; land use change, etc.

The Project's ESIA Terms of Reference (ToRs) were prepared as the main output of the scoping study.

1.6.2. Literature review

A comprehensive review of literature related to the proposed project and the project area was carried out. The literature included studies on physiography, geology, hydrogeology, water resources and socio-economics of the project area. Relevant policies and legislation on the housing sector and on environmental management were also reviewed.

1.6.3. Baseline data collection

Baseline data was collected on the biophysical and socioeconomic characteristics of the project area. This entailed collection of information on aspects such as topography, local flora and fauna, soils and geology, water resources, drainage, ambient air quality, waste management, settlement patterns, human activities, exiting infrastructure, etc.

1.6.4. Identification, prediction and determination of environmental impacts

A systematic approach was used to rank identified impacts according to their significance determined by consideration of project activity **event magnitude** and **receptor sensitivity**. The expected significance of environmental impacts was assessed considering:

Event Magnitude determined by the following parameters:

- **Extent** – the size of the area across which the effect of the activity extends;
- **Duration** – the length of time over which the effect of the activity occurs;
- **Frequency** – how often the activity occurs; and
- **Intensity** of the impact – concentration of an emission or discharge with respect to standards of acceptability that include applicable legislation and international guidance; toxicity or potential for bioaccumulation, and likely persistence in the environment; and degree and/or permanence of disturbance or physical impact

Receptor Sensitivity determined by:

- **Presence** – whether biological species present are unique, threatened, protected or not vulnerable and are present during a period of high sensitivity (e.g. breeding or nesting). For human receptors, whether they are permanently present to uncommon in the area of impact and for physical features whether those present are highly valued or of limited or no value. For physical receptors/features, whether they are national or international value (e.g. state protected monument), local or regional value and is sensitive to disturbance or none of the above; and
- **Resilience** – how vulnerable people and/or species and/or features are to the change or disturbance associated with the environmental interaction with reference to existing baseline conditions and trends (such as trends in ecological abundance/diversity/status, ambient air quality etc.) and their capacity to absorb or adapt to the change. For physical receptors/features, highly vulnerable, undergoes moderate but sustainable change which stabilizes under constant presence of impact source, or unaffected or marginally affected.

Socio-economic impacts were assessed considering event magnitude and receptor sensitivity. However, a more qualitative approach was applied, which considered how significant the change would be on social, economic and cultural dynamics, the potential for governmental and stakeholder intervention, the value of the receptor (on a local, regional, national or international scale) and the resilience of the receptor to change or adapt to a given change.

Impact significance was assessed considering existing control measures that are incorporated into the project design.

Sets of criteria were defined for both impact magnitude and receptor sensitivity and these were then combined in an appraisal matrix to identify relative degrees of impact significance. The matrix is accompanied by ancillary definitions of the resulting final significance categories.

1.6.5. Stakeholder consultations

Stakeholder consultations during the ESIA were carried out to: inform project stakeholders of the proposed project; to explain the likely impacts (positive/negative) of implementing the project; and to obtain views, concerns, comments and suggestions from interested and affected parties regarding the proposed project.

Stakeholder identification and analysis was carried out to determine who are the project affected people and the most appropriate means of engagement. The methods of engagement ranged from questionnaires, interviews and holding of a public meeting with the local community. There were limitations in the size of crowd that could be accommodated at the meeting due to existing government restrictions on public gatherings to prevent the spread of COVID-19 coronavirus.

1.6.6. Reporting

A Draft and Final ESIA Study Report, including Environmental and Social Management Plans was prepared and submitted to the Project Proponent for review and endorsement.

This Final ESIA Study Report is submitted to NEMA for review and approval. Since the Project is categorized as a High-Risk Project in the Second Schedule of the EMCA,1999, further public disclosure is expected through print media. Depending on comments received following the disclosure, the Report may be revised before a determination on the ESIA by NEMA.

1.7. The ESIA Study Team

The ESIA was undertaken by a multidisciplinary team of consultants that included the following:

Table 1-1 The ESIA Team

Name	Position
Simon Wandeto	Team Leader/ Environmental Expert
Beatrice Githinji	Sociologist
Carolina Larrazabal	Project Architect/Planner
Esther Segero	Project Structural engineer
MEP Design Limited	Project Electrical, Mechanical and Plumbing Engineer
Dixon Kiptanui	Hydrogeologist -WD/WRP/269
Samuel Ndungu	Enumerator/Data collector
Mary Mumbi	Enumerator/Data collector

As required under Regulation 14 of the Environmental (Impact Assessment and Audit) Regulations 2003, the above-named environmental expert is registered and licensed by NEMA as an Environmental Impact Assessment and Audit Expert. The Registration certificate and license for the Lead Expert are attached in **Appendix A** of this Report.

2. Project description

2.1. Geographical location

The proposed project site is located along Gitaru Road in Kibiku – Ngababa area approximately 1.3Km from Wangige Town, Kiambu County on Plot LR No KABETE/KARURA/3979. The coordinates of the site are Lat:1°12'29.04"S and Long:36°42'41.36"E. The Figure below shows a satellite image of the site.

Figure 2-1 Proposed Zima Homes Project site

2.2. Existing developments on site

The site is developed with a block of 8No. residential houses which will be demolished to pave way for the proposed apartments. Tenants occupying the houses will be given adequate notice to vacate the premises before demolition.

Also found on site is a tin-structure ablution facility and a well, both of which will be demolished/filled during site preparation.

Figure 2-2 Existing structures on the land

2.3. Project scope

2.3.1. Project features

The proposed development is comprised of 143No housing units of varying sizes including: 34No. Studio, 69No. One-Bedroom, and 40No. Two-bedroom apartments. The units will be in 3No. four-storey blocks of apartments set on a 0.504-acre parcel of land.

Figure 2-3 An artist's impression of the development

The Table below provides the proposed development's built-area characteristics vis-a vis the County Government of Kiambu (CGK) physical planning limits.

Table 2-1: Gross area, Plot Ratio and Ground Coverage

	Plot Ratio (PR)		Ground Coverage % (GC)	
Gross Area (m^2)	Zima Homes	CGK Regulation	Zima Homes	CGK Regulation
5,475.64	2.3	4.0	36.10%	50%

Other features of the proposed development include:

- Onsite borehole to meet the residents' water demand;
- An 125m^3 underground water storage tank and 11No shared roof tanks with a combined storage capacity of 33.5m^3 of water;
- A boundary wall around the development and guardhouse;
- 34No. parking bays;
- A 70.4m^3 Septic tank and soak pit;
- Grid-power supply;
- Site stormwater drainage infrastructure;
- Refuse collection and storage area;
- 2No. common laundry areas with sinks and clothes hanging lines;

- Green/recreation space and service space on the roofs of the apartment blocks;
- Solar PV panels for borehole and water booster pumps, and common areas lighting; and
- Solar water heating panels and cylinders for residents' hot water requirements

Layouts of the project are included in **Appendix F** of this Report.

2.3.2. Population projection

The estimated resident population that will be added to the area by the development when fully occupied is 347 people. The population estimate is broken down in the Table below.

Table 2-2: Estimated population

Unit Type	No of Units	Occupants per unit	Total Occupancy
2-Bedroom	40	3.5	140
1-Bedroom	69	2.5	172.5
Studio	34	1	34
Totals	143		346.5

2.3.3. Estimated water demand and proposed water supply source

The estimated water demand for the entire project in operation assuming 100% occupation by families is approximately 35m^3/d. The Table below breaks down the water demand of the entire development. The water consumption rates used have been adopted from the guidelines given in the Ministry of Water and Irrigation Practice Manual for Water Supply Services in Kenya (2005).

Table 2-3: Estimated water demand

Unit Type	Total Occupancy	Water usage/day (l/h/d)	Total Usage
2-Bedroom	140	100	14,000
1-Bedroom	172.5	100	17,250
Studio	34	100	3,400
Totals	346.5		34,650

The proposed water source is an on-site borehole to be drilled and equipped during the construction phase of the housing development.

2.3.3.1. Project borehole

A hydrogeological survey has been carried out which established that the site had a moderate groundwater potential, and a borehole drilled at the site could yield above 6m^3/hr of water. The recommended depth of the hole is at least 250m below ground level. The hydrogeological survey Report is attached in **Appendix E** of this Report.

Various locations where the borehole could be dug were identified, with the proposed location being the northeast corner of the plot near the site entrance.

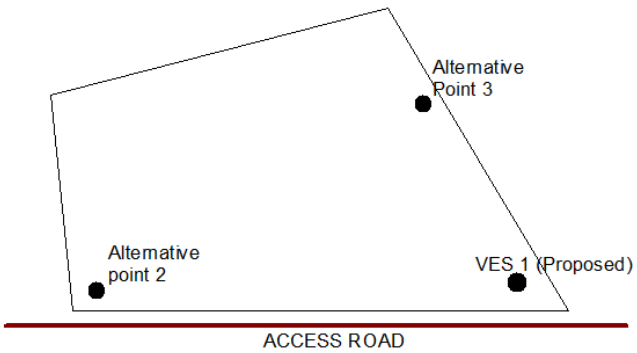

Figure 2-4 Proposed borehole location

2.3.4. Sewage generation, collection and disposal systems

The estimated volume of sewage to be generated by the development is approximately 28m^3/d. The quantity of wastewater generated has been computed as a function of water consumption by applying a sewage factor of 0.8 (for average urban housing) as recommended by the World Health Organization Sectorial Study Report No. 9. The internal sewerage drainage systems shall be installed in heavy duty PVC piping, suitably sized for

collection of wastewater from the various fittings and accessories. The waste water will be conveyed in buried pipe work via connections and access manholes where appropriate, to underground inspection chambers for further gravity flow, through suitably sized underground heavy-duty PVC piping systems to the septic tank located within the site.

2.3.5. Solid waste generation and disposal

The development is expected to generate approximately 165 kgs of waste per day. This is computed from a capita solid waste generation rate of 0.474kg/d[7]. The types of wastes anticipated from the residential units include kitchen wastes, and inorganics such as paper/plastic/metallic wastes. Some hazardous wastes (mainly e-wastes) are also expected from these units.

The development will have a designated temporary refuse storage area within the site from where the domestic waste will be collected by a contracted refuse handler.

2.3.6. Power demand and supply

The power demand for the development is estimated at 260 KVA considering a single-phase supply to each unit of 4KVA. Power will be sourced from the existing grid electricity supply network in the area.

2.3.7. Storm water drainage

Gutters, down pipes, French drains, detention pond, precast concrete open invert block channels and pipes will be provided for drainage as necessary on site. These will collect most of the runoff from roof catchment and other paved surfaces at the site and convey to the constructed storm drainage facilities along the slip road and highway in the area.

2.4. Project activities

2.4.1. Pre-construction activities

Various pre-construction activities have been and will be undertaken. These include: application for change of use from agricultural to multi-dwelling residential use; site investigations such as Environmental and Social Impact Assessment, hydrogeological investigations, topographical survey, and preliminary/detailed architectural and engineering work for the proposed development.

2.4.2. Construction activities

Construction activities will entail the following:

2.4.2.1. For buildings:

- Site hoarding and access management;
- Site clearance and demolition of the existing structures;
- Excavation and disposal of topsoil and subsoil;
- Foundation development and anti-termite treatment;
- Construction of super-structures; and
- Mechanical/electrical installations and connection to services

2.4.2.2. For driveways

- Setting out, site clearance and top soil striping;
- Earthworks including removal of unsuitable materials and rock filling;
- Construction of side and cross drainage structures;
- Construction of sub-base and road base with suitable materials;
- Preparation and construction of surfacing; and
- Landscaping.

[7] JICA (2010). Preparatory Survey for Integrated Solid Waste Management in Nairobi City in the Republic of Kenya

2.4.2.3. For services and other auxiliary works:

These will include the construction/ installation of the following:

- Water storage and reticulation network;
- Wastewater collection and disposal system;
- Security systems;
- Temporary solid waste collection and storage facilities; and
- External electrical works

2.4.2.4. Borehole construction method

2.4.2.4.1. Borehole depth and diameter

The Drilling Contractor will drill to an approximate depth of 250m and diameter of 216mm/153mm.

2.4.2.4.2. Drilling methods

The drilling method will be any of the following four methods:

- Down-the-hole hammer with air or foam;
- Direct rotary with air and foam (light or boosted);
- Direct rotary flush using a water-based fluid;
- Reverse-circulation rotary

2.4.2.4.3. Sampling and cutting

Geological samples of dry weight 500g will be collected at 2m intervals, and at prominent lithological boundaries. These will be sun- or oven-dried, packed in polythene bags of appropriate size, and clearly marked with tie-on labels indicating date of collection, depth interval and the borehole name and number.

2.4.2.4.4. Temporary casing

Installation and diameter of any temporary casing required for the construction of the borehole will be left to the Contractor so long as the finished product meets the borehole specifications.

2.4.2.4.5. Plain and screen casing

Well casing will be mild steel manufactured in accordance with applicable parts of ASTM A 139 Grade B, with the following additions:

- Welding will be by the butt welding arc process using at least two passes on the outside;
- Casing will be 6 ¼ inches outside diameter and ¼ inch wall thickness;
- Casing will be furnished in 6 metre lengths.

Screen slot size: 1mm slots are recommended. Before installation of casing and screen, the Contractor will ensure that the hole is clear to total depth and will flush out any backfilled material if present. The Supervisor, prior to the installation by the Contractor, shall provide the design of casing and screen string.

2.4.2.4.6. Verticality test

The Contractor will conduct a verticality test during and after drilling by approved methods to demonstrate that the departure from the verticality does not exceed 3 in 100 between ground level and the base of the borehole. If this departure is exceeded, the Contractor will make the necessary corrections to the approval of the Engineer. If the error cannot be corrected, drilling shall cease and a new borehole shall be drilled at a position nearby as shall be indicated by the Engineer.

2.4.2.4.7. Gravel pack

The Contractor will supply suitable gravel pack consisting of well-rounded particles of uniform grading with 90% siliceous material and conform to the 2-4 mm diameter. There shall be no clay, shales, silt, fines, excessive amounts of calcareous materials and no crushed rock. The gravel will be washed before installation. Sufficient amount of gravel pack will be installed to completely cover the uppermost screen and yonder by an additional 2-metre to allow for setting. A good supply of water will be introduced with the gravel to prevent bridging. The gravel pack will be capped with a 2-metre vertical column of clay seal to prevent any seepage that may contaminate aquifers with subsequent pollution of ground water. The annular space above the clay seal will be back filled with inert drill-cuttings. The quantity of the gravel pack and backfill to be installed will be

measured using a suitable volumetric method as approved by the Engineer. The Contractor will provide the Supervisor with the bulk density of the pack material, expressed as kg per m^3.

2.4.2.4.8. Sanitary seal and backfill material

To provide an effective seal to the entry of contaminants, up to 2.0-metres depth of the borehole from the surface will be grouted using cement slurry 1.65-2.15kg/litre. Grout is to be injected, by a method approved by the Engineer, into the annulus between the casing and the wall of the hole. In addition, any aquifer bearing saline or poor-quality water shall also be sealed.

Backfill material will comprise fine or clayey drill cuttings and will be installed from the top of the filter pack to 5 m below ground level (bgl) unless otherwise directed by the Supervisor. The installation method will ensure that no bridging occurs within the annular space. The Contractor will measure the depth to the top of the backfill and provide the means by which this level may be measured.

2.4.2.4.9. Yield estimate during drilling

A 900 V-notch flow measurement will be used in the drain line so that continuous monitoring of air-lift yields can be obtained if the Contractor decides to use rotary drilling method. Care will be taken to ensure that no floating debris impede the flow of water over the V-notch. The weir will at all times be kept clear of a build-up of silt and other fines. The Contractor will provide the calibration curve, to be verified and approved by the Engineer, for the V-notch weir. Average yields will be read and rated at every aquifer struck and as otherwise directed by the Engineer. For percussion drilling, a bailer test of at least 30 minutes duration will be carried out for each aquifer encountered.

2.4.2.4.10. Development and cleaning of the borehole

The borehole will be comprehensively developed in accordance with modern borehole construction practices. The methods that will be considered include using high-velocity water-jetting and polyphosphate clay strippers to first degrade polymer, and then remove clays, fines and other undesirable debris. This method calls for super-chlorination as a means of hastening polymer degradation by polymer oxidation.

Surging ("Rawhiding") using air, either with or without eductor pipes, is an acceptable alternative method of development. The use of eductor pipe effectively focuses the development energy to specific parts of the screen, allowing development in detail. Fines are flushed to the surface by airlift pumping. Development will be considered complete only when less than 15 ppm of suspended solids remain in the water, provided that pumping test data do not indicate further development taking place during the boreholes pumping tests.

2.4.2.4.11. Physical development

Physical development will adopt any of the commonly used methods, including but not necessarily restricted to, the following:

- Surging with a surge block;
- High-velocity water jetting;
- Airlift rawhiding;
- Airlift rawhiding with eductor pipe;
- Polishing using a submersible pump

2.4.2.4.12. Test pumping

A test-pumping unit will be provided for the testing of the borehole. The method for varying the discharge rate of the pump used will depend on the type of the pump used. Test pumping will start at least 12 hours after completion of the development and cleaning of the borehole. Sufficient time will be allowed for the recovery of water levels between each type of test.

Discharge measurement will be made by volumetric method or otherwise approved calibrated measuring devise. During the test pumping, the discharged water will be handled and disposed of in an appropriate manner to a point of overland drainage sufficiently far from the well to prevent recharge. The water will be diverted over a distance of at least 100metre from the wellhead.

During all test-pumping operations, once the flow rate has been determined and preliminary adjustments made, the measured discharge rate will be maintained within 5% of the required rate for the duration of the test. Failure of the pump operations during the tests will require abortion of the whole test and the test shall be repeated after recovery of the water level.

The British Standards BS 6316:1992 Code of Practice for test pumping of water wells prescribes the following elements of test pumping:

- A period of recovery after production pumping/development;
- A pre-test (Calibration, typically 2 to 3 hours);
- A period of recovery after pre-test
- A step draw-down test (typically five steps, each of 2 hours duration; total 10 hours);
- A period of recovery after step draw-down test;
- A constant discharge test (typically 48 hours); and
- A recovery test (typically 24 hours).

Test pumping will comprise of the following activities:

Calibration test: The borehole will be subjected to calibration test to establish the approximate yield and draw down characteristics and to decide upon pumping rate for step draw down or constant discharge test. The total duration of calibration test shall not exceed 2 hours.

Step draw down test: This test will comprise pumping the well at three to five separate discharge rates as shall be specified by the Engineer. Each discharge rate will be pumped for a period of one hour. The change from one pumping rate to the next will be effected without stopping the pump, but by means of regulating a gate valve in the discharge pipe, or by other means to be approved by the Engineer. The change from one step to the next will take place in the shortest time possible. During each step of the test, water levels and discharge measurements will be taken at appropriate time intervals as shall be instructed by the Engineer; while at the same time electrical conductivity (EC) readings shall be taken. After completion of the last step, the borehole will be tested at a constant discharge for 24 hours after which a recovery test is to be undertaken. If the borehole's yield is very low (<3 m^3/h), the Engineer may waive the requirement of step draw down test.

Constant discharge test: Separate constant discharge test for maximum duration of twenty-four (24) hours of pumping and twelve (12) hours of recovery will be implemented at the end of the last step of the step draw down test. The discharge rate at which the well is to be pumped will be specified prior to the test. During the test, water level discharge measurements will be taken at the same time intervals as for the step draw down test. Test pumping data from all tests conducted from the borehole will be supplied to the Engineer. These will show dates, water levels, discharge rates, EC values, times of starting and stopping the pumping, change in discharge, weather and other conditions that could affect the test data. The total duration of the test will not exceed 36 hours and 12 hours recovery, unless with the written instructions of the Engineer.

