



ZESCO

Zambia-Tanzania Interconnector Project (ZTIP)

Detailed Biodiversity Management Plan

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Zambia-Tanzania Interconnector Project (ZTIP)

Detailed Biodiversity Management Plan



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Executive Summary

The Biodiversity Management Plan (BMP) for the Zambia-Tanzania Interconnector Project (ZTIP) sets out the requirements to avoid, minimize, restore, and compensate for potential impacts on fauna, flora and their habitats and in particular on critical habitats, protected areas and natural habitats during the detailed design, pre-construction, construction, operation and rehabilitation phases of the project.

Main potential impacts on biodiversity that need to be appropriately managed are:

- Permanent loss of natural habitat areas (including mature and secondary miombo woodland, riverine forests and wetlands) and associated flora;
- Loss of critical habitat for two critical habitat triggering flora species (primarily *Disa aequiloba* and *Euphorbia perplexa* var. *kasamana*);
- Encroachment of the transmission line in seven Forest Reserves;
- Habitat fragmentation and degradation for fauna species, including species of conservation concern;
- Direct mortality of birds through collisions with the earth wire/ground wire, including priority species and species of conservation concern.

The overarching objective of the BMP is to ensure biodiversity considerations are fully integrated into project planning, design, construction and operation in accordance with the World Bank's Environmental and Social Framework (ESF), particularly Environmental and Social Standard (ESS) 6, as well as relevant Zambian legal and policy requirements. This is in addition to ZESCO's own environmental and social commitments. The BMP outlines the approach to be taken by the Project Implementation Unit (PIU) from ZESCO to meet obligations regarding the long-term conservation of important biodiversity features. It establishes the biodiversity management objectives, mitigation measures, conservation actions, compensation mechanisms, monitoring requirements, institutional responsibilities, and the rationale and actions that will enable a No Net Loss/Net Gain (NNL/NG) outcome, as well as the cost estimated necessary to meet these outcomes.

The development of the BMP, and more specifically the biological baseline, relies on several rounds of field campaigns conducted at different stages of the ZTIP development and covering several taxonomic groups (flora, birds, bats, large mammals and herpetofauna). The BMP also relies on stakeholder engagement activities, especially a round of consultation held in November 2025 specifically on the detailed BMP.

Impact Avoidance and Mitigation Strategy

Key risks and impacts on biodiversity are managed through an impact avoidance and mitigation strategy based on the mitigation hierarchy, i.e., avoid, reduce (minimize), remedy (restore), and compensate, in line with the World Bank ESF (ESS 1 and ESS 6).

In addition to measures to avoid and mitigate impacts through project design and specific work procedures and field work in biodiversity sensitive areas, detailed in Table 1, a series of mitigation measures are identified and will need to be implemented through pre-construction, construction and operation phases.

Table 1 Overview of Avoidance and Mitigation Measures through Project Design, Field Work and Specific Work Procedures

Type of measure	
Avoidance and mitigation through project design	<ul style="list-style-type: none"> ■ Avoid siting construction facilities in natural habitat; ■ Minimize the construction of new access roads; ■ Minimize encroachment on rock outcrops in proximity and within the Kasama Forest Reserve through micro-siting of tower foundations and workspaces; ■ Minimize encroachment in wetlands and riparian areas, including towers, access roads and temporary construction areas; ■ Reduce width to be cleared in Forest Reserves; ■ Apply same design when two lines are side by side; ■ Ensure sufficient spacing is maintained between energized components and grounded hardware; ■ Install bird flight diverters.
Required field work	<ul style="list-style-type: none"> ■ Undertake right-of-way (ROW) vegetation clearing with the supervision of a botanist; ■ Surveys and salvage transplant of <i>Disa aequiloba</i> and <i>Euphorbia perplexa</i> var. <i>kasamana</i> specimens; ■ Pre-construction inspection (avifaunal walk-through surveys); ■ Pre-construction inspection to identify bat roosts.
Avoidance and mitigation through specific work procedures	<ul style="list-style-type: none"> ■ Non-native invasive species management plan; ■ Work methods within or in proximity to wetlands and aquatic habitats; ■ Work methods in critical habitat rock outcrops.

For all biodiversity management measures identified in the Detailed BMP, the location where the management measure must be applied, responsibilities for implementation and monitoring, the implementation timing, performance indicators and costs are identified.

Summary of Residual Impacts

Residual impacts after the application of the impact avoidance and mitigation strategy are preliminarily quantified and an appropriate compensation strategy to achieve no net loss for natural habitats (miombo woodlands and riverine forests) and net gain for critical habitat qualifying features (*Disa aequiloba*/wetlands and *Euphorbia perplexa* var. *kasamana*/rock outcrops) is established, in accordance with ESS 6. The quantified residual impacts are as follows:

- Natural habitat loss: loss of 39.4 ha of mature miombo woodland, 529.0 ha of secondary miombo woodland, 48.9 ha of riverine forest and at least 5.5 ha of natural wetlands.

- *Disa aequiloba* critical habitat loss: permanent loss of 2.91 to 4.96 ha (included in overall areas of natural habitat loss above).
- *Euphorbia perplexa* var. *kasamana* critical habitat loss: permanent loss of 0.14 ha of habitat (included in overall areas of natural habitat loss above), zero loss of individuals estimated for tower footprints and uncertain loss of individuals from temporary workspaces, estimated at 129 individuals (range from 0 to 356 individuals).
- Natural habitat in legally protected areas and internationally recognized areas: loss of 1.85 ha in Chitimukulu Forest Reserve (FR), 61.38 ha in Kanona FR, 13.70 ha in Kasama FR, 2.15 ha in Mungwi FR and 18.58 ha in Nkole Mfumu FR (included in overall areas of natural habitat loss above).

Residual impacts within Forest Reserves and other legally protected areas are treated with heightened management measures consistent with ESS 6 requirements for protected and internationally recognized areas. These residual impacts are compensated through the Natural Habitats Compensation Plan (NHCP) to offset natural habitat loss using a habitat-based quality metric and targeted, species-specific conservation actions designed to secure net gain outcomes for critical habitat triggering species.

Natural Habitats Compensation Plan

The NHCP defines the compensation strategy to address residual impacts associated with the loss of miombo woodlands and riverine forests in accordance with the World Bank’s Biodiversity Conservation and Sustainable Management of Living Natural Resources Standard (ESS 6).

A habitat-based metric, integrating area of habitat loss and its relative ecological quality, was applied to quantify habitat loss. Specifically, a quality ratio was applied to adjust the area of impact to account for differences in ecological condition, structural complexity and functional value among patches of the same habitat type. Application of this methodology resulted in compensation targets of 366.8 quality-hectare of miombo woodland habitat and 48.9 quality-hectare of riverine forest habitat. These targets represent the minimum required to achieve no net loss of natural habitats. The achievement of no net loss will be evaluated over a time horizon sufficient to capture habitat recovery and maturation and will be verified through periodic independent audits as part of the Biodiversity Monitoring Program.

Compensation Approach

The compensation approach relies on guiding principles such as ‘like-for-like or better’ replacement of affected habitats, additionality (ensuring conservation outcomes would not occur in the absence of the project), stakeholder engagement and institutional collaboration, feasibility and adaptation to local context and long-term sustainability of biodiversity outcomes. Potential compensation sites were identified in existing managed forests, including Forest Reserves and Community Forests. Responsible management authorities and Community Forest Management Groups were consulted to identify ecological conditions, governance challenges and opportunities for enhanced conservation outcomes.

Compensation actions were designed to include assisted natural regeneration (ANR) as well as active reforestation using native species. A total of 40 candidate sites were identified for compensation of miombo woodland and riverine forest (some candidate sites are targeted for compensation of both habitats). For compensation of miombo woodlands, 35 candidate sites were identified and are expected to result in 528.76 ha of ANR and 995.76 ha of reforestation. For compensation of riverine forests, a total of 18 potential sites were identified and are expected to result in 220.07 ha of ANR and 144.16 ha of reforestation. Preferred species for compensation activities were identified for each habitat based on species abundance and ecological representation in affected habitats, use value for local communities, compatibility with current reforestation practices by the Forestry Department and Community Forest Management Groups (as discussed during consultation activities), conservation value of species and association with bird and bat species of conservation value.

Compensation actions in candidate sites are expected to result in a gain of up to 595.9 quality-hectare in miombo woodland and up to 124.7 quality-hectare in riverine forest. Compensation activities at candidate sites could thus result in a net gain in both habitats thereby providing a buffer to manage implementation risks and ecological uncertainties. Final site selection will be confirmed through a structured feasibility assessment. The budget for the Natural Habitats Compensation Plan was developed based on no net loss, i.e., not all candidate sites will need to be selected as a result of the feasibility assessment.

Supporting actions were also identified to achieve enabling conditions and ensure compensation actions are properly supported and positioned for success. These supporting actions aim to increase enforcement and monitoring capacity of implementing partners (i.e., District Forestry Department and Community Forest Management Groups), to ensure community commitment and participation as well as to develop alternative livelihoods and reduce anthropogenic pressures in and around compensation sites.

Feasibility, Planning and Implementation Phases

Before implementation of compensation and supporting actions, a feasibility study will be completed to confirm the viability of compensation actions and sites. This feasibility study should consider ecological, technical and implementation, social and cultural, legal and political as well as financial feasibility. Specific guidance is provided in the NHCP for the feasibility assessment which should involve stakeholders and result in selected compensation sites where compensation actions are expected to achieve no net loss/net gain.

Following feasibility, a Forest-Specific Compensation Plan will be developed for each managed forests where compensation activities will be implemented. The goal is to detail the compensation strategy for each Forest Reserve and Community Forest where compensation sites were selected. This strategy should be supported by a detailed characterization of each compensation site, maps and photographs of targeted areas, and a clear plan for the implementation phase. Planning should consider compensation actions as well as supporting actions and seedling production.



As part of the implementation phase, compensation and supporting actions will be executed and seedlings produced in project-dedicated nurseries. At the end of implementation, the PIU will be responsible to demonstrate that no net loss/net gain was achieved.

Conservation Actions for Critical Habitat Triggering Species

Ex-situ conservation, translocation and reintroduction of specimens, and long-term monitoring and adaptive management will be implemented as conservation actions to contribute towards conservation and management of *Disa aequiloba* and achieve net gain for its critical habitat.

Also, specific actions will be implemented for *Disa aequiloba* and wetlands, including community-based habitat protection and awareness campaigns to prevent early burning, promote sustainable harvesting techniques and burial of roots after tuber collection.

For *Euphorbia perplexa* var. *kasamana* and rock outcrops, specific actions to be implemented include ex-situ conservation, translocation and reintroduction, habitat protection and enforcement to strengthen protection of rock outcrops and support the National Heritage Conservation Commission (NHCC) in showcasing biodiversity in rock outcrops.

Biodiversity Monitoring Program

A Biodiversity Monitoring Program was developed to monitor the nature, extent, quality, and spatial configuration of the biodiversity features identified in relation to project impacts, and to validate the efficiency of biodiversity management measures, conservation actions for critical habitat triggering species, and natural habitats compensation actions to be applied.

The objective is to track project performance in terms of biodiversity protection and compensation. As such, the program includes monitoring of planned management measures, resulting and residual impacts on biodiversity components, the success of implemented conservation actions for critical habitat triggering species and the implementation of the Natural Habitats Compensation Plan during both the construction and operation phases.

For each biodiversity feature, associated monitored components are identified with specific supervision methods, indicators and targets. The location, frequency and responsibility of monitoring are also specified.

Implementation Framework

Roles and Responsibilities

The proper implementation of the BMP falls under the responsibilities of the PIU but involves the collaboration of multiple actors including the Supervising Engineer and Contractors. The PIU will ensure that all relevant BMP requirements, including the Natural Habitats Compensation Plan and species-specific measures, are incorporated into bidding documents, works contracts, and Contractor's Environmental and Social Management Plans (C-ESMPs).

The Supervising Engineer will verify that these requirements are reflected in Contractors' method statements and implemented on site and will report non-compliances to the PIU with time-bound corrective actions.

For some components of the BMP such as the NHCP, the PIU will collaborate with various institutions including District Offices of the Forestry Department, Community Forest Management Groups, the National Heritage Conservation Commission, Copperbelt University and other non-governmental organizations as required.

During operation, the implementation of biodiversity management strategy and monitoring activities will be under the responsibility of ZESCO. Contractors shall prepare, implement, and periodically update C-ESMP sub-plans (e.g., invasive species management, wetland works procedures, rock outcrop work methods, and fauna/flora protection plans) consistent with this BMP and subject to review and approval by the PIU and Supervising Engineer prior to commencement of related works.

Capacity Building

Successful implementation of the BMP will be largely dependent on the capacities of the actors in charge of its implementation. As such, a dedicated capacity building program was designed to ensure institutions involved in implementation have sufficient capacity and to support enabling conditions for a successful implementation of activities associated with the NHCP. Capacity building will prioritize: (i) implementation and enforcement of the Natural Habitats Compensation Plan; (ii) monitoring and management of critical habitats and associated species; and (iii) data management and reporting to demonstrate compliance with ESS 6 and achievement of NNL/NG outcomes.

Implementation Schedule and Cost Estimate

An implementation schedule for BMP activities was developed in alignment with the project construction schedule. It includes all key biodiversity management activities to be implemented during pre-construction, construction and operation phases.

It is estimated that the proposed biodiversity management strategy and associated mitigation measures, including compensation actions, will cost USD 464,573.42 for the pre-construction phase and USD 1,683,702.91 for the construction phase. Monitoring during the operation phase is expected to cost USD 5,000 in fixed costs and USD 242,049.45 annually for periodic activities.

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Abbreviations

Abbreviation	Description
ACSR	Aluminum-Conductor Steel-Reinforced Cable
AEWA	Agreement on the Conservation of African-Eurasian Migratory Waterbirds
AM	Afro-tropical Migrant
ANR	Assisted Natural Regeneration
BBOP	Business and Biodiversity Offset Programme
BIIA	Biodiversity Indirect Impact Area
BFD	Bird Flight Diverters
BMMP	Biodiversity Management and Monitoring Plan
BMP	Biodiversity Management Plan
BOD	Biochemical Oxygen Demand
C-ESMP	Contractor's Environmental and Social Management Plan
CBD	Convention on Biological Diversity
CF	Community Forest
CFMG	Community Forest Management Group
CHA	Critical Habitat Assessment
CIGZambia	Cities and Infrastructure for Growth Zambia
COMACO	Community Markets for Conservation
CR	Critically Endangered
DACO	District Agricultural Coordinator
DD	Data Deficient
DIA	Direct Impact Area
DNPW	Department of National Parks and Wildlife
DRC	Democratic Republic of the Congo
DVSD	Dynamic Voltage Support Devices
E	Expected
EAAA	Eastern Africa Avifaunal Atlas
EAPP	Eastern Africa Power Pool
EHS	Environment, Health and Safety
EMA	Environmental Management Act
EN	Endangered
EOO	Extent of Occurrence

Abbreviation	Description
ERB	Energy Regulation Board
ES	Ecosystem Services
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Standards
EU	European Union
E&S	Environmental and Social
FAO	Food and Agriculture Organization of the United Nations
FCDO	Foreign, Commonwealth and Development Office
FR	Forest Reserve
GBIF	Global Biodiversity Information Facility
GDP	Gross Domestic Product
GIIP	Good International Industry Practice
GIS	Geographic Information System
GISD	Global Invasive Species Database
GMA	Game Management Area
GRM	Grievance Redress Mechanism
ha	Hectare
IAS	Invasive Alien Species
IBA	Important Bird Area
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
KP	Kilometer point
kV	Kilovolt
LC	Least Concern
LFP	Local Focal Point
LMNP	Lavushi Manda National Park
MEA	Millennium Ecosystem Assessment
MoU	Memorandum of Understanding
N	Not Expected
NA	Not Applicable
NE	Not Evaluated
NF	National Forest
NG	Net Gain
NGO	Non-Governmental Organization
NHCC	National Heritage Conservation Commission



Abbreviation	Description
NHCP	Natural Habitats Compensation Plan
NNL	No Net Loss
NT	Near Threatened
PAR/POS	Partial/Possible Migrant
PES	Priority Ecosystem Services
PIU	Project Implementation Unit
PM	Palaearctic Migrant
PPE	Personal Protective Equipment
q	Quality
q-ha	Quality-hectare
R	Recorded
RAP	Resettlement Action Plan
RR	Restricted Range
ROW	Right-of-Way
SABAP2	Southern African Bird Atlas Project 2
SAPP	Southern African Power Pool
STATCOM	Static Synchronous Compensator
SVC	Static Volt-Ampere Reactive Compensator
TAZARA	Tanzania-Zambia Railway Authority
TRALARD	Transforming Landscapes for Resilience and Development
UK	United Kingdom
USD	United States Dollar
VU	Vulnerable
WB	World Bank
WBG	World Bank Group
WSP	WSP Canada Inc.
WWF Zambia	World Wildlife Fund Zambia
ZAFFICO	Zambia Forestry and Forest Industries Corporation
ZESCO	Zambia Electricity Supply Corporation Limited
ZEMA	Zambia Environmental Management Agency
ZIFLP	Zambia Integrated Forest Landscape Project
ZTIP	Zambia-Tanzania Interconnector Project

1. Introduction

1.1 Scope and Objectives

The Biodiversity Management Plan (BMP) for the Zambia-Tanzania Interconnector Project (ZTIP) sets out the requirements to avoid, minimize, restore and compensate for potential impacts on fauna, flora and their habitats and in particular on Critical Habitats, protected areas and Natural Habitats during the detailed design, pre-construction, construction, operation and rehabilitation phases of the project.

Main potential impacts on biodiversity that need to be appropriately managed are:

- Permanent loss of natural habitat areas (including mature and secondary miombo woodland, riverine forests and wetlands) and associated flora;
- Loss of critical habitat for two critical habitat triggering flora species (primarily *Disa aequiloba* and *Euphorbia perplexa* var. *kasamana*);
- Encroachment of the transmission line in seven Forest Reserves;
- Habitat fragmentation and degradation for fauna species, including species of conservation concern;
- Direct mortality of birds through collisions with the earth wire/ground wire, including priority species and species of conservation concern.

The overarching objective of the BMP is to ensure biodiversity considerations are fully integrated into project planning, design, construction and operation in accordance with the World Bank's Environmental and Social Framework (ESF), particularly Environmental and Social Standard (ESS) 6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources, as well as relevant Zambian legal and policy requirements. This is in addition to ZESCO's own environmental and social commitments. The BMP outlines the approach to be taken by the Project Implementation Unit (PIU) from Zambia Electricity Supply Corporation Limited (ZESCO) to meet obligations regarding the long-term conservation of important biodiversity features. It establishes the biodiversity management objectives, mitigation measures, conservation actions, compensation mechanisms, monitoring requirements, institutional responsibilities, and the rationale and actions that will enable a No Net Loss/Net Gain (NNL/NG) outcome, as well as the cost estimated necessary to meet these outcomes.

The BMP is effective throughout the project planning, construction, and operation phases. It is a living document that will be updated as results of additional studies and consultations become available, the project's design becomes detailed, and the project monitors its impacts and assesses mitigation effectiveness. Updates to the BMP, including the Natural Habitats Compensation Plan and species-specific conservation actions, will be prepared by the PIU and submitted to the World Bank and Zambia Environmental Management Agency (ZEMA) (as applicable) for review and concurrence, and disclosed in a manner consistent with the World Bank ESF and national requirements.

The document first provides updated biodiversity baseline conditions, through recent studies and consultations, forming the basis for identifying and mitigating risks and impacts. It then outlines key risks and impacts of the project on biodiversity features, including natural and critical habitat, and details the set of management measures to ensure no significant impact on biodiversity features is caused by the project. Specific management strategies for critical habitat triggering values are presented, including additional conservation actions to achieve net gain. A conceptual Natural Habitats Compensation Plan is also presented to address residual impacts on natural habitat.

A biodiversity monitoring program is established to validate the efficiency of mitigation and compensation measures. The institutional framework, capacity building requirements, implementation schedule, and budget are also specified.

1.2 Project Overview

The Zambia-Tanzania Interconnector Project (ZTIP) is the last electrical line segment to be completed to enable the interconnection between the Southern African Power Pool (SAPP) and the Eastern Africa Power Pool (EAPP). This critical point of connection between the two power pools will facilitate future power trading transactions between countries as far south as South Africa and as far north as Libya. Once completed, this could potentially create the largest geographic energy market in the world – from Cape Town to Cairo.

An Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) were prepared in 2019, and a Biodiversity Management and Monitoring Plan (BMMP) was developed in 2020. The ESIA was submitted to ZEMA on October 25, 2023, and a decision letter was delivered on March 19, 2024. The ESIA and ESMP were subsequently updated in 2024 to reflect the revised project design and in accordance with the new World Bank ESF adopted in 2018.

The ZTIP main components are:

- The Kasama-Nakonde section, which consists of:
 - 212 km of a 330kV double circuit transmission line from Kasama to Nakonde;
 - A new 330/132/66kV substation at Nakonde including installation of a dynamic voltage support device (± 250 MVAR Static Volt-Ampere Reactive Compensator [SVC] or Static Synchronous Compensator [STATCOM]);

- 15 km of a 400kV double circuit transmission line from Nakonde to the Zambia – Tanzania border;
- 12 km of a 132kV double circuit into the existing Isoka-Nakonde 66kV line (loop in loop out).
- The Pensulo-Kasama section, which consists of:
 - 386 km of a 330kV single-circuit transmission line between the Pensulo and Kasama Substations, via the Mpika Substation; this line will be more or less parallel to an existing 330kV single-circuit transmission line (Pensulo to Mpika 186 km and Mpika to Kasama 200 km);
 - Expansion works on the existing substations at Pensulo, Mpika and Kasama;
 - Installation of Dynamic Voltage Support Device (± 250 MVar SVC or STATCOM) and associated substation works at Pensulo Substation.

1.2.1 Proposed Line Route

The general project location is illustrated on Map 1-1.

The proposed line route for the segment of the double circuit 400kV line between the Nakonde Substation and the Tanzanian border starts at the Nakonde Substation and extends towards the northwest for approximately one kilometer and then turns north to cross the D1 Road. It continues towards the north for 7 km and then turns to the north-east and continues straight to the border.

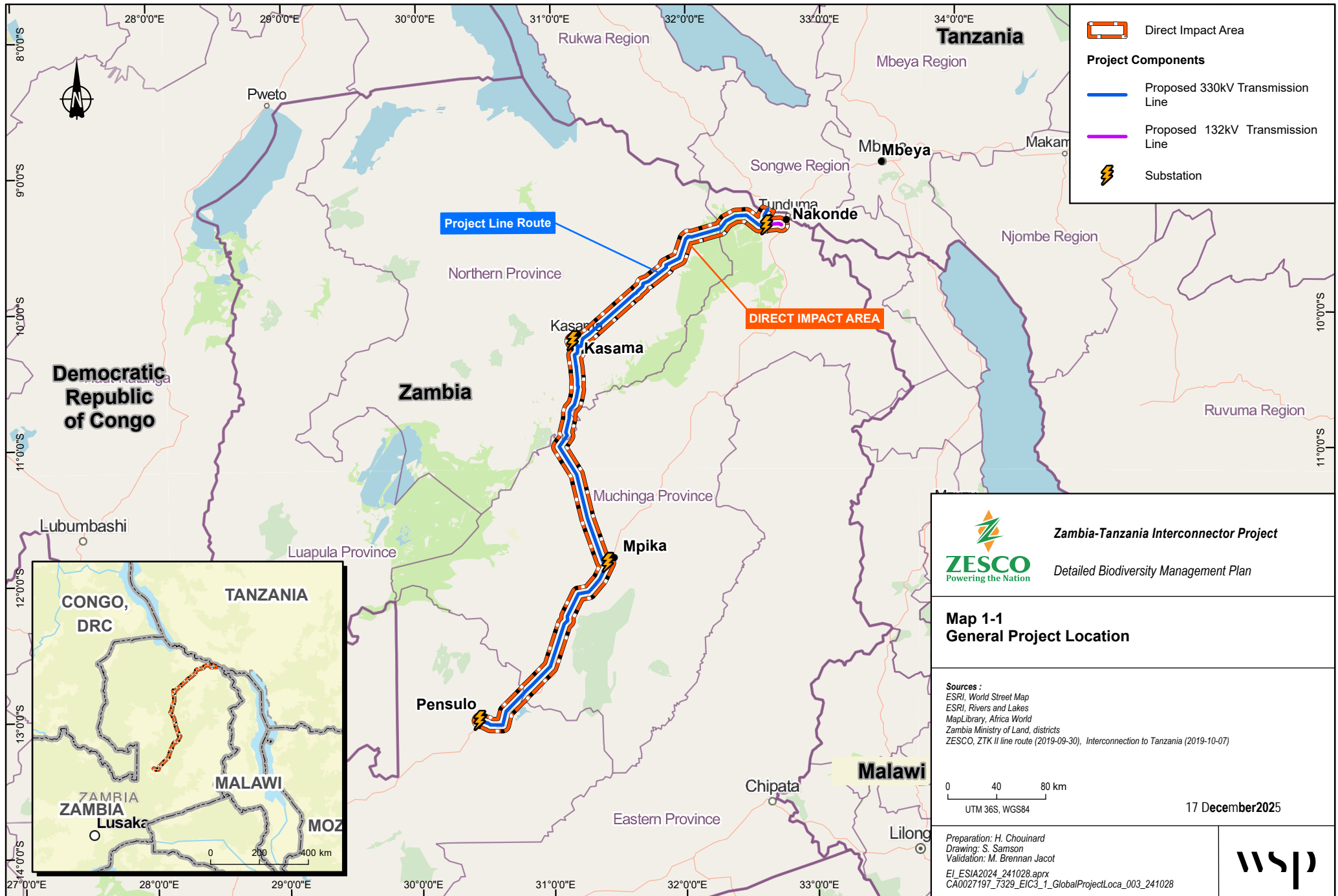
The proposed 12 km double circuit 132kV transmission line starts at the proposed Nakonde 330/132kV Substation, extending east in a straight line traversing Nakonde Zambia Forestry and Forest Industries Corporation (ZAFFICO) Pine Plantation for a distance of approximately 1.4 km before terminating on to the existing 66kV Isoka-Nakonde line.

As for the main double circuit 330kV line route, it starts at the proposed location of the Nakonde Substation. It then follows a section of the south side of the D1 Road towards the northwest before turning west and following the southern side of the D3 Road. The proposed alignment then leaves the side of the D3 Road and descends in a straight line towards Kasama district traversing Mungwi, Chitimukulu and Kasama Forest Reserves respectively. After crossing the D18 Road, the alignment turns towards the southwest to bypass Kasama's built area from the south and crossing the M1 Road before turning towards the northwest and reaches the Kasama Substation.

From Kasama, the proposed line continues south following the western side of the M1 Road as well as the alignment of a recently built 330kV Pensulo-Kasama line for about 11 km, before diverging towards the west to avoid the Bwikashi farm. The line then goes in a southwestern direction for about 3 km, where it makes an angle and heads in a south-south-western direction. It crosses the Pensulo-Kasama 330kV Project at kilometer point (KP) 24 and continues in the same direction until it reaches Road M1 at KP 35 and veers in a southern direction.

The project follows Road M1 for approximately 5 km before crossing to its eastern side and then crossing the Tanzania-Zambia Railway Authority (TAZARA) railway to get to its eastern side. It follows the TAZARA railway and M1 Road until KP 77, where it veers to the south-south-east to follow Road RD56, avoiding Chambeshi to the east and south. From there, it joins again with the Pensulo-Kasama 330kV Project, crosses it and follows its western side until reaching the Mpika Substation located in the southern part of the community.

For the last segment between Mpika and Pensulo, the proposed alignment follows a southwestern. It veers west after Lake Lusiwasi, at the level crossing of the town of Kanona within Kanona National Forest, to connect to the Pensulo Substation from the north-east.



Direct Impact Area

Project Components

- Proposed 330kV Transmission Line
- Proposed 132kV Transmission Line
- Substation

Zambia-Tanzania Interconnector Project
ZESCO Powering the Nation
 Detailed Biodiversity Management Plan

Map 1-1
General Project Location

Sources :
 ESRI, World Street Map
 ESRI, Rivers and Lakes
 MapLibrary, Africa World
 Zambia Ministry of Land, districts
 ZESCO, ZTK II line route (2019-09-30), Interconnection to Tanzania (2019-10-07)

0 40 80 km
 UTM 36S, WGS84

17 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 EI_ESIA2024_241028.aprx
 CA0027197_7329_EIC3_1_GlobalProjectLoca_003_241028

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.

1.2.2 Project Components

1.2.2.1 Voltage Level

The transmission line will be operated at 330kV from the Pensulo Substation to the Nakonde Substation, which is the standard high-voltage tension level in Zambia. However, the last section between the Nakonde Substation and the Tanzanian border will be designed and built at 400kV but operated at 330kV.

Note that in addition to the above, the project also includes the construction of a line segment designed at 132kV between the Nakonde Substation and linking to the 66kV Isoka-Nakonde line; this is part of ZESCO's scope, to reinforce the existing network and increase reliability and security of energy supply.

1.2.2.2 Number of Circuits

The project involves four distinct line segments:

- The section between the Tanzanian border and the Nakonde Substation will be a double circuit 400kV line.
- The section between Kasama and Nakonde will be a double circuit 330kV line.
- The section between Pensulo and Kasama will be a single circuit 330kV line and it will be operated in pair with an existing Pensulo-Kasama 330kV single circuit line.
- The section between Nakonde and Isoka will be a double circuit 132kV line (loop in and out of 66kV Isoka-Nakonde line).

Overall, these components will form a double circuit interconnection with the Tanzanian network, mounted on two distinct one-circuit lines for the section between Pensulo and Kasama and on one double circuit line for the section between Kasama and Nakonde.

The pylons configuration along the line will be adapted based on voltage level and number of circuits for each section.

1.2.2.3 Tower Types

Technical studies recommend selection of a combination of guyed and self-supporting lattice steel towers, as they are commonly used in Zambia. However, ZESCO is presently opting to predominantly use self-supporting steel lattice towers at the 330kV voltage level and this will be adopted for this project. Tower characteristics that are planned in double circuit and single-circuit scenarios are presented in Table 1-1 below. It should be noted that pylon heights vary in function of technical requirements caused by local constraints such as topography, line spans, crossings of infrastructure, etc.

Table 1-1 Tower Characteristics¹

Characteristics	Single circuit, rigid suspension, 330kV	Double circuit DC suspension 330kV	Double circuit DC suspension 400kV	Double circuit suspension 132kV
Tower heights (m from top of foundations to top of pylons)	Standard: 31 Minimum: 26.5 Maximum: 37	Standard: 44.45	Standard: 50.3 Minimum: 44.3 Maximum: 60.8	Standard: 21 Minimum: 18 Maximum: 30
Average line span (m)	400	375	400	300
Locations	Kasama to Pensulo Substations	Kasama to Nakonde Substations	Nakonde Substation to Tanzanian border	Nakonde new Substation to Nakonde–Isoka (Loop in-Loop out)
Footprint (m ²)	Average: 34.2 Minimum: 26.4 Maximum: 149.6	Average: 103.0 Minimum: 81.0 Maximum: 182.9	Average: 77.9 Minimum: 64.0 Maximum: 140.4	Average: 30.2 Minimum: 25.9 Maximum: 55.2

1.2.2.4 Phase Conductor

Conductors will be the Bison type (Aluminum-Conductor Steel-Reinforced Cable [ACSR]) for the single circuit (Pensulo-Kasama) and double circuit (Kasama-Nakonde) 330kV line. Their use is justified because of their high strength parameter, necessary for very long spans and heavy loads. A bundle of two conductors per phase is necessary.

For the 400kV double circuit line between the Nakonde Substation and the Tanzania border, the conductors will be BlueJay type (ACSR) in bundle of two conductor per phase. For the 132kV double circuit line that will loop in and out of the 66kV Isoka-Nakonde line, the conductor will be a Wolf ACSR.

1.2.2.5 Foundations

Foundation design will be subject to re-evaluation on completion of the site geotechnical investigations. Soil properties including actual quantities of foundations for each tower type located in these soil classifications will be estimated following a full review of the geotechnical results and quantified within the Price Schedules.

- Rock Socket / Rock Anchors where solid rock is encountered
- Concrete pad and chimney: generally based on the allowable bearing capacity of each soil type
- Special foundations either piled or raft type, where soils are particularly poor.

The Contractors will be fully responsible for determining the soil classification at each tower location prior to installation.

¹ AECOM, 2017. Feasibility Study and Conceptual Design of Tanzania-Zambia Power Interconnection Study. Final Feasibility Study.

A slab foundation with reinforced concrete body consists of reinforced concrete slabs buried about 3.0 m below the ground, one for each leg of the tower. Backfilling is done with dug up material excluding organic surface matter. This foundation is adequate for firm or rigid clay soils, firm or rigid laterite soils, medium to large grained alluvial formations lying above the water table, and diggable bedrock. In firm soil the slab may be poured directly into the dug-up soil to take advantage of the better capacity of intact soil. Wider footings will be required for foundations in loose soil or soil below the water table.

When bedrock is encountered that is too hard to be excavated by an excavator, rock-anchored concrete blocks will be required to support the towers. Reinforcement bars are driven and grouted into holes bored into the rock. This type of foundation is appropriate for locations where bedrock is found less than 3.0 m below the surface and is too hard for digging without hammer tools or blasting.

Concrete pylon foundations are commonly used in Zambia.

1.2.2.6 Right-of-Way (ROW)

The width of the ROW had to be determined to satisfy minimum technical requirements and comply with the Energy Regulation Board (ERB) Wayleave Code of Practice standards which ZESCO uses. ROW width will vary according to the voltage level.

Furthermore, the width of the acquired wayleave varies along the alignment, depending on whether or not the project is paired with another ZESCO wayleave. The additional wayleaves required can be summarized as follows (AECOM, 2017):

- 60 m for the double circuit 400kV line between Nakonde and the Tanzanian border;
- 50 m when the new 330kV line wayleave is not paired with another existing wayleave;
- 35 m for 330kV line segments paired with the existing 330kV line present between Pensulo and Kasama;
- 32 m for the 132kV between the Nakonde Substation and linking to the 66kV Isoka-Nakonde line.

The current ROW management practices in Zambia, according to ZESCO officials, are described in the following table.

Table 1-2 Current ROW Management Practices in Zambia

Item	Practices
ROW acquisition practices	ZESCO obtains the right-of-way for the wayleave through a negotiated agreement with affected parties but does not acquire the land.
Uses allowed in the ROW	Growing of seasonal low-laying crops; below 2 m in height (e.g., maize, wheat, etc.) is allowed.
Uses not permitted	Growing crops exceeding 2 m in height is not allowed. As per ZESCO policy, crop(s) destroyed during construction or maintenance will be compensated for.
Policy regarding service road minimization	The ZESCO environmental guidelines urge the Contractors to only create new access roads where there are no existing ones. They are always encouraged to use and maintain existing roads.

1.2.2.7 Substations

Only one substation will need to be built for the project, that is the Nakonde Substation. For the Kasama, Mpika and Pensulo substations, they are already built but will require the addition of some new equipment within their existing boundaries in relation to the new interconnector project. No additional footprint will be required for these substations.

Nakonde Substation

The proposed substation in Nakonde District is located within Chitamba village in Chieftainess Nawaitwika area, at an altitude of 1,500 m. The total substation area is 49.76 ha.

High-level scope of works at Nakonde substation shall comprise of the following:

- Two (02) x Kasama - 330kV Feeder Bays each fully equipped with 1 x 30 MVAr 330kV Line Shunt Reactor Bay;
- One (01) x Tunduma 1 - 330kV Feeder Bay fully equipped;
- One (01) x Tunduma 2 - 330kV Feeder Bay fully equipped;
- Two (02) X 60MVA, 330/132kV transformer Bays;
- Isoka and Nakonde 66kV Feeder Bays;
- 330 and 66kV Busbars complete with Buscouplers;
- One (01) x ±250 MVAr SVC or STATCOM.

1.2.2.8 Temporary Facilities

During construction, it will be necessary to establish temporary facilities and installations where required:

- Construction camps,
- Access roads,

- Laydown and storage areas,
- Concrete facilities, etc.

Construction activities are forecast to include the following activities, as per detailed in the ESIA: site preparation, transportation and traffic circulation, construction (including tower erection, stringing works, etc.), and waste management and hazardous materials management. Those broad categories will be defined in more detail by the Contractors at the beginning of the assignment, during the pre-construction phase, when the Contractors will develop various construction plans.

The location and extent of these components are not yet known and will be the Contractor's responsibility. To the extent possible, the sites required for that infrastructure should be acquired under willing-buyer, willing-seller agreements to avoid involuntary resettlement.

1.2.3 Project Costs and Schedule

The budgetary estimate for the project is 285 million USD, including associated project management and capacity building costs. The project shall be co-financed with contributions from the European Union (EU) and United Kingdom (UK) Government through the Foreign, Commonwealth and Development Office (FCDO) and the World Bank (WB), with the WB acting as the fund administrator. The project will be implemented by ZESCO and incorporated within ZESCO's Planning and Projects Directorate.

As for implementation schedule, activities are divided into five separate packages, all of which are planned to require 24 months, starting from the start-up meeting of the construction contract to commissioning. Package 1 is for the Pensulo-Mpika Section, Package 2 is for the Mpika-Kasama Section, Package 3 is for the Kasama-Nakonde Section, Package 4 is for the new Nakonde Substation and Package 5 is for the equipment at Pensulo and Nakonde Substations. For each of these packages, the first months will be dedicated to preparation activities such as detailed survey, preparation of construction schedule, detailed design, etc. Field construction activities are planned to begin on month 7 and therefore will last 17 months. Details of the construction schedule are provided in the ESIA (stand-alone report).

1.2.4 Project Activities

1.2.4.1 Pre-Construction Phase

The pre-construction phase will start once all studies are completed and the project is ready to be implemented. The main activities being conducted at different stages include:

- Labour recruitment, including hiring of local and foreign workers.
- Land use restrictions and resettlement of affected persons and assets, which will include displacement of economic activities.

- Site preparation: site preparation activities, including establishment of equipment storage yards and worker camps, vegetation clearing, removal of topsoil, excavation, earthworks and construction of access roads. The exact size and location of the storage yards and worker camps remain to be specified. The extent and configuration of vegetation clearing will require only strips of land to be cleared due to it being for line construction and certain access roads.

1.2.4.2 Construction Phase

The construction phase will mainly involve the following activities:

- Transportation and traffic: road transportation of materials, equipment and workers to and from the site, including fueling and maintenance of vehicles and machinery.
- Construction activities: construction of the power transmission line and substations, including temporary facilities used during the work phase, such as borrow pits, as well as the erection of towers and stringing of conductors.
- Waste and hazardous materials management: management and storage of waste, hazardous substances and other materials to be removed, including hydrocarbons.
- Purchase of materials, goods and services: purchases required for the construction of the power transmission line and substations.
- Presence of workers: presence of the construction workforce, including hiring foreign and local skilled/unskilled workers, as well as the installation and operation of construction work camps.

1.2.4.3 Operation Phase

The following activities are expected during the operation phase:

- Presence and operation of line, substations, and access roads: presence and operation of facilities.
- Transportation and traffic: road transportation of materials and equipment, including vehicle fueling and maintenance.
- Maintenance and repairs: inspection, maintenance, and repair of conductors, towers, and structures in substations, as well as ROW maintenance.
- Waste and hazardous materials management: handling operations and storage of hazardous waste used during the operation, including oil used in transformers at substations.
- Purchase of materials, goods, and services: purchases required for the operation of the substations and the transmission line.
- Presence of workers: hiring local and foreign workers, as appropriate, and presence of employees operating substations, during maintenance along the line.

1.3 Summary of Requirements

The BMP was developed with consideration to:

- Relevant ZESCO environment and social management policies and commitments;
- National requirements; and
- WB requirements.

Contractors will need to review ZESCO's Environmental and Social (E&S) management policies and commitments in addition to any National or International requirements relevant to their (Contractors) work scope and responsibilities.

1.3.1 National Requirements

Environmental Management Act, No. 12 of 2011

The Environmental Management Act (EMA), 2011 provides the legislative framework for environmental protection in Zambia. The EMA was enacted to establish ZEMA, provide for integrated environmental management and the sustainable use and management of natural resources, and address emerging environmental issues and challenges such as climate change and pollution from persistent organic pollutants. The EMA is the parent legislation for the Environmental Management (Environmental Impact Assessment) Regulations, 2026 and Environmental Management (Licensing Regulations, 2013.

Part IV, Division 8 of the EMA sets out requirements for environmental protection and pollution control regarding natural resources management. Requirements such as the protection of hills and landscapes, the promotion of conservation of natural resources, and the prohibition to introduce invasive alien species were considered in the BMP.

Environmental Management (Environmental Impact Assessment) Regulations, 2026

This regulation outlines the Environmental Impact Assessment process to be carried out prior to implementation of a project. This regulation revokes the Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997 under which the ESIA for the ZTIP was developed.

The regulations state that an environmental and social management plan should be prepared, describing measures proposed for preventing, minimizing or compensating for any adverse impact, and measures to monitor adverse effects of the project. The BMP provides such measures.

Environmental Management (Licensing) Regulations, S. I. No. 112 of 2013

The Regulations provide for the licensing of pollution sources to protect human health, plant, and animal life and the environment against adverse effects. These regulations provide the right for ZEMA to issue site restoration, prevention, protection, environmental restoration, and compliance orders when projects or project-related activities pose a risk of causing adverse impacts on the environment.

Energy Regulation Act, No. 12 of 2019

The Act creates the Energy Regulation Board (ERB). The role of the ERB, among other functions, is to ensure all energy utilities in the sector are licensed, to monitor levels and structures of competition, to investigate and remedy consumer complaints, as well as to formulate measures to minimize the environmental impact of activities carried out in the energy sector.

Water Resources Management Act, 2011

The Act provides for the ownership, control and use of water. It delegates management of water resources through Catchment Councils established under the Act, consisting of the water users of the catchment. It further provides for the equitable, reasonable and sustainable use of water resources in Zambia.

This Act establishes a regulatory and administrative framework for the management, development, conservation, protection and preservation of the water resource in Zambia and provides with respect to water rights and the equitable and sustainable use of water resources and related matters.

Forest Act, No. 4 of 2015

This Act provides for the management and development of National Forests, Local Forests, Joint Forest Management Areas, Botanical Reserves, Private Forests and Community Forests; provides for the participation of local communities, local authorities, traditional institutions, non-governmental organizations and other stakeholders in sustainable forest management; and provides for the conservation and use of forests and trees for the sustainable management of forest ecosystems and biological diversity, among others.

This Act is relevant to the BMP as the transmission line crosses seven Forest Reserves, and compensation actions are targeted in Forest Reserves and Community Forests. Community Forest Management Groups, which are identified as key partners in the implementation of the Natural Habitats Compensation Plan, are recognized and organized by the Forest Act, 2015.



Natural Resources Conservation Act, Cap 315, 1970

The Act relates to the monitoring of natural resource conservation and utilization outside Forest Reserves and National Parks, as well as controlling bush fires and powers of Minister to make regulations.

Zambia Wildlife Act No. 14 of 2015

This Act governs the affairs of the Zambia Wildlife Authority; establishes the Department of National Parks and Wildlife in the Ministry responsible for tourism; provides for the establishment, control and management of National Parks, bird and wildlife sanctuaries and for the conservation and enhancement of wildlife ecosystems, biological diversity and objects of aesthetic, pre-historic, historical, geological, archeological and scientific interest in National Parks; provides for the promotion of opportunities for the equitable and sustainable use of the special qualities of public wildlife estates; and provides for the development and implementation of management plans, among others.

The Act is relevant to the BMP in regard to the avoidance and mitigation strategy for impacts on wildlife and habitats.

Zambia Wildlife (Protected Animals) Order, S. I. No. 42 of 2016

The Zambia Wildlife (Protected Animals) Order, S.I. No. 42 of 2016 revokes the National Parks and Wildlife (Protected Animals Order and 1993) and lists the animals that should not be hunted without a license. The order has been made in accordance with the provisions of section 36 of the Zambia Wildlife Act No. 14 of 2015, which gives the minister responsible for wildlife the power to specify protected animals that cannot be hunted without a license.

National Parks and Wildlife (Game Animals) Order, S. I. No. 41 of 2016

The Zambia Wildlife (Game Animals) Order, S. I. No. 41 of 2016 specifies animals considered as game management animals and prohibits hunting such animals without a license. The order further revokes the Zambia Wildlife (Game Animals) Order No. 10 of 2015.

Fisheries Act, No. 22 of 2011

An Act to provide for the appointment of the Director of Fisheries and fisheries officers and provide for their powers and functions; promote the sustainable development of fisheries and a precautionary approach in fisheries management, conservation, utilization and development; establish fisheries management areas and fisheries management committees; provide for the regulation of commercial fishing and aquaculture; establish the Fisheries and Aquaculture Development Fund; repeal and replace the Fisheries Act, 1974; and provide for matters connected with, or incidental to, the foregoing.

Water Supply and Sanitation Act No. 28 of 1997

This Act regulates water supply and sewerage utilities to protect consumers from unjustified tariffs.

National Heritage Conservation Commission Act, Cap 173, 1989

The Act provides for the conservation of ancient, cultural and natural heritage, relics and other objects of aesthetic, historical, pre-historical, archaeological or scientific interest, by preservation, restoration, rehabilitation, reconstruction, adaptive use and good management.

The Commission also provides regulations for archaeological excavation and export of relics. If a development is unable to proceed without affecting an item of heritage, permission must be sought from the National Heritage and Conservation Commission. This Act applies as the project impacts the Mwela Heritage Site, located in Kasama Forest Reserve which is crossed by the transmission line.

Land Act, Cap 184, 1995

Under the Land Act 1995, all land in Zambia is vested in the President who has the power of alienation to any Zambian and to non-Zambian under certain circumstance. Alienation of land situated in a district or an area where land is held under customary tenure requires taking local customary law into consideration, consulting the Chief and local authority. The President can take measures to set aside land for forest reserves and national parks. The Land Act is relevant to the BMP in regard to land rights at compensation sites.

Land Acquisition Act, Cap 296, 1970

This Act grants the President of the Republic to compulsorily acquire property provided that appropriate compensation be paid. Notices to show the intention to acquire, to yield up property and to take up possession are required to be issued prior to the acquisition. Under this Act, all land and structures to be acquired must be valued at market value.

Though land acquisition for the ZTIP is addressed in the Resettlement Action Plan (RAP) (separate report), land acquisition at compensation sites may result from reforestation and assisted natural regeneration actions.

Convention on Biological Diversity

The Convention on Biological Diversity (CBD) is an international convention (to which Zambia is a signatory) and represents a commitment to sustainable development. The Convention has three main objectives: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits from the use of genetic resources (<http://www.cbd.int/convention/guide/>). The convention makes provisions (in a general policy guideline) for maintaining and restoring biodiversity. In addition to this, the CBD is an ardent supporter of thorough assessment procedures (Strategic Environmental Assessments and Environmental Impact Assessments) and requires that Parties apply these processes when planning activities that will have a biodiversity impact.

An important principle encompassed by the CBD is the precautionary principle, which essentially states that where serious environmental threats exist, lack of full scientific certainty should not be used as a reason for delaying management of these risks. The burden of proof that the impact will not occur lies with the proponent of the activity posing the threat. In addition, the Aichi Biodiversity Targets (CBD, 2011) address several priority issues, i.e., the loss of biodiversity and its causes, reducing direct pressure on biodiversity, safeguarding ecosystems, species, and genetic diversity, and participatory planning to enhance the implementation of biodiversity conservation. Each of these is relevant in the case of powerline and substation infrastructure development and biodiversity conservation through all project phases, from planning to the implementation of mitigation measures for existing developments.

The Agreement on the Conservation of the African-Eurasian Migratory Water Birds

The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory waterbirds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland, and the Canadian Archipelago. The AEWA covers 255 species of birds ecologically dependent on wetlands for at least part of their annual cycle, including many species of divers, grebes, pelicans, cormorants, herons, storks, rails, ibises, spoonbills, flamingos, ducks, swans, geese, cranes, waders, gulls, terns, tropic birds, auks, frigate birds, and even the South African penguin. The core activities carried out under AEWA are described in their Action Plan, which is legally binding for all countries that have joined the Agreement. The AEWA Action Plan details the various measures to be undertaken by Contracting Parties and Non-Party Range States (Zambia included) to guarantee the conservation of migratory waterbirds within their national boundaries. The objectives of the Action Plan are to:

- Objective 1: strengthen species conservation and recovery and reduce causes of unnecessary mortality
- Objective 2: ensure that any use and management of AEWA-listed migratory waterbird populations is sustainable across their flyways
- Objective 3: establish and sustain a coherent and comprehensive flyway network of protected areas and other sites, managed to maintain – and where necessary restore – their national and international importance for migratory waterbird populations
- Objective 4: ensure there is sufficient quantity and quality of habitat in the wider environment for achieving and maintaining favorable conservation status for migratory waterbird populations
- Objective 5: secure and strengthen the knowledge, capacity, recognition, awareness and resources required for the Agreement to achieve its conservation objectives

1.3.2 World Bank Requirements

ESS 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources

Environmental and Social Standard (ESS) 6 recognizes that protecting and conserving biodiversity and sustainably managing living natural resources are fundamental to sustainable development. Biodiversity is defined as the variability among living organisms from all sources, including inter alia, terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems.

ESS 6 requires Borrowers, such as the government of Zambia in this instance², to avoid adverse impacts on biodiversity and habitats. When avoidance of adverse impacts is not possible, measures to minimize adverse impacts and restore biodiversity in accordance with the mitigation hierarchy must be implemented. Where significant risks and adverse impacts on biodiversity have been identified, the Borrower will develop and implement a Biodiversity Management Plan, consistent with the mitigation hierarchy and the specific requirements of ESS 6. Where significant residual impacts remain, appropriate biodiversity offsets or compensation measures must be implemented.

This ESS addresses and applies to all habitats, which are categorized as ‘modified habitat’ (taken to mean areas that have been substantially altered by human activity), ‘natural habitat’, and ‘critical habitat’, along with ‘legally protected and internationally and regionally recognized areas of biodiversity value’. The ESS requires a differentiated risk management approach to habitats based on their sensitivity and values:

- In natural habitats, which are areas composed of viable assemblages of largely native species where ecological functions remain largely intact, mitigation measures must achieve no net loss of biodiversity and, where feasible, preferably a net gain of biodiversity over the long term through application of the mitigation hierarchy and, where necessary, biodiversity compensation.
- In critical habitats, which essentially are areas of high biodiversity value meeting defined criteria (e.g., presence of endangered species, endemic species, restricted-range species, or significant ecological concentrations), a mitigation strategy will be designed to achieve net gains in the biodiversity values for which the critical habitat was designated. Projects may only proceed if stringent conditions are met, including demonstration that there are no measurable adverse impacts on the biodiversity values for which the habitat was designated, and that a mitigation strategy is designed to achieve net gain of those biodiversity values.
- In protected areas, additional programs must be implemented to promote and enhance the conservation aims and effective management of the area.

² The World Bank is awarding a grant to the Government of Zambia for the ZTIP.



This BMP for the ZTIP has been prepared to ensure full compliance with ESS 6, including achievement of no net loss for natural habitats and net gain for critical habitat values.

1.4 Methodology

Various methods were used to complete this BMP, including field work to gather biological baseline data and information and stakeholder consultations.

1.4.1 Field Work

The development of the BMP, and more specifically the biological baseline, relies on several rounds of field campaigns at different stages of the ZTIP development, covering several taxonomic groups. Main biological field work completed is summarized in Table 1-3. The detailed methodologies for each survey are presented in Appendix 2-1 and in the appended 2025 sectorial reports (Appendices 2-4, 2-5, 2-10, 2-11 and 2-14).

Table 1-3 Overview of Surveys Conducted to Establish Biological Baseline Conditions

Taxonomic group	Survey	Timing	Objectives
Flora	2015-2016 Flora Surveys	September 2015 and June 2016	Characterize flora communities and habitat types in the project area.
	2019 Walkover Surveys in Forest Reserves	September 2019	Assess and verify land use conditions and habitat type and quality within the Forest Reserves crossed by the transmission line.
	2019 Rapid Flora Surveys	October-November 2019	Characterize vegetation structure, composition, density, and conservation value of the different habitat types along the line route.
	2025 Targeted Surveys for <i>Euphorbia perplexa</i> var. <i>kasamana</i>	September 2025 (dry season)	Determine the presence and distribution of <i>Euphorbia perplexa</i> var. <i>kasamana</i> within the project's area of influence in the Kasama Forest Reserve and its surroundings.
	2025 Targeted Surveys for <i>Disa aequiloba</i>	February 2025 (wet season)	Determine the presence and distribution of <i>Disa aequiloba</i> within the wetlands crossed by the transmission line.
	2025 Habitat Validation Campaign	September 2025	Update mapping of natural habitats, more specifically affected miombo woodland, and gather additional information on species and biophysical parameters of miombo woodland.

Taxonomic group	Survey	Timing	Objectives
Bird	2019 Bird Surveys	October-November 2019	Collect bird occurrence data and delineate migratory flyways within the proposed powerline corridor and its immediate surroundings.
	2025 Bird Surveys	March-April 2025 (wet season) September 2025 (dry season)	Document current species presence along the transmission line, identify migration routes and local movement patterns of bird species and confirm spans of the power line that require mitigation.
	2025 Bird Mortality Monitoring	April-May 2025 (wet season) September 2025 (dry season)	Identify and quantify avian mortality due to collisions with existing power line infrastructure in areas adjacent to the proposed ZTIP 330kV transmission power line alignment.
Bat	2019 Bat Surveys	November 2019	Collect evidence of bat occurrences, especially special status species, and document migration routes in and around the proposed line route.
	2025 Bat Surveys	January 2025	Update and supplement information on bat occurrences, especially special status species, and document migration routes in and around the proposed line route.
Large mammals	2019 Terrestrial Mammals Assessment	November 2019	Validate and account for the large mammals present in the project area.
Herpetofauna	2025 Herpetofauna Surveys	March 2025 (wet season) August-September 2025 (dry season)	Establish a baseline understanding of the herpetofauna within the project area.

1.4.2 Consultation

Several stakeholder engagement activities have been undertaken as part of the environmental and social studies associated with the ZTIP. Consultations were organized at key stages of the ESIA, ESMP and Resettlement Action Plan (RAP) development so that results could be integrated to the various studies. The results of these consultations rounds are detailed in the ESIA (WSP, 2024). A specific round of consultation was organised as part of the development of the Detailed BMP in November 2025.

This round of consultation had the following objectives:

- Present the project and Natural Habitats Compensation Plan (NHCP) context to national and decentralised stakeholders, explaining the guiding principles for compensation of natural habitat loss in alignment with WB ESS 6, and secure their collaboration for the next steps.
- Clarify any national legal requirements and acquire any relevant documentation at national or local level regarding biodiversity offsets, conservation targets, biodiversity protection strategies, as well as biodiversity and landscape policy documents.



- Identify conservation efforts and planned conservation activities within the project area, including within Forest Reserves and Community Forests, to inquire about key takeaways from these projects and potential partners to provide support during implementation.
- Validate the proposed actions and criteria for the selection of compensation and restoration sites.
- Explore opportunities for biodiversity compensation and restoration actions within the ZTIP landscape with local actors.
- Discuss conservation initiatives for *Disa aequiloba*, *Euphorbia perplexia* var. *kasakama* and wetland habitats with local experts and/or Non-Governmental Organizations (NGOs).

Table 1-4 provides an overview of meetings held as part of this round of consultation. The detailed minutes of meetings and signature sheets are provided in Appendix 1-2.

Table 1-4 Overview of Consultation Activities Undertaken as part of the Detailed Biodiversity Management Plan

Stakeholder	Dates	Number of participants ¹
Workshop with the following stakeholders: <ul style="list-style-type: none"> ▪ Department of National Parks and Wildlife (DNPW), National Office; ▪ Forestry Department, National Office; and ▪ Zambia Environmental Management Agency (ZEMA). 	November 10, 2025	6
Meetings with the following stakeholders: <ul style="list-style-type: none"> ▪ Forestry Department, Northern, Central and Muchinga Province Offices; ▪ Forestry Department, Serenje, Chitambo, Mpika, Nakonde, and Kasama District Offices; ▪ DNPW, Muchinga and Northern Province Offices; ▪ National Heritage Conservation Commission (NHCC), Northern Province Office; ▪ Ilumbwe, Kaloswe, Isolala, Nankungu, and Kampabwa Community Forest Management Groups (CFMGs); ▪ Kasanka Trust; ▪ Community Markets for Conservation (COMACO); ▪ Center for Environmental Justice; ▪ Copperbelt University. 	November 11 to 19 and December 11, 2025	79

Note: ¹ The indicated number of participants excludes representatives from ZESCO, Cities and Infrastructure for Growth Zambia (CIGZambia) and WSP.

The results of stakeholder engagement activities held at previous stages of the environmental and social studies for the ZTIP have also contributed to the development of the Detailed BMP and associated studies (such as the Critical Habitat Assessment):

- Meetings with the Department of National Parks and Wildlife (DNPW) to confirm park boundaries, gather information on wildlife and discuss concerns regarding the changes in line route alignment (2019);
- Meetings with the Forestry Department at national and district levels to confirm Forest Reserve boundaries, collect information on habitats within these areas and discuss concerns and requirements regarding the changes in line route alignment (2019);
- Meetings with eleven key informants in the areas along the powerline to discuss the presence of large mammals (2019);
- Meetings with the DNPW at the national level regarding project updates (2024); and
- Meetings with the Forestry Department at district level regarding project updates (2024).

The results of all stakeholder engagement activities were integrated into the relevant sections of the Detailed BMP. The following table summarizes some of the main findings and recommendations coming from the stakeholder engagement activities and particularly the ones associated with the development of the Detailed Biodiversity Management Plan.

Table 1-5 Results from Stakeholder Engagement Activities and Integration in the Detailed BMP

Area of concern	Concerns, comments and recommendations	Consideration in the detailed BMP
Proposed restoration actions	Miombo woodlands show strong natural regeneration potential, making Assisted Natural Regeneration (ANR) a viable restoration method.	Restoration actions described in Section 6.3.3.1 include both ANR and Reforestation.
Conditions for long term conservation results	Managed Forests face multiple challenges in the protection of miombo woodlands and forests. Challenges include encroachment from surrounding communities (charcoal production, agriculture, uncontrolled fire, human settlements) exacerbated because of the lack of boundary demarcation and capacities from the Forestry Departments and Community Forest Management Group	Section 6.6 identifies the enabling conditions and mechanisms to support compensation actions. It addresses challenges expressed. Proposed capacity building program also includes various training and identification of equipment to improve the human and material capacities of the Forestry Departments and the CFMGs.
Conditions for long term conservation results	Incentives for the surrounding communities and involved Community Forest Management Groups officers are key to ensure their full collaboration in the protection of the forest and respects of the bylaws included in the Management Plans. Livelihood alternatives including bee keeping, sustainable caterpillars or mushrooms collect, and agroforestry could be integrated in the NHCP.	Section 6.6 identifies the enabling conditions and mechanisms to support compensation actions. It includes the development of alternative livelihoods to reduce anthropogenic pressures. Also, the capacities building program include training of local communities on forest-based livelihood, alternative techniques for land preparation, etc.

Area of concern	Concerns, comments and recommendations	Consideration in the detailed BMP
Conditions for long term conservation results	Multiple rounds of sensitization with surrounding communities will be needed to ensure long term results. The village leaders and villages headmen will need to be involved and committed.	The NHCP includes community commitment and participation as an enabling condition (Section 6.6.2). It includes sensitization campaigns in local communities.
Actors	Forestry Departments and Community Forest Management Groups are motivated to participate in the implementation of the Natural Habitats Compensation Plan.	Forestry Departments and Community Forest Management Groups are identified as implementation partners for the NHCP.
Actors	Copperbelt University and NGOs offer valuable expertise in nursery management, native miombo species, orchid conservation and ecosystem monitoring.	Copperbelt university has been engaged further for the development of the conservation actions for <i>Disa aequiloba</i> and <i>Euphorbia perplexa</i> var. <i>kasamana</i> and their experts have validated the list of species used for restoration actions. The Copperbelt university is also identified as an implementation partner for the NHCP.
Actors	The Forestry Commission will be an important actor for the planning and implementation of the NHCC. Memorandums of Understanding (MoUs) should be signed to clarify each actor's responsibilities. There is an issue with staff turnover, so MoUs could help mitigate potential issues in this regard.	It is indicated in Section 9.1.4 that Letters of notification should be sent to partners, especially District Forestry Departments and CFMGs, to clearly define their involvement and responsibilities.
Conservation actions for <i>Disa aequiloba</i>	Conservation actions to be implemented for <i>Disa aequiloba</i> could integrate community-based conservation of wetlands (successful with the Darwin-funded project) as well as propagation and translocation of individuals.	The recommendations are integrated within the proposed Conservation Actions for <i>Disa aequiloba</i> and wetlands (Section 7.1).

2. Biodiversity Baseline Conditions

This chapter details the information collected on the biological environment in the project area. It is based on recent secondary data from literature review and databases, as well as primary data collected during field surveys for targeted biological components, including vegetation and habitats, birds, bats, large mammals and herpetofauna.

This biological baseline is an update of the biological baseline contained in the ESIA (WSP, 2024) and includes results of most recent biological surveys completed in 2025 for birds, bats, herpetofauna and critical habitat triggering flora species, as well as results from previous biological surveys carried out in previous phases of the project (2016 and 2019). This baseline also relies on an updated photointerpretation of habitat types and land uses, based on recent satellite imagery (2025). All this information allowed to reach a comprehensive, well-documented assessment of the existing biodiversity conditions in the project area, updating the baseline of targeted species and habitats, in order to better characterize natural habitats and biodiversity values associated to them.

Standardized, scientifically accepted survey methods and data collection protocols have been applied to ensure data reliability and comparability over time. The biological baseline characterization detailed methodology is presented in Appendix 2-1.

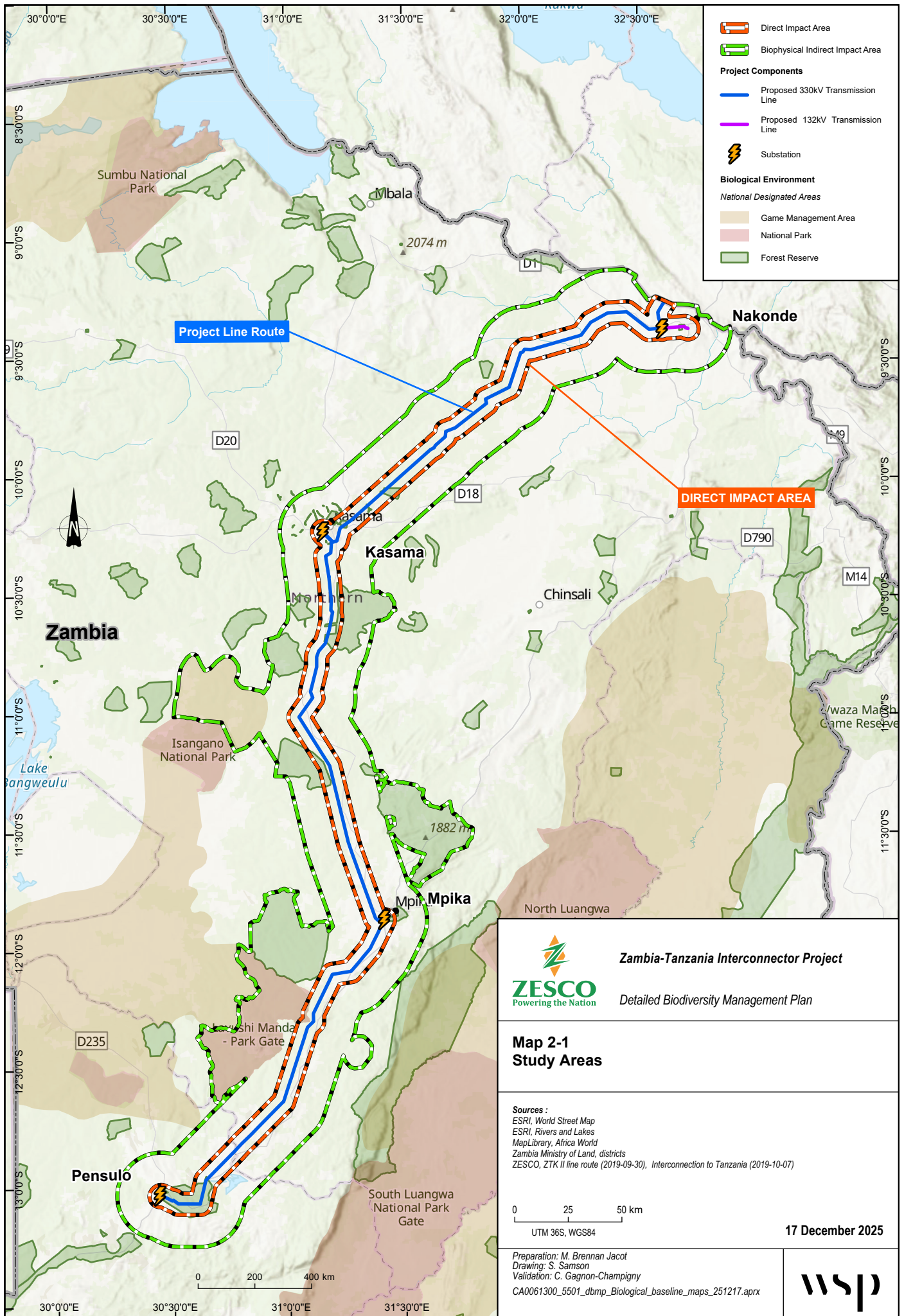
2.1 Identification of Study Areas

To describe the biological baseline conditions, two study areas have been identified:

- A Direct Impact Area (DIA) consisting of a 5 km buffer area on either side of the line route and around substations. The DIA has an area of 6,152.07 km² and is considered to be the area where the project's immediate environmental and social effects are mainly felt. The DIA integrates the project's direct footprint.
- A Biophysical Indirect Impact Area (BIIA) consisting of a 20 km buffer area on either side of the line route and around substations, as well as all protected areas that are completely or partially contained within this buffer area. The BIIA was determined to take into account ecosystems and habitat connectivity. It is used to portray the biophysical environment and is where indirect impacts on physical and biological components are likely to be felt. The BIIA has an area of 28,676.18 km².