2.4.2.4.13. Analysis of test results

Step draw down test results will be analyzed to determine the turbulent pressure losses at the well face, and an estimate of the aquifer's transmissivity to determine a suitable pump rate for the constant discharge test. The constant discharge test will be analyzed to determine whether the aquifer is confined, unconfined or semi-confined; the aquifer's transmissivity; and where measurements from an observation well are also available, the aquifer's storage coefficient.

2.4.2.4.14. Water level observation

The Contractor will supply an appropriate electric contact level gauge for measuring water levels in the borehole to the nearest 10-millimetre at pre-determined intervals. Wellhead arrangement will permit the gauge to be inserted and passed freely. At the same time the Contractor will install a dipping tube, minimum 19-millimetre internal diameter (ID) lowered approximately 1-metre above the pump intake or approximately 2-metres below anticipated maximum draw down level. Other methods for measuring water levels are subject to the approval by the Engineer.

2.4.2.4.15. Electrical conductivity (EC) measurement

The Contractor shall have an operational EC meter on site to take electrical conductivity readings whenever required during drilling, development and test pumping.

2.4.2.4.16. Records

The Contractor will keep daily activities records for the borehole. The records will contain the following information:

Daily records: The daily records will contain:

- Site name;
- Borehole reference number;
- Date of reporting;
- Names of drilling team staff;
- Drilling method;

- Bore diameter and depth, including diameter changes and their corresponding depths;
- Depth of the bore at the start and end of shift/working day;
- Depth and size of casing at start and end of shift/working day;
- Description of rocks drilled with depths of transitions encountered;
- Depths of water struck levels;
- Depths of main aquifer;
- Estimated yield of airlift measurement when drilling and developing with air;
- Time log (min/meter), for penetration rates for given type of bit and standby time due to breakdown;
- Depth intervals at which each formation samples are taken;
- Records of components and quantities used or added to the drilling or air;
- Water level at the start of each working day;
- EC measurements;
- Problems encountered during drilling;
- Details on installation in the borehole (if any);
- Depth and description of well plain and screen casing, and
- Details of work to be invoiced at hourly rates (e.g. test pumping)

A copy of the daily record will be made available daily to the Engineer for signature, including any other pertinent data as may be requested by the Engineer.

Borehole completion records: The following records will be prepared upon completion of the works for the borehole:

- Borehole number/name and schematic diagram of borehole in section;
- Pumping test times, discharge and water level data;
- Results of chemical analysis;
- Originals of signed daily reports;
- Drilling penetration log;
- Geological log, and
- WAB 28 Borehole Completion Record

2.4.2.4.17. Water sampling

Water samples for testing the chemical water quality will be taken by the Contractor at the end of the test pumping. The Contractor will take the samples to a qualified laboratory for bacteriological and chemical analyses.

2.4.2.4.18. Capping of the borehole

The Contractor will seal the top of the borehole pending installation of a production pump. This seal will comprise a round plate of mild steel, of thickness not less than 6 mm and diameter 266 mm. This will be spot-welded to the mild steel sanitary seal casing at 300 centres, such that the plate can be removed with a hammer and cold chisel.

2.4.2.4.19. Acceptance of the borehole

The borehole will only be accepted by the Engineer and the Proponent upon satisfactory completion of construction operations as per the technical specifications, and clearance of the site.

2.4.2.4.20. Loss of equipment down the borehole

Any equipment lost down in the proposed borehole shall be removed or the borehole will be considered a lost bore. A replacement borehole will have to be constructed and tested.

2.4.2.4.21. Lost bore/abandoned borehole

In case the Contractor is unable to finish the drilling or has to abandon a well due to the loss of tools or any other accident or contingency, the borehole will be deemed a lost bore. The Contractor will remove any casing or drill pipe already placed in the hole where this is possible, and refill it to surface with clay or concrete.

2.4.2.4.22. Construction of wellhead

A sanitary seal will be constructed at the wellhead of the borehole. This will comprise the following elements:

- A 2m length of 209 mm (8”) Outside Diameter (OD) plain mild steel sanitary steel casing installed around the permanent casing string;
- A grout seal between the 209mm sanitary seal casing and the 152mm permanent casing string;

- A 1x1x1 m concrete block cast around the sanitary seal casing.

2.4.2.4.23. Sanitary seal casing

A 2-meter length of 209 mm (8") OD mild steel casing will be installed around the 152 mm (6") permanent casing string in the conductor pipe hole drilled to 2 meters. This will project not less than 0.2 m above original ground level and will be flush with the permanent casing string.

2.4.2.4.24. Grout seal

A sanitary grout seal will be installed between the 152 mm (6") and 209 mm (8") OD casing and grouted into place. Grout will be of cement slurry, or cement and fine sand, and will have a density of at least 1.75 kg/l. This will be introduced into the annular space from the top of the inert backfill to ground level, using a method that must be approved by the Supervisor.

2.4.2.4.25. Concrete plinth

The ground surface at the wellhead will be excavated to a depth of one meter, and be one meter square, to allow a concrete plinth to be cast. The 1 x 1 x 1 m pit will be filled with concrete, to be finished flush with the ground surface. Concrete will be 1:2:4, OPC: sand: half-inch ballast. This will be cast with two 0.8 m lengths of 12 mm reinforcing bar welded to the 209mm (8") OD casing 0.7 m below ground level.

2.4.2.4.26. Borehole disinfection

The Contractor before demobilization from site will carry out disinfection of the borehole. This will be done by placing a chlorine solution into the well so that a concentration of at least 50 mg/l of available chlorine exists in all parts of the borehole at static conditions. The borehole's surface above the static water level shall be completely flushed with the solution. The solution will remain in the borehole for a minimum of 2 hours before pumping the borehole waste.

2.4.2.4.27. Anticipated Wastes

It is anticipated that the following wastes will be generated in drilling of the borehole:

- Exhaust emissions from the drilling machine and contractor's vehicles;
- Waste water;
- Drilling mud and foam;
- Drilling cuttings, chips and rock debris; and
- Used oil, and oil filters.

2.4.2.4.28. Clearing the site

On completion of the borehole, the site will be left clean and free from all debris, hydrocarbons and waste, and all pits filled to the approval of the Engineer. If the site is not delivered clean the borehole may be unacceptable.

2.4.2.4.29. Water abstraction monitoring

A borehole water meter will be installed to monitor water abstraction levels at the site.

2.4.2.5. Construction materials sources

Sand, aggregate, murram and hardcore will be procured from existing and licensed commercial quarries. Cement, adhesives, paints, wood, boards, roofing materials, bricks, iron bars and other materials and chemicals will be sourced from local suppliers. Those materials and fixtures that are not locally available will be imported. Construction water will be sourced from the existing well at the site, or purchased from water vendors who supply it in trucks.

The main energy sources for construction activities include grid electricity and fossil fuels. The area is connected to grid electricity supply and equipment requiring this power will be connected through appropriate installations. Other equipment powered by fossil fuel will be regularly fueled with supplies from the nearest petrol station.

2.4.3. Project operations

The main activities to be undertaken during project operations include:

- Occupation of the residential houses;
- Maintenance of the buildings, water supply systems, wastewater disposal systems and other services; and
- Collection and disposal of wastes.

2.4.4. Project decommissioning

The main activities during project decommissioning are expected to either be:

- Cessation and abandonment of all or some of the buildings;
- Removal of some installations at the site; or
- Demolition of all structures and environmental restoration of the site

2.4.5. Inputs and outputs

The Table below outlines the anticipated inputs and outputs during the construction, operation and decommissioning stages of the Project

Table 2-4: Anticipated inputs and outputs

Phase	Inputs	Outputs
Construction	• Fossil fuels for running machinery/ equipment; • Water • Raw materials such as ballast, sand, bitumen, cement, gravel, iron bars, masonry blocks, electrical cables etc	• Exhaust emissions; • Material spoils (wastes) • dust, noise and vibrations • construction wastewater
Operation	• Routine maintenance/ repairs; • Various consumables by households	Solid and liquid waste
Decommissioning	Fossil fuels for running machinery/ equipment	• Solid waste/ rubble • Exhaust emissions • Dust, noise and vibrations

2.5. Project Cost estimates

The estimated total construction cost of the project is KES 245 million. The Table below summarizes the cost of key elements of the project

Table 2-5: Summary Bill of Quantities

PROPOSED CONSTRUCTION OF ZIMA HOMES ELEMENTAL CONSTRUCTION COST EVALUATION SUMMARY JUNE 2021			
	TOTAL COST	Rate per m2 (Kshs.)	% of construction cost
Block A	79,138,506	28,411	43%
Block B	61,495,787	26,448	33%
Block C	31,571,976	30,415	17%
Common Services	13,765,650		7%
Cost of Building Works	185,971,920	28,424	100%
Add 5% preliminaries (Electricity, water, security, insurances, permits, health & safety etc)	9,298,596		
VAT (16%)	31,243,283	4,548	
Add 10% contingency (To be expended on authority of the client)	18,597,192		
Total Construction Cost			**245,110,990**
Average cost per m2 (Kshs)			**32,972**

2.6. Estimated construction period

The estimated construction period for the proposed development is 21 months.

3. Analysis of alternatives

3.1. Overview

Various options were analyzed for the Zima Homes Housing Project. The options included the 'No Development' consideration, location of the development, water supply options, sewerage management options; density of housing, and energy efficiency options.

3.2. The No Development option

This alternative assumes the status quo is maintained with no development of the proposed housing project. This would avoid a realization of the impacts concomitant to development and operation of a housing scheme. However, with the projected population increase and the growing housing deficit, a lack of development of new affordable housing could hamper Kenya's socioeconomic development, and relegate a large portion of the population to a low quality of life. The No development option was therefore discounted on the basis that increased development of affordable housing is a necessity for Kenya's socioeconomic growth.

3.3. Location of the housing project

The goal of the developer is to create a positive social impact by choosing sites in neighborhoods within dense urban and growing peri-urban contexts where the target market currently lives. The neighborhoods considered in site selection included Githurai, Kikuyu, Ndenderu, Ongata Rongai, Kawangware, Kiambu, Ruai and Mlolongo. Key factors that guided the identification and consideration of these neighborhoods were:

- The land prices are below KES 60 million per acre and in close proximity to a major highway with access to public transport;
- The Land Use Zoning in these neighborhoods has been shifting from agricultural to residential over the past decade in order to accommodate the rapidly growing urban population of Nairobi and its environs;
- The typical context of each of these neighborhoods features buildings that are between 2-5 storeys where the ground floor of the buildings have commercial space if the site is in a denser part of the neighborhood and near a major transport hub.

Ndenderu neighborhood was chosen due to favorable land prices, proximity to Nairobi's CBD and other amenities. The neighborhood also has suitable soils (red soils) that would reduce the cost of excavation and establishment of foundations. Ndenderu urban centre is 19km from the Nairobi CBD with a population of 2,349 residents and a thriving commercial center. Additionally, the neighborhood has a strong social infrastructure that supports the growing population. These factors led to identification of a suitable parcel of land within a radius of 4km from the urban centre and with good links to transport networks and public services.

3.4. Building materials and technology

Construction materials take up the greatest investment in terms of the costs of a building. Factors such as cost, social acceptability and embodied energy are key considerations to the viability of a material for Zima Homes. The criteria in selection of materials includes:

- Cost: the market price of material
- Buildability by local labor: Whether the average local construction worker has experience or skill in building with the material
- Embodied energy: The amount of energy used in the production of the material
- Accepted in Building Code: Whether the current Kenyan Building code approves the use of the material
- Build time: How quickly the material could be used to construct a building

Some materials, such as rammed earth, are innovative and sustainable but high in labor costs and thus overall cost. Compressed Stabilized Earth Blocks (CSEBs) on the other hand are low in cost and embodied energy, highly scalable and are already accepted in the building code. Stone as a material is also viable due to ease of implementation and low cost but has a high embodied energy due to transport and quarrying.

Table 3-1 Comparison of materials options

	Wall System	Cost	Buildability by local labor	Embodied Energy	Build Time	Accepted in Building Code
Earthen Materials	Fired Brick Wall					Yes
	CSEB Wall (Compressed stabilized earth blocks) *					Yes
	EPS Wall Panels (expanded polystyrene)					No
Block Systems	Quarry Stone Wall					Yes
	CMU Wall (Concrete masonry units) *					Yes

High (undesirable)	Medium	Low (desirable)

** Build time would be accelerated for both CSEB or CMU wall system methods if using interlocking blocks during construction*

The selected materials were masonry stones for external and load-bearing walls, and concrete panels for internal non-load bearing walls.

3.5. Structural design

Various options of structural design were considered such as concrete frame, steel frame and load-bearing masonry. Key considerations in selection of a suitable structural design were: Height limitations; Carbon emission; Sustainability; Buildability; Availability of material; and Best System

Table 3-2 Structural design options

Structure type	Concrete Frame	Steel Frame	Load Bearing Masonry
Height limitations			
Carbon emission;			
Sustainability;			
Buildability			
Availability of material;			
Best System			

High (undesirable)	Medium	Low (desirable)

The selected structural system was a reinforced concrete frame combined with load bearing masonry stone for efficient structural design. Although concrete has a relatively high amount of embodied energy, it is readily available in the market and is a known technology therefore does not require any skills training. The frame allows flexibility for the material used for the walls as well as the position of these walls.

3.6. Density of housing

The density of the units was arrived at while considering the need to ensure optimal use of the available land; need to meet zoning requirements; need to create a dignified, and comfortable space; and the need to meet the affordability criteria.

A modular layout was adopted based on a 3m X 3m grid, which would allow flexibility in the units' sizes and functions. It would also allow for a range of unit sizes to be developed without changing the overall structure. The mix of units (and therefore the numbers) can easily respond to market demand, with the final ratio of studio, 1-bed and 2-bed units able to be changed during early construction based on sales performance and forecasts.

3.7. Water supply options

Residents in the development would require a stable supply of water to meet their domestic water needs. The surrounding area is not served by municipal water supply, and the inhabitants mostly rely on private wells, and supply networks from individual or community boreholes. The developer had limited water supply options, necessitating the development of an onsite borehole to supply water to the development. This would also improve the attractiveness of the houses to potential buyers. Sustainability measures such as low-volume fixtures and water harvesting have also been considered in project designs for water resource conservation

4. Environmental and social baseline conditions

This Section discusses the Project's baseline conditions at a general (County) and site-specific level based on information collected from field studies and review of literature relevant to the Project and the area.

4.1. Location

The Project is in Kibiku area, Ngababa village, Nyathuna Ward, Kabete Constituency in Kiambu County. The nearest trading centre is Wangige town, approximately 1.3km south of the site.

Administratively, Kiambu County is divided into 12 sub-counties and 60 wards. Nyathuna Ward – where the Project is located, is one of the 5 Wards in Kabete Constituency. The others are Gitaru, Muguga, Kabete and Uthiru Wards.

4.2. Biophysical environment

4.2.1. Topography

Kiambu County is divided into four broad topographical zones[8];

Upper Highland Zone: Covers Lari Constituency and is an extension of the Aberdare ranges. The altitude here ranges between 1,800 - 2,550 meters above sea level (masl), and the zone is steep and dominated by highly dissected ranges.

Lower Highland Zone: Mostly covers Limuru and parts of Gatundu North, Gatundu South, Githunguri and Kabete constituencies. The zone is characterized by hills, plateaus, and high-elevation plains, and the altitude ranges between 1,500-1,800masl.

Upper Midland Zone: Covers parts of Juja and other constituencies with the exception of Lari. The landscape comprises of volcanic middle level uplands and the altitude ranges between 1,300 -1,500masl.

Lower Midland Zone. The zone partly covers Thika Town (Gatuanyaga), Limuru and Kikuyu constituencies, with the altitude ranging between 1,200 -1,360 masl. The zone is also characterized by steep slopes and valleys.

The local topography of the site is slopy at 1914masl, and is in the transition area between the upper and lower highland zones of the County.

4.2.2. Water resources, hydrology and drainage

4.2.2.1. Surface water resources

Numerous rivers mostly emanating from the Aberdare Ranges drain the County which is divided into two major catchments for the Athi and Tana Rivers. The County is divided into several sub-catchments including:

- The Nairobi River sub-catchment which occupies the southern part of the County with major rivers being Nairobi, Gitaru, Gitathuru, Karura, Rui Rwaka, and Gatharaini;
- The Kamiti and Ruiru Rivers sub-catchment which is located to the north of the Nairobi River sub-catchment. It has eight permanent rivers which include Riara, Kiu, Kamiti, Makuyu, Ruiru, Bathi, Gatamaiyu and Komothai;
- The Aberdare plateau which forms two sub-catchments of Thiririka and Ndarugu Rivers. The main streams found in the two areas include Mugutha, Theta, Thiririka, Ruabora, Ndarugu and Komu; and
- The Chania River and its tributaries comprising of Thika and Karimenu Rivers which rise from Mt. Kinangop in the Aberdare ranges

The nearest watercourse to the site is Thigii stream found approximately 250m northeastwards and flowing eastwards to form Mathare River downstream. Local runoff flows northeastwards through natural and constructed stormwater drainage channels into the stream.

[8] County Government of Kiambu (2018). County Integrated Development Plan 2018-2022

4.2.2.2. Groundwater resources

There are two main aquifers in the county – the Nairobi Suite and Basement Athi Suite. Most of the ground water exploitation is from the Nairobi Suite which is predominantly volcanic. The project area is considered to be within zones of medium to high groundwater potential. Ground water recharge is from the northwest, and flows occur horizontally through the porous sediments of the Athi series and the fractured system of the tertiary volcanics.

A number of boreholes have been dug within the wider area of Wangige. The depth of these boreholes ranges from 94m – 305m below ground. The struck levels vary from 10m – 207m below ground with water rest level varying from 4.3m – 86m below ground level. Tested yield ranges from 680l/h - 11,400l/h. The wide variation of the tested yields is due to varying drilled depths, aquifer characteristics differences, and differences in borehole designs[9].

4.2.3. Geology and soils

Located on volcanic footridges of the Aberdare ranges, soils of the Project area are developed on Tertiary basic igneous rocks. They are well drained, extremely deep, dusky red to dark-reddish brown friable clay with an acid humic topsoil (humic NITISOLS)[10].

4.2.4. Climate

Kiambu County experiences bi-modal rainfall. The long rains fall between March and May, followed by a cold season usually with drizzles and frost between June and August. The short rains fall October and November. The rainfall varies with altitude, with higher areas receiving as much as 2,000 mm while the lowlands receive as little as 600 mm of rainfall. The average rainfall received by the County is 1,200 mm.

The mean temperature in the County is 26°C with temperatures ranging from 7°C in the upper highland areas to 34°C in the lower midland zones. July and August are the months during which the lowest temperatures are experienced, whereas January, February and March are the hottest months.

Deducing from the climate information of proximal areas such as Kikuyu, the Project area's climate is warm and temperate, and is considered to be Cfb according to the Köppen-Geiger climate classification. The annual temperature here averages 17.1 °C, with the highest temperatures experienced in February. Annual rainfall averages 674mm, with most of the precipitation falling in April, at an average of 125mm[11].

4.2.5. Biodiversity

Land use has a significant influence on the biodiversity of an area. It determines the vegetation types and other characteristics such as composition, density and abundance, and in turn, the fauna that can be found in the area.