The study areas are shown on Map 2-1.

Though the DIA comprises a 5 km buffer area around the project footprint, the ROW and substation footprints are more thoroughly characterized as these are where impacts will be the most important, including in terms of habitat modification and resettlement.




Zambia-Tanzania Interconnector Project
ZESCO
 Powering the Nation

Detailed Biodiversity Management Plan


Map 2-1
Study Areas

Sources :
 ESRI, World Street Map
 ESRI, Rivers and Lakes
 MapLibrary, Africa World
 Zambia Ministry of Land, districts
 ZESCO, ZTK II line route (2019-09-30), Interconnection to Tanzania (2019-10-07)

0 25 50 km
 UTM 36S, WGS84

17 December 2025

Preparation: M. Brennan Jacot
 Drawing: S. Samson
 Validation: C. Gagnon-Champigny
 CA0061300_5501_dbmp_Biological_baseline_maps_251217.aprx

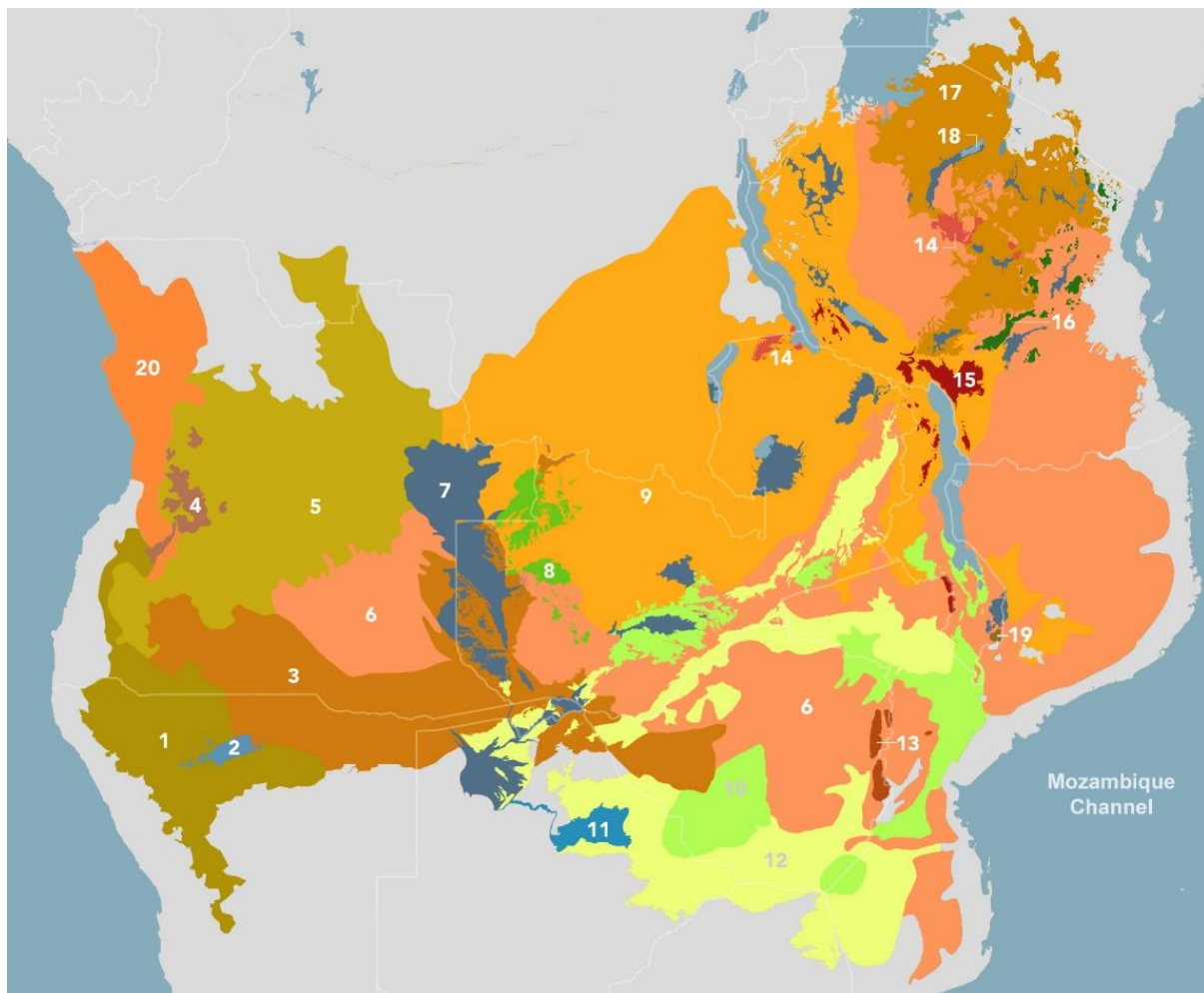


Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.

2.2 Regional Biodiversity Context

The study area is part of the Greater African Subequatorial Savannas & Mixed Woodlands Bioregion. It is the largest in the Afrotropics realm, covering the entire width of the continent from the drylands and grasslands of southern Africa north to the beginning of the Equatorial forest zone, extending to the southern shore of Lake Victoria.

The bioregion consists mostly of savannas and woodlands but also includes pockets of dry forest and flooded grasslands. It is made up of twenty ecoregions, as illustrated in Figure 2-1 (One Earth, 2024a).



Note: Angolan Mopane Woodlands [1], Etosha Pan Halophytics [2], Zambebian Baikiaea Woodlands [3], Angolan Montane Forest-Grassland [4], Angolan Wet Miombo Woodlands [5], Dry Miombo Woodlands [6], Zambebian Flooded Grasslands [7], Zambebian Evergreen Dry Forests [8], Central Zambebian Wet Miombo Woodlands [9], Zambebian-Limpopo Mixed Woodlands [10], Makgadikgadi Halophytics [11], Zambebian Mopane Woodlands [12], Nyanga-Chimanmani Montane Forest-Grassland [13], Itigi-Sumbu Thicket [14], Southern Rift Montane Forest-Grassland [15], Eastern Arc Forests [16], Southern Acacia-Commiphora Bushlands and Thickets [17], East African Halophytics [18], Mulanje Montane Forest-Grassland [19], Angolan Scarp Savanna and Woodlands [20]

Source: One Earth, 2024a

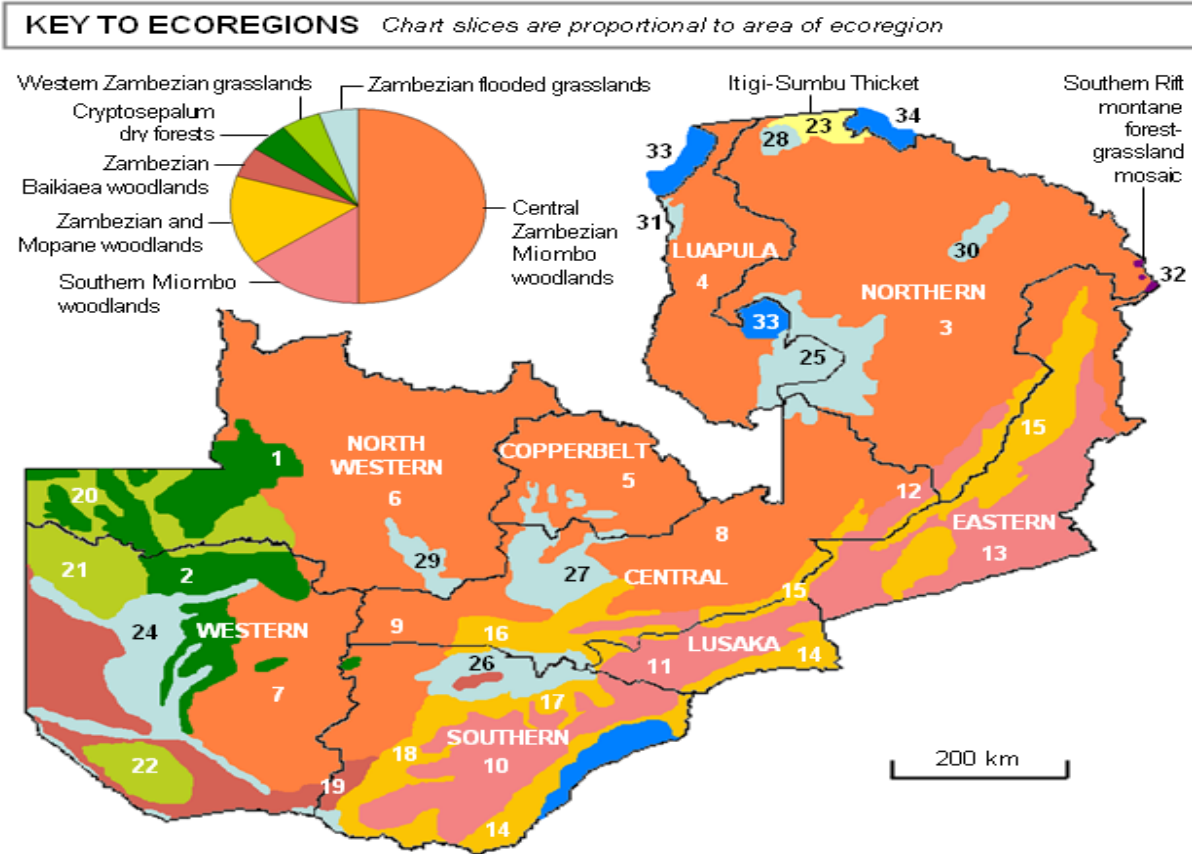
Figure 2-1 Greater African Subequatorial Savannas and Mixed Woodlands Bioregion

A majority of woodland in the bioregion consists of miombo woodland. Miombo is a vernacular word for *Brachystegia*, a genus of trees comprising many species. It is a woodland ecosystem that is dominated by tree species in the genera *Brachystegia*, *Julbernardia* and *Isoberlinia* (Photo 2-1). An estimated 8,500 plant species grow in the central Miombo woodlands, about half of which are endemic. Miombo woodlands are home to many large mammals including antelopes, giraffes, rhinos, lions and the largest population of elephants in Africa (WWF, 2024). Most of the BIIA is set in the Central Zambezian Wet Miombo Woodlands. The ecoregion covers about 70% of central and northern Zambia (Figure 2-2).



Source: Field Investigations

Photo 2-1 Typical Miombo Woodlands Vegetation Association



Source: Malambo and Syampungani, 2008.

Figure 2-2 Major Ecoregions of Zambia

The Central Zambebian Miombo woodland is the most extensive Zambian ecoregion, covering about 70% of the country (Malambo and Syampungani, 2008). The ecoregion has a high degree of floral richness when compared to the other miombo ecoregions in Zambia. This ecoregion may support over 3000 plant species, including several hundred endemic species (One Earth, 2024a). There are typically more evergreen trees than in most miombo woodlands. The classic miombo trees *Brachystegia*, *Julbernardia*, and *Isoberlinia* dominate the woodlands with canopy dominant tree species such as *Brachystegia floribunda*, *B. glaberrima*, *B. taxifolia*, *Julbernardia globiflora*, *J. Paniculata*, and *Isoberlina angolensis* (One Earth, 2024b).

There is a low density of large mammals, attributed to the harsh dry season, long droughts, and poor soils, which results in vegetation of low nutrient content – ideal conditions for elephant and African buffalo. Other species make more use of non-miombo habitats, including sable antelope, roan antelope, Lichtenstein’s hartebeest, and southern reedbeek (One Earth, 2024a). Rates of mammal endemism are low, with three strict endemics: Rosevear’s striped grass mouse and two white-toothed shrews, Ansell’s shrew and Upemba shrew. Threatened species include lions, cheetahs, and African wild dogs. The only strict avifauna endemics are Ruwet’s masked weaver and black-faced waxbill. (One Earth, 2024a).

Finally, the project area also overlies some areas of the Zambebian flooded grassland ecoregion. Embedded predominantly within miombo and mopane woodlands, the ecoregion occurs as isolated patches, mainly in the Kafue Flats and the Bangwuelu/Luapala/Chambezi system in Zambia. The vegetation is characterized mostly by a mosaic of edaphic grassland and semi-aquatic vegetation. This ecoregion has few endemic species, but the overall species richness is high, especially for birds. While several of the wetlands have been occupied for centuries, more recent large-scale changes are becoming evident in many areas as human activities and land-use intensify, including converting pastoral areas to farmland (One Earth, 2024c).

Forested areas in Zambia are crucial for biodiversity conservation, socioeconomic development and sustaining livelihoods. About 60% of rural households heavily depend upon the use of natural resources. Socioeconomically, miombo woodlands are a vital source of livelihoods for rural communities who depend on them for firewood, charcoal, timber, and non-timber forest products such as mushrooms, honey, and medicinal plants. Forests contribute approximately 5.2% of the country's Gross Domestic Product (GDP) and are estimated to employ 1.1 million people. However, Zambia has one of the highest rates of tree cover loss globally, from 2001 to 2022 the country lost the equivalent to a 9.4% decrease in tree cover (WB, 2024).

This has led to the degradation of woodlands due to anthropogenic activities. Habitat degradation intensifies near roads, villages and watercourses, where agricultural activities encroach on the natural vegetation. However, some sparse natural vegetation patches are still present in the BIIA, especially in isolated areas or protected and managed areas such as Lavushi Manda National Park, Forest Reserves or Community Forests.

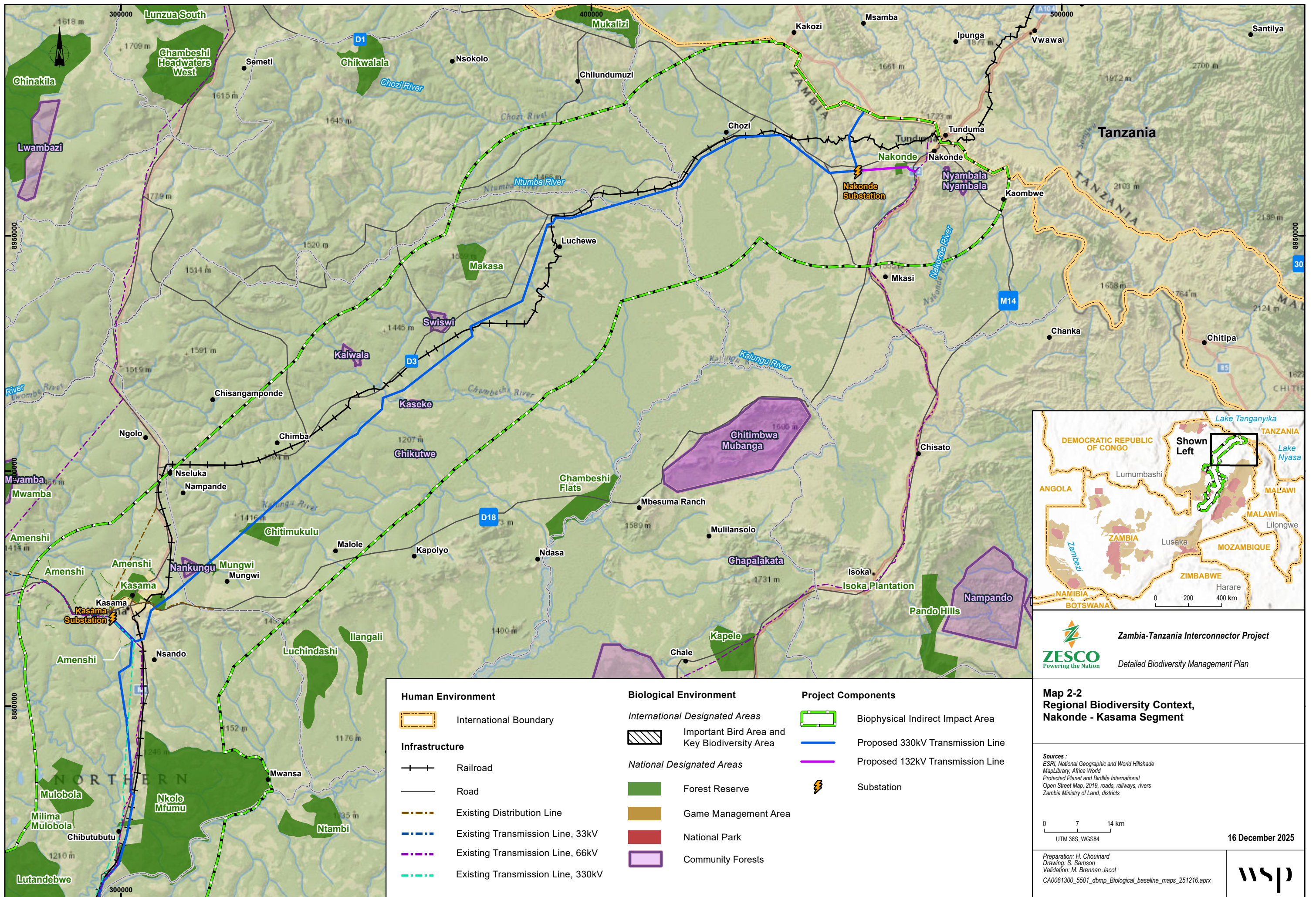
Despite the importance of Miombo and riverine ecosystems, deforestation and forest degradation persist. Significant contributors include large-scale land clearing for commercial agriculture, settlements, infrastructure development, and livestock grazing, leading to extensive land use changes. Woodlands and riverine forest are also being degraded and cleared for fuelwood, charcoal, and building materials, as well as for agricultural land. National forested areas also provide 70% of the energy needs in the form of firewood and charcoal. Slash and burn agriculture is widespread. In particular, chitimene, a traditional form of ash-fertilizing agriculture, is commonly practised throughout northern Zambia. Growing staple, as well as cash crops, are present in several areas, which have been converted into maize, cassava, sorghum, millet, and tobacco crops (One Earth, 2024b).

The high incidence of fires in the area poses further threats to the ecoregion. Although fire is an integral part of Miombo ecology, fires of anthropogenic origin are believed to have increased the frequency of fire far above the natural level. Most of the deliberate burning and uncontrolled fires occur at the end of the dry season, just before the onset of the summer rains. Fires burn with greater intensity during this time because of the extent of dry fuel that accumulate over the dry season. Repeated fires during the late season have a negative impact on forest regeneration, seed germination, and seedling survival growth, which can be severely disturbed (One Earth, 2024b).

The above practices contribute to soil degradation, which can cause further biodiversity loss through increased erosion and stormwater runoff, reduced species diversity, and reduced biomass production. These effects combine with existing impacts from climate change, with changes in temperature and rainfall patterns that adversely affect the growth and distribution of tree species in miombo woodlands. Addressing these multifaceted issues demands coordinated efforts across government, private sector, and civil society to safeguard Zambia's natural habitats (WB, 2024). Weak policy harmonization, sectoral coordination, inadequate knowledge management, and law enforcement, coupled with insufficient stakeholder engagement, hinder the sustainable management of land and forest resources.

Finally, poaching and illegal hunting for bushmeat have a significant impact on the wildlife throughout the ecoregion. Elephant and rhino poaching has been extremely severe throughout the ecoregion. Most areas outside parks and reserves have relatively little wildlife left (One Earth, 2024b).

Inside the study area itself, the natural vegetation cover has been largely modified by human presence. Habitat degradation intensifies near roads, villages and watercourses, where agricultural activities encroach on the natural vegetation. However, some sparse natural vegetation patches are still present. These patches are mainly conserved as they have been classified nationally as managed or protected areas (National Parks, Game Management Areas, Forest Reserves, Communities Forests, etc.) or as areas of international ecological importance (Ramsar sites or Important Bird Areas). The study area hosts several of these protected areas, which are described in the next section and identified on Maps 2-2 to 2-4.



Human Environment	Biological Environment	Project Components
International Boundary	<i>International Designated Areas</i>	Biophysical Indirect Impact Area
Infrastructure	Important Bird Area and Key Biodiversity Area	Proposed 330kV Transmission Line
Railroad	<i>National Designated Areas</i>	Proposed 132kV Transmission Line
Road	Forest Reserve	Substation
Existing Distribution Line	Game Management Area	
Existing Transmission Line, 33kV	National Park	
Existing Transmission Line, 66kV	Community Forests	
Existing Transmission Line, 330kV		

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Map 2-2
Regional Biodiversity Context,
Nakonde - Kasama Segment

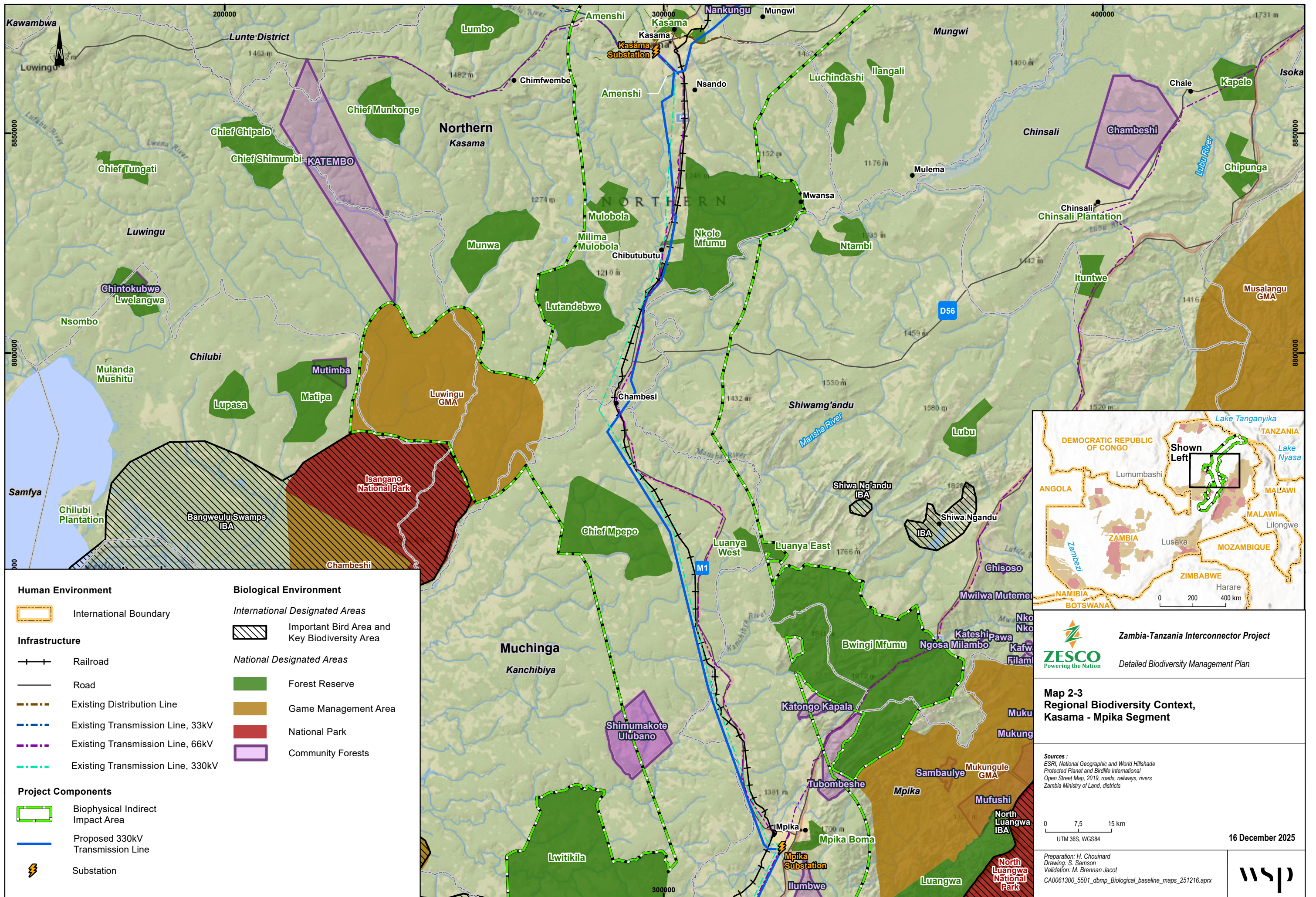
Sources :
ESRI, National Geographic and World Hillshade
MapLibrary, Africa World
Protected Planet and Birdlife International
Open Street Map, 2019, roads, railways, rivers
Zambia Ministry of Land, districts

0 7 14 km
UTM 36S, WGS84

16 December 2025

Preparation: H. Chouinard
Drawing: S. Samson
Validation: M. Brennan Jacot
CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



Human Environment

International Boundary

Infrastructure

Railroad
 Road
 Existing Distribution Line
 Existing Transmission Line, 33kV
 Existing Transmission Line, 66kV
 Existing Transmission Line, 330kV

Project Components

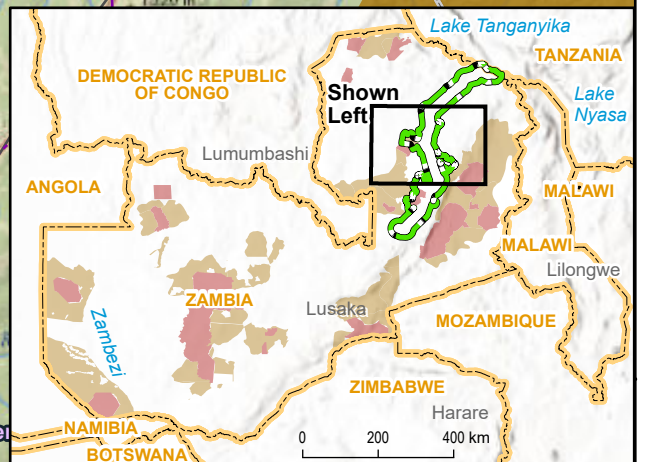
Biophysical Indirect Impact Area
 Proposed 330kV Transmission Line
 Substation

Biological Environment

International Designated Areas
 Important Bird Area and Key Biodiversity Area

National Designated Areas
 Forest Reserve
 Game Management Area
 National Park
 Community Forests

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



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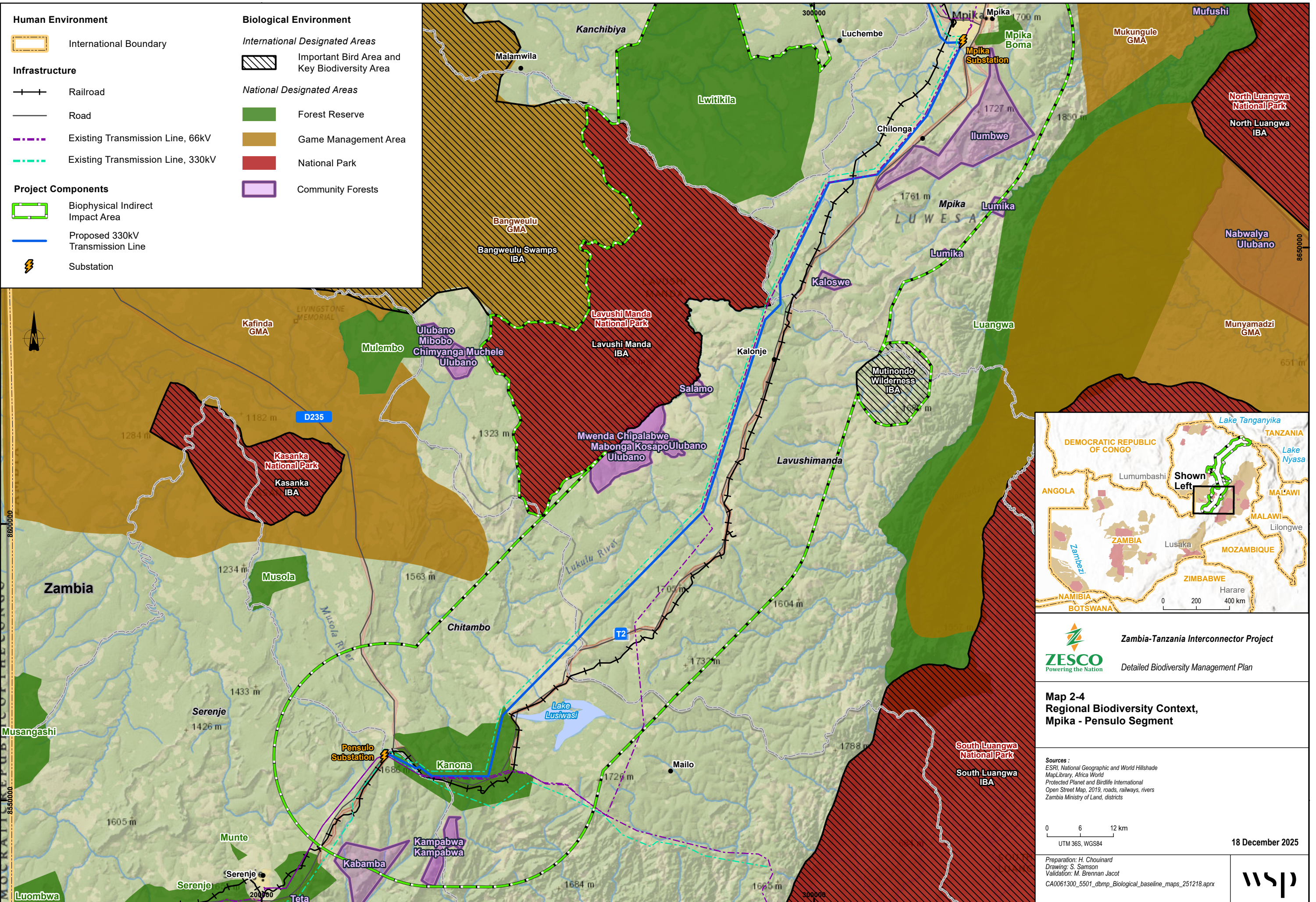
Map 2-3
Regional Biodiversity Context,
Kasama - Mpika Segment

Sources :
 ESRI, National Geographic and World Hillshade
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts

0 7.5 15 km
 UTM 36S, WGS84

16 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx



Human Environment	Biological Environment
International Boundary	International Designated Areas
Infrastructure	Important Bird Area and Key Biodiversity Area
Railroad	National Designated Areas
Road	Forest Reserve
Existing Transmission Line, 66kV	Game Management Area
Existing Transmission Line, 330kV	National Park
Project Components	Community Forests
Biophysical Indirect Impact Area	
Proposed 330kV Transmission Line	
Substation	



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Map 2-4
Regional Biodiversity Context,
Mpika - Pensulo Segment

Sources :
ESRI, National Geographic and World Hillshade
MapLibrary, Africa World
Protected Planet and Birdlife International
Open Street Map, 2019, roads, railways, rivers
Zambia Ministry of Land, districts

0 6 12 km
UTM 36S, WGS84

18 December 2025

Preparation: H. Chouinard
Drawing: S. Samson
Validation: M. Brennan Jacot
CA0061300_5501_dbmp_Biological_baseline_maps_251218.aprx

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.

2.2.1 Protected Areas and Internationally Recognized Areas

Many protected areas are found within the BIIA. They are listed in Table 2-1 with the distance from the proposed transmission line route. One National Park (also an Important Bird Area), one Game Management Area and one Private Wilderness Area (also an Important Bird Area) are located inside the local study area and are further described below.

As shown in Table 2-1 below, a total of 15 Forest Reserves are found within the BIIA, with seven of them being crossed by the proposed transmission line route. These seven Forest Reserves are described in more detail below.

Table 2-1 National Protected Areas and Internationally Recognized Areas in the BIIA

Name	Type	Distance from the proposed transmission line route (km)
Lavushi Manda	National Park / Important Bird Area	1.1
Luwingu	Game Management Area	15.0
Mutinondo Wilderness Area	Important Bird Area	18.7
Lwitikila	Forest Reserve	4.4
Mpika Boma	Forest Reserve	2.5
Bwingi Mfumu	Forest Reserve	17.4
Chief Mpepo	Forest Reserve	1.1
Luanya	Forest Reserve	14.0
Lutandebwe	Forest Reserve	4.3
Mulobola	Forest Reserve	7.7
Makasa	Forest Reserve	8.3
Kanona	Forest Reserve	0.0 (crossed by the line along 30.7 km)
Amenshi	Forest Reserve	0.0 (crossed by the line along 0.3 km)
Kasama	Forest Reserve	0.0 (crossed by the line along 2.9 km)
Nkole Mfumu	Forest Reserve	0.0 (crossed by the line along 4.4 km)
Chitimukulu	Forest Reserve	0.0 (crossed by the line along 3.2 km)
Mungwi	Forest Reserve	0.0 (crossed by the line along 0.4 km)
Nakonde	Forest Reserve	0.0 (crossed by the line along 1.4 km)

Lavushi Manda National Park

Lavushi Manda National Park (LMNP) was created in 1972 to protect 1,500 km² of Central Zambesian Miombo woodlands. It is bordered by the Bangweulu Game Management Area (GMA) along much of the western boundary, and the Lwitikila National Forest (NF) along most of the northern boundary. It lies between the Muchinga Escarpment and the alluvial flats of the Bangweulu Wetlands (ZAWA and Kasanka Trust Ltd, 2014). A 40 km long dramatic rocky massif runs through the centre and holds large patches of pristine hill miombo woodlands, dambo wet grasslands, plains, and gallery forests along the headwaters of the Lukulu and Lulima rivers. The major reasons for establishing the park were to protect a large watershed area of regional importance, as well as to provide a preserved corridor between South Luangwa National Park, North Luangwa National Park and Bangweulu swamps. The park is also an Important Bird Area (IBA) and is of major importance for African and palearctic migrants. It also serves as an upland wildlife refuge for ungulates of the Bangweulu during the wet season (WB, 2009). A total of 50 large mammal species have been recorded in the LMNP. Even though the wildlife population has been depleted due to poaching, LMNP still hosts most of the large mammals that historically occurred in the area. Notable are lion, leopard, African elephant, hippopotamus and African buffalo, but also the large roan and sable antelopes, although only in very low densities (ZAWA and Kasanka Trust Ltd, 2014). Other wildlife species can still be found in the park include kinda baboon, vervet monkey, warthog, bush pig, reedbuck, bushbuck, common duiker, klipspringer, hartebeest, black lechwe, waterbuck, porcupine, side-striped jackal and caracal (WB, 2009).

The proposed powerline for the ZTIP passes some 1.5 km away from the Eastern tip of the National Park. Two existing lines already pass within the park's boundaries in this area (see Photo 2-2). Field observations and stakeholder consultations confirmed that the eastern area of the park has largely been converted to agriculture. However, in 2018, communities within the park's boundaries were relocated and the area is now recovering.



Photo 2-2 Powerline and Disturbed Woodland Along the Eastern Tip of the Lavushi Manda National Park

Luwingu Game Management Areas

GMA in Zambia were established as buffer-zones for National Parks and have been used primarily for hunting (mainly by foreign nationals) and hunting for meat by local and national residents. Unlike in the National Parks, human settlement is permitted in GMAs and there are large and expanding human populations in many of them, which is accompanied by widespread habitat loss (Lindsey et al., 2014).

Luwingu GMA is located within the Bangweulu swamp ecosystem. It covers an area of 1,090 km² (Simasiku et al., 2008) and is located North of Isangano National Park. Despite their size and potential, the wildlife resources in many GMAs are in a state of steep decline and are not sufficiently productive in ecological, economic or social terms (Lindsey et al., 2009). Wildlife communities in the GMAs are considered depleted, but they still host some large mammal populations with small numbers of black lechwe and sitatunga.

Forest Reserves

The management and protection of all national and local forests in Zambia is covered by the Forest Act 4 of 2015. According to their provisions, two main categories of Forest Reserves are found in the country: local and national forests. Zambia has a total of 481 Protected Forest Areas of which 181 are National Forests and 300 are Local Forests (Jachmann, 2000). In National Forests, logging and collection of forest products are regulated by the Forestry Department, whereas Local Forest Reserves are meant to serve the needs of the local people in the surrounding area. These two types of Forest Reserves relate to the conservation and sustainable use of forests and trees, and the implementation of international instruments. For these reasons, both local and national forests fall under category VI of the International Union for Conservation of Nature (IUCN) conservation area.

Regardless of the type of Forest Reserve, no permanent settlements are allowed. However, enforcement of forest protection is lacking in many Forest Reserves. Nearly all forests in Zambia are currently managed without management plans. The country lacks up-to-date forest inventory data. The only management tool for Forest Reserves under the Forestry Department has been licensing. A licence simply states the minimum amount of timber to be removed annually. The effectiveness of this system has been limited by a number of problems, including but not limited to inadequate capacity of the Forestry Department (Food and Agriculture Organization of the United Nations [FAO], 2002).

Habitats within the seven Forest Reserves that are crossed by the proposed transmission line were assessed in detail. Satellite imagery analysis, walkover surveys and expert and stakeholder consultation were carried out to better understand land uses within these areas and to describe habitat type and quality. The general state of each Forest Reserve is described below.

Generally, most Forest Reserves crossed by the transmission line suffered from encroachment through human settlements and agricultural activities, which resulted in habitat degradation. The land take acreage in each Forest Reserve and habitat types/land use affected are presented in Table 2-2.

Table 2-2 Habitat Types in the ROW in the Affected Forest Reserves

Habitat type/ land use	Amenshi	Chitimukulu	Kanona	Kasama	Mungwi	Nakonde	Nkole Mfumu
Agriculture	1.19	2.28	22.73	0.46	-	<0.01	2.85
Built environment	-	-	0.18	0.01	-	-	-
Fallow land	-	7.59	14.07	-	-	-	0.69
Grassland - open area	-	-	2.69	0.11	-	-	-
Rock Outcrop	-	-	-	4.81	-	-	-
Riverine forest	-	-	0.89	-	0.74	-	-
Wetland	-	-	6.70	0.21	1.41	-	-
Plantation	-	-	-	-	-	4.18	-
Woodland - degraded	-	4.43	6.48	-	-	0.34	-
Miombo woodland - mature	-	-	19.22	-	-	-	4.55
Miombo woodland - secondary	-	1.85	34.57	8.68	-	-	14.03
Total	1.19	16.15	107.53	14.28	2.15	4.52	22.12

Kanona Forest Reserve

Kanona National Forest No. P172 covers a total of 28,500 ha. It shares boundaries with three Chiefs (Chief Muchinka, Chiefteness Serenje and Chief Kabamba) and falls within two districts (Serenje and Chitambo). This Forest Reserve covers a large watershed that houses a number of river sources that drain into the Luangwa River and Luapula River. According to the Serenje District Forestry Department, the management plan for the Kanona Forest Reserve is out of date and many communities are illegally settled within the reserve. The Forestry Department is currently working on reforesting degraded areas where plantations currently exist.

The town of Kanona is found within the Kanona Forest Reserve, along the T2 Road, which crosses the area. Encroachments on the reserve are common, including several human settlements and agricultural land (see Photo 2-3). The Forest Reserve is also crossed by many other transmission lines, under which the woodland has been cleared and only herbaceous vegetation is maintained (see Photo 2-4). The proposed line follows an existing 330kV line built in 2016 with a 50 m row (Figure 2-3).

The remaining forest is primarily escarpment miombo woodland, a habitat type described in Section 5.3.2.2. Due to poor soil conditions in these areas, vegetation remains low between 6-12 m, with some exceptions. Most of the remaining woodland has been disturbed by tree cutting, fires and charcoal burning. Although human disturbance is widespread, some areas of the Kanona Forest Reserve are characteristic of mature miombo woodland (i.e., species composition and height are typical of miombo woodland).

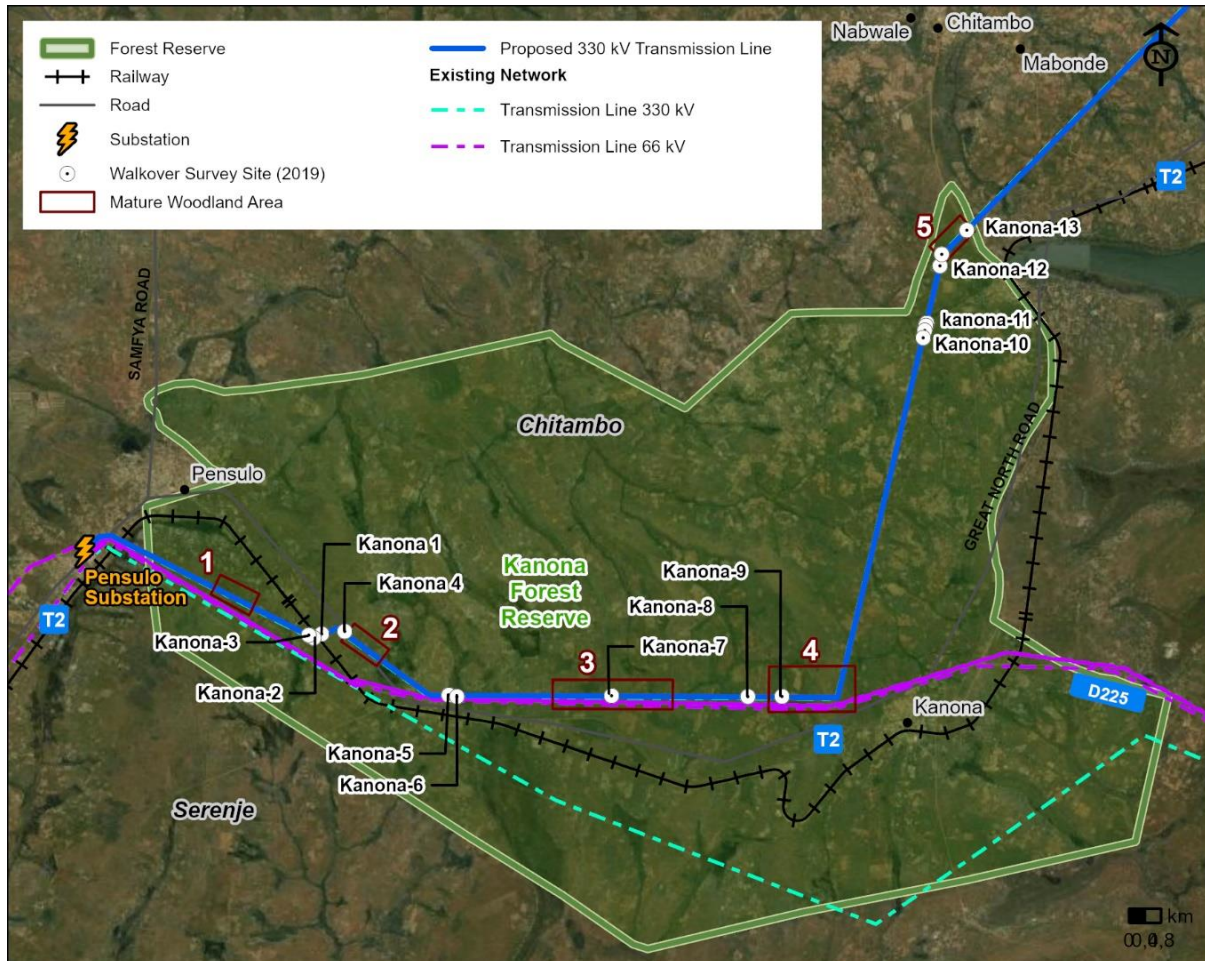


Figure 2-3 Kanona Forest Reserve



Photo 2-3 Encroachment by Agriculture in the Kanona Forest Reserve



Photo 2-4 Miombo Woodland and Existing 330kV Powerline in the Kanona Forest Reserve

Nkole Mfumu Forest Reserve

Nkole Mfumu National Forest No. P48 is a very large reserve, covering an area of 54,228 ha. It lies to the east of the Kasama-Mpika motor road (M1), and spreads eastwards all the way to the confluence of the Lukashya River with the Chambeshi River. The proposed powerline crosses the western part of the Forest Reserve, where it is composed of two separated arms (Figure 2-4). This section of the Forest Reserve is already crossed by several linear infrastructure: the Tanzania-Zambia Railway Authority (TAZARA) railway, a 66kV transmission line, as well as the M1 motor road.

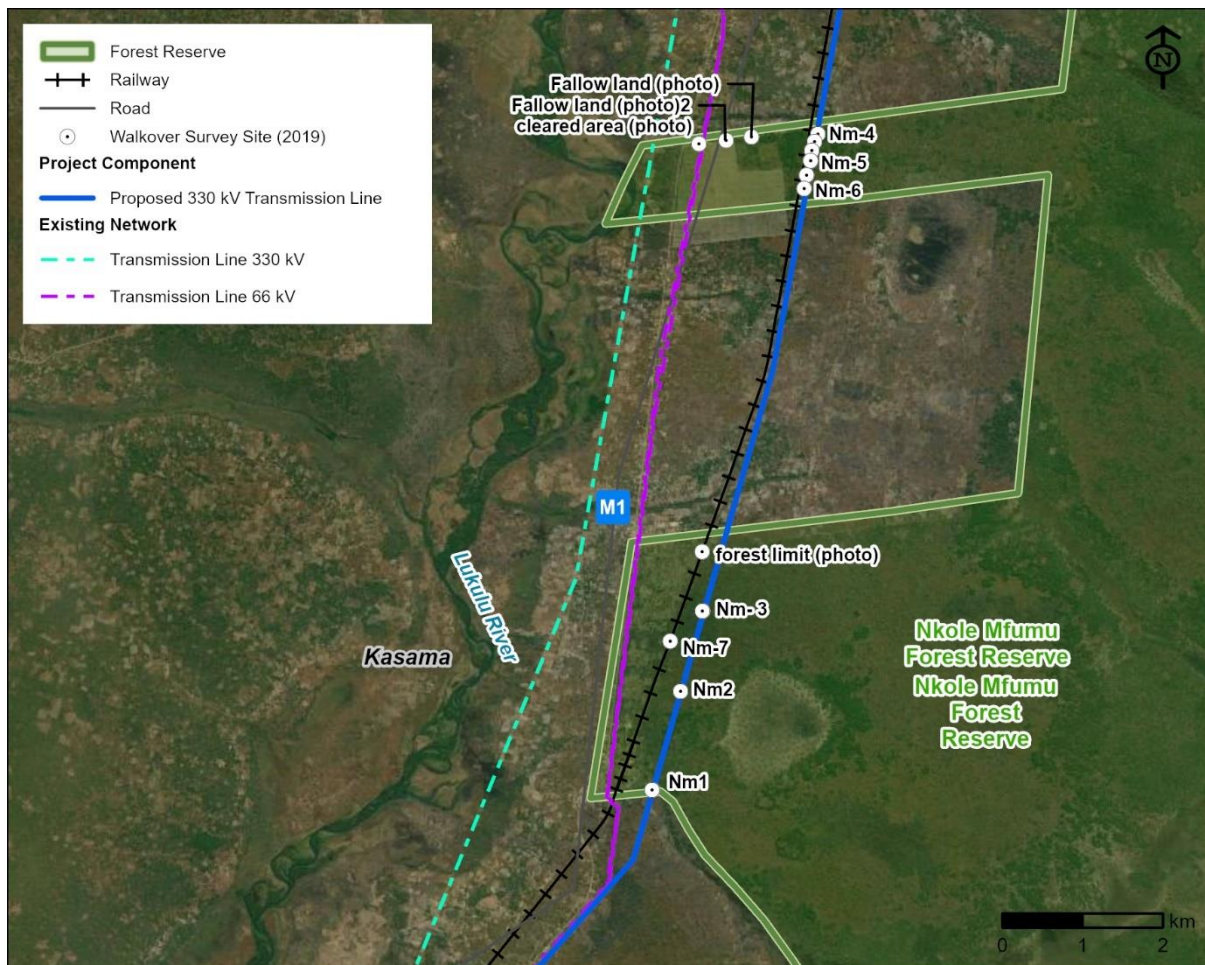


Figure 2-4 Nkole Mfumu Forest Reserve

The habitat within this Forest Reserve is composed of miombo woodland, associated with *Parinari curatellifolia* and *Marquesia obtusifolia*. The woodland within the area where the proposed line passes is generally disturbed by tree cutting, charcoal burning and fire. Relic patches of mature trees are still present within the disturbed forest, especially in the northern section of the Forest Reserve, where the line crosses the area (Photo 2-5). However, even in these patches with mature trees, the under cover has been severely disturbed by fire and tree cutting for charcoal. Large plantations were exploited in the Forest Reserve in the area west of the TAZARA railway. These have been harvested in recent years, leaving now place to large areas of cleared or fallow land.



Photo 2-5 Mature Original Woodland Trees in the Nkole Mfumu Forest Reserve with Disturbed Undercover

Amenshi Forest Reserve

The Amenshi Local Forest No. P298 is found around the town of Kasama and is composed of several separate fragments that cover sections of watercourses and surrounding wetlands (Figure 2-5). These seem to have been created to protect small water catchments, Amenshi meaning “water” in the Bemba language. The section crossed by the powerline covers an area of 38.2 ha. Satellite imagery shows it covers a wetland area along a small watercourse that is used for agricultural purposes. Only small areas with trees are present, most of the area being composed of rice fields.

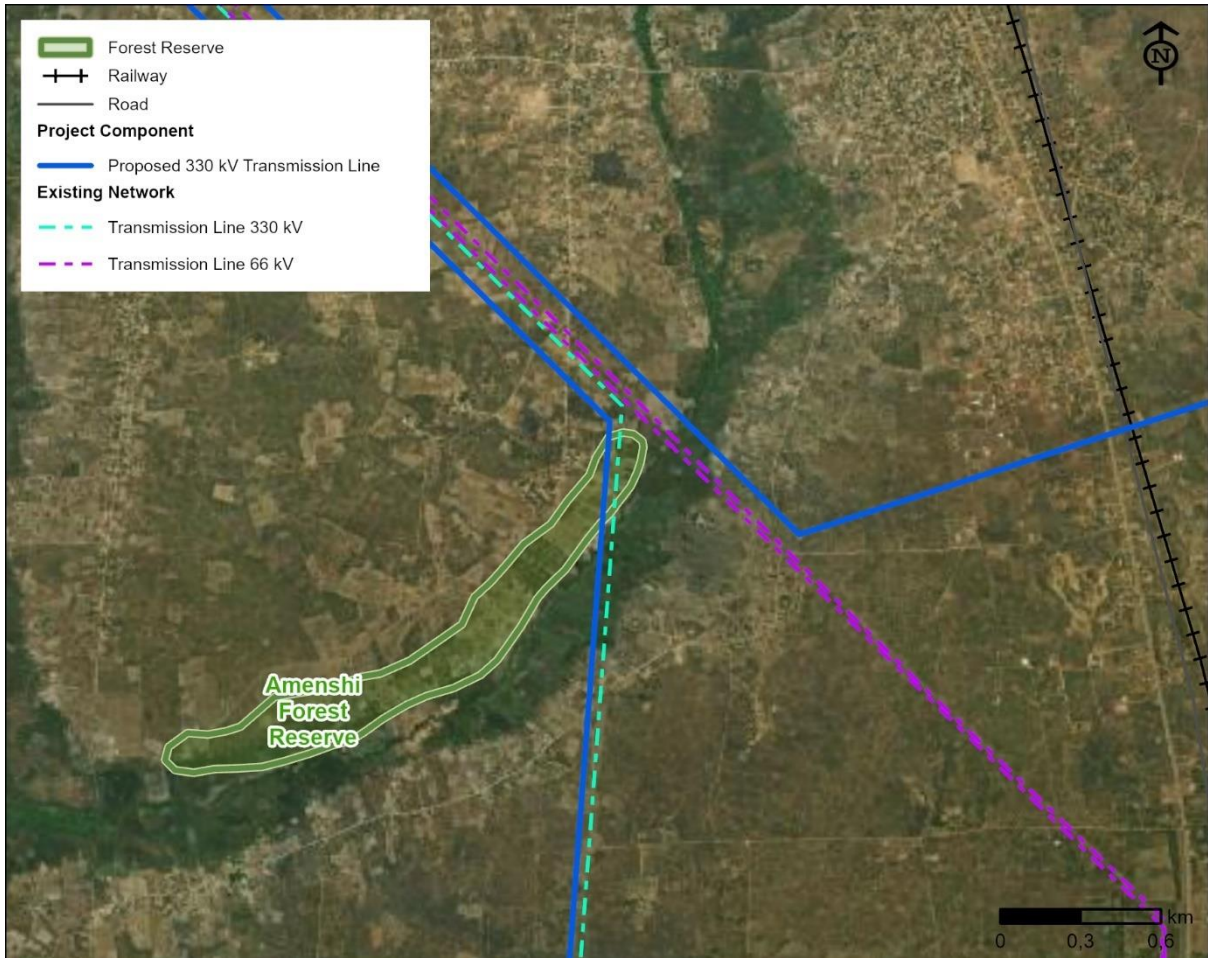


Figure 2-5 Amenshi Forest Reserve

Kasama Forest Reserve

The Kasama National Forest Reserve No. 47 is found in the immediate project area, the line crossing the eastern section of the Reserve. According to the Kasama Province Forestry Department, the Forest Reserve covers an area of 1,086 ha. Part of the Forest Reserves was degazetted in 2015, where the area north of the railway was excised from the protected area. The Mwela Rock Art Heritage site is found within the Kasama Forest Reserve (Figure 2-6).

The forest is primarily miombo woodland but is highly disturbed by human activities. The northern part of the Forest Reserve is composed of heavily disturbed woodland. The area is strongly affected by fire and tree cutting for charcoal burning and vegetation has been modified by human activity (Photo 2-6). The southern part of the Forest Reserve where the line passes is a large area of rock outcrop characterized by sparse vegetation (Photo 2-7). Tree cutting and fire have affected the vegetation on these rock outcrops. Cactus from the *Euphorbia perplexa* var. *kasamana*, an endemic and rare species in Zambia, was observed on these outcrops (see Section 2.3.4).

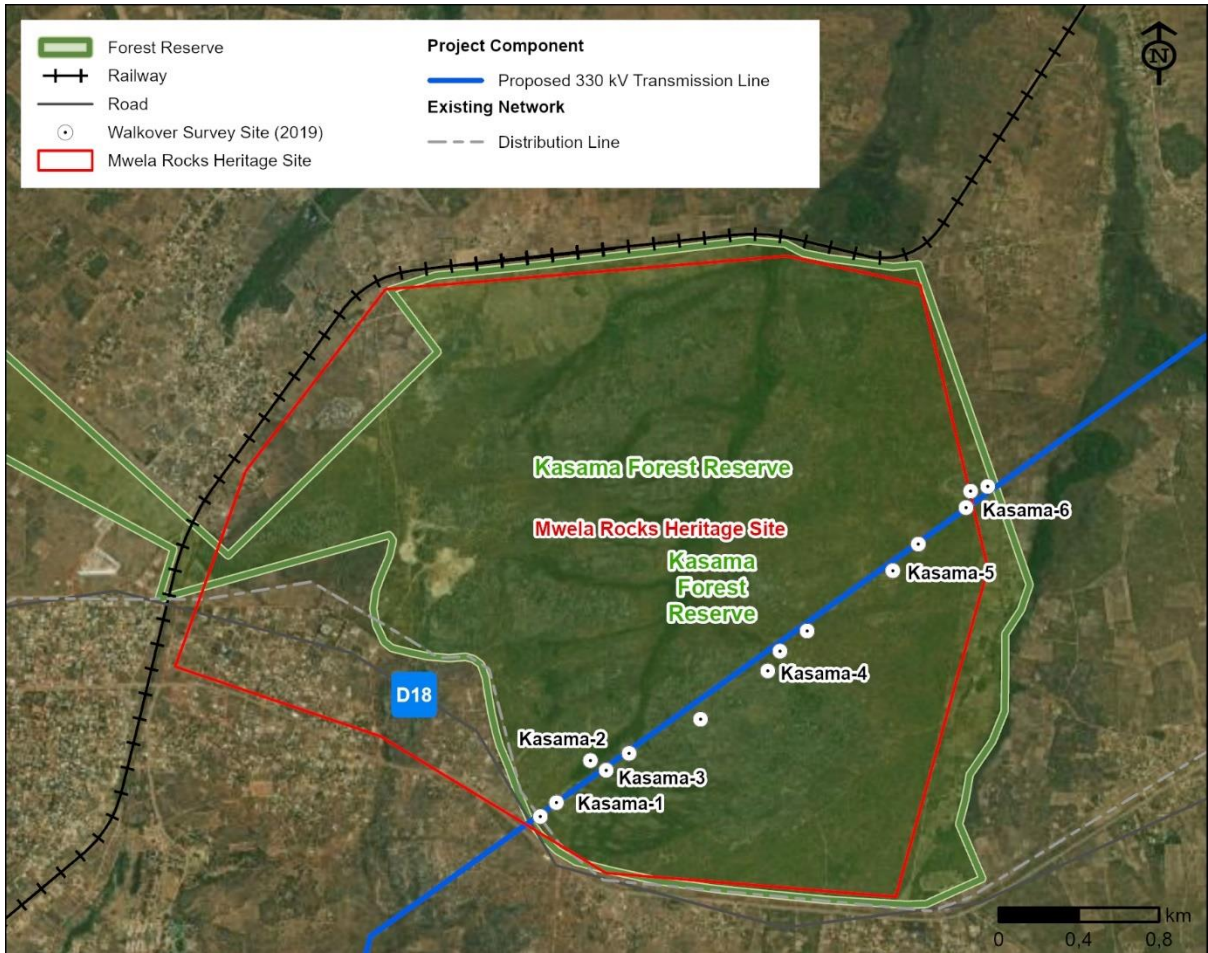


Figure 2-6 Kasama Forest Reserve



Photo 2-6 Rock Outcrop on the Southeast of the Kasama Forest Reserve



Photo 2-7 Disturbed Woodland in the Northeast of the Kasama Forest Reserve

Mungwi Forest Reserve

The Mungwi Local Forest No. 335 protects a catchment area of the Mungwi and Chibile rivers over an area of 130 hectare (ha) (Figure 2-7). The protected area is composed of a dambo area that is partly natural and partly used for agriculture. It is traversed by small streams, some of which have been canalized to support local agriculture. Forestry agents consulted at the Mungwi Forestry Department stated that some illegal timber harvesting occurs in the Forest Reserve and that wetlands in the Forest Reserve are used for gardens.

Riverine forests are also present, particularly in the area where the proposed line crosses the Forest Reserve is found a 150 m strip of mature riverine forest, dominated by *Khaya nyansica*, *Rothmania engleriana*, *Syzygium cordatum*, *Syzygium guineense* and *Diplorhynchus condylocarpo* (Photo 2-8). Disturbances in this forest are minor, as local communities seem to recognize the importance of preserving the forest and granting it protection.

When this riparian ecosystem is looked at as an ensemble, even though some patches of less disturbed riverine forest and dambos are present, the Mungwi Forest Reserve is largely disturbed as most areas are used for agriculture and natural water flow has been modified for agricultural purposes. For these reasons, it does not qualify as natural habitat, nor does it qualify as critical habitat. However, the habitats present play an important role in protecting the water catchment and maintaining important ecological functions, such as water retention and purification, which support local communities.



Figure 2-7 Mungwi Forest Reserve



Photo 2-8 Preserved Riverine Forest within the Mungwi Forest Reserve

Chitimukulu Forest Reserve

The Chitimukulu Local Forest No. 305 covers a total area of 3,180 ha in the Mungwi District (see Figure 2-8). It is mainly composed of disturbed woodland.

The Mungwi District Forestry Department mentioned that legal charcoal burning takes place in the Chitimukulu Forest Reserve (where charcoal producers pay the Forestry Department for their activities), as well as illegal charcoal burning. It also stated that people have encroached on the forest, mostly for cassava and ground nuts cultures.

Few mature trees remain within this forest, largely affected by agriculture, tree cutting, charcoal burning and fires (see Photo 2-9). Human activity has essentially modified the area's primary ecological functions. Hence, the area should be considered a modified habitat and does not qualify as a natural habitat or critical natural habitat.

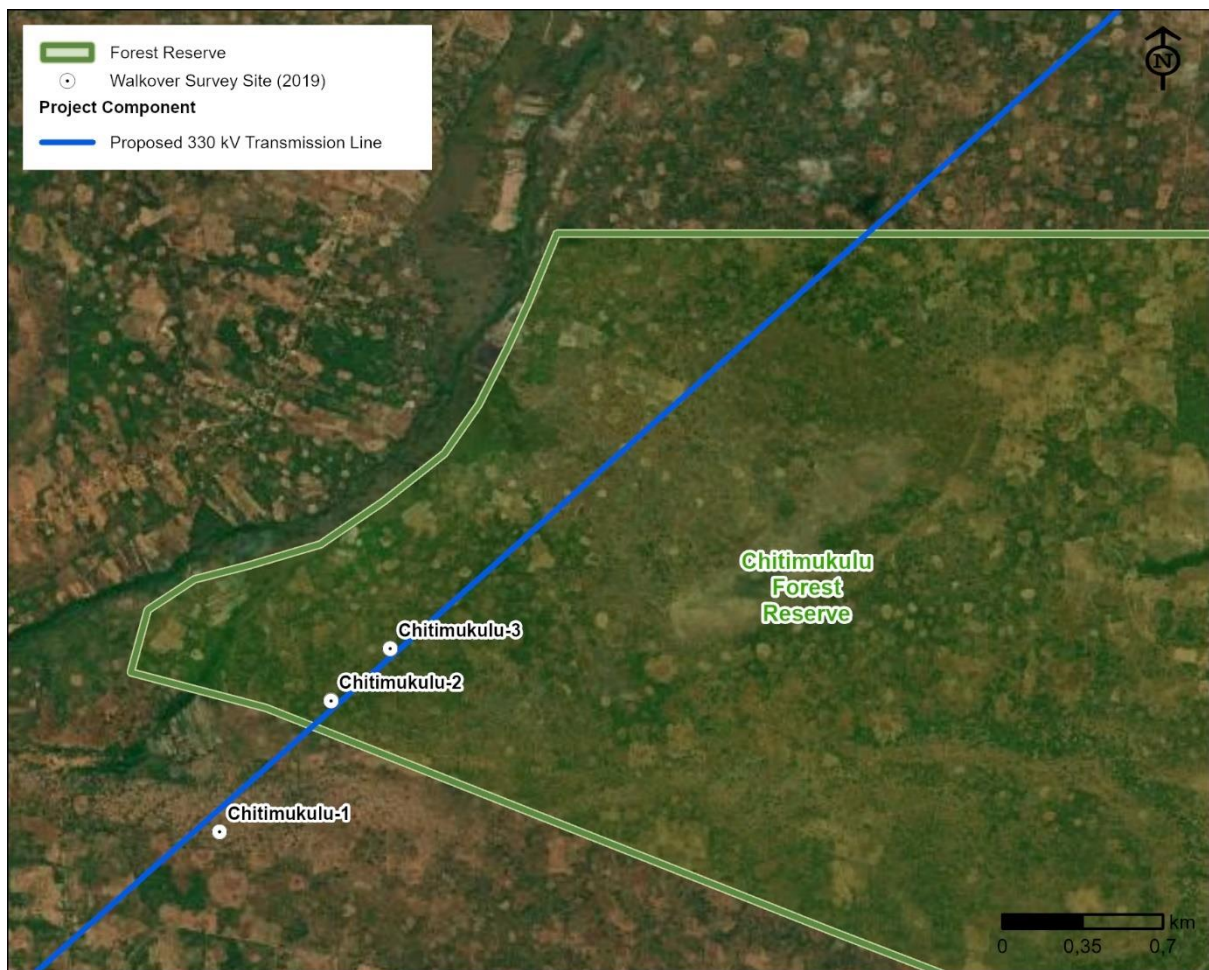


Figure 2-8 Chitimukulu Forest Reserve



Photo 2-9 Area Affected by Tree Cutting and Fire in the Chitimukulu Forest Reserve

Nakonde Forest Reserve

The Nakonde Local Forest No. P303 covers a total of 417 ha in extent (Figure 2-9). The Forest Reserve (FR) is almost entirely composed of plantations that have been planted and are being managed by ZAFFICO with the permission of the Forest Department. The forest department has also planted 10 ha of pine trees within the Forest Reserve. ZAFFICO has initiated discussions with the forestry department for them to get a separate title deed for the land the company is using. At the time of writing this report, validation by the Forestry Department of the detailed limits of the Forest Reserve, as well as the coordinates of the 10 ha the department has used in the Forest Reserve, is pending.

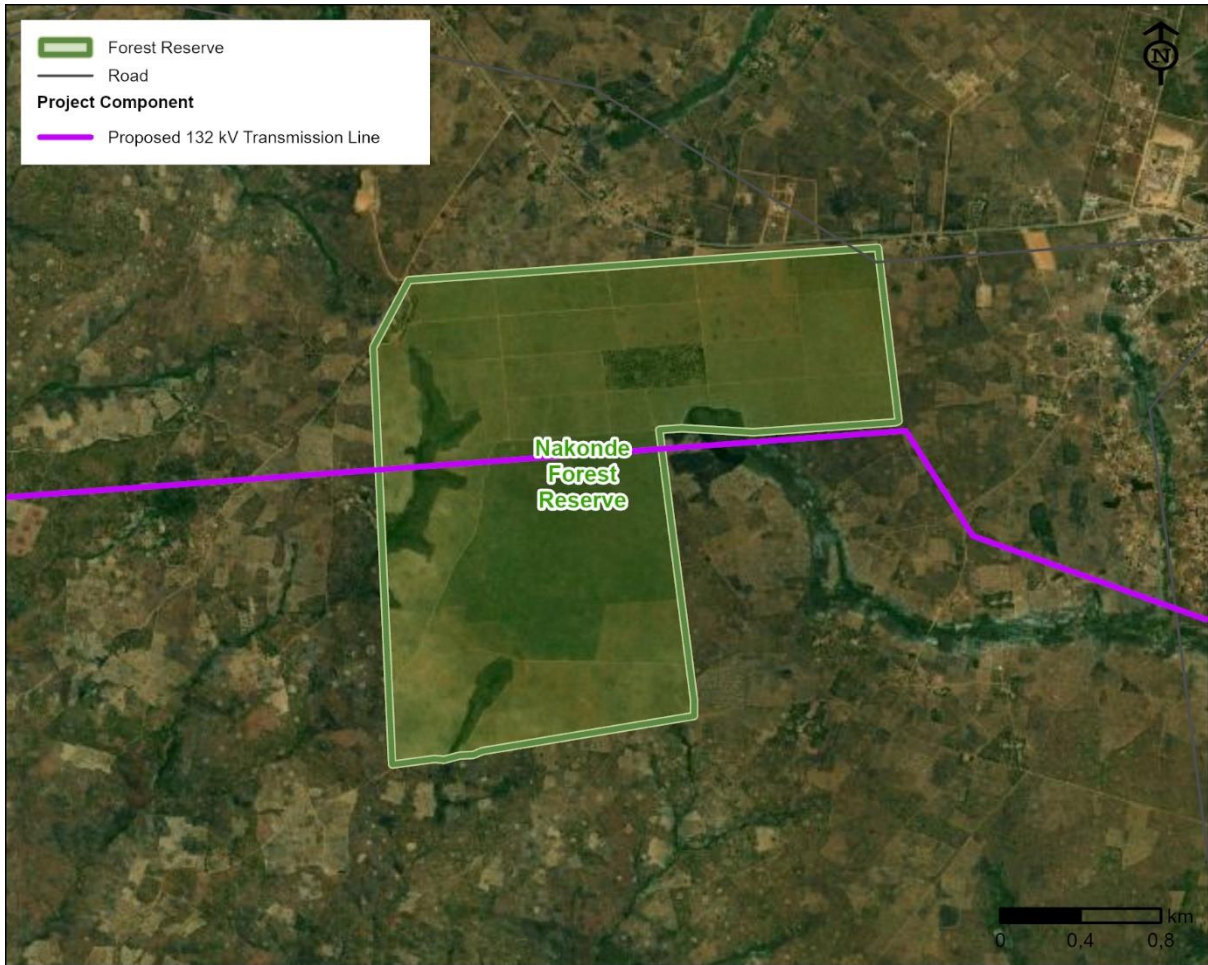


Figure 2-9 Nakonde Forest Reserve

2.2.2 Community Forests

A Community Forest is defined in the Forests Act, 2015 as a forest controlled, used and managed under an agreement between a Community Forest Management Group (CFMG) and the Forestry Department. As per the Forests (Community Forest Management) Regulations, 2018, Community Forest management can be applied in open areas (i.e., outside protected areas), in local forests (as established under Section 17 of the Forests Act, 2015) in Game Management Areas, or any other type of forest Community Forestry at the discretion of the Director of Forestry.

Community Forests are managed by CFMGs whose purpose is the communal control, use and management of a forest (Section 29, Forests Act, 2015). Under the Forests Act, 2015, Community Forests are designed to give an opportunity to people living in close proximity to or deriving their livelihood from or having strong traditional ties to a forest to manage such forest in a sustainable manner that promotes forest ecosystems and biological diversity.

Community Forest agreements result in the obligation for the CFMG to protect, conserve and manage the Community Forest in a manner that is consistent with traditional forest user rights and in accordance with sustainable forest management as well as to protect sacred groves and protected trees. The agreement confers the CFMG the right to collect medicinal herbs, harvest honey and timber or fuel wood, use grass for livestock grazing. Agreement collect forest produce for community-based industries, operate; operating eco-tourism and recreational activities, establish plantations, and engage in scientific and educational activities among others.).

There are 18 Community Forests in the BIIA, listed in Table 2-3 and shown on Maps 2-2 to 2-4.

Table 2-3 Community Forests in the BIIA

Community Forest	District	Distance from the proposed transmission line route (km)
Shimumakote	Kanchibiya	11.96
Mabonga Kosapo	Lavushimanda	11.62
Mwenda Chipalabwe	Lavushimanda	6.44
Salamo	Lavushimanda	5.65
Ilumbwe	Mpika	0.99
Kaloswe	Mpika	5.71
Katongo Kapala	Mpika	17.27
Lumika	Mpika	18.20
Tubombeshe	Mpika	15.60
Chikutwe	Mungwi	11.2
Kalwala	Mungwi	8.41
Kaseke	Mungwi	2.69
Nankungu	Mungwi	0.27
Swiswi	Mungwi	4.28
Isalala	Nakonde	6.24
Nyambala	Nakonde	10.18
Kabamba	Serenje	12.43
Kampabwa	Serenje and Chitambo	7.43

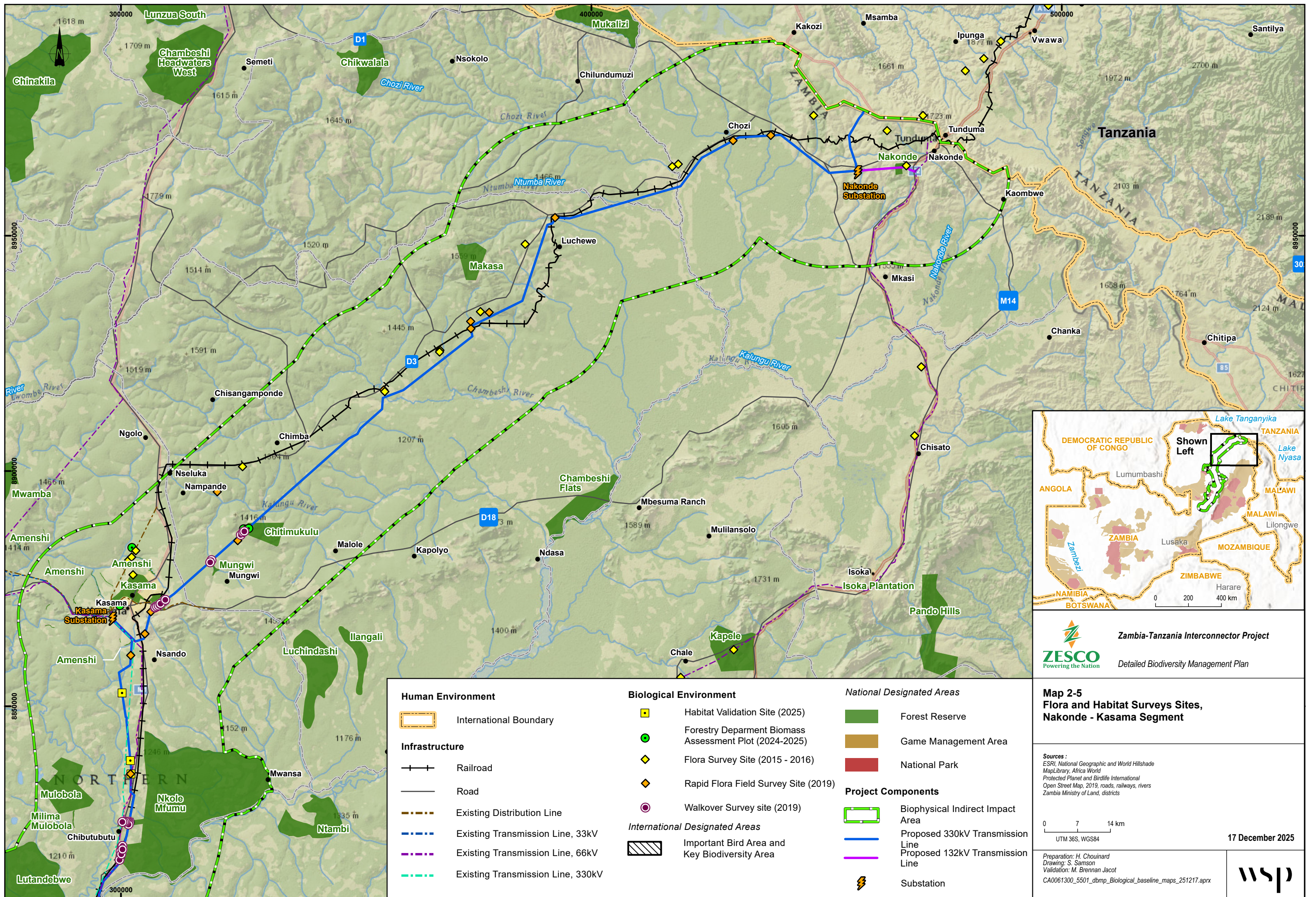
Source: CFMG Database, Ministry of Green Economy and Environment, n.d.

2.3 Habitat Types and Flora

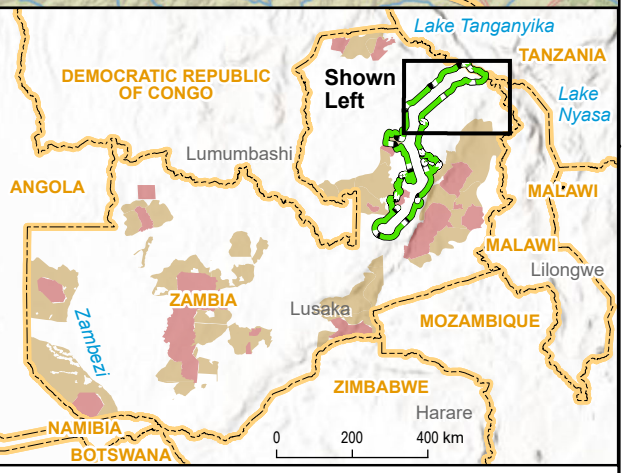
The characterization of habitat types and flora communities inside the project area is based on several field investigations and flora occurrence data from the Global Biological Information Facility (GBIF, 2024) in the last 20 years (2004-2024).

Habitat and flora surveys were conducted during several different campaigns. A first campaign of field surveys was completed in September 2015 and June 2016. In 2019, walkover surveys to characterize habitats in Forest Reserves crossed by the line were completed in September 2019 and rapid flora surveys were done throughout the line route in October-November 2019. In 2025, specific surveys were completed for critical habitat triggering species: *Disa aequiloba* (February 2025) and *Euphorbia perplexa* var. *kasamana* (September 2025) and an additional round of habitat validation in woodlands were completed (September 2025). The detailed methodology for each campaign is detailed in Appendix 2-1. Data from biomass assessments completed by the Forestry Department in the main Forest Reserves crosses by the line was also compiled. These are available in Appendix 2-2.

Maps 2-5 to 2-7 illustrate the location of habitat and flora survey sites.



Human Environment	Biological Environment	National Designated Areas
International Boundary	Habitat Validation Site (2025)	Forest Reserve
Infrastructure	Forestry Department Biomass Assessment Plot (2024-2025)	Game Management Area
Railroad	Flora Survey Site (2015 - 2016)	National Park
Road	Rapid Flora Field Survey Site (2019)	Project Components
Existing Distribution Line	Walkover Survey site (2019)	Biophysical Indirect Impact Area
Existing Transmission Line, 33kV	International Designated Areas	Proposed 330kV Transmission Line
Existing Transmission Line, 66kV	Important Bird Area and Key Biodiversity Area	Proposed 132kV Transmission Line
Existing Transmission Line, 330kV		Substation



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Map 2-5
Flora and Habitat Surveys Sites,
Nakonde - Kasama Segment

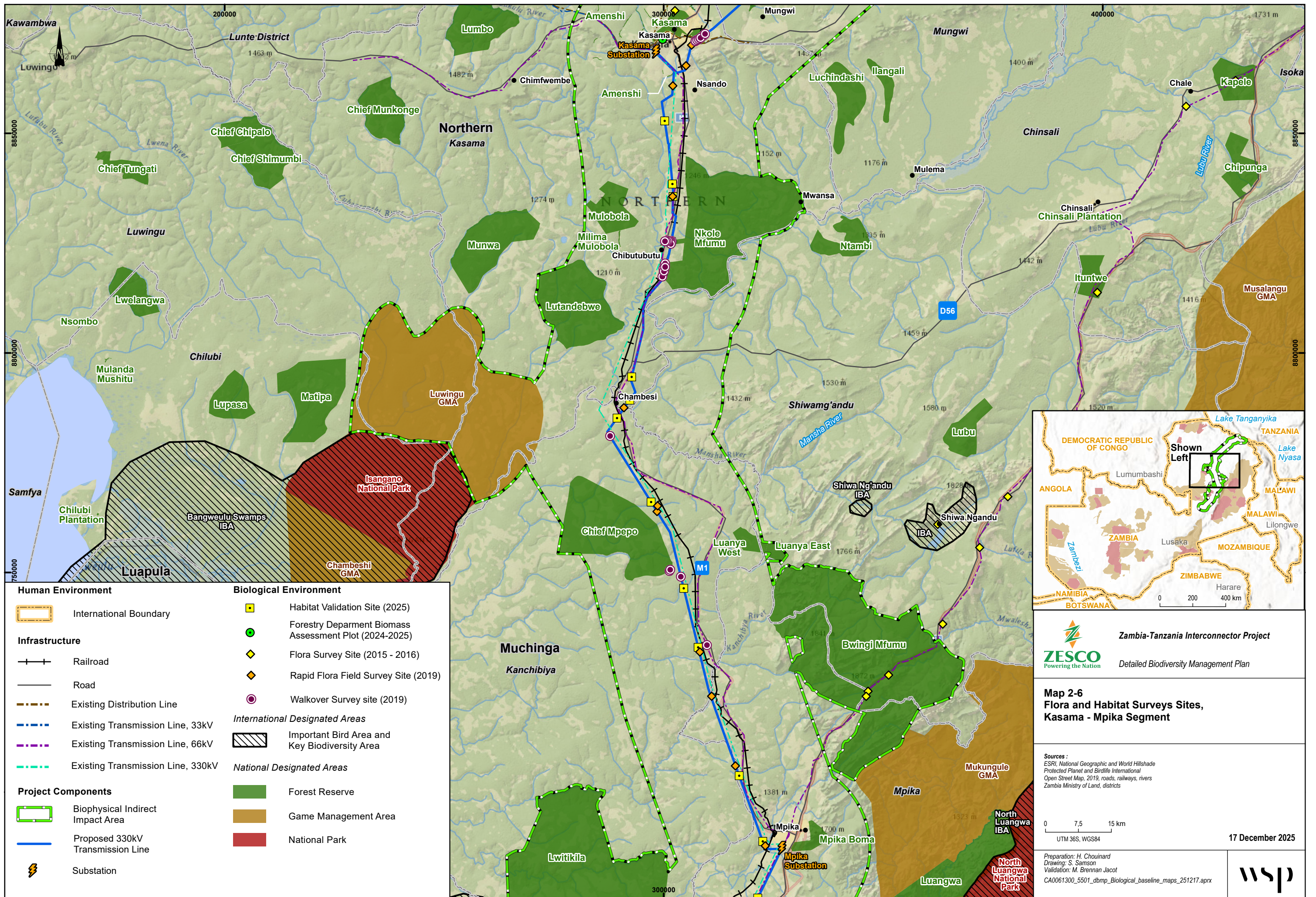
Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts

0 7 14 km
 UTM 36S, WGS84

17 December 2025

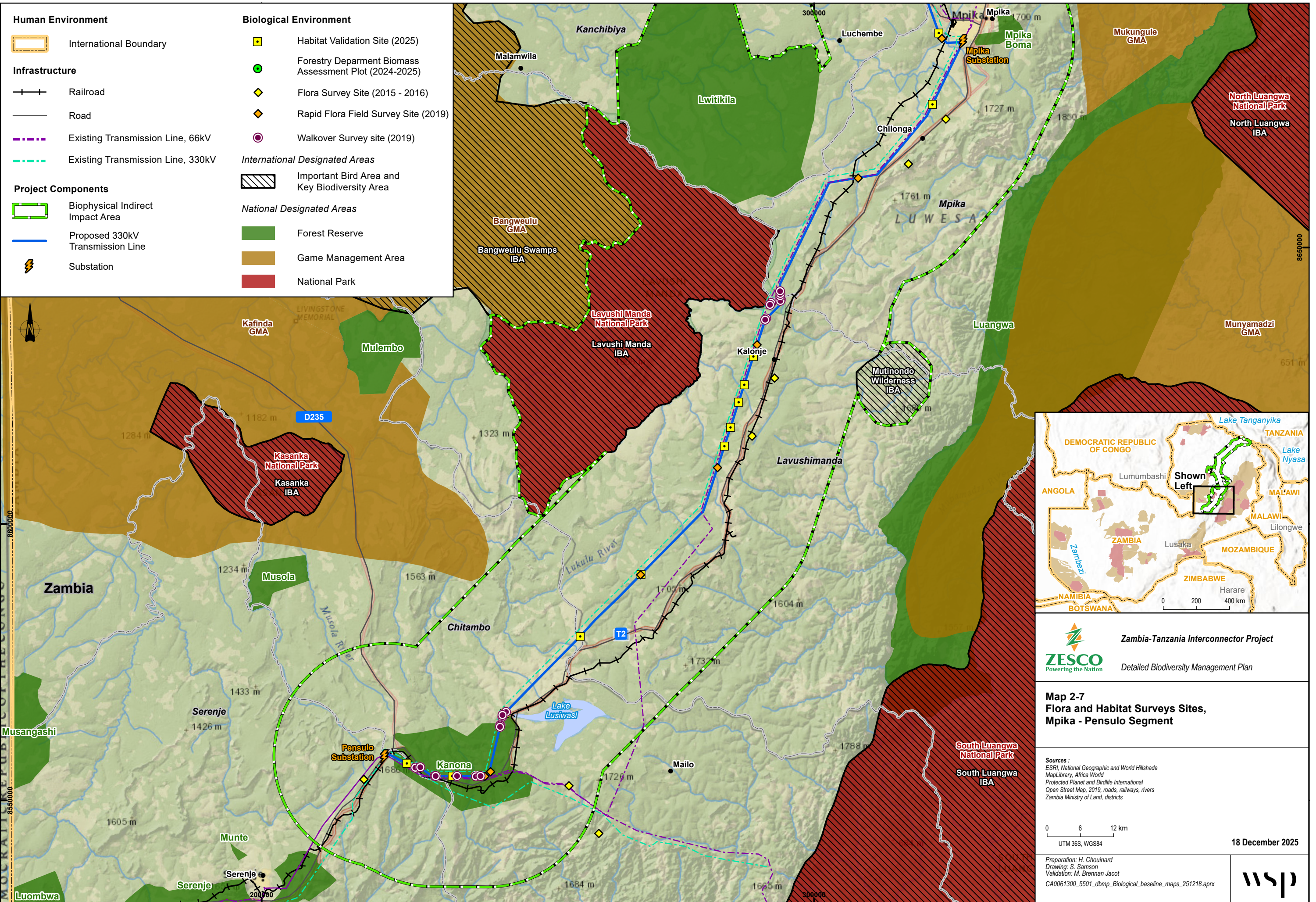
Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251217.aprx

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.





Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



Zambia-Tanzania Interconnector Project
ZESCO Powering the Nation
 Detailed Biodiversity Management Plan

Map 2-7
Flora and Habitat Surveys Sites,
Mpika - Pensulo Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts

0 6 12 km
 UTM 36S, WGS84
 18 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251218.aprx



2.3.1 Habitat Types

The study area features various habitat types that are distributed across the landscape according to diverse biophysical and anthropogenic factors. Habitat types and land uses inside the ROW were identified using satellite imagery, a Geographic Information System (GIS) and field validations. The main habitat types encountered within the ROW are presented in Table 2-4. The vegetation types are described below.

Table 2-4 Habitat Types and Land Use Encountered within the Proposed ROW

Habitat type/land use	Area (ha)	Proportion
Agriculture	670.5	23.8%
Built environment	8.8	0.3%
Fallow land	473.5	16.8%
Grassland - open area	125.9	4.5%
Riverine forest	48.9	1.7%
Rock outcrop	4.8	0.2%
Wetland – high disturbance	39.5	1.4%
Wetland – medium disturbance	223.7	7.9%
Wetland – low disturbance	56.5	2%
Degraded miombo woodland	583.9	20.7%
Mature miombo woodland	39.4	1.4%
Secondary miombo woodland	539.0	19.1%
Plantation	4.2	0.1%
Total	2,818.58	100.0%

The WB ESS 6 requires a differentiated risk management approach to habitats based on their sensitivity and values. This ESS categorizes the habitats as ‘modified habitat’, ‘natural habitat’, and ‘critical habitat’. Based on the ESS 6 definitions:

- Modified habitats are areas that may contain a large proportion of plant and/or animal species of nonnative origin, and/or where human activity has substantially modified an area’s primary ecological functions and species composition.
- Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area’s primary ecological functions and species composition.

Most of the habitats located inside the ROW have been modified to a various extent by human activities, including cultivation, grazing, urban expansion, and industry. The only habitat types considered as natural habitats are the riverine forest, the mature and secondary miombo woodland and wetlands with low to medium levels of degradation. Presence of critical habitats is assessed in Section 2.9.

Miombo Woodlands

The dominant terrestrial habitat type along the proposed transmission line route is the miombo woodland, with 41% of the total ROW area. This habitat type occurs where it is warm year-round and may receive several hundred centimetres of rain yearly. The miombo woodland includes a wide range of plant communities varying in terms of their structure and their dominant vegetation layer. Due to disturbance or environmental characteristics, some miombo woodland areas can be dominated by grasses or shrub species. These plant communities are usually in transition and the woodland is probably the climax plant community. A picture of typical miombo woodland observed on the field is presented in Photo 2-10.

Wet miombo occurs on the plateau and escarpment and receives average rainfall of 1,500 mm/annum. When not disturbed it is a two-layered woodland up to 20 m in height and made up of *Brachystegia* species (*B. boehmii*, *B. longifolia*, *B. manga*, *B. spiciformis* and *B. utilis*), *Julbernardia paniculata* and *Isoberlinia angolensis* on the plateau and *Brachystegia bussei*, *B. microphylla* or *B. taxifolia* and *B. utilis* on the escarpment. The shrub layer was usually sparse, with the most common species being *Landolphia kirkii*, *Indigofera podocarpa*, *Kotschyia carsonii*, and *Vellozia equisetoides*.

The density of plants is relatively higher on the escarpment and hilly areas compared to the lowlands, especially near settlements. This was equally true of most Forest Reserves and the Lavushi Manda National Park. Areas easily accessible to local people are the most degraded, especially from charcoal production and slash-and-burn agriculture, or Chitemene in the local Bemba dialect.

The following tree species: *Brachystegia boehmii*, *B. bussei*, *B. floribunda*, *B. glaberrima*, *B. longifolia*, *B. manga*, *B. microphylla*, *B. spiciformis*, *B. stipulata*, *B. taxifolia*, and *B. utilis*, were commonly found in the studied sites in 2019. The following woodland associative forms were frequent: *Brachystegia* woodlands, *Brachystegia – Julbernardia*, and *Brachystegia – Isoberlinia – Julbernardia* woodlands.



Photo 2-10 Miombo Woodland

Miombo Woodland Classification

Woodland found in the transmission line ROW were classified in three categories (see Table 2-4):

- **Mature:** Primary habitat that are mature and largely intact, or well-established secondary forests that have developed a mature structure and composition over time. Representative of the late seral stage in the process of woodland succession.
- **Secondary:** Forest of woodland that has regenerated following deforestation or other human disturbance. Habitat largely contains the principal characteristics and functions of a native ecosystem. Human activity has not essentially modified the area's primary ecological functions and species composition.
- **Degraded:** Treed areas that are damaged or altered from their natural state. Human activity has substantially modified the area's primary ecological functions and species composition. Habitat has lost its complex structure and biodiversity, often characterized by soil compaction, bare patches, and reduced tree cover. These areas are typically transitioning towards a deforested state.

Mature and secondary miombo woodlands are considered as natural habitats whereas degraded miombo woodlands are considered modified habitat because they have been negatively altered by human activities, and have lost key components of their natural structure, function, and composition. They are unlikely to return to their natural state and do not support significant biodiversity values.

Figures 2-10 to 2-12 illustrate the different categories.



Figure 2-10 Satellite Imagery and Photo of Mature Miombo Woodland



Figure 2-11 Satellite Imagery and Photo of Secondary Miombo Woodland



Figure 2-12 Satellite Imagery and Photo of Degraded Miombo Woodland

Wetlands (Edaphic Grassland on Drainage-Impeded or Seasonally Flooded Soils and Freshwater Swamps)

Within the main watersheds of the study area, low-lying areas consist of seasonally or permanently flooded wetlands or dambos. These habitats usually have a very low tree and shrub cover and a very dense herbaceous layer. Some common wetland grass species include: *Phragmites mauritiana*, *Cyperus papyrus*, *Loudetia simplex*, and *L. angolensis*. Wetland edges are often used for agriculture, and their herbaceous layer was often burnt. Large wetland far from settled area or located in protected areas such as Shiwa Ngandu, show a more diverse herbaceous layer with rushes (*Juncus spp.*), flatsedges (*Cyperus spp.*), bulrushes (*Scirpus spp.*), and carnivorous plants such as *Drosera spp.*, forming a larger proportion of the herbaceous layer cover (see Photo 2-11). Permanent wetlands have areas of open water where submerged and floating plant species are present.

The analysis of satellite imagery identified 112 distinct wetlands along the ZTIP transmission line. Wetlands were classified as low, medium, or high disturbance: high disturbance denotes complete transformation by agriculture, medium is partial agricultural use, and low remains largely undisturbed. Low and medium classes are considered natural habitat, while high disturbance wetlands are classed as modified habitat. The compilation of surface area within the ROW per wetland disturbance class is presented in Table 2-5.

Table 2-5 Wetland Area within the ROW for Each Disturbance Class

Wetland disturbance class	Total area within ROW	% of total wetland area within ROW
High disturbance	39.5	12%
Medium disturbance	223.7	70%
Low disturbance	56.5	18%
Total	319.7	100%



Photo 2-11 Flooded Wetland crossed by the powerlinesouth of Kasama

Riverine Habitat

With agricultural activities often taking place along the banks of streams and rivers, riverine habitats are most often narrow strips of natural or semi-natural vegetation along watercourses (see Photo 2-12). The tree layer is usually sparse and composed of small trees, usually less than 5 m high, such as *Acacia polyacantha*, *Diospyros mespiliformis*, *Rauvolfia caffra*, *Syzygium cordatum*, *S. Guineense*, and *Xylopia odoratissima*. The main species of shrub present is *Rhus longipes*. The herbaceous layer is dense and dominated by *Hyparrhenia rufa*, *Loudetia simplex* and *Phragmites mauritiana*.



Photo 2-12 Riverine Habitat

Mosaic Croplands-Vegetation

Mosaic croplands-vegetation habitats are made of a mosaic of agriculture and non-forest vegetation. Croplands are mixed with natural vegetation representing up to 30% of the total cover (Mayaux et al., 2003). This vegetation type is found mostly around larger towns and villages and is expanding as population increases and small-scale farmers move to new areas. A large portion of the mosaic croplands in the areas covered by the proposed transmission line route are interspersed with dambos/grasslands or disturbed miombo woodlands. Most of the grasslands are found in the lower areas which get flooded during the rainy season. Croplands often reach streams and riverbanks, leaving very little natural vegetation around most watercourses. Slash and burn practices are used within the area, involving coppicing or pollarding of standing trees in primary or secondary growth stands, stacking of the removed biomass and, eventually, burning it to create a thicker layer of ash recognized as fertilizer (see Photo 2-13).



Photo 2-13 Slash and Burn Practices

2.3.2 Species Diversity

A total of 587 species were identified during flora surveys in 2015, 2016, 2019 and 2025, including during biomass assessment within Forest Reserves completed by the Forestry Department. 233 species were additionally detected within the BIIA according to the GBIF database, for a total of 820 plant species from 123 families. The most abundant family is the *Fabaceae*, with 100 species, followed by *Orchidaceae*, *Cyperaceae*, *Poaceae*, and *Lamiaceae*, with 70, 52, 47, and 33 species, respectively. The detailed list of species is provided in Appendix 2-3.

2.3.3 Invasive Species

As shown in Table 2-6, a total of 21 invasive species from 15 families are reported in Zambia according to Global Invasive Species Database (GISD). These species generally occur in grasslands and disturbed areas, and tolerate a great variety of conditions, facilitating their colonization to new habitat. Some of them are found in aquatic ecosystems, such as *Lagarosiphon major* and *Trapa natans*.

Three species from this list have been observed in the study area, which are *Bidens pilosa*, *Imperata cylindrica*, *Leucaena leucocephala* and *Lantana camara*.

Table 2-6 List of Invasive Species and their Respective Habitats Found in Zambia

Family	Scientific name	Habitats
Asteraceae	<i>Bidens pilosa</i>	Grassland, heathland, forest clearings, wetlands, plantations, streamlines, roadside, pasture, coastal areas, and agriculture areas.
Bignoniaceae	<i>Tecoma capensis</i>	Bush or scrub, occasionally on forest margins.
Commelinaceae	<i>Commelina benghalensis</i>	Disturbed sites, forest edges, roadsides, agricultural sites, and home gardens.
Cyperaceae	<i>Cyperus rotundus</i>	Cultivated fields, farmlands, neglected areas, wastelands, grasslands, at the edges of forests, and on roadsides, sandy or gravelly shores, riverbanks and irrigation canal banks.
Cyperaceae	<i>Oxycaryum cubense</i>	Wetland-river.
Fabaceae	<i>Leucaena leucocephala</i>	Open (often coastal or riverine) habitats, semi-natural, disturbed, degraded habitats and other ruderal species.
Hydrocharitaceae	<i>Lagarosiphon major</i>	Clear, still or slow-moving fresh water with silty or sandy bottoms.
Lygodiaceae	<i>Lygodium microphyllum</i>	Cypress stands, but also infests pine flatwoods, wet prairies, sawgrass marshes, mangrove communities. Mesic forests, rain forest, and open swampy areas.
Poaceae	<i>Cenchrus ciliaris</i>	Favours alkaline soils and within arid areas establishes best in pockets of high nutrients and moisture.
Poaceae	<i>Cenchrus polystachios</i>	Disturbed, mostly dry, lowland areas and cultivated fields up to 2,100m elevation.
Poaceae	<i>Imperata cylindrica</i>	Degraded forests, grasslands, arable land, and young plantations within tropical and subtropical climates.
Poaceae	<i>Panicum repens</i>	Moist, often sandy soil along beaches and dunes, margins of lagoons, marshy shorelines of lakes and ponds, drainage ditches and canals.
Poaceae	<i>Paspalum scrobiculatum</i>	Along the ditch, roadsides, upland and tidal rice fields, rubber plantations; wet, open, cultivated areas.
Poaceae	<i>Rottboellia cochinchinensis</i>	Roadside and in other open, well-drained sites but it can be found in wet places, and even in shallow water.
Polypodiaceae	<i>Phymatosorus scolopendria</i>	Degraded areas, sclerophyll forest.
Pontederiaceae	<i>Eichhornia crassipes</i>	Shallow temporary ponds, wetlands and marshes, sluggish flowing waters, lakes, reservoirs and rivers.
Salviniaceae	<i>Salvinia molesta</i>	Still or slow-moving water bodies, including ditches, ponds, lakes, slow rivers, and canals.
Sapindaceae	<i>Cardiospermum grandiflorum</i>	Often near riverbanks.
Scrophulariaceae	<i>Striga asiatica</i>	Agricultural lands, especially those with light soils and/or low nitrogen fertility where it infests a wide range of grass crops (maize, millet, rice, sorghum, sugarcane) and some broadleaf crops (e.g., sunflower, tomatoes, some legumes).
Trapaceae	<i>Trapa natans</i>	Lakes, ponds, canals, and slow water.
Verbenaceae	<i>Lantana camara</i>	Open, unshaded situations such as wastelands, rainforest edges, beachfronts, and forests recovering from fire or logging.

2.3.4 Flora Species of Conservation Concern

Four species listed on the IUCN Red List of threatened species were encountered in the study area during field surveys: *Khaya nyasica*, vulnerable (VU), *Ansellia Africana* (VU), *Disa aequiloba*, endangered (EN) and *Prunus Africana* (VU).

East African Mahogany (*Khaya nyasica*) – Vulnerable. This species is typically associated with riverine forest and frequently occurs near water (ITHAKA, 2025). The species may be globally listed as vulnerable but this status is considerably outdated and does not consider recent taxonomic revisions. *Khaya nyasica* was previously part of the *Khaya anthotheca* taxon, which was split into six distinct species (Bouka et al., 2022). East African Mahogany is native to Kenya, Malawi, Mozambique, Tanzania, Zambia, Zimbabwe (Royal Botanic Gardens Kew, 2025). One observation of a single East African Mahogany tree was recorded in the Eastern Africa Avifaunal Atlas (EAAA), in the Kasama Forest Reserve.

Leopard Orchid (*Ansellia Africana*) – Vulnerable. This orchid widespread and grows in riverine vegetation and mopane or miombo woodlands near rivers, growing on trees and shrubs. The species, however, has many traditional uses within Africa and is a very desirable orchid for collectors. It is harvested both legally and illegally throughout Africa, where entire areas are destroyed during its collection (Crook, 2013).

***Disa aequiloba* – Endangered.** This orchid grows in wetlands (swamps, wet grassland, wet meadows). This species is endangered due to habitat loss caused mainly by agriculture, expansion of tea plantations and potato farming (IUCN SSC East African Plants Red List Authority, 2019). As the species triggers critical habitat, targeted surveys within the project area were carried out in 2025. Results are described in the next section.

African Cherry (*Prunus Africana*) – Vulnerable. This tree's distribution extends over much of sub-Saharan Africa, from montane areas in Central Africa eastwards to East Africa and southwards to South Africa (Hills and Cheek, 2021). It mainly occurs in moist montane forest above 1,800 m (Hills and Cheek, 2021). Four individual African Cherry trees were recorded in the EAAA, all from one survey plot in the Kasama Forest Reserve.

Five other threatened species according to the IUCN Red-List are considered potentially present along the proposed line route according to the observation registered in the GBIF in the BIIA (GBIF, 2024). Four of these are ornamental species occurring outside their natural distribution range, namely *Kalanchoe daigremontiana* (Endangered), *Jacaranda mimosifolia* (Vulnerable), *Cedrela odorata* (Vulnerable), *Brugmansia suaveolens* (Extinct in the wild). The only threatened native species extracted from GBIF is *Encephalartos schmitzii*.

***Encephalartos schmitzii* – Vulnerable.** This species occurs along the Muchinga Escarpment in the Muchinga province in Zambia. In the BIIA, there would be a disjunct population in wet miombo woodlands of Bwingi Mfumu Forest Reserve, which is about 20 km to the east of the proposed line (Dr Mulongwe, Principal Research Officer, Forestry Department, personal communication). GBIF also has a record of the species from the Mutinondo Wilderness area.

It grows in sandy quartzitic soils in miombo woodlands. The species is threatened due to over-collecting for ornamental purposes and as a result of habitat loss caused by bush clearing for agricultural purposes. Too frequent fires may also have driven this cycad's pollinator to extinction (Bösenberg, 2022). Although present in the BIIA, because its distribution is limited to the Muchinga escarpment, its presence in the DIA is unlikely.

Other species present or potentially present in the project's wayleave or study area are of conservation value because of endemism. These are presented in Table 2-7 below. Amongst the endemic species, *Euphorbia perplexa* var. *kasamana*, *Gladiolus serenjensis* and *Encephalartos schmitzii*, can be considered as restricted range (RR) according to International Finance Corporation (IFC) Performance Standard 6 (PS 6) definition (Extent of Occurrence (EOO) smaller than 50,000 km²). Targeted surveys of *Euphorbia perplexa* var. *kasamana* were completed in 2025 as the species triggers critical habitat and is found within the wayleave. Results are described in the next section.

Table 2-7 Flora Species of Conservation Interest Potentially Present in the Study Area

Scientific name	Family	Habitat	Endemic/restricted range	IUCN Red List status	Occurrence in relation to wayleave
<i>Rhus fanshawei</i>	Anacardiaceae	On rocky hills and in woodlands.	Endemic to Zambia	NE	Near the line crossing with Chambeshi River Crossing. Found in Northern, Muchinga and Western Provinces.
<i>Euphorbia cooperi</i> var. <i>ussanguensis</i>	Euphorbiaceae	Rock outcrops Sandy area base of outcrops	Endemic to Zambia	NE	Found within wayleave. Found in Northern, Central, Eastern and Luapula Provinces.
<i>Euphorbia jubata</i>	Euphorbiaceae	Rocky outcrops	Endemic to Zambia	NE	Found less than 1 km from wayleave. Found in the Northern, Luapula and Muchinga Provinces.
<i>Euphorbia speciosa</i>	Euphorbiaceae	Rocky outcrops	Endemic to Zambia	NE	Found within wayleave. Found in the Northern and Muchinga Province.
<i>Euphorbia perplexa</i> var. <i>kasamana</i>	Euphorbiaceae	Rocky outcrops	Endemic to Zambia, Restricted Range	NE	Found within wayleave. Recorded only from Kasama and north of Kasama.
<i>Gladiolus serenjensis</i>	Iridaceae	Hilly area	Endemic to Zambia, Restricted Range	NE	Herb, on thin soils and rock crevices. Muchinga Escarpment, Serenje District. Unlikely presence in the DIA.
<i>Khaya nyasica</i>	Meliaceae	Riverine forest	NA	VU	Found within wayleave in the Kasama Forest Reserve.
<i>Ansellia africana</i>	Orchidaceae	Epiphyte on woodland trees	NA	VU	Found within wayleave.

Scientific name	Family	Habitat	Endemic/restricted range	IUCN Red List status	Occurrence in relation to wayleave
<i>Disa aequiloba</i>	Orchidaceae	Wetland or swamps	NA	EN	Found within wayleave. Wetland or swamps with low to medium anthropogenic disturbances.
<i>Habenaria macrotidion</i>	Orchidaceae	Wetland or swamps	Endemic to Zambia	NE	Wetland or swamps in the Copperbelt, Central, Muchinga, Northern and North-western Provinces.
<i>Prunus africana</i>	Rosaceae	Evergreen montane and riverine forest	NA	VU	Found within wayleave in the Kasama Forest Reserve.
<i>Otiophora angustifolia</i>	Rubiaceae	Rock outcrops and faces in riverine vegetation	Endemic to Zambia	NE	Rock outcrops in the Northern, Luapula and Muchinga Provinces.
<i>Encephalartos schmitzii</i>	Zamiaceae	Sandy quartzitic soils in miombo woodlands	Endemic to Zambia, Restricted Range	VU Restricted range	Approximately 20 km from wayleave in the Mutinondo Wilderness area and the Bwingi Mfumu FR. Unlikely presence in the DIA.

Note: EN: Endangered; VU: Vulnerable; LC: Least Concern; NE: Not Evaluated; NA: Not Applicable.

2.3.5 Species of Use-Value

Several uses are reported for flora species present in the study area. These species are important sources of livelihood for local communities, providing medicinal plants, wild fruits and vegetables and edible leaves and seeds, construction timber, firewood, charcoal, edible caterpillars, beekeeping opportunities, and ecological functions among others. These uses were reported in numerous studies (Chinsembu, 2016; Fern, 2014; Mickels-Kokwe, 2006; Mubemba, 2024; Mwambo and Chuba, 2024; Nyirenda and Chipuwa, 2024; Pelletier et al., 2019; Welcome to Zambia, 2025) as well as during the census of affected assets conducted as part of the Resettlement Action Plan (RAP). These products are, to a large extent, dependent on habitat's management condition, with intact mature woodlands usually being more productive and the over-exploited and degraded ones being less so (Mickels-Kokwe, 2006).

Table 2-8 summarizes the main use value of flora species in the study area. Overall, 109 flora species are used by communities in the study area, most (94) used for their medicinal properties. Additionally, 43 species provide wild food products to communities (mostly wild fruits, with a few species having edible seeds or leaves). *Fabaceae* is the family with the most species of use value with a total 29, mostly used for their medicinal properties (22) or for construction (11) and charcoal production (10). *Moraceae* is the second most widely used family with seven (7) species of use value, all with medicinal properties and some used for construction (5) and wild food products (4).

Detailed use value associated with specific species can be found in Appendix 2-3.

Table 2-8 Use Value of Flora Species

Family	Type of use										Total number of species of use value
	Medicinal	Food	Construction	Dye	Firewood	Charcoal	Beekeeping	Ecological function	Edible caterpillars	Other ¹	
<i>Fabaceae</i>	22	4	11	6	6	10	8	1	4	9	29
<i>Moraceae</i>	7	4	5	0	0	0	0	1	0	0	7
<i>Lamiaceae</i>	5	3	2	0	0	0	2	0	0	0	5
<i>Euphorbiaceae</i>	5	3	3	1	0	0	0	0	0	1	5
<i>Combretaceae</i>	5	0	0	1	0	0	0	0	0	1	5
<i>Anacardiaceae</i>	3	2	0	0	0	0	0	0	0	0	4
<i>Chrysobalanaceae</i>	3	3	1	1	1	2	0	1	0	0	4
<i>Apocynaceae</i>	2	2	0	0	0	0	1	0	0	0	3
<i>Annonaceae</i>	3	0	0	0	0	0	0	0	0	0	3
<i>Myrtaceae</i>	3	3	2	2	0	0	0	0	0	2	3
<i>Ebenaceae</i>	2	3	1	2	0	0	0	0	0	1	3
<i>Clusiaceae</i>	3	0	0	0	0	0	0	0	0	0	3
<i>Strychnaceae</i>	3	3	1	2	2	0	0	0	0	2	3
<i>Poaceae</i>	1	0	0	0	0	0	0	0	0	0	2
<i>Dipterocarpaceae</i>	1	0	1	0	0	1	0	1	0	1	2
<i>Phyllanthaceae</i>	2	1	2	1	2	1	0	0	0	1	2
<i>Rhamnaceae</i>	2	2	2	1	0	2	1	0	0	1	2
Other families ²	22	10	4	1	5	0	0	0	0	3	24
Total number of species	94	43	35	18	16	16	13	4	4	21	109

Source: RAP Census, 2024; Chinsemu, 2016; Fern, 2014; Mickels-Kokwe, 2006; Mubemba, 2024; Mwambo and Chuba, 2024; Nyirenda and Chipuwa, 2024; Pelletier et al., 2019; Welcome to Zambia, 2025.

Notes: 1 Other use includes insecticides and pesticides, fodder, pottery, basketry, canoes, rope, hunting and fishing, and soap.

2 Families included under 'Other' have only one reported species of use value. These families are *Asparagaceae*, *Amaranthaceae*, *Anisophylleaceae*, *Apiaceae*, *Arecaceae*, *Bignoniaceae*, *Capparaceae*, *Celastraceae*, *Compositae*, *Cucurbitaceae*, *Dioscoreaceae*, *Kirkiaceae*, *Loganiaceae*, *Malvaceae*, *Musaceae*, *Ochnaceae*, *Olacaceae*, *Pedaliaceae*, *Picrodendraceae*, *Polygalaceae*, *Salicaceae*, *Salvadoraceae*, *Sapindaceae*, and *Verbenaceae*.

2.4 Birds

2.4.1 Birds Context

Zambia is rich in avifaunal diversity, with 734 species recorded across the country. Three percent of these species (n=22) are globally threatened, with an IUCN Red List status of Critically Endangered, Endangered or Vulnerable (BirdLife International, 2024a). The country is home to one true endemic species, the *Zambian Barbet (Lybius chaplini)*, and also supports the Black-cheeked Lovebird (*Agapornis nigrigenis*), a species considered endemic to Zambia due to its highly restricted range. The latter is regarded as the most endangered and geographically localized of all African parrot species. In addition to its resident birdlife, Zambia serves as a critical staging area and destination for migratory birds arriving from the northern hemisphere during the boreal winter.

The region is also a major staging post and destination for avifauna migrating south during the boreal winter. Well-known avifauna include vultures, raptors, ostrich, bustards, cranes and storks (BirdLife International, 2024a). While many of the aforementioned species feature prevalently in protected areas such as Lavushi Manda National Park, which contains more pristine habitats compared to those habitats found within the confines of the proposed power line alignment, their presence within the proposed study area cannot be discounted. This is especially true for far-ranging species that may forage out of protected areas.

GMA also host important ecosystems for birds. Relevant to this assessment, both the Kafinda and Luwingu GMAs are adjacent to other protected areas and the Kafinda GMA contains an important wetland ecosystem, which is likely to support various avifaunal species associated with wetland habitats. In addition, the presence of ungulates and the commercial and subsistence hunting practices taking place in these areas are likely to attract vultures and Marabou Stork (*Leptoptilos crumenifer*) because of the availability of carcasses on which to feed. These species are particularly susceptible to interactions with transmission line developments.

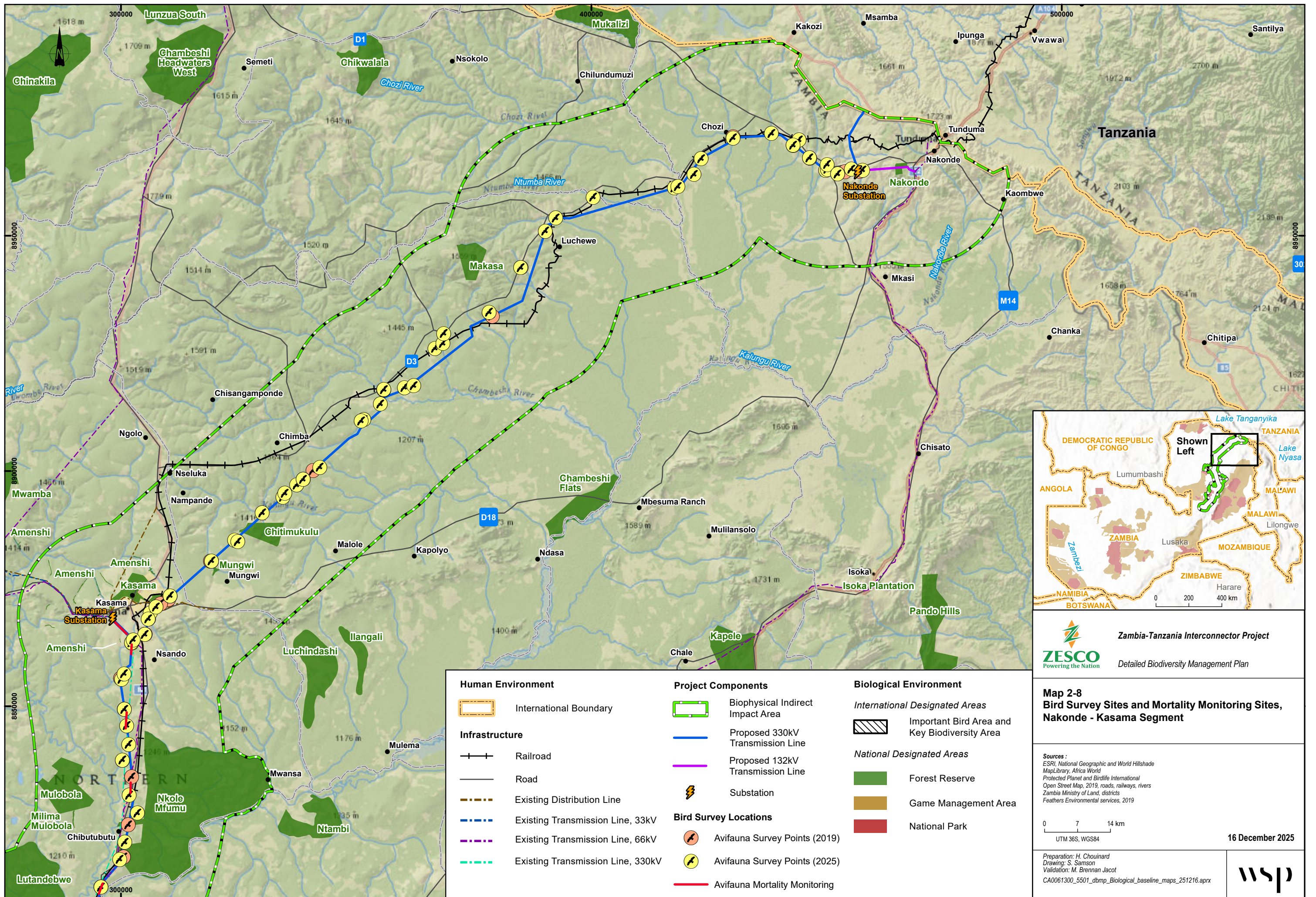
2.4.2 Birds Species Diversity

Bird occurrence data was obtained from field surveys conducted in November 2019, and during the 2025 wet and dry season, in March- April 2025 and September 2025 respectively. The 2025 bird survey sectorial report is available in Appendix 2-6. This field data was completed by consulting various data sets, including GBIF (2024) or the Southern African Bird Atlas Project 2 (SABAP 2, 2019) to complete the list of species of conservation concern potentially present within the BIIA. The detail on data sources and survey methodology is described in Appendix 2-1. Bird survey sites are illustrated on Maps 2-8 to 2-10.

Priority bird species were defined in terms of i) global and/or regional (species that are considered to be threatened within Zambia) status, ii) uniqueness or endemism, iii) susceptibility to powerline-associated impacts, and iv) relative use of the habitats within the proposed development area, e.g., migratory species. The list of priority species is available in Appendix 2-7.

The field surveys conducted within the DIA produced a combined list of 315 species. Fifty-three priority species were observed during the surveys. Five species are listed in the IUCN Red List with either an endangered or a vulnerable status. Additionally, three species are in the regional Red List with either a conservation concern or range restricted status.

The detailed observations from each survey method are described below. The list of all bird species surveyed is available in Appendix 2-8.



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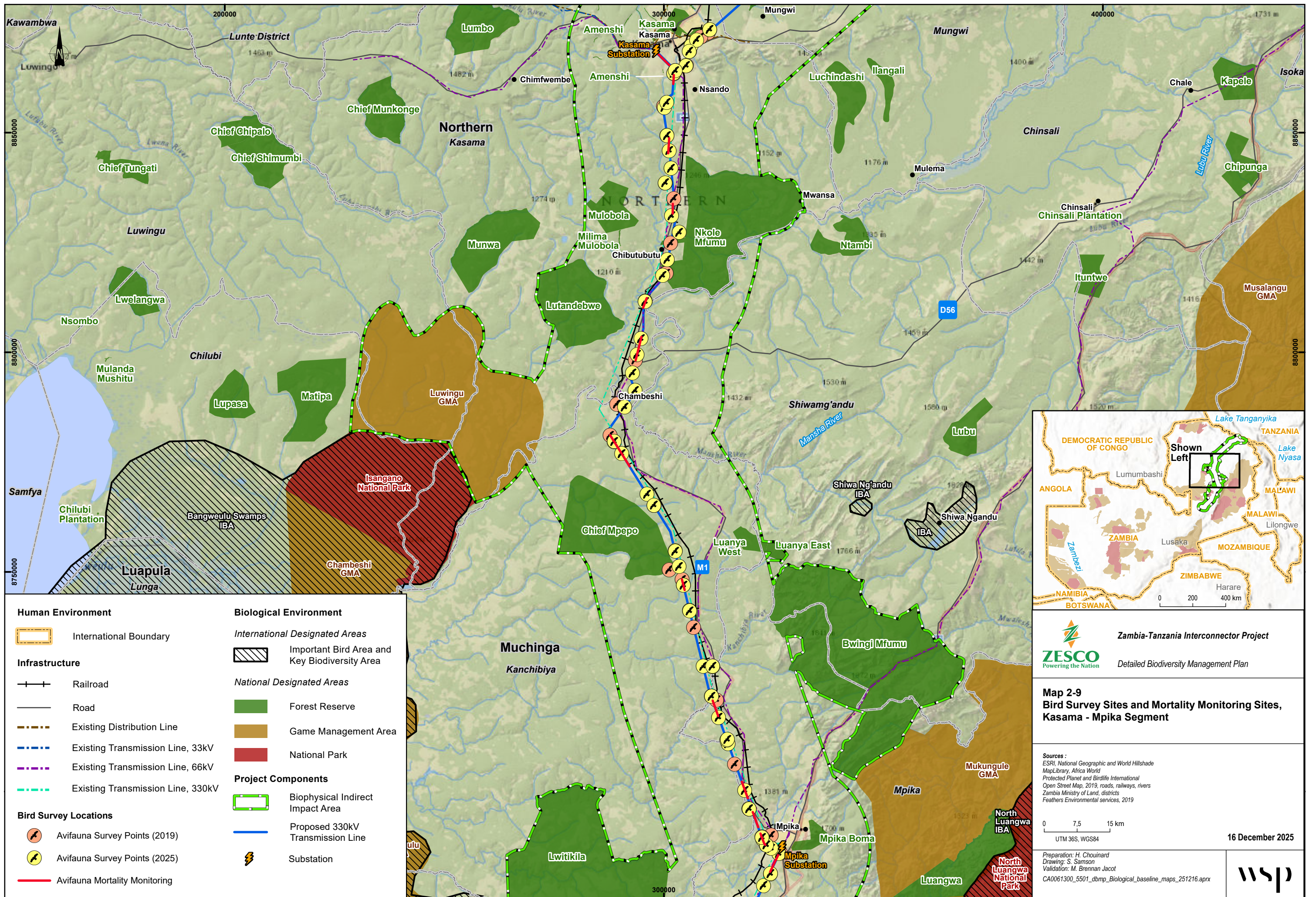
Map 2-8
Bird Survey Sites and Mortality Monitoring Sites,
Nakonde - Kasama Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

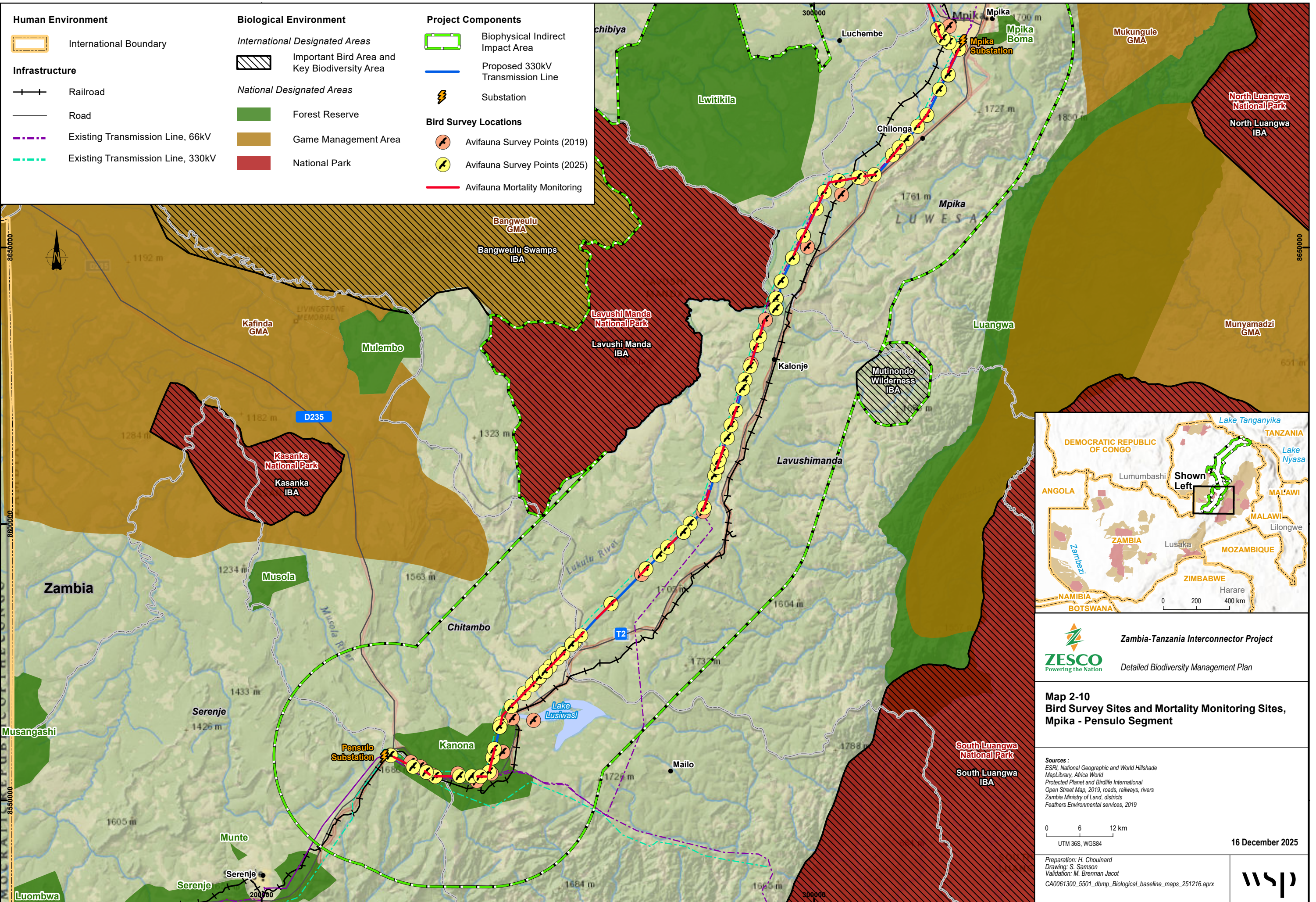
0 7 14 km
 UTM 36S, WGS84

16 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
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<p>Human Environment</p> <p>International Boundary</p> <p>Infrastructure</p> <p>Railroad</p> <p>Road</p> <p>Existing Transmission Line, 66kV</p> <p>Existing Transmission Line, 330kV</p>	<p>Biological Environment</p> <p>International Designated Areas</p> <p>Important Bird Area and Key Biodiversity Area</p> <p>National Designated Areas</p> <p>Forest Reserve</p> <p>Game Management Area</p> <p>National Park</p>	<p>Project Components</p> <p>Biophysical Indirect Impact Area</p> <p>Proposed 330kV Transmission Line</p> <p>Substation</p> <p>Bird Survey Locations</p> <p>Avifauna Survey Points (2019)</p> <p>Avifauna Survey Points (2025)</p> <p>Avifauna Mortality Monitoring</p>
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Map 2-10
Bird Survey Sites and Mortality Monitoring Sites,
Mpika - Pensulo Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

0 6 12 km
 UTM 36S, WGS84
 16 December 2025

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Point Counts Survey Results

A total of 283 species were recorded across the point count locations throughout all survey periods. Small passerine species, i.e., Dark-capped Bulbul (*Pycnonotus tricolor*), Bronze Mannikin (*Lonchura cucullata*), Blue Waxbill (*Uraeginthus angolensis*), Common Waxbill (*Estrilda astrild*), Fork-tailed Drongo (*Dicrurus adsimilis*), Yellow Bishop (*Euplectes capensis*) and Yellow-mantled Widowbird (*Euplectes macroura*), Black-backed Puffback (*Dryoscopus cubla*), Black-collared Barbet (*Lybius torquatus*), Little Bee-eater (*Merops pusillus*) and various sunbird species, were common in most habitat types.

The 2025 wet season surveys yielded the most bird species, notably because of large numbers of migratory and breeding species such as Barn Swallow (*Hirundo rustica*) and European Bee-eater (*Merops apiaster*), along with resident Yellow-fronted Canary (*Crithagra mozambica*), and Red-collared Widowbird (*Euplectes ardens*), contributing to the higher overall species richness. The contrast between seasons demonstrates the ecological role of the wet season in supporting peak breeding activity and migratory influxes, while the dry season results illustrate how resident species persist under reduced resource availability, providing a robust understanding of seasonal variation in avian community structure along the ZTIP alignment.

During all surveys, the high-richness points (>20 species recorded) were associated with heterogeneous landscapes comprising combinations of riverine systems, waterbodies, miombo woodland, open grasslands, cultivated lands, and areas influenced by anthropogenic activity such as villages and power line infrastructure. This mosaic of habitat types likely plays a pivotal role in sustaining elevated avifaunal diversity by offering a broad range of foraging resources, nesting substrates, and refuge environments. The recurrence of these high-diversity sites in both wet and dry seasons highlights their importance as stable biodiversity nodes within the wider landscape and highlights the ecological value of maintaining habitat heterogeneity along the ZTIP corridor.

Fourteen raptor species were observed in 2019, while 25 raptors species were observed during the wet season 2025 and 16 species during the dry season 2025.

A flock of seven Abdim's Stork (*Ciconia abdimii*) was observed flying at a height of approximately 100 m in a northwesterly direction at point count A-32, mainly comprised of floodplains.

Their presence and flight pattern suggest that they (and other species) may commute through this area on route to the Bangweulu Swamps, an IBA located approximately 50 km west of point count A-32. This is a relatively short distance for far-ranging and migratory species. This area may be an important flyway for both migratory and resident wetland-dependent species.

Vehicle Based Surveys

Species diversity and density were low with only 12 priority species observed over the 2019 vehicle-based survey period, 11 of which were previously recorded during the point count surveys. The African Harrier-hawk (*Polyboroides typus*), not previously recorded, was observed during vehicle-based surveys. The Yellow-billed Kite (*Milvus aegyptius*), one of the most common raptors in Africa and one of the most visible birds in urban areas, was recorded most frequently. Disturbed areas, i.e., roadsides and villages, suit this bird well, as it is incredibly opportunistic in its behaviors. Its diet is varied, and it will feed on any prey small enough to be caught and eaten, such as small mammals, reptiles, birds, and insects. Carrion is regularly eaten, as well as human leftovers and scraps. The Cattle Egret (*Bubulcus ibis*) was the only large terrestrial bird observed during the vehicle-based surveys. Vehicle-based surveys 3 and 7 yielded the highest species richness with nine and five species observed, respectively.

Vehicle-based surveys, conducted during wet season 2025 yielded a total of 99 avian species, including 12 raptor species. Raptors were detected along nine of the 21 transect routes, indicating a localized and somewhat fragmented distribution across the survey area. Among these, the Amur Falcon (*Falco amurensis*) was the only raptor species recorded in notable abundance (n=30). This elevated count is consistent with the species' migratory behaviour and preference for open habitats often associated with road verges and disturbed landscapes. The remaining raptor species were observed in low numbers, suggesting either naturally low detection probabilities owing to their cryptic nature, low densities, or possible sensitivity to anthropogenic disturbance.

Vehicle-based surveys, conducted during the dry season 2025, recorded a total of 75 avian species, including 15 raptor species. Raptors were observed along all eight transect routes, indicating that these species are broadly distributed across the landscape rather than confined to localized areas. This widespread occurrence suggests that the traversed habitats collectively provide suitable conditions for raptor activity, including hunting perches, foraging opportunities, and nesting or roosting sites, which in turn reflects the effectiveness and spatial coverage of the survey methodology. Among the raptors, the Yellow-billed Kite (*Milvus aegyptius*) was the only species recorded in substantial numbers (n=37). This abundance can be attributed to its high adaptability and ability to exploit a wide range of natural and human-modified habitats.

2.4.3 Waterfowl Observations

In 2019, Lake Lusiwasi was targeted as a focal site for waterfowl observations. A relatively low total of 16 species were observed, seven of which were only recorded at this focal site: Cuckoo-finch (*Anomalospiza imberbis*), Cattle Egret *Bubulcus ibis*, Great Egret (*Egretta alba*), Yellow-billed Egret (*Egretta intermedia*), Common Moorhen (*Gallinula chloropus*), African Pygmy-goose (*Nettapus auritus*) and Red-billed Quelea (*Quelea quelea*). The lake is heavily utilized by the surrounding community resulting in a limited food supply. In addition, the significant levels of disturbance emanating from the nearby roads, railways, and villages have likely displaced many species that would ordinarily inhabit this important habitat feature. The flight behaviour of priority species was observed at this focal site to determine if flights occur across the proposed powerline located to the west of the lake.

Flights were short in distance and associated with foraging (African Marsh-harrier and Yellow-billed Kite) and a single direct commute to another side of the lake (Great Egret) in an easterly direction.

Although no focal site surveys were done in 2025, a total of 17 waterfowl species were recorded, comprising 169 individual birds during the wet season surveys (point count and vehicle-based survey combined). This species richness reflects the diversity of aquatic and semi-aquatic habitats within the study area and indicates a relatively high level of habitat suitability for water-dependent avifauna during the wet season. Among the recorded species, the African Openbill (*Anastomus lamelligerus*) and the African Marsh Harrier (*Circus ranivorus*) were the most abundant, with 84 and 43 individuals observed, respectively. Together, these two species accounted for 75.4% of all waterfowl records, indicating a strong dominance in the observed assemblage.

2.4.4 Nest Sites

Field-based nesting surveys along the ZTIP power line alignment were conducted during the 2019 and 2025 wet and dry season surveys to provide a comprehensive assessment of raptor and corvid reproductive activity within the project area. These surveys aimed to document the presence, spatial distribution, and breeding status of nests, including behavioral indicators such as courtship displays, nest building, incubation, and fledgling activity.

In 2019, several passerine nests were observed, mostly belonging to various weaver species. In addition, three active Pied Crow (*Corvus albus*) nests were observed within the lattice towers of the existing 330kV transmission powerline, between Pensulo and Mpika. All three nests were in the earth peaks, i.e., the attachment point of the powerline's earth wire-ground wire. In addition, another unidentified and inactive nest was found in the dense riverine forest near point count A-8, within the Mungwi Forest Reserve (NEST 1).

During 2025 bird surveys, six African Marsh Harrier nest were observed, two Lanner Falcon nest, one African Hawk Eagle nests, 41 Pied Crow nests and four nests of unknown species were identified. The location of bird nest sites recorded during the 20205 field surveys are illustrated in Figure 2-13.