The Project area is within the rural-urban transition zone where the main land uses are agriculture and settlements. Thus, vegetation is mostly comprised of agricultural crops, agroforestry trees, and ornamental vegetation around homesteads. The vegetation at the project site includes crops such as maize, beans and vegetables, fruit trees and herbs such as avocado (*Persea americana*) and banana (*Musa* sp.) and other trees such as *Croton macrostachyus.* Various grasses including napier grass (*Pennisetum purpureum*), *Cymbopogon nardus*, and invasives such as *Lantana camara* and *Solanum incanum* are also found on cultivated areas of the plot.

Figure 4-1 Vegetation found at the site

[9] Hydrogeological Survey Report for BXS Group Limited

[10] W. D. Sombroek, H. M. Braun and B. J. van der Pouw, "Exploratory Soil Map and Agro-Climatic Zone Map of Kenya, 1980 Scale 1:1,000,000. Kenya Soil Survey.," 1982.

[11] https://en.climate-data.org/africa/kenya/kiambu/kikuyu-57885/

Apart from domestic cats and dogs, other fauna likely to be found at the site includes birds and small mammals such as rats, mice and moles.

4.2.6. Ambient air quality and noise levels

The Project site's immediate environs are relatively low density residential cum-agricultural areas. The main sources of air pollution are the surrounding agricultural land and earth roads that generate fugitive dust especially under dry conditions. Other sources of emissions include slash and burn activities on agricultural land, and burning of domestic wastes at household level.

The project site is next to Gitaru Road, and exhaust emissions from vehicles along the road are also affect the ambient air quality. Currently, the road is under construction, the works being the upgrading of the existing road from a single carriage to a dual carriage highway (Western Bypass). The construction works (earthworks and deviations) are an additional source of dust emissions affecting local air quality.

The main source of noise in the Project area is vehicular and motorcycle traffic along Gitaru Road. With the upgrading of the road to a dual carriage highway, vehicular traffic and vehicle speeds will increase. With higher speeds, the road noise will also increase significantly. Construction works for the road, though temporal have elevated the noise levels in the project area.

Figure 4-2 Conditions and activities contributing to noise and dust nuisance

4.3. Socio-economic environment

4.3.1. Population

The Project is located in Nyathuna subcounty, Nyathuna location, Kabete subcounty in Kiambu County. According to the 2019 Kenya Population and housing census, Kiambu County had a population of 2,417,735 people, 49% of whom were male, while 51% were female. Kabete sub-county had a population of 199,653 people, while Nyathuna Location had a population of 20,215 in 6,228 households. Nyathuna sublocation where the Project is located had 8,163 people in 2,458 households.

The Population density in Kiambu County was 952 people per square kilometer, while Kabete subcounty had a density of 3,289 – the highest among the 12 sub-counties. The number of households in Kabete was 66,710, with an average household size of 3 people. Nyathuna sublocation had a population density of 1,457 people per square kilometer.

4.3.2. Land use, land ownership and Local economy

4.3.2.1. Land use

The main land uses in the County include industrial, agricultural, commercial, and residential uses. The total arable land in the County is 1,878.4 Km^2 of which approximately 21,447Ha is under food crops while 35,367Ha is under cash crops. The main food crops grown in the County include maize, beans, Irish potatoes, bananas and vegetables.

Settlement patterns in Kiambu are either dispersed, linear, or nucleated depending on factors such as land subdivisions, transportation routes, or proximity to trade hubs.

In the project area, settlement patterns are mostly linear along transportation routes. The types of settlements include single user on-farm dwellings and multi-user storied dwellings.

Figure 4-3 Land uses neighboring the site

4.3.2.2. Land ownership

Most of the land is privately owned (95%) while Public land is about 5%. Approximately 85% of land owners in the County have title deeds to their land. The average land holding size is approximately 0.045Ha on small scale and 69.5Ha on large scale. The small land holdings are mostly found in upper parts of Gatundu North, Gatundu South, Kiambaa, Limuru and Kikuyu constituencies.

4.3.2.3. Employment

Most of the people in Kiambu County are employed as wage earners in tea and coffee estates and in horticulture. The self-employed people are engaged in trade of goods and services, construction, manufacturing, hospitality etc. Unemployment levels in the County are high at 60%.

4.3.3. Infrastructural services

4.3.3.1. Transport network

By 2018, Kiambu County had a road network of 5533 Km, 865.4kms of which were bitumen, 1051kms gravel, and 3167kms earthen. Since then, new roads have been opened, while some previously earthen or gravel roads have been upgraded to bitumen standard. The County is also served by a railway line that traverses several subcounties, with railway stations in Kahawa, Ruiru, Juja, Thika, Kikuyu and Limuru.

The County in conjunction with the various roads authorities has the ambition to provide sustainable mobility for all by inclusion of non-motorized traffic lanes for the people as well as reduction of air pollution by road users.

4.3.3.2. Information, Communication Technology

The County has 98% mobile network coverage owing to its location and proximity to Nairobi City. The fiber-optic communication network is also well distributed in the County, easing communication and access to information.

4.3.3.3. Energy access

Kiambu County has 98% grid electricity coverage owing to several initiatives such as the ‘last mile’ and rural electrification programmes. The total households connected to electricity is 70%, and the number is expected to rise to 100% by the year 2022. Solar energy is harnessed by a few in the county, while biogas is widely used especially by farmers in Githunguri, kikuyu, Limuru and other sub-counties where dairy farming is practiced.

4.3.3.4. Solid and liquid waste management facilities

Kiambu County has designated solid waste landfill and dumpsites, incinerators, recycling facilities and bio-decomposers. The dumpsites are located in Limuru, Githunguri, Kiambu, Ruiru, Gacharage and Gatundu South. Incinerators are mostly found in hospitals and other institutions, while the recycling, composting and bio-decomposing facilities are privately owned and located in Thika and Kiambaa sub-counties.

4.3.3.5. Water supply

Kiambu County has eight registered Water Supply Providers (WSPs) that run water supply schemes. The WSPs serve about 54% of the County population, with the rest relying on Community Based Organizations, private water vendors, and direct abstraction from surface and ground water sources.

The Project's immediate environs are not served by any WSP, and residents rely on private wells and boreholes. There is a community water scheme across Gitaru Road with a distribution tank at Kibiku Police Station, but the scheme does not serve the site and adjacent areas.

5. Policy, legal and administrative framework

This section discusses the policy, legal and regulatory framework that governs the environmental quality, health and safety, protection of sensitive areas, land use control at the local and national levels, and relevant to the proposed housing Project.

5.1. National policies

The key policies and their provisions relevant to the housing sector are outlined and summarized in the Table below:

Table 5-1: Relevant National and County Policies and Plans

Policy Instrument	Relevant provision
Kenya Vision 2030	• Envisions an adequately and decently housed nation in a sustainable environment • Recognizes the need to plan for decent and high-quality urban livelihoods for the population • Aims at facilitation of production of 200,000 housing units annually through various initiatives
National Housing Policy (Sessional Paper No. 3 of 2016)	• Seeks to put in place mechanisms for the provision of adequate and affordable housing in order to facilitate progressive realization of the right to housing • Seeks to support sustainable mixed-income housing developments that meet the needs of all socioeconomic groups and also take cognizance of the needs of vulnerable groups; • Seeks to support adequate growth, maintenance and improvement of housing stock to meet the housing needs • Expresses the government's commitment to: encourage rental housing and rent- to- own forms of access to housing; and encourage use of appropriate and low-cost building materials and technologies
The National Environment Policy, 2014	• Expresses the government's commitment to promote sustainable urban and peri-urban land uses; promote high rise building as an efficient land utilization practice; Promote technologies for efficient and safe water use, especially in respect to wastewater use and recycling
Draft National Sustainable Waste Management Policy, 2020	• Seeks to promote sustainable waste management through implementation of the waste hierarchy and circular economy concepts • Expresses the government's commitment to develop regulations that require all Institutions, businesses, commercial trading, Industrial, residential and property developers to provide source segregation receptacles at their premises; design standard waste segregation receptacles to be mainstreamed in building designs; Develop food waste regulations to require separate collection, transport and processing into useful products thus diverting organic waste from landfilling by all institutions, commercial, industrial and households waste generators
The National Land Policy (Sessional Paper No. 3 of 2009)	• Seeks to ensure that all land uses, and practices conform to land use plans and the principles of biodiversity protection, conservation and sustainable development;
The National Land Use Policy (Sessional Paper No.1 of 2017)	• Seeks to promote best land use practices for optimal utilization of the land resource in a productive, efficient, equitable and sustainable manner • Seeks to facilitate the development of planning guidelines, policies and standards to be observed and enforced by the county governments and other sectoral agencies within the frameworks of approved physical development plans

	• Seeks to protect agricultural land from indiscriminate extension of urban boundaries and other encroachments
Green Economy Strategy and Implementation Plan, 2016 – 2030	• Aims at promotion of sustainable design, construction and maintenance of buildings by: Ensuring 75% of new and renovated large scale buildings are green by 2030; Developing capacity of architects, engineers, contractors and other stakeholders to integrate green technologies in design and construction; Developing and implementing certification standards for green buildings • Aims at promotion of resource efficiency including energy and water use efficiency by rolling out demand-side energy and water efficiency programmes in urban residential, commercial and industrial establishments
Updated Nationally determined contribution (NDC) (Kenya's climate change mitigation and adaptation contribution to abate GHG emissions by 32% by 2030 relative to BAU)	• For Water and sanitation, seeks to promote water harvesting and storage at County and household levels • For population, urbanization and housing, seeks to strengthen the enforcement of green building codes by national and county governments; and conduct climate risk and vulnerability assessment of building/housing infrastructure especially to flooding, and sea level rise
Kiambu County Integrated Development Plan, 2018-2022	• Seeks the densification of residential areas in Kikuyu, Kabete, Limuru and other areas to avoid urban sprawl

5.2. National legislation

The key legislation and their provisions relevant to the housing sector and other envisaged project activities are outlined and summarized in the Table below.

Table 5-2: Relevant Legislation and Project's commitment to compliance

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ Activity requiring regulation	Project's compliance/ commitment to comply with Requirements
The Constitution of Kenya (2010)	• Provides for the protection of the right to private property • Provides for the sound conservation and protection of ecologically sensitive areas • Supports the settlement of land disputes through recognized local community initiatives • Gives powers to the state to regulate use of land • Provides for individual rights to adequate housing and reasonable standards of sanitation • Provides for access to clean and safe water in adequate quantities • Provides for individual rights to a clean and healthy environment	• The need to protect/conserve ecologically sensitive areas such as streams from pollution • Need to ensure that the public is not exposed to nuisances from project activities	The Proponent will institute measures for environmental protection and prevention of nuisance to the public in construction and operation of the Project
Environmental Management & Coordination Act,1999	• Provides for protection and conservation of the environment, • Provides for EIA, environmental auditing and monitoring • Provides in the 2nd Schedule, that a housing development with more than 100 units shall carry out a full EIA study	EIA to be carried out and EIA License to be acquired before commencement of development	The Proponent will undertake an EIA of the Proposed Development and develop an Environmental and Social Management Plan to protect and conserve the environment
Environmental Management and Co-ordination (Water Quality) Regulations 2006	• Provides for the protection of ground and surface water resources • Provides for the quality of wastewater discharged from any facility/activity into the environment or sewer	• Effluent discharge license to be acquired if any effluent will be generated/discharged • Generation of construction wastewater	• Proponent will apply for an effluent discharge license Contractor will manage construction wastewater to prevent it from entering surface water courses

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ Activity requiring regulation	Project's compliance/ commitment to comply with Requirements
Environmental Management and Co-ordination (Noise and Excessive Vibration Pollution) (Control) Regulations 2009	• Prohibits the generation of unreasonable, unnecessary or unusual noise which annoys, disturbs, injures or endangers the comfort, repose, health or safety of others and the environment • Provides for the maximum noise levels permissible in various environmental set ups such as residential areas, places of worship, commercial areas and mixed residential	• Sound level limits of 50dB (day) and 35dB(night) to be observed • License to emit noise/vibrations in excess of permissible levels to be acquired if necessary	Contractor will put in place measures to manage construction noise to prevent nuisance in the neighborhood
Environmental Management and Co-ordination (Waste Management) Regulations 2006	• Provides for standards for handling, transportation and disposal of various types of wastes including hazardous wastes • Requires implementation of measures for waste minimization or cleaner production, waste segregation, recycling or composting • Provides for licensing of vehicle transporting waste • Provides for the licensing of waste disposal facilities	• Disposal of generated waste including soil, vegetation, and other wastes from construction activities • Generation of hazardous wastes such as used oil and oily parts from maintenance of construction machinery • Generation of household wastes during occupation of the development	• Proponent will commit the contractor to ensuring that construction waste is disposed in designated areas if recycling and/or reuse is not possible • Proponent will contract a licensed waste handler to collect and dispose in an appropriate manner, wastes generated by the households in occupation
Environmental Management and Co-ordination (Fossil Fuel Emission Control) Regulations 2006	Provides for emission standards for internal combustion engines	Use of diesel-powered engines in construction machinery	Proponent will commit the contractor to ensuring that his equipment does not emit fumes in excess due to poor maintenance
Environmental Management and Coordination (Air Quality) Regulations, 2014	• Provides for ambient air quality tolerance limits • Prohibits air pollution in a manner that exceed specified levels • Provides for installation of air pollution control systems where pollutants emitted exceed specified limits • Provides for the control of fugitive emissions within property boundary • Provides for the control of vehicular	• Exhaust emissions from construction machinery • Site clearance and excavation of foundations • Transportation and disposal of spoil	• Proponent will commit the contractor to ensuring that his equipment does not emit fumes in excess due to poor maintenance. • Proponent will also commit the contractor to implementing dust control measures including sprinkling of the site with water, use of covered trucks in transportation of materials and wastes

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ Activity requiring regulation	Project's compliance/ commitment to comply with Requirements
	emissions • Provides for prevention of dispersion of visible particulate matter or dust from any material being transported • Provides for acquisition of an emission license		
The Physical and Land Use Planning Act, 2019	• Provide for controls on the use and development of land and buildings in the interest of proper and orderly development of an area • Requires that development permission be sought through a development application • Provides that a development application may be accompanied by an EIA Report	Development of the plot	• Proponent has applied for the necessary permits from the Physical Planning arm of the County Government of Kiambu • Proponent is also carrying out an EIA of the proposed development
The Public Health Act (Cap 242)	Provides for the prevention of the occurrence of nuisance or conditions dangerous/injurious to humans	• Generation of wastes during project construction • Handling and storage of waste during construction and occupation of the development	• Proponent will commit the contractor to procuring solid waste management services and maintaining the construction site in a clean and orderly state • Proponent will also procure services of cleaners/gardeners and a licensed waste handler to ensure that the property is kept in a clean state and that waste is appropriately disposed
Occupational Safety and Health Act, (OSHA) 2007	• Provides for the safety, health and welfare of workers and all persons lawfully present at work places • Provides for the registration of workplaces • Outlines safety requirements in use of machinery to prevent accidents and injuries	• Construction site requires registration as workplace • Safety measures are required in use of machinery on site • The need to protect the general public and workers	• The contractor will register the site as a workplace before commencement of construction • Proponent will commit the contractor to implementing a health and safety plan that ensures protection of both workers and the general public from safety hazards

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ Activity requiring regulation	Project's compliance/ commitment to comply with Requirements
The Factories and Other Places of Work (Noise Prevention and Control) Rules, 2005	• Rules provide for the maximum noise exposure levels for workers in places of work and for the provision of protective equipment for those exposed to high noise levels. • Provides that an occupier shall also institute noise reduction measures at the source of noise in the workplace	Use of noisy machinery at the construction site	Proponent will commit the contractor to providing Personal Protective Equipment (PPE) to workers operating noisy machinery
Water Act 2016	• Provides for measures for the conservation of groundwater in order to protect public water supplies • Provides for the right to clean and safe water in adequate quantities and to reasonable standards of sanitation • Provides that a permit shall be required for any use of water from a water resource, especially where there is abstraction and use of water with the employment of works; • Provides that where any well is being constructed within the proximity of an existing well, tests to be applied to the existing well and to supply to the Authority the particulars of the results of such tests including the rate of pumping and rest levels of water • Prohibits the wastage of groundwater	• Drilling of the borehole at the project site • Testing of the well, cleaning and sterilizing • Abstraction of water for domestic use during occupation of the development	• Proponent will apply for a drilling permit before commencement of drilling • Proponent will commit the drilling contractor to avoid wastage of groundwater; to conduct tests on neighboring wells • Proponent will apply for an abstraction permit to use the groundwater from the well
Water Resource Management Rules 2007	• Provides for application by all those intending to abstract ground water; • Provides that where any borehole or well is intended to be equipped with a motorized pump the application shall be accompanied by a hydrogeological assessment report	• Drilling of the borehole at the project site with intent to abstract water for domestic use • Installation of a pump in the well to abstract the groundwater	• Proponent will apply for an abstraction permit to use the groundwater from the well • Proponent has carried out a hydrogeological survey at the site
Water Harvesting and Storage Regulations 2019 (Draft)	• Provides for gutters on roofs or ground catchments to harvest rainwater from	• Construction of buildings that generate runoff	• Proponent will explore the opportunity to harvest and utilize stormwater from

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ Activity requiring regulation	Project's compliance/ commitment to comply with Requirements
	buildings for human occupation as dwellings • Provides that storage capacity of tanks installed shall meet 7 days water demand of the building		roofs
The Energy Act 2019	• Promotes the development and use of renewable energy technologies including solar and other forms; • Provides that installation of electrical works shall be carried out by a licensed person • Provides that the amount of electrical energy supplied to the consumer or the number of hours during which the supply is given, or the maximum demand taken by the consumer, or any other quantity or time connected with the supply shall be ascertained by meters of a type approved by the Kenya Bureau of Standards, or determined in a manner agreed upon by the licensee and the consumer	• Installation of electrical works in the houses and connection to grid electricity • Grid electricity consumption by the households	• Proponent will hire licensed electrical contractor for the electrical installation works • Proponent will also apply for authorized electricity consumption meters from KPLC
The Energy (Solar Water Heating) Regulations, 2010	Provides that all premises with hot water requirements of a capacity exceeding 100 liters per day shall install and use Solar Water Heaters (SWH)	Heating of water for various uses in the households	Proponent will install SWHs on the rooftops of the apartments
The National Building Code, 2020 (Draft)	• Seeks to promote order and safety in construction works, and the health and safety of persons in or about construction works. • Provides for the design, construction, operation, inspection and maintenance of buildings; • Provides standards for building materials, products, elements, systems and services; standards for	The need to maintain set standards in building design and construction activities	Proponent and Contractor will abide by the building code in design and construction activities

Legislation/Regulation/ Standard	Provisions	Relevance to the Project/ License or Permit Required/ Activity requiring regulation	Project's compliance/ commitment to comply with Requirements
	infrastructure services; standards for the operations and works at construction sites; • Provides for disaster management at construction sites; and • Provides for the safety and security of the users and occupants of a building		
The National Construction Authority Regulations, 2014	• Provides for the registration of contractors • Provides for the accreditation and certification of all construction workers and site supervisors • Provides for the registration of construction works with the Authority	The need for the appointed contractor, the construction site and workers to have the necessary registrations	• The site will be registered with the National Construction Authority • The Proponent will select a contractor duly registered with the NCA
Climate Change Act, 2016	Provides for the integration of climate risk and vulnerability assessment (CRVA) into all forms of assessment	The need to consider climate risks to the proposed development	A CRVA is conducted on the proposed development to identify risks and vulnerabilities that could affect the projects sustainability

6. Public consultation and participation

6.1. Overview

This chapter describes the process and activities in public consultation and participation that were followed/undertaken to ensure that all stakeholders are informed about the project and are involved in the identification of key issues and impacts pertaining to the proposed Housing Project.