A nest occupation survey was also conducted concurrently with the avifaunal mortality monitoring in 2025 along the existing 330kV alignment A total of 91 nests were recorded at 77 distinct towers locations along the surveyed alignment during the wet season while 79 nests were recorded at 66 locations during the dry season. Twelve nests were classified as active during the wet season and 43 during the dry season. The status of the remaining nests remained unknown. Nests observations are summarized in Figures 2-14 and 2-15 below. Most found nests on towers were positively identified as belonging to Pied Crows. This observation aligns with known behaviour of Pied Crows, which frequently exploit anthropogenic structures- including transmission towers – for nesting due to the elevation, structural stability, and reduced predation risk these sites offer.

These observations confirm the ZTIP alignment as an important nesting landscape for African Marsh Harrier, with active and probable breeding documented at multiple locations. Pied Crows are widespread across both natural and anthropogenic structures, though confirmed breeding was recorded at only a subset of sites. Lanner Falcons and other larger raptors were present but exhibited limited or unconfirmed breeding activity.

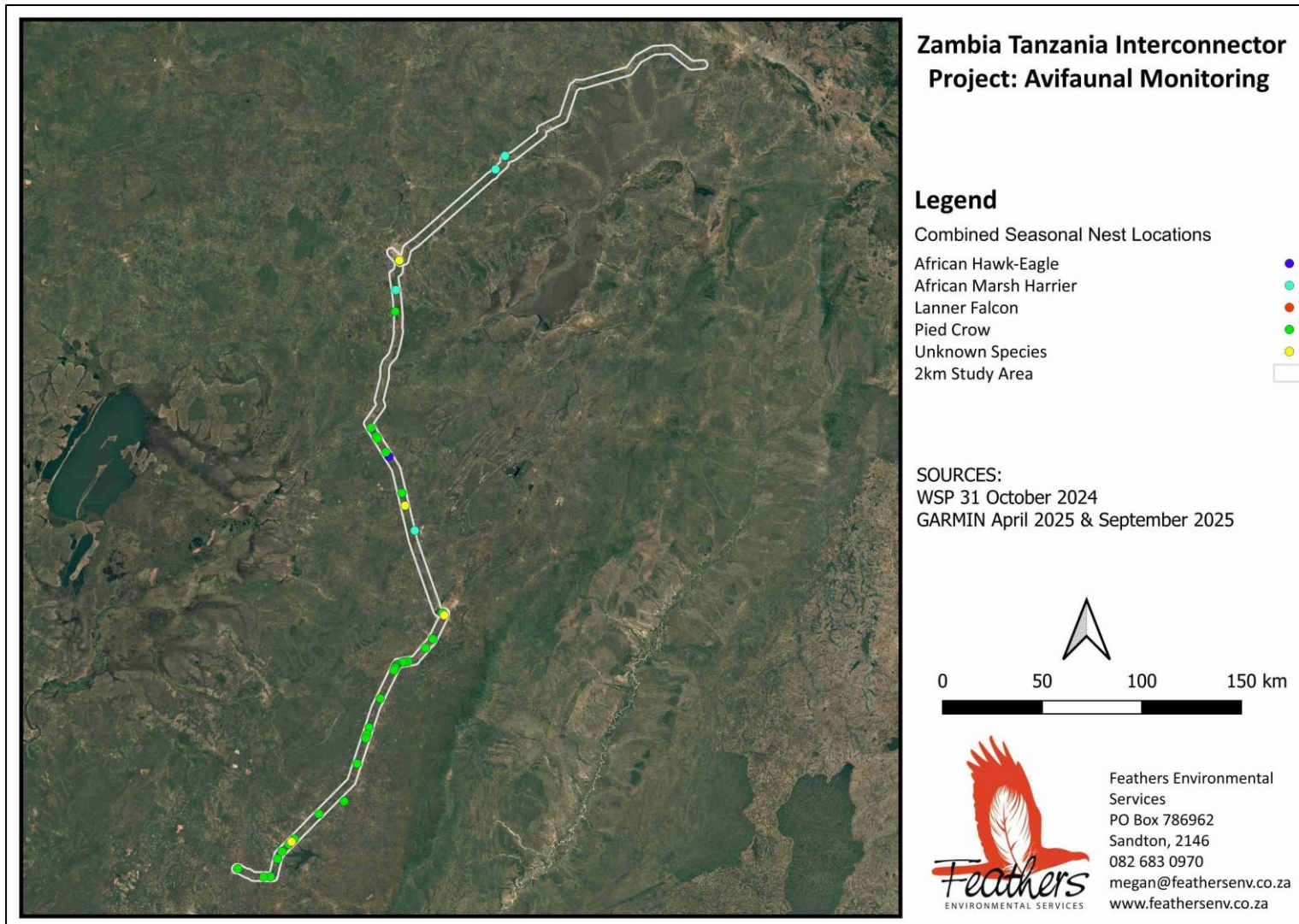


Figure 2-13 Combined Distribution of Nests along the ZTIP Power Line Alignment Recorded during the 2025 Wet and Dry Season Surveys

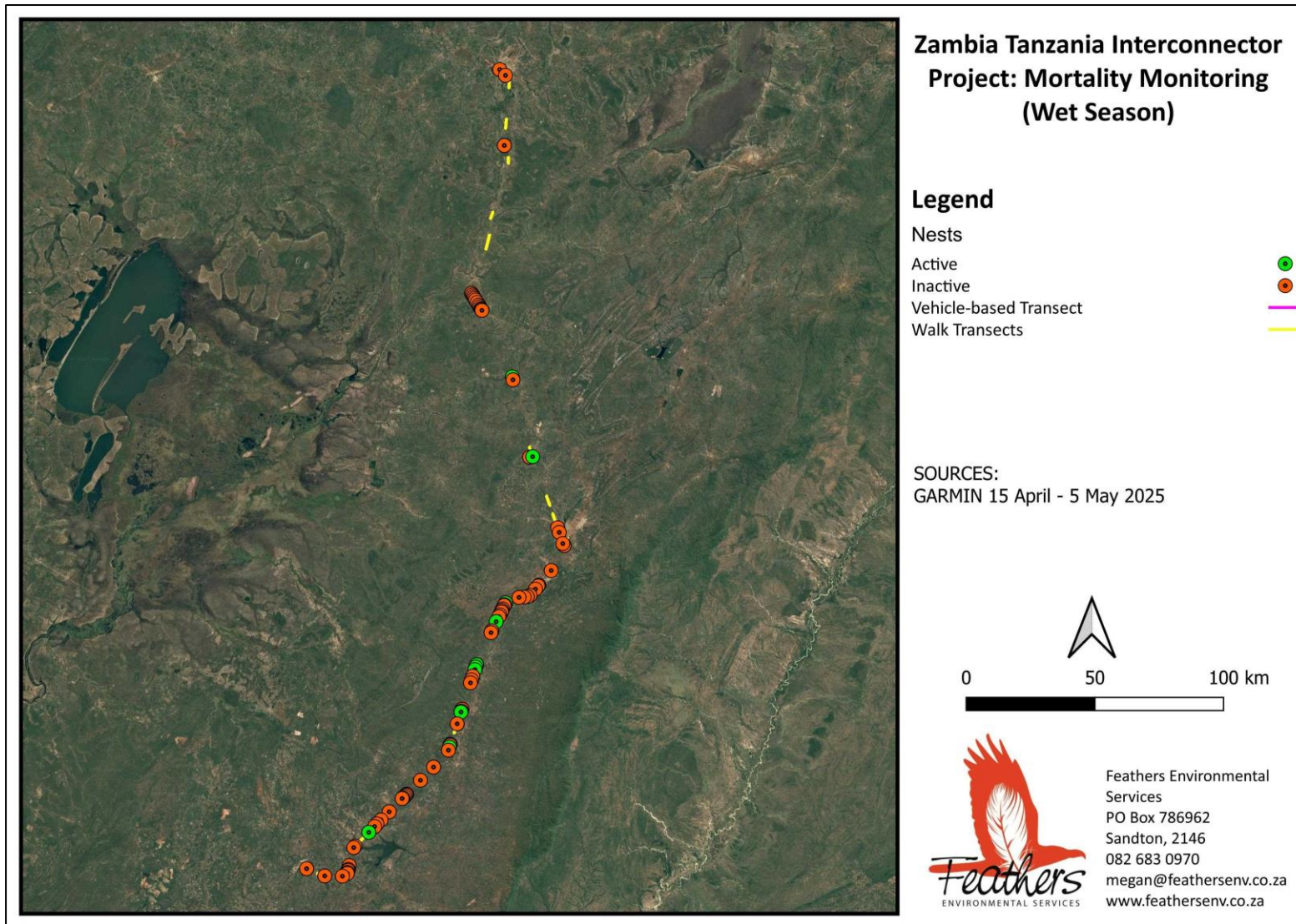


Figure 2-14 Spatial Distribution of All Nests Recorded during the 2025 Wet Season Mortality Monitoring

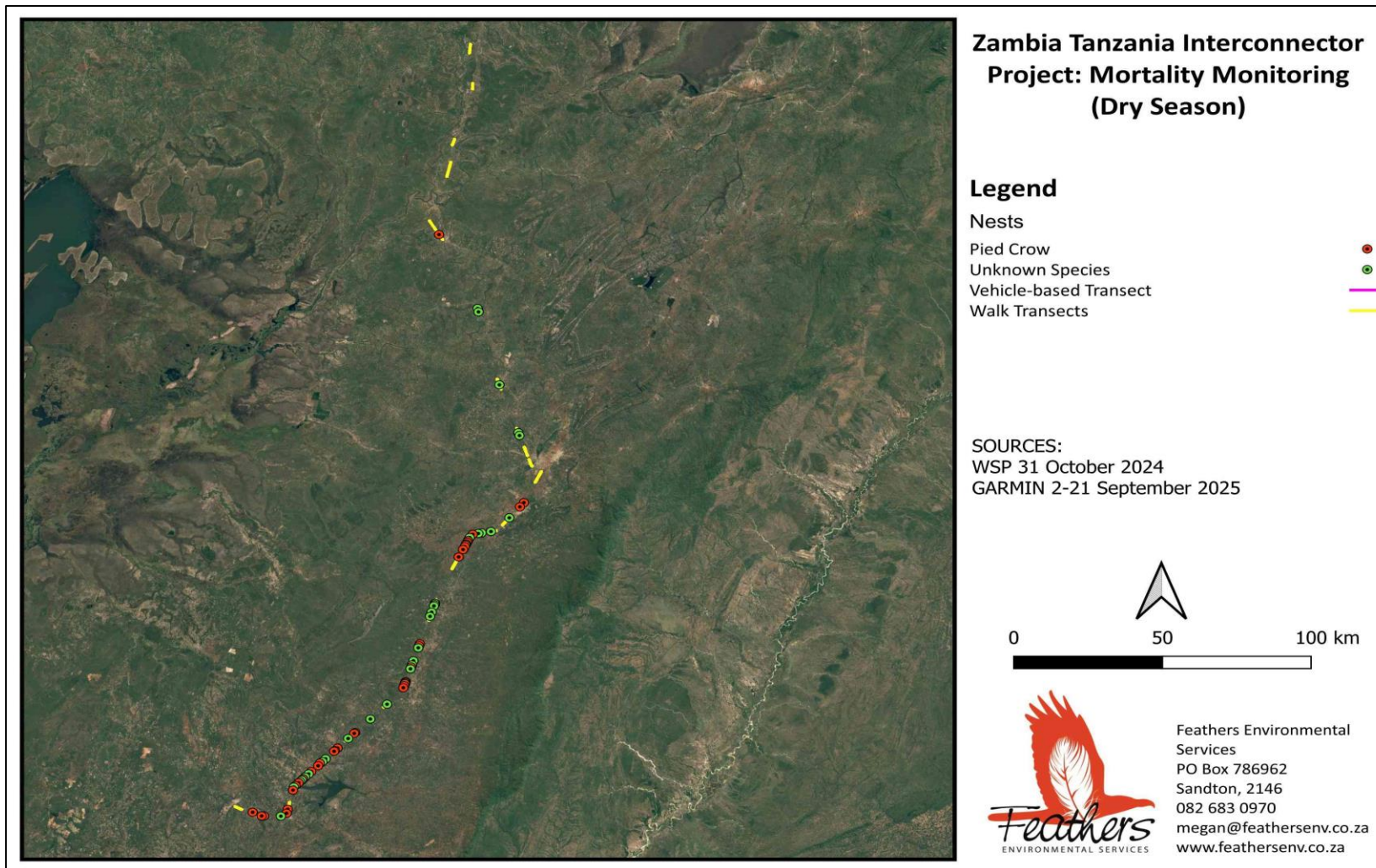
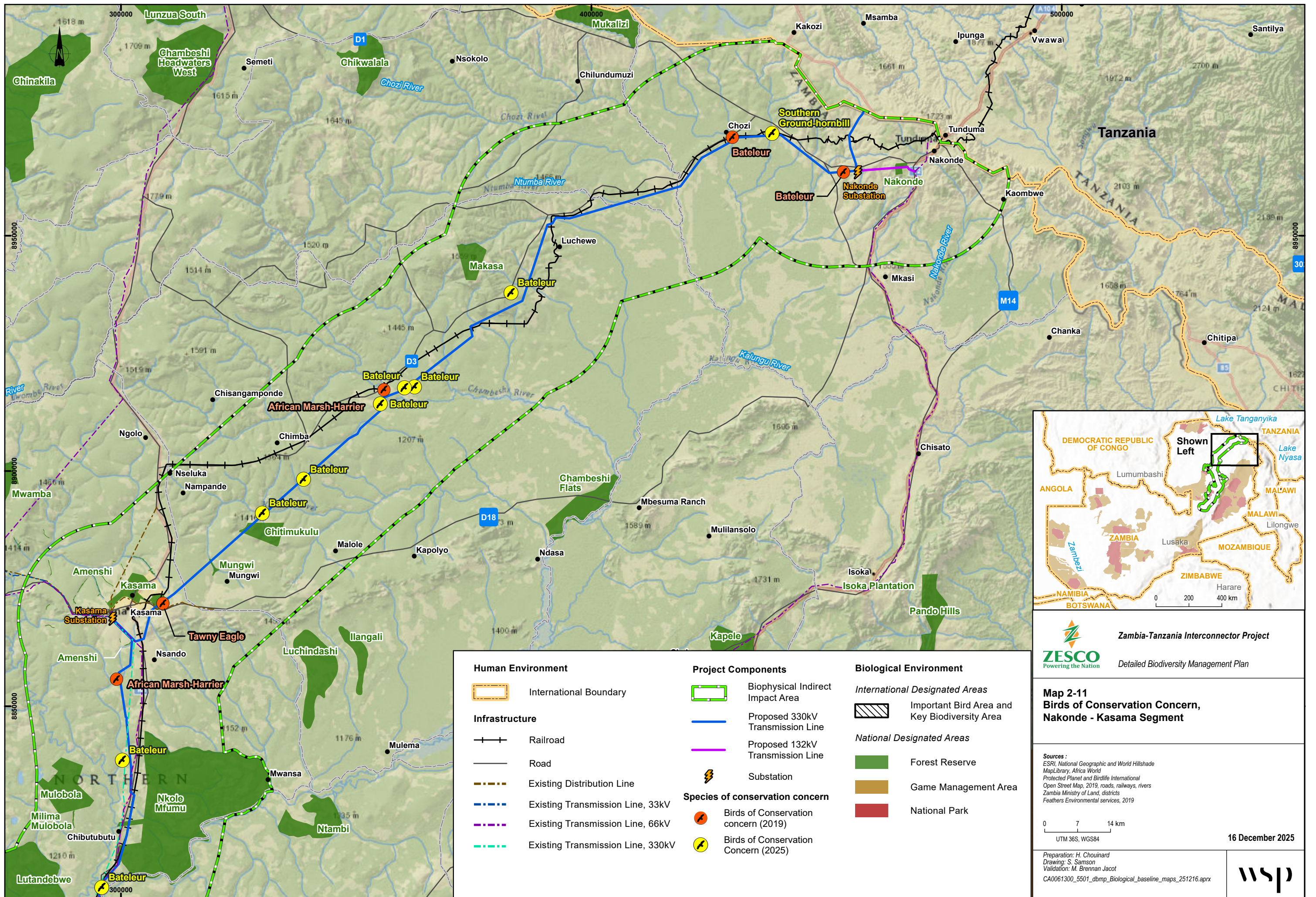


Figure 2-15 Spatial Distribution of All Nests Recorded during the 2025 Dry Season Mortality Monitoring

2.4.5 Birds Species of Conservation Concern and Priority Species

Of all the species sighted during the bird surveys, five are listed in the IUCN Red List, Bateleur (*Terathopius ecaudatus*) – EN, Tawny Eagle (*Aquila rapax*) – VU, Steppe Eagle (*Aquila nipalensis*) – EN, Blue Swallow (*Hirundo atrocaerulea*) – EN and Southern Ground-hornbill (*Bucorvus leadbeateri*) – VU. Two species are of conservation concern in the regional Red List, African Marsh-Harrier (*Circus ranivorus*) and Goliath Heron (*Ardea goliath*) (Willems & Leonard, 2019). The location of species of conservation concern observed during the field surveys is shown in Maps 2-11 to 2-13.



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Human Environment

International Boundary

Infrastructure

- Railroad
- Road
- Existing Distribution Line
- Existing Transmission Line, 33kV
- Existing Transmission Line, 66kV
- Existing Transmission Line, 330kV

Project Components

- Biophysical Indirect Impact Area
- Proposed 330kV Transmission Line
- Proposed 132kV Transmission Line
- Substation

Species of conservation concern

- Birds of Conservation concern (2019)
- Birds of Conservation Concern (2025)

Biological Environment

- International Designated Areas**
- Important Bird Area and Key Biodiversity Area
- National Designated Areas**
- Forest Reserve
- Game Management Area
- National Park

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Map 2-11
Birds of Conservation Concern,
Nakonde - Kasama Segment

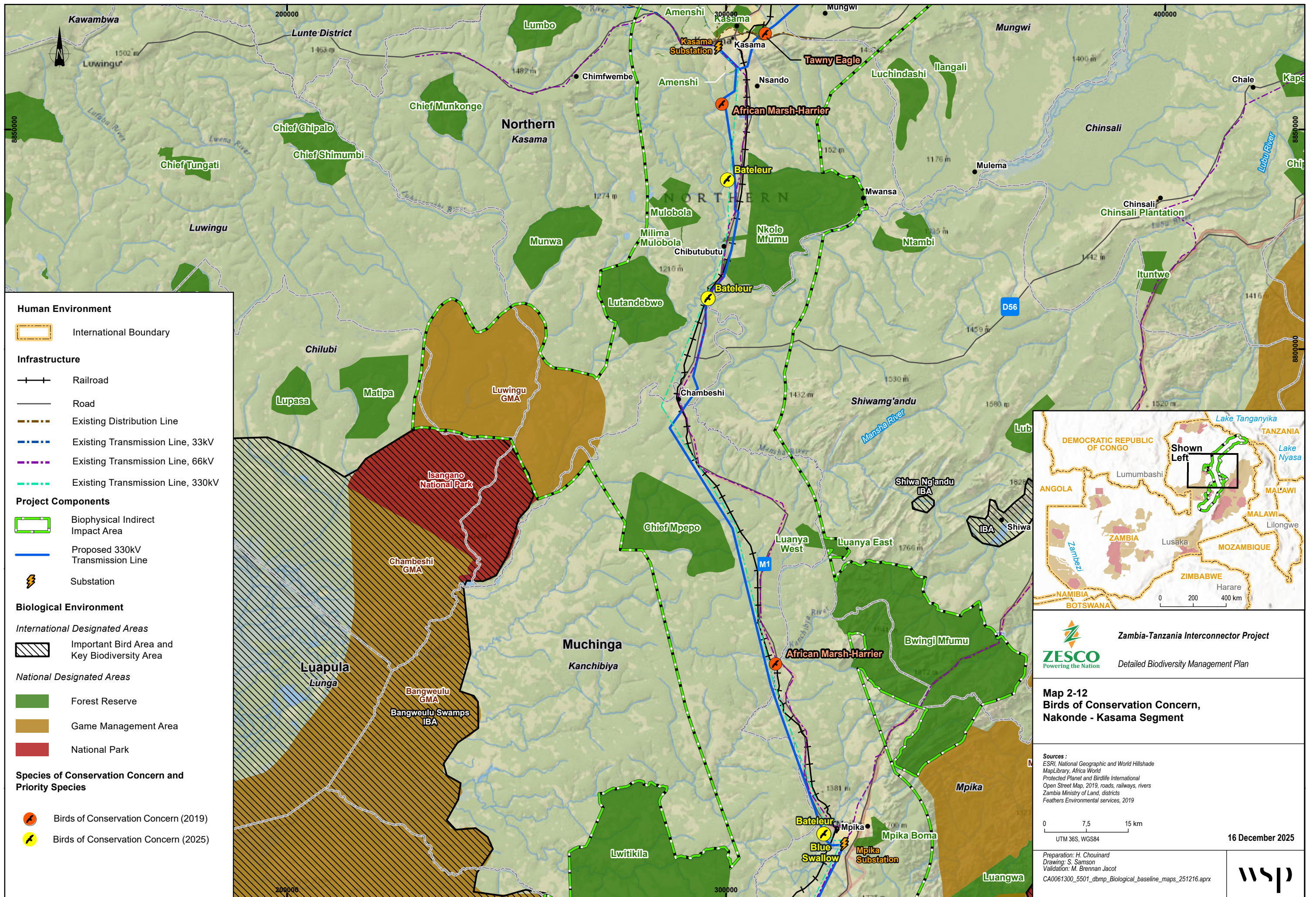
Sources :
ESRI, National Geographic and World Hillshade
MapLibrary, Africa World
Protected Planet and Birdlife International
Open Street Map, 2019, roads, railways, rivers
Zambia Ministry of Land, districts
Feathers Environmental services, 2019

0 7 14 km
UTM 36S, WGS84

16 December 2025

Preparation: H. Chouinard
Drawing: S. Samson
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Human Environment

- International Boundary

Infrastructure

- Railroad
- Road
- Existing Distribution Line
- Existing Transmission Line, 33kV
- Existing Transmission Line, 66kV
- Existing Transmission Line, 330kV

Project Components

- Biophysical Indirect Impact Area
- Proposed 330kV Transmission Line
- Substation

Biological Environment

International Designated Areas

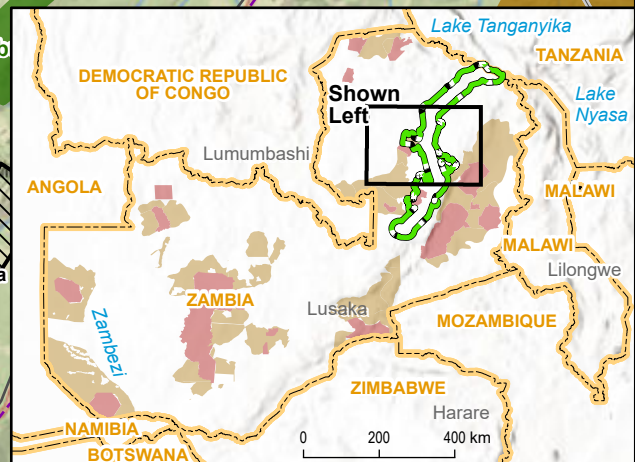
- Important Bird Area and Key Biodiversity Area

National Designated Areas

- Forest Reserve
- Game Management Area
- National Park

Species of Conservation Concern and Priority Species

- Birds of Conservation Concern (2019)
- Birds of Conservation Concern (2025)



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Map 2-12
Birds of Conservation Concern,
Nakonde - Kasama Segment

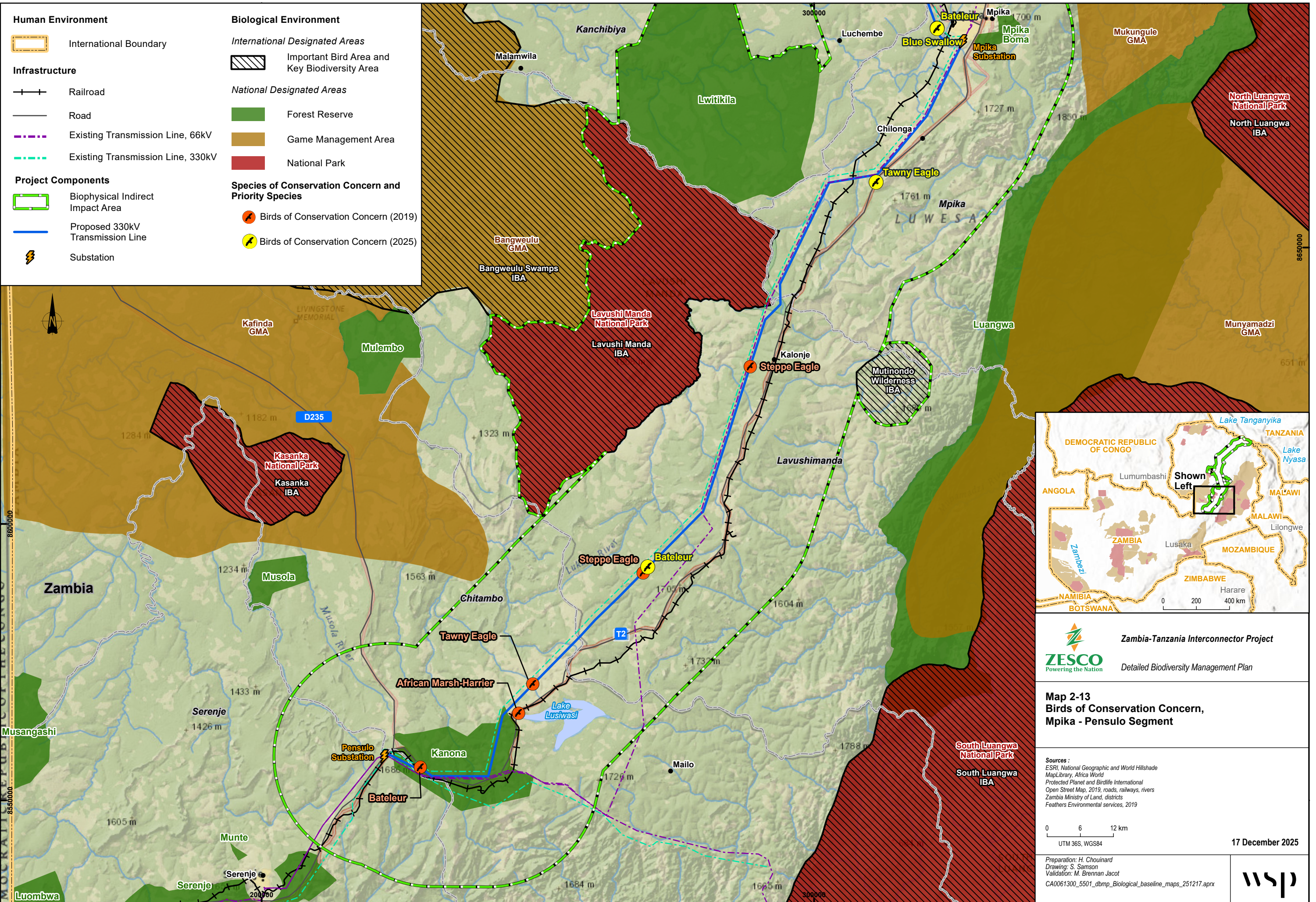
Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

0 7.5 15 km
 UTM 36S, WGS84

16 December 2025

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Map 2-13
Birds of Conservation Concern,
Mpika - Pensulo Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

0 6 12 km
 UTM 36S, WGS84

17 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251217.aprx



A further six Red-Listed species are potentially present, based on GBIF and Southern African Bird Atlas Project 2 (SABAP2) records in the BIIA. These include the Crowned Eagle (*Stephanoaetus coronatus*) – near threatened (NT), the Martial Eagle (*Polemaetus bellicosus*) – EN, the Pallid Harrier (*Circus macrourus*) – NT, the Lappet-faced Vulture (*Torgos tracheliotos*) – EN, the White-backed Vulture (*Gyps africanus*) – critically endangered (CR) and the White-headed Vulture (*Trigonoceps occipitalis*) – CR. One additional potentially present species is of conservation concern in the regional Red List, the Bar-winged Weaver (*Ploceus angolensis*) (Willems & Leonard, 2019).

Of the 400 species recorded during surveys and in the GBIF and SABAP2 databases, 80 are considered priority species, 52 of which were observed during surveys, including fourteen of the special status species listed above. The full list of species of conservation concern and priority species present and potentially present in the BIIA is available in Appendix 2-9. The ecology of Red-listed species and threats are further discussed below.

Table 2-9 lists UCN Red List and regional Red List present or potentially present in the BIIA. The table also details the potential for each species to occur in a specific habitat class and potential interactions with powerline projects.

Table 2-9 Bird Species of Conservation Concern and Priority Species Recorded in the Relevant Pentads Surrounding the Proposed Study Area

Common name	Global conservation status	Migration	Source	Habitat					Potential interactions with powerline			
				Miombo woodland	Dambos	Rivers, wetlands & waterbodies	Mountainous areas	Agricultural lands	Displacement (habitat loss disturbance)	Powerline collision	Substation electro-cution	Quality of supply impact (faecal pollution & nesting)
Bateleur <i>Terathopius ecaudatus</i>	EN	Par /Pos	2019-2025 Survey; GBIF, 2024; SABAP2, 2019	x	-	-	-	-	x	x	-	-
Eagle, Crowned <i>Stephanoaetus coronatus</i>	NT		GBIF, 2024	x	-	x	-	x	x	x	-	-
Eagle, Martial <i>Polemaetus bellicosus</i>	EN		GBIF, 2024; SABAP2, 2019	x	-	-	-	-	x	x	-	x
Eagle, Steppe <i>Aquila nipalensis</i>	EN	PM	2019 Survey; GBIF, 2024; SABAP2, 2019	x	-	-	-	-	-	x	-	-
Eagle, Tawny <i>Aquila rapax</i>	VU		2019-2025 Survey; GBIF, 2024; SABAP2, 2019	x	-	-	-	-	x	x	-	x
Goliath Heron <i>Ardea goliath</i>	Regional		2025 Survey; SABAP2, 2019			x			x	x		
Ground-hornbill, Southern <i>Bucorvus leadbeateri</i>	VU		2025 Survey; GBIF, 2024; SABAP2, 2019	x	dry	-	-	-	x	x	-	-

Common name	Global conservation status	Migration	Source	Habitat					Potential interactions with powerline			
				Miombo woodland	Dambos	Rivers, wetlands & waterbodies	Mountainous areas	Agricultural lands	Displacement (habitat loss disturbance)	Powerline collision	Substation electrocution	Quality of supply impact (faecal pollution & nesting)
Marsh-harrier, African <i>Circus ranivorus</i>	Regional		2019 Survey; GBIF, 2024; SABAP2, 2019	-	x	x	-	-	-	x	-	-
Harrier, Pallid <i>Circus macrourus</i>	NT	PM	GBIF, 2024; SABAP2, 2019	-	x	x	-	-	-	x	-	-
Vulture, Lappet-faced <i>Torgos tracheliotus</i>	EN		GBIF, 2024; SABAP2, 2019	x	-	-	-	-	x	x	-	x
Vulture, White-backed <i>Gyps africanus</i>	CR		GBIF, 2024	x	-	-	-	-	x	x	-	x
Vulture, White-headed <i>Trigonoceps occipitalis</i>	CR		GBIF, 2024; SABAP2, 2019	x	-	-	-	-	x	x	-	x
Weaver, Bar-winged <i>Ploceus angolensis</i>	Regional		SABAP2, 2019	x	-	-	-	-	-	-	x	-
Swallow, Blue <i>Hirundo atrocaerulea</i>	EN	AM	Survey 2025		x			x			x	

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near-threatened; PM = Palearctic Migrant; AM = Afro-tropical Migrant; PAR/POS = Partial/Possible Migrant.

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Detailed Biodiversity Management Plan

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Seven of Zambia's eight vulture species are threatened. Three threatened vulture species are potentially present in the study area, but were not observed during 2019 nor 2025 surveys: the White-backed Vulture (*Gyps africanus*), the Lappet-faced Vulture (*Torgos tracheliotos*) and the White-headed Vulture (*Trigonoceps occipitalis*). The persistent absence of vultures across all surveys suggests that the project area does not fall within their regularly used foraging range. This pattern may reflect several interacting ecological and land-use factors. In particular, vultures in many parts of southern Africa show strong spatial associations with protected areas and game management zones, where higher densities of large mammals and active wildlife management ensure more reliable carrion availability. By contrast, the project landscape, dominated by miombo woodland and mixed agricultural or settlement areas, offers limited open foraging habitat and reduced carrion resources, further constraining the suitability of the area for scavenging raptors. Regional observations from Tanzania similarly indicate that miombo systems are generally avoided by vultures (Dr. Corinne Kendall, pers. comm.). Collectively, these factors indicate that vulture presence within the project area is likely to be infrequent, opportunistic, or transitory rather than reflective of consistent habitat use.

Five additional threatened species from the *Accipitridae* family are of conservation concern.

- **Bateleur (*Terathopius ecaudatus*) – Endangered** (see Photo 2-14). Bateleurs are widespread across southern Africa and prefer savannah woodland with long grass. These diurnal scavengers and hunters locate prey aerially, swooping down on prey from several hundred metres in the sky. They follow roads, looking for roadkill and attracted to veld fires to scavenge dead animals and hunt small mammals (BirdLife International, 2020a).
- **Martial Eagle *Polemaetus bellicosus* – Endangered**. This eagle inhabits open woodland, wooded savannah, bushy grassland, thornbush and, in southern Africa, more open country and even subdesert, from sea level to 3,000 m but mainly below 1,500 m. The main prey are sizeable mammals, birds and reptiles. Mating seasons vary across the geographic range, although it generally occurs during the dry season, from February until November in South, Central and East Africa. Martial Eagles tend to breed once every two years (BirdLife International, 2020b).
- **Steppe Eagle (*Aquila nipalensis*) – Endangered**. The species is a common non-breeding Palaearctic migrant that arrives in October-November and departs again in March-April. Usually localized and gregarious, they are found in flocks where good rains have fallen. It favours open savannah woodland and feeds largely on termites and Red-billed Quelea nestlings.
- **Tawny Eagle (*Aquila rapax*) – Vulnerable**. This eagle is common in protected areas and prefer lightly wooded savannah. These eagles can colonize treeless grasslands by breeding on powerline towers and in alien trees. Birds hunt from a perch or in flight, swooping to catch agile prey. They can kill flamingos in flight and will compete with vultures and Marabou Stork at carcasses, and regularly with scavengers at roadkill. Most nest locations are used for 1-3 years but the same nesting area is used for 50-60 years.

- **African Marsh-harrier (*Circus ranivorus*) – Regional Red-List** (see Photo 2-15). This species has an extremely large range and is a resident of wetlands from South Africa north to the Democratic Republic of Congo and southern Sudan. The species breeds in wetlands, foraging primarily over reeds and lake margins. Its diet consists largely of small mammals (BirdLife International, 2016a).
- **Pallid harrier (*Circus macrourus*) – Near Threatened.** This palearctic migrant breeds in southern parts of eastern Europe and central Asia. Reliable records from migration routes and wintering grounds are difficult to obtain owing to the rarity of the species, although important concentrations of birds have been identified in parts of India and Africa. Mosaics of forest/ shrubland and grassland and, to a lesser extent, agricultural land, are used in winter (BirdLife International, 2021).
- **Crowned Eagle (*Stephanoaetus coronatus*) – Near Threatened.** This species is a widespread resident of sub-Saharan Africa. It inhabits forest, woodland, savanna and shrubland, as well as some modified habitats, such as plantations and secondary growth, and can persist in small forest fragments including urban greenspace forests. It shows dietary plasticity and can feed on a diversity of prey (BirdLife International, 2018).



Photo 2-14 Bateleur (*Terathopius ecaudatus*)



Photo 2-15 African Marsh Harrier (*Circus ranivorus*)

One threatened species from the *Bucorvidae* and one from *Hirundinidae* family is of conservation concern.

- **Southern Ground-Hornbill (*Bucorvus leadbeateri*) – Vulnerable.** inhabits woodland and savannah, also frequenting grassland adjoining patches of forest up to 3,000 m in parts of its range in eastern Africa. The species fares well in protected areas where human threats are excluded and rural areas where cattle assist in maintaining their preferred short grass habitat. Laying occurs in large cavities in trees, cliffs or earth banks, mainly from September to December, with a clutch of one to three (usually two) eggs, although only one survives to fledging (BirdLife International, 2016b). Atlas data implies extensive occupancy. However, expert opinion suggests large declines in the north-western and southern provinces but stable populations in protected areas and sparsely inhabited rural areas. Local extirpation is reported to be greatest for areas with intensive and rapidly expanding agricultural activity and dense human populations (estimated 25% of the country), likely due to hunting, rapid deforestation for large-scale charcoal production and degazetting of Forest Reserves (Kemp, 2017). The loss of trees in the miombo woodland due to excess logging has severe negative impacts on all cavity nesters. In a meeting with World Wildlife Fund Zambia (WWF Zambia), representatives noted that Southern Ground-Hornbill is prevalent in the miombo woodland habitat within the study area and that congregations and nesting sites may be present along the proposed route alignments (WWF Zambia, personal communication). Unfortunately, detailed locations of these sites were not made available.
- **Blue Swallow (*Hirundo atrocaerulea*) – Endangered.** This species is an intra-African migrant. The project area overlaps with the ‘passage’ range of this species, which identifies area where the species could occur regularly during a relatively short period of the year while migrating between breeding and non-breeding ranges (BirdLife International, 2024b). It typically occurs in open habitats, such as grasslands and wetlands, and is considered uncommon to rare in Zambia (BirdLife International, 2024b). Field surveys recorded one individual Blue Swallow in grassland-shrubland.

Two more threatened species have past occurrences in the BIIA and are considered potentially present.

- **Cape Parrot (*Poicephalus robustus*) – Vulnerable.** The species restricted to South Africa, which has small, isolated populations. This species inhabits the temperate zone, particularly the montane mist-belt evergreen *Podocarpus* forest. This resident of Africa undertakes three different types of excursions related to the availability of the *Podocarpus* fruits, including daily flights, overnight stops or more extensive wanderings.
- **Bar-winged Weaver (*Ploceus angolensis*) – Regional Red-List.** This weaver occurs in miombo woodland from Angola to Zambia. It inhabits mature, tall *Brachystegia* woodland where it is moist enough to grow copious *Usnea* lichen on the trees (Weaver Watch, 2024). The presence of threatened crane species has been documented in the area between Nakonde and Chozi, approximately 5 km north of the proposed power line (WWF Zambia, personal communication).

2.4.6 Collision Mortality Monitoring

In accordance with WB recommendations, collision mortality monitoring was conducted during both wet and dry season in 2025 to examine bird mortality associated with existing power lines situated in proximity to the proposed ZTIP 330kV transmission line alignment, in order to support the prediction and mitigation of potential avian collision risks along the planned alignment by analysing mortality patterns within ecologically comparable landscapes. The mortality monitoring was conducted primarily along the existing Mpika-Pensulo and Kasama-Mpika 330kV power line and the existing 66kV Mpika-Kasama power line servitudes, which run parallel to the proposed ZTIP 330kV transmission line. The complete report on collision mortality monitoring can be found in Appendix 2-10.

A total of 9 avian collision mortalities were documented during the wet season and 5 during the dry season 2025. These mortalities were identified and classified as collision-related based on a combination of eyewitness accounts from local community members and the physical location of feather spots directly beneath the power line conductors – a characteristic indicative of collision events.

While the possibility exists that some carcasses could have originated elsewhere and been deposited within the surveyed area by scavengers or predators, this scenario is considered unlikely given the spatial context of the findings and the consistency of the physical evidence. Moreover, collision-related mortality is widely recognised as being under detected, and it is therefore appropriate at this stage of assessment to document all records that exhibit characteristics consistent with collision events.

Of the 14 recorded mortalities, 12 were classified as recent, based on carcass condition and corroborating accounts from local observers, suggesting that these deaths occurred within the preceding 2 to 4 weeks. The remaining two mortalities were categorized as historic, as indicated by skeletal remains and contextual evidence suggesting the deaths occurred well outside the recent time frame. Recorded mortalities are presented in Table 2-10.

Notably, four of the nine collision events were reported by local community members. In these instances, no carcasses were available for verification, as the birds had been removed by residents. While such reports lack physical evidence for species confirmation or precise collision location, they nonetheless highlight local awareness and a willingness to report incidents. This suggests potential for involving communities in long-term monitoring or mitigation initiatives, provided that verification protocols are developed to improve data reliability.

No bird mortality was recorded along the vehicle-based transect.

Table 2-10 Recorded Mortality during the 2025 Wet and Dry Season

Date and record number	Powerline segment	Tower numbers	Voltage (kV)	Common name	Species name	Family	Distance from tower A (m)	Distance from tower B (m)	Habitat	Carcass	Note	Time of the year
01/04/09/25	Mpika-Kasama	489-490	330	Unidentified			290	161	Bush	Recent	Possibly a Pennant-winged Nightjar	Dry season
01/09/09/25	Mpika-Kasama	427-428	330	Peregrine Falcon	<i>Falco peregrinus</i>	<i>Accipitridae</i>	68	398	Bush	Recent	Decomposed and burnt	Dry season
02/09/09/25	Mpika-Kasama	425-426	330	Unidentified			187	167	Bush	Recent	Raptor species	Dry season
01/12/09/25	Pensulo-Mpika	296-295	330	Unidentified			123	237	Bush	Recent	Raptor species – only feathers found	Dry season
01/13/09/25	Pensulo-Mpika	232-231	330	Unidentified			155	278	Bush	Recent	Raptor species – only feathers found	Dry season
01/16/04/25	Mpika-Kasama	445-446	330	Hamerkop	<i>Scopus umbretta</i>	<i>Scopidae</i>	341	64	Farmland	Recent	Reported by community member - bird was taken away by people	Wet season
02/16/04/25	Mpika-Kasama	445-446	330	Purple Heron	<i>Ardea purpurea</i>	<i>Ardeidae</i>	402	1	Farmland	Recent	Reported by community member - bird was taken away by people	Wet season
01/18/04/25	KM 66kV	229-230	66	Dark-capped Bulbul	<i>Pycnonotus tricolor</i>	<i>Pycnonotidae</i>	187	87	Farmland	Historic	Reported by community member - no carcass	Wet season
01/23/04/25	Pensulo-Mpika	429-429	330	Yellow-billed Kite	<i>Milvus aegyptius</i>	<i>Accipitridae</i>	10	410	Bush	Recent	Reported by community member - a single feather found	Wet season

Date and record number	Powerline segment	Tower numbers	Voltage (kV)	Common name	Species name	Family	Distance from tower A (m)	Distance from tower B (m)	Habitat	Carcass	Note	Time of the year
02/23/04/25	Pensulo-Mpika	422-423	330		Unidentified		334	229	Grassy area	Recent	Pied Crow / White-necked Raven (immature bird)	Wet season
01/24/05/25	Pensulo-Mpika	389-390	330		Unidentified		145	260	Bush	Recent	Possible Pigeon sp. Only feathers observed	Wet season
01/29/04/25	Pensulo-Mpika	259-260	330	Ring-necked Dove	<i>Streptopelia capicola</i>	<i>Columbidae</i>	252	181	Bush	Recent		Wet season
01/30/04/25	Pensulo-Mpika	218-219	330	Schalow's Turaco	<i>Tauraco schalowi</i>	<i>Musophagidae</i>	35	383	Scrub	Historic		Wet season
02/30/04/25	Pensulo-Mpika	215-216	330	Pied Crow	<i>Corvus albus</i>	<i>Corvidae</i>	32	377	Scrub	Recent		Wet season

Species Composition of Recorded Mortality

The avian mortalities recorded during the dry season survey show a marked shift in species composition compared to those detected during the preceding wet season. Whereas the wet season fatalities predominantly involved water-associated and generalist species (e.g., Hamerkop *Scopus umbretta*, Purple Heron *Ardea purpurea*, and Yellow-billed Kite *Milvus aegyptius*), the dry season dataset is characterised by exclusively aerial, open-habitat species, including one confirmed Peregrine Falcon *Falco peregrinus*, three unidentified raptors, and a probable Pennant-winged Nightjar *Caprimulgus vexillarius*. This seasonal divergence reflects underlying changes in habitat structure, resource distribution, and flight behaviour between the two climatic periods.

During the wet season, elevated water availability, increased insect abundance, and broader use of wetland and riparian habitats draw waterbirds and generalist foragers into flight paths that intersect with power line alignments. The lower and more predictable flight heights of waterbirds, combined with increased periods of reduced visibility due to rainfall, cloud cover, and humid atmospheric conditions, likely contributed to their higher representation among wet-season collision victims.

Interestingly, several smaller-bodied passerine species were also recorded among the mortalities, including the Ring-necked Dove *Streptopelia capicola* and Dark-capped Bulbul *Pycnonotus tricolor*. Although these species are generally considered more agile in flight and less prone to collision, their presence among the fatalities suggests that even small birds may be at risk under certain environmental or behavioural conditions.

Perhaps most unexpectedly, two Pied Crow *Corvus albus* mortalities were documented. Given the species' well-known adaptability, frequent association with human-modified landscapes, and regular perching and flying activity around power line infrastructure, it might be assumed that they are habituated to the presence of overhead wires and capable of avoiding collisions. Their inclusion in the mortality records suggests that even highly adaptive and intelligent birds may not be immune to the risks posed by transmission lines, particularly when engaged in distraction-prone behaviours such as aerial play, foraging, or in-flight social interactions.

Additionally, the probable Pennant-winged Nightjar mortality is also ecologically significant. Nightjars rely heavily on aerial hawking at dusk and during low-light periods, conditions that heighten the risk of wire strikes due to limited visibility and reduced depth perception. The species' presence among the dry-season fatalities highlights the vulnerability of nocturnal insectivores to infrastructure during periods of heightened activity and reduced ambient lighting.

Spatial Distribution and Habitat Context of Recorded Mortalities

Assessment of carcass locations relative to the nearest towers indicates that most dry-season collision events occurred within the central span zone, with four of the five carcasses positioned approximately midway between adjacent towers. Only one mortality fell near a tower end. This spatial pattern suggests that, during the dry season, birds are primarily intersecting the conductor at its lowest point rather than while manoeuvring around tower structures. During the wet season, more than half collisions were located within the outer 20% of the power line span, rather than in the central 60% mid-span area where collisions are typically expected to be more frequent like in the dry season. The unexpected clustering of collisions near the tower ends during the wet season may be influenced by several factors, including flight path alterations as birds navigate around or between towers, changes in airflow or turbulence, or localized habitat features that attract birds to these areas. These findings suggest that tower proximity and edge-span design may play a more significant role in collision risk than previously assumed especially during the wet seasons and should be considered in the development of targeted mitigation measures, such as strategic placement of line markers or diverters near tower structures.

Collision mortalities were recorded in various habitat suggesting that collision risk is not confined to any single land cover type but may be influenced by a combination of habitat structure, flight behavior, and landscape context. This emphasizes the need for site-specific risk assessments when planning mitigation strategies, particularly in transitional zones between habitat types where changes in bird movement patterns are likely to occur.

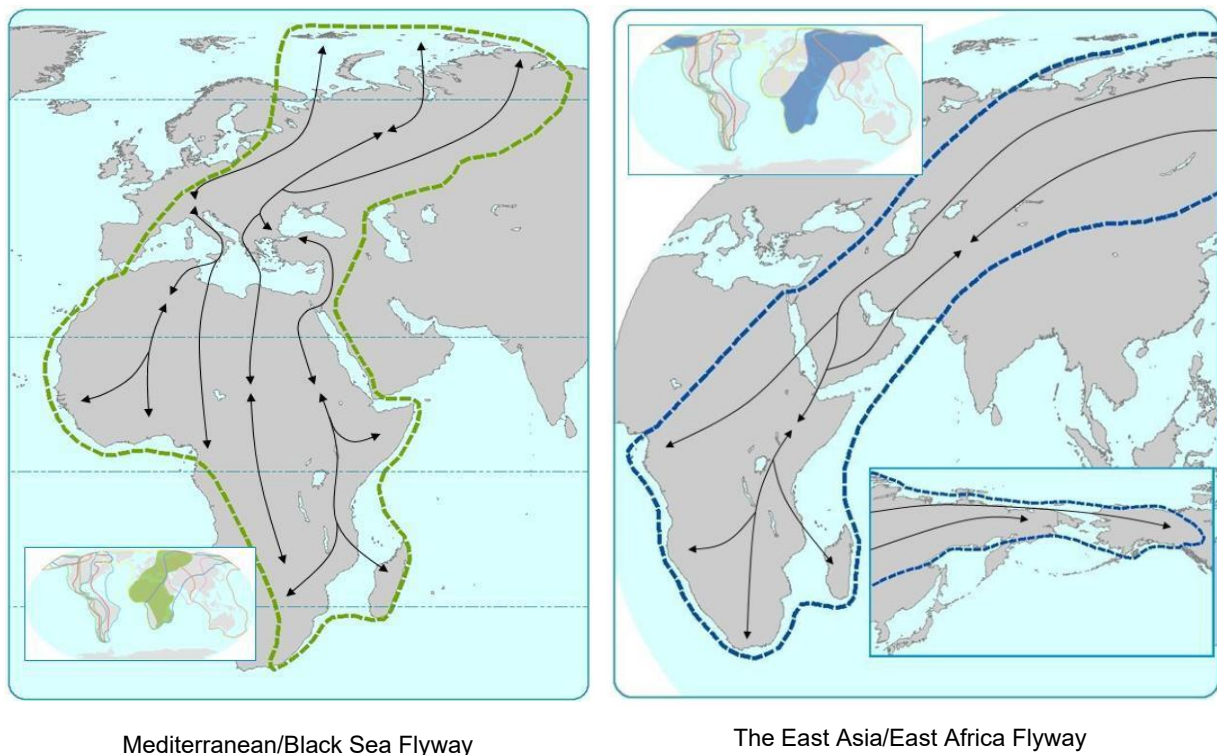
2.4.7 Migration Flyways

Despite their ability to adapt, birds have specific food, water and habitat requirements. The seasonal variability of these resources necessitates migration for many species. Familiar and widely known migrations occur annually, connecting breeding areas to non-breeding areas. Opportunistic, nomadic movements also occur amongst some species in response to rainfall. These species move into areas where it has recently rained to capitalize on the seeds, insects and other food sources that sporadically become available. When the area is no longer attractive or viable, they move on again (UNEP/CMS, 2012).

Migration patterns are extremely species-specific. Passerines, especially insectivorous birds, tend to migrate by night on a very broad front, crossing expansive seas and deserts, while finches and larks migrate for a few hours just before and after sunrise – all needing closely spaced staging points to rest and forage. Shorebirds adopt a different strategy altogether, migrating over long distances between fixed staging points, traversing large stretches of land, often without being seen. Soaring birds, e.g., storks, pelicans, albatrosses, petrels, terns, and many birds of prey, rely on thermal currents associated with mountain chains, allowing them to gain height and glide for extended periods of time along these ranges.

Birds that flap their wings to gain height and propel themselves forward consume a great deal of energy to do so. These species migrate over broader fronts and can be concentrated in favourable areas along the route to restore depleted energy levels. Similarly, migrating waterbirds depend on distinct sites of suitable habitat along their flyways and are often found concentrated at coastal and/or inland wetlands (UNEP/CMS, 2012).

The proposed powerline is contained within the Mediterranean/Black Sea and East Asia/East Africa migratory flyways, two of three Palearctic-African flyways that connect Europe with Africa, which are illustrated in Figure 2-16. Collectively, these three flyways constitute the world's largest bird migration system (BirdLife International, 2024c), with over two billion passerines and near-passerines, 2.5 million ducks, and two million raptors migrating from their breeding grounds in Europe and central and western Asia to winter in tropical Africa.



Source: BirdLife International, 2024c

Figure 2-16 Flyways Overlapping the Region of the Project

The Luangwa Valley, located approximately 50-90 km east of the study area, is an important migratory route for White Stork (Gerkmann et al., 2008). The valley's topographical characteristics provide the thermals necessary for flight. Three National Parks situated along the Luangwa River (i.e., North Luangwa National Park, Luambe National Park, and South Luangwa National Park) protect this critical part of the migration corridor, particularly during their southward migration.

However, the northward flyway directs storks towards the escarpment and the more populated areas. It is also likely that these and other migratory species, which are dependent on water sources, will move between the Luangwa Valley and Lake Bangweulu and the associated Bangweulu swamps located 30 km west of the proposed powerline at its closest point. In addition, the presence of Important Bird Areas, National Parks and Forest Reserves in the area between the Luangwa Valley and Lake Bangweulu, make it an attractive flyway option.

Finer scale, migratory flyways along the proposed powerline route are largely associated with the avifaunal microhabitats that occur along the alignment. Most of the migratory priority species recorded in the study area during the survey are raptors. As soaring birds, raptors are likely to utilize mountain plateaux and escarpment areas, especially those areas located to the east of the proposed powerline alignments. Mass migratory movement across the powerline alignments is unlikely, but for those birds of prey that do not continue their journey southwards, sections of the proposed powerline that traverse mixed habitats containing mature woodlands and dambos will require mitigation to minimize the potential displacement and collision impacts. During the survey, observations of Abdim's Stork suggest that dambos associated with watercourses and large-scale commercial agriculture are favoured habitats for these species. Typically, for species dependent on water, river systems, wetlands, and large waterbodies are key staging areas that provide suitable roosting and foraging habitats while en route to their terminal staging grounds. The river systems and waterbodies present along the route alignment are heavily utilized by the surrounding communities and, as such, may not provide the necessary foraging opportunities. However, topographic features, like rivers, may aid certain species in their navigation during migration. The smaller passerine migratory species recorded in the study area are not susceptible to collision impacts. Still, disturbance associated with construction activities may displace these species from areas that they utilize to replenish their energy reserves.

Potential migration flyways have been delineated and illustrated in Maps 2-14 to 2-16. The section below provides details pertaining to their sensitivity.

2.4.8 Areas of High Ecological Importance for Birds

The following section describes the areas of high ecological importance in the study area that fall outside the protected areas but should be considered important bird conservation features. These areas host endemic or threatened species and support ecological processes needed to increase or at least maintain local bird biodiversity.

Areas of high ecological importance include IBAs, which are sites carefully identified based on the bird numbers and species complements they hold that are exceptionally important for maintaining the taxa dependent upon the habitats and ecosystems in which they occur.

The Lavushi Manda National Park (ZM026) and Mutinondo Wilderness (ZM027) IBAs are within the BIIA and host species that could also occur within DIA. Several other IBAs are present in other areas surrounding the project (i.e., Shiwa Ng'andu, Bangweulu Swamp, Kasanka National Park, and South Luangwa National Park), which are strongholds for a significant diversity and abundance of bird species. However, these sites are associated with specific ecological features which are not characteristic of the habitats found within the study area.

Wetland and riparian areas, as well as specific microhabitats, are other areas of high ecological importance for birds.

Wetlands are usually rich in both the number of birds and the variety of species). Wetlands and riparian habitats provide important corridors for waterbirds that will regularly utilize rivers not only as a source of drinking water and food but also for bathing and cover for skulking species. In addition, thick riverine woodland with large shady riparian trees offers an important breeding substrate for a variety of birds, including raptors (Hockey *et al.* 2005). Relevant to this study, the rivers, drainage lines, and surrounding riparian habitat could, on occasion, attract species such as Reed Cormorant and African Black Duck, as well as heron, egret, and ibis species.

Several fairly extensive wetlands occur within the study area and will represent attractive foraging habitats for collision-sensitive species such as the Pallid Harrier (*Circus macrourus*). They are also the preferred roosting and foraging habitats for the African Marsh Harrier (Hockey *et al.*, 2005). Various common species, such as ibis, herons, and geese, will also utilize wetlands for their foraging needs.

Micro Habitats

It is important to understand the habitats available to birds at a smaller spatial scale, i.e., microhabitats. Micro habitats are shaped by factors other than vegetation, such as topography, land use, food sources, and anthropogenic factors, which are critically important in mapping the site in terms of avifaunal sensitivity and ultimately informing the mitigation requirements.

Dryland subsistence cultivation is the dominant form of agricultural activity in the study area. The agricultural activity is largely centred around villages and towns. These areas have been cleared of trees and bushes to grow crops. Frequently, these open areas have weedy forbs replacing grass cover. Ground cover may be sparse or completely absent. Cultivated areas provide diverse habitats: they may be recently ploughed, planted with growing crops or with stubble and weeds after harvesting. Cultivated areas may attract Common Buzzard, Amur Falcon, Black Kite, Wahlberg's Eagle, Lanner Falcon (*Falco biarmicus*), Black-headed Heron, Black-shouldered Kite and African Woollyneck. Although not recorded in the study area, White Stork and Abdim's Stork, Capped Wheatear (*Oenanthe pileata*) and Temminck's Courser (*Cursorius temminckii*) are also attracted to ploughed fields or bare fallow land, whilst weedy stubble and older fallow land may be used by open grassland species, e.g., the global Red List Secretarybird (*Sagittarius serpentarius*). Kori Bustard (*Ardeotis kori*) could also be attracted to agricultural clearings in woodland.

Residential areas include surface infrastructure such as buildings and roads. Built-up areas generally are of little value to sensitive Red List bird species due to their degraded nature and the associated disturbance factor, apart from the Lanner Falcon, which hunts feral pigeons and possibly free-ranging poultry. These areas may play an important role in providing safe refuge and foraging opportunities for small passerine species that have become common in urban, peri-urban, and rural environments.

2.4.9 Habitat Sensitivity Classification

Habitat and species observations made during the field surveys enabled the classification of sensitivity zones along the proposed powerline alignment. According to the mitigation hierarchy, measures to minimize the identified impacts depend on the sensitivity of each of these zones. Four types of sensitivity were identified and classified based on the presence of IBAs, mature reserves, Forest Reserves, microhabitats, the species richness within the habitat, the presence of priority species, and levels of existing disturbance in the immediate area: The High, Medium-High and Medium Sensitivity zones are illustrated in Maps 2-14 to 2-16.

High Sensitivity Zones

The four High Sensitivity Zones that occur along the proposed powerline alignment are areas of elevated bird collision risk, arising from the combined influence of ecological structure, species behaviour, and habitat characteristics. These zones are not designated simply for the presence of trees or water, but because their structural, hydrological, and biological features significantly increase the likelihood of bird-powerline interactions.

Key Drivers of Collision Risk

1. Ecological Value – Riverine Forests and Dambos

High Sensitivity Zones include mature riverine forests and dambos, which are structurally complex and ecologically rich. Tall trees, multi-layered canopies, riparian corridors, and scattered clearings create a vertical profile that overlaps with conductor heights. Wet soils and seasonal water retention attract resident and migratory wetland birds, concentrating activity and increasing collision likelihood during breeding, foraging, and migrations.

2. Hydrological Function and Resource Concentration

These riverine forests and dambos regulate floodwaters, sustain baseflows, and support highly productive ecosystems. Abundant invertebrates, amphibians, and fish attract diversity of bird species, including waterfowl, waders, raptors, and forest-edge specialists. High local densities of birds elevate exposure to transmission lines.

3. Behavioural Ecology

Birds in High Sensitivity Zones often fly at mid-canopy heights, undertake repetitive foraging flights, and use riverine and wetland habitats as migratory stopovers. These behaviours increase the probability of repeated crossings of powerline corridors, amplifying collision risk.

4. Landscape Configuration

Linear forest edges along watercourses or dambos, open water patches, and habitat convergence zones act as predictable bird attractors. Birds frequently move along these areas, which could cause crossing powerline paths multiple times thereby creating concentrated hotspots of risk.

An area is classified as a High Sensitivity Zone when it meets one or more of the aforementioned critical criteria: supports species of conservation concern, hosts high abundance and diversity of birds, experiences repeated use over time, or contains irreplaceable habitats. These factors justify prioritising mitigation measures, as unmitigated powerline crossings could result in significant bird mortality and long-term ecological impacts.

Medium-High Sensitivity Zones

Medium–High Sensitivity Zones present elevated bird collision risk due to habitat composition, species richness, and landscape-scale movement patterns. While these areas may be more widespread or contain habitats of lower irreplaceability, their ecological characteristics still generate significant collision exposure when combined with the presence of a powerline. These zones support high bird densities, diverse guilds, and predictable flight pathways, making targeted mitigation essential.

Key Drivers of Collision Risk

1. Habitat Composition and Ecological Function

Medium–High Sensitivity Zones contain mosaics of river systems, floodplains, dambos, and mature woodlands. This combination of wetland and terrestrial habitats creates structurally and functionally diverse environments supporting aquatic and terrestrial food webs. Wetland–woodland interfaces provide abundant invertebrates, seasonal fish and amphibians, seed and fruit resources, and nesting or roosting substrates. Literature and survey results confirm this habitat complexity attracts a high diversity and density of birds, increasing collision likelihood.

2. Species Richness and Functional Diversity

Field surveys indicate these zones have the highest species richness along the alignment. Greater diversity correlates with increased aerial activity, overlapping feeding guilds, and continuous movement between habitat types. Functional diversity includes waterbirds, waders, woodland passerines, and raptors, many flying within the height envelope of 330kV powerlines, thereby increasing exposure and collision probability.

3. Potential Migration Flyways

Clusters of Medium–High Sensitivity Zones may function collectively as directional movement corridors or migration flyways. River systems and floodplains serve as navigation routes, stopover habitats, and linear features guiding flight. Transmission powerlines intersecting this multi-habitat landscape can concentrate collision risk temporally, particularly during seasonal influxes or peak migration periods.

4. Flight Behaviour and Collision Mechanisms

Birds in these zones frequently commute between wetlands, woodlands, and dambos at low altitudes overlapping conductor heights. Seasonal mist, high humidity, and haze reduce visibility, increasing collision probability. Flocking behaviour further increases risk, as individuals in large groups have reduced reaction times and obstacle avoidance.

5. Landscape Configuration and Risk Amplification

Powerlines traversing open floodplains, converging drainage lines, or perpendicular movement paths intersect predictable daily flight routes. Long uninterrupted conductor spans in open habitats expand the exposure zone, amplifying collision risk.

The 21 identified Medium–High Sensitivity Zones are landscapes where habitat heterogeneity, high species richness, and predictable bird movements combine to create increased collision risk. While they may not possess the habitat irreplaceability or concentrated local risk of High Sensitivity Zones, repeated commuting flights, seasonal and migratory influxes, and cumulative corridor effects highlight these zones as areas for mitigation. Targeted management and monitoring are therefore necessary to minimise bird mortality and preserve ecological integrity along the proposed powerline alignment.

Medium Sensitivity Zones

The 36 Medium Sensitivity Zones along the proposed powerline alignment are areas of measurable, though comparatively lower, bird collision risk. These zones consist primarily of smaller or isolated dambos, often situated near disturbed or transformed landscapes. While they lack the habitat continuity, species richness, or movement concentration of High or Medium–High Sensitivity Zones, these areas remain ecologically functional and support local avian activity.

Key Drivers of Collision Risk

1. Ecological Characteristics of Medium Sensitivity Dambos

Medium Sensitivity Zones comprise seasonally waterlogged, grass-dominated depressions that provide local water retention, groundwater recharge, and seasonal foraging areas for wetland-associated birds. Isolated or partially degraded dambos are smaller, influenced by edge effects from adjacent agriculture or roads, and lack mature trees (vegetation complexity), leading to lower bird density compared to intact wetland–woodland mosaics.

2. Reduced Habitat Connectivity and Species Richness

Isolation and disturbance limit integration into ecological corridors, reducing sustained bird traffic and fewer directional commuting routes. Species assemblages are dominated by adaptable generalist species rather than wetland specialists or threatened species. The absence of mature woodland margins and large open floodplains further limits attractiveness for roosting or breeding.

3. Collision Risk Mechanisms

Despite lower abundance, collision risk in these zones persists through:

- *Seasonal resource pulses*: Small dambos can attract feeding waterbirds, waders, and hunting raptors during peak rainfall.
- *Short-range movements*: Birds commuting between feeding areas, nearby perches, or adjacent agricultural fields may traverse conductor/earth wires particularly at lower heights.
- *Edge effects*: Birds exploiting habitat edges, including generalist and flocking species, may intersect powerline spans.

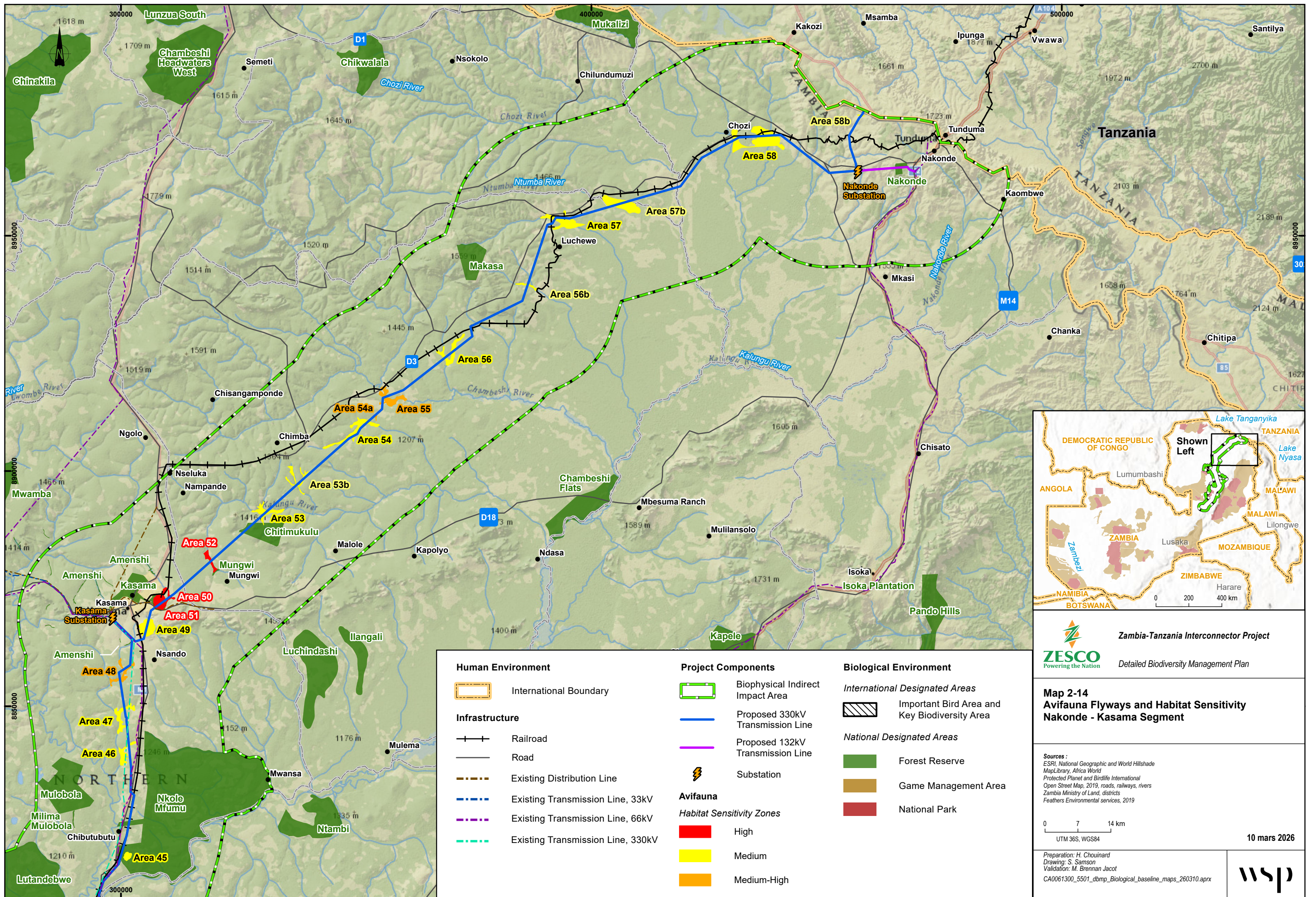
4. Influence of Disturbance

Proximity to transformed landscapes reduces habitat integrity and overall bird density, lowering large-scale movement and risk. However, open landscapes can make conductors less visible, scattered trees create localised flight paths, and agricultural mosaics may attract flocks, maintaining collision potential.

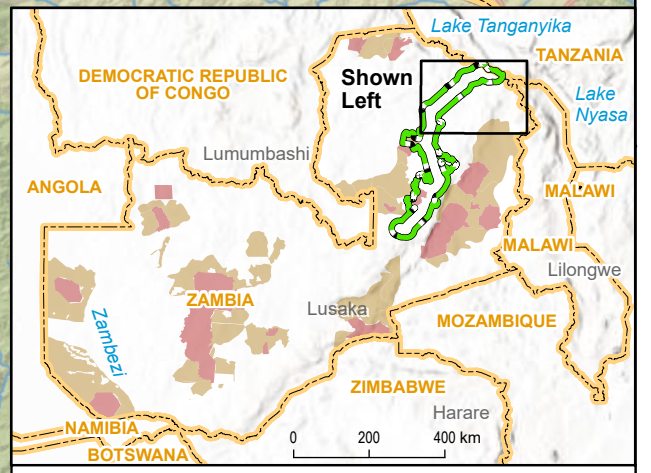
5. Cumulative Significance

Although individual Medium Sensitivity Zones present modest risk, the thirty-five zones along the alignment collectively increase total exposure length. Seasonal peaks may coincide across multiple dambos, and distributed small-risk sections can contribute meaningfully to overall collision mortality, making corridor-scale mitigation necessary.

Medium Sensitivity Zones represent landscapes where smaller, isolated dambos support local avian activity, seasonal resource use, and low-level commuting flights. While their collision risk is lower than High or Medium–High Sensitivity Zones, cumulative exposure, seasonal influxes, and edge effects make these zones significant in the broader alignment context. Targeted mitigation measures remain important to reduce collision risk and preserve ecological function.



<p>Human Environment</p> <p> International Boundary</p> <p>Infrastructure</p> <p> Railroad</p> <p> Road</p> <p> Existing Distribution Line</p> <p> Existing Transmission Line, 33kV</p> <p> Existing Transmission Line, 66kV</p> <p> Existing Transmission Line, 330kV</p>	<p>Project Components</p> <p> Biophysical Indirect Impact Area</p> <p> Proposed 330kV Transmission Line</p> <p> Proposed 132kV Transmission Line</p> <p> Substation</p> <p>Avifauna</p> <p>Habitat Sensitivity Zones</p> <p> High</p> <p> Medium</p> <p> Medium-High</p>	<p>Biological Environment</p> <p>International Designated Areas</p> <p> Important Bird Area and Key Biodiversity Area</p> <p>National Designated Areas</p> <p> Forest Reserve</p> <p> Game Management Area</p> <p> National Park</p>
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Zambia-Tanzania Interconnector Project
Detailed Biodiversity Management Plan

Map 2-14
Avifauna Flyways and Habitat Sensitivity
Nakonde - Kasama Segment

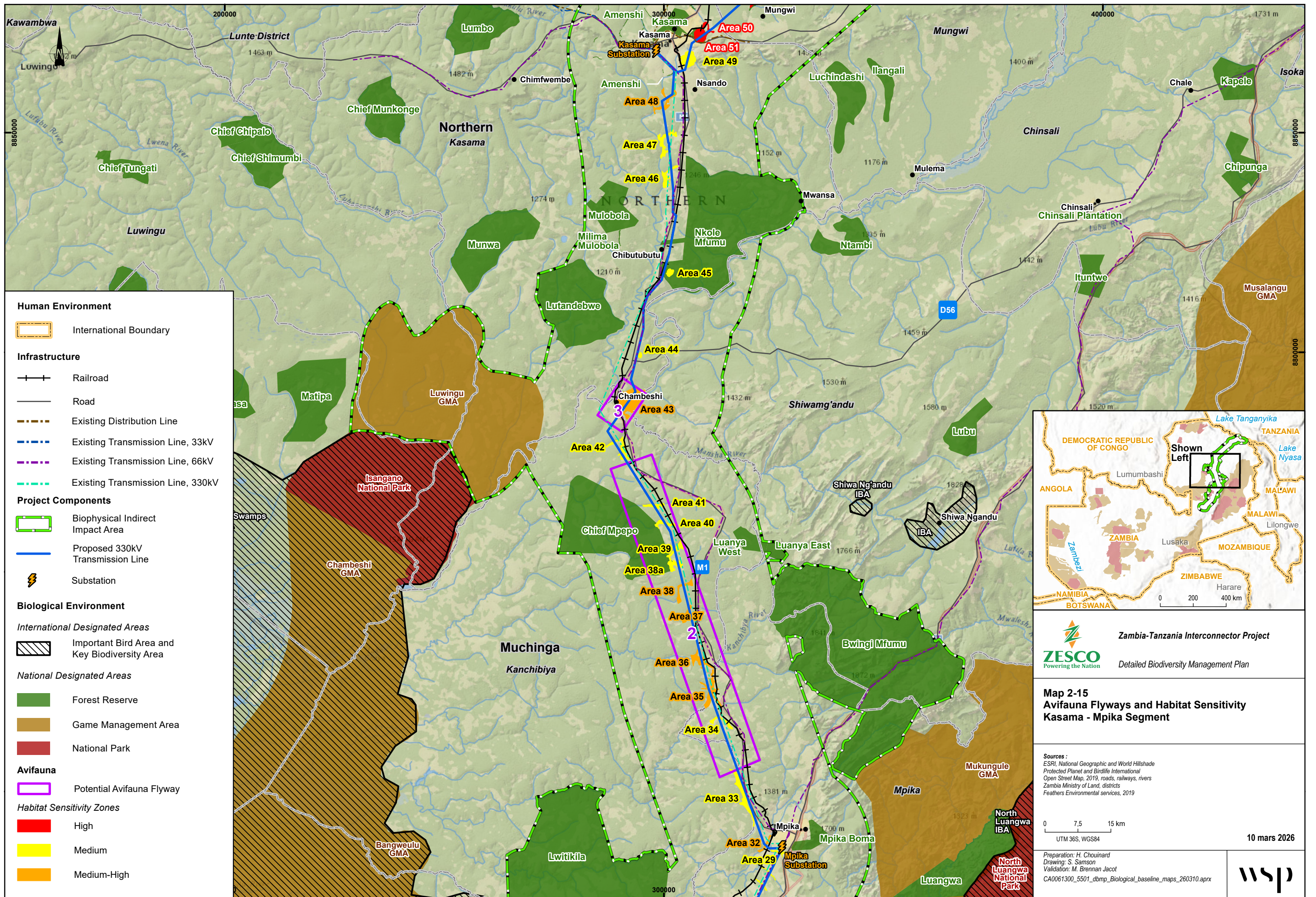
Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

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 UTM 36S, WGS84

10 mars 2026

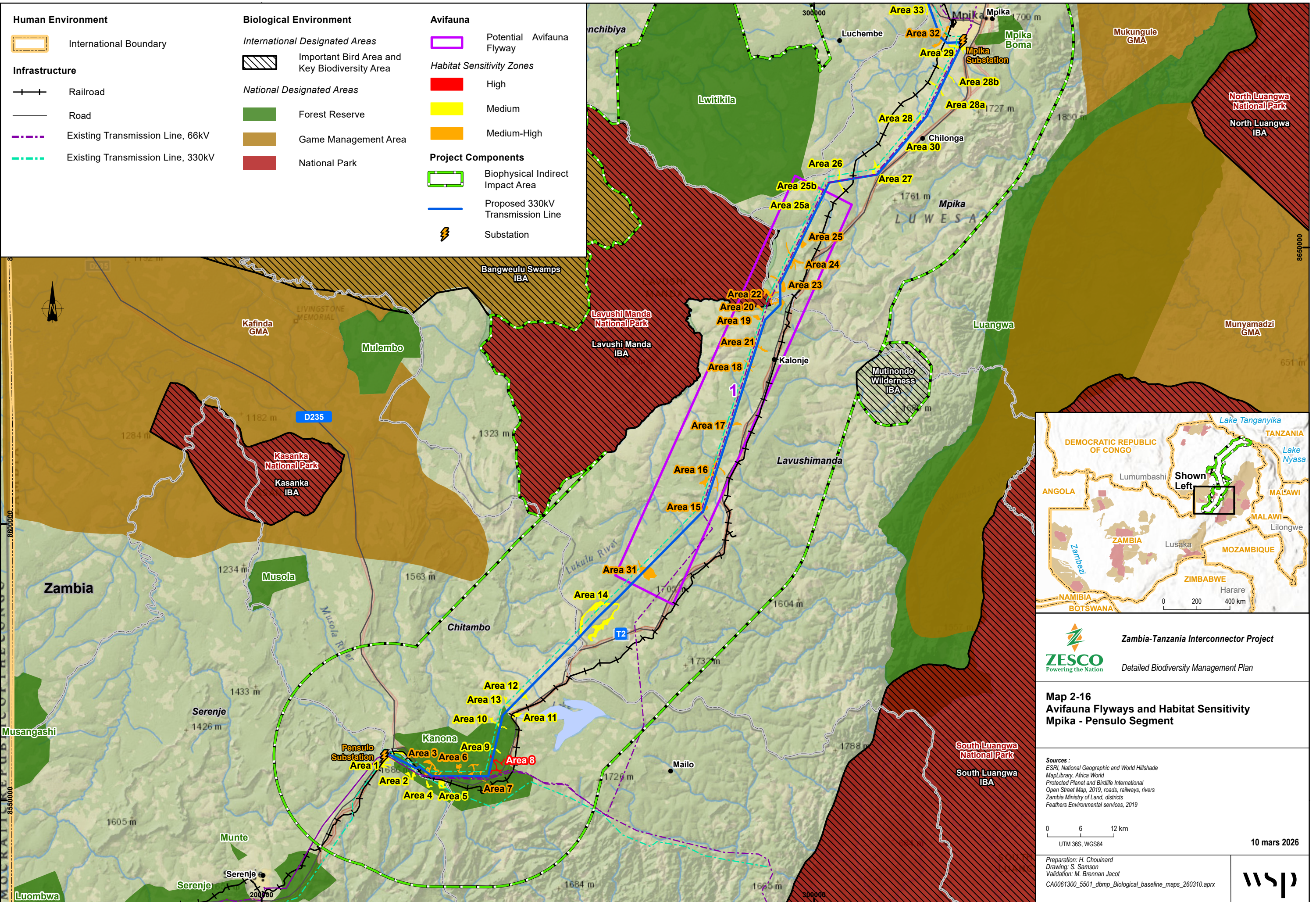
Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_260310.aprx

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



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Zambia-Tanzania Interconnector Project
ZESCO Powering the Nation
 Detailed Biodiversity Management Plan

Map 2-16
Avifauna Flyways and Habitat Sensitivity
Mpika - Pensulo Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

0 6 12 km
 UTM 36S, WGS84
 10 mars 2026

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_260310.aprx



2.5 Bats

Bat species within the study area have been described using information collected from a literature review and review of existing data, including known occurrences from the Global Biological Information Facility (GBIF, 2024) and the African Chiroptera Report (ACR, 2024). Field surveys were also conducted within the study area in November 2019 and in January 2025. Field survey methodology is described in Appendix 2-1, whereas the complete sectorial report bat survey is available in Appendix 5-11. Location of Bat surveys are illustrated on Maps 5-17 to 5-19.

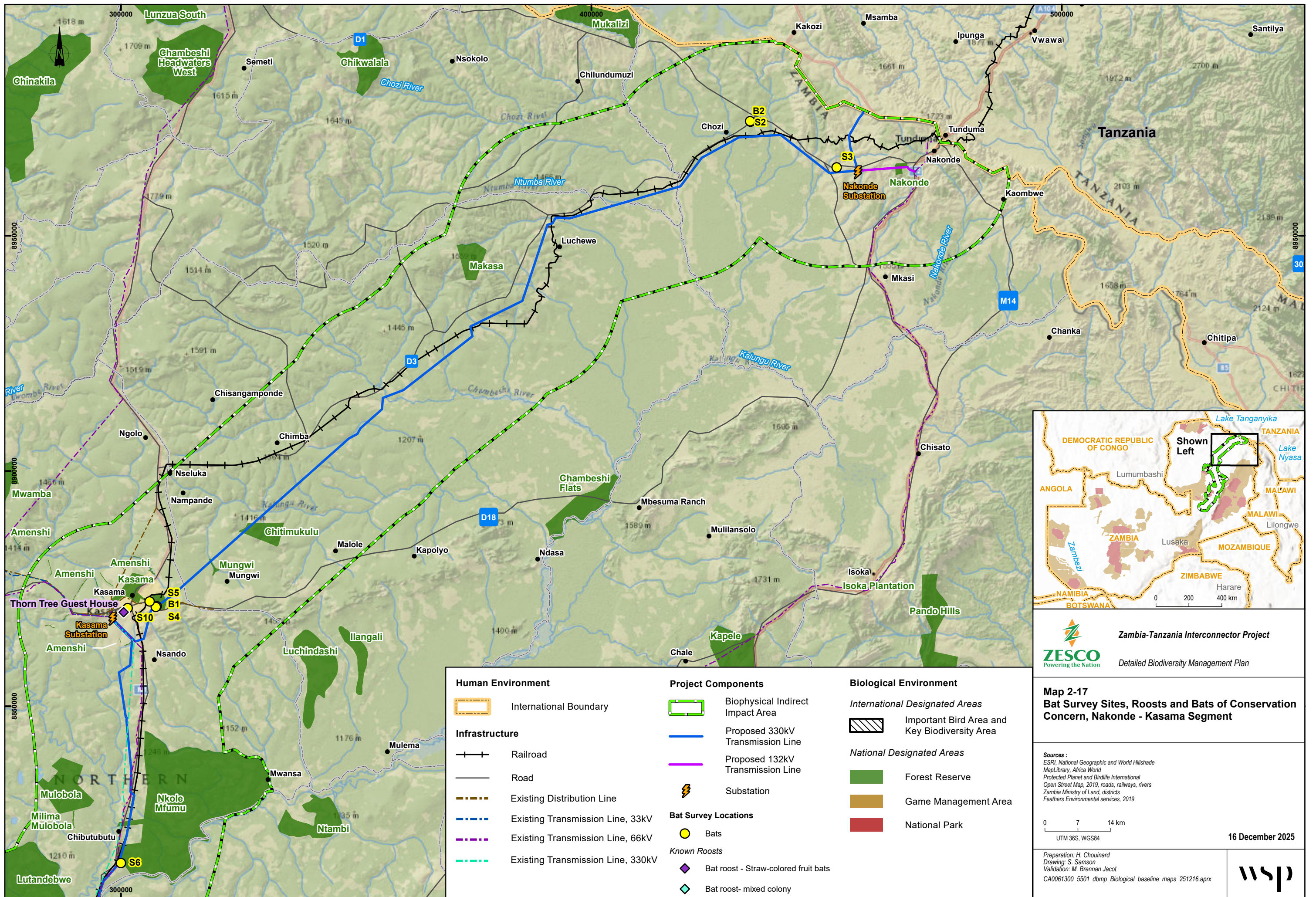
Consultations with conservation NGOs, such as Kasanka Trust, have allowed further information on species and migration routes to be gathered.

2.5.1 Bat Species Diversity

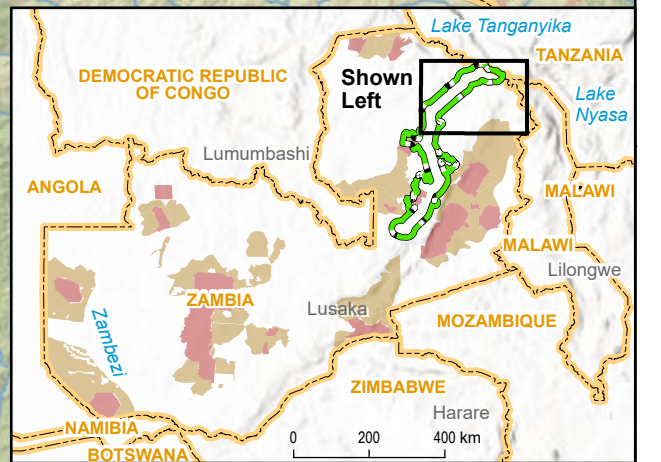
A total of 42 species of bats from 10 families are known to occur in Zambia (GBIF, 2024; ACR, 2024). The detailed list of bat species, known to be present in the study area from literature and confirmed through the field surveys, is available in Appendix 5-11.

A total of 70 bats were captured during field surveys, 19 individuals in 2019 and 51 in 2025. In addition, two species were not captured but were identified either by an echolocation call or visual observation. These comprised 19 species from six families.

In 2019, 10 species were detected in the study area. The 2025 survey added 7 new species and introduced one new family (*Nycteridae*) to the list. However, five species recorded in 2019 were not detected again in 2025. This information is summarized in Table 2-11.



Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



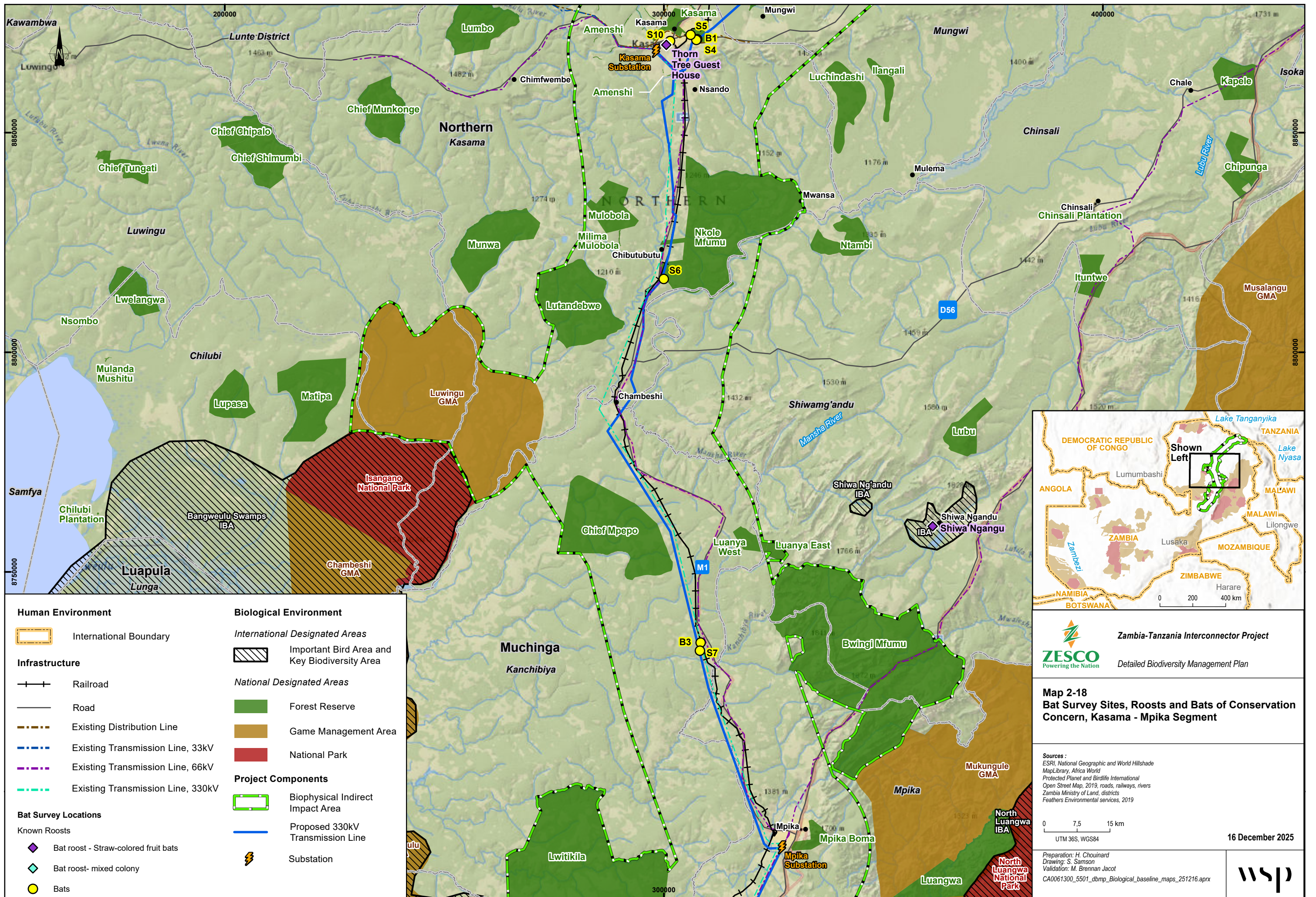
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Map 2-17
Bat Survey Sites, Roosts and Bats of Conservation Concern, Nakonde - Kasama Segment

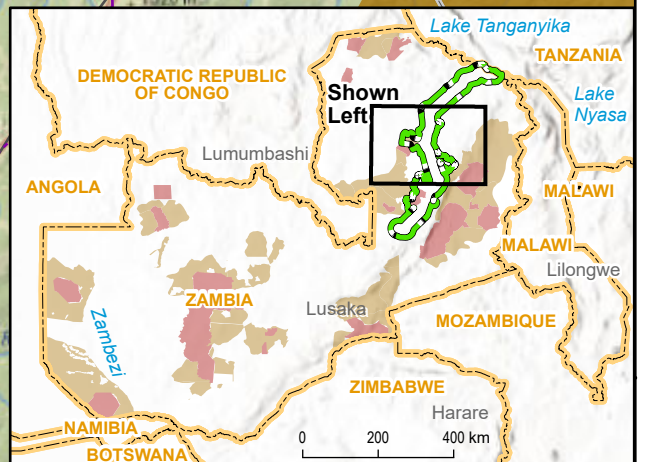
Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

0 7 14 km
 UTM 36S, WGS84
 16 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx



Human Environment	Biological Environment
International Boundary	International Designated Areas
Infrastructure	Important Bird Area and Key Biodiversity Area
Railroad	National Designated Areas
Road	Forest Reserve
Existing Distribution Line	Game Management Area
Existing Transmission Line, 33kV	National Park
Existing Transmission Line, 66kV	Project Components
Existing Transmission Line, 330kV	Biophysical Indirect Impact Area
Bat Survey Locations	Proposed 330kV Transmission Line
Known Roosts	Substation
Bat roost - Straw-colored fruit bats	
Bat roost- mixed colony	
Bats	



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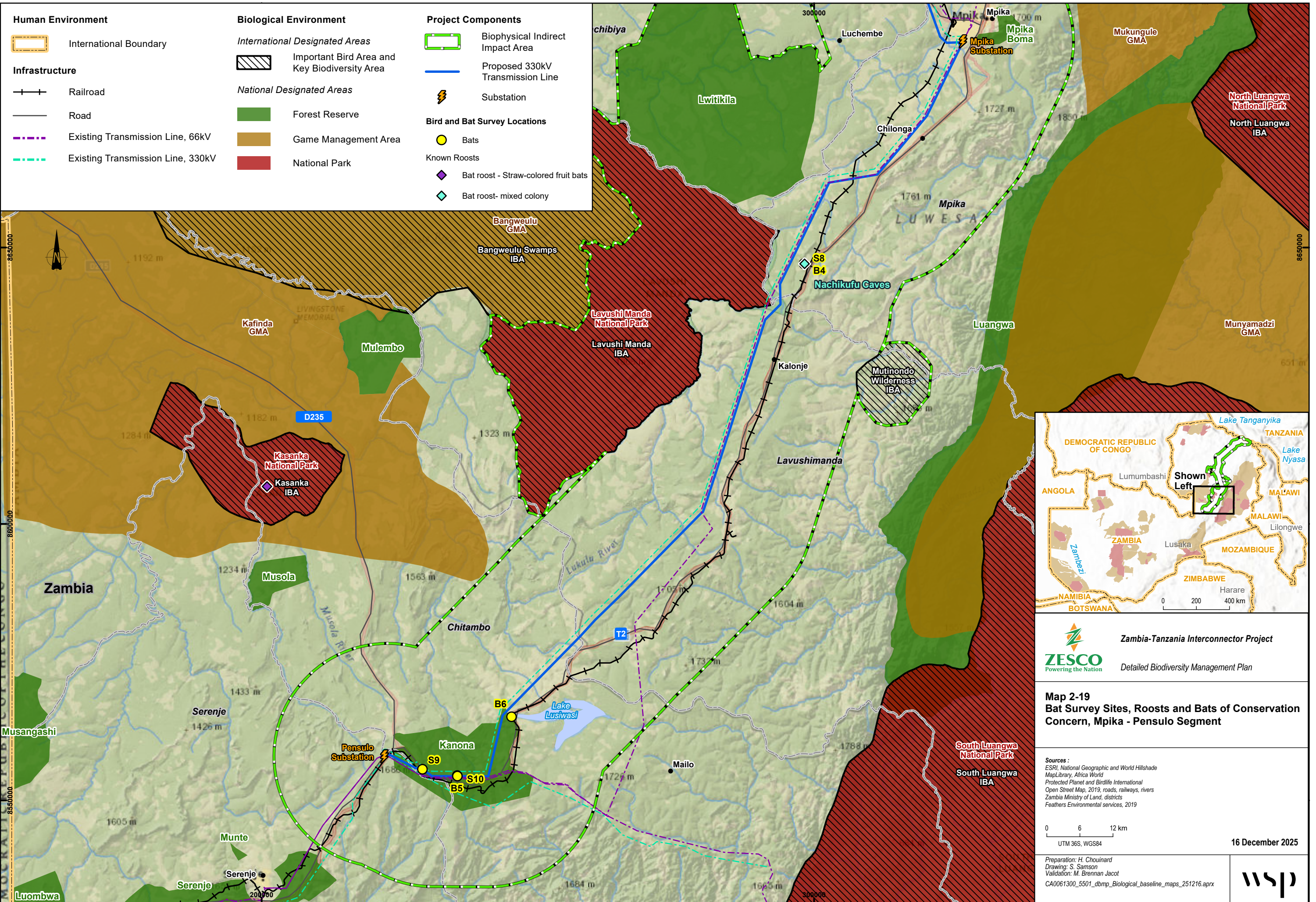
Map 2-18
Bat Survey Sites, Roosts and Bats of Conservation Concern, Kasama - Mpika Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

0 7.5 15 km
 UTM 36S, WGS84
 16 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



Human Environment	Biological Environment	Project Components
International Boundary	<i>International Designated Areas</i>	Biophysical Indirect Impact Area
Infrastructure	Important Bird Area and Key Biodiversity Area	Proposed 330kV Transmission Line
Railroad	<i>National Designated Areas</i>	Substation
Road	Forest Reserve	Bird and Bat Survey Locations
Existing Transmission Line, 66kV	Game Management Area	Bats
Existing Transmission Line, 330kV	National Park	Known Roosts
		Bat roost - Straw-colored fruit bats
		Bat roost- mixed colony



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Map 2-19
Bat Survey Sites, Roosts and Bats of Conservation Concern, Mpika - Pensulo Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

0 6 12 km
 UTM 36S, WGS84 16 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.

Table 2-11 Bat Species Recorded during Field Surveys

Family	Species	Common name	IUCN Red List status	Year of observation	Number	Habitats where the species was recorded					Notes
						Miombo woodland	Wetlands	Caves/rock outcrops	Cultivated area	Residential area	
<i>Hipposideridae</i>	<i>Hipposideros caffer</i>	Sundevall's Leaf-nosed Bat		2019	Counted 100 1 captured	x	x				
				2025	Counted 300 2 captured				x		
<i>Macronycteridae</i>	<i>Macronycteris (Hipposideros) vittatus</i>	Striped Leaf-nosed Bat	NT	2019	1			x			Echolocation call only
<i>Nycteridae</i>	<i>Nycteris thebaica</i>	Egyptian Slit-faced Bat		2025	Counted 30 3 captured	x		x			
<i>Pteropodidae</i>	<i>Eidolon helvum</i>	African Straw-coloured Fruit Bat	NT	2025	Counted 300					x	Observed, but not captured
<i>Pteropodidae</i>	<i>Epomophorus crypturus</i>	Peters's Epauletted Fruit Bat		2019	5	x	x				
				2025	8	x			x		

Family	Species	Common name	IUCN Red List status	Year of observation	Number	Habitats where the species was recorded					Notes
						Miombo woodland	Wetlands	Caves/rock outcrops	Cultivated area	Residential area	
<i>Pteropodidae</i>	<i>Epomophorus dobsonii</i>	Dobson's Epauletted Fruit Bat		2019	1	x	x				
				2025	8	x					
<i>Pteropodidae</i>	<i>Epomophorus labiatus</i>	Little Epauletted Fruit Bat		2019	1	x	x				
				2025	11	x	x	x			
<i>Rhinolophidae</i>	<i>Rhinolophus mossambicus</i>	Mozambican Horseshoe Bat		2019	4	x	x				
				2025	4	x	x	x			
<i>Rhinolophidae</i>	<i>Rhinolophus fumigatus</i>	Rüppell's Horseshoe Bat		2025	1	x	x	x			
<i>Vespertilionidae</i>	<i>Afronycteris nanus</i>	Banana Bat		2025	2	x	x				
				2019	2	x	x				
<i>Vespertilionidae</i>	<i>Afropipistrellus grandidieri</i>	Dobson's Pipistrelle		2025	1	x	X				The record is provisionally identified with a species but cannot be identified with certainty.
<i>Vespertilionidae</i>	<i>Eptesicus hottentotus</i>	Long-tailed Serotine		2019	1			x			

Family	Species	Common name	IUCN Red List status	Year of observation	Number	Habitats where the species was recorded					Notes
						Miombo woodland	Wetlands	Caves/rock outcrops	Cultivated area	Residential area	
<i>Vespertilionidae</i>	<i>Laephotis angolensis</i>	Angolan Long-eared Bat		2025	1	x			x		The record is provisionally identified with a species, but cannot be identified with certainty.
<i>Vespertilionidae</i>	<i>Laephotis capensis</i>	Cape Serotine		2025	5	x	x	x	x		
<i>Vespertilionidae</i>	<i>Laephotis botswanae</i>	Botswana Long-eared Bat		2019	1	x	x				
<i>Vespertilionidae</i>	<i>Nycticeinops schlieffeni</i>	Schlieffen's Twilight Bat		2025	4	x	x				
<i>Vespertilionidae</i>	<i>Pipistrellus group</i>	(Pipistrelle)		2019	1						Could not be identified to species
<i>Vespertilionidae</i>	<i>Scotoecus hirundo</i>	Dark-winged Lesser House Bat		2025	1	x	x				

IUCN Red-list status: CR: Critically endangered; EN: Endangered; VU: Vulnerable; NT: Near-Threatened.

2019 Activity Level Based on Acoustical Data

From the acoustical data compiled from the bat detectors in 2019 (which only recorded insect bats since most fruit bats – *Pteropodidae* – do not echolocate), an estimated number of 19 insect bat species were recorded. Other than those already identified through capture of individual bats, only one of these could be identified to species level from the acoustical data, the Striped Leaf-nosed Bat. Table 2-12 gives the estimated number of species by family (excluding *Pteropodidae*).

Unfortunately, due to battery and other challenges in 2025, bat detectors were only occasionally used to help identify certain species. No activity level could be derived from acoustical data in 2025.

Table 2-12 Number of Insect Bat Species Estimated from Acoustical Data in 2019

Family	Estimated number of species
<i>Hipposideridae</i>	1
<i>Macronycteridae</i>	1
<i>Molossidae</i>	6
<i>Rhinolophidae</i>	3
<i>Vespertilionidae</i>	8
Total	19

The average number of passes (or calls) per hour was calculated for each site as a measure of bat activity in 2019. These calls were recorded between 18:00 and 22:00 hrs. The number of species per site (excluding *Pteropodidae*) was also estimated. These figures are given in Table 2-13.

Table 2-13 Comparison of Activity and Species by Site Based on Acoustical Data in 2019

Survey site	Average passes per hour	Number of species
B1 – Kasama Forest Reserve	3	7
B2 – 40 km east of Nakonde	19	13
B3 – 50 km north-west of Mpika	2	4
B4 – Nachikufu Caves	6	8
B5 – Kanona Forest Reserve	0	0
B6 – Lake Lusiwasi	4	3

Diversity by Site and Habitat

Bat species diversity appeared to be highest in areas with a variety of habitat types, such as woodland, wetland and rocky outcrops. This is likely due to high availability of roosting sites as well as diversity of available food. Site B2/S2 hosted by far the highest bat diversity in 2019 followed by B1/S4/S5 and B4/S8. The latter two sites also had the highest bat diversity in 2025. This information is presented in Figure 2-17.

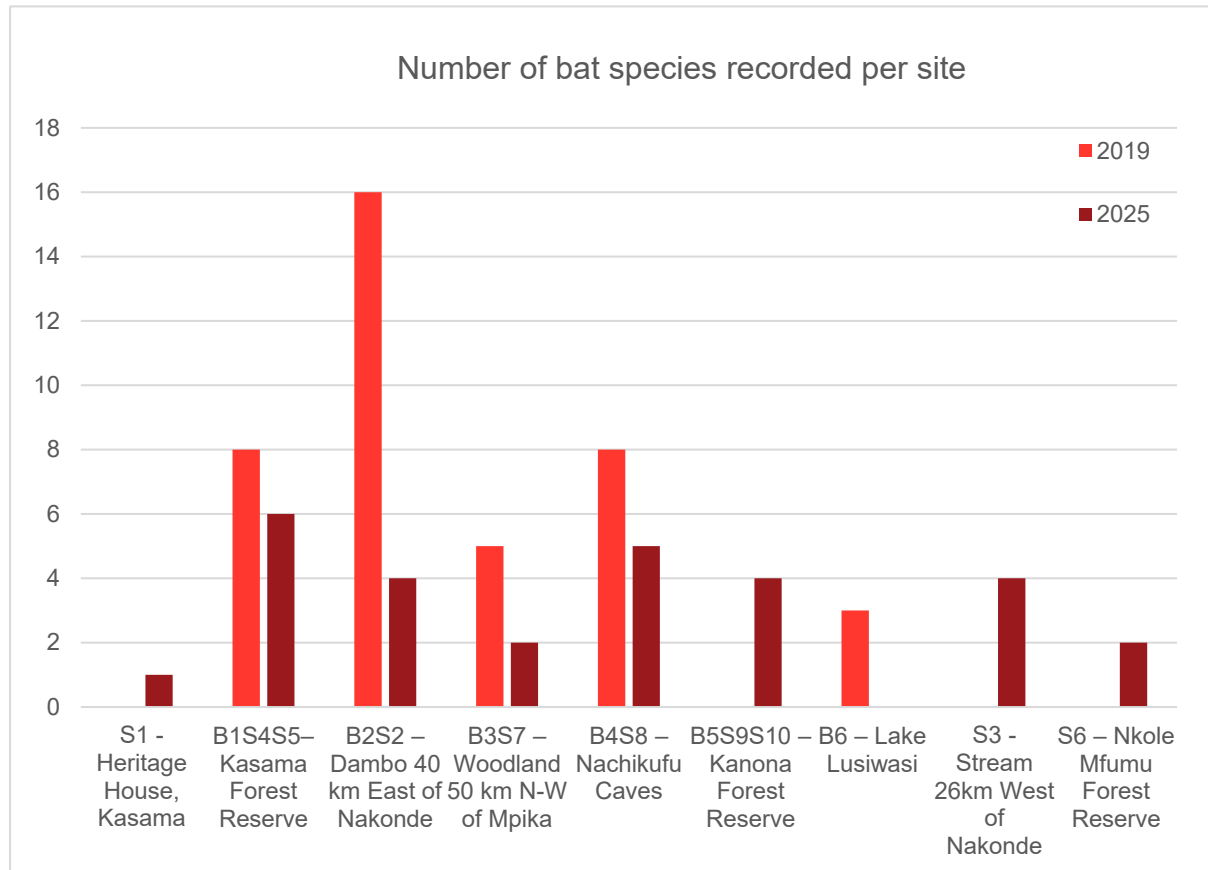


Figure 2-17 Number of Bat Species Recorded per Site in 2019 and 2025

Roost Sites

There are four other known seasonal roosts of the African Straw-coloured Fruit Bat that are located within or very close to the study area (see Photo 2-16). Three of these are in Kasama at Thorn Tree Guest House, next to Hector Croad Heritage House, and along an unnamed road near Milungu Road, while the other is at Shiwa Ng'andu near Lake Ishiba N'gandu (Taylor-Boyd, pers. comm., 2019). It is unclear whether the three roosts in Kasama are being used at the same time by different bat colonies, or if they serve as alternative sites for a single colony.

The known roost of the African Straw-coloured Fruit Bat at Thorn-Tree Guest House in Kasama was visited in 2019. However, the specialist was informed by the co-owner, Hazel Powel, that the bats had first arrived by the thousands in October, two years previously, and had left early the following year. They had arrived again the next year at the same time and left again in January or February. They were thought to have arrived from the southwest and gone foraging each day in the east. However, in 2019, there was no sign of the bats, even though colonies of the same species had arrived at the usual time at known roosts in Kasanka National Park and Ndola. It was not known why they had not turned up. A possible reason given for this by management of the Guest House was due to disturbance by children outside the premises near the roosting area.

In 2025 the specialist was informed of another roost next to Hector Croad Heritage House, in a stand of tall bamboo and eucalyptus trees, and also in some tall pine trees along an unnamed road near Milungu Road, nearly 1km to the north-west. Both reported roosts were checked in 2025, and the one at the Heritage House was found to still have approximately 300 bats present, but it was reported that this was the tail end of the roost, as most of the colony had already left, as they do every year around that time. The second reported roost was not found to have any bats in it. Kasama is still considered an important roosting and foraging area for large numbers of migratory African Straw-coloured Fruit Bat.



Photo 2-16 African Straw-Coloured Fruit Bat (*Eidolon helvum*) Colony in Tree Roost in Kasama

In 2019, the Mwela Rock Art Site to the east of Kasama was visited. However, only bat droppings and one bat were observed during the daytime visit. The guide reported that sometimes there were many bats and crevices in the small caves. Since the rocky area was vast, it was quite possible that there were more bat roosts in the area. Site B1 was not far from this area, and some cave-roosting bats were captured here in 2019. In 2025, an area in the eastern part of the site known as Mwankole (Site S5) was visited. A few caves were located and at least two were found to have small numbers of Slit-faced bats (*Nycteris* sp.) roosting inside (see Photo 2-17). These were later visited again to capture and identify some of the bats, which were identified as Egyptian Slit-faced bats (*Nycteris thebaica*). At another location within the site (Site S4), during night-time trapping, two species of Horseshoe bats (*Rhinolophus* sp.), which are known to roost in caves, were captured. The highest diversity of species and one of the highest number of bats captured during the survey in one night was at this site. The area is, therefore, considered an important potential roosting area for a number of bat species.



Photo 2-17 *Nycteris thebaica* Colony Roosting in Cave

At site B4/S8, Nachikufu Cave, the caretaker in 2019 informed the specialist that during the cold months of the year, thousands of bats roost in the caves in the rocky hills (this had also been reported by another acquaintance previously). However, he said he thought that most of the bats had now left. During a day-time survey in 2019, only one or two bats were observed in one of the higher caves, not the main cave. However, after dark, individuals of Sundevall's Leaf-nosed Bat (*Hipposideros caffer*) were observed exiting the cave and flying around the entrances of the cave tunnels. Newly born juveniles of the same species were also observed. Most of the adult bats captured were either pregnant or lactating. The colony, which is estimated at over 100 individuals, was therefore determined to be a maternity colony.

It is possible there were still more bats deeper in the tunnels. Another species of cave/crevice-roosting bat (*Eptesicus hottentotus*) was captured near the cave entrance and was not previously known from the study area. The distribution of this species is very sparse and is limited to the availability of rocky outcrops as roosting sites. Meanwhile, echolocation recordings in the cave indicated the possible presence of another cave-dwelling bat (Striped Leaf-nosed Bat, *Macronycteris vittatus*), a Near Threatened species, although it was not observed or captured during the survey, could not be confirmed. It is not known which species is present during the cool months of the year, but it can be concluded that this is an important roosting and breeding site for bats and is less than 3 km from the line route.

The site B4/S8- Nachikufu Cave was visited again in 2025. However, this time, no new-born babies were observed (as in November 2019), but older, flying juveniles were captured. However, another cave-roosting species, the Mozambican Horseshoe Bat (*Rhinolophus mossambicus*), was also captured in the nearby woodland, as were a large number of fruit bats of three different species. Considering that the area has a number of caves, fairly well-preserved woodland, and a stream nearby, it is still considered an important roosting and foraging area for a variety of bat species and potentially a large number of bats. During the previous survey the specialist had been informed that the bat colony roosting in the caves can reach thousands during the cold months of the year. It can be concluded that this is an important roosting and breeding site for bats and is less than 3 km from the line route.

2.5.2 Bat Species of Conservation Concern

Two bat species known to occur within the study area are classified as Near-Threatened on the IUCN Red List: the Smithers's horseshoe bat (*Rhinolophus smithersi*) and the African Straw-coloured Fruit Bat (*Eidolon helvum*). The latter was observed roosting within the study area in Kasama during the 2025 survey. A third species in the same category, the Striped Leaf-nosed Bat (*Macronycteris vittatus*) echolocation calls was recorded during the 2019 rapid bat survey at Nachikufu Caves, although it was not actually observed.

African Straw-Coloured Fruit Bat (*Eidolon Helvum*) – NT

The African Straw-coloured Fruit Bat is the second-largest bat on mainland Africa and occurs widely across Africa's lowland rainforest and savannah regions (Monadjem *et al.*, 2010). It is also present in the extreme southwest Arabian Peninsula (Cooper-Bohannon *et al.*, 2020). The species has been recorded from various habitats through moist and dry savannah woodland mosaics, including tropical rainforests, coastal forests, and riverine forests. It also exists in modified landscapes and is often recorded in urban areas (Cooper-Bohannon *et al.*, 2020). Colonies are rarely found in protected areas or forests but frequently near human habitations, especially gardens, probably because fruit trees are nearby (Webala *et al.* 2014). In central Africa, the species has been recorded using Zambezian miombo woodlands, forest-savannah mosaics, lowland forests, and riverine forests (Richter & Cumming, 2008).

This common species forms large colonies of thousands to even millions of individuals. Within colonies, they form tight clusters of up to 100 animals. During migration, this species disperses into small groups (Cooper-Bohannon *et al.*, 2020). Its well-known daily migration in Kasanka National Park is described in detail in the next section. It primarily feeds on fruit (wild and cultivated) and flowers (Monadjem *et al.* 2016). In southern Africa, its seasonal appearances and disappearances likely reflect the responses of these bats to changing food supplies (Richter and Cumming, 2008). The role of frugivorous bats is crucial in ecosystems as these species perform key functions as pollinators and seed dispersers. This species has been shown to retain ingested seeds for long periods and to travel large distances, making it an important seed disperser in tropical Africa (Abedi-Lartey *et al.* 2016).

The species is locally threatened in parts of its range by severe deforestation, and more generally across Western and Central Africa by hunting for food and medicinal use (Cooper-Bohannon *et al.*, 2020). Large pre-migration colonies are considered particularly vulnerable to threats.

In some areas, it is considered a pest species and roosting locations may be restricted by cutting down trees (P. Racey *pers comm.* [in Cooper-Bohannon *et al.*, 2020]). The species is also persecuted because it often damages fruit plantations (Webala *et al.*, 2014).

As tree density is an important factor in roost-site selection (Webala *et al.*, 2014), the removal of roost trees could impact this species, especially outside protected areas. In Western and Central Africa, there is evidence of a widespread decline due to harvesting for bushmeat. It is the most heavily harvested bat for bushmeat in these regions, and this is believed to be a major factor in reported population declines (P. Racey, *pers. comm.* in Cooper-Bohannon *et al.*, 2020).

There are known seasonal colonies of the African Straw-coloured Fruit Bat in Kasanka National Park, Kasama and Shiwa Ng'andu, all within or near the study area (see Maps 5-17 to 5-19). The species was recorded roosting in an urban area of Kasama during the 2025 survey, although it was towards the end of the season, and most of the colony was reported to have already left.

Striped Leaf-Nosed Bat (*Macronycteris Vittatus*) – NT

The Striped Leaf-nosed Bat (*Macronycteris vittatus*) is sparsely but widely distributed in southern, eastern and central Africa. It depends entirely on large caves for breeding, where large colonies numbering hundreds of thousands of individuals may aggregate (Monadjem *et al.*, 2010). In eastern and southern Africa, it seems to be largely associated with savanna woodland habitats (Skinner & Chimimba, 2005). The species can occur locally in very large numbers where suitable cave habitats are available. However, animals have been recorded (presumably in considerably smaller numbers) roosting in tree canopies, hollow trees, and dense vegetation as well as under the eaves of buildings (Skinner & Chimimba, 2005).

The species is listed as Near Threatened by IUCN because, although it is still widely distributed, a large proportion of its global population is found in a few very large cave roosting colonies that are threatened by disturbance, habitat loss, and overhunting (Mickleburgh et al., 2020).

During the 2019 field surveys, this species was indicated to be present at Nachikufu Cave from echolocation calls recorded using a bat detector. However, no individuals were observed.

Smithers's Horseshoe Bat (*Rhinolophus Smithersi*) – NT

The Smithers's horseshoe bat (*Rhinolophus smithersi*) was formerly included in *Rhinolophus hildebrandti* but acoustic, biogeographical, morphological and molecular data show that it is a distinct species (Taylor, 2017). It is known from Lutope-Ngolangola Gorge south of the Zambezi Escarpment in north-west Zimbabwe and also from Pafuri in the Limpopo Valley in the foothills of the Soutpansberg Mountains of northern Limpopo Province, South Africa, but likely more widespread across savannah woodlands of the Limpopo and Zambezi valleys and their escarpments (Taylor et al., 2012). Accurate delimitation of this species' range is subject to further collecting and reappraisal of existing museum material, previously referred to as *R. hildebrandtii* (van Cakenberghe & Seamark, 2024). The African Chiroptera Report (van Cakenberghe & Seamark, 2024) shows a much wider distribution range, extending into Zambia and Mozambique, based on re-examination of some museum material.

The ecology of this species is poorly known. It occurs sympatrically with *R. mossambicus* at one locality in miombo savannah on Karoo Sandstone, dominated by *Brachystegia glaucescens* trees, and including large specimens of baobabs, *Adansonia digitata*. More diverse riparian woodland fringes the Lutope and Ngolanola rivers as well as along the Limpopo River at Pafuri. Daylight roosts were not located but these bats could use caves in the sandstone cliffs and/or hollows in baobabs (Taylor et al., 2012.) In northern South Africa, the species appears to be dependent on natural caves or man-made underground cavities such as old mine audits. Colony sizes here are small (just a few individuals) (Taylor, 2017).

Recent collecting has shown that the species is quite widespread. There is no evidence of declines in the species or its habitat. However, colony sizes are very small, and the species appears to have a scattered occurrence in the landscape. Since it is limited by availability of roosting sites, and possibly suitable water sources, it is hard to believe that the entire population of the species could be much more than 1,000 individuals, so it could potentially be Vulnerable. However, until the population size can be confirmed to be below 1,000, the species is assessed as near-threatened (Taylor, 2017). There are no known major threats to this species at present. The threat of mining and other developments over much of its South African range could impact heavily on populations through roosting and foraging habitat loss, pollution and degradation of riparian habitats. Suppression of fire together with over-grazing of cattle and game and climate change has resulted in serious bush encroachment of savannahs across much of its range which has been shown to have a negative effect on biodiversity generally (Taylor, 2017).

The species was not recorded during the field surveys.

2.5.3 Bat Migrations

Bat migration pathways have not been well studied in Zambia. However, African Straw-coloured Fruit Bats that roost in large numbers (5-10 million) in Kasanka National Park, approximately 50 km from the transmission line, are known to migrate seasonally from there to the Democratic Republic of Congo as well as to Tanzania and Malawi. This is known as one of the largest wildlife migrations in Africa. Population estimates have ranged from 1 to 10 million bats (Stuart and Stuart, 2003; Richter and Cumming, 2008). However, a recent attempt by Koger et al (2023) to come up with a more accurate estimate the population size arrived at a range of 750,000 to 1 million bats. The authors do acknowledge, however, that this might not have been at the peak point in the season, and that the size of the roost may vary from year to year.

Richter and Cumming (2006) reported that the bats arrived at Kasanka between October 18 and 21 and departed between December 23 and January 9 each year. They come in search of fruit. Richter and Cumming (2006) identified the following tree species (with local or English names in brackets) as food sources for these bats: *Ficus spp* (Mukunyu), *Magnistipula butayi* (Imipande), *Mangifera indica* (Mango), *Musa spp* (Banana), *Parinari curatellifolia* (Mupundu), *Syzygium cordatum* (Mufinsa), *Syzygium guineense* (Insafwa), *Syzygium guineense huillense* (Mufinsa), *Uapaca kirkiana* (Masuku), *Uapaca benguelensis* (Makonko) and *Uapaca sansibarica* (Swebya). Most of these species, other than the exotic mango and banana, occur widely in miombo woodlands.

The arrival of the colony at Kasanka coincides with a marked increase in the number of fruiting *Syzygium* and *Uapaca* species; these trees accounted for more than 80% of all fruit-bearing trees at that time (Richter & Cumming, 2006). Each bat will feast on approximately 5 lbs of fruit nightly. The bats have been recorded travelling up to 59 km from the roost in Kasanka to forage at night. This means at least some of the bats will travel within parts of the study area daily to feed (Richter & Cumming, 2008). Foraging is done at night, between dusk and dawn. Calderón-Capote *et al* (2020) showed that bats in roosting in Kasanka National Park travelled up to almost 100 km per night, with an average distance of 50km per night from their roost. Similarly, Randhawa *et al* (2020), found that in Tanzania, the same species of bats flew up to 97 km in a single foraging night, frequenting both urban built-up and protected areas, with maximum straight-line distances of 62 km from day roosts to foraging areas/feeding roost locations.

When migrating, the African Straw-coloured Fruit Bat has been recorded travelling an average distance of 90 km per night but may reach up to 370 km per night. Over a three-month period, bats were found to migrate up to 2,500 km (Richter and Cumming, 2008).

The large colony at Kasanka is thought to be an aggregation of multiple smaller colonies (Richter and Cumming, 2008). Evidence shows that some of the bats at Kasanka also migrate from Tanzania and Malawi (O'Mara, pers. comm., 2019). These migrations would cross the study area. The migration routes for other known roosts have not yet been studied, but it is very likely that at least some of these bats migrate annually through the study area and forage within the study area.

2.5.4 Areas of High Ecological Importance for Bats

Zambeziian Escarpment

Birdwatch Zambia identified the importance of the Zambeziian Escarpment, particularly in front of Serenje, as an important area for bats. They undertake migrations moving north, passing through Kasanka National Park and going to Mbala and Nieka. The rocky hills in the escarpment are likely to provide roosting sites for a variety of bats.

Riparian Habitats

Riparian habitats are within the study area known to support some fruit tree species, such as *Syzygium cordatum*, which has been identified as an important food source for some fruit-eating bats (Richter & Cumming, 2006), and the large, leafy trees occurring in riparian habitats provide important roosting sites for many bat species.

Wetlands are important foraging habitats for bats because they provide drinking water and high abundances of insect densities and studies of bat habitat use have shown that bats spend a significant amount of active time over habitats associated with water (Vaughan *et al*, 1997, Russo & Jones, 2003, Adam & Hayes, 2008, Blakey *et al*, 2018). In the study area wetlands include rivers, lakes and dambos. The field survey indicated a higher diversity and abundance of bats in areas associated with water.

Caves

Caves provide important roosting sites for several bat species. There are at least two cave complexes within the site. Nachikufu Caves, approximately 55 km southwest of Mpika, is known to house many bats of various species that are likely to be foraging within the study area.

During the field surveys, approximately 100 in 2019 and 300 in 2025 individuals of Sundevall's Leaf-nosed Bat (*Hipposideros caffer*) were found to be present and breeding in the main cave at Nachikufu Caves. An individual of Long-tailed Serotine (*Eptesicus hottentotus*) (2019) and of Mozambican Horseshoe Bat (*Rhinolophus mossambicus*) (2025) were also recorded and were likely present in smaller numbers. Meanwhile, the Striped Leaf-nosed Bat (*Macronycteris vittatus*), which is classified by IUCN as Near Threatened, was identified from echolocation calls at the same cave during the 2019 survey. Striped Leaf-nosed bats tend to roost in large numbers in big caves. In 2019, the caretaker reported that thousands of bats occupy the cave in the cold, dry months of the year. The smaller caves and crevices in the rocky hills in the area likely provide roosts for many more bats of various species. The area was, therefore, identified as a major bat roost. Another area of importance identified was the Mwela Rock Art Site, east of Kasama. This site comprises rocky outcrops and small hills covering a large area. Evidence of small numbers of roosting Slit-faced (*Nycteris* sp.) bats were identified in some small caves and two species of Horseshoe bats (*Rhinolophus fumigatus* and *Rhinolophus mossambicus*), both known to roost in caves, were recorded in a nearby area.

Protected Areas

Protected areas such as National Parks, Forest Reserves, and private reserves tend to have higher levels of biodiversity than other areas due to the level of protection they receive. Many protected areas were chosen because of some important ecological aspects of the area. These areas should continue to be protected from disturbance as much as possible. IBA, though not receiving the same level of attention, have also been identified as important ecological areas, often not only for birds, but for other wildlife as well. Some privately protected areas in or close to the study area should also be considered as possibly having higher biodiversity levels, such as Kapishya Hot Springs and Mutinondo Wilderness Area.

2.6 Terrestrial Mammals

Terrestrial mammal species within the study area have been described using information from a review of available literature and other known sources of existing data, including known occurrences from Ansell (1978), Kingdon et al. (2013a; 2013b) and GBIF (2024). Rapid surveys of large mammals were also conducted in November 2019 by consulting eleven key informants in the areas along the powerline. The full methodology is in Appendix 5-2. Signed data collection meeting forms are contained in Appendix 5-10.

2.6.1 Mammals Species Diversity

Generally, all key informants interviewed confirmed that large mammals were more abundant in the project area in the past than in the present day. Due to the illegal harvesting of large mammals and very limited support for resource protection, the study is mainly dominated by communities of small and medium-sized mammals (Nyangu & Zgozi, pers. comm., 2019). Consultations, available literature and data bases provided a list of the historic and present-day occurrences of large mammals in the project area (Appendix 5-11), excluding bats, which are discussed separately in the previous section. This suggests that up to 38 species of terrestrial mammals from 16 families may be found in the BIIA, although 11 of these are considered a historical distribution and may no longer exist in the project area, and 10 are considered rare. Species are mainly associated with the *Bovidae* family, comprising 17 species. The differences in the occurrences of large mammals between historical and present-day were mainly attributed to human influence (100% of respondents indicated this), including encroachment into wildlife habitats for human settlements, agriculture, illegal harvesting of wildlife, fuel wood (charcoal), and, more recently, mining.

Sightings of large mammals in the study area were described as very rare by almost all respondents, with some areas only seeing spoor and scat left by the animals. In areas around Kanona Forest Reserve, primates (e.g., monkeys and baboons) that were once considered a nuisance by farmers are no longer present (Mupeta, pers. comm., 2019). Forestry officers in Serenje accounted for only the bush hare as being the largest mammal sighting in the Kanona area (Kangwa, pers. comm., 2019).

In areas north of Kanona (i.e., Chandesi, Kalonje, Chilonga, Mpika, Kanchibiya, and Chambeshi), hippos, monkeys and baboons were the most frequently sighted animals. Areas where hippos have been reported are illustrated in Maps 5-20 to 5-22. Occasionally, buffalos were sighted, and carnivores (i.e., lions and jackals) encountered are problem animals for livestock. Records of human-wildlife conflicts from DNPW validated the presence of large mammals in these areas.

2.6.2 Mammal Species of Conservation Concern

Among the terrestrial mammals potentially present in the BIIA, two are considered endangered and six are considered either Vulnerable or Near Threatened by the IUCN.

African Savanna Elephants (*Loxodonta africana*) – Endangered. The species has been described as using the northern section of the study area (Mungwi, via Senga area) during the dry season period. They are migrating in response to human influences in areas where humans heavily settle. Their movements are from Nsumbu National Park and the protected area adjacent to Kalambo falls in Tanzania via Mukalizi area in Nakonde and back. Occasionally, they will come down to Mungwi in Chief Makasa's area (Zulu, Mucleta & Mambwe, pers. comm., 2019). Furthermore, according to the DNPW (pers. comm., 2024), elephants have recently been moving from Kasanka NP passing through Kanona Forest Reserve. These occurrence areas are illustrated in Maps 5-20 to 5-22.

White-bellied Pangolin (*Phataginus tricuspis*) – Endangered. In northwestern and central Zambia and southern Democratic Republic of the Congo (DRC), this species occurs in dense miombo (*Brachystegia-Julbernardia*) woodland, as well as in forest fragments and riparian forests. White-bellied Pangolins are predominantly nocturnal and equally at home in trees and on the ground (Pietersen et al., 2021). The species feeds exclusively on ants and termites. According to Pietersen et al. (2021), there are also confirmed records from northwestern Zambia (near Solwezi) and central Zambia (Serenje) close to the DRC border from 2016–2018. According to the DNPW (pers. comm., 2024) the species is present within the Mungwi area. These are captured for trade.

Lions, Hippos, Leopards and Temminck's Pangolins are considered Vulnerable by the IUCN.

Lion (*Panthera leo*) – Vulnerable. The sighting of lions was consistent amongst the key informants north of Kanona. Further, their presence was corroborated by human wildlife conflict reports received and recorded by DNPW. Recent sightings (September 2019) of lions were recorded in the Kalonje area along the Tazara corridor, where they reportedly attacked livestock. Other areas include Chilonga and Chief Chikwanda area in Mpika. Lions are thought to be using these areas as migratory routes from North Luangwa's protected area network via Bwingi Mfumu Forest Reserve and into Mpika, then back to Mukungule GMA and from Munyamadzi GMA via Mutinondo Wilderness to Kalonje and back. Occurrence areas and potential migration routes are illustrated in Maps 5-20 to 5-22. These accounts of lions in the project area are further corroborated by recent scientific evidence that describes lions as 'sneaky', as they are moving across areas that were previously thought to be inhabitable for them (Curry, 2019).

Hippopotamus (*Hippopotamus amphibius*) – Vulnerable. Almost all the key informants interviewed indicated the presence of hippos in the project area. In the Kanona area, these sightings were further east of the project area, in Chitambo. Others were described as occurring in the rivers at Kalonje, Chilonga, Mpika, Kachimbaya, and Chandeshi flowing through the project area. Occurrence areas are illustrated in Maps 2-20 to 2-22.

Leopard (*Panthera pardus*) – Vulnerable. Very few respondents described leopards as occurring in the project area. Only in Nakonde at the DNPW offices did we encounter a leopard skin confiscated from a poacher. The leopard skin was described as having originated from the Mukalizi area, west of Nakonde. Despite this, leopards were earlier described as being widespread by DNPW (Zgozi and Nyangu, pers. comm., 2019). Leopards will most likely inhabit areas along the riparian forests and in forested areas where baboons and monkeys are found, as this may be their preferred food source. No records of human wildlife conflicts involving leopards were disclosed during the interviews/consultation meetings.

Temminck's Pangolin (*Smutsia temminckii*) – Vulnerable. This is the most widespread African pangolin species. According to the DNPW (pers. comm., 2024), the species is present within the Mungwi area. These are captured for trade.

Puku, Plains Zebra and African Clawless Otter are considered Near Threatened by the IUCN.

Puku (*Kobus vardonii*) – Near threatened. Puku are obligate grazers, occupying grasslands near permanent water within the savannah woodlands and floodplains of south-central Africa. Although associated with wet areas and swamp vegetation, Puku avoids deep-standing water and is ecologically distinct from Lechwe (IUCN SSC Antelope Specialist Group, 2016). In the study area, puku may be encountered in the grasslands and dambos along the Lukulu and Lwitikila rivers and around the Luchembe area (Mwansa, pers. comm., 2019). Their populations are extremely low, given the high levels of encroachment in their habitats.

Plains Zebras (*Equus quagga*) – Near threatened. Zebras tend to be found in mid-productive grasslands in areas where there is the highest green standing crop, selecting areas of the highest grass biomass regardless of quality. Across studies, Plains Zebras were found in open savanna with an abundance of grass and the presence of some trees or open woodland. There are between 8,000 and 16,000 Plains Zebra in Zambia, with populations declining in most protected areas (King and Moehlman, 2016).

African Clawless Otter (*Aonyx capensis*) – Near-threatened. Otters are predominantly aquatic and seldom found far from water. Freshwater is an essential habitat requirement, and it only occurs in marine habitats where there is access to fresh water (Jacques et al., 2021).

Although classified as Least Concern in the IUCN Red-List, the Roan Antelope (*Hippotragus equinus*) is considered Threatened according to an assessment of critical mammals provided in the Fifth National report of Zambia for the Convention on Biological Diversity. The Roan Antelope usually inhabits savannah woodlands and grasslands, where the cover of high grasses and woody plants plays an important role in both grazing and calving. It is a water-dependent grazer and browser (IUCN SSC Antelope Specialist Group, 2017).

2.6.3 Large Mammal Migration Pathways

Despite declining numbers of large game in the study area, large mammals are thought to be making seasonal migrations between the two protected area networks, namely Luangwa and Bangweulu (Curry, 2019; WB, 2009). Their numbers are considered extremely low and are often encountered as problem animals in human wildlife conflicts.

According to consultations with Peter S. Indala and Rhoda N. Kachali from DNPW (Mpika office), there are two large distinct ecosystems around the project area: the Bangweulu swamps ecosystem and the Luangwa valley ecosystem. Both ecosystems see large wildlife migrations within their respective boundaries. There are also records of animal migration between those two large ecosystems, mainly coming from the Luangwa Valley to Bangweulu swamps during dry periods and back to the Luangwa Valley during the wet season. These migrations do not occur yearly as they depend on the quality of grazing resources and the presence of water in the Bangweulu swamps, even in dryer periods. Main migrants include elephants, lions, and buffalos (Kandanga, Zulu & Maimde, pers. comm., 2019). However, the fragmentation of the area has led to a significant decrease in animal movement.

According to our sources, Lavushi Manda National Park was created notably to improve ecological connectivity. The park's current species diversity and abundance are not exceptionally high, but its habitats have been in a transitional rehabilitation phase since its classification as a National Park.

Species described as using the project area as part of their migration routes include lions, hippos, and elephants. Migration for lions mainly occurs in the dry season and is thought to be in response to the scarcity of habitat resources (i.e., water) in the Luangwa protected area network (Mwansa, pers. comm., 2019; Makombe, pers. comm., 2019; Mwimba, pers. comm., 2019; Zulu, Mucleta & Mambwe, pers. comm., 2019). Lions will move from North Luangwa National Park to Mukungule via Bwingi Mfumu Forest Reserve to Mpika and back. They will also move from the North and South Luangwa protected area complex via Munyamadzi GMA to Kalonge. These routes are corroborated by the human wildlife conflict reports recorded in these areas and are schematized in Maps 5-20 to 5-22. The most recent report was at Chilonga, north of Kalonje, in September 2019.