Stakeholders are persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively.

Stakeholder engagement and public consultation are an integral aspect of successful decision making in the ESIA process and in the implementation of development projects, plans and/or programmes. It presupposes that the public has access to timely and accurate information on the environment and the proposed development in order to make meaningful contributions in discussions.

The stakeholder engagement strategy should be scaled relative to the risks and impacts a project/plan/programme is likely to create. For the proposed housing project, stakeholder engagement mainly focused on project information disclosure, communication on project construction and operation impacts and mitigation measures, and collection of Interested and Affected Parties (IAPs') comments and recommendations.

6.2. The legal context of public participation

6.2.1. The Constitution of Kenya, 2010

Article 10 of the Constitution of Kenya, 2010 outlines the national values and principles of governance which include democracy and participation of the people, human dignity, equity, inclusiveness, social justice and human rights including non-discrimination and protection of the marginalized.

Article 33 guarantees the freedom of expression including the freedom to seek, receive or impart information or ideas. Hence, every person should feel constitutionally empowered to share information and ideas during public participation processes.

Article 35 provides for every citizen's right of access to information held by the state, and information held by another person and which is required for the exercise or protection of any right or fundamental freedom. This includes information required for effective public participation to take place.

Article 69 (1) (d) provides that the State shall: "Encourage public participation in the management, protection and conservation of the environment.

Article 174(c) provides that one of the objects of the devolution of government is to give powers of self-governance to the people and enhance the participation of the people in the exercise of the powers of the State and in making decisions affecting them.

6.2.2. The County Government Act, 2012

The legislation is based on Chapter Eleven of the constitution, and provides for the powers, functions and responsibilities of county governments. Section 87 of the Act provides for citizens' participation based on timely access to information, data, documents, and other information relevant or related to policy formulation and implementation.

6.3. Benefits of stakeholder engagement

6.3.1. Benefits to the developer

- The developer is likely to benefit from local knowledge;
- Costs may be saved as key issues are identified by the public and studies are focused on key issues as opposed to a broad range of issues;
- Measures to reduce adverse impacts and enhance benefits will be identified with stakeholders;
- Relations with the communities in the vicinity of the development are likely to be improved;
- Delays in decision making may be reduced because of good participation early in the process;
- The public are unlikely to raise objections to the project; and
- The developer's image and reputation is likely to be enhanced.

6.3.2. Benefits to the public

- Capacity is built through people playing an active role during the process. The skills learnt can be used in other community projects;
- Public rights are exercised and protected in participating; and
- Inputs are likely to influence the form and nature of the development and is likely to lead to better development that takes society's needs into account.

6.4. Stakeholders' identification

Project stakeholders were identified during the scoping exercise conducted in March 2021. The following questions guided the mapping of the stakeholders:

- Who will be adversely affected by the potential environmental and social impacts in the project's Area of Influence (AOI)?
- Who are the most vulnerable among the potentially impacted, and is special engagement necessary?
- At which stage of the project will the stakeholders be mostly affected (i.e. construction, operation, decommissioning)?
- Which stakeholders might help enhance the project design?
- Who strongly supports or opposes the changes that the project will bring?
- Who is critical to engage with first and why?
- What is the optimal sequence of engagement?

6.4.1. Categories of identified stakeholders

6.4.1.1. The local community in the Project's AOI

The community in the Project's Area of Influence i.e., Ngababa village, Kibiku, are expected to be the direct recipients of any accruing impacts from the proposed project. The communities are mainly comprised of area residents in homesteads surrounding the project site or small business owners along the access road leading to the site.

6.4.1.2. National Government

The national government stakeholders identified include:

- Ministry of Transport, Infrastructure, Housing and Urban Development;
- Ministry of Interior and Coordination of National Government represented by the Kiambu County Commissioner, Deputy County Commissioner for Kabete Sub-County, Assistant County Commissioner Gathiga, and the Chief and Assistant Chiefs in Gathiga Location.

6.4.1.3. The County Government of Kiambu

The particular department of the County Government of Kiambu identified is the Department of Land, Housing, Physical Planning & Urban Development

6.4.1.4. Regulatory bodies

Other government agencies interested in the proposed development include:

- National Construction Authority (NCA) and
- Water Resources Authority (WRA)

6.5. Stakeholder engagement

6.5.1. Questionnaire's administration

To ensure a formal record of community views, concerns and/or recommendations regarding the proposed Project, a structured questionnaire was administered to a representative sample of the population in the project area. A total of 56 questionnaires were randomly administered to households in the project area. The filled-out questionnaires are included in **Appendix B** of this Report.

As part of involvement of the local community in project activities, local qualified data collection assistants were engaged for the questionnaire administration exercise.

6.5.1.1. Findings from the questionnaire administration

The questionnaire sought to obtain views from respondents on various environmental and social aspects likely to be impacted by project activities during construction and operation. After a brief presentation on the proposed project, the respondents invited to express their views. Summaries are made under the following themes:

6.5.1.1.1. Traffic impact

From analysis of the responses, majority (60%) of the respondents were of the view that traffic management would be necessary during construction, while 22% did not perceive traffic increase as an issue of concern. Other observations were that the access road to the site was narrow for the anticipated traffic.

6.5.1.1.2. Water resources

On potential impacts of the development on local water resources, 25% of the respondents did not perceive any adverse impacts, with an additional 18% noting that the locality had enough water sources to accommodate the development. Another 25% cautioned that the developer's activities should be such as not to adversely impact on the local water sources pointing out that local people are dependent on shallow wells as their main sources of water. A number of respondents (21%) proposed that the developer supplies the local community with water if a borehole is drilled. Others (11%) opined that the developer should properly manage waste water and sewage from the development to avoid pollution of existing water resources.

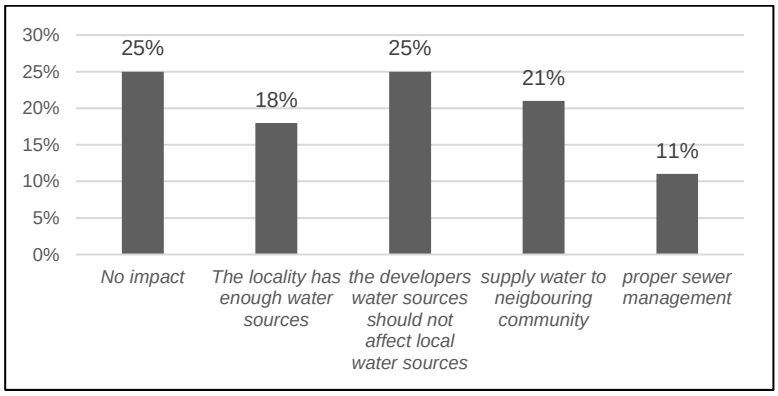

Figure 6-1 Community views on impacts on water resources

6.5.1.1.3. Air quality

On impacts of the development on local air quality, 64% proposed that the developer puts in place measures to mitigate air pollution from dust and exhaust fumes, and establish measures to manage wastes. 32% of the respondents perceived that the development would not have any adverse impacts on local air quality.

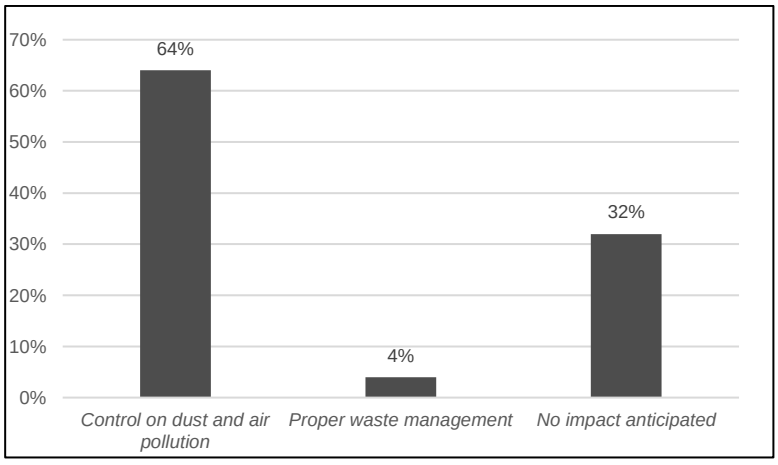

Figure 6-2 Community views on impacts on local air quality

6.5.1.1.4. Land quality/characteristics, aesthetics

On impacts of the development on land quality and characteristics, most respondents (71%) believe that the development will not lead to degradation of the surrounding land, but rather to an appreciation in economic and aesthetic value. Some however, were of the view that there will be loss of vegetation, and conversion of surrounding land from agricultural to commercial use.

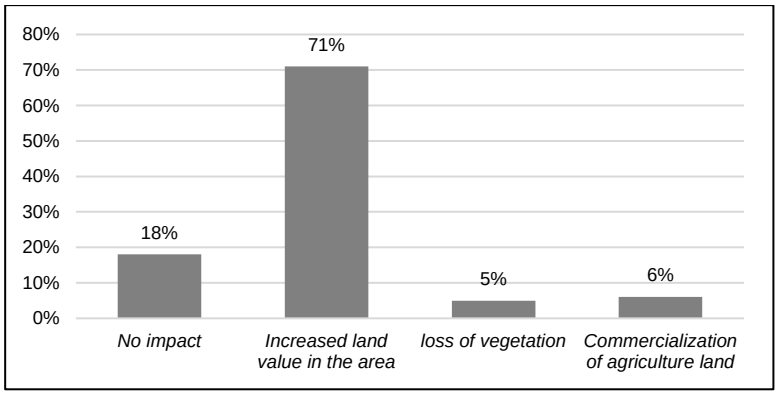

Figure 6-3 Community views on impacts on land quality and aesthetics

6.5.1.1.5. Socio-economic impacts

The survey established that 32% of the respondents anticipate growth in business opportunities in the area due to an increase in resident population, while others anticipate the creation of employment opportunities in construction work. Some respondents also foresee an increase in insecurity also due to the increase in population.

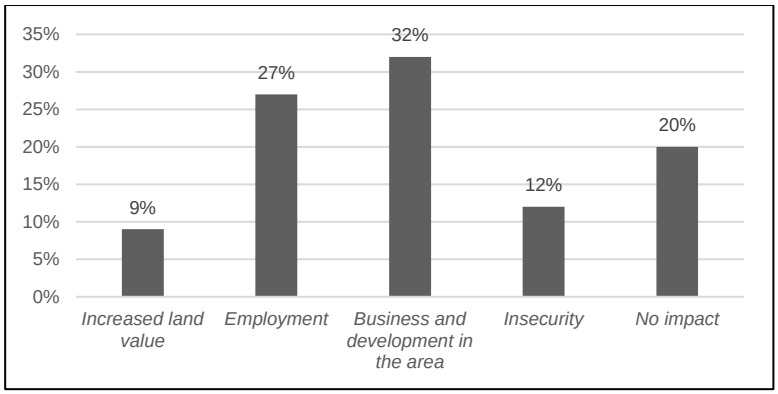

Figure 6-4 Community views on impacts on socioeconomics of the project area

6.5.1.1.6. Noise

Majority (62%) of the respondents opine that construction activities will generate noise and vibrations, and there will be need to implement noise controls. A smaller number (38%) do not expect any significant noise nuisance from construction works.

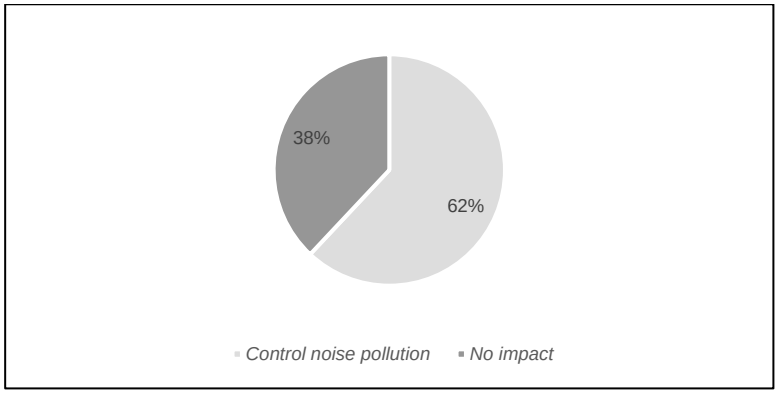

Figure 6-5 Community views on noise impacts

6.5.1.1.7. Flora/fauna

Majority (77%) of the respondents opine that the Project Proponent should enhance vegetation cover at the site and protect the existing vegetation as much as possible. The other 23% of the respondents do not anticipate any significant adverse impacts on the local flora and fauna

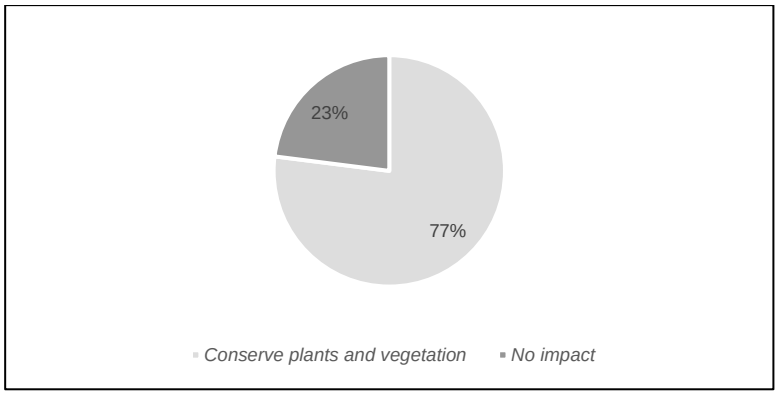

Figure 6-6 Community views on impacts on flora and fauna

6.5.1.1.8. Health and safety

The survey established that 71% of respondents were concerned about potential impacts on occupational and community health and safety resulting from hazards at the construction site and surroundings. Their recommendations included cordoning of the construction site, employment of a health and safety officer at the site, and management of construction vehicle movements.

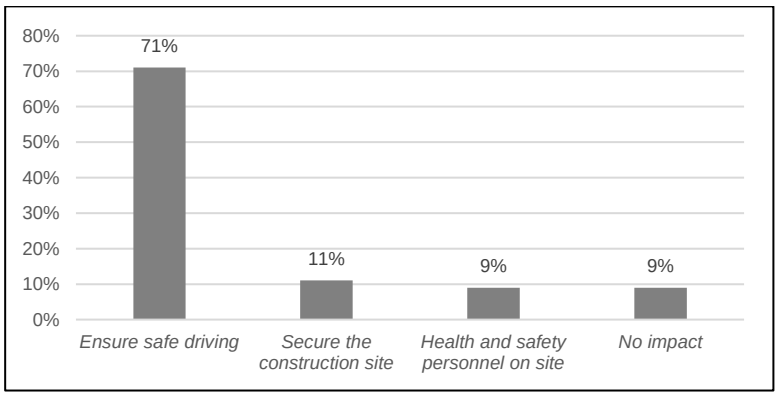

Figure 6-7 Community views on impacts on health and safety

6.5.1.1.9. Other Comments/Suggestions Regarding the Proposed Project

There was general consensus among respondents that the proposed project is a good initiative that will bring a positive transformation of the neighborhood.

6.5.2. Community meeting

The organization of a public meeting in the project area was affected by the prevailing government restrictions on public gatherings to contain the spread of the COVID -19 virus. The meeting was only organized after easing of the restrictions, and was limited to participation by a maximum of 50 members of the surrounding community. The local community leadership was used to mobilize the community for the meeting, giving a notice of 7 days prior to holding the meeting on 19th June 2021 at the proposed project site. Communication at the meeting was through languages understood by the local community, and these included English, Swahili and Kikuyu.

The meeting commenced with a presentation on the Project to disclose its components and how the stakeholders may be affected by these. The presentation was then followed by a collection of views, insights and concerns from the stakeholders. Records of the proceedings were taken through minutes and photographs. Prior to this however, the stakeholders were informed of the purpose for keeping of records and their consent sought to ensure that they are done in a culturally acceptable manner. Minutes of the meeting are included in **Appendix B** of this Report.

Participation by both genders was considered and encouraged during the consultations to ensure that women's as well as men's rights are given attention in as far as the project is concerned.

Figure 6-8 ESIA community meeting at the project site

The following were the key points from the community meeting:

- There is need to ensure wastewater generated by the development does not contaminate local groundwater resources;
- There is need to ensure that the onsite borehole does not affect the productivity of neighboring wells;
- There is need to ensure that noise and dust nuisance from the construction site is adequately managed;
- There is need to ensure that excavation at the site does not cause collapse and damages on the neighboring premises; and
- There is need to prioritize the employment of area residents in sourcing construction labor

6.5.3. Engagement with the County Government and Regulatory bodies

Engagement with the County Government begun at an early stage of project development during the application for a change of user from agricultural to multi-dwelling residential units (flats). An approval was granted with conditions to be met by the developer. A copy of the approval is included in **Appendix C** of this Report. The proponent also submitted architectural drawings of the proposed development to the County Government for approval and was awaiting approvals.

Engagement with the National Construction Authority and Water Resources Authority will be carried out in the application for the necessary registration of the proposed construction works, and in the application for drilling and water abstraction permits.

6.5.4. Summary of the stakeholder engagement

Stakeholder engagement for the Zima Homes Affordable Housing Development established that the community has a positive outlook towards the project. The community views it as one that will catalyze growth of the neighborhood by attracting other similar developments and cause an increase in land value. They also foresee

creation of employment and business opportunities from construction activities and occupation of the houses. The concerns raised were mainly related to construction activities that have potential to cause nuisance and create health and safety impacts. These comprise activities that generate noise, dust and cause obstruction or traffic snarl-up along the access road. Other concerns related to occupation of the houses were on groundwater abstraction from the onsite borehole and wastewater disposal through the septic tank and soak pit, both of which have potential to affect groundwater resources.

Elaboration was done to enlighten the community on proposed measures to manage the potential adverse impacts during construction and operation phases of the project. The elaboration was satisfactory to the community, yielding their wholesome support of the project.

7. Prediction and evaluation of environmental and social impacts

This section outlines the methodology used to assess impact significance. For the purpose of the study, an impact was defined as any change to the environment, whether adverse or beneficial, wholly or partially resulting from project-related activities or products and which can interact with the environment.

An impact was defined where an interaction occurred between a project activity and an environmental receptor. The ESIA process ranked impacts according to their significance determined by considering project activity **event magnitude** and **receptor sensitivity**.

Determination of event magnitude entailed the identification and quantification (as far as practical) of the sources of potential environmental and socio-economic effects from routine and non-routine project activities.

The approach to evaluating the significance of potential environmental and socio-economic impacts is outlined below.

7.1.1. Environmental impacts

7.1.1.1. Method for determining event magnitude

Event magnitude was determined based on the following parameters, which were equally weighted and assigned a rating of 1, 2, or 3

7.1.1.1.1. Extent/Scale

Events range from those where the effect extends across an area:

1 – Near to the source (in the range of tens to hundreds of metres);

2 – At intermediate distance from the source (in the range of hundreds to thousands of metres); and

3 – At far distance from the source (in the range thousands of metres and above).

7.1.1.1.2. Frequency

Events range from those occurring:

1 – Once or twice; to

2 - Repeatedly but intermittently; to

3 – Frequently and persistently.