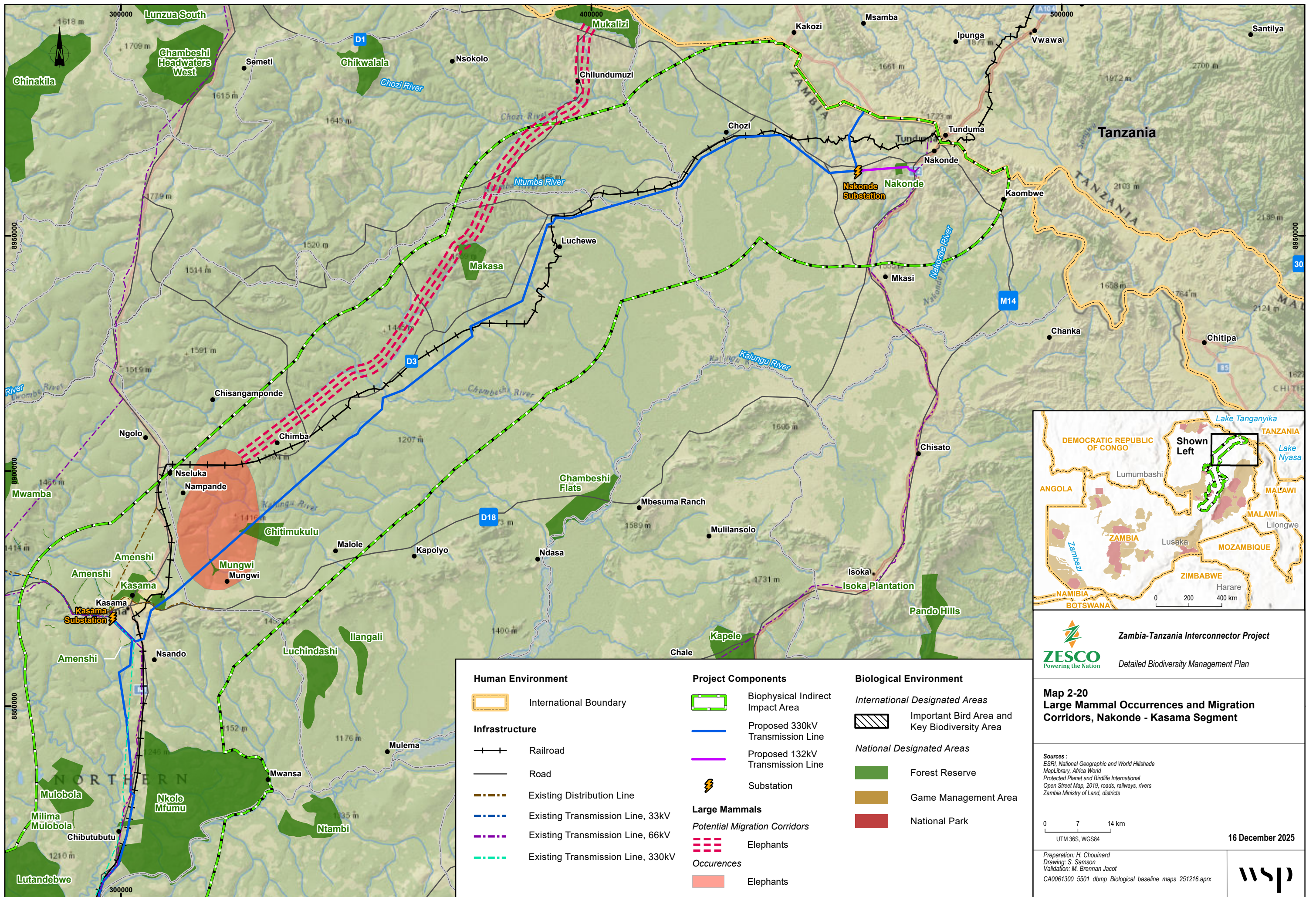
Elephants using the project area as part of their migration routes occur in the northern section of the project area, i.e., between Mukalizi and Mungwi. They are thought to be moving from Nsumbu National Park and the protected area in Tanzania that lies adjacent to Kalambo falls via Mukalizi area in Nakonde en route to Mungwi, as schematized in Maps 5-20 to 5-22. Furthermore, as mentioned above, according to the DNPW (pers. Comm, 2024). elephants have recently been moving from Kasanka NP passing through Kanona Forest Reserve. Elephants are thought to be migrating in response to human influence in areas where humans are heavily settled.

Hippos can be found along the tributaries of major rivers in the project area. Areas where they were mentioned to be present are highlighted in Maps 5-20 to 5-22. These are thought to have daily and monthly migration routes in search of food and water. In areas that are heavily settled, i.e., Kanona, they are extremely rare.

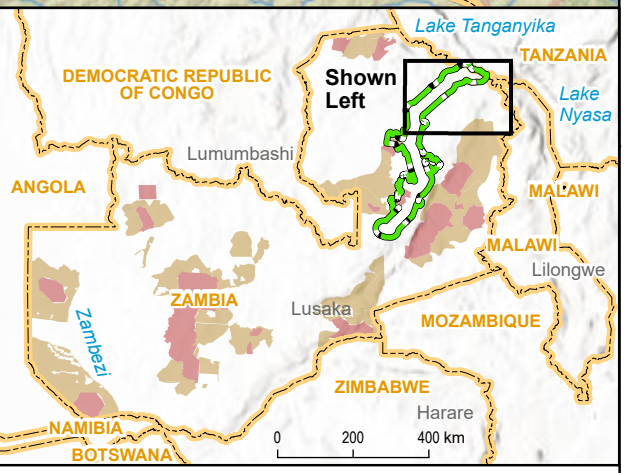
Lechwes (*Kobus leche*) inhabit margins between swamps and shallow floodplains. Lechwes have been reported to aggregate in large numbers (approximately 40,000) in a 100 km² area in the floodplain around Lake Bangweulu during the wet season.

During the dry season, this large aggregation dissolves as small groups disperse into permanent wetlands.

Thus, this aggregation cannot be considered a mass migration with clearly defined migratory routes, such as the wildebeest or zebra migrations (Harris et al., 2009). According to the pattern described above, large lechwe aggregations do not occur in the extended study area. Smaller dispersed groups may use parts of the extended study area in the dry season.



Human Environment	Project Components	Biological Environment
International Boundary	Biophysical Indirect Impact Area	<i>International Designated Areas</i>
Infrastructure	Proposed 330kV Transmission Line	Important Bird Area and Key Biodiversity Area
Railroad	Proposed 132kV Transmission Line	<i>National Designated Areas</i>
Road	Substation	Forest Reserve
Existing Distribution Line	Large Mammals	Game Management Area
Existing Transmission Line, 33kV	<i>Potential Migration Corridors</i>	National Park
Existing Transmission Line, 66kV	Elephants	
Existing Transmission Line, 330kV	Occurrences	
	Elephants	



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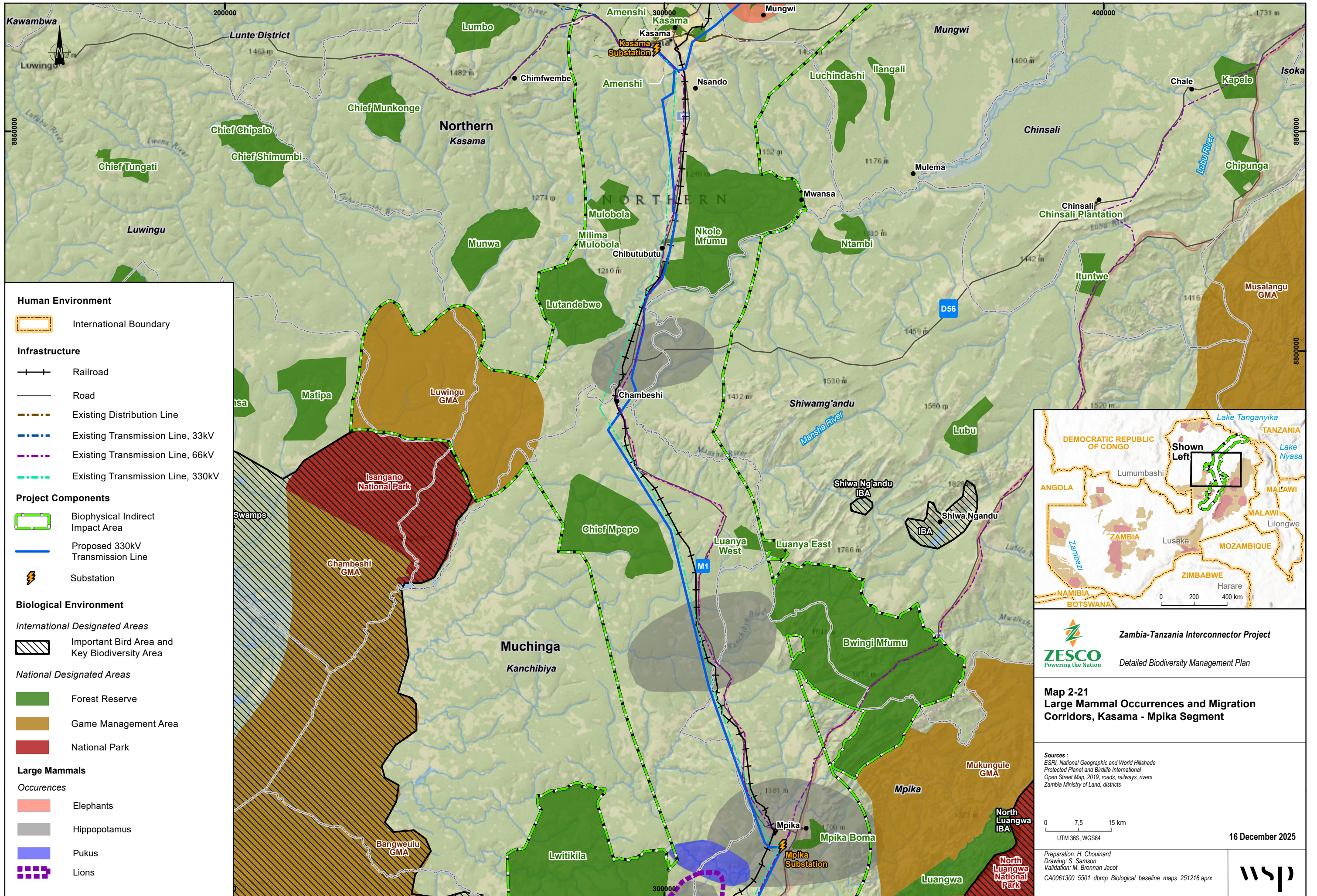
Map 2-20
Large Mammal Occurrences and Migration
Corridors, Nakonde - Kasama Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts

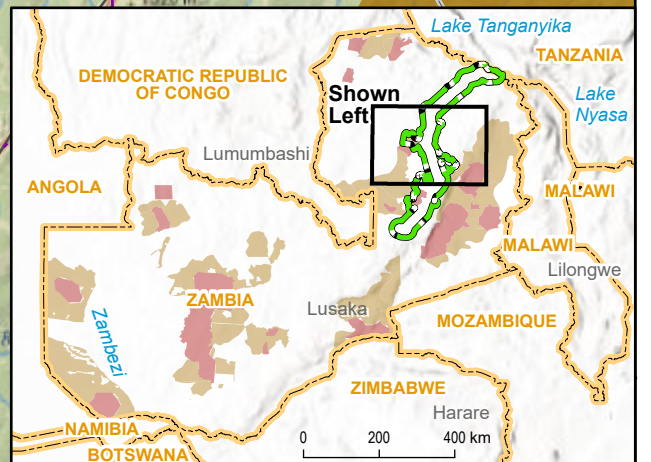
0 7 14 km
 UTM 36S, WGS84
 16 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



- Human Environment**
- International Boundary
- Infrastructure**
- Railroad
 - Road
 - Existing Distribution Line
 - Existing Transmission Line, 33kV
 - Existing Transmission Line, 66kV
 - Existing Transmission Line, 330kV
- Project Components**
- Biophysical Indirect Impact Area
 - Proposed 330kV Transmission Line
 - Substation
- Biological Environment**
- International Designated Areas*
- Important Bird Area and Key Biodiversity Area
- National Designated Areas*
- Forest Reserve
 - Game Management Area
 - National Park
- Large Mammals**
- Occurrences*
- Elephants
 - Hippopotamus
 - Pukus
 - Lions



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Map 2-21
Large Mammal Occurrences and Migration Corridors, Kasama - Mpika Segment

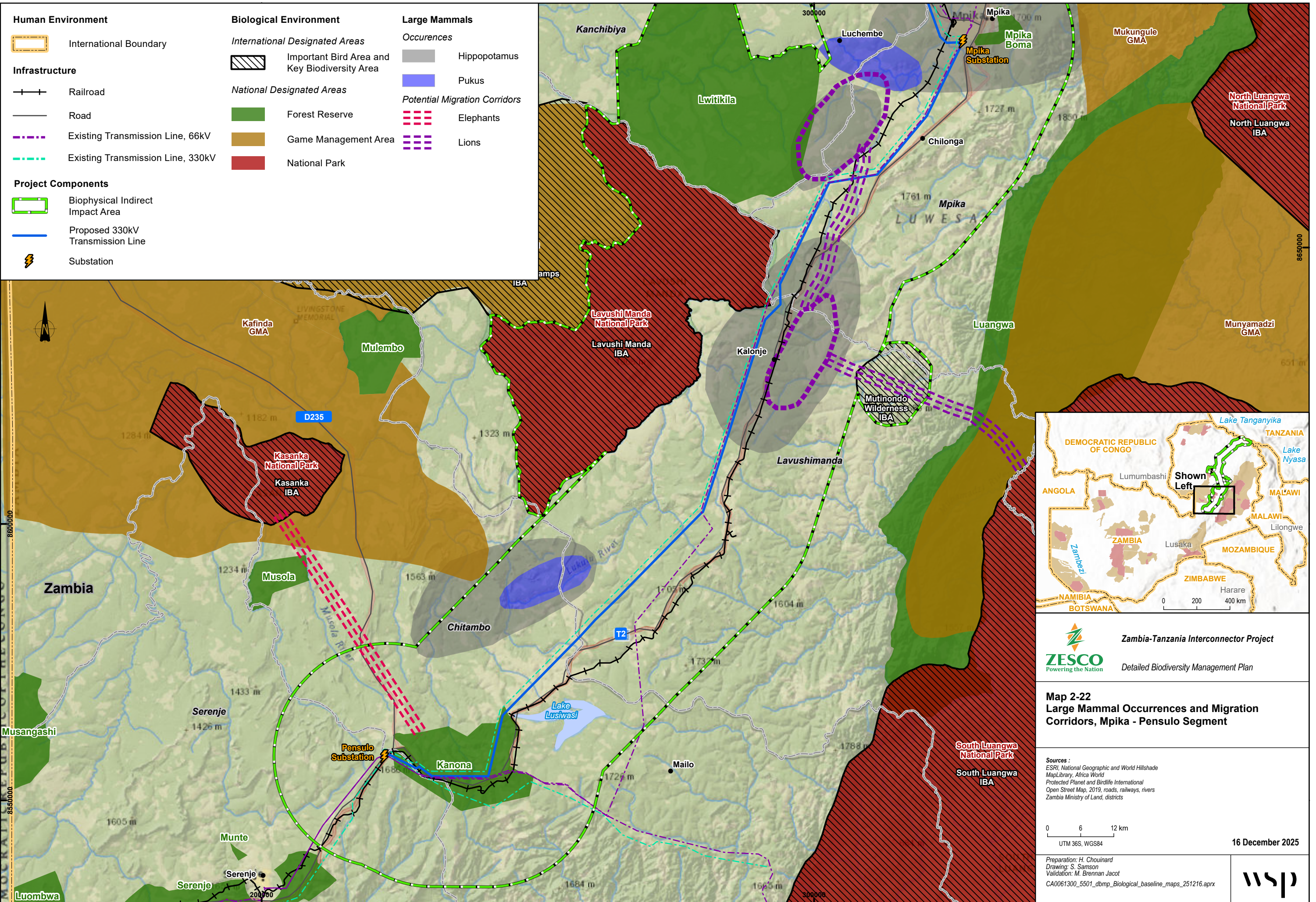
Sources :
 ESRI, National Geographic and World Hillshade
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts

0 7.5 15 km
 UTM 36S, WGS84
 16 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx



Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



- Human Environment**
- International Boundary
- Infrastructure**
- Railroad
 - Road
 - Existing Transmission Line, 66kV
 - Existing Transmission Line, 330kV
- Project Components**
- Biophysical Indirect Impact Area
 - Proposed 330kV Transmission Line
 - Substation

- Biological Environment**
- International Designated Areas*
- Important Bird Area and Key Biodiversity Area
- National Designated Areas*
- Forest Reserve
 - Game Management Area
 - National Park

- Large Mammals**
- Occurrences*
- Hippopotamus
 - Pukus
- Potential Migration Corridors*
- Elephants
 - Lions



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Map 2-22
Large Mammal Occurrences and Migration Corridors, Mpika - Pensulo Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts

0 6 12 km
 UTM 36S, WGS84
 16 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx



Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.

2.6.4 Areas of High Ecological Importance for Terrestrial Mammals

Based on interviews with DNPW (Kandanga, Zulu & Maimde, pers. comm., 2019; Mwansa pers. comm., 2019; Makombe, pers. comm., 2019; Zgozi, pers. comm., 2019; Zulu, Mucleta & Mambwe, pers. comm., 2019), accounts from local communities (WB, 2009) and recent scientific research (Curry, 2019), large mammals occur in extremely low densities and are described as using a combination of habitats including grasslands, miombo woodlands and riparian forests. These habitats may be considered as having a stepping-stone effect, particularly for migratory species, i.e., lions that are now described as ‘sneaky’ as they are moving across areas that were previously thought to be inhabitable for them (Curry, 2019). Given the dependency of predators on prey, it may be reasonable to also expect the presence of other large herbivores, such as buffalo and waterbuck (Mwansa, pers. comm., 2019; Zyozi & Ngangu, pers. comm., 2019), albeit in very low numbers. However, the presence of large carnivores, i.e., lions, particularly those accounted by DNPW (Mwansa, pers. comm., 2019; Makombe, pers. comm., 2019), is mainly associated with livestock predation.

2.7 Herpetofauna

Herpetofauna species within the study area have been described using information collected from a review of existing data and literature, including known occurrences from the GBIF between 2004 and 2024 (GBIF, 2024). Field surveys were also conducted within the study area in March 2025 (wet season) and in August-September 2025 (dry season). Field survey methodology is described in Appendix 2-1. The complete herpetofauna survey sectorial report is available in Appendix 2-14. Locations of herpetofauna survey sites are illustrated on Maps 5-23 to 5-25.

2.7.1 Herpetofauna Species Diversity

During the two field survey periods, a total of 704 herpetofauna observations were made (430 during wet season and 274 during dry season), with 50 taxa recorded, comprising 27 reptile species and 23 amphibian species. This is based on visiting 79 sampling points (40 during wet season and 39 during dry season) across the study area.

The reptile species most frequently encountered were *Lygodactylus angloensis* (Angola Dwarf Gecko; n = 26; Photo 2-18) and *Trachylepis varia* complex (Common Variable Skink n = 25). For amphibians, *Hyperolius nasicus* (Pointed Reed Frog; n = 79; Photo 2-19), and *Phrynobatrachus mababiensis* (Mababe Puddle Frog; n = 65) and were the most observed. This information is summarized in Tables 2-14 and 2-15.

Literature and databases identified an additional 69 reptile species and 39 amphibian species that potentially occur in the study area based on the predicted distribution maps (Pietersen et al., 2021; Channing & Rodel, 2019; IUCN, 2025; iNaturalist, 2025). Therefore, including the results from the field-based survey, 164 herpetofauna species potentially occur within the study area, 87 of which have been confirmed either directly through the present body of field work or can be validated by records on iNaturalist.org. The full species list is available in the sectorial report in Appendix 2-14.

Table 2-14 Reptiles Species Recorded in the Study Area with their Abundance, their Broad-Scale Habitat Association and 2025 IUCN Red List Status

Species name	Common name	IUCN Red List status ¹	Abundance	Habitat type ²					
				Agricultural	Fallow land	Grassland	Riverine forest	Rock outcrop	Woodland
Snakes									
Family: <i>Vipera</i>									
<i>Bitis arietans</i>	Puff Adder	LC	1	E	E	R	E	R	E
Family: <i>Psammophiidae</i>									
<i>Psammophis angolensis</i>	Dwarf Sand Snake	LC	1	E	E	E	E	R	E
Family: <i>Lamprophiidae</i>									
<i>Lycophidion multimaculatum</i>	Spotted Wolf Snake	LC	1	N	N	N	N	E	R
Family: <i>Elapidae</i>									
<i>Naja nigricollis</i>	Black-necked Spitting Cobra	LC	1	E	E	E	E	R	R
Family: <i>Colubridae</i>									
<i>Dispholidus punctatus</i>	Spotted Boomslang	LC	1	E	N	E	E	E	R
<i>Philothamnus angolensis</i>	Western Green Snake	LC	2	E	N	R	R	E	E
<i>Philothamnus heterolepidotus</i>	Slender Green Snake	LC	1	E	N	E	E	R	E
<i>Telescopus semiannulatus</i>	Eastern Tiger Snake	LC	1	E	N	E	E	E	R
Lizards									
Family: <i>Gekkonidae</i>									
<i>Hemidactylus mabouia</i>	Tropical House Gecko	LC	7	E	E	E	E	R	E
<i>Chondrodactylus laevigatus</i>	Button-scaled Gecko	LC	7	E	E	E	N	R	R
<i>Pachydactylus oshaughnessyi</i>	O'Shaughnessy's Thick-tailed Gecko	LC	2	N	N	E	N	E	R

Species name	Common name	IUCN Red List status ¹	Abundance	Habitat type ²					
				Agricultural	Fallow land	Grassland	Riverine forest	Rock outcrop	Woodland
<i>Lygodactylus angolensis</i>	Angola Dwarf Gecko	LC	26	E	E	R	E	E	R
<i>Lygodactylus angularis</i>	Angulate Gecko	LC	10	E	E	R	E	E	E
Family: Scincidae									
<i>Gerrhosaurus intermedius</i>	Eastern Black-lined Plated Lizard	LC	1	N	N	E	N	N	R
<i>Panaspis maculicollis</i>	Spotted-necked Snake-eyed Skink	LC	2	N	N	E	E	E	R
<i>Panaspis wahlbergii</i>	Wahlberg's Snake-eyed Skink	LC	10	N	N	R	E	E	R
<i>Panaspis sp.</i>		-		N	N	R	E	E	R
<i>Mochlus sundevallii</i>	Sundevall's Writhing Skink	LC	3	E	N	E	N	R	R
<i>Trachylepis varia complex</i>	Variable Skink	-	25	R	E	R	R	R	R
<i>Trachylepis wahlbergi</i>	Wahlberg's Striped Skink	LC	10	R	R	E	E	R	R
Family: Lacertidae									
<i>Latastia johnstonii</i>	Johnston's Long-tailed Lizard	LC	1	N	N	E	N	R	E
<i>Meroles squamulosus</i>	Rough-scaled Savanna Lizard	LC	7	E	N	R	N	N	R
Family: Chamaeleonidae									
<i>Chamaeleo dilepis</i>	Flap-necked Chameleon	LC	11	E	N	R	R	R	R
Family: Agamidae									
<i>Acanthocercus cyanocephalus</i>	Western Tree Agama	LC	4	E	N	N	N	E	R
<i>Acanthocercus branchi</i>	Bill's Tree Agama	LC	1	E	N	N	N	E	R
<i>Agama armata</i>	Peter's Ground Agama	LC	8	E	E	R	N	E	R
Family: Pelomedusidae									
<i>Pelusios nanus</i>	Dwarf Hinged Terrapin	NE	2	N	N	R	N	N	N
Family: Testudinidae									
<i>Kinixys spekii</i>	Speke's Hinged Tortoise	LC	1	N	N	E	N	E	R

Notes: 1 LC: Least Concern; NE: Not Evaluated

2 R = Recorded; E = Expected; N = Not Expected

Table 2-15 Amphibian Species Recorded in the Study Area with their Abundance, their Broad-Scale Habitat Association and 2025 IUCN Red List Status

Species name	Common name	IUCN Red List status ¹	Abundance	Habitat type ²					
				Agricultural	Fallow land	Grassland	Riverine forest	Rock outcrop	Woodland
Family: Pipidae									
<i>Xenopus poweri</i>	Power's Clawed Frog	LC	31	R	E	R	E	E	R
<i>Xenopus muelleri</i>	Muller's Clawed Frog	LC	11	R	R	E	E	E	E
Family: Bufonidae									
<i>Sclerophrys pusilla</i>	Southern Flat-backed Toad	LC	13	E	E	R	E	R	R
<i>Schismaderma carens</i>	Red Toad	LC	6	E	E	E	E	R	R
<i>Mertensophryne taitana</i>	Tiata Forest Toad	LC	1	N	N	E	E	R	E
Family: Brevicipitidae									
<i>Breviceps poweri</i>	Power's Rain Frog	LC	2	E	E	E	N	N	R
Family: Hyperoliidae									
<i>Kassina kuvangensis</i>	Kuvango Running Frog	LC	4	E	N	R	E	N	R
<i>Kassina senegalensis</i>	Senegal Running Frog	LC	10	E	N	R	E	E	E
<i>Hyperolius marginatus</i>	Marginated Reed Frog	LC	44	R	E	R	R	E	E
<i>Hyperolius nasicus</i>	Pointed Reed Frog	LC	79	E	N	R	E	E	R
<i>Hyperolius quinquevittatus</i>	Five-striped Reed Frog	LC	42	E	N	R	E	E	R
Family: Arthroleptidae									
<i>Arthroleptis xenodactyloides</i>	Dwarf Squeaker	LC	6	N	N	N	R	E	E
<i>Arthroleptis stenodactylus</i>	Long-fingered Squeaker	LC	23	R	E	R	R	R	R
Family: Phrynobatrachidae									
<i>Phrynobatrachus natalensis</i>	Natal Puddle Frog	LC	32	R	E	R	N	N	E
<i>Phrynobatrachus mababiensis</i>	Mababe Puddle Frog	LC	64	R	E	R	N	N	E
<i>Phrynobatrachus parvulus</i>	Dwarf Puddle Frog	LC	7	R	E	R	N	N	N
<i>Phrynobatrachus rungwensis</i>	Rungwe Puddle Frog	LC	14	E	N	R	N	N	E

Species name	Common name	IUCN Red List status ¹	Abundance	Habitat type ²					
				Agricultural	Fallow land	Grassland	Riverine forest	Rock outcrop	Woodland
Family: Ptychadenidae									
<i>Ptychadena oxyrhynchus</i>	Sharp-nosed Grass Frog	LC	7	E	N	R	N	E	E
<i>Ptychadena taenioscelis</i>	Southern Dwarf Grass Frog	LC	11	E	N	R	N	E	E
<i>Ptychadena anchietae</i>	Anchieta's Grass Frog	LC	10	E	N	R	N	E	E
<i>Ptychadena mutinondoensis</i> *	Mutinondo Grass Frog	NE	10	N	N	E	E	R	E
<i>Ptychadena mascareniensis</i>	Mascarene Grass Frog	LC	7	R	E	R	N	N	E
<i>Ptychadena guibei</i>	Guibe's Grass Frog	LC	19	E	N	R	N	E	E

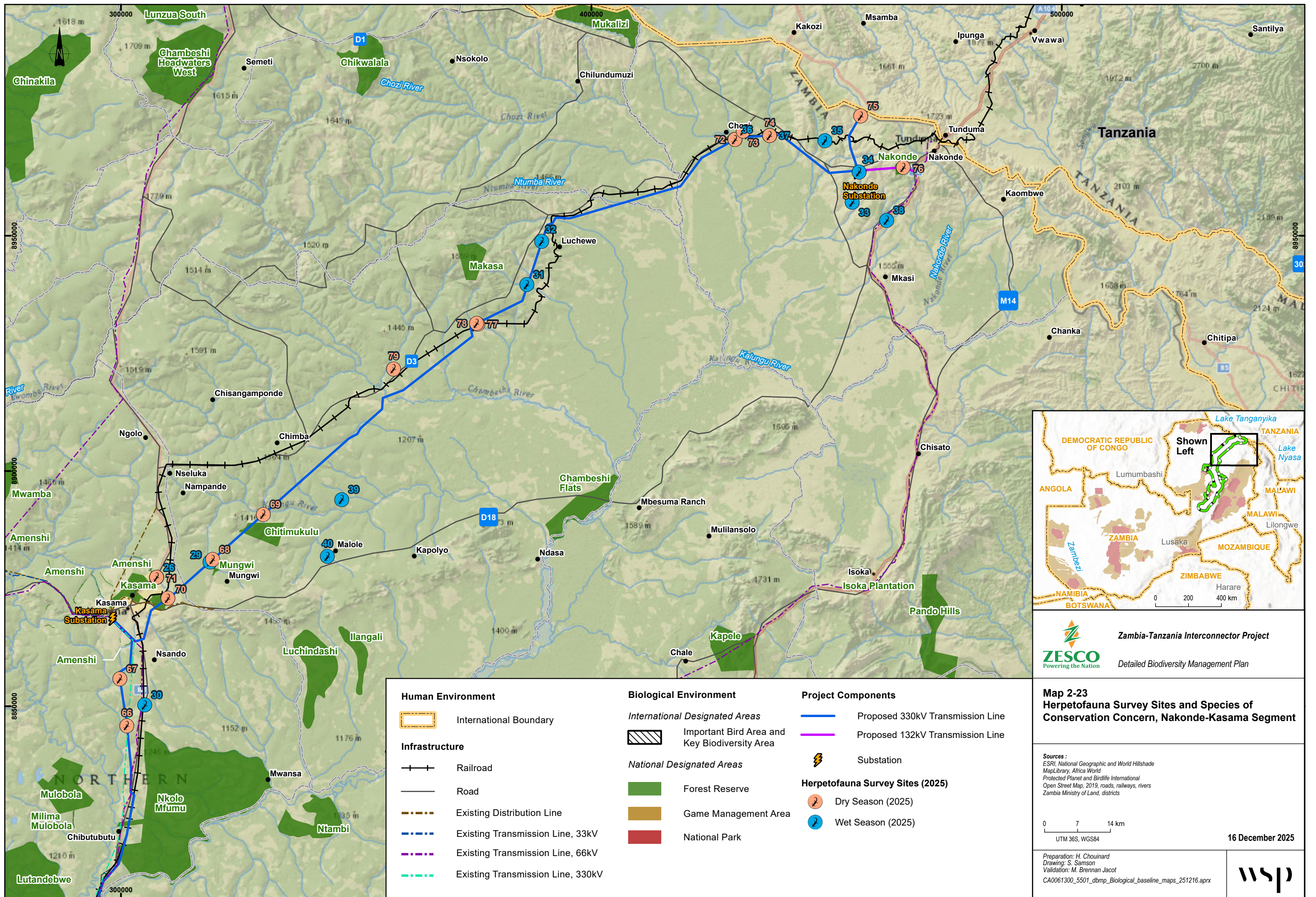
Notes: 1 LC: Least Concern; NE: Not Evaluated
2 R = recorded; E = expected; N = not expected



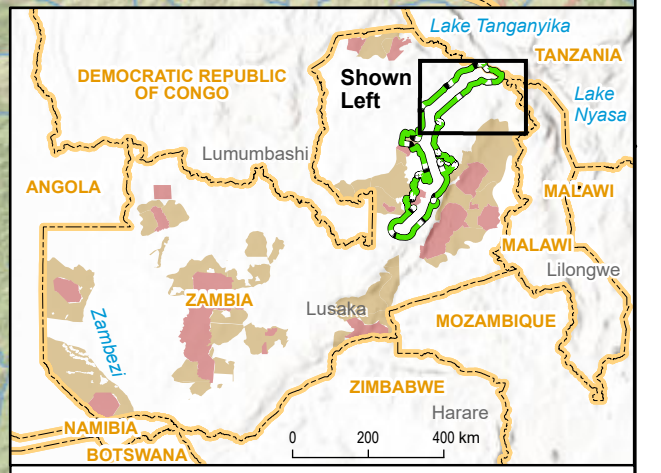
Photo 2-18 Angola Dwarf Gecko (*Lygodactylus angolensis*)



Photo 2-19 Pointed Reed Frog (*Hyperolius nasicus*)



Human Environment	Biological Environment	Project Components
International Boundary	<i>International Designated Areas</i>	Proposed 330kV Transmission Line
Infrastructure	Important Bird Area and Key Biodiversity Area	Proposed 132kV Transmission Line
Railroad	<i>National Designated Areas</i>	Substation
Road	Forest Reserve	Herpetofauna Survey Sites (2025)
Existing Distribution Line	Game Management Area	Dry Season (2025)
Existing Transmission Line, 33kV	National Park	Wet Season (2025)
Existing Transmission Line, 66kV		
Existing Transmission Line, 330kV		



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Map 2-23
Herpetofauna Survey Sites and Species of Conservation Concern, Nakonde-Kasama Segment

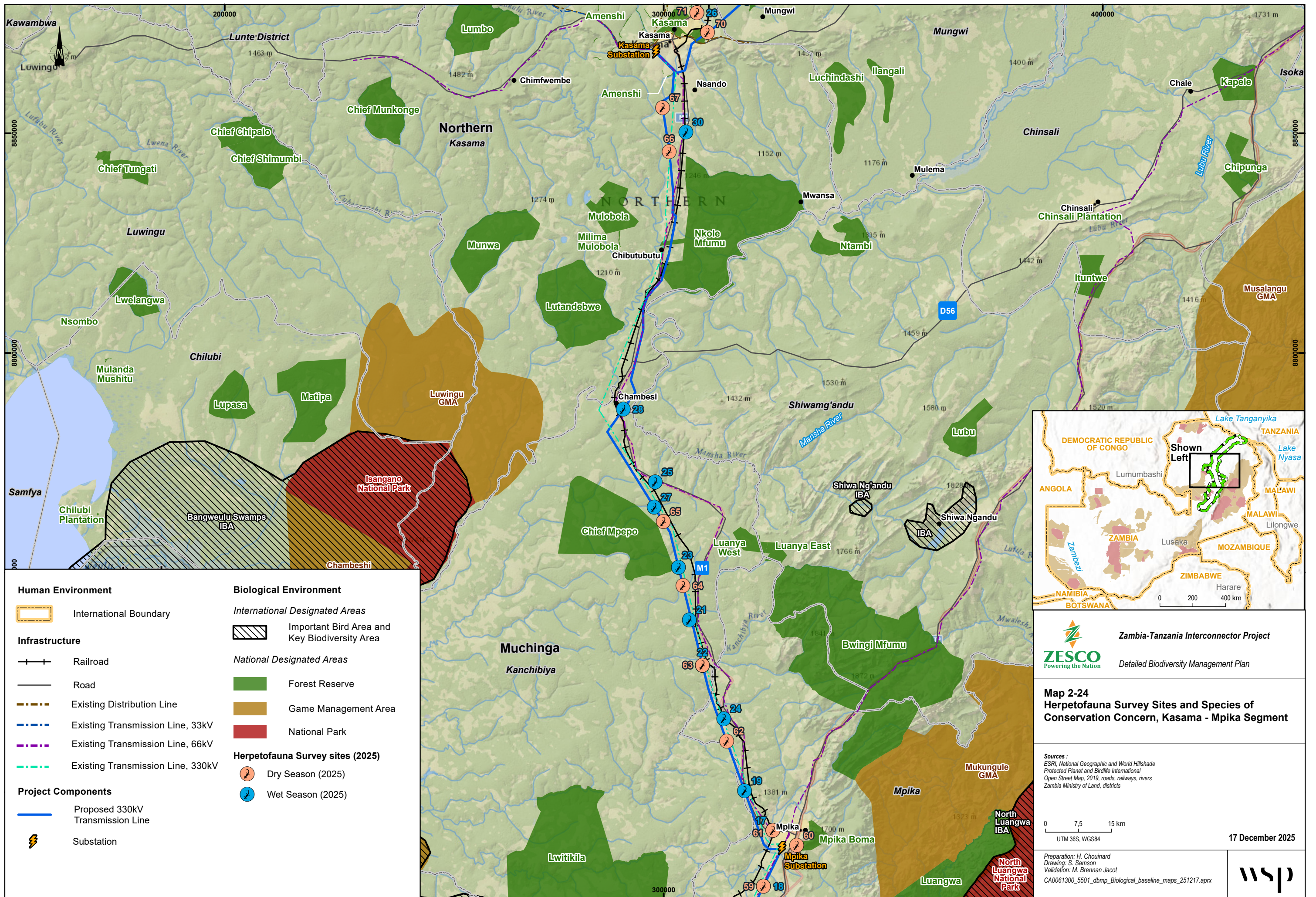
Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts

0 7 14 km
 UTM 36S, WGS84

16 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



Human Environment

International Boundary

Infrastructure

Railroad
 Road
 Existing Distribution Line
 Existing Transmission Line, 33kV
 Existing Transmission Line, 66kV
 Existing Transmission Line, 330kV

Project Components

Proposed 330kV Transmission Line
 Substation

Biological Environment

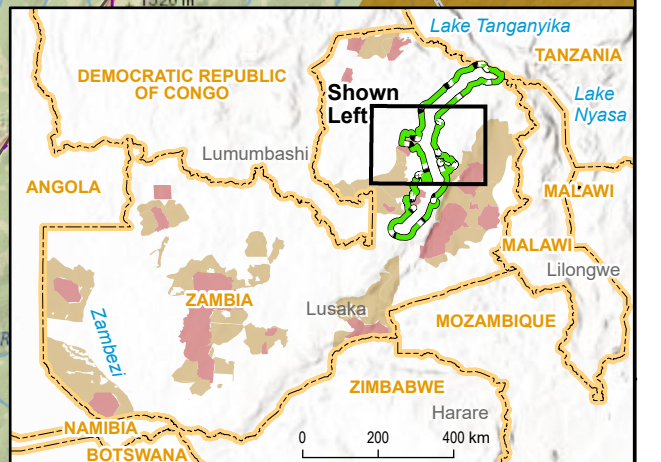
International Designated Areas
 Important Bird Area and Key Biodiversity Area

National Designated Areas
 Forest Reserve
 Game Management Area
 National Park

Herpetofauna Survey sites (2025)

Dry Season (2025)
 Wet Season (2025)

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



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Detailed Biodiversity Management Plan

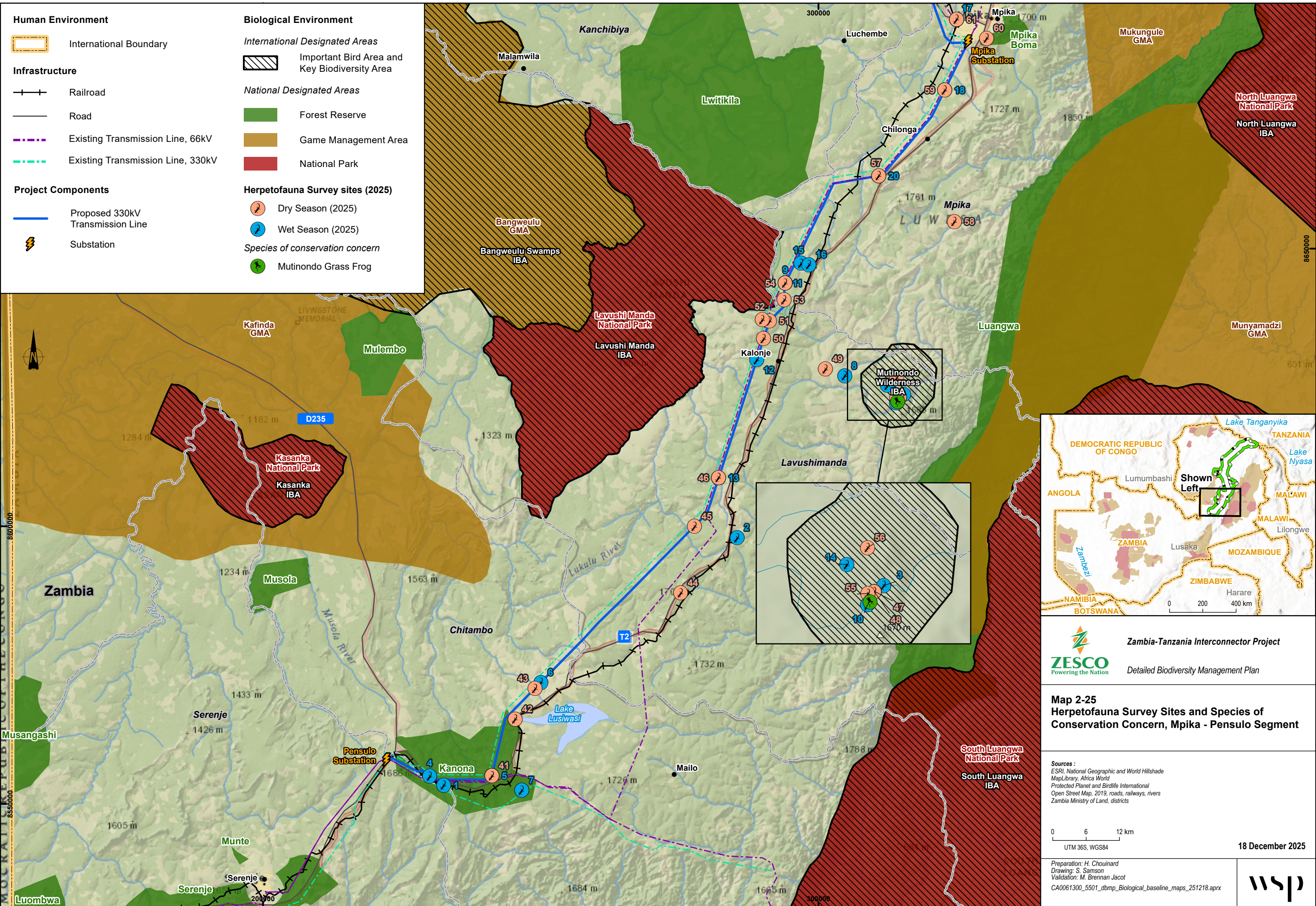
Map 2-24
Herpetofauna Survey Sites and Species of Conservation Concern, Kasama - Mpika Segment

Sources:
 ESRI, National Geographic and World Hillshade
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts

0 7.5 15 km
 UTM 36S, WGS84

17 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251217.aprx



Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



Zambia-Tanzania Interconnector Project
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Map 2-25
Herpetofauna Survey Sites and Species of Conservation Concern, Mpika - Pensulo Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts

0 6 12 km
 UTM 36S, WGS84
 18 December 2025

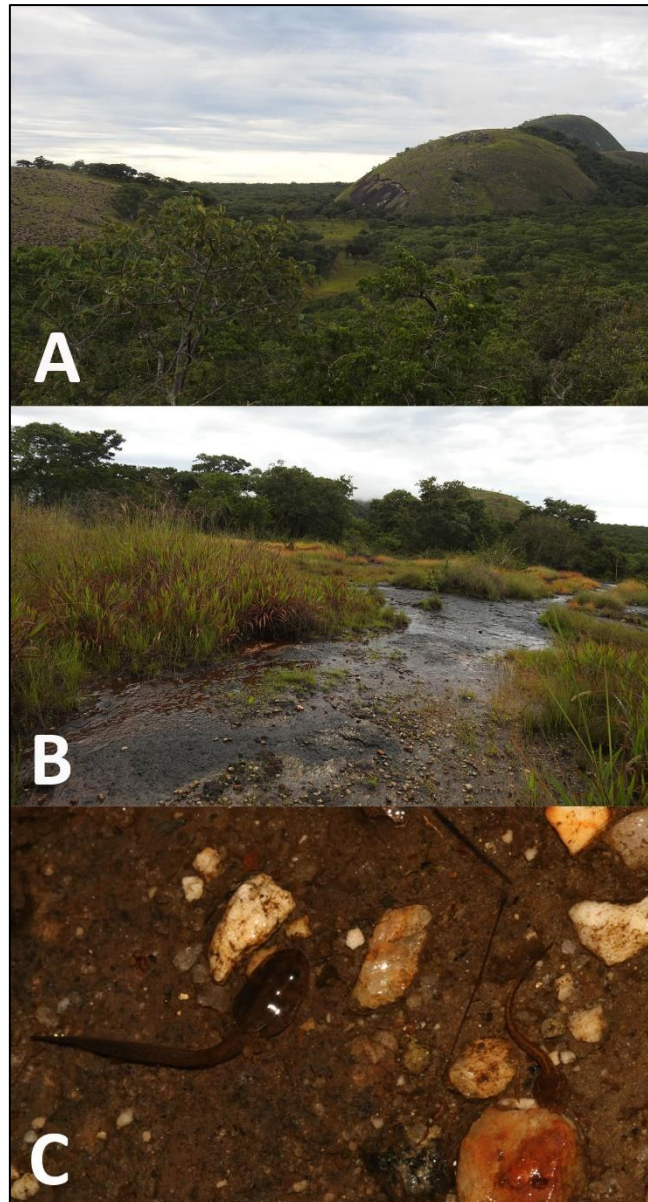
Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251218.aprx



2.7.2 Herpetofauna Species of Conservation Concern

No amphibians recorded or predicted to occur in the study area are currently assigned a higher threat category than Least Concern (LC) by the IUCN (2025). However, *Ptychadena mutinondoensis* (Mutinondo Grass Frog), a recently described Zambian endemic, was recorded during the wet season survey (Figure 2-18). This species is Not Evaluated (NE) by the IUCN but is currently only known from a 25 km² area within Mutinondo Wilderness in the Muchinga Highlands, where it is restricted to granite inselbergs (Channing & Willems 2018). Given its small known range, low population size, and habitat specificity, this species may meet the criteria for Near Threatened (NT) under the IUCN framework. As this species has highly specific habitat requirements, it is unlikely to occur within the Project's Direct Impact Area or powerline wayleave. However, its entire known range falls within the study area, just 25 km from the proposed powerline.

No reptile species with a threat category higher than LC were recorded during the survey. However, several species of conservation concern are likely to occur in the study area based on habitat suitability assessments. Additionally, some predicted species are listed as Data Deficient (DD), a category that has been shown to include a disproportionately high number of threatened species (Howard & Bickford, 2014; Borgelt et al., 2022; Wotherspoon et al., 2024). Therefore, as a precaution, these species are also considered of conservation concern. Threatened and DD reptile species likely to occur in the project area are described below.



Note: A) Granite inselbergs where species is found, B) microhabitat tadpoles live on shallow films of water in seeps on rocks, C) *Ptychadena mutinondoensis* tadpoles feeding on the rock surface

Figure 2-18 *Ptychadena mutinondoensis* (Mutinondo Grass Frog) Habitat

IUCN Threatened or Data Deficient Reptile Species Likely to Occur in the Study Area

Schmidt's Blind Snake (*Afrotyphlops schmidti*) – Data Deficient. This fossorial species is likely widespread in woodland, and forest habitats but is rarely encountered due to its subterranean lifestyle. Its conservation status remains uncertain, but the development of the powerline is unlikely to impact its persistence.

Seydel's Snake-eyed Skink (*Panaspis seydeli*) – Data Deficient. This rare terrestrial skink is known from only four specimens, and it is predicted by Pietersen et al. (2021) to occur in the study area. Although no specimen was recorded during the survey, it is possible that this species is present in the woodlands of the study area.

Gaboon Adder (*Bitis gabonica*) – Vulnerable. A hyper-cryptic species found in forests, dense woodlands, and thickets. Pietersen et al. (2021) indicate its presence in the study area, and there is suitable habitat throughout the study area for this species.

Pancake Tortoise (*Malacochersus tornieri*) – Critically Endangered. This rock-dwelling species has a limited range, extending into the northeastern part of the study area. Suitable rocky habitat was identified in the Nakonde area, though no individuals were recorded. Further surveys are necessary to confirm its presence. Construction activity should avoid heavy clearing of rocky outcrops in Nakonde area to prevent habitat loss for this species.

Zambian Sand Snake (*Psammodon zambiensis*) – Near Threatened. Found in Zambia, Malawi, and the Democratic Republic of Congo, this species likely occurs in dambos, marshes, and wet woodlands in the study area. It is fast-moving and well-camouflaged, making it difficult to detect. The powerline construction is unlikely to impact its persistence.

Zambian Protected Species

Four species of reptiles found in the study area are under special protection by the Zambian Government (Government of Zambia, 1961).

Nile Crocodile (*Crocodylus niloticus*) – Least Concern. While no crocodiles were observed during the survey, suitable river and wetland habitats were identified and this species likely occurs in the larger rivers throughout the study area. Given that powerline construction is unlikely to significantly alter water bodies, this species is unlikely to be impacted.

Southern African Python (*Python natalensis*) – Least Concern. Likely widespread in the study area, occurring in rock outcrops, woodlands, wetlands, and grasslands. The development is not expected to impact its populations.

White-throated Monitor (*Varanus albigularis*) – Least Concern. This species is common in woodlands and rocky areas and is likely to occur within the study area. The powerline construction is unlikely to impact this species.

Water Monitor (*Varanus niloticus*) – Least Concern. Associated with wetlands and expected to be common throughout the study area. No significant impact from the development is anticipated for this species.

2.7.3 Areas of High Ecological Importance for Herpetofauna

Riverine forest and woodland supported the highest reptile diversity, with nearly all recorded species occurring in these habitats. Woodland with thickets was expected to host a broad range of reptiles, particularly snakes and lizards, highlighting its importance for reptile diversity. In contrast, agriculture, fallow land, and grassland exhibited lower observed diversity, with fewer species recorded despite several being expected. This likely reflects the challenges of active searching in these open habitats rather than lower habitat suitability. Woodland with open elements supported a moderate reptile presence, while water-dependent species, such as *Pelusios nanus* (Dwarf Hinged Terrapin), were recorded only in grassland, emphasising its role in providing aquatic and semi-aquatic environments. Rock outcrops, although uncommon in the area, provide habitat to generalist and specialist species.

Overall, the data suggest that woodland habitats are key to reptile diversity, providing higher habitat heterogeneity and structural complexity. Open landscapes and disturbed habitats, such as agriculture and fallow land, support fewer species, likely due to the sensitivity of reptiles to human disturbances such as mechanical clearing, frequent burning, and cultivation.

Grassland and agriculture represent open habitats, often including floodplains, reedbeds, papyrus swamps, and a matrix of cultivated and natural areas. These environments are important for several frog species, particularly *Hyperolius* spp. and *Ptychadena* spp. Riverine forests and dense woodlands support forest-dwelling species such as *Mertensophryne taitana* (Tiata Forest Toad) and *Arthroleptis xenodactyloides* (Dwarf Squeaker), though *Hyperolius* spp. are also present where these habitats transition to waterbodies. Woodlands (including thickets) generally accommodate a wide range of species, including reed frogs (*Hyperolius* spp.), running frogs (*Kassina* spp.), and several *Ptychadena* species. Finally, open woodland areas support a moderate number of species, including *Xenopus*, *Hyperolius*, and *Ptychadena* spp. Their diverse structure makes it suitable for both open-habitat specialists and species requiring more shelter and vegetation cover.

Water-dependent species (*Xenopus*, *Hyperolius*, *Phrynobatrachus* spp.) were recorded across multiple habitats but showed a preference for grassland areas with permanent water, such as dambos, swamps, and the edges of pans and rivers. Forest-associated species depend on dense tree cover and leaf litter, making them particularly vulnerable to frequent burning, which degrades habitat suitability (*Mertensophryne taitana*, *Arthroleptis* spp.). Some species, like *Hyperolius marginatus* (Marginated Reed Frog) and *Hyperolius quinquevittatus* (Five-striped Reed Frog), were widespread across habitats, indicating their adaptability.

Overall, the habitat assessments suggest that riverine forests, grasslands, and woodlands (including thickets) are critical for maintaining frog diversity, yet they are also the most vulnerable to human transformation. Open landscapes, such as grassland, provide important seasonal breeding conditions, particularly during the wet season when temporary waterbodies form. However, field observations indicate that these habitats exhibit some resilience to disturbance.

2.8 Fish

2.8.1 Methodology

Fish species within the study area have been described using information collected from a literature review and review of existing data, including known occurrences from the Global Biological Information Facility between 2004 and 2024 (GBIF, 2024).

2.8.2 Fish Species Diversity

The tropical and sub-tropical regions of southern Africa have higher diversity and lower endemism than the temperate zone. Therefore, several families and genera can be investigated to infer drainage history, mainly associated with the Congo and Zambezian ichthyofaunas (Darwall et al., 2009). Zambia hosts 440 species of freshwater fish (Fishbase, 2024).

A total of 89 species of fish from 14 families are likely to be present within the study area. *Cyprinidae* is the most abundant family, with 28 species, followed by the *Mormyridae*, which has 11 species. The detailed list of species is provided in Appendix 5-14.

2.8.3 Fish Species of Conservation Concern

Among the species potentially present inside the study area, only *Chiloglanis elisabethianus* is considered Vulnerable by the IUCN red list. *Chiloglanis elisabethianus* is a benthopelagic species. It is oviparous and has a distinct pairing during breeding. It is known from the outer range of the upper Congo River basin so that the BIIA would be at the limit of its range (Moelants, 2010).

2.9 Critical Habitat Assessment

WB ESS 6 requires critical habitat identification to manage risks and avoid, mitigate, and offset impacts to areas with high biodiversity value. The biodiversity value of an area, as determined by species, ecosystems, and ecological processes, is referred to as a modified, natural, or critical habitat. Critical habitats are a subset of modified or natural habitats. In accordance with ESS 6, the project's objective in critical habitat is to avoid measurable adverse impacts on the biodiversity values for which the habitat is designated and to achieve a demonstrable net gain in those values. This BMP therefore combines avoidance and minimization measures with habitat enhancement and compensation actions whose performance will be tracked through measurable indicators (e.g. population trends, habitat quality scores and threat-reduction metrics) over time.

Critical habitats are areas with high biodiversity value, including:

- Criteria 1: habitat of significant importance to Critically Endangered (CR) and/or Endangered (EN) species;
- Criteria 2: habitat of significant importance to endemic and/or restricted-range species;
- Criteria 3: habitat supporting globally significant concentrations of migratory species and/or congregatory species;
- Criteria 4: highly threatened and/or unique ecosystems; and/or
- Criteria 5: ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described in above criteria.

According to ESS 6, on areas of critical habitat, the Borrower will not implement any project activities that have potential adverse impacts unless all of the following conditions are met:

a) No other viable alternatives within the region exist for development of the project in habitats of lesser biodiversity value;

(b) All due process required under international obligations or national law that is a prerequisite to a country granting approval for project activities in or adjacent to a critical habitat has been complied with;

(c) The potential adverse impacts, or likelihood of such, on the habitat will not lead to measurable net reduction or negative change in those biodiversity values for which the critical habitat was designated;

(d) The project is not anticipated to lead to a net reduction in the population of any Critically Endangered, Endangered, or restricted-range species, over a reasonable time period;

(e) The project will not involve significant conversion or significant degradation of critical habitats.

(f) The project's mitigation strategy will be designed to achieve net gains of those biodiversity values for which the critical habitat was designated; and

(g) A robust and appropriately designed, long term biodiversity monitoring and evaluation program aimed at assessing the status of the critical habitat is integrated into the Borrower's management program.

The detailed critical habitat assessment (CHA) is presented in Appendix 2-16. All species present or potentially present in the BIIA, including species observed during surveys and species in the GBIF database, were screened against criteria 1 to 3 using the IUCN Red List of Threatened Species for criterion 1, the Living National Treasures (2023) checklist and checklist of Zambia vascular plants (Phiri, 2005) for criterion 2, and the BirdLife International database and IUCN Red List for criterion 3. Because ESS 6 provides high-level criteria but limited procedural guidance on critical habitat determination, the CHA adopts IFC Performance Standard 6 (2012) and Guidance Note 6 (2019) as good international industry practice.

Candidate species and ecosystems were assessed within Ecologically Appropriate Areas of Analysis against IFCMs Guidance Note 6 quantitative and semi-quantitative thresholds, and critical habitat polygons were then delineated within the DIA and BIIA using habitat mapping and species' ecological requirements as the basis for the BMP's avoidance, mitigation, monitoring and net-gain measures.

Candidate biodiversity values screened for critical habitat included 2 CR species, 7 EN species, 5 VU species, 4 endemic/restricted range species, and 123 migratory and/or congregatory species, noting that some species are screened under multiple criteria.

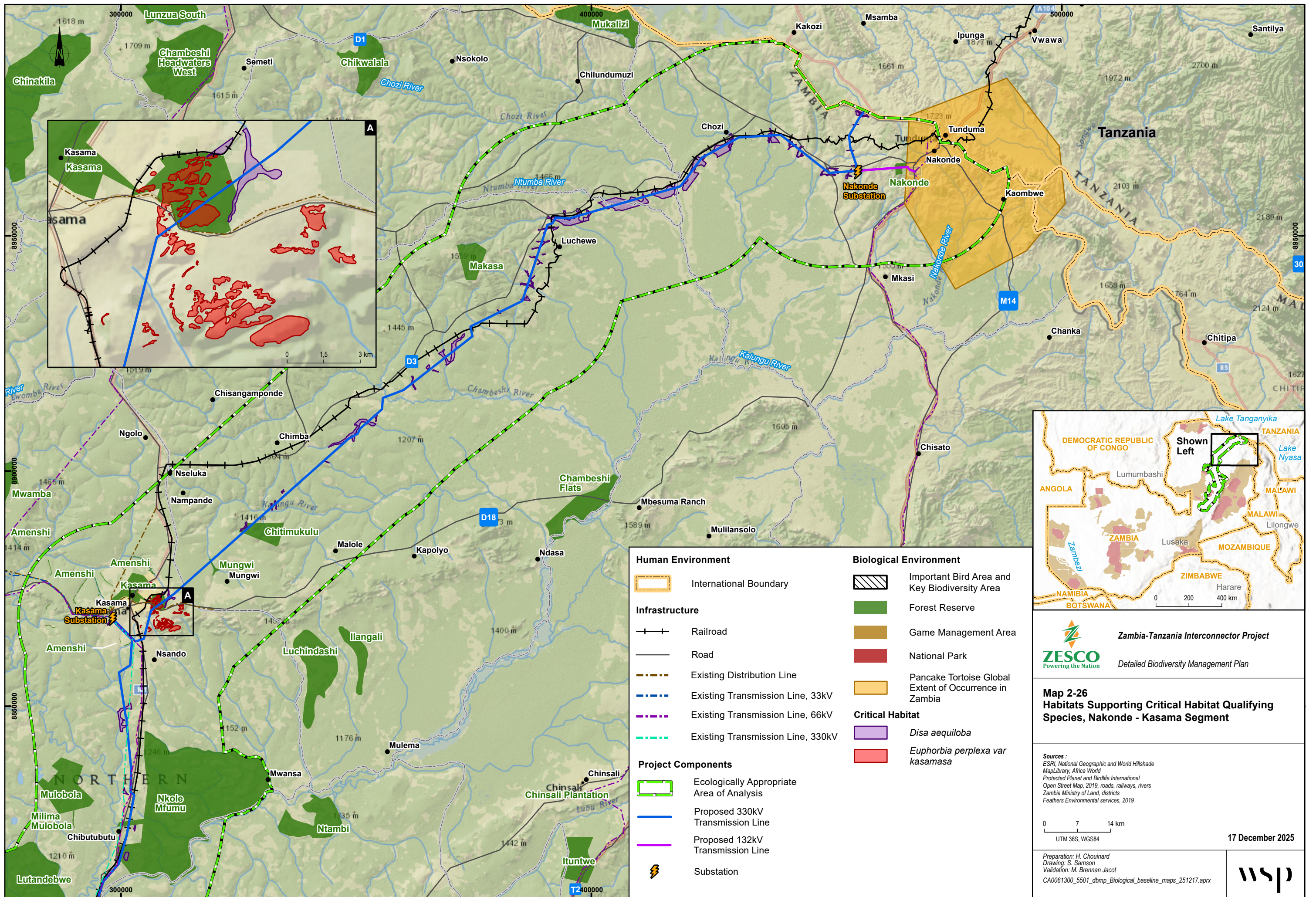
Natural habitats in the BIIA were screened against criterion 4. Lastly, broader landscape units were screened against criterion 5, taking into consideration the outcome of screenings for criteria 1 through 4.

Of the 19 species assessed in detail under criteria 1, 2 and 3, four flora species and one frog trigger critical habitat. Habitats supporting critical habitat qualifying species are shown in Maps 2-26 to 2-28 and include:


- Miombo woodland within Mutinondo Wilderness Area (Map 2-28) and Bwingi Fumu Forest Reserve (Map 2-27) for Schmitz's Cycad. The distribution of this critical habitat does not intersect the Project DIA;
- Wetlands occupied by *Disa aequiloba*, and other natural, mainly undisturbed, wetlands (dambos) (Map 2-26);
- Rock outcrop in the Kasama Forest Reserve and its surrounding for *Euphorbia perplexa* var *kasamasa* (Map 2-26);
- Thin soils and rock crevices in the Muchincha Escarpment in Serenje for *Gladiolus serenjensis*. The distribution of this critical habitat does not intersect the Project DIA. Refer to Map 2-28 and 2-29 for the location of the Muchinga Escarpment;
- Rock outcrops in Mutinondo Wilderness for Mutinondo Grass Froghe distribution of this critical habitat does not intersect the Project DIA;
- Rocky hills and rock outcrops within the Pancake Tortoise EOO, which is in the northernmost area of the Nakonde District (Map 2-27). There are no rock outcrops or rocky hills in the portion of the transmission line corridor that intersects the Pancake Tortoise EOO; therefore, the distribution of this critical habitat does not intersect the Project DIA.

Also, Lavushi Manda National Park and Mutinondo Wilderness were identified as critical habitat under criterion 5. The critical habitats located within the DIA are:

- Wetlands occupied by *Disa aequiloba*, and other natural, mainly undisturbed, wetlands (dambos).
- Rock outcrop in the Kasama Forest Reserve and its surroundings for *Euphorbia perplexa* var. *kasamasa*.