7.1.1.1.3. Duration

Events range from those where effects occur over:

1 – Instantaneous/short term (hours to days); to

2 - Medium term (between a week and 3 months); to

3 - Long term (more than 3 months to permanent).

7.1.1.1.4. Intensity

Defined as the concentration of an emission or discharge with respect to standards of acceptability that include applicable legislation and international guidance, its toxicity or potential for bioaccumulation, and its likely persistence in the environment; and degree/permanence of disturbance or physical impact (e.g. disturbance to species, loss of habitat or damage to cultural heritage).

Intensity ranges from:

1 - A low intensity event; to

2 - A moderate intensity event; to

3 - A high intensity event

Overall, event magnitude will be scored from low (1) to high (12) by adding the individual parameter scores:

Resulting individual ratings were summed to give the overall event magnitude ranking. The Table below presents the score ranges for magnitude rankings of Low, Medium and High.

Table 7-1: Event Magnitude Rankings

Event Magnitude	Score (Summed Parameter Rankings)
Low	1 - 4
Medium	5 - 8
High	9 - 12

7.1.1.2. Method for determining receptor sensitivity

Receptor sensitivity considered the type of receptor (namely, biological/ecological, human and physical receptor/feature); and was determined based on the following parameters, which are equally weighted and are each assigned a rating of 1, 2, or 3:

7.1.1.2.1. Biological/Ecological Receptors

Presence ranges from:

3 – Internationally threatened species/protected area within the area impacted by the project activities during period of high sensitivity (e.g. during breeding, spawning or nesting) and during routine or reliably predictable peak presence; to

2 - Internationally threatened species/protected area within the area impacted by the project activities outside of period of high sensitivity or during routine or reliably predictable peak presence.

Internationally near threatened species within the area impacted by the project activities during period of high sensitivity and/or during routine or reliably predictable peak presence.

Nationally protected species and/or species which are of importance to the local and regional ecosystem within the area impacted by the project activities.

1 - Presence of species which is none of the above.

Resilience (to the identified stressor) ranges from:

3 - Species and/or population which has little or no capacity to absorb or adapt to change (i.e. little or no capacity to move away from or adapt to the project impact), leading to potential for substantial change of character and/or loss of ecological functionality.

2 - Species and/or population which has moderate capacity to absorb or adapt to change (i.e. has capacity to move away from or adapt to the project impact), leading to potential temporary but sustainable effect which does not substantially alter character or result in significant loss of ecological functionality.

1 - Species and/or population has high capacity to absorb or adapt to change (i.e. has capacity to move away from or adapt to the project impact) and is potentially unaffected or marginally affected.

7.1.1.2.2. Human Receptors

Presence ranges from:

3 - People being permanently present (e.g. residential property) in the geographical area of anticipated impact; to

2 - People being present some of the time (e.g. commercial property); to

1 - People being uncommon in the geographical area of anticipated impact.

Resilience (to the identified stressor) ranges from:

3 - Most vulnerable groups (i.e. ambient conditions such as air quality are at or above adopted standards); to

2 - People being vulnerable to change or disturbance (i.e. ambient conditions such as air quality are below adopted standards); to

1 - People being least vulnerable to change or disturbance (i.e. ambient conditions such as air quality are well below applicable legislation and international guidance)

7.1.1.2.3. Physical Receptors/Features:

Presence (to the identified stressor) ranges from:

3 - Presence of feature which has, in reverse order, national or international value (e.g. state protected monument); to

2 – Feature with local or regional value and is *sensitive* to disturbance; to

1 - Feature which is none of the above.

Resilience (to the identified stressor) ranges from:

3 – Highly vulnerable (i.e. potential for substantial damage or loss of physical integrity);

2 – Undergoes moderate but sustainable change which stabilizes under constant presence of impact source, with physical integrity maintained; and

1 – Feature/receptor is unaffected or marginally affected (i.e. resilient to change);

Overall, receptor sensitivity was then scored on a scale from low (1) to high (6) by adding the individual parameter scores:

The Table below presents the score ranges for sensitivity rankings of Low, Medium and High

Table 7-2: Receptor sensitivity ranking

Receptor Sensitivity	Score (Summed Parameter Rankings)
Low	1 - 2
Medium	3 - 4
High	5 - 6

7.1.2. Socio-economic impacts

The socio-economic impact assessment used a semi-qualitative assessment approach to describe and evaluate potential impacts based on the event magnitude and receptor sensitivity rankings set out in the tables above. Indirect socio-economic impacts (i.e. induced effects) were also assessed using a similar approach.

Table 7-3: Event Magnitude Rankings

Magnitude	Criteria
Low	Changes in social, economic or cultural dynamics with slight and temporary effect on any given sector performance and/ or population wellbeing. These impacts are unlikely to result in concerns being raised by governmental bodies or stakeholders. Events may include: • Minor disruption to livelihoods or living conditions resulting in a localized, reversible and temporary nuisance; • Temporary disruption to businesses that does not result in a loss of revenue or any reputational damage; • No change in the health status of local communities; and • Temporary disruption to public infrastructure (such as a road closure) that results in minor inconveniences to affected communities.
Medium	Changes in social, economic or cultural dynamics with moderate and noticeable adverse effect on any given sector performance and/or population wellbeing. Such impact may result in concerns being raised by governmental bodies or stakeholders. Events may include: • Negative change in livelihood status, household assets/income or living conditions; • Temporary disruption to businesses resulting in a small drop in business revenue; • Increased risk to public health that can be controlled using detailed mitigation measures; and • Disruption to public infrastructure (such as a road closure, or failure of a sewer) that results in an inconvenience to other users.
High	Changes in social, economic or cultural dynamics with major adverse effect on any given sector performance and/or population wellbeing. Such impacts may result in immediate intervention by governmental bodies and stakeholders. Events may include: • Negative change in livelihood status, household income/assets or living conditions affecting a high proportion of people resulting in economic loss and protests against the project;

Magnitude	Criteria
	• Reputational damage and/or drop in business revenue that threatens the future viability of the economic activity; • Increased risk to public health leading to a fatality or injury to a member of a community; and • Damage to public infrastructure (such as a sewer, regional water pipeline, etc.) leading to environmental or socio-economic impacts to other users.

Table 7-4: Receptor sensitivity ranking

Sensitivity	Criteria
Low	Receptor sensitivity is considered low when there is a moderate to high capacity and means to adapt to a given change and maintain / improve quality of life. Receptors of low sensitivity may include: • Individuals who are able to quickly adapt to temporary disruption in their living conditions, livelihood status or a change in the status of public infrastructure (such as a road closure); and • Businesses with a robust economic model that are able to adapt easily to any restrictions placed upon their activities, or who are able to gain economically from such changes.
Medium	Receptor sensitivity is considered medium when there is limited capacity and means to adapt to a given change and maintain / improve quality of life. Receptors of medium sensitivity may include: • Individuals who rely heavily on their livelihood to maintain their socio-economic status and have a limited ability to adapt to change; and • Businesses that have a limited ability to adapt to change and are *sensitive* to any reduction in economic revenue or reputation.
High	Receptor sensitivity is considered high in the case of vulnerable receptors, who have little capacity and means to adapt to a given change and maintain / improve quality of life (e.g. homeless people, Internally Displaced Persons community in temporary accommodation, people with low access to recourse (e.g. no land titles), people with no or low representation (e.g. migrants, seasonal herders with no permanent assets in the area). Receptors of high sensitivity may include: • Individuals with a marginal livelihood, low socio-economic income or poor-quality living conditions; • Individuals who are vulnerable due to their age, disability or other reason and who may require special assistance during engagement activities; and • Businesses with a marginal economic existence which are not able to easily adapt to change.

7.1.3. Environmental and socioeconomic impact significance

For both environmental and socioeconomic impacts, **impact significance**, as a function of **event magnitude** and **receptor sensitivity**, was ranked as **Negligible**, **Minor**, **Moderate** or **Major** as presented in the table below.

Table 7-5: Impact significance

		Receptor Sensitivity		
		Low	**Medium**	**High**
Event Magnitude	**Low**	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	High	Moderate	Major	Major

Any impact classified as **Major** is considered to be significant and, where the impact is negative, requires additional mitigation. Impacts classified as **Moderate** also require formulation of mitigation measures to eliminate or reduce to negligible or minor significance. Impacts classified as of **Negligible** or **Minor** significance are considered as being acceptable and may not require further mitigation.

8. Potential impacts and mitigation measures

This Chapter identifies and discusses both positive and negative impacts associated with the proposed housing Project, and mitigation measures for the adverse impacts. Where relevant, anticipated impacts are discussed in phases namely: design, construction, operational and decommissioning Phases.

8.1. Socioeconomic impacts

8.1.1. Design and construction phase impacts

The different phases of project design, construction, and occupation have a direct impact on the gross domestic product (GDP) of the country when the housing economic value chain is considered. Diverse jobs and business opportunities will be created both directly in design, construction, supply of construction materials and other goods and services, and indirectly along the value chains. This will also increase the circulation of money in the economy.

Design and construction activities will require the direct employment of staff, both professional and casual. These include architect(s), engineers, technicians, masons, and specific equipment operators, among others. Indirect employment opportunities will also be created off-site where construction materials are sourced, or in procurement of non-core services by the professional staff. Various case studies have shown that the housing multiplier effect creates jobs for every house or housing unit constructed. Each housing unit could create up to 8 direct and indirect jobs. The premise is that every unit spent on housing will generate a multiple amount of benefit for the economy, as it creates jobs through horizontal and vertical supply chains. This includes jobs in areas such as raw material production, mining, cement production, timber, and aggregates. In addition, there is also an impact on local economies where the construction jobs are created, and in the service industries linked to housing, such a mortgage lending, real estate agents, and retailers of home goods such as furniture or white goods.

The purchase of construction materials from suppliers, payment for professional services for the consultants involved, and purchase of consumables will all result in increased revenue for suppliers and other vendors, and tax remitted to the exchequer.

8.1.2. Operation phase impacts

Kenya experiences a significant affordable housing deficit especially in urban areas due to rapid population growth and high rural-urban migration. The proposed development is less than 20Km from Nairobi City Centre, and is also proximal to other satellite towns in the Nairobi Metropolitan Region. Apart from reducing the housing deficit, the prime location of the development will be a key consideration for both property buyers and tenants.

Occupation of the houses will also create new demand for various types of goods and services from an increase in the resident population.

8.2. Visual and landscape impacts

8.2.1. Construction phase impacts

Site clearance, earthworks and construction of the housing project will lead to loss of vegetation, mainly trees and grass cover at the site, disturbance and potential loss of topsoil during excavation works. Deposition or dumping of construction waste or unsightly stockpiles of any material on the premises are also likely to cause an eyesore, loss of serenity and aesthetic value.

The construction site will be visible to a large number of people due to its elevation and proximity to an important road, and the visual intrusion caused by the site and activities may be of some adverse impacts to humans in the project area. The effect is insignificant when compared to the visual disturbance and landscape alteration caused by the ongoing road construction works a short distance away from the site.

Some measures can however be applied to reduce the visual nuisance and adverse impacts on the landscape caused by construction activities:

- Construction works should be carried out in such a manner that will not hinder drainage, or introduce physical changes that are not in harmony with the physical setting of the Project area. The structures to be developed should be aesthetically acceptable to blend in with the surrounding;

- The Proponent should as much as possible complete the works in such a way that natural aesthetics are retained at the site. Re-vegetation should be undertaken to restore the disturbed grounds; and
- Landscaping activities should include planting of indigenous trees and shrubs around the houses, and other open areas

8.2.2. Operation phase impacts

The high-rise buildings will be a permanent feature visible from afar, and the visual appeal of the neighborhood is likely to be lowered by these and other development projects in the area. Project designs include external finishes that enhance the visual appeal of the buildings. Ornamental vegetation will also be planted and maintained in open areas to compensate for the loss during construction.

8.3. Impacts on ambient noise and vibrations levels

Considering that the project site is next to a busy road, the baseline ambient noise levels are relatively high due to road noise and other vehicular noise. Activities at the site during construction and occupation may contribute to the noise levels and impacts in the project area.

The significance of noise impacts depends on whether the Project will increase noise levels above the existing ambient levels by introducing new sources of noise. Noise impacts are considered significant if the Project results in:

- Exposure of persons to, or generation of, noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;
- Exposure of persons to, or generation of, excessive ground-borne vibration or ground-borne noise levels;
- A substantial permanent increase in ambient noise levels (more than 3 dB) in the project vicinity above levels existing before the project; and
- A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing before the project.

8.3.1. Construction phase impacts

Demolition of the existing building, site clearance and construction works – excavations, delivery of materials, carting away of spoil and the use of machinery/equipment will contribute to elevated levels of noise and vibrations within the construction site and the immediate surroundings. The increase in traffic movements along the access road may cause a noticeable increase in daytime noise levels through the settled area. The higher noise and vibrations levels may be of some nuisance to the immediate neighboring public to the construction site.

The noise impact will be localized and temporary, and will, for the most part, be restricted to the construction phase of the project. In addition, due to the nature of the construction process, noise levels will fluctuate in line with operating periods and the combination of machinery being used at any one time.

Local residents may not, therefore, be continually exposed to elevated noise levels for extended periods.

Table 8-1: Vibrations and noise nuisance

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	1	6	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
3	1	4	Medium	Moderate

8.3.1.1. Noise management

The following noise-suppression techniques should be employed to minimize the impact of temporary construction noise at the project site.

- Portable hoods should be installed to shield compressors and other small stationary equipment where necessary;
- Pumps, generators and other mobile equipment should be sited as far as practicable from noise sensitive locations;
- The contractor should endeavor to use equipment installed with noise abatement devices as much as practicable;
- Idling time on trucks and other noisy equipment should be limited to a minimum. Drivers should be encouraged to turn off vehicle engines when not in use, avoid unnecessary hooting or revving of engines;
- Personal protective equipment such as noise-cancelling earmuffs should be provided to workers at the site as necessary; and

- Construction work should be carried out during the day only. No works should be carried out on Sunday

Noise monitoring is also proposed especially at noise-sensitive receptor locations (such as homesteads) proximal to the construction site and the access road.

8.3.2. Operation phase impacts

Noise and vibrations are not expected to increase considerably during project operation. The expected noise will be mainly from humans residing in a cluster of houses, and the significance of the noise impact during operations is deemed to be Minor.

8.4. Impacts on local air quality

8.4.1. Construction phase impacts

Construction activities are likely to generate air pollutants which have potential to adversely affect the local air quality, and thereby affect human and vegetation health. The activities include:

8.4.1.1. Dust generation

Demolition works and construction activities such as site clearance and grading, excavations/ earthworks, stockpiling of materials and spoils, and vehicular movements in the project area will generate dust and increase the levels of particulate matter (PM) in the atmosphere. Dust and sand particles are also likely to be blown from the upper floors of the buildings onto surrounding premises as construction progresses above the ground level.

Once airborne, dust will generally travel downwind before resettling. The distance travelled depends primarily on wind speed and particle size. For example, smaller particles and strong winds result in greater dilution effects but mean that the dust is deposited over a larger area.

8.4.1.2. Exhaust emissions

Construction vehicles and machinery are likely to emit oxides of carbon, nitrogen, and sulphur, and depending on the level of maintenance performed on the vehicles and machinery, the emissions may be significant, causing a deterioration of the local air quality.

8.4.1.3. Burning of waste

Disposal of waste (vegetation and other combustible materials) by burning will also cause local air pollution in the emission of gases and particulate matter. There is the additional risk of spread of fire to unintended areas with potential to cause damage/destruction of property and vegetation.

The potential impacts are nuisance and adverse health effects such as respiratory problems on workers and people in the surrounding area, coverage of crops (possibly leading to reduced yields) and deposition on natural vegetation especially during the dry season.

Table 8-2: Nuisance and health effects on humans

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	1	6	Medium
Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking		Impact Significance
Presence	Resilience				
2	2	4	Medium		Moderate

Table 8-3 Adverse impacts on natural vegetation

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	1	6	Medium
Biological Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking		Impact Significance
Presence	Resilience				
1	3	4	Medium		Moderate

8.4.1.4. Air quality management

In order to control point source and fugitive emissions that may occur during construction of the project, the following measures should be implemented:

- Installation and maintenance of dust screens on the buildings as construction progresses above the ground level;
- Maintenance of equipment and machinery to manufacturers' specifications by regular servicing to maintain efficiency in combustion and reduce carbon emissions;
- Use environmentally friendly fuels such as low sulphur diesel;
- Minimize idling of machinery;
- Ensure no burning of waste at the site and non-designated areas;
- Regular sprinkling of disturbed ground and dusty access roads;
- Control of construction vehicle speeds by imposition and enforcement of speed limits especially along access roads;
- Rehabilitation of disturbed areas once completed;
- Use of tarpaulins to cover trucks carting away spoil using public roads. Additionally, the trucks should maintain at least two feet of freeboard;
- Proper planning of transportation of spoil to ensure that the number of trips and/or the number of vehicles used is minimized; and
- Provision of appropriate Personnel Protective Equipment (PPE) such as dust masks to site workers.

8.4.2. Operation phase impacts

Occupation of the houses is unlikely to have any significant impact on the local air quality. Depending on the finish level of the access road, dust may be generated by vehicle movements along the road. Additionally, if the maintenance level on the development's sewage collection and disposal system is poor, there may also be nuisance from foul odor.

Development and maintenance of the access road is the responsibility of KeNHA, and there are plans to pave the road as part of the works for dualling of the Gitaru Road. Maintenance schedules will also be developed and implemented for the project's sewer system.

The impacts are thus expected to be Negligible or Minor.

8.5. Impacts on water resources

8.5.1. Construction phase impacts

8.5.1.1. Increased demand for water

During the construction phase of the proposed Project, both the construction workers and the construction works will increase the demand for potable water. The water will be required in mortar and concrete works, for drinking and cleaning purposes, and for dampening of dusty areas. The water demand is expected to be met from the site borehole and/or water vendors. Since the existing demand on local ground and surface water resources in the area is relatively low, water use conflicts with the surrounding community are unlikely, and the effects of the increased demand are perceived to be Minor

Table 8-4 Increased water demand

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	2	2	1	7	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
1	1	2	Low	Minor

8.5.1.2. Degradation of water quality

8.5.1.2.1. Spillage of contaminants

Various risks to water quality could arise from sources of pollution during construction including spillage of fuels, lubricants and other toxic materials at the construction site, discharge of silt laden runoff from the site, and the inadequate treatment and disposal of waste and wastewater from the site.

Materials such as oil, diesel fuel, concrete additives, and solvents are likely to be stored and used at the construction site and in construction vehicles and equipment. Storage and handling of these materials could lead to spills or leakages which could pollute the underlying soil, and ground water resources. Contaminated runoff from the site could enter into local stormwater drainage systems and eventually into receiving watercourses.

The extent of impact would depend on the size, frequency and timing of spills in relation to flow conditions in the receiving waters and the nature of the materials involved including their toxicity and likelihood for bio-magnification or bio-accumulation.

Table 8-5 Contamination of water resources by spillages

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	1	1	1	5	Medium
Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking		Impact Significance
Presence	Resilience				
2	2	4	Medium		Moderate

The risk of water pollution from these sources can be reduced by adopting protective measures to prevent spills and establishing suitable spill response plans to be implemented in the event of accidents occurring.

Suitable measures to collect, treat and dispose of chemical wastes will also be required. With good construction site practices, the risk of water pollution from spills and waste could be downgraded to Minor.

8.5.1.2.2. Direct discharge of waste into the environment

Construction activities will generate liquid wastes such as concrete wash water and/or other wastewater which if not appropriately managed, could result in direct flows into the neighboring stream where it would have negative effects on local water quality (including reduction in dissolved oxygen levels, nutrient loading causing increased algal growth, and the spread of pathogenic disease vectors) and cause the loss of aquatic organisms.

With adequate provision for on-site waste and wastewater management during construction, the extent of impact is judged as Moderate, and will depend on the location of discharge points and the dilution potential of receiving waters.

Table 8-6 Contamination of water resources by direct discharges

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	2	1	2	7	Medium
Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking		Impact Significance
Presence	Resilience				
2	2	4	Medium		Moderate

8.5.1.3. Management of construction phase impacts

- The Contractor should ensure that water is used efficiently at the site by sensitizing construction staff to avoid extravagant water use and wastage. He should also monitor water consumption and maintain records;
- Wherever possible, harvest storm water to complement other sources of water;
- Recycle and reuse construction wastewater wherever possible and where this does not compromise the quality of construction works;
- Develop and implement a site construction waste and wastewater management plan to minimize environmental damage from construction activities. This should include the delivery of regularly updated training to construction workers in the safe and proper storage, handling, use, clean- up, and disposal of oils, fuels and other chemicals and the putting in place of a comprehensive spill response plan including equipment and training;
- Install secondary containment measures in areas where fuels, oils, lubricants etc. are stored and loaded or unloaded, including filling points;
- Construct a concrete washout pit to contain wash water and enable consolidation of solids for easier disposal. The consolidated solids can then be recycled or used as fill material;
- Implement soil erosion control measures and install and regularly empty sediment traps in surface drains around construction areas;
- Minimize soil disturbance and excavation during wet season;

8.5.2. Operation phase impacts

Occupation of the residential houses will lead to increased water demand for consumption, cleaning, and flushing of toilets. The main source of water for the proposed development will be an on-site borehole. Over abstraction of ground water from the well could lead to a lowering of the water table and affect the yield in other neighboring wells. The impact is perceived to be Moderate if water resource conservation measures are implemented in the development.

Table 8-7 Diminishing of groundwater resources from over abstraction

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	2	2	2	8	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
2	2	4	Medium	Moderate

The development will generate significant volumes of sewage which will be disposed through a septic tank with a soak pit at the site. Wastewater discharged into the soak pit could contaminate neighboring shallow wells if biological treatment of the waste within the tank is inadequate. With implementation of groundwater protection measures, the significance of the impact will be Moderate.

Table 8-8 Contamination of groundwater by effluent from the septic tank

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	3	3	1	8	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
2	2	4	Medium	Moderate

8.5.2.1. Water resource management

- Institute measures to ensure conservative use of water in the development such as:
  - Monitoring of water resource use at the premises through water meters installed in the houses;
  - Rain water harvesting from roof catchments for indoor and outdoor water requirements; and
  - Installation of low volume fixtures and fittings such as taps, and cisterns in the houses
- Implement measures to prevent contamination of ground water by:
  - Ensuring that the septic tank is adequately sized to increase detention time of the wastewater and allow biodegradation of the waste
  - If necessary, supplementing the microbial community in the septic tank with available septic tank treatment products to reactivate and maintain the system
  - Installing Fats Oils and Grease (FOG) traps on the waste water collection system to remove FOG that could reduce the efficiency and effectiveness of the microbes in the septic tank

8.6. Impacts on soil resources

8.6.1. Construction phase impacts

Project construction will involve earthworks and excavation specially to achieve the desired levels for the apartment blocks, underground water storage facilities, and profile for the driveway. This will result in the generation of spoil materials requiring disposal. Offsite disposal of the soil will lead to loss of the fertile topsoil and depletion of local soil resources.

Construction activities at the site may lead to soil sealing especially when heavy construction machinery and trucks compact the surface soil. Soil compaction and sealing may lead to increased surface runoff and soil erosion from the site.

Any spillage of hazardous materials on site is likely to cause soil contamination and/or eventual Surface /groundwater contamination. The hazardous materials include oils, fuel, grease, paints, solvents, curing compounds, adhesives, acids, soil stabilizers and binders etc. These materials require careful handling and storage to prevent spillage.

Vehicle, plant and machinery maintenance on site can also lead to soil pollution in the event of spillage of hydrocarbons (such as oil and fuel).

Table 8-9 Soil loss resulting from erosion and carting to spoil

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	1	3	2	7	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
1	3	3	Medium	Moderate

Table 8-10 Soil contamination from pollution incidences

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	2	1	6	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
1	3	3	Medium	Moderate

8.6.1.1. Soil resources management

To prevent soil erosion, re-vegetation of disturbed areas should be done as soon as possible. Vehicles should use predetermined tracks at the site to reduce ground compaction;

Vehicle and equipment maintenance activities should be done as much as possible away from the site while a designated area away from drainage courses should be identified to carry out necessary repair or maintenance activities. Drip pans and absorbent materials should be availed at these designated areas to manage spillages;

The Contractor should review spill response requirements at all applicable work sites and train workers on spill prevention and clean-up. Clean-up requirements should include: Immediate clean-up of leaks and spills; use of absorbent materials for large spills; avoidance of hosing down or burying dry material spills; and proper disposal of materials used to clean up hazardous materials

8.6.2. Operation phase impacts

Once the project is in operation, impacts on soil resources are likely to occur if stormwater management plans are inadequate such that stormwater discharge from the premises causes soil erosion on neighboring low-lying areas. Project designs however include a site stormwater drainage system which will connect to the main road's drainage system. The risk of soil erosion will thus be Negligible.

8.7. Impacts on local biodiversity

A portion of the proposed site is developed with a block of residential units, while the other portion is either under crop cover, grass or shrubbery. Natural vegetation has been heavily modified by human activities. The few trees and shrubbery found on the plot are utilized by various passerine birds' species as resting and foraging sites, while rodents may also inhabit suitable surface and subsurface environments at the site.

8.7.1. Construction phase impacts

Construction works will remove existing vegetation utilized by birds as forage grounds, and habitat for rodents. The vegetation cover is however minimal and its removal is unlikely to have any significant impacts on local biodiversity. The birds and rodents will move on to other suitable sites in the neighborhood.

Table 8-11 Loss of local biodiversity

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	1	3	1	6	Medium

Biological Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
1	1	2	Low	Minor

8.7.1.1. Management of biodiversity

Clearance of part of the vegetation at the site will be inevitable. However, some remedial measures that can be implemented include:

- Re-vegetation of open areas;
- Prioritization of the planting of indigenous trees and shrubs -, although various species of exotic trees and shrubs could also be planted
- Preservation of an existing mature Avocado tree on the site.

8.7.2. Operation phase impacts

Occupation of the houses is unlikely to have any additional adverse impacts on local biodiversity. Maintenance of planted ornamental vegetation on open areas may however attract some birds species.

8.8. Impacts on energy resources

8.8.1. Construction phase impacts

Fossil fuels (mainly diesel) will be used in the running of vehicles and other motors at the construction site. Fossil energy is non-renewable, and its use emits greenhouse gases and other air pollutants.

Construction activities for the project will not require significant volumes of fossil fuels. At the local scale, depletion of the resource is of little significance and is best analyzed/quantified at a national/global scale.

Table 8-12 Depletion of fossil fuel resources

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	1	1	1	4	Low

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
1	2	3	medium	Minor

8.8.1.1. Energy resource management

Despite the low impact on energy resources, it is prudent to institute measures to conserve fossil fuel since these also impact on local air and noise pollution levels. Proposed measures include:

- Minimize idling of machinery;
- Avoid overloading of trucks and machinery; and
- Regularly service vehicles, plant and machinery.

8.8.2. Operation phase impacts

Occupation of the houses will lead to an increase in the grid energy demand. This will be due to the wide array of household electronics that are likely to be in use, with the concomitant higher demand for electricity to power these electronics. The area is served by grid energy infrastructure, and the electricity distributor – Kenya Power continually upgrades the infrastructure (transformers, poles and conductors) as the demand grows. Project designs also include technologies to utilize solar energy for lighting, pumping of water and water heating. Other energy conservation measures incorporated in designs include properly sized windows to allow maximum natural light entry. The size of windows also factors the need to maintain a warm internal environment. Energy use will also be monitored during the project lifetime through installation and reading of energy consumption meters.

The impact of the increase in demand is therefore likely to be Negligible or Minor.

8.9. Waste management

8.9.1. Construction phase impacts

Construction activities will generate inert, non-hazardous and hazardous wastes over the construction period. Wastes likely to be generated during construction include spoils (rubble and soil from demolition and excavations), vegetation (felled trees, shrubs, stumps and their root systems) packaging materials used for packing cement, plastics, reject materials including damaged bricks/blocks, and leftovers/excesses, wastewater (concrete washout), and equipment maintenance waste. An active construction site also requires proper sanitation facilities to manage sewage generated by construction workers.

Improper waste management at the construction site will interfere with the aesthetic status of the surrounding while creating health and safety hazards. Improper disposal of the wastes off-site could also cause nuisance, health and safety hazards, and create breeding grounds for vermin.

Table 8-13 Pollution and health & safety hazards from poor management of wastes during construction

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	2	2	2	8	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
3	2	5	High	Major

8.9.1.1. Construction phase waste management

The following measures are proposed to manage wastes generated at the site:

- Contractor should apply caution in demolition activities in order to salvage fixtures and building components as much as possible for reuse elsewhere;
- Construction waste should be recycled or reused as much as possible to ensure that materials that would otherwise be disposed off as waste are diverted for productive uses. In this regard, the Contractor should ensure that construction materials left over at the end of construction are used in other projects rather than their disposal
- Land-fill spoils as much as possible at identified fill areas;
- Felled trees, shrubs and stumps can be isolated for collection by locals as firewood;
- Provide a pit latrine at the site for use by workers. The pit latrine should be backfilled upon project completion;
- Vehicle maintenance should as much as possible be done off-site (at a commercial garage) and wastes (used oil, oily rags, cans and used parts) disposed in a designated area. Where maintenance must be carried out on site, wastes generated should be carted away from site for disposal in a designated area; and
- The Contractor should put in place measures to ensure that construction material requirements are carefully budgeted and to ensure that the amount of construction materials left on site after construction is kept minimal.

Additional measures for minimization of solid waste during construction of the proposed Project could include the use of durable, long-lasting materials that will not need to be replaced often, thereby reducing the amount of construction waste generated over the project lifetime.

8.9.1.1.1. Concrete waste management

Concrete will be used in establishment of foundations, slabs, columns and other elements of the buildings. Equipment and tools that are in contact with concrete and mortar need to be washed after use, and this generates significant volumes of wash water. The following measures are proposed for concrete waste management at the premises:

- The Contractor should avoid mixing of excess concrete if possible, and should discard excess concrete in a designated area away from water courses;
- Washing of concrete coated vehicles or equipment should be done off-site or in a designated wash area a minimum of 50 feet away from drainage channels. The runoff from the on-site concrete wash area should be contained in a temporary pit where the concrete can set; and
- The temporary pit should be lined with plastic or clay to prevent seepage of the wash water into the ground. The wash water should be allowed to evaporate or collected along with all concrete debris in a concrete washout system bin.

8.9.2. Operation phase impacts

The residential houses are expected to generate significant amounts of organic/inorganic solid and effluent wastes. Project designs include a designated area for the collection and temporary storage of solid waste generated by the households, and a septic tank with a soak pit for the collection and disposal of sewage from the development.

Failure of these systems for waste management can cause nuisance, environmental pollution, and create health hazards, and the significance of the potential impacts is perceived to be Major.

Table 8-14 Pollution and health & safety hazards from poor management of wastes during occupation

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	3	2	2	8	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
3	2	5	High	Major

8.9.2.1. Waste management

- The Proponent should procure services of a certified waste management company to ensure appropriate disposal of the generated solid wastes. Wastes generated should be collected and held at the designated temporary storage area near the main gate awaiting collection by the certified waste handler at regular intervals.
- The Proponent should ensure the regular inspection and maintenance of all drainage networks at the premises to prevent malfunction.
- Grease traps should also be installed to remove fats, oil and grease in grey water from kitchens and prevent it from entering the sewer system

8.10. Traffic impacts

8.10.1. Construction phase impacts

Inevitably, the site access road and Gitaru Road will encounter increased traffic due to presence of construction vehicles. These vehicles will include both heavy and light vehicles and equipment travelling in and out of site. Likely impacts of increased construction traffic include; nuisance from obstruction and slow movement of construction vehicles; and increased safety hazards for other motorists and pedestrians.

Table 8-15 Traffic nuisance and hazards during construction

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	3	2	8	Medium
Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking		Impact Significance
Presence	Resilience				
3	1	4	Medium		Moderate

8.10.1.1. Traffic management

In order to reduce adverse impacts of increased vehicular traffic at/around the construction site, the following measures are proposed:

- Develop and implement a Traffic Management Plan (TMP) and principles to ensure safety, prevention of traffic snarl ups and congestion.
- The TMP should minimize the points of conflict between construction traffic and existing traffic to limit the possibility of traffic accidents and disruptions to road users. It should also reduce the number of deliveries where practicable, including staging of deliveries such that the volume of traffic is kept as even as possible avoiding peaks, and control vehicular movements on the project.

Other elements of the TMP should include:

- Planning and managing both vehicles and pedestrian routes;
- The elimination of reversing where possible;
- Safe driving and working practices;
- Protection of the public;
- Adequate vision and lines of sight;
- The provision of signs and barriers; and
- Adequate parking and offloading/storage areas

8.10.2. Operation phase impacts

Occupation of the proposed houses is expected to cause a permanent increase in vehicular traffic on the access road, with the resultant increase in nuisance and safety hazards. In a worst-case scenario, there would be a traffic increase by about 150 vehicles, assuming one car per household. However, the development targets the lower middle-income households – some of whom may not own cars. The actual number of vehicles attributable to the development may thus be significantly lower, and the potential adverse impacts are perceived to be Moderate. The critical times of increased traffic and congestion may be in the morning and evenings when the populace is headed out or returning home.

Table 8-16 Traffic nuisance and hazards during occupation

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	2	3	2	8	Medium
Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking		Impact Significance
Presence	Resilience				
3	1	4	Medium		Moderate

8.10.2.1. Traffic Management

To minimize disruption of traffic flow along the site access road, the main entrance to the development should be recessed and widened to allow waiting for a vehicle before entry/exit from the property

Clear signage should also be installed and maintained to warn drivers on the maximum vehicle speed limit, and other hazards.

8.11. Impacts on health and safety

8.11.1. Construction phase impacts

8.11.1.1. Occupational health and safety

Safety hazards are likely to increase during demolition and construction activities resulting in a possible increase in accidents involving workers and/or the general public. The construction works inevitably expose workers to occupational health and safety risks and injuries resulting from accidental falls, or use of hand tools and construction equipment. Safety hazards are also posed to the public especially pedestrians and motorists passing near the site. Whereas some incidences/accidents can be minor resulting in minor bruises/injuries, others can be serious to fatal resulting in both loss of life and destruction of property. Adequate sanitary facilities (toilets, potable water) are also required at the construction site to prevent the occurrence of hygiene related ailments among construction staff and the general public.

Table 8-17 Exposure of workers to health and safety hazards

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
1	3	2	2	8	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
3	2	5	High	Major

8.11.1.2. Community health, safety and security

Poor construction management practices by the Contractor have potential to cause direct adverse effects on the safety, human health and wellbeing of the surrounding community. Such include inadequate management of air emissions, wastes generated, traffic and other safety hazards posed by construction sites or construction activities, and the poor management of his labor force.

Any incident that harms a person has potential to diminish the quality of life for that person, negatively impacting them or their household livelihood, and potentially creating tension between the local community and project teams.

The overall significance of the impact is judged to be Moderate but this may reduce depending on mitigation and management measures in place, the severity of any accidents and availability of emergency health care to deal with such accidents.

Table 8-18 Nuisance and increased safety hazards to the community

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	2	2	1	7	Medium

Human Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact significance
Presence	Resilience			
2	2	4	Medium	Moderate

8.11.1.3. Occupational health and safety management

The following measures are proposed to enhance occupational health and safety at the construction site:

- To reduce accidents and hazards involving/ posed to workers, the Proponent should commit the Contractor to adherence to site occupational health and safety rules and regulations as stipulated in the Occupational Safety and Health Act, 2007;
- The Contractor should provide all workers on site with the necessary Personal Protective Equipment (PPE), and ensure a safe and healthy environment for the construction workers;
- Workers accidents during construction should be mitigated by enforcing adherence to safety procedures and preparing contingency plans for accident response. In addition, safety education and training should be emphasized;
- The Proponent should require the Contractor to have qualified first aider(s) among the workers and maintain fully stocked first aid equipment at the site; and
- The Contractor should avail to the workers adequate sanitary facilities such as toilets and potable water to maintain high health standards at the construction site

8.11.1.4. Community health and safety management

The following measures are proposed to enhance community health and safety during construction work for the project:

- Implementation of specific management plans on housekeeping, waste, air quality, traffic, health and safety and pollution prevention;
- Informing local communities of major activities in advance;
- Development and implementation of a community grievance redress mechanism;
- Ensuring that the construction site is fenced off to prevent unauthorized access;
- Following best practice to prevent the creation of breeding areas for vermin;
- Spraying construction areas and local roads regularly with water to suppress dust emissions;
- Ensuring that potentially disturbing construction noise is not produced outside of working hours;
- Safety training, traffic management and a high prioritization of public safety by the Contractor
- Developing and enforcing a strict code of conduct for workers to regulate behavior in the local communities;
- Providing awareness training to the workforce regarding the transmission of STDs, and traffic safety awareness;
- Provision of adequate sanitation; and
- Provision of the workforce with access to healthcare.

8.11.2. Operation phase impacts

Potential sources of hazards that can result in adverse impacts during occupation of the houses include stairways, open terraces on top of buildings, electricity and electrical appliances, cook stoves in the houses, etc. Stairways and roof terraces present the danger of trip and falls, while use of electrical appliances and cook stoves presents fire risks. Project designs include provisions for adequately sized and lit stairways with hand rails, parapet walls with railing on the rooftops, and cabinets for firefighting equipment on each floor. These provisions will minimize the occurrence of accidents or mitigate the escalation of incidents such as fire within the households.

8.12. Impacts on other natural resources

8.12.1. Construction phase impacts

Some of the construction materials that will be used include masonry stones, hardcore, ballast, quarry dust, sand, and cement. These raw materials will be obtained from stone quarries, hardware shops and sand harvesters who extract such materials from natural resource banks such as rivers and land. Unsustainable extraction of these resources can cause environmental damage where they are sourced.

Table 8-19 Environmental degradation in extraction of materials

Extent/Scale	Frequency	Duration	Intensity	Score	Event Magnitude
2	2	2	1	7	Medium

Physical Receptors		Receptor Sensitivity	Receptor Sensitivity Ranking	Impact Significance
Presence	Resilience			
1	3	3	Medium	Moderate

8.12.1.1. Raw materials management

- The Contractor should source construction materials such as sand ballast, quarry stones, and hard core from registered and approved quarries and sand mining firms whose projects have undergone satisfactory environmental impact assessment/audit and received NEMA approval. Since such firms are expected to apply acceptable environmental performance standards, the negative impacts of their activities at the extraction sites are considerably well mitigated;
- The Contractor should implement stringent inventory management mechanisms and only order for materials after a fairly accurate estimation of actual construction requirements;
- Where possible, building elements should be manufactured off-site and delivered to site, to maximize benefits of off-site manufacture including minimizing waste, maximizing recycling (because manufacture is in one location), high quality elements, better occupational health and safety management, less noise and dust

8.12.2. Operation phase impacts

Apart from impacts of groundwater exploitation, no other impacts on natural resources are foreseen when the houses are occupied. Impacts of groundwater use are discussed in Section 8.5 of this Report.