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Map 2-26
Habitats Supporting Critical Habitat Qualifying Species, Nakonde - Kasama Segment

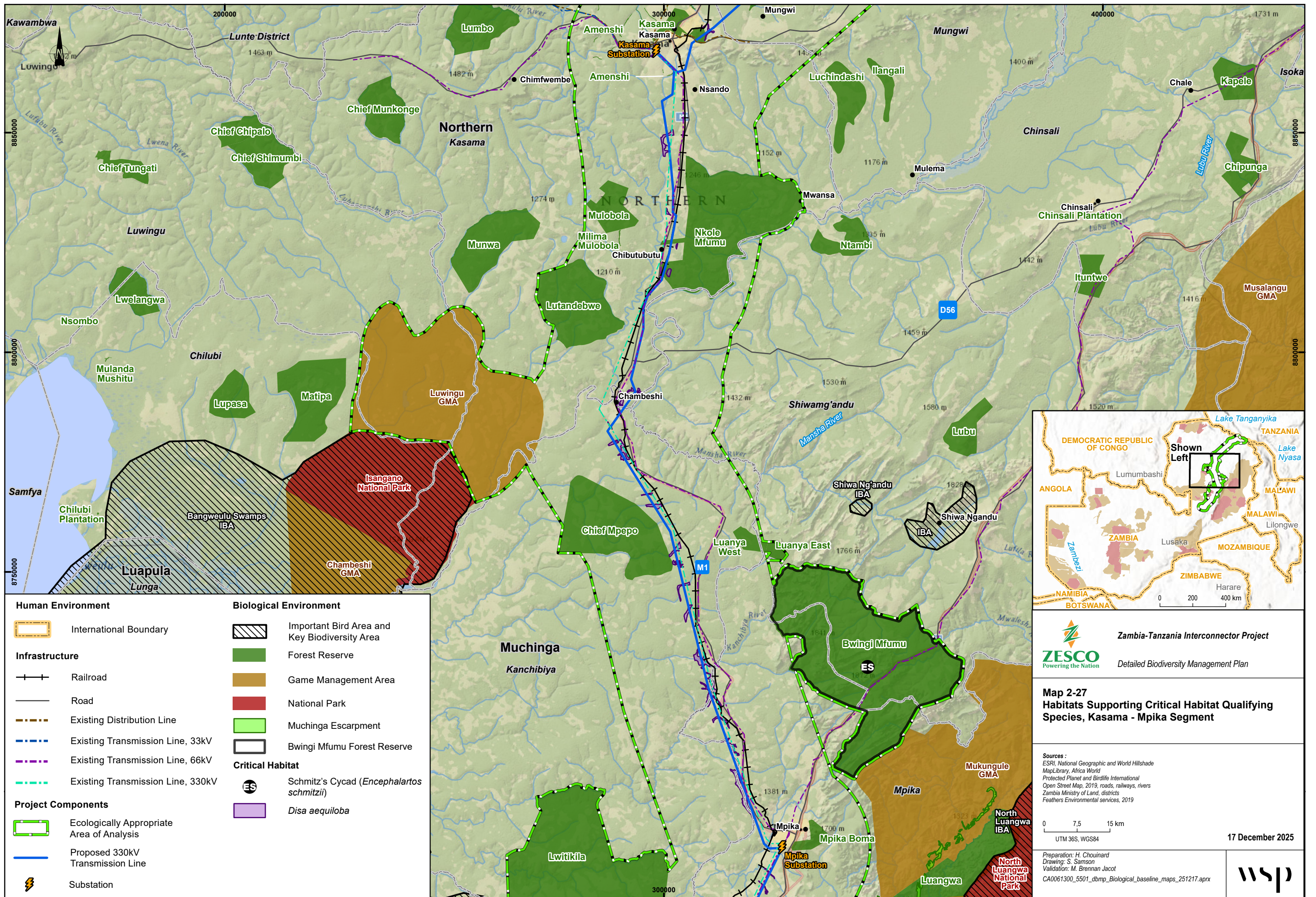
Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

0 7 14 km
 UTM 36S, WGS84

17 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251217.aprx





Human Environment

International Boundary

Infrastructure

Railroad
 Road
 Existing Distribution Line
 Existing Transmission Line, 33kV
 Existing Transmission Line, 66kV
 Existing Transmission Line, 330kV

Project Components

Ecologically Appropriate Area of Analysis
 Proposed 330kV Transmission Line
 Substation

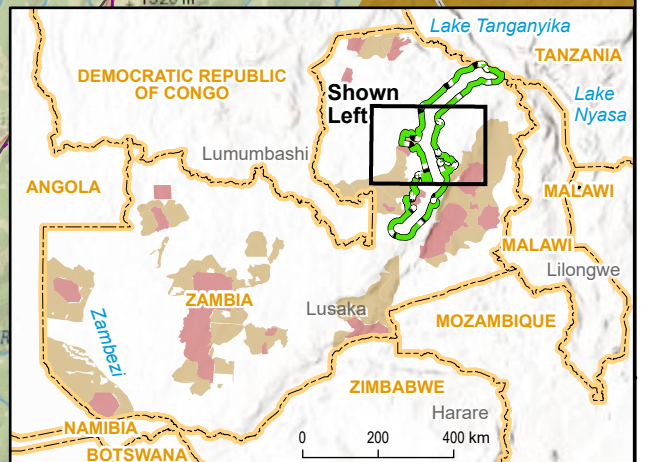
Biological Environment

Important Bird Area and Key Biodiversity Area
 Forest Reserve
 Game Management Area
 National Park
 Muchinga Escarpment
 Bwingi Mfumu Forest Reserve

Critical Habitat

Schmitz's Cycad (*Encephalartos schmitzii*)
Disa aequiloba

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



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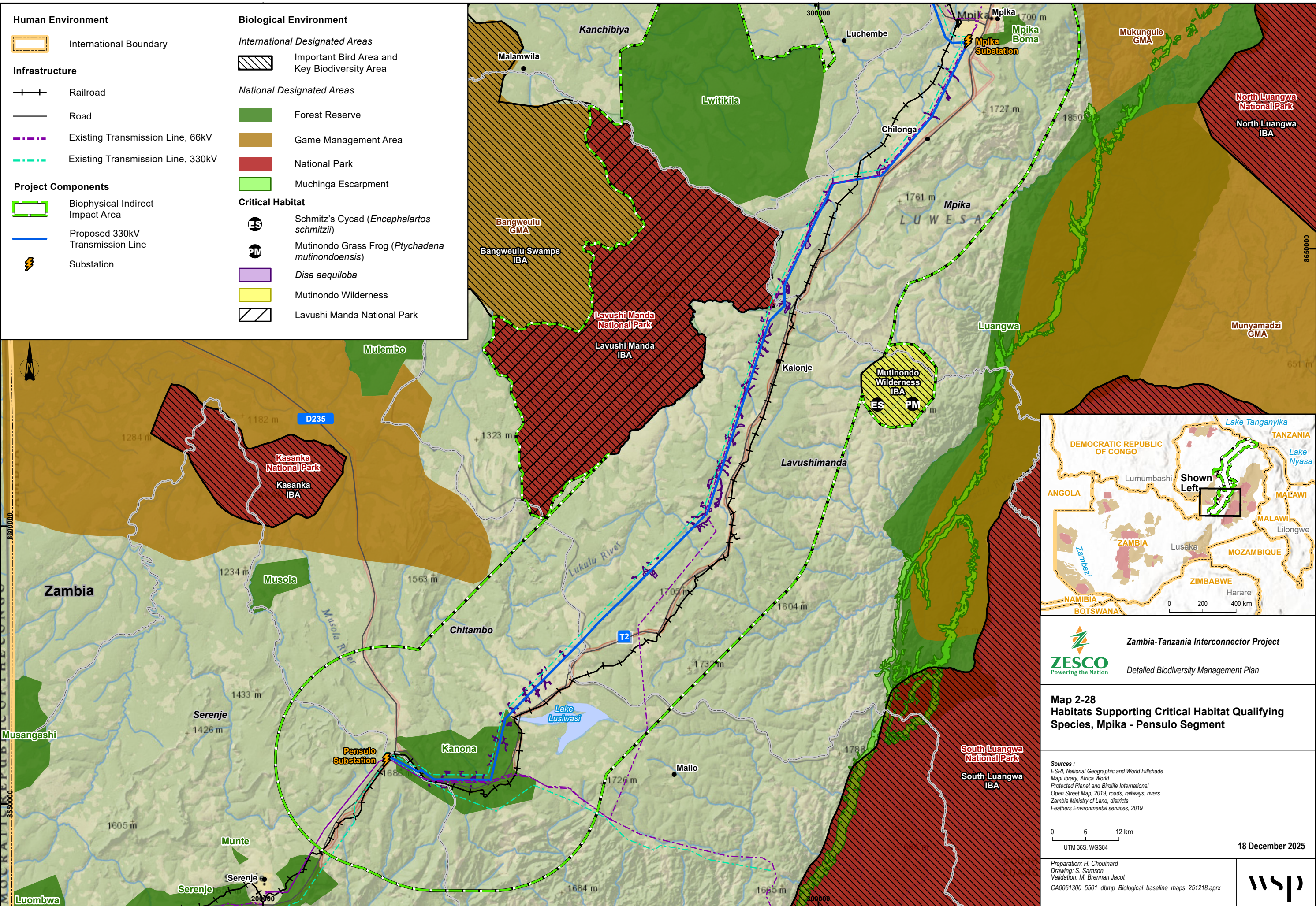
Map 2-27
Habitats Supporting Critical Habitat Qualifying Species, Kasama - Mpika Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and BirdLife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

0 7.5 15 km
 UTM 36S, WGS84
 17 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251217.aprx





- Human Environment**
- International Boundary
- Infrastructure**
- Railroad
 - Road
 - Existing Transmission Line, 66kV
 - Existing Transmission Line, 330kV
- Project Components**
- Biophysical Indirect Impact Area
 - Proposed 330kV Transmission Line
 - Substation

- Biological Environment**
- International Designated Areas*
- Important Bird Area and Key Biodiversity Area
- National Designated Areas*
- Forest Reserve
 - Game Management Area
 - National Park
 - Muchinga Escarpment
- Critical Habitat**
- Schmitz's Cycad (*Encephalartos schmitzii*)
 - Mutinondo Grass Frog (*Ptychadena mutinondoensis*)
 - Disa aequiloba*
 - Mutinondo Wilderness
 - Lavushi Manda National Park



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Map 2-28
Habitats Supporting Critical Habitat Qualifying Species, Mpika - Pensulo Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and BirdLife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 Feathers Environmental services, 2019

0 6 12 km
 UTM 36S, WGS84
 18 December 2025

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
 CA0061300_5501_dbmp_Biological_baseline_maps_251218.aprx



Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.

2.9.1 Targeted Surveys for Critical Habitat Qualifying Flora Species

Targeted flora surveys were completed to better understand the distribution and potential impacts of the project on the two critical habitat qualifying species found in the DIA: *Disa aequiloba*, an endangered orchid species, and *Euphorbia perplexa* var. *kasamana*, an endemic succulent with a restricted range. Results are summarized below.

2.9.1.1 *Disa aequiloba*

Specific surveys were conducted to determine the presence and distribution of *Disa aequiloba* in February and March 2025 in wetlands along the ZTIP (see Photo 2-20). Results are summarized below, and the detailed sectorial report can be found in Appendix 2-5.

A total of 150 wetlands were identified through satellite imagery analysis along the ZTIP line route. Fifty of these wetlands were identified as potential habitats for *Disa aequiloba*, based on how pristine or intact they are. A total of 33 sites were prioritised and surveyed. The surveyed wetlands were all found to host a number of orchid species including the species of interest.

Out of 33 wetlands surveyed, 16 were found to have *Disa aequiloba* in them. The rest had other orchid species sometimes growing in association with *Disa aequiloba*, including: *Brachycorythis buchmanii*, *Disa welwitschii*, *Eulophia cucliata*, *E. latilobilis*, *Habenaria amoena*, *H. disparilis*, *H. macrura*, *H. zambesina*, *Platycoryne crocea*, *Satyrium trinerve*. Results by districts are presented in Table 2-16. Wetlands where *Disa aequiloba* presence was confirmed are illustrated in Maps 2-29 to 2-31.

Table 2-16 Occurrence and Average Number of *Disa aequiloba* and Other Orchids in Transects in Districts and Wetlands Surveyed

District	Number of wetlands surveyed	Number of wetlands with <i>Disa aequiloba</i>	Average number of <i>Disa aequiloba</i> per transect*	Average number of other orchids per transect
Serenje/Chitambo	6	0	0	5
Lavushi Manda	4	3	1	20
Mpika	4	3	5	8
Kachibiya	6	4	2	3
Kasama	2	0	0	4
Mungwi	8	4	2	7
Nakonde	3	2	1	5
Total	33	16	11	52

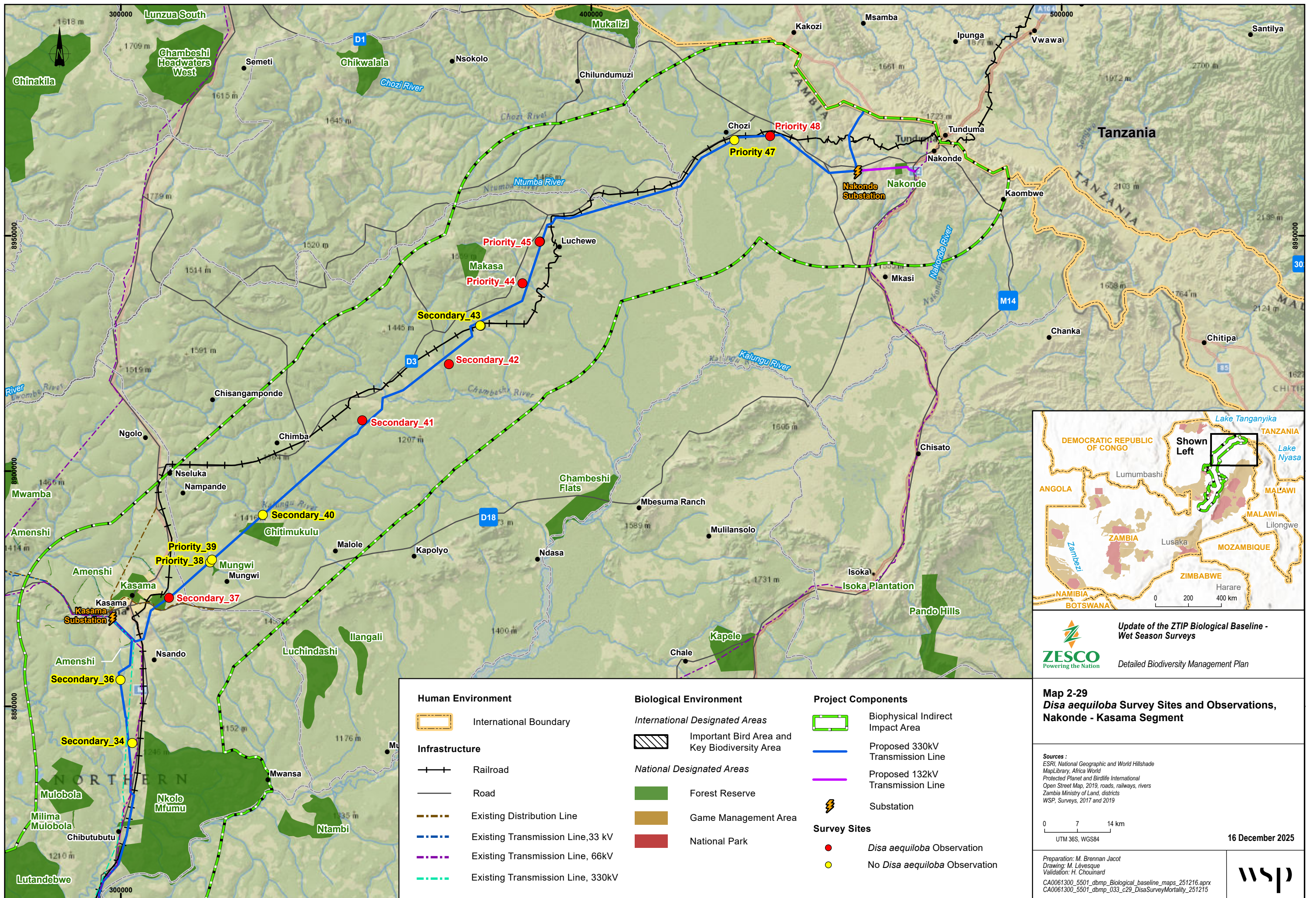
Note: * Average number of orchid plants in a transect was calculated by adding all the orchid plants in the transects assessed in all wetlands in each district divided by total number of transects.

Out of all the districts in which wetlands were surveyed, only two, Serenje and Kasama were found not to host *Disa aequiloba*. Lavushi Manda, Mpika and Kachibiya were found to have wetlands with the most occurrence of *Disa aequiloba*, compared to wetlands which were found in Kasama, Serenje, Mungwi and Nakonde. Although the wetlands in the three districts were affected by the same kind of disturbances, the areas in the three districts with the most *Disa aequiloba* appeared to have fewer people and in some cases the wetlands were less accessible, which appeared to favour growth and survival of orchids in general.

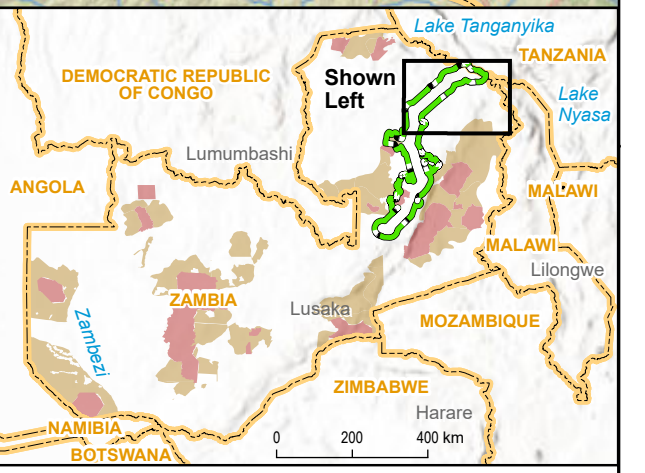
A number of wetland disturbance regimes were identified and sampled for during the field survey. These included: cultivation, draining or creation of canals, fires, excavation of wells or sand, compaction, digging of fish ponds, creation of vegetation or earthen impoundments. The disturbance regimes affected growth and survival of orchids and isolation of disturbed areas gave an idea of where orchids could be found.



Photo 2-20 *Disa aequiloba* Specimen



Human Environment	Biological Environment	Project Components
International Boundary	<i>International Designated Areas</i>	Biophysical Indirect Impact Area
Infrastructure	Important Bird Area and Key Biodiversity Area	Proposed 330kV Transmission Line
Railroad	<i>National Designated Areas</i>	Proposed 132kV Transmission Line
Road	Forest Reserve	Substation
Existing Distribution Line	Game Management Area	Survey Sites
Existing Transmission Line, 33 kV	National Park	<i>Disa aequiloba</i> Observation
Existing Transmission Line, 66kV		No <i>Disa aequiloba</i> Observation
Existing Transmission Line, 330kV		



Update of the ZTIP Biological Baseline - Wet Season Surveys
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Map 2-29
***Disa aequiloba* Survey Sites and Observations, Nakonde - Kasama Segment**

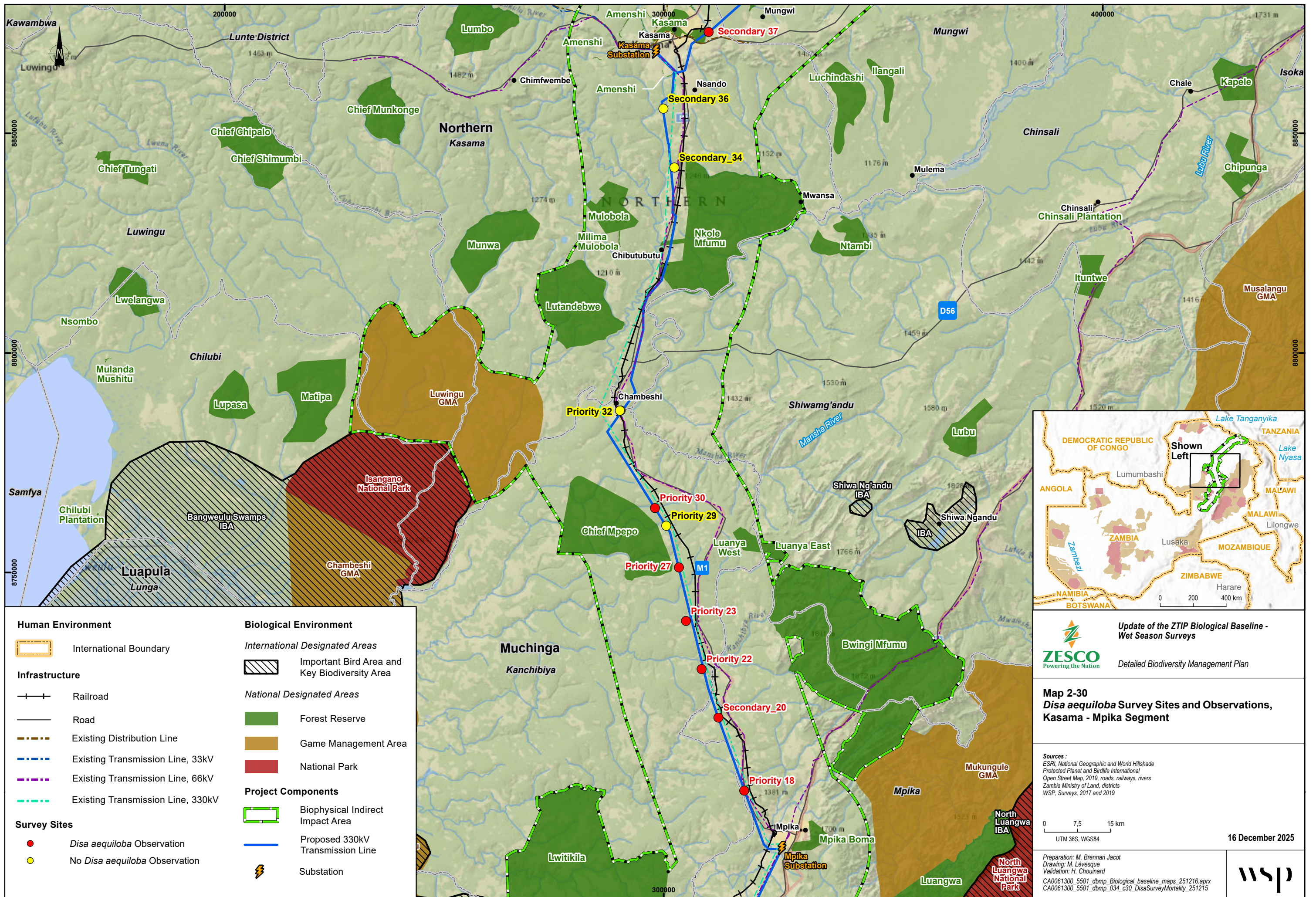
Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 WSP, Surveys, 2017 and 2019

0 7 14 km
 UTM 36S, WGS84

16 December 2025

Preparation: M. Brennan Jacot
 Drawing: M. Lévesque
 Validation: H. Chouinard
 CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx
 CA0061300_5501_dbmp_033_c29_DisaSurveyMortality_251215

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



Human Environment

International Boundary

Infrastructure

Railroad
 Road
 Existing Distribution Line
 Existing Transmission Line, 33kV
 Existing Transmission Line, 66kV
 Existing Transmission Line, 330kV

Survey Sites

Disa aequiloba Observation
 No *Disa aequiloba* Observation

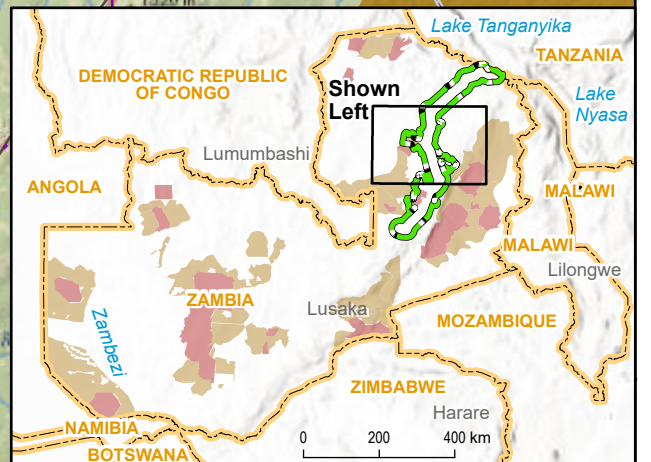
Biological Environment

International Designated Areas
 Important Bird Area and Key Biodiversity Area

National Designated Areas
 Forest Reserve
 Game Management Area
 National Park

Project Components

Biophysical Indirect Impact Area
 Proposed 330kV Transmission Line
 Substation



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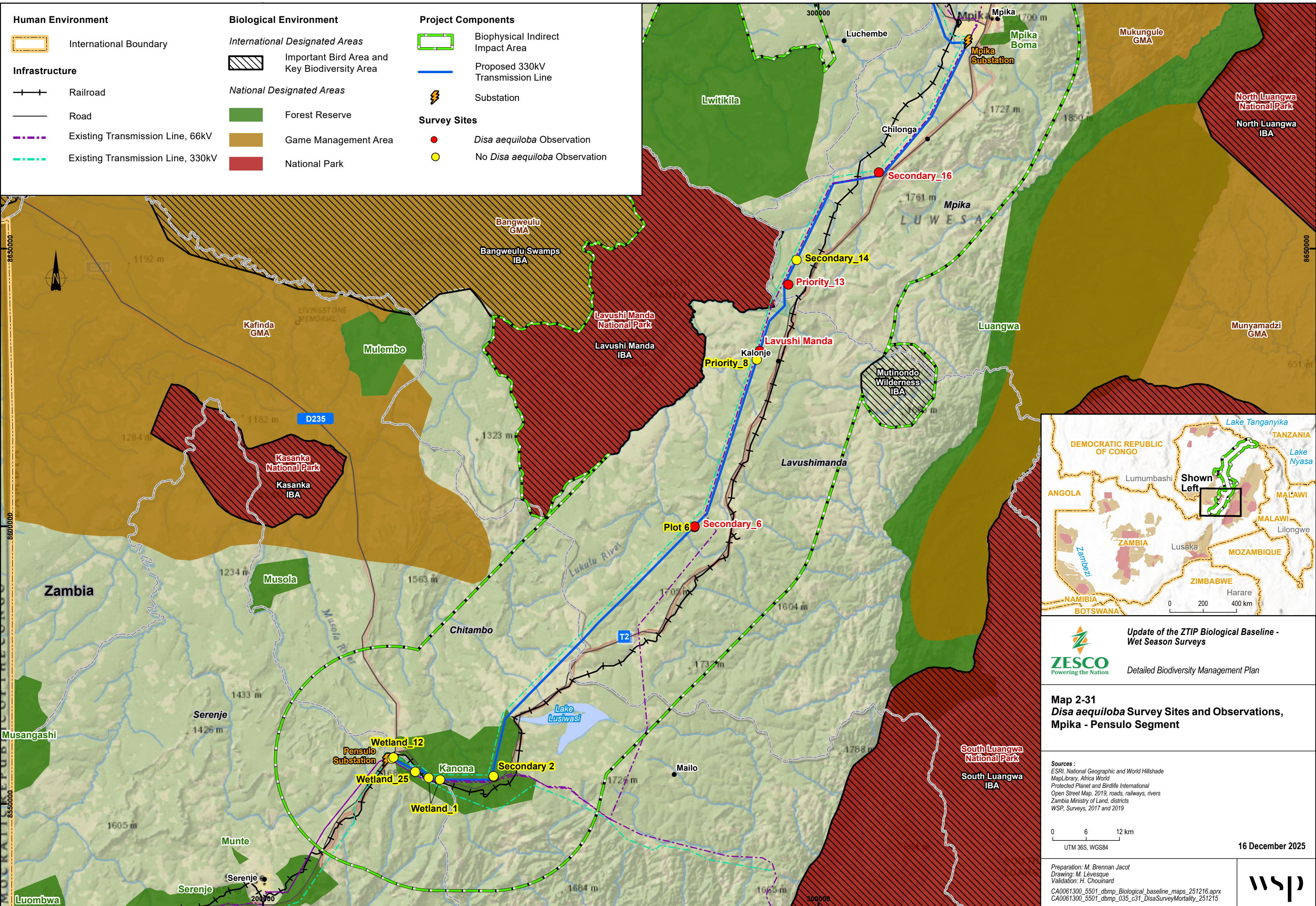
Map 2-30
Disa aequiloba Survey Sites and Observations, Kasama - Mpika Segment

Sources :
 ESRI, National Geographic and World Hillshade
 Protected Planet and BirdLife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts
 WSP, Surveys, 2017 and 2019

0 7.5 15 km
 UTM 36S, WGS84
 16 December 2025

Preparation: M. Brennan Jacot
 Drawing: M. Lévesque
 Validation: H. Chounard
 CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx
 CA0061300_5501_dbmp_034_c30_DisasurveyMortality_251215

Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



Human Environment	Biological Environment	Project Components
International Boundary	<i>International Designated Areas</i>	Biophysical Indirect Impact Area
Infrastructure	Important Bird Area and Key Biodiversity Area	Proposed 330kV Transmission Line
Railroad	<i>National Designated Areas</i>	Substation
Road	Forest Reserve	Survey Sites
Existing Transmission Line, 66kV	Game Management Area	<i>Disa aequiloba</i> Observation
Existing Transmission Line, 330kV	National Park	No <i>Disa aequiloba</i> Observation



Update of the ZTIP Biological Baseline - Wet Season Surveys
ZESCO Powering the Nation
 Detailed Biodiversity Management Plan

Map 2-31
***Disa aequiloba* Survey Sites and Observations, Mpika - Pensulo Segment**

Sources:
 ESRI, National Geographic and World Hillshade MapLibrary, Africa World Protected Planet and Birdlife International Open Street Map, 2019, roads, railways, rivers Zambia Ministry of Land, districts WSP, Surveys, 2017 and 2019

0 6 12 km
 UTM 36S, WGS84
 16 December 2025

Preparation: M. Brennan Jacot
 Drawing: M. Lévesque
 Validation: H. Chouinard
 CA0061300_5501_dbmp_Biological_baseline_maps_251216.aprx
 CA0061300_5501_dbmp_035_c31_DisasurveyMortality_251215



Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.

2.9.1.2 *Euphorbia perplexa* var. *kasamana*

Specific surveys were conducted in September 2025 to determine the presence and distribution of *Euphorbia perplexa* var. *kasamana* within the Kasama Forest Reserve and the Mwela Rock Art Site and their surroundings (see Photo 2-21). Results are summarized below, and the detailed sectorial report can be found in Appendix 2-4.

Euphorbia perplexa var. *kasamana* is an obligate resident of granite rock outcrops, with a strict dependence on this specific habitat. Potential habitat within a 5 km buffer area around the Kasama Forest Reserve was mapped based on satellite imagery analysis, resulting in the identification of 63 discrete rock outcrops units. The survey was conducted systematically over an eight-day period across 24 of the 63 identified rock outcrops, providing coverage for 38% of the potential habitat.

The species' presence seemed to be primarily determined by the physical substrate, as it was absent from the surrounding woodland and only absent from two of the 24 surveyed rock outcrops. The two rocks on which the species was absent displayed significant disturbance from quarrying which could have eliminated the species. The species coexists within a core plant community dominated by xerophytic specialists, including *Rubiaceae*, mosses, *Coleochloa setifera*, and *Xerophyta* species. The abundance of desiccation-tolerant plants confirms that the species thrives in harsh, seasonally dry microclimates. Therefore, the key factors determining its presence are the availability of rock outcrop habitat and the ecological conditions it creates.

The total population of *Euphorbia perplexa* var. *kasamana* across the 22 occupied outcrops was quantified at 23 950 individuals. The average population size per occupied outcrop was 1 089 individuals. The average density of individuals on rock outcrops where the species was present was of 89.5 individuals/ha. On rock outcrops most likely to be affected by construction of the transmission line, the number of individuals and density was:

- On Rock 5, density of 94.1 individuals/ha (10,397 individuals within 110,8 ha).
- On Rock 9, density of 42.3 individuals/ha (807 individuals within 19,1 ha).

Location of observations are illustrated in Figure 2-19, with the number of individuals recorded per observation.

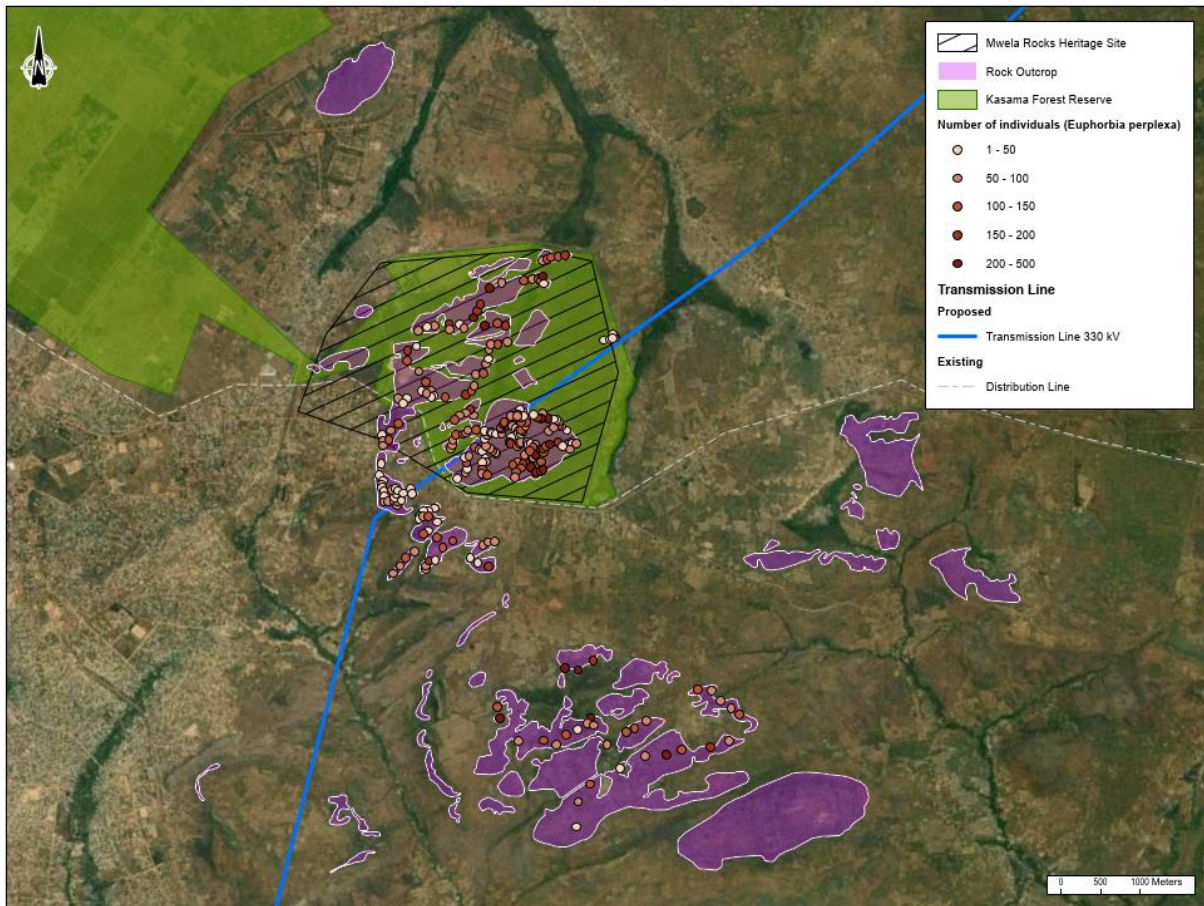


Figure 2-19 Location of *Euphorbia perplexa* var. *kasamana* and Number of Individuals per Observation

There are two subspecies of *Euphorbia perplexa*: subspecies *kasamana* and subspecies *perplexa*. However, this species has not been sufficiently researched to draw definitive distinctions between them. Based on the needle-like shape of the spines, subspecies *perplexa* was excluded. Morphometric analysis of the 296 sampled individuals confirmed the field identification and provided quantitative data on the population's physical structure. The key morphometric characteristics of the sampled individuals were as follows:

- Spine & Shield: mean spine length was 6.8 mm (\pm 0.15 mm), with mean spine shield dimensions of 8.4 mm (\pm 0.08 mm) in length and 2.7 mm (\pm 0.03 mm) in width.
- Height: the average plant height was 63.06 cm (\pm 2.24 cm).
- Bracts: bracts were absent on all individuals at the time of the survey.
- Habit: all surveyed specimens displayed the characteristic prominently sinuate branch angles and a general growth habit that was erect to semi-prostrate.



Photo 2-21 *Euphorbia perplexa* var. *kasamana*

Survey results show the project area constitutes a significant habitat for *Euphorbia perplexa* var. *kasamana*, supporting a substantial population. The primary threat to *Euphorbia perplexa* var. *kasamana* is the direct loss and degradation of its rock outcrop habitat. Quarrying activities pose a significant risk, as they would completely destroy the granite inselbergs upon which this obligate species depends. Additional threats include habitat fragmentation and potential damage from infrastructure and other development projects intersecting its restricted range. Residential expansion further threatens the rock habitats. Given the species' limited global range and obligate association with this specific rock outcrop habitat, the project's footprint necessitates stringent mitigation.

2.10 Ecosystem Services

Human communities are an integral part of ecosystems and benefit from many goods and services those ecosystems provide. These benefits are recognized as Ecosystem Services (ES). The definition of this concept comes from the Millenium Ecosystem Assessment (MEA) evaluation report, which states that such services are the benefits people obtain from ecosystems (IFC, 2019; MEA, 2005; World Bank Group [WBG], 2017). Expanding on this definition, ES are ecosystems' direct and indirect contributions to human well-being.

ES are grouped into four categories:

- Provisioning services: which refer directly to products people obtain from ecosystems (e.g., agricultural products, plants to eat, game, medicinal plants, fresh water, biofuel, timber, etc.).

- Regulating services: which are the benefits humans obtain from the regulation of ecosystem processes (e.g., climate regulation, waste decomposition, purification of water and air, protection from natural hazards, etc.).
- Cultural services: which refer to the non-material benefits people obtain from ecosystems (e.g., sacred and spiritual sites, ecotourism, education, etc.).
- Supporting services: which are the natural processes that maintain the other services (e.g., nutrient cycling, genetic production and genetic exchange channels, etc.).

ES are divided into two types according to IFC’s Performance Standard 6 (2019):

- Type I: Those services on which project operations are most likely to have an impact and, therefore, which result in adverse impacts to affected communities.
- Type II: Those services on which the project directly depends for its operations.

Ecosystem services provided by habitats located within the DIA have been identified and assessed based on the results from biological surveys and community surveys. Priority ecosystem services (PES) were identified following the methodology presented in Appendix 2-1. Community (Type I) or project performance (Type II) dependence level to ES, interaction with drivers of change on ES (Type I) or with project operations (Type II) and ES replaceability and management potential are assessed using the criteria presented in Table 2-17.

Table 2-17 Priority ecosystem service assessment criteria

Level of Dependence on the ES – for affected communities and their well-being (Type I) or for project performance (Type II)	
Low	A few households/communities are beneficiaries for this given ES or this ES contributes slightly to their well-being (Type I) or the project depends slightly on ES and its performance is slightly affected by the loss. The intensity of use and the degree of dependence are low.
Medium	Benefit from the ES is important among local communities or generalised for given groups (Type I) or the ES loss could affect project performance without compromising it (Type II). Intensities of benefit and degrees of dependence are variable.
High	Widespread or significant benefit for local communities and ES is of major importance for them (Type I). Project performance is considerably reduced by the ES loss (Type II). Benefit is high and degree of dependence is major.
Interaction with drivers of change on ES (Type I) or with project operations (Type II)	
Low	The ES can slightly be impacted without changing significantly its availability for beneficiaries or for project performance. The disturbance can be within the normal range of natural variations.
Medium	The ES can be altered at a point where the availability for beneficiaries or for project performance can be reduced. However, the impact does not threaten the long-term viability of the ecosystem which provides the ES.
High	The ES can be lost, or a significant proportion of its availability could be reduced for beneficiaries or for project performance. The long-term viability of the ecosystem which provides the ES is threatened.

Replaceability/Management potential – accessibility and efficiency of possible alternative to the ES affected	
Low	Highly specific ES, with no alternatives easily accessible or effective.
Medium	Some alternatives exist even if they are less favourable. Beneficiaries can access to the ES considering their capacity to pay or to find an effective alternative.
High	Many accessible and effective alternatives for beneficiaries.

Description of each ES, along with a categorization of the level of dependence, interactions, and replaceability, are presented in Table 2-18.

Based on the ES analysis, the identified PES are as follows:

- Agricultural potential and production;
- Wild food products; and
- Recreation and tourism.

Table 2-18 Description of ES Provided in the DIA and their Prioritization

Ecosystem service	Definition and description of ES within the Project DIA	Level of dependence on ES	Interaction of ES with drivers of change	Replaceability of ES	Identification of PES
Provisioning services					
Agricultural potential and production	<p>Areas with agricultural potential, including all crops and agricultural products grown by local communities for human and livestock consumption.</p> <p>Agriculture is the most widespread livelihood and economic activity in affected communities (see Section 5.4.4 of the ESIA (WSP, 2024)) and among affected households between Pensulo and Kasama (see Section 3.7.3 of the RAP (WSP, 2025)). Agriculture is a source of livelihood for 95.7% of affected households between Pensulo and Kasama (WSP, 2025). Crops cultivated in the ROW include maize, cassava, groundnut, sweet potatoes, and beans. Agricultural land is also widespread, covering 633.69 ha (23% of the total 2,773 ha ROW). As such, local communities depend highly on ecosystems' agricultural potential and production, both for revenues and food.</p> <p>It is expected that project activities disrupt agricultural land. Some agricultural areas will be permanently lost at the location of the pylons. Interactions with drivers of change should be limited to the construction phase, as crops will be allowed within the ROW during the operation phase. Further damages could arise during maintenance activities but should be of a limited extent. As for replaceability, there were some concerns in affected communities about the lack of replacement land for agricultural activities, mainly in the southern part of the study area (Central Province). However, as agriculture is a widespread land use in the DIA, replaceability is deemed medium.</p>	High	Medium	Medium	PES
Livestock and forage resources	<p>Forage resources, water and others supporting livestock and animals owned for domestic or commercial consumption.</p> <p>Based on RAP data, 70.7% of affected households between Pensulo and Kasama own livestock, with an average of 21.3 animal per household (WSP, 2025). The main livestock species are poultry, goats, cows, and pigs, which are used for food and revenue by households. Aside from private lands used for grazing, there are ten (10) communal natural areas used for grazing between Pensulo and Kasama, totalling an area of 54.9 ha.</p> <p>Interactions between drivers of change and livestock should be limited to temporary access restrictions to grazing land during the construction phase. Fallow lands and degraded woodland are usually used as pasture areas. Replaceability is high as fallow land and degraded woodland land uses represent over 45% of land uses in the ROW and neighbouring areas.</p>	Medium	Low	High	Not a PES

Ecosystem service	Definition and description of ES within the Project DIA	Level of dependence on ES	Interaction of ES with drivers of change	Replaceability of ES	Identification of PES
Fishing and fishery resource	<p>Fishing stock caught or harvested for consumption or commercial purposes in marine and coastal ecosystems.</p> <p>Fishing is a livelihood activity reported by 12.8% of affected households, though none report it as their main source of livelihood (WSP, 2025). The situation is similar at community-level where fishing is the main occupation of only 1.7% men in the affected communities of Northern Province (WSP, 2025). There are seven (7) affected fishponds within the ROW and satellite imagery in the DIA indicates that fish farming is widespread, especially in the Kasama area.</p> <p>There could be an indirect impact on fisheries during work near water bodies due to water contamination or fish disruption. Replaceability is medium as there are lots of water bodies in the BIIA, though some communities may have limited capacities to move to new fishing locations.</p>	Medium	Medium	Medium	Not a PES
Hunting and bush meat	<p>Animal species trapped or hunted for consumption, including insects, mammals, birds, amphibians and reptiles.</p> <p>Hunting and bush meat were reported in some areas within the ROW, namely in Kafinda GMA and Luwingu GMA. Furthermore, only 1.0% of affected households between Pensulo and Kasama have indicated hunting as a livelihood activity (WSP, 2025).</p> <p>Dependence on hunting and bush meat remains low. Project activities may affect hunting areas, mainly due to restricted access and disruption of game. However, nothing indicates that the ROW provides a unique habitat for the game. Thus, it is expected that replaceability is high.</p>	Low	Medium	High	Not a PES

Ecosystem service	Definition and description of ES within the Project DIA	Level of dependence on ES	Interaction of ES with drivers of change	Replaceability of ES	Identification of PES
Wild food products	<p>Products collected in the wild for food other than animal proteins (vegetal products, mushrooms, or honey).</p> <p>Miombo woodlands are important sources of livelihood for local communities, providing, in some cases, many edible mushrooms, edible insects, beekeeping opportunities, wild fruits, and wild vegetables.</p> <p>A variety of wild food products are used within the ROW and in the DIA. A total of 43 flora species recorded during flora surveys (see Table 2-8) are known to be used as wild food products. A total of 14 communal natural areas, representing a total area of 52.51 ha, are used by populations for wild food picking and are associated with livelihood (WSP, 2025). Numerous indigenous trees, some used for fruits or edible roots/leaves, were inventoried within the ROW between Pensulo and Kasama as part of the RAP (WSP, 2025). These include 6,083 Amasuku trees (Wild loquat), 1,498 Mfungo trees, 1,377 Mupundu trees (Mobola plum) and 475 Kasongolo trees (Natal oranges), among others (WSP, 2025).</p> <p>During the operation phase, trees over 2 m won't be allowed in the ROW, meaning that some wild food product areas will be lost permanently. Replaceability is expected to be medium as wild food products are numerous and are expected to be easily accessible elsewhere in the DIA.</p>	High	Medium	Medium	PES
Traditional medicine	<p>Mineral, plants, or animals are used in order to maintain people's health as well as to prevent, diagnose, treat, or care for physical and mental diseases.</p> <p>A variety of medicinal plants are used within the ROW and in the DIA. A total of 94 flora species identified are used for their medicinal properties (see Table 2-8). There are six (6) communal natural areas used for the collection of medicinal plants within the ROW between Pensulo and Kasama, totalling an area of 16.07 ha (WSP, 2025). However, based on RAP data, 55.9% of affected households between Pensulo and Kasama have reported never using traditional medicine (WSP, 2025).</p> <p>Species used for their medicinal properties are present in the DIA, and collection areas are reported, but traditional medicine being used by less than half of affected households leads to a medium dependence on this ES. It is expected that replacement supply areas will be readily available within the DIA, and modern medicine could also play a role in its replaceability.</p>	Medium	Medium	High	Not a PES

Ecosystem service	Definition and description of ES within the Project DIA	Level of dependence on ES	Interaction of ES with drivers of change	Replaceability of ES	Identification of PES
Biofuel	<p>Animal or vegetal products are used as energy sources.</p> <p>A total of 18 flora species recorded during flora surveys, either for firewood, charcoal or for both (see Table 2-8) are known to be used as biofuel. Wood can be sourced in various habitat types, both modified and natural ones. Loss of biofuel resources and supply areas was not mentioned as a concern during community surveys, though eleven (11) communal natural areas are used for firewood and charcoal wood collection, totaling 51.48 ha, are located within the ROW between Pensulo and Kasama (WSP, 2025).</p> <p>As such, level of dependence is estimated to be low. Interaction with drivers of change will mostly be due to loss of trees and disruption of supply areas during construction work. As woody species will be regularly cut during ROW maintenance, loss of trees will be permanent. Replaceability is deemed high, as other supply areas can be found in the DIA.</p>	Low	Medium	High	Not a PES
Water resources	<p>Groundwater and surface water used as tap water for domestic, commercial, or agricultural purposes comprise all the natural processes that regulate its quality or quantity.</p> <p>Water resources are quite widespread in the DIA, with many rivers and streams draining the territory. The northern part of the project line route is in the Chambeshi – Luapula Watershed, with the Chambeshi and its tributaries being the main river in this area. After Mpika, however, the project line route advances approximately on the split line between the two watersheds. Kafue and Luangwa Rivers are the main tributaries of the Zambezi River Basin.</p> <p>Communities depend heavily on water resources, but the DIA is highly replaceable due to the number of rivers. Interactions with drivers of change are expected to be limited to contamination risks during construction activities near waterbodies and watercourses.</p>	High	Medium	High	Not a PES
Regulating services					
Air quality control	<p>Ecosystems influence the exchange of gases or the filtration of physical or chemical particles in the air (e.g., dust, O₂, CO₂).</p> <p>In accordance with the World Health Organization's guidelines (2021), the air quality in Zambia is considered moderately unsafe (European Commission and UNEP GRID-Geneva, 2024). Air quality is thus somewhat degraded in the DIA. Trees and forest ecosystems help with air quality control by exchanging gases and providing filtration of particles. Project-related activities could increase air avert locally during a limited amount of time and lead to the removal of trees, reducing the ecosystem's air quality regulating capacity. However, trees are widespread in the DIA, thus replaceability is deemed high.</p>	Medium	Medium	High	Not a PES

Ecosystem service	Definition and description of ES within the Project DIA	Level of dependence on ES	Interaction of ES with drivers of change	Replaceability of ES	Identification of PES
Climate regulation	<p>Global: Ecosystems influence the absorption or emission of greenhouse gases and in the regulation of air masses.</p> <p>Regional and local: Ecosystems influence regional and local temperatures, rainfalls or on other climatic parameters.</p> <p>The miombo woodland is the main habitat type within the ROW, which is expected to be representative of the DIA.</p> <p>Degradation of habitats and riverbeds may lead to increased climate change-related risks. As mentioned in the ESIA (WSP, 2024) in Section 5.2.2., climate risks in the DIA include drought, extreme temperature and flash flooding, both of which could be enhanced by degraded habitats and altered watercourses. However, project activities are not expected to significantly change land cover and habitat and riverbeds' degradation. As such, interactions are expected to be limited.</p>	Medium	Low	Medium	Not a PES
Water regulation and erosion control	<p>Ecosystems influence on the amplitude and period of water flow, water storage, aquifer filling and flood prevention as well as their ability to prevent erosion.</p> <p>Vegetation, especially forested habitats, plays a significant role in soil erosion control. Their role is increased in areas with strong slopes. Riverine forests also play an important role in the control of erosion from water action. Flooding and droughts are known climate risks in the DIA. These were not mentioned as key issues during consultation activities, leading to a medium level of dependence. Project activities near watercourses may lead to the removal of trees on the bank, resulting in increased erosion risk. However, mitigation measures are expected to limit these interactions.</p>	Medium	Medium	Medium	Not a PES
Cultural services					
Sacred components	<p>Cultural or religious value that a population attaches to an ecosystem, a place, or a species. Several sites were reported in surveyed communities; neither the 2021 RAP nor the 2017 Resettlement and Compensation Action Plan for the Kasama-Nakonde section have reported any private sacred assets located within the wayleave. There are three (3) graveyards located within the ROW between Pensulo and Kasama (WSP, 2025), but no sacred or religious elements associated with natural components such as forests, trees, or specific species.</p>	Not Applicable (NA)	NA	NA	Not a PES

Ecosystem service	Definition and description of ES within the Project DIA	Level of dependence on ES	Interaction of ES with drivers of change	Replaceability of ES	Identification of PES
Recreation and tourism	<p>Nature, particularly protected areas and wildlife, plays an important role in supporting tourism. Ecosystems and biodiversity are, therefore, an important source of employment and income generation.</p> <p>There will be a permanent loss of land from heritage conservation and potential tourism development at the Mwela Rock Paintings site, considering that this whole area is meant for tourism trails and sustainable tourism development. The Mwela Rock Paintings site is affected by the ROW. While the ROW does not impact the cave with the paintings, the site's natural environment may be affected. NHCC judges all the environmental features as important for the sites.</p>	Medium	High	Medium	PES
Supporting services					
Primary production	Production of organic matter by plants through photosynthesis and nutrient input. It forms the basis of the food chain.	<p>Due to their complexity and overarching quality, support ES have not been specifically assessed inside the DIA but are known to contribute to all types of ES.</p> <p>Refuge habitat for birds, pollinator insects, nursery and spawning grounds for fish.</p>			
Nutrients cycle	Nutrients cycle in the ecosystems (phosphorus, nitrogen, carbon, sulfur, etc.).				
Habitat	Natural or modified areas that support flora and fauna communities.				
Water cycle	Water transition through different receptors (atmosphere, terrestrial and aquatic habitats) in all its phases (solid, liquid and gaseous).				

3. Key Risks and Impacts on Biodiversity

3.1 Natural Habitat

The spatial extent of natural habitat types in the transmission line corridor is summarized in Table 3-1. The project includes improvement of existing substations within their current site and construction of one new substation (Nakonde), which is located entirely within modified habitat.

Natural habitat loss mainly involves permanent conversion of forested habitats to herbaceous cover that will result from clearing and will be maintained during the operation phase in alignment with land uses restriction within the ROW. This permanent habitat loss includes 39.4 ha of mature miombo woodland, 539.0 ha of secondary miombo woodland, and 48.9 ha of riparian forest. These natural habitats are known to host biodiversity values, including IUCN Red Listed flora species East African Mahogany (*Khaya nyasica*) (VU), Leopard orchid (*Ansellia Africana*) (VU), and African Cherry (*Prunus africana*) (VU), and endemic *Rhus fanshawei*, that will be directly impacted by vegetation clearing.

Much smaller impacts are anticipated in wetlands and rock outcrops, which will involve permanent loss from tower footprints, and temporary disturbance from access roads (in wetlands only). In these habitat types, vegetation clearing in the wayleave will be minimal because the vegetation structure (i.e., low height, mainly herbaceous plants) is compatible with operational and maintenance requirements of transmission lines.

Additional habitat losses will result from required clearing for new access roads, construction sites, construction camps and earthworks during construction phase.

Widespread and uncontrolled burning is common during the dry season in Zambia, destroying large areas of woodlands and forests. The uncontrolled fires can spread accidentally from their sources into the surrounding bush and many of the woodlands are beginning to show signs of damage from too frequent and intense fires. Fire risk management at construction camps shall be implemented, to avoid the propagation of uncontrolled fires by workers or by construction activities.

There are 134 towers in natural wetlands, including 104 towers in moderately disturbed wetlands and 30 towers in low disturbance wetlands. Assuming a minimum disturbance footprint of 410 m² (0.041 ha) for each tower, at least 5.5 ha of wetlands will be impacted.

This estimate does not include access-related disturbance as the placement of access routes has not yet been defined. Access road disturbance in natural wetlands will be temporary, assuming effective implementation of measures described in Section 4.1. Key measures include using construction mats or wooded paths (i.e., no ground disturbing road construction) for access into wetlands and performing construction activities working during the dry season. Biodiversity values associated with wetland habitat that might be directly affected include endemic orchid *Habenaria macrotidion* and Endangered orchid *Disa aequiloba*, the latter's habitat qualifying as critical habitat (see Section 3.2.1 for specific impacts on this species).

Rock outcrop habitat also hosts key biodiversity values, including several endemic species such as *Euphorbia cooperi* var. *ussanguensis*, *Euphorbia jubata*, *Euphorbia speciosa*, and *Otiophora angustifolia* and *Euphobira perplexa* var. *kasamana*. Refer to Section 3.2.2 for a more detailed discussion of impacts to rock outcrop habitat, which constitutes critical habitat for the succulent species *Euphobira perplexa* var. *kasamana*.

Table 3-1 Natural Habitat Types in the Transmission Line ROW

Natural habitat type	Area (ha)
Miombo woodland – mature	39.4
Miombo woodland – secondary	539.0
Riverine forest	48.9
Rock outcrop	4.8
Wetland – with low disturbance	56.5
Wetland – with moderate disturbance	223.7

Vegetation clearing, earthworks and the movement of vehicles and equipment will increase the risk of introducing and/or spreading non-native invasive species. The risk will be highest during construction as part of earth moving activities. The risk will persist during operations but will decrease relative to the construction phase.

The presence of workers during construction and maintenance, as well as the opening of new access roads can lead the increased pressure on natural resources.

Impacts during operation will also include periodic vegetation management. This will involve removal of incompatible woody species using manual or mechanical measures and trimming or felling trees that are encroaching into the wayleave.

Maintenance and repair of conductors or towers during operation may require the creation of temporary access routes, depending on the area that needs to be accessed and if heavy machinery is needed to support the activities.

3.2 Critical Habitat

3.2.1 *Disa aequiloba*

As described in the Critical Habitat Assessment (CHA) report, *Disa aequiloba* is a critical habitat qualifying species. It is an orchid associated with wetland habitats (dambos), specifically those with low to medium levels of anthropogenic disturbance. In accordance with ESS 6, impacts to critical habitat require demonstration that (i) there are no measurable adverse impacts on the biodiversity values for which the habitat was designated that could impair its ability to function, and (ii) a mitigation strategy is designed to achieve a net gain of those biodiversity values. The assessment below therefore focuses on quantifying direct habitat loss and characterizing potential indirect and temporary disturbances in order to inform the mitigation and conservation strategy.

The wayleave corridor includes 239.5 ha of *Disa aequiloba* critical habitat. The species' critical habitat was defined as all natural wetlands (i.e., those with low and medium levels of anthropogenic disturbance) but excluded the extent of natural wetlands where the species was confirmed as absent (refer to Map 4 in Appendix 2-16 [Critical Habitat Assessment]). Dambo wetland vegetation is generally compatible with the operational safety requirements and maintenance of transmission lines. Wetland vegetation clearing to create a wayleave corridor is not anticipated because its vegetation is naturally low-growing and predominantly herbaceous. As such, no systematic vegetation clearing is required beyond localized tower footprints, substantially limiting the spatial extent of permanent habitat conversion within critical habitat. However, the construction of transmission towers and their associated foundations in wetland habitats will result in permanent loss of critical habitat for *Disa aequiloba*. The spatial distribution of towers within wetlands is dispersed, resulting in localized disturbances that are not expected to impede wetland connectivity.

The project includes 121 towers in wetlands with confirmed or potential presence of *Disa aequiloba*. Among these, 24 towers are in wetlands with confirmed occurrences of *Disa aequiloba* and the remaining 97 towers are in wetlands where *Disa aequiloba* were not surveyed but suitable habitat is present. Tower footprints in these wetlands will be kept to the smallest extent practicable. Each tower is assumed to require a disturbance footprint of approximately 410 m² (0.041 ha) to accommodate the physical dimensions of the tower and foundation excavation (185 m²) and a small amount of workspace around it (225 m²). Using these assumptions, total permanent loss of critical habitat is estimated at 4.96 ha. As described in Section 4.2, pre-construction surveys of all permanent and temporary footprint elements will be implemented in critical habitat to confirm the actual loss of critical habitat.

The estimated loss of 4.96 ha likely represents the upper limit of permanent critical habitat loss because it is unlikely that *Disa aequiloba* will be present in all affected wetlands. A lower limit of critical habitat loss was also estimated based on the ratio of surveyed wetlands with and without detections of *Disa aequiloba*, which is 48%. Using this assumption, it was estimated that 48% of the 97 towers in wetlands without confirmed species occurrences are occupied by *Disa aequiloba*. In total, 71 towers are assumed to be in wetlands with occupied by *Disa aequiloba*, which would correspond to a permanent loss of 2.91 ha of critical habitat.

In summary, the actual permanent loss of critical habitat will fall somewhere between 2.91 ha and 4.96 ha, with the upper bound representing a conservative estimate of permanent habitat loss assuming occupancy in all suitable wetlands and the lower bound incorporating observed detection rates. The upper estimate of loss is also precautionary because it assumes that temporary workspaces in wetlands, when in practice the construction protocols emphasize siting these features outside of wetlands, or at least outside of flooded areas, to the extent possible.

At present, the number of individual plants affected by the project cannot be estimated with a reasonable degree of accuracy. Although field surveys recorded counts of individuals along sampling transects, these data are not representative of *Disa aequiloba* density at the wetland level. Surveys consisted of small transects (2 m by 10 m) preferentially placed in areas with known orchid presence, as identified by local community members. Using these density estimates would considerably overestimate the number of impacted individuals in the tower footprints. As described in Section 4.2, pre-construction footprint searches by qualified experts are proposed following completion of the final design to more accurately define the number of individual plants affected. Where individual plants are identified within tower footprints during pre-construction surveys, salvage and translocation measures will be implemented where technically feasible. These measures, combined with habitat-level conservation actions described in Section 7, are intended to contribute toward achieving net gain for the biodiversity values associated with *Disa aequiloba*.

Wetland access requirements for tower construction and line stringing will cause additional disturbance in critical habitat. However, the location of access routes is not yet defined. As noted previously, there are 239.5 ha of *Disa aequiloba* critical habitat in the wayleave corridor and a small portion of this area would be disturbed to create access to 121 towers. Access road disturbance will be temporary, assuming effective implementation of measures described in Section 4.1. Key measures include using construction mats or wooded paths (i.e., no ground disturbing road construction) for access into wetlands and performing construction activities during the dry season. Temporary access disturbances will be restored immediately following construction activities, including re-contouring (where necessary) and reinstatement of natural hydrological flow paths. No permanent drainage modification within wetlands is anticipated.

As described for natural habitats (Section 3.1), vegetation clearing, earthworks and the movement of vehicles and equipment will increase the risk of introducing and/or spreading non-native invasive species. The risk will be highest during construction and will decrease during operations, relative to the construction phase. In addition, there may be a need for temporary access routes in *Disa aequiloba* critical habitat during operation, depending on the area that needs to be accessed for maintenance and repair activities and if heavy machinery is needed to support these activities. To prevent indirect pressures on critical habitat, access will be controlled, and worker awareness training will include strict prohibition of orchid harvesting. Monitoring of critical habitat wetlands will continue during both construction and operation phases to detect any unforeseen degradation or invasive species colonization, enabling adaptive management.

3.2.2 *Euphorbia perplexa* var. *kasamana*

As described in the CHA report, *Euphorbia perplexa* var. *kasamana* is a critical habitat qualifying species. It has a highly localized distribution in the project area, occurring in rock outcrop habitats of the Kasama Forest Reserve, and those in proximity to the Kasama Forest Reserve. In accordance with ESS 6, impacts to critical habitat must demonstrate that (i) there are no measurable adverse impacts on the biodiversity values for which the habitat was designated that could impair its long-term viability, and (ii) a mitigation strategy is designed to achieve Net Gain for those biodiversity values. The assessment below, therefore, focuses on quantifying permanent habitat loss and estimating individual-level impacts to inform the conservation strategy.

Four towers are located in rock outcrop habitat, i.e., towers 46, 49, 50 and 51 (Figure 3-1). These consist of regular tangent towers with footprints that vary in size according to the design: towers 50 and 51 have a base of 9 m by 9 m (i.e., a footprint of 81 m²) and towers 46 and 49 have a base of 9.6 m by 9.6 m (i.e., a footprint of 92 m²). When accounting for the additional area required around the tower base to accommodate the foundation excavations, the total permanent footprint is either 13.0 m by 13.0 m (169 m²) or 13.6 m by 13.6 m (185 m²), depending on the tower type. In addition to the area permanently disturbed, a small amount of temporary workspace is required next to each tower. The exact dimensions of required workspaces have yet to be confirmed but were estimated at 225 m² for each tower based on the typical requirements for similar structures. The footprint and foundation excavation areas represent permanent habitat conversion. Workspace areas are conservatively treated as permanent loss for impact estimation purposes; however, portions of these areas may be restored following construction where technically feasible.



Figure 3-1 Pylon Location in Rock Outcrops

Impacts on critical habitat were estimated by overlaying the tower structure footprints with detailed land use interpretation (Figure 3-2). The number of individual plants impacted was estimated based on field survey observation as Rock 5 (110.5 ha) and Rock 9 (19.1 ha) were surveyed completely.

The following summarizes the estimated impacts of each tower:

- Tower 46 is completely in rock outcrop habitat. The tower footprint and foundation excavation will disturb 185.0 m² of rock outcrop. The temporary workspace may disturb another 225 m²; however, micro-siting could reduce the extent of temporary impacts as there may be an opportunity to overlap with secondary woodland. The excavation footprint of tower 46 is located 4 m from a documented cluster of *Euphorbia perplexa* var. *kasamana* that includes 53 individual plants. There is a high risk that the temporary workspace will disturb this cluster of plants. With pre-construction surveys, careful placement of workspace, and tower micro-siting, the Contractor will need to confirm the extent of avoidance that was achieved.
- Tower 49 has a small amount of overlap with rock outcrop habitat. The tower footprint and foundation excavation will disturb 22.3 m² of rock outcrop. The temporary workspace may disturb another 225 m²; however, micro-siting is expected to reduce or completely avoid the extent of temporary impacts because there are grassland/open area and secondary woodland around most of the footprint. Field surveys overlapped with the proposed tower location recorded an absence of *Euphorbia perplexa* var. *kasamana*.
- Tower 50 is completely within rock outcrop habitat. The tower footprint and foundation excavation will disturb 169.0 m² of rock outcrop. The temporary workspace will likely disturb another 225 m² of critical habitat. Tower 50 does not directly impact individual plants, but pre-construction surveys and careful placement of workspace are required to confirm this prediction. Field surveys documented one cluster of *Euphorbia* less than 20 m north of the footprint boundary (with 59 individuals).
- Tower 51 is completely within rock outcrop habitat. The tower footprint and foundation excavation will disturb 169.0 m² of rock outcrop. The temporary workspace will likely disturb another 225 m² of critical habitat. Tower 51 does not directly overlap plant clusters but it is surrounded by five occurrence records, which suggests that the temporary footprint is likely to affect some individuals. The excavation footprint for tower 51 is less than 6 m from a plant cluster (with 76 individuals recorded); therefore, there is a high risk that these individuals will be affected. Another two plant clusters are located less than 15 m from the excavation area to the north and west (with 75 and 93 individuals recorded). Careful placement of workspace, and tower micro-siting based on pre-construction surveys will need to be completed to confirm the extent to which individual plants will be avoided.

The following table provides a summary of impacts from each tower located within the critical habitat.

Table 3-2 Summary of Impacts for each Tower Located within the *Euphorbia perplexa* var. *kasamana* Critical Habitat

Impacts	Tower 46	Tower 49	Tower 50	Tower 51	Total
Total footprint of the combined legs and excavation/foundations zones (m ²)	185.0 m ²	185.0 m ²	169.0 m ²	169.0 m ²	708.0 m ²
Total impacted areas within rock outcrops including towers legs and foundations (m ²)	185.0 m ²	22.3 m ²	169.0 m ²	169.0 m ²	545.3 m ²
Required working areas in rock outcrops (m ²)	225 m ²	Less than 225 m ²	225 m ²	225 m ²	Less than 900 m ²
Number of individuals less than 6 m from the excavation footprint	53	0	0	76	129
Number of individuals less than 25 m from the excavation footprint ¹	53	0	59	244	356

Note: 1 Number of individuals less than 6 m is included in the number of individuals less than 25 m from the excavation footprint.

Based on the above analysis and with the application of precautionary assumptions about the placement of temporary workspace, the project footprint will result in the permanent loss of 1,445.3 m² (0.14 ha) of *Euphorbia perplexa* var. *kasamana* critical habitat. Pending validation from pre-construction surveys, the tower foundations will not result in the loss of individual plants. However, temporary workspaces are likely to affect individuals given the proximity of some towers to known plant clusters. Based on the current configuration of tower placement relative to plant clusters, it is estimated that 129 individuals will be affected (individuals less than 6 m from the excavation footprint, see Table 3-2), though the impact could range between 0 and 356 individuals depending on micro-siting (number of individuals less than 25 m from the excavation footprint). Final workspace boundaries will be established through pre-construction botanical walk-down surveys to minimize individual-level impacts.

Affected areas are limited to discrete tower footprints and do not result in fragmentation or division of rock outcrop habitat at the landscape scale. The spatial integrity and ecological function of the broader rock outcrop systems will therefore remain relatively unchanged.

Where feasible, individuals located within tower footprints will be salvaged and translocated to suitable adjacent microhabitats within the same rock outcrop system under supervision of qualified botanists. Post-translocation monitoring will be conducted to assess survival rates and inform adaptive management.