8.13. Cumulative impacts

It is important to consider the cumulative effects of placing the development in the particular environment proposed. This assessment considers the cumulative effects that are likely to result from the project in combination with other projects or activities that have been, or will be carried out in the foreseeable future.

Anticipated cumulative effects of the proposed development and other developments in the neighborhood include:

8.13.1. Impacts on the microclimate of the area

An increase in the development density of the neighborhood while eliminating vegetation cover will lead to a change in the microclimate of the area. This may be experienced in form of warmer local temperatures, and higher wind speeds.

To mitigate the above effects, property owners and local authorities could collaborate to ensure that developments maintain a specific level of vegetation cover as a minimum - preferably of trees planted in green spaces and Tree Boxes/Planter Boxes.

8.13.2. Impacts on the surface and ground water regimes

A higher development density in the neighborhood will lead to an increase in paved surfaces, reduced infiltration of storm water, and higher dependance on groundwater for consumption. This will negatively affect ground water recharge and water table levels in the area. The increase in paved surfaces in the general area will lead to an increase in surface runoff generated during rain episodes. Inadequate construction and maintenance of storm water drainage systems in the area my lead to increased incidences of erosion and local flooding.

The above impacts can be mitigated to a certain degree through harvesting and utilization of storm water, and restricting the ground coverage of developments to allow for green spaces within properties. Developments could then be encouraged to incorporate rain gardens and bio-retention areas, vegetated swales and buffers, and permeable pavements to encourage storm water infiltration. Other drainage infrastructure could include infiltration trenches, drywells, seepage pits, and improved sinkholes.

8.13.3. Impacts on traffic

An increase in residential and commercial development density in the neighborhood is likely to increase vehicular and pedestrian traffic in the general area potentially resulting in traffic delays and queues, and increase in accidents involving motor vehicles and pedestrians.

Mitigation of the above impacts will require involvement of the roads' authorities/local government in installation and maintenance of road signage, expansion and maintenance of roads and walkways

8.14. Climate and disaster risk and vulnerability assessment

8.14.1. Background

Kenya has a complex climate that varies significantly between its coastal, interior and highland regions and from season to season, year to year, and decade to decade. This climatic variability is influenced by naturally occurring factors such as movement of the Intertropical Convergence Zone and the El Niño Southern Oscillation (ENSO).,

Observed mean annual temperatures in recent decades have increased by 1.0°C since 1960 (or at a rate of 0.21°C per decade). There are observed changes in rainfall patterns whereby greater rainfall is received during the short rains of October – November – December (OND) while less and unreliable rainfall is received in the period between March-April-May (MAM). There are however no statistically significant national trends toward wetter or drier conditions.

Floods and droughts are the most significant climate extremes that face many regions in Kenya. Major droughts occur about every 10 years, and moderate droughts or floods every three to four years. Historically, these extreme climatic events have caused significant loss of life and adversely affected the national economy. Other climate-related hazards in Kenya include forest fires and landslides, the latter of which mostly affect the highland regions

Global climate change is projected to alter Kenya's mean annual climatic conditions as well as its pattern of climate extremes. Temperatures are expected to continue to rise in all seasons, with models suggesting that warming of about 1° C will occur by the 2020s, and 4° C by 2100. Warming will vary from region to region within Kenya. Greater uncertainty however persists regarding how precipitation patterns might be altered by climate change.

8.14.2. Climate and disaster risk vulnerability of Kiambu County

From the ThinkHazard analysis[12], the disaster risk from hydro-meteorological and geophysical hazards in Kiambu County is summarized as follows:

Table 8-20 Sensitivity analysis for climate and geohazards

Geophysical Hazard	Hazard Level	Explanation
Volcano	High	Kiambu is located less than 50Km from a volcano for which a potentially damaging eruption has been recorded in the past 2,000 years and that future damaging eruptions are possible The aerial distance of the project site to Mt Longonot and Mt Suswa is 42Km and 39Km respectively There are records of lava flow on the northern flank of Mt Longonot during the 19th century. Similarly youthful-looking lava flows also occur on the southwestern flank. The last known eruption was in 1863 The latest eruptions of Mt Suswa have originated from satellitic vents that issued lava flows which remain unvegetated and may be only a century or so old[13].
Wildfire	High	There is greater than a 50% chance of encountering weather that could support a significant wildfire that is likely to result in both life and property loss in any given year. Modelled projections of future climate identify a likely increase in the frequency of fire weather occurrence in this region, including an increase in temperature and greater variance in rainfall
Water Scarcity	Medium	There is up to 20% chance droughts will occur in the coming 10 years. The present hazard level may decrease in the future due to the effects of climate change
Earthquake	Low	There is a 2% chance of potentially-damaging earthquake shaking in the project area in the next 50 years
Landslide	Low	The area has rainfall patterns, terrain slope, geology, soil, land cover and (potentially) earthquakes that make localized landslides an uncommon hazard phenomenon. Climate change is likely to alter slope and bedrock stability through changes in precipitation and/or temperature
River flood	Very low	There is a chance of less than 1% that potentially damaging and life-threatening river floods occur in the coming 10 years (return period of c. 1 in 1000 years). The present hazard level is expected to increase in the future due to the effects of climate change
Urban flood	Very low	There is a chance of less than 1% that potentially damaging and life-threatening river floods occur in the coming 10 years (return period of c. 1 in 1000 years). The present hazard level is expected to increase in the future due to the effects of climate change
Cyclone	Very low	There is less than a 1% chance of potentially-damaging cyclone-strength winds in the project area in the next 10 years
Extreme heat	Very low	There is less than a 5% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years. The temperature increase in the project area in the next fifty years will be slightly lower than the worldwide average, but still significant

Volcano and wildfire are identified as significant hazards facing the project area. These hazards also require development of emergency response and preparedness measures at a national /regional scale since they require early warning systems and wide area evacuation and shelter plans. Planning for these is beyond the scope of this project.

The Project can however plan for scenarios of water scarcity and drought which are identified to be hydrometeorological hazards of medium significance in the project area. Adaptations to water scarcity include provision of water harvesting infrastructure such as gutters, down pipes and an appropriately-sized underground

[12] https://thinkhazard.org/en/report/51333-kenya-central-kiambu/EH

[13] https://volcano.si.edu/volcano.cfm?vn=222110

storage tank; an onsite borehole to exploit ground water, and water conservation technologies in household fixtures (taps, cisterns, shower heads)

Other geophysical and hydrometeorological hazards are considered to be of low/very low significance, and do not require development of adaptation measures for the project

8.15. Impacts during decommissioning phase

The decommissioning process is part of a buildings or other infrastructure disposition. Disposition starts when the development's mission ends, or when other external factors dictate (such as acquisition of the land for expansion of a road) and may include dismantlement and release for reuse, or demolition and environmental restoration. During the decommissioning phase, all buildings, infrastructure and related facilities at the site are dismantled and/or demolished safely and efficiently using appropriate procedures and work controls.

Decommissioning in the case of the proposed project refers to demolition of the buildings and environmental restoration. Demolition poses potential hazards, and also generates wastes which ought to be dealt with appropriately. Decommissioning impacts are closely related to the reason for the decommissioning and include but are not limited to:

8.15.1. Beneficial impacts

Decommissioning activities result in a creation of employment opportunities for workers involved in demolition and restoration activities. Demolition works also generate materials that can be reused or recycled, thus preserving some value, and reducing the need for virgin materials.

8.15.2. Adverse impacts in decommissioning

- Decommissioning, and especially demolition activities, involve use of light and heavy machinery that generates noise and vibrations;
- Demolition activities generate rubble that requires proper disposal and can create health and safety hazards if inadequately managed;
- Demolition activities create occupational and public health and safety hazards with the likely occurrence of accidents involving workers/general public and machinery or rubble; and
- Demolition activities generate dust which if improperly managed can create health risks to workers and the general public, and cause stunted vegetation growth.

8.15.2.1. Mitigation of decommissioning phase impacts

An EIA would be prepared prior to implementation of this plan, to assess and minimize potential environmental and social impacts arising from the decommissioning and abandonment operations. This decommissioning /abandonment EIA would be submitted to NEMA for approval.

The Proponent with the assistance of a Health, Safety, and Environment expert should develop environmental, health, and safety procedures for decommissioning, in keeping with the formulated Decommissioning Environmental Management Plan (DEMP). These procedures should, among other issues, address the following:

- A Health and safety plan;
- The extent of decommissioning;
- Pollution prevention plans including air, water, and soil pollution prevention plans;
- Waste management plans; and
- Restoration plans.

At the end of decommissioning works, the Proponent should obtain certificates of completion from all the necessary authorities including NEMA.

9. Environmental and social management plan

9.1. Overview

This Environmental and Social Management Plan (ESMP) for the proposed residential apartments is an overarching framework of environmental management principles and control plans that will be applied during project implementation.

The measures presented here summarize in a matrix format, the key impacts identified, the remedial measures to be taken, the responsible person(s) for execution, and the monitoring activities to be undertaken. An indication of the timing for implementation and the cost involved is also provided.

The actions proposed in the ESMP are designed to ensure compliance with local legislation and adoption of best practices that apply to environmental and social management.

The outline management plans have been developed and will be further expanded (for construction and operations purposes) with documented procedures and guidelines for work practices in order to be responsive to the situations that the construction Contractor and Property Manager will encounter.

The effectiveness of the ESMP will be monitored and assessed regularly through inspections and reporting throughout construction and during operations.

9.2. Implementation of the ESMP during the construction phase

9.2.1. Project organization structure

The housing project will be implemented as unit pricing construction contract whereby the appointed contractor will be responsible for all construction and handover of the project to the Project Proponent.

Overall Project Management (PM) will be performed by the project proponent through a Project Management Company (PMC). There will be Environmental, Social, Health & Safety (ESHS) resources in the PMC who will be responsible for achievement of ESHS objectives in construction work. To strengthen his role, the Project Proponent will include in the construction contract, ESHS provisions in line with local standards and good international industry practice (GIIP) to ensure that the Contractor gives full attention to the requirements.

9.2.1.1. Contractor's organization

Construction phase potential impacts and mitigation measures were identified during the ESIA study. These have been carried forward to outline management plans proposed for construction phase activities to mitigate environmental, social, health and safety risks. The outline plans deal with the following issues:

- General site management;
- Aesthetics (visual and landscape);
- Noise and vibrations;
- Air quality;
- Water resources;
- Soil resources;
- Ecology and biodiversity (flora and fauna);
- Energy resources;
- Waste management;
- Traffic Management;
- Occupational health and safety; and
- Community health and safety.

The outline plans shall be further detailed in the Construction Phase Environmental & Social Management Plan (CP-ESMP) which is a practical and achievable plan of management to ensure that any environmental, social health and safety impacts during the construction phase are minimized.

The construction Contractor appointed for the project shall develop the CP-ESMP to ensure actions and mitigation necessary to protect the environment are incorporated into all site procedures.

The CP-ESMP shall also include the following overarching guidance:

- Policy
- Planning

- Implementation and Operation

9.2.1.1.1. Policy

The Contractor shall develop an environmental policy that integrates ESHS requirements and that includes, as a minimum, the following:

- A commitment to comply with applicable regulations and other requirements that the construction company subscribes to;
- A commitment to provide a safe work environment;
- A commitment to provide the training and equipment necessary for employees to conduct their work safely;
- A commitment to continuously improve performance and to pollution prevention; and
- A commitment to communicate the policy to all persons working for and on behalf of the company.

9.2.1.1.2. Planning

Environmental and social issues and the legal and other requirements in construction of the housing project have been identified in this ESIA. The construction contractor must demonstrate within his plan that he has read and understood the ESIA Report and its provisions for environmental management and monitoring.

9.2.1.1.3. Implementation and Operation

Roles, responsibilities and authorities shall be defined, documented and communicated to ensure effective environmental and social management.

The Contractor shall assign an EHS officer responsible for ensuring that the CP-ESMP is established, implemented and maintained and is responsible for reporting performance, reviewing the Plan and making recommendations for improvement.

The Contractor shall establish, implement and maintain procedures to identify potential emergency situations and potential accidents that can have an impact on the environment, surrounding communities, the employees, and/or the public.

The Contractor shall anticipate and be prepared to respond to actual emergency situations and accidents and prevent or mitigate associated adverse environmental or social impacts.

Awareness training shall be provided for all persons working for or on the Contractor's behalf whose work poses significant hazards to their health and safety and/or may create a significant impact on the environment. Records of all training shall be maintained.

Records shall be legible, identifiable and traceable to the activity. Records shall be stored and maintained in such a way that they are retrievable and protected against damage, deterioration or loss.

9.2.2. Environmental monitoring

Environmental monitoring will commence at the initiation of the construction activities for the project and will be carried out through the construction phase to commissioning.

The PMC shall carry out environmental monitoring through a qualified ESHS officer who shall perform the following:

- Verify that all project approvals and permits are in place prior to the start of construction;
- Evaluate contractor plans (e.g., Spill Response and Waste Management Plans) and monitor their implementation;
- Develop inspection checklists to ensure site inspections are focused and useful;
- Ensure that mitigation measures are developed for emerging issues and that they are appropriately implemented; and
- Prepare regular written reports to the PMC, the Proponent, Contractor and, where need be, NEMA on an agreed to schedule.

9.3. Implementation of the ESMP during operations phase

Operation phase potential impacts and mitigation measures were also identified during the ESIA study, and these were carried forward to outline management plans for operation phase activities.

The Project will be handed over to the Project Proponent to operate upon commissioning through an Estate Management Company (EMC). Part of the EMC's obligations will include management of the predicted and unforeseen environmental and social impacts arising during operations, in accordance with this ESIA.

The Operations Phase Environmental & Social Management Plan (OP-ESMP) will focus on sound environmental and social management practices that will be undertaken to minimize adverse impacts on the environment from day-to-day activities of the project.

9.4. Outline management plans comprising the ESMP

The tables below provide the outline management plans and indicative budget to address environmental and social concerns arising during construction and operation phases of the water project.

9.4.1. Construction phase management plans

Table 9-1 General site management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
General construction activities; unsafe site conditions; unsafe acts and practices	Accidents with potential to cause physical injury, damage to property; environmental pollution	Provide Environmental, Health and Safety training to workers to ensure that they understand the requirements of the environmental, health and safety management plans as applicable to their responsibilities	Contractor	Construction Phase	Trainings carried out on the ESMP and HSP	Quarterly inspection of training records	-
		Ensure that workers sign a code of conduct to observe established procedures and are well behaved towards the surrounding community	Contractor	Construction Phase	Signed code of conduct by workers	Quarterly inspection of worker contracts	-

Table 9-2 Visual and landscape management

Source of Impact	Potential Impact	Control	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Site clearance; Excavations; alteration of ground level; piling of spoils on site	loss of vegetation; soil erosion; siltation of water courses; loss of aesthetic value	Maintain as much as possible the natural drainage systems and patterns;	Contractor	During Construction	Non-interference with drainage patterns;	Regular (monthly) Inspections	-
		Preserve the existing natural vegetation as much as possible	Contractor	During Construction	Number of mature trees cleared/retained	Regular (monthly) Inspections	-
		Ensure the protection of vegetation using any of the following methods: mark, flag or fence areas of vegetation to be preserved; designate limits of root systems (tree drip line); and locate construction traffic routes, spoil piles etc away from existing vegetation	Contractor	During Construction	Marks, Fences and flags around vegetation to be preserved; storage of spoils away from vegetation	Regular (monthly) Inspections	10,000.00
		Where possible, commence landscaping activities as soon superstructures are erected;	Contractor	During Construction	Commenced landscaping works	Regular (monthly) Inspections	
		Set out a plan for re-vegetation of disturbed areas,	Contractor	During Construction	Revegetation plan for disturbed areas	Once towards Project completion	
		Prioritize indigenous trees and shrubs in the choice of plants	Contractor	During Construction	Species of trees proposed for revegetation	once-Upon preparation of revegetation plan	

Table 9-3 Air quality management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Earthworks; vehicle movements; transportation of materials and wastes; running of engines and motors	local air pollution by dust and exhaust fumes; potential respiratory illnesses among impacted neighbors	Sprinkle water on work areas, and materials heaps to minimize dust emissions;	Contractor	During construction	Dust levels at the site and accesses	Regular (weekly) inspections; sprinkling records	10,000.00
		Minimize exposed areas through the schedule of construction activities to enable dust control	Contractor	During construction	Disturbance outside active work areas	Regular (weekly) inspections	-
		Utilize vegetation, mulching, sprinkling and stone/gravel layering to quickly stabilize exposed soil	Contractor	During construction	Stabilized sections at construction site and accesses	Regular (weekly) inspections	5,000.00
		Identify and stabilize primary entrances/exits prior to commencement of construction;	Contractor	During construction	Stabilized site entrance/exit	Regular (weekly) inspections	5,000.00
		Direct construction vehicular traffic to stabilized roadways	Contractor	During construction	Existence of stabilized roadway; Use of stabilized roadways by construction traffic	Regular (weekly) inspections	-
		Maintain equipment and machinery to manufacturers' specifications by regular servicing to maintain efficiency in combustion and reduce carbon emissions;	Contractor	During construction	opacity of exhaust gases from vehicles; Regular maintenance of vehicles; vehicle maintenance schedule	Quarterly inspection of maintenance records	100,000.00
		Use environmentally friendly fuels such as low Sulphur diesel;	Contractor	During construction	Type of fuel in use	quarterly inspection fuel records	-
		Minimize the period for machinery idling;	Contractor	During construction	Existing practices and awareness of operators about machinery idling	quarterly inspection of practices	-
		Ensure that no burning of waste is done on site; and	Contractor	During construction	Waste Disposal methods in use	Weekly inspection of practices	-
		Provide appropriate Personnel Protective Equipment such as dust masks to site workers.	Contractor	During construction	Existence and usage of PPE including dust masks by workers	Weekly inspection of usage of PPE	20,000.00

Table 9-4 Energy management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Use of fossil fuel-ran and/or electricity-ran equipment in construction works	Increased demand on fossil fuel and electricity to run equipment	Ensure the use of rated equipment in welding and related works;	Contractor	During Construction	Rating cards/plaque on equipment	One-time inspection of existence of rating cards on equipment	-
		Maintain equipment and machinery to manufacturers' specifications by regular servicing to maintain efficiency in combustion and reduce carbon emissions;	Contractor	During Construction	Established maintenance schedules for equipment in use	Quarterly review of maintenance records for adherence to schedules	-
		Use environmentally friendly fuels such as low Sulphur diesel;	Contractor	During Construction	Type of fuel in use on equipment	Quarterly review of the fuel type in use	-
		Minimize the period for machinery idling to save on fuel;	Contractor	During Construction	Existing practices and awareness of operators about machinery idling	Visual observation of practices in weekly inspections	-
		Specify and procure the most energy efficient plant options fit for purpose and avoid use of plant with unnecessary and excess capacity	Contractor	During Construction	List of requirements for each type of equipment	one-time inspection of the rating on equipment against specifications	-

Table 9-5 Noise and vibrations management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Noise emissions by construction equipment and activities	Nuisance to surrounding communities	Install portable hoods to shield compressors and other small stationary equipment where necessary;	Contractor	During Construction	Presence of noise attenuation features on equipment	Visual observation in monthly inspection of equipment features and state	50,000.00
		Endeavour to use equipment installed with noise abatement devices as much as practicable;	Contractor	During Construction	Presence of noise attenuation features on equipment	Monthly inspection of equipment features and state; quarterly noise measurements at point sources	50,000.00
		Reduce idling time on trucks and other noisy equipment	Contractor	During Construction	Existing practices and awareness of operators about machinery idling	Quarterly inspection of practices	-
		Encourage drivers to turn off vehicle engines when not in use and avoid unnecessary hooting/revving of engines;	Contractor	During Construction	Existing practices and awareness of operators about machinery idling and noise generation	Quarterly inspection of practices	-
		Provide personal protective equipment such as ear muffs to workers at the site as necessary; and	Contractor	During Construction	Existence and usage of PPE including earmuffs by workers	Weekly inspection of usage of PPE	10,000.00
		Carry out construction work during the day only. No works shall be carried out on Sundays	Contractor	During Construction	Defined construction hours of between 7am and 6pm	Weekly review of start and stoppage times	-

Table 9-6 Water resource management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Construction water needs; generation of wastewater during construction works	Increased demand in the project area; contamination of surface and ground water resources	Measures for protection of soil erosion shall also apply;	Contractor	During Construction			
		Ensure that water is used efficiently by avoiding extravagant water use and wastage;	Contractor	During Construction	Instituted measures for efficiency in consumption	Continuous review of usage and water requirements	-
		Monitor water consumption and maintain records;	Contractor	During Construction	Installed consumption meter(s); records of deliveries by bowsers	Monthly inspection of records	3,000.00
		Harvest storm water wherever possible to supplement other sources of water;	Contractor	During Construction	Water harvesting infrastructure at the site	Quarterly review of water harvesting opportunities	10,000.00
		Channel construction wastewater into temporary holding ponds to allow sedimentation before release in to the environment; and	Contractor	During Construction	Presence of a sump for holding construction wastewater	Visual observation in weekly review of effectiveness of the sump	20,000.00
		Recycle and reuse construction wastewater wherever possible	Contractor	During Construction	evidence of recycling of wastewater at the site	monthly review of opportunities for reuse or used of recycled water	-

Table 9-7 Soil resource management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Excavation for foundations; leveling of the site; compaction of the soil by construction vehicles and machinery; storage and handling of hazardous materials and wastes at the site	Compaction of soil by vehicles leading to loss of soil structure and increased susceptibility to erosion; depletion of fertile top soil at the site; contamination of soil resources from spillages and leakages of hazardous materials and wastes; erosion and sedimentation of surface water resources	Salvage, stockpile and ensure re-use of native topsoil during re-vegetation activities in disturbed areas	Contractor	During Construction	Preservation and reuse of topsoil at the site	Visual observation in quarterly inspection of soil management practices	-
		Identify fertile soil borrow-pits as close as possible to the project site;	Contractor	During Construction	Nearness of identified borrowpits	one-time inspection of identified borrow pit	-
		Ensure re-vegetation of disturbed areas as soon as possible to prevent soil erosion;	Contractor	During Construction	Time lag between disturbance actions and revegetation	Visual observation in monthly inspection of activities and program of works	-
		Ensure that construction vehicles use predetermined tracks at the site to reduce ground compaction;	Contractor	During Construction	Established tracks/paths for use by construction vehicles	Visual observation in weekly inspection of the site for extent of compaction outside established tracks	-
		Utilize vegetation, mulching, sprinkling and stone/gravel layering to quickly stabilize exposed soil	Contractor	During Construction	Stabilized sections at construction site and accesses	Visual observation in monthly inspection of accesses	5,000.00
		Identify and stabilize primary entrances/exits prior to commencement of construction	Contractor	During Construction	Stabilized site entrance/exit	Visual observation in monthly inspection of entry/exit for effectiveness of stabilization	5,000.00
		Construction wastewater shall be channeled to a predetermined area such as a temporary holding pond where sedimentation can take place and reduce the amount of soil carried away in wastewater;	Contractor	During Construction	Presence of a sump for holding construction wastewater	Visual observation in weekly inspection of use and effectiveness of the sump	20,000.00
		Oils, fuels, paints and any hazardous materials to be stored in accordance with their respective MSDS's, and in such a manner to avoid spillages or leakages. Bund walls should be constructed around these substances' storage area so as to enable containment in the event of spillage or leakage	Contractor	During Construction	Storage of hazardous chemicals and wastes in bunded areas	Visual observation in weekly inspection of storage practices and evidence of leakage/spillage	20,000.00
		Implement erosion and sedimentation controls and ensure proper disposal of liquid waste	Contractor	During Construction	Use of silt traps on potential erosion channels	Visual observation in monthly inspection of effectiveness of silt traps	5,000.00

Table 9-8 Traffic management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Construction vehicles movements in the project area	Accidents involving the surrounding community; nuisance from snarl ups	Contractor shall ensure that construction traffic movement does not coincide with the known rush hours in the project area, and that speed and loading limits are observed	Contractor	During Construction	Delivery times for materials and carting of wastes; established speed limits	Review of delivery records for delivery times	-
		Develop a traffic management plan to ensure that site vehicles do not interfere with the regular traffic on the access roads, or pose safety hazards to site workers or the general public	Contractor	During Construction	Established Traffic management plan	monthly review of effectiveness of the Traffic management plan	-
		Set up traffic control/warning signs along the access road near the site entrance informing other motorists of potential hazards of construction vehicles turning	Contractor	During Construction	Erected warning signage at critical areas	Visual observation in weekly inspection of signages	10,000.00

Table 9-9 Waste management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Demolition works for existing structures; Use of materials in construction; rejection of defective construction materials; packaging of materials	Generation of construction wastes that cause environmental pollution, nuisance and breeding grounds for vermin	Identify a temporary holding area for demolition and construction wastes;	Contractor	During Construction	Identified area for storage of wastes	Weekly inspection of housekeeping practice	5,000.00
		Recycle and re-use demolition and construction waste as much as possible;	Contractor	During Construction	Amount of recycled wastes at the site	Monthly review of records on quantities of recycled materials	-
		Ensure that all non-recyclable/reusable wastes are cleared from site at the earliest opportunity to avoid pile-up;	Contractor	During Construction	Existent plans for off-site disposal of wastes	Weekly review of waste management practices	-
		Avoid mixing excess concrete if possible. Discard excess concrete in a designated area;	Contractor	During Construction	Amount of concrete that is disposed as waste	Weekly review of quantities of concrete wastes generated	-
		Washing of concrete-coated vehicles/equipment off-site or in a designated area. The concrete wash area will be at least 50m away from storm drain inlets or open drainage facilities. Runoff from onsite concrete wash area shall be contained in a temporary pit where concrete can set;	Contractor	During Construction	Designated wash area; an existent concrete washout pit at the site	Weekly review of usage of wash area and maintenance of washout pit	20,000.00
		Surface runoff within the site to be diverted in order to avoid flushing away soil and other material. Sediment traps to also be installed to remove sediments before discharge of the runoff from the site;	Contractor	During Construction	Installed sediment traps; lined drain for channeling of runoff	Monthly review of effectiveness of the site drainage	5,000.00
		Ensure that cleared waste is disposed appropriately in designated disposal/landfill sites;	Contractor	During Construction	Identified waste disposal site; established measures for regular collection of waste for disposal; Identified and contracted waste handler	Quarterly review of waste collection and disposal plans	100,000.00
		Establish measures to ensure that construction material requirements are carefully budgeted to avoid leftovers; and	Contractor	During Construction	Existent stock management plans	Quarterly review of inventories to identify excesses	-
		Ensure the use of durable, long-lasting materials that will not need to be replaced often, thus reduce the amount of construction waste generated over time.	Contractor	During Construction	Manufacturer's specified durability of the materials; Rate at which materials become defective or damaged in normal use	Quarterly review of the types of wastes generated and causes/sources	-

Table 9-10 Raw materials management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Extraction of raw materials such as sand, masonry stones, ballast	environmental degradation at quarry sites	Source construction materials such as sand, ballast, quarry stones, and hard core from registered and approved quarries and sand mining firms;	Contractor	During Construction	Available permits for materials sites	Annual check of the licensing status of materials sources	-
		Implement stringent inventory management mechanisms and only order for materials after a fairly accurate estimation of actual construction requirements; and	Contractor	During Construction	existent stock management plans	quarterly review of procurement plans for materials	-
		Manufacture building elements off-site where possible, and deliver to site.	Contractor	During Construction	Existing arrangements for offsite preparation of building elements	Quarterly review of opportunities for off-site manufacture of elements	-

Table 9-11 Health and safety management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Use of hand tools and machinery in construction; construction vehicle movements; housekeeping practices at the construction site; unsafe acts by construction workers	Physical injuries to workers and/or the public; damage to property	Comply with the requirements of OSHA, 2007;	Contractor	During Construction	Level of compliance with OSHA provisions	Annual Health and Safety Audit	50,000.00
		Access to the construction site shall be controlled to prevent access by the general public	Contractor	During Construction	Hoarded and restricted construction site	Visual observation of hoarding in weekly inspections	40,000.00
		Provide for appropriate signage and warnings in work areas;	Contractor	During Construction	Installed warning signage	Visual observation of signages in weekly inspections	10,000.00
		Provide appropriate personnel protective equipment (PPE) to site workers;	Contractor	During Construction	Appropriate PPE provided to workers	Visual observation in weekly inspections of construction activities	100,000.00
		Provide for First Aid facilities as per the OSHA, 2007, and ensure that workers are trained on emergency response such as first aid skills;	Contractor	During Construction	Trained first aider(s) among workers; fully stocked first aid kit at the construction site	Monthly inspection of First aid stocks and records of usage	30,000.00
		Provide and clearly display emergency contacts on site;	Contractor	During Construction	Displayed emergency contacts at the site	Visual observation in monthly inspection of activities	-
		Provide adequate sanitary facilities on site; and	Contractor	During Construction	Provided toilets and handwashing water at the site	One-time inspection of existence of facilities; weekly inspection of cleanliness of facilities	30,000.00
		Develop and implement a detailed and site-specific Emergency Response Plan	Contractor	During Construction	Operational emergency response plan	quarterly review of effectiveness of emergency response measures	-

9.4.2. Operation phase management plans

Table 9-12 Noise management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Use of the standby power generator during grid-power outages	Noise nuisance	Ensure that noise abatement devices are installed and maintained for the standby generator for power supply	EMC	Operation Phase	Noise levels from the standby generator when in use	Annual noise measurements	10,000.00

Table 9-13 Energy resource management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Use of electrical appliances; lighting within the development	Increased demand on grid energy supply	Encourage residents to conserve energy through awareness programs;	EMC	Operation phase	Instituted awareness and conservation program	Annual audit	-
		Install and maintain energy efficient appliances e.g., indoor lights and outdoor security lights; and	EMC	Construction and operation phase	Installed energy efficient lighting	Annual audit	Part of construction cost
		Continually seek avenues for energy conservation as international best practices evolve	EMC	Operation phase	Other energy-saving measures instituted	Annual audit	-

Table 9-14 Water resource management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Usage of water by residents	Increased water demand; increased generation of wastewater	Incorporate water accounting systems and metering for all areas;	EMC	During Construction	Installed water meters	Annual Environmental audit of the project	Part of construction cost
		Encourage Residents to conserve water through awareness programs;	EMC	During Operation	Instituted awareness programs	Annual Environmental audit of the project	-
		Install and maintain low volume fixtures in toilets, baths and other wet areas;	EMC	During Construction	Installed low-volume fixtures	Annual Environmental audit of the project	Part of construction cost
		Use harvested storm water in cleaning and irrigation of lawns; and	EMC	During Operation	Use of harvested stormwater around the compound	Annual Environmental audit of the project	-
		Continually seek new avenues for water conservation as international best practices evolve.	EMC	During Operation	other conservation measures instituted	Annual Environmental audit of the project	-

Table 9-15 Waste management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Occupation of the housing by the residents; consumption/use of materials	Generation of wastes; environmental pollution and creation of health and safety hazards from mismanagement of wastes	Pursue waste minimization at source principles e.g., zero generation, reduction, re- use and/or recycling;	Residents	Operation phase	Implemented measures for reuse/recycling at household level	Annual environmental audit	-
		Provide mechanisms to segregate wastes at source, ensure that all wastes are stored temporarily at the designated common collection area, and that they are regularly carried away for disposal in designated areas; and	EMC	Operation phase	Established mechanisms that allow segregation; Contracted waste handler; waste collection schedule	Annual environmental audit	-
		Ensure regular inspection and maintenance of foul water drainage works and storm water drainage works at the premises to prevent clogging, and fore-stall breakdowns.	EMC	Operation phase	Maintenance/inspection schedule; Blockage incidences	Annual review of records	-

Table 9-16 Occupational/public health and safety

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Maintenance activities within the property; Installations such as electric fence; Manholes, trenches or other features; Flames and flammable substances within houses	Accidents causing injuries; fire incidences with potential to cause damage to property and/or loss of life	Comply with the requirements of the OSHA 2007;	EMC	Operation phase	Compliance level with OSHA provisions	Annual Health and Safety Audit	50,000.00
		Provide for the appropriate signage and warnings in potential risk areas;	EMC	Operation phase	Installed warning signage at risk areas	Annual Health and Safety Audit	Part of construction cost
		Provide appropriate Personnel Protective Equipment (PPE) to maintenance staff at the premises where applicable; and	EMC	Operation phase	Availability of PPE and usage during maintenance works	Annual Health and Safety Audit	-
		Install firefighting equipment at strategic places within the property	EMC	Operation phase	Installed firefighting equipment at the premise	Annual Fire Safety Audit	Part of construction cost
		Develop and implement detailed and site-specific emergency response plans	EMC	Operation phase	An established Emergency Response Plan for identified hazards	Annual Risk Assessment	-

Table 9-17 Traffic management

Source of Impact	Potential Impact	Controls	Responsibility	Timing	Performance Indicator	Monitoring Requirement	Costs (KES)
Movement of vehicles and pedestrians in and out of the premises	Accidents involving pedestrians and/or motor vehicles	Develop and maintain a traffic management plan that caters for vehicular and pedestrian traffic associated with the development especially at the main entrance to the property	EMC	During Operations	Established Traffic Management Plan; Traffic incidents related to the development	Annual inspection of traffic management facilities	-

9.4.3. Decommissioning environmental management plan (DEMP)

9.4.3.1. Introduction

The development is expected to be operational for a long period of time – perhaps reaching 70 years or more. However, once the Proponent has decided to proceed with decommissioning a part or the entire development, has completed any precursor activities, and has scheduled the work on a suitable program of works, the decommissioning process may begin.

The following steps would be followed in the decommissioning process:

9.4.3.2. Scoping

This is a consultative process to discuss the scope of the decommissioning action for all buildings/infrastructure, including the schedule, budget, risks and approach for performing the work.

9.4.3.3. Facility walk down

Site personnel would perform a facility walk down to obtain the information necessary to prepare the hazard assessment and the Reconnaissance Level Characterization Report (RLCR). Safety and physical hazards at the site would be identified as part of the initial development's reconnaissance. The safety and physical hazard assessment is meant to help site personnel determine the possible risks to workers, the public and the environment during decommissioning. To identify and control hazards, an Integrated Safety Management (ISM) process description and implementation plan would be followed. The ISM integrates the identification, analysis and control of hazards and provides feedback for improvement. The ISM would consist of five core safety management functions which include:

- Definition of the scope of work;
- Identification and analysis of hazards associated with the work;
- Development and implementation of hazard controls;
- Performance of the work within such controls; and
- Provision of feedback on the adequacy of the controls.

9.4.3.4. Reconnaissance level characterization

The Reconnaissance Level Characterization produces an overall assessment of the hazards, and other conditions associated with each structure/facility to be decommissioned. The physical condition of the structures/facilities would be assessed in order to identify hazards, as well as physical obstacles or other conditions that could affect decommissioning activities. The Reconnaissance Level Characterization would include a detailed review of hazards that require special work controls to complete decommissioning safely. In all cases, the team performing the RLC would check the historic information against current observed conditions.

9.4.3.5. Prepare reconnaissance level characterization report (RLCR)

Based on the Reconnaissance Level Characterization, the Proponent would prepare a report for review and approval by NEMA. The report summarizes the results of the Reconnaissance Level Characterization and provides an analysis of the risks presented in the development. The RLCR would also contain sufficient detail including analysis of analytic information to establish the basis for decommissioning activities. The project points of contact and staff would use the RLCR to provide input to the preparation of the health and safety analysis, the determination of the engineering support requirements, and the determination of appropriate milestones.

9.4.3.6. Perform physical work of disposition operations

These activities include, for example, dismantling and removing equipment and removing internal building components. After demonstration that the structure/facility meets the established criteria, it would be demolished. The requirements and procedures set out in the ISM plans would be followed by workers performing decommissioning.

9.4.3.7. Perform and validate final characterization

At the end of the decommissioning, site personnel would confirm that their activities have achieved the standard required in the completion of disposition for structures/facilities that are demolished such that only environmental restoration activities remain. After the structure/facility is demolished, the final characterization would then occur. The demolition survey would be conducted in accordance with the site's characterization protocols, and would provide sufficient data to demonstrate that the site has successfully completed decommissioning in conformance with the set regulation requirements.

The post-demolition survey may result in a loop of activity for site decommissioning personnel, because if the survey reveals insufficient decommissioning to meet the requirements of the regulations, additional action would have to be taken. Only at such time as the site project point of contact is satisfied that the post-demolition survey shows that decommissioning is complete, would the survey be deemed final.

9.4.3.8. Environmental restoration

Environmental restoration constitutes those activities necessary to characterize, assess and remedy contamination in soils, sediments, surface and ground water from past activities at the site. It may also entail re-vegetation of the site through planting of indigenous trees and shrubs. Soil and surface/ground water remediation would be carried out as necessary after it is established that soil/water quality has been compromised by activities at the development. Re-vegetation would be carried out to the extent determined by the proposed future use of the site.

10. Conclusions and recommendations

This ESIA Study report has identified, assessed and presented mitigation measures for the anticipated adverse environmental, social, health and safety impacts of the proposed Zima Homes Affordable Housing development. Beneficial impacts identified in the assessment included the creation of employment and business opportunities across the housing value chains and the positive contribution towards meeting the affordable housing demand in the Nairobi Metropolitan Region. The added employment and business opportunities will increase the velocity of money and positively contribute to a higher GDP for the country. There will also be increased revenue to the exchequer through taxes from the economic activities.

Adverse impacts identified include such as increased noise and air pollution, pollution of soil and water resources, increased health and safety hazards, and traffic nuisances during demolition of existing structures, site clearance and construction phase of the project. Increased demand on energy and water resources and an increase in solid waste generation are some of the impacts anticipated during the operation phase of the project.

Mitigation measures proposed during construction include institution of noise management mechanisms on machinery at the site, dust control by sprinkling of water around construction areas and stockpiles, soil and water pollution prevention through proper management of construction wastewater, storage and use of hazardous chemicals, and implementation of health and safety and traffic management plans.

During project operation, energy and water conservation measures are proposed which include the sensitization of residents and other users on conservation practices, installation, use and maintenance of energy and water conserving appliances, fixtures and fittings, and institution of suitable waste management practices.

From the foregoing, no adverse environmental impacts are anticipated that cannot be mitigated. An environmental audit is recommended upon the completion of construction works to corroborate the implementation of the proposed mitigation measures. Any unforeseen project impacts would be identified and addressed through annual environmental audits.

The Consultant proposes that project approval and an Environmental Impact Assessment license be issued by NEMA based on the environmental management measures contained in this EIA Study Report.

Appendices