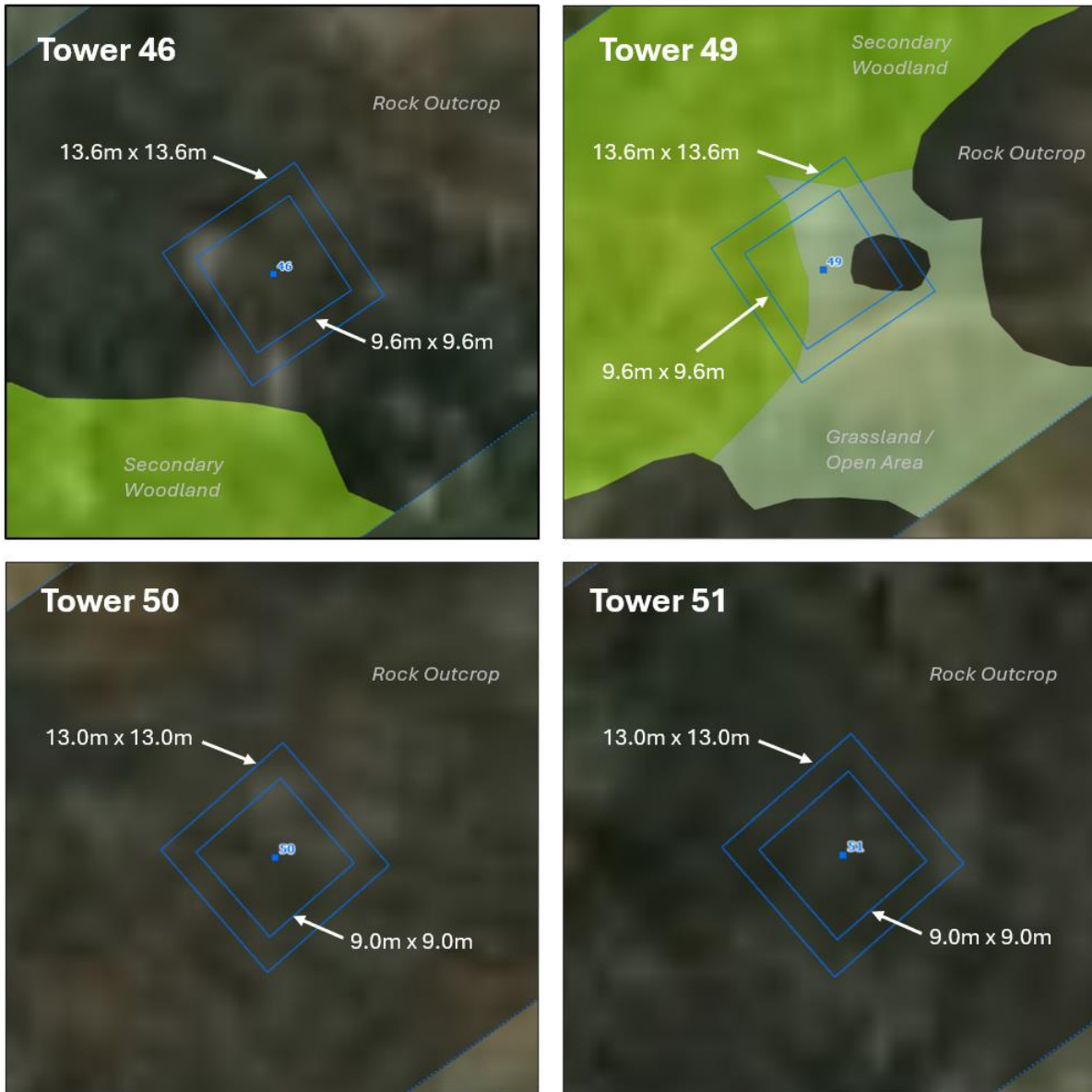


Figure 3-2 Land Use in Tower Footprints within Rock Outcrop Areas

As described for natural habitats (Section 3.1), there will be risk of introducing and/or spreading non-native invasive species during construction and, to a lesser extent during operation. The risk of invasive species establishment within rock outcrops is inherently lower than in soil-dominated habitats due to limited substrate availability; however, preventive measures including equipment cleaning and monitoring will be implemented to eliminate introduction pathways.

During operation, disturbance within rock outcrop critical habitat is expected to be negligible. Routine maintenance will not require vegetation management within rock outcrops, and access for any major repair activities will preferentially use helicopter support to avoid ground disturbance.

3.3 Legally Protected Areas and Internationally Recognized Areas

Seven Forest Reserves are crossed by the transmission line, including Amenshi (0.3 km), Chitimukulu (3.2 km), Mungwi (0.4 km), Kanona (30.7 km), Kasama (2.9 km), Nakonde (1.4 km), and Nkole Mfumu (4.4 km) Forest Reserves. However, these Forest Reserves have been degraded by human activities and infrastructure to varying degrees. During construction, vegetation clearing in the ROW will affect natural and modified habitats as summarized in Table 3-2. Loss of natural forested habitats (mature and secondary miombo woodlands and riverine forest) is expected in all Forest Reserves except Amenshi and Nakonde. The most important impacts to forest resources are anticipated in the Kanona Forest Reserve (54.68 ha) and Nkole Mfumu Forest Reserve (18.58 ha). Despite being gazetted as legally protected areas, the affected Forest Reserves are characterized by mosaics of natural habitats intermixed with agriculture and degraded woodlands. Even in the Kanona and Nkole Mufu Forest Reserves, where the wayleave will convert mature miombo woodlands, the affected areas are relic habitat patches within a degraded and disturbed forest.

Table 3-3 Land Cover Types in the Transmission Line Corridor within Forest Reserves

Land cover type	Area (ha)						
	Amenshi	Chitimukulu	Kanona	Kasama	Mungwi	Nakonde	Nkole Mfumu
Modified habitat							
Agriculture	1.19	2.28	22.73	0.46	-	<0.01	2.85
Build-environment	-	-	0.18	0.01	-	-	-
Fallow land	-	7.59	14.07	-	-	-	0.69
Grassland/open area	-	-	2.69	0.11	-	-	-
Plantation	-	-	-	-	-	4.18	-
Woodland - degraded	-	4.43	6.48	-	-	0.34	-
<i>Subtotal – modified habitat</i>	<i>1.19</i>	<i>14.30</i>	<i>46.15</i>	<i>0.58</i>	<i>-</i>	<i>4.52</i>	<i>3.54</i>
Natural habitat							
Miombo woodland – mature	-	-	19.22	-	-	-	4.55
Miombo woodland – secondary	-	1.85	34.57	8.68	-	-	14.03
Riverine forest	-	-	0.89	-	0.74	-	-
Rock outcrop	-	-	-	4.81	-	-	-
Wetland	-	-	6.70	0.21	1.41	-	-
<i>Subtotal – natural habitat</i>	<i>-</i>	<i>1.85</i>	<i>61.38</i>	<i>13.70</i>	<i>2.15</i>	<i>-</i>	<i>18.58</i>
Total area	1.19	16.15	107.53	14.28	2.15	4.52	22.12

As described in Section 3.1, broad vegetation clearing to create a wayleave corridor is not required in wetlands and rock outcrops. In these habitat types, impacts will be localized and limited to the tower footprints (with required work areas) and construction access roads. As detailed in Section 3.2.2, no new access roads will be created in rock outcrops.

Impacts during operation will also include periodic vegetation management to manually or mechanically remove incompatible woody species in the wayleave. Maintenance and repair of conductors or towers during operation may require the creation of temporary access routes, depending on the area that needs to be accessed and if heavy machinery is needed to support the activities.

3.4 Bird Habitat and Flyways

Displacement as a Result of Habitat Loss

Habitat transformation and loss constitute a primary driver of avian displacement. Vegetation clearing within the ROW, the development of access roads, clearing and widening of servitudes, work areas, and construction of the Nakonde substation will lead to a permanent loss of bird habitats within the ROW along the length of the powerline alignment. A large portion of the proposed transmission line (296 km of the 625 km) runs parallel to existing or planned linear infrastructure, reducing additional habitat fragmentation and loss. However, habitat fragmentation is still expected.

These modifications directly alter habitat structure and ecological functions and could reduce the availability of suitable nesting substrates, diminish foraging opportunities, and eliminate or fragment roosting and sheltering areas. Species with high site fidelity, specialized habitat needs, or limited ecological tolerance are particularly vulnerable to displacement, which may be temporary or permanent depending on the extent of habitat alteration and the availability of nearby alternative sites.

The High and Medium-High Sensitivity Zones identified in Maps 2-14 to 2-16 contain habitat types that support diverse and conservation-relevant species groups, including African Marsh Harrier (*Circus ranivorus*), Bateleur (*Terathopius ecaudatus*), and Southern Ground Hornbill (*Bucorvus leadbeateri*). These species typically maintain large territories and rely on structurally intact landscapes. Habitat loss within these zones may force individuals to relocate into suboptimal or degraded areas, where reduced resource availability and increased competition can negatively affect survival, breeding productivity, and long-term population viability. In fragmented or heavily modified landscapes, suitable alternative habitats may be scarce, resulting in increased energetic costs as birds search for replacement territories or roosts.

Habitat transformation poses additional risks for migratory species such as the Amur Falcon (*Falco amurensis*), Barn Swallow (*Hirundo rustica*), and European Bee-eater (*Merops apiaster*). These species depend on specific stopover habitats for rest and refueling during migration. Loss of these habitats can disrupt migration efficiency, increase energetic stress, and lower the probability of successful long-distance movement. For large raptors and other territorial breeders, the removal or degradation of nesting sites can result in multi-season reproductive failure, particularly for species like Wahlberg's Eagle (*Hieraaetus wahlbergi*) that demonstrate strong nest-site fidelity. The ecological implications extend beyond individual species, as displaced birds may no longer fulfil key ecological functions such as seed dispersal, scavenging, insect regulation, or pollination within the affected landscape.

Displacement as a Result of Disturbance

Disturbance-related displacement arises from increased human presence and activity associated with construction and maintenance operations. Operation of heavy machinery, piling, drilling, blasting, foundation excavation, repeated movement of vehicles and personnel can cause birds to temporarily or permanently abandon otherwise suitable habitat. Disturbance disproportionately affects species with low tolerance for human activity, species reliant on open or exposed nesting sites, and those with sensitive breeding behaviors that require prolonged periods of undisturbed incubation and chick rearing.

Displacement due to disturbance will be most acute within High and Medium-High Sensitivity Zones, where sensitive or disturbance-averse species occur at higher densities. Territorial species such as African Marsh Harrier and Southern Ground Hornbill may vacate key portions of their home ranges if disturbance levels exceed behavioral thresholds. For migratory species, disturbance of key foraging or roosting areas can result in avoidance of historically used stopovers, forcing individuals to seek alternative sites and expend additional energy during an already demanding migration cycle.

Breeding birds are particularly vulnerable to disturbance effects. Many large raptors breed from March to November, with critical sensitivity windows during incubation (March–August) and fledging (September–November). Disturbance during these periods can lead to nest abandonment or reduced parental attention, increasing the likelihood of egg failure, chick mortality, or premature fledging.

Disturbance-linked displacement also interacts cumulatively with other project-related impacts. Birds forced to alter their movement patterns due to disturbance may be compelled to fly through areas of higher collision risk, especially where movement corridors intersect with transmission power lines. Increased movement between alternative habitats may elevate exposure to overhead conductors, compounding the risk of collision mortality.

Collisions

Collisions with overhead power lines represent one of the most significant anthropogenic threats to avifauna in southern Africa, particularly for large, slow-flying species with limited maneuverability. Bustards, cranes, storks, and various waterbirds are especially vulnerable due to their substantial body mass, poor vertical lift, and flight behaviors (i.e. low-altitude gliding, crepuscular movements, and limited capacity for rapid directional change) that reduce their ability to avoid thin overhead conductors under low-visibility or adverse weather conditions (van Rooyen 2004; Anderson 2001).

Within the current development footprint, avifaunal sensitivity mapping indicates that collision risk is strongly spatially patterned. High, Medium-High and Medium sensitivity areas overlap with known distributions of priority species identified through conservation status, flight morphology, and documented propensity to interact negatively with transmission infrastructure. These zones are associated with habitats that concentrate bird activity such as wetlands, floodplains, dambos, river corridors, and open grasslands and therefore represent areas where birds are most likely to fly at heights intersecting the transmission line.

The results of the wet and dry season avifaunal surveys provide strong empirical support for this risk mapping. During the wet season, species typically prone to collisions, such as African Openbill (*Anastomus lamelligerus*), Goliath Heron (*Ardea goliath*), Abdim's Stork (*Ciconia abdimii*) and African Marsh Harrier (*Circus ranivorus*), were recorded predominantly within or adjacent to high-sensitivity wetland and floodplain systems. These areas support intense foraging, roosting, and movement activity, and function as local movement corridors and staging sites for both intra-African and Palearctic migrants. High numbers of Amur Falcon (*Falco amurensis*) and European Bee-eater (*Merops apiaster*) further indicate that portions of the alignment intersect migratory flyways where birds routinely fly at heights overlapping the conductor envelope.

Dry season data refine this understanding by illustrating a clear seasonal shift in both species at risk and collision locations. All recorded dry season mortalities occurred in bushveld-dominated habitat and involved fast-flying raptors or nocturnal/crepuscular species, including Peregrine Falcon (*Falco peregrinus*), probable Pennant-winged Nightjar (*Caprimulgus vexillarius*), and unidentified eagles, that hunt at high speed and are prone to impact mid-span conductors. Unlike the tower-proximal pattern observed in the wet season, dry season collisions occurred almost exclusively at mid-span where conductor sag is lowest, suggesting seasonal variation in the height and manner in which birds interact with the line. This shift is likely driven by changes in prey distribution, flight behaviour, habitat structure, and visibility conditions.

Collectively, the multi-season dataset demonstrates that collision risk along the alignment is both spatially and temporally dynamic. High-risk sections consistently correspond to the mapped sensitivity zones, but the drivers of risk vary seasonally, with wetlands and floodplain systems dominating wet season exposure and open bushveld and associated raptor activity driving dry season risk. These insights highlight the importance of strategically targeting mitigation in areas where seasonal bird movement patterns intersect most directly with conductor height and where the landscape funnels flight paths toward the transmission corridor.

Although mortality monitoring has recorded relatively few confirmed collision incidents on the existing power lines adjacent to the ZTIP, these numbers likely underestimate true collision frequency due to dense vegetation, removal by scavenger and communities, and limited detectability within portions of the servitude. When interpreted alongside the spatial and seasonal patterns observed during the surveys, it remains clear that collision risk is concentrated within the High, Medium-High, and Medium sensitivity areas (see Maps 2-14 to 2-16).

Electrocutions

Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen, 2004). Due to the large size of the clearances on most overhead lines of above 132kV, electrocutions are generally ruled out as even the largest birds cannot physically bridge the gap between dangerous components. It can be concluded that electrocutions on the ZTIP 330kV power line will not be possible through conventional mechanisms.

Electrocutions within the existing Pensulo, Mpika, Kasama and proposed Nakonde substation yards are possible, particularly for the more common, non-threatened species which may be attracted to the electrical infrastructure because it offers a suitable substrate on which to nest. Since it is difficult to predict any certainty if and where birds are likely to nest within the substation yard, coupled with the costs associated with insulating the entire substation proactively, electrocutions can be mitigated reactively using site-specific recommendations (provided by a suitably qualified avifaunal specialist) if they occur.

Operational Risks

Bird Streamers and Bird Pollution

Bird streamers and bird pollution represent important operational risks associated with avian interactions on transmission power line infrastructure. These events occur when birds perch or roost on tower structures, often directly above live conductors, resulting in fecal contamination or electrical flashovers caused by long, moisture-laden fecal matter bridging the air gap between energized components. Such incidents can lead to line tripping, equipment damage, and temporary loss of supply, particularly during wet conditions when conductivity is increased. The risk is elevated on tower types that offer ample perching opportunities, such as the guyed and self-support structures proposed for the ZTIP. These structures provide horizontal braces, cross-arms, and sheltered recesses that attract a variety of bird species, especially larger raptors and corvids that favor elevated vantage points.

This issue is expected to be most pronounced within the High and Medium-High sensitivity zones, where avian abundance and species diversity are greatest and where birds routinely utilize tall structures as hunting perches, territorial lookouts, or roosting sites. Raptors such as snake eagles, kites, and buzzards commonly exploit transmission towers within open savanna and grassland habitats, while corvid species may roost communally on tower frameworks.

The concentration of birds in these zones increases the likelihood of contamination-related faults, creating overlaps between ecological sensitivity and system reliability concerns.

Nesting

Nesting on transmission towers is generally considered a beneficial impact for many avifaunal species, particularly raptors and other large birds that rely on elevated structures for breeding, territorial surveillance, and predator avoidance. Self-support towers, as structure types predominantly proposed for the ZTIP, are especially attractive to nesting species due to their height, stability, and the availability of wide, sheltered platforms. These structures can therefore contribute positively to local avian ecology by providing additional nesting opportunities in landscapes where suitable natural sites (e.g., large trees or cliff ledges) may be limited or declining.

Despite these ecological benefits, nesting activity can create operational risks for the power line if not appropriately managed. Large stick nests, such as those built by raptors, may protrude into the electrical clearance zone, compromising the air gap and increasing the likelihood of flashovers, conductor faults, or insulator contamination. Nesting material accumulated on cross-arms or near insulator strings can also become dislodged during strong winds, storms, or fledging events, potentially falling onto live components and causing unplanned outages. Nesting behaviour by certain species, particularly corvids, may exacerbate these operational risks. Pied Crows (*Corvus albus*) are known to incorporate a wide range of non-natural materials into their nests, including wires, metallic objects, and other anthropogenic debris. When conductive materials are used, the risk of electrical bridging or flashovers increases substantially, especially if such items protrude into the air gap or come into contact with live components during high winds or nest maintenance activity. This behaviour adds an additional layer of complexity to managing nesting impacts on transmission infrastructure, as even relatively small amounts of conductive material can result in equipment damage or unplanned outages. Furthermore, towers that support persistent or multi-year nests may experience localized increases in bird activity, including higher volumes of droppings, prey remains, and nesting debris. This can exacerbate pollution-related faults and elevate the probability of equipment deterioration over time. While the ecological advantages of providing nesting platforms are substantial, these operational concerns may necessitate an adaptive management approach.

3.5 Bat Habitat and Flyways

The main impacts on bats will be related to habitat fragmentation and degradation associated with the clearing of natural and modified habitats within the ROW, construction areas and access roads, leading to loss of food sources and to loss or disturbance of roosting and breeding sites for bats.

Fruit bats are likely to be affected by loss of fruit-trees during vegetation clearing. The Near-Threatened African Straw-coloured fruit bat (*Eidolon helvum*) is known to feed in miombo woodlands within parts of the study area, on fruit from a variety of fruit trees, including *Ficus spp*, *Magnistipula butayeei*, *Parinari curatellifolia*, *Syzygium cordatum*, *Syzygium guineense guineense*, *Syzygium guineense huillense*, *Uapaca kirkiana*, *Uapaca banguelensis*, and *Uapaca sansibarica*. Clearing of such trees over large areas would reduce the food availability for this bat species.

Two other Near-Threatened species, the Striped Leaf-nosed Bat (*Macronycteris vittatus*) and the Smithers's Horseshoe Bat (*Rhinolophus smithersi*), are both cave bats that can also use tree canopies, hollow trees and dense vegetation for roosting. Disturbance of vegetation or landscapes and felling of large hollow trees, such as baobab trees, could disturb or destroy permanent roosts of this species.

During operation, no significant impacts are anticipated, bat collisions with the powerline and electrocution are both very unlikely.

The main bat migration known in the study area is the African Straw-coloured Fruit Bat, which can cover large distances for feeding. It is unlikely the proposed powerline will interact with this migration flyway. In fact, bat collisions with the transmission are unlikely as bats generally have exceptional obstacle avoidance capabilities.

Electrocution is only possible when frugivorous bats get in contact with two live wires at the same time, although this is most often observed with distribution lines which have smaller spacing between live components. Due to the large size of the clearances on most overhead lines above 132kV, it can be concluded that electrocutions on the ZTIP power line will not be possible through conventional mechanisms.

3.6 Terrestrial Fauna

During the construction phase, site preparation for access roads, construction areas, transmission line and substation construction will lead to habitat loss for terrestrial fauna species. Removal of vegetation along the transmission line, particularly in areas where natural vegetation is found, can also increase habitat fragmentation in the study area, particularly where the ZTIP is not combined with existing linear infrastructure.

Mechanical clearing and habitat alteration during construction can pose direct threats to reptiles and amphibians in the impacted areas (Finn & Stephens 2017). Many species rely on cryptic behaviour rather than fleeing disturbances, making them particularly vulnerable to injury or mortality during site preparation. Consequently, habitat destruction may lead to reduced herpetofauna abundance and diversity within the development zone (Doherty et al., 2020).

Habitat fragmentation could affect particularly sensitive species, such as Red-Listed mammal species potentially found in the study area. These include the White-bellied Pangolin (*Phataginus tricuspis*) (EN), the African Savanna Elephant (*Loxodonta Africana*) (EN), Lions (*Panthera leo*) (VU), Hippopotamus (*Hippopotamus amphibius*) (VU), Leopards (*Panthera pardus*) (VU) and Temminck's Pangolins (*Smutsia temminckii*) (VU), Puku (*Kobus vardonii*) (NT), Plains Zebra (*Equus quaggai*) (NT) and African Clawless Otter (*Aonyx capensis*) (NT), as well as the Roan Antelope (*Hippotragus equinus*), which is threatened according to the Fifth National report of Zambia for the Convention on Biological Diversity. For some of these species, i.e., Puku and Plains Zebra, the BIIA is part of their historical distribution, and they may no longer exist. Others are rarely sighted.

Construction activities can also cause increased noise, which may disturb species present in the area. These impacts are temporary and terrestrial fauna species are likely to migrate to similar but quieter habitats in the vicinity of construction areas. Additionally, workers' presence could lead to increased poaching of certain terrestrial fauna species.

Waste generation has the potential to increase pest fauna locally if it is not managed properly, especially around workers' camps. All construction materials, particularly those used to reinforce structures, such as steel wires, should be safeguarded and cleared from worksites to avoid their use as wire snares, which are widely used in the illegal harvesting of large animals. Wire snaring is now the most sophisticated and deadliest method used by illegal hunters of large game.

The construction activities and the influx of workers could inadvertently facilitate the introduction of non-native invasive species by increasing human presence and activity in the area, which may alter local predator-prey dynamics. The construction process itself could transport non-native species either through construction materials, vehicles, or personnel. The introduction of non-native invasive species poses a risk to the study area's herpetofauna and other terrestrial species.

During the operation phase, vegetation clearing and maintenance within the ROW will maintain the vegetation in the early stages of regeneration, reducing the quality of habitats for fauna species with stricter ecological requirements that require mature vegetation. It could lead to a local adaptation of wildlife communities with a higher representation of common species. The vegetation maintenance can also affect fauna migration and movements within the study area through disturbance and higher exposure within the ROW. It can also create a barrier effect for smaller terrestrial fauna species.

3.7 Aquatic Habitat

The construction of access roads and towers as well as vegetation clearing in the ROW, earthworks and vehicles and machinery traffic, could lead to impacts on rivers, wetlands, and riparian areas. As mentioned above (Section 3.1 Natural habitats) at least 5.5 ha of wetlands considered natural will be directly impacted. Additionally, 14 pylons fall within highly disturbed wetlands considered modified habitat, representing an additional loss of 0.6 ha of wetland (410 m² footprint per tower), not considering additional access-related disturbance.

The construction of access roads can change the quantity or direction of water flow, causing permanent damage to hydrological conditions sustaining wetland and stream dynamics and habitats. If flowing water is stopped by structures, a lentic habitat could replace the existing lotic ones. Also, if the road blocks the runoff water, it could lead to the creation of wetlands locally. Typical flora communities would consequently switch and be replaced by adapted vegetation.

At water crossings, access roads have the potential to cause modifications to water dynamics and, consequently, deterioration, destruction, or disturbance of wetlands and watercourses comprising habitats for amphibians, fish and other aquatic organisms. Moreover, access roads have the potential to obstruct aquatic fauna movements, leading to restricted access to specific habitats for a variety of species. Aquatic habitat destruction and altered hydrology have the potential to affect amphibian breeding sites.

Construction activities could increase suspended solids, silt spawning and feeding sites for aquatic and semi-aquatic species. Increases in organic material inside the aquatic environment could also result in a higher biochemical oxygen demand (BOD) and a reduction of dissolved oxygen for aquatic wildlife locally.

Additionally, water could also be contaminated through accidental spills of chemical products, hydrocarbons, and wastewater resulting from poor environmental management. Such contamination during dry seasons, with shallow and slow-moving water, will exacerbate the impacts as the contaminants could be locally concentrated. Environmental contamination could affect the aquatic and semi-aquatic fauna, including amphibians and fish, which are sensitive to the presence of contaminants in their habitats. The implementation of the Emergency Response Plan and the appropriate mitigation measures will reduce this impact.

Moreover, vehicles and construction equipment can introduce non-native invasive species that adapt well in wetlands. Non-native invasive species may compete with native vegetation, destroying valuable wildlife habitats, adding to direct habitat loss and can lead to increased predation pressure, which may further threaten fauna and flora populations. Vehicles and construction equipment also introduce diseases and parasites such as the amphibian Chytrid fungus (*Batrachochytrium dendrobatidis*), which is a major threat to amphibian biodiversity and has caused population declines and extinctions in parts of the world. The fungus disrupts amphibian skin function, impacting hydration, electrolyte balance, and oxygen exchange, ultimately causing death in infected animals. This pathogen is likely to be of Asian origin (O'Hanlon et al., 2018) and has been introduced to Africa (Doherty-Bone et al., 2020). Its presence in the study area is not confirmed, but a precautionary approach is advised.

Project impacts on aquatic habitats may negatively affect one species of fish considered vulnerable by the IUCN, *Chiloglanis elisabethianus*, a benthopelagic species.

During the operation phase, possible changes in the hydrological conditions that could be related to the presence of access roads and pylons within a flood zone of a wetland or a watercourse could lead to modification of ecological parameters and associated disturbances of the aquatic and semi-aquatic fauna. Maintenance of access roads and related ditches and water-crossings is essential in order to prevent the creation of insurmountable obstacles for the aquatic fauna and for soil erosion to encroach spawning grounds or other critical ecological habitats. Movement of people and vehicles along the ROW, and access roads for ROW maintenance and for repair of the transmission line, can lead to the introduction of non-native invasive species and accidental spills. Seeds and other propagating parts of non-native invasive species can be carried out into a wetland or watercourse inadvertently by equipment.

4. Impact Avoidance and Mitigation Strategy

This chapter defines the biodiversity impact avoidance and mitigation strategy for the project to ensure the preservation of key biodiversity features during implementation of the project. It includes measures to be implemented during pre-construction, construction and operation phases of the project, as well as measures to support the project's design. The chapter is structured in accordance with the mitigation hierarchy and aligned with the requirements of ESS 1 and ESS 6.

Implementation of the mitigation hierarchy, i.e., avoid, reduce (minimize), remedy (restore), and compensate has been systematically applied, as outlined in Figure 4-1. In accordance with ESS 6, avoidance and minimization measures are prioritized and embedded within technical design, site selection and construction methodology. In case of residual impacts, compensation will be considered as a last resort, only if significant residual adverse impacts remain after all technically and financially feasible avoidance, minimization, and restoration measures have been considered. Where residual impacts to natural habitat remain, compensation actions have been designed to achieve no net loss (NNL) of natural habitat and net gain (NG) of critical habitat, as required by World Bank ESS 6. For critical habitat, the mitigation strategy is also designed to demonstrate that the project will not result in measurable adverse impacts on the biodiversity values that qualify the habitat as critical, nor reduce the long-term viability of the affected species populations.

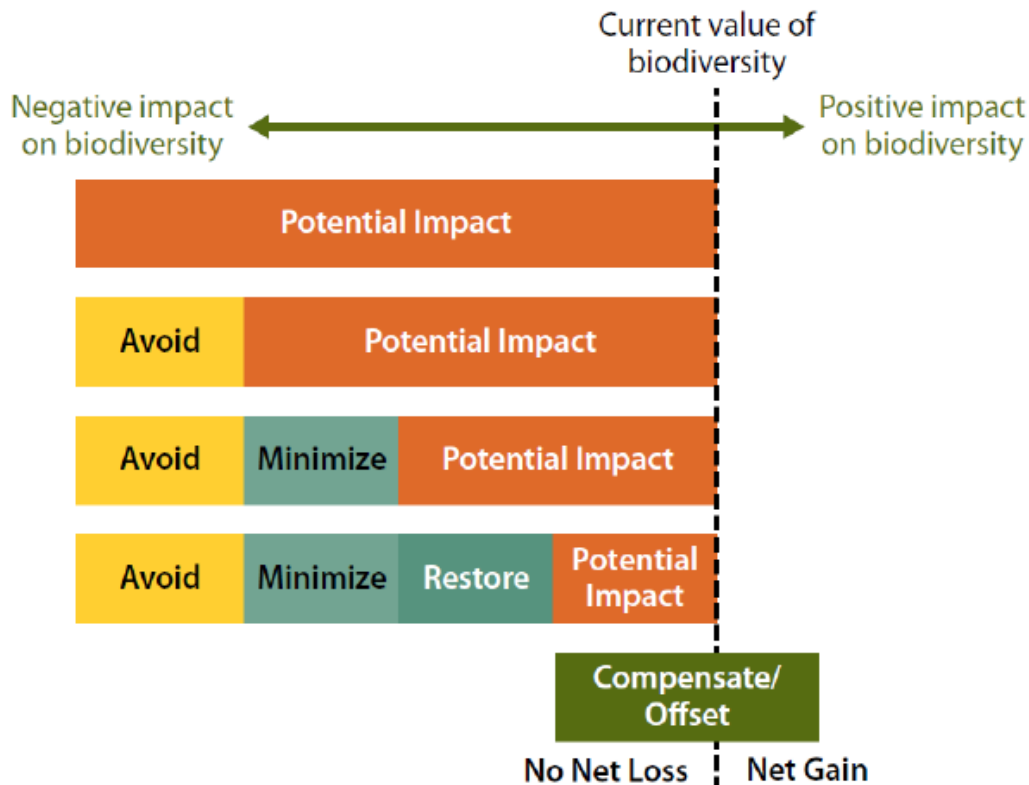


Figure 4-1 Mitigation Hierarchy

The mitigation strategy includes design-based measures, additional field verification requirements, and specific construction and operational procedures tailored to biodiversity-sensitive areas. These are described in detail in the sections below.

The complete set of biodiversity management measures to be implemented during project implementation, including those related to design, field work or work procedures are presented in Table 4-3 for pre-construction and construction phases and Table 4-4 for the operation phase.

4.1 Avoidance and Mitigation through Project Design

Avoid Siting Construction Facilities in Natural Habitat

Promote the selection of areas of modified habitat with less or no need to cut trees for the installation of temporary construction work and storage areas and construction of access roads. Planning must ensure that construction laydown areas, work camps, temporary access tracks and material stockpiling zones are clearly demarcated, with all personnel briefed on no-go areas and biodiversity protection requirements.

Ensure construction activities, including vehicle movements and material storage, remain within the ROW, temporary construction areas and identified access roads. Use only designated access.

Minimize the Construction of New Access Roads

The use of existing access roads must be maximized to reduce the need for new road construction, increasing their width as necessary. Where new roads are unavoidable, they must follow already disturbed corridors such as farm tracks or degraded areas and avoid ecologically intact habitats. Any unavoidable vegetation clearing within the servitude must be kept to the minimum extent required for safe construction and line operation, and natural vegetation outside the working corridor must remain undisturbed.

Minimize Encroachment on Rock Outcrops in Proximity and within the Kasama Forest Reserve through Micro-Siting of Tower Foundations and Workspaces

Project risks within the Kasama Forest Reserve and the Mwela National Monument site are attributable to the presence of highly valued features (critical habitat for *Euphorbia perplexa* var. *kasamana* and cultural heritage) associated with the rock outcrops. Though a line deviation was determined to be operationally constrained by ZESCO and the World Bank (Appendix 4-1), encroachment on rock outcrops should be minimized. Minimization measures will include evaluating tower design and placement strategies to limit footprint overlap with rock outcrop habitat – specifically, micro-siting of tower foundations and workspaces to avoid impacting individuals based on pre-construction surveys and identification of *Euphorbia perplexa* var. *kasamana* specimens. Specific work methods were also designed for any construction activities on critical habitat rock outcrops (see Section 4.3). These measures represent the technically feasible avoidance and minimization options available at this stage of Project development. Residual impacts are addressed through the biodiversity mitigation and conservation strategy described in subsequent sections.

Minimize Encroachment in Wetlands and Riparian Areas, Including Towers, Access Roads and Temporary Construction Areas

Tower siting inside wetlands and riparian habitats will be avoided as much as possible by detailed tower micro-siting and using longer spans between towers to avoid erecting structures in these habitats – except where no technically feasible alternative exists. Final tower coordinates will be confirmed through pre-construction site walk-downs involving engineers and qualified ecologists from the Contractors in collaboration with ZESCO to ensure that foundations are positioned outside the most sensitive microhabitats and to avoid direct encroachment into wetland core areas where feasible.

Reduced encroachment in these areas will help reduce loss of natural habitat and critical habitat for *Disa aequiloba*. This will also prevent permanent modifications to local drainage, reduce temporary disturbance of aquatic life, as well as help preserve ecological functions of these habitats. Tower foundation design in wetlands will ensure no alteration of natural hydrological flow patterns. Excavation spoil will not be deposited within wetland areas, and foundation backfilling will restore pre-existing surface contours to maintain hydrological connectivity. Permanent impacts within wetlands will be limited to tower foundation footprints. Access-related disturbance will be temporary and subject to immediate restoration following construction.

The placing of access roads and temporary construction areas within wet grasslands and dambos identified as critical habitat for *Disa aequiloba* will be avoided. Where access is unavoidable, low-impact methods such as construction mats or temporary timber pathways will be used, and no permanent road construction will occur within these habitats. These measures are designed to ensure that impacts to *Disa aequiloba* critical habitat are limited to discrete and unavoidable foundation footprints and do not impair the ecological functioning or hydrological integrity of wetland systems.

Reduce Width to be Cleared in Forest Reserves

According to the Energy Regulation Board (ERB) Wayleave Code, wayleaves for overhead lines in recognized forestry areas should be of 78 m for 330kV lines. This restriction is in the Code to ensure security of the line by avoiding risk of tall trees falling and damaging the line. However, considering the miombo woodland in the project area does not host tall canopy trees and in order to minimize impacts in the six Forest Reserves crossed by the line, ZESCO reduced the width of the wayleave to 50 m in these areas.

Apply Same Design when Two Lines Are Side by Side

The design of the ZTIP involves optimization directly aligned with the avoidance and reduction of associated impacts in combining the ZTIP alignment with existing transmission line (in between Pensulo and Kasama) or in combining two single circuit lines in a single wayleave and mounted on the same pylons (combined with the Kasama-Nakonde single circuit 330kV line). Approximately 328 km of the powerline is paired with an existing powerline in between Pensulo and Kasama substations. It is recognized that placing a new line next to an existing line of similar size, voltage, and tower specifications reduces the risk of collision for birds. The reasons are two-fold, namely it creates a more visible obstacle for birds. Also, resident birds, particularly breeding adults, which are accustomed to an obstacle in that geographic location and have learned to avoid the powerline infrastructure, will be less likely to collide with the line (APLIC, 2012; Sundar & Choudhury, 2005). Hence, when parallel to an existing 330kV line, the new line will be designed to have the same elevation to avoid creating a larger obstacle.

Ensure Sufficient Spacing is Maintained Between Energized Components and Grounded Hardware

There is a small risk of birds or bats being electrocuted by the powerlines. This can happen if a bird or bat touches both an energized component and grounded hardware at the same time, which could occur if these components are close together. Therefore, it is recommended that a minimum distance of 3 meters be maintained between energized components and grounded hardware, which would be larger than the wingspan of large birds.

Install Bird Flight Diverters

Collision mitigation during construction focuses on the correct and timely installation of bird flight diverters (BFD) along identified high-risk spans. The recommended marking requirements for the ZTIP 330kV power line are as follows:

- Both earthwires must be marked, as they are the least visible components of the transmission structure and represent the greatest collision hazard for fast-flying or low-light species.
- Diverters must be installed at intervals of 10m along the span.
- Diverters on the two earth wires must be staggered relative to each other to create a visually continuous deterrent along the entire span.
- Installation on the full earthwire/groundwire span length. Partial marking (i.e. installing BFDs on the middle 60% of the earthwire span) appears to displace rather than reduce collisions.
- Diverters must alternate between highly visible colours to enhance conspicuity against diverse backgrounds and varying light conditions.
- All BFDs must be fully installed and inspected prior to the line being energised.

The Contractors Environment, Health and Safety (EHS) Manager will verify that diverters are installed according to these specifications and that no high-risk spans are omitted. Any design or alignment changes during construction that affect span height, tower location, or wire sag must trigger a review to confirm that mitigation remains adequate.

It is recommended to install bird flight diverters within all High, Medium-High and Medium sensitivity areas for birds (see section 2.4.9 and Maps 2-14 to 2-16). Span-level collision mitigation recommendations are summarised in Table 4-1 below.

The selection of appropriate bird flight diverters must be confirmed, with preference for high-visibility, industry-standard devices that have shown proven efficacy for the species groups present in the area. Pre-construction briefings will also be used to ensure that the Contractors' team clearly understands the rationale for all avifaunal safeguards and how these need to be incorporated into the build sequence.

Table 4-1 Span-Level Collision Mitigation Recommendations and Number of Bird Diverters Needed

Habitat sensitivity zone	Sensitivity	Recommended span (tower numbers)	Span length (m)	Estimated number of bird diverters
Pensulo – Mpika (PM)				
Area 1	Medium	005-006	405.63	82
Area 3	Medium-high	023-025	834.79	167
		028-032	1370.20	275
Area 7	Medium-high	044-050	2664.04	533
Area 8	High	054-056	779.91	156
		061-063	735.32	148
Area 9	Medium	066-067	470.19	95
Area 10	Medium	075-078	1117.11	224
Area 13	Medium	086-090	1439.49	288
Area 12	Medium	095-097	859.83	172
Area 14	Medium	132-133	479.38	96
		150-153	1160.11	233
Area 31	Medium-high	171-176	1990.43	399
Area 15	Medium-high	212-215	1253.94	251
Area 16	Medium-high	228-230	861.98	173
		233-240	2713.68	543
Area 17	Medium-high	253-254	441.84	89
Area 18	Medium-high	280-283	1229.72	246
Area 21	Medium-high	291-293	820.55	165
Area 22	Medium-high	315-318	1216.00	244
Area 23	Medium-high	320-326	2491.11	499
Area 24	Medium-high	332-337	2145.93	430
Area 25	Medium-high	343-351	3138.76	628
Area 25a	Medium	361-363	831.31	167
Area 25b	Medium	370-374	1380.61	277
Area 26	Medium	381-382	457.98	92
Area 27	Medium	397-398	425.67	86
Area 30	Medium	419-420	380.13	77
Area 28	Medium	428-431	1255.34	252

Habitat sensitivity zone	Sensitivity	Recommended span (tower numbers)	Span length (m)	Estimated number of bird diverters
Area 28a	Medium	448-449	435.36	88
Area 28b	Medium	456-458	803.48	161
Area 29	Medium	469-471	652.28	131
Total			37,242.10	7467
Mpika – Kasama (MK)				
Area 29	Medium	006-007	375.46	76
Area 32	Medium-high	010-011	514.85	103
Area 33	Medium	029-032	1224.98	245
		040-057	6840.39	1369
Area 34	Medium	087-089	769.76	154
Area 35	Medium-high	100-111	4498.92	900
Area 36	Medium-high	118-124	2620.03	525
Area 37	Medium-high	150-153	1335.24	268
Area 38	Medium-high	165-166	430.24	87
Area 38a	Medium	176-180	1774.28	355
Area 39	Medium	185-187	848.15	170
Area 40	Medium	201-205	1695.42	340
Area 41	Medium	212-215	1220.10	245
Area 42	Medium	250-252	805.11	162
		258-260	815.01	164
Area 43	Medium-high	283-298	5771.15	1155
Area 44	Medium	317-321	1529.98	306
Area 45	Medium	369-375	2363.90	473
Area 46	Medium	433-435	757.34	152
Area 47	Medium	444-445	465.06	94
		454-456	824.41	165
Area 48	Medium-high	469-472	1253.23	251
		478-479	399.78	80
Total			39,132.79	7839
Kasama-Nakonde				
Area 49	Medium	29-40	4,069.06	814
Area 51 -50	High	47-60	4,788.03	958

Habitat sensitivity zone	Sensitivity	Recommended span (tower numbers)	Span length (m)	Estimated number of bird diverters
Area 52	High	90-92	745.95	150
Area 53	Medium	131-136	1,972.84	395
Area 53b	Medium	157-158	429.47	86
		162-164	783.48	157
Area 54	Medium	201-203	756.05	152
		213-216	1,071.93	215
Area 54a	Medium-high	219- 222	1,171.48	235
Area 55	Medium-high	229- 230	453.51	91
		233-236	985.07	198
Area 56	Medium	276-279	1,114.35	223
		282-286	1,400.02	281
Area 56b	Medium	348-349	410.26	83
Area 57	Medium	391- 400	3,101.72	621
Area 57b	Medium	429- 439	3,533.61	707
Area 58	Medium	511-515	1,388.42	278
		527-536	3,573.03	715
Total			31,748.28	6359
400kV Nakonde Border				
Area 58b	Medium	35-36	456.99	92
Total				
Total			108,580.16	21,757.00

4.2 Required Field Work

Undertake ROW Vegetation Clearing with the Supervision of a Botanist

Vegetation clearing will be done with the supervision of a botanist from the Contractors in order to confirm and detail habitat losses. The expert shall be deployed whenever vegetation clearing occurs for each work package in all sections being cleared. If several areas are being cleared simultaneously multiple experts will be needed to ensure all clearing works are supervised.

The expert will be responsible for identifying species and number of all special status trees cleared, identify vegetation to be protected, confirm habitat types and surface area lost, and implement relocation or seed collection measures. Where clearing happens within Forest Reserve, the Contractors' botanist should be assisted by a technician from the Forestry Department.

If possible, relocate specimens or collect cuttings or seeds of species of conservation concern, including IUCN Red Listed flora species East African Mahogany (*Khaya nyasica*) (VU), Leopard orchid (*Ansellia Africana*) (VU), and African Cherry (*Prunus africana*) (VU), and endemic *Rhus fanshawei*. When feasible, Red-Listed plants and endemic plants will be removed and relocate to secure wooded sites or other appropriate sites. This will be possible for *Ansellia africana*, an epiphyte, which can be removed from host tree and positioned on a new tree in a similar habitat or brought to a nursery to be re-established in a secure habitat.

The supervision will also aim to protect vegetation that does not represent a risk for the powerline. Specimens of species of conservation concern will be preserved, when possible.

If cutting of a species of conservation concern is necessary during clearing activities, GPS coordinates of each specimen and the description of their habitats will be noted. Each lost specimen will be offset by replanting, and the success of their plantation will be monitored.

Surveys and Salvage Transplantation of *Disa aequiloba* Specimens

Pre-construction surveys for *Disa aequiloba* must be completed within a 100 m buffer of permanent and temporary footprint elements located in critical habitat (i.e., low and medium disturbance wetlands, except those where the species was recorded as absent during previous surveys). In order to be able to identify the species, surveys shall be done during the wet season, when the species is flowering (January to February). Within the project footprint, where ground disturbance is unavoidable, the following actions will be undertaken:

- Record the number of individuals present within the footprint.
- Carefully remove individual orchid tubers/plants and prepare them for transport and transplant.
- Transplant salvaged individuals to a pre-identified, secure, and ecologically similar 'receptor wetland' located outside of the project ROW.

In survey areas outside the project footprint, the following actions will be undertaken:

- Record the number of individuals present.
- Delineate the occupied area with stakes.
- For each occupied area delineated, install at least one warning sign informing workers of the biological sensitivity and the requirement to remain outside of the demarcated boundaries.

In all instances, surveys and transplant efforts will be conducted by qualified professionals. In collaboration with orchid researchers at Copperbelt University, the PIU will develop a detailed salvage and transplantation procedure, including the identification of 'receptor wetlands', prior to construction. Salvage and transplant measures will be implemented early during the growing season (i.e., December to early February) to increase the likelihood of survival for transplanted individuals.

Surveys and Salvage Transplantation of *Euphorbia perplexa* var. *kasamana* Specimens

Pre-construction surveys for *Euphorbia perplexa* var. *kasamana* will be completed within a 100 m buffer of permanent and temporary footprint elements located in critical habitat (i.e., rock outcrops). Within the project footprint, where ground disturbance is unavoidable, the following actions will be undertaken:

- Record the number of individuals present within the footprint.
- Carefully remove healthy individuals from the direct impact zone and prepare them for transport and transplant.
- Transplant salvaged individuals to a pre-identified, secure, and unoccupied site in the Kasama Forest Reserve. Locations should be confirmed in collaboration with District Forestry Department and NHCC.

In survey areas outside the project footprint, the following actions will be undertaken:

- Record the number of individuals present.
- Delineate the occupied area with stakes.
- For each occupied area delineated, install at least one warning sign informing workers of the biological sensitivity and the requirement to remain outside of the demarcated boundaries.

In all instances, surveys and transplant efforts will be conducted by qualified professionals. In collaboration with botanists at Copperbelt University, forest managers from the Kasama Forest Reserve, and specialists with the NHCC, the PIU will develop a detailed salvage and transplantation procedure, including the identification of 'receptor sites', prior to construction. Salvage and transplant measures will be implemented early during the dormancy season (i.e., at the height of the dry season, in July and August) to increase the likelihood of survival for transplanted individuals.

Pre-Construction Inspection (Avifaunal Walk-Through Surveys)

Undertake a pre-construction inspection (avifaunal walk-through surveys) of the powerline ROW and access roads to identify Priority species and Red List species that may be breeding. This inspection aims to verify the presence of nests prior to site establishment, map their locations, and enforce appropriate no-go buffers to prevent inadvertent disturbance.

Where a priority species is nesting, no vegetation clearing or tower/pylon construction activity or continuous vehicle/pedestrian activity within a radius of 1 km to ensure minimal disturbance and reduce risk of nest abandonment. The avifauna specialist shall be consulted for guidance on actions to be taken. Wait until the nest is deserted before resuming work, conducting weekly checks to verify nest activity.

In order to compensate for potential loss of priority species breeding/nesting sites, the use of trees that are important for nesting of special status bird species and for nesting/perching of large raptors will be integrated in the NHCP. However, protecting existing large trees when possible is critical, as newly planted trees cannot quickly replace the nesting and roosting opportunities they already provide. Many bird species depend on cavities that only form in old, mature trees, a process that takes decades to achieve.

Priority species nest locations presented in Table 4-2 must be integrated into the construction scheduling. The pre-construction survey shall validate if these nests are still active and work near these areas should be avoided during breeding period.

Table 4-2 Priority Species Nest Locations

Species	Latitude	Longitude	Breeding period	Notes
African Hawk-Eagle <i>Aquila spilogaster</i>	-11,1617189	31,1480582	June – November peaking in June - July	
African Marsh Harrier <i>Circus ranivorus</i>	-10,4032790	31,1808759	December - August	
African Marsh Harrier <i>Circus ranivorus</i>	-10,4041219	31,1797209	December - August	
African Marsh Harrier <i>Circus ranivorus</i>	-11,4979784	31,2672300	December - August	
African Marsh Harrier <i>Circus ranivorus</i>	-11.8818097	31.4038470	December - August	
African Marsh Harrier <i>Circus ranivorus</i>	-9,7922181	31,6867402	December - August	
African Marsh Harrier <i>Circus ranivorus</i>	-9.853257	31.641396	December - August	
African Marsh Harrier <i>Circus ranivorus</i>	-	-	December - August	Nest on PSL MPK Tower 151
Lanner Falcon <i>Falco biarmicus</i>	-12,904801	30,699201	June – November peaking in July - August	2 nests on power line
Unknown Species Potentially Large Eagle	-11,385352	31,223220	To be determined upon confirmation of species	Large nest in tree (<i>Brachystygia boehmii</i>)
Unknown Species *Brown Snake-Eagle	-	-	To be determined upon confirmation of species	Nest on MPK KSM Tower 261

Pre-Construction Inspection to Identify Bat Roosts

Undertake a pre-construction inspection on the final route alignment and access roads to identify any major bat roosts within or close to the areas to be cleared. Places to be checked include holes in large, hollow trees, inside caves and rock crevices, under bridges and in large culverts under roads.

Bats can also roost in foliage in large trees. Indirect evidence to look for is the presence of piles of droppings, urine stains on rocks inside and at the exits of potential roosts. Bat droppings look like dark brown or black grains of rice and are shiny, due to the undigested insect parts they contain. When touched, they easily break apart into powder. Bat droppings usually accumulate in heaps where bats roost. Local populations can also be consulted to identify known roosts. Local bat experts can be hired to identify species in major roosts.

Specific places to be surveyed for bat roosts are:

- Along the line route near and in Kasama; check for African Straw-coloured Fruit Bats, which are big bats that roost in large numbers in tall trees and can be located by the noise they make during the day and the individual bats hanging in and flying around within the trees;
- In rocky outcrops in Kasama Forest Reserve; particularly check for large caves or crevices among the rocks that might house Striped Leaf-nosed Bats or Smithers's Horseshoe Bats.

Where major bats roost (over 100 bats) especially near where threatened species are identified, do not undertake tree clearing within a radius of 1 km. Also inspect all large trees (live or dead) with hollows for presence of bats. Do not cut trees that are in use by bats nor the surrounding trees. Wait until the roost is deserted. Come monthly to the roosting site to verify, not more often.

4.3 Avoidance and Mitigation through Specific Work Procedures

Non-Native Invasive Species Management Plan

The Contractors will develop a detailed non-native invasive species management plan prior to the construction phase. ZESCO will develop a similar plan for the operation and maintenance phase. As described in the baseline, a total of 21 invasive species from 15 families are reported in Zambia according to Global Invasive Species Database (GISD). These species generally occur in grasslands and disturbed areas, and tolerate a great variety of conditions, facilitating their colonization of newly cleared or disturbed areas. Some of them are found in aquatic ecosystems, such as *Lagarosiphon major* and *Trapa natans*. Four species from this list have been observed in the study area, which are *Bidens pilosa*, *Imperata cylindrica*, *Leucaena leucocephala* and *Lantana camara*.

To prevent non-native species propagation, construction and maintenance equipment will be properly cleaned before arriving in work areas and again when leaving if it is contaminated with invasive species. Before equipment is used in a new work area, vehicles and machinery will be inspected and cleaned to remove any plant residue from invasive alien flora species. This measure will avoid transport of invasive species from an area to another and prevent potential introduction and spread of invasive alien species into the line ROW and adjacent habitats and avoid any modification of species composition in fauna communities present in the project area.

Appropriate clearing techniques will be used in areas where invasive flora species have been identified (such as hand clearing rather than mechanized clearing). Where large quantities of non-native invasive flora are found, residues will be buried to reduce the risk of propagation to other areas. During vegetation clearing within the ROW or along access roads, stem, branches, roots, leaves and fruits or seeds from invasive species will be gathered in one pile, then buried. This will help prevent their dissemination and spread within the line ROW and adjacent areas.

During site rehabilitation activities, any reseeded which takes place will occur with native species to ensure that no invasive species are introduced to the site

Work Methods within or in Proximity to Wetlands and Aquatic Habitats

The Contractors will be responsible to develop a detailed Management Plan for all works within or in proximity to wetlands and aquatic habitats during the construction phase. ZESCO will develop a similar plan for the operation and maintenance phase. The plan will describe the procedures for working in or near watercourses, wetlands, and riparian areas and will ensure the avoidance and mitigation of impacts within *Disa aequiloba* critical habitat and natural habitats which include wetlands with low and medium disturbances as well as riverine forests. The plan will also avoid and reduce impacts on aquatic habitats. The management plan will:

- Incorporate the relevant avoidance and minimization measures identified below for protection of watercourses, wetlands, riparian areas, and aquatic life.
- Define and implement protective buffers around wetlands and watercourses.
- Describe and implement appropriate watercourse crossing methods that define requirements for different types of watercourses (e.g., streams with perennial versus intermittent flow). Where watercourse crossings are needed, work must be prioritized during the dry season and emphasize the use of temporary crossings over permanent structures. The crossing method description will be sufficiently detailed to allow for an understanding of which watercourse crossings will require fish rescues, how the bed and banks of watercourses will be protected and restored following works, how hydrological connectivity will be maintained, how erosion and sedimentation will be avoided and minimized, and how the risk of localized flooding will be mitigated.

- Describe measures to minimize wetland damage associated with site access. Measures will include the use of temporary protective materials (e.g., wood mats) to minimize soil compaction and vegetation damage and appropriate rehabilitation measures following their removal. Prioritize the use of tracked equipment for work in wetlands, on riverbanks, and in floodplains.
- Confirm the approach for staking work areas and minimizing the size of work areas in wetlands and riparian areas.
- Describe the strategy for handling and storing excavated materials and identify where these materials will be placed (outside of wetlands or flood zones).
- If applicable, describe the strategy for dewatering work areas. Confirm where water will be pumped and how wetland hydrology will be maintained and/or restored following construction.

General measures for work within or in proximity to wetlands and aquatic habitats

At all times during any type of work within or in proximity to wetlands and aquatic habitats, the following measures will need to be applied:

- Avoid works within the defined buffers of waterbodies from the beginning of in-water works to protect bank stability.
- To ensure minimal tree loss, reduce the width of cleared areas to a minimum where the line crosses riverine forests, including within the Mungwi Forest Reserve. Clearing of only 10 m of riverine forest vegetation to accommodate conductor stringing will be considered.
- Avoid vegetation clearing in wetlands and riparian areas and on steep slopes. Only cut the tree strata in riparian areas within the ROW. Maintain shrubby vegetation compatible with the clearance required for the line.
- Protect vegetation along watercourses by delineating water crossings and restoring banks immediately after work.
- Avoid work in watercourses during high flow events and during heavy rainfall to reduce the risk of fine sediment release, watercourse erosion and increased flood risk.
- Avoid construction of temporary access roads along river banks, wetlands, or in areas where soils are saturated. No access routes will be constructed in riverine forests, access will be limited to the ROW corridor.
- Minimize direct access of vehicles to watercourses. If it is necessary for any vehicle to enter a watercourse, it will be inspected in advance and, if required, remedial action will be taken to prevent contamination from oil/fuel leakages.
- Instruct all drivers regarding the use and safe disposal of clean up equipment and the need to carry absorbent materials in their vehicles.

- Aquatic fauna rescue and removal will take place in all isolated work areas prior to in-water construction. All aquatic fauna (fish, amphibian, reptiles) will be relocated to suitable habitats (preferably in the same waterbody, immediately upstream or downstream of the isolated work area).
- Do not throw debris in aquatic habitats and remove any debris introduced accidentally into the aquatic environment as soon as possible.
- Store hazardous material and vehicles away from wetlands and watercourses floodplains, respecting recommended buffer width. Apply the same distance for any refueling activity.
- Avoid material piling inside wetlands and aquatic habitat, including floodplains, respecting recommended buffer width.
- Use impervious surfaces for refueling and other fluid transfer. Provide adequate secondary containment for fuel storage tanks and for the temporary storage of other fluids such as lubricating oils and hydraulic fluids.
- Use backfill materials free of contamination or of leachable waste; prior controls and analyses will certify their quality.
- Maintain hydrologic connectivity between upstream and downstream work areas.
- Contain any spills onsite and clean up spills as soon as possible.
- Characterize, remove, and dispose of soils contaminated with petroleum products or other hazardous materials at sites authorized by State waste management authorities.
- Keep a spill containment kit, including absorbents, readily accessible onsite in the event of an accidental spill and ensure onsite staff is trained to use it.
- At the detailed design stage, minimize encroachment within wetlands and aquatic habitat and select exact location for towers that will ensure minimal disturbances on local hydrology at large water and floodplain crossings.
- Limit transport of fine particles into watercourses/waterbodies beyond the immediate work area using a method appropriate for the affected area (i.e., sedimentation trap/barrier, turbidity curtain, etc.).
- Prepare and implement control plans to limit erosion and sediment transport to waterways, particularly in areas with high erosion potential.

Watercourse Crossing

Crossing watercourses repetitively with vehicles and machinery will deteriorate shorelines, disturb bottom sediments, degrade water and sediment quality, and affect aquatic habitats. Watercourse crossing will be avoided as much as possible and when required, the use of existing infrastructure will be prioritized. However, if no such infrastructure exists near the transmission line's ROW, then the following measures need to be applied:

For intermittent watercourses that are generally dry part of the year:

- Concentrate crossing activities during the dry season.
- Install a protective mat (made of wood beams, a thick geomembrane with a layer of granular material, etc.) over the watercourse bed to minimize its perturbations. Ensure removal of this mat once work is over or before the beginning of the wet season.
- Dismantle temporary access roads built for the construction phase in temporary wetland areas. Perform this dismantlement during the dry season and dispose of materials outside wetland areas.

For watercourses flowing yearlong or for intermittent watercourses that need to be crossed during the wet season:

- Favour the installation of a temporary bridge or a culvert designed to ensure the passage of a one-in-twenty-year flow event to minimize the risk of upstream flooding.
- Install the temporary bridge and culvert during low-water or dry periods.
- Avoid installation of temporary bridges or culvert in known fish spawning area.
- Minimize the required construction zone adjacent to and within watercourses to reduce the impacts of flow constriction and loss of fluvial floodplain water storage and conveyance.
- Ensure the temporary bridges and culverts are designed to preserve the aquatic and riverine environment's integrity, allow free passage to fishes, and for navigable watercourses, allow the passage of the biggest types of boat used on the watercourse.
- If, during the installation of the temporary bridge or culvert, a section of the watercourse needs to be dried up to facilitate work, ensure continuous water flow through:
 - Pumping of water from one side of the dried area to the other or installing a pipe connecting both extremities of the dried area. This is possible for watercourses with small flows.
 - Creating a temporary diversion (channel) around the work area. This is particularly important when the watercourse is a known fish habitat. The temporary diversion channel must be sufficiently wide and deep for fish to circulate safely.

- Temporary dams used to block water on each side of the dried area will be composed of a rock or earth mound covered with a geomembrane which will be kept in place with a rocks layer.
- If the watercourse is wide enough to require more than one culvert, isolation of part of its stream with cofferdams can be realised (no more than 2/3 at a time). Once the culvert is installed in this section the dams can be removed, and water will flow through the culvert while isolating the other section of the watercourse to install the second culvert.
- If the bridges and culverts are to be used for maintenance purposes during the operation phase, they can be left in place. If not, they will be removed and the watercourse's shores and bottom will be restored to the conditions prevailing prior to start of work.

Works in Watercourses

Other than crossings, works in a watercourse or within its floodplain may be required for the construction of a tower when it is too wide to be avoided with a reasonable span. Reaching the location of the tower base and completing the construction work can potentially have important effects on the watercourse's physical properties (flow) and chemical properties (increase suspended sediments, spill/leaks of contaminants), thus also affecting the biological components (habitat, flora and fauna).

When the tower to be built is located outside the effective normal water flow of the watercourse but within its floodplain, the following measures will be implemented:

- Ensure the design of the tower base has taken into consideration a 1-in-100-year flooding scenario.
- As much as possible, undertake works during the dry season to avoid the need for the construction of a temporary jetty.
- If a jetty must be constructed:
 - Limit vegetation clearing to the necessary width only.
 - Install a geomembrane to separate the natural soil from the aggregate that will be installed for the movement of machinery.
 - Ensure a sufficient height of clean granular material (no fines) to exceed known 1--in-20-year flooding events and add an additional height of 500 to 600 mm.
- Once work is completed, the jetty will be removed, and the corridor revegetated except for a narrow access path for future maintenance. The removal work will be conducted once water has receded from the flooding area.

When the tower to be built is located within the watercourse, the following measures will be implemented:

- If it is located close enough to the shore, the construction of a jetty may be considered to reach the construction site. In this case, the same measures as for the floodplain area will apply. At no time will the jetty impede more than 2/3 of a river's width.
- If the tower location does not allow for the construction of a jetty, construction will be done from anchored barges and all material carried by boat and additional barges.
- In all cases, the construction of the tower's base will be done using cofferdams installed around the construction area. Their presence will minimize the increase in suspended sediments and facilitate excavation and concrete laying work.
- Once the cofferdam is in place, remove any trapped aquatic fauna (fish, amphibian, reptiles) prior to pumping the water out and release them into the watercourse.
- For any of the above in-water activities, and if local water flows allow it, consider surrounding the work areas with silt curtains to intercept any suspended sediment generated by the work.
- Once work is completed, remove the cofferdams, the jetty and the work equipment and then remove the silt curtains.
- Restore the natural habitat to initial conditions once work is completed and all work-related material and equipment have been removed.

Works in Wetlands

Wetlands are sensitive ecosystems that can be easily and strongly disturbed by any type of construction activities. All low and medium disturbance wetlands in the project area are considered critical habitat for *Disa aequiloba*. Considering this, crossing or positioning a tower within a wetland will be avoided as much as possible. If such work is unavoidable, the following measures will be implemented:

- Position any tower preferably near the periphery of the wetland, not in its center.
- Any circulation will be conducted on a wood mat that will offer some protection to the flora and soils.
- Favour the use of low contact pressure machinery (equipped with tracks).
- If the construction of granular based path must be made, ensure laying a tick membrane over the natural components prior to laying the granular material. This will facilitate removal of materials at the end of the construction work and minimize impacts to the natural components of the wetland.
- Vegetation clearing of the ROW will only target trees. Shrubs and herbaceous vegetation will be left in place. Avoid using heavy machinery for clearing, favour manual approaches.

- Avoid locating the work area within a wetland. Limit the size of the work area for building towers to what is strictly necessary.
- Favour the use of tower and foundation types that minimize the ground area required.
- Store removed organic layer to be reused for the work site restoration.
- Forbid the installation of drainage channels that would modify the natural drainage conditions of the wetland.
- If water needs to be pumped from the work area, evacuate it within vegetated area located at least 20 m outside the wetland.
- Once work is completed, ensure the removal of all equipment and material no longer required and restore the freed areas using the saved organics materials and locally present plant species.

Work Methods in Critical Habitat Rock Outcrops

Construction activities within the critical habitat for *Euphorbia perplexa* var. *kasamana* will require a high level of precaution by the Contractor in charge of the construction of the infrastructure along the Kasama-Nakonde section, covered by Package 3. A mandatory construction method will be integrated within the Package 3 tender document to ensure the impacts on *Euphorbia perplexa* var. *kasamana* and its associated critical habitat are reduced as much as possible and that the method is integrated within Contractors plans and budget. Work methods to reduce impact on critical habitat rock outcrops include:

- Minimize vegetation clearing on rock outcrops as vegetation is typically scarce.
- Prohibit the construction of new access roads on the rock outcrops. Use existing access roads to get as close as possible to towers with vehicles and use access by foot to reach the tower location. Based on satellite imagery, existing access roads should allow access to tower 49, but access to towers 46, 50 and 51 should be done by foot or by helicopters.
- Use helicopters to airlift machines to excavate or drill in the rocks at towers foundations where there is no existing direct access. Perform those activities manually when possible without the use of heavy machinery.
- Airlift with helicopters or transport by foot towers components, insulator strings and hardware where there is no existing direct access.
- Erect towers 46, 49, 50 and 51, located on the rock outcrops, piece-by-piece using gin poles or other lightweight lifting methods. Erection activities will be closely monitored by the Contractor's E&S Specialist.
- Between towers 45 and 52, use a helicopter to install the pilot cable wires section and then pull the required cables under tension. Ensure the cables (pilot wires, ground wires and conductors) never touch the ground to avoid damaging the vegetation and the wires from friction on the rock.

- Minimize the spatial extent of temporary work areas (separate from the tower and foundations footprint) at each tower site. Work areas will not exceed 15 m x 15 m, for a total of 225 m² at each tower, and will be preferentially located outside the rock outcrops where possible.
- No rock levelling with import of backfilling material will be used on rock outcrops outside the pylon bases.

4.4 Biodiversity Management Measures

The complete set of biodiversity management measures to be implemented during project implementation, including those related to design, field work or work procedures, are presented in Table 4-3 for pre-construction and construction phases and Table 4-4 for the operation phase. The tables detail the location where the management measure must be applied, who is responsible for implementation and supervision, the implantation timing, performance indicators and costs. During the pre-construction and construction phases, the majority of costs will be assessed by the Contractors and included in their costs. During the operation phase, several measures will be covered in ZESCO's regular operation budget.

Table 4-3 Biodiversity Management Measures during Pre-Construction and Construction Phases

Biodiversity feature	Potential impacts addressed	Sources of impact	Management measure	Location	Responsibilities	Implementation timing	Performance indicators	Costs
Natural habitat	Permanent loss, fragmentation and degradation of natural habitat area and of its associated flora	Site preparation Construction activities Transportation and traffic Worksites' restoration	Avoid siting construction facilities in natural habitat. Promote the selection of areas of modified habitat with less or no need to cut trees for the installation of temporary construction work and storage areas and construction of access roads.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	During pre-construction phase	Temporary work and storage areas installed in already disturbed areas whenever possible.	Included in Contractors costs
			Minimize the construction of new access roads. Promote the use of existing access roads for machinery and vehicle movements, increasing their width as necessary.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	During pre-construction phase	Length and width of new access roads. Length and additional width for existing access roads.	Included in Contractors costs
			Clearly mark the extent of the ROW and temporary construction areas with stakes at intervals of 50 m or less. Identify and mark the vegetation to be preserved along sections of the ROW. Avoid all encroachment outside the ROW. Adhere to the stipulated wayleave size when clearing vegetation to avoid cutting trees unnecessarily.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	During pre-construction phase and throughout the construction phase	Limits of ROW and vegetation to be preserved marked prior to beginning of works in a given area.	Included in Contractors costs
			Ensure construction activities, including vehicle movements and material storage, remain within the ROW, temporary construction areas and identified access roads. Stick to designated access.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Number of encroachments outside identified rights-of-way. Visible and legible marking of rights-of-way and work zones.	Included in Contractors costs
			Obtain authorization from relevant authorities for vegetation clearing and limit vegetation cutting to the strict minimum required.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	During pre-construction phase	Required permits obtained.	Included in Contractors costs
			Undertake ROW vegetation cutting with the supervision of a botanist in order to confirm and detail the habitat losses. The expert will be responsible for identifying the species and number of all special status trees cleared, identifying vegetation to be protected, confirming habitat types and surface area lost, and implementing relocation or seed collection measures.	Along the length of the powerline alignment	Implementation: Contractors' Botanist Monitoring: Supervising Engineer	During pre-construction phase	Botanist(s) hired for ROW and wayleave clearance. All special status trees cleared counted. Habitat losses characterized and quantified.	Included in Contractors costs
			Any threatened or protected flora species that needs to be cut will be located and its habitat will be fully described. If possible, relocate specimens or collect cuttings or seeds of species of conservation concern.	Along the length of the powerline alignment	Implementation: Contractors' Botanist Monitoring: Supervising Engineer	During pre-construction phase	Species of conservation concern identified by a botanist and protected where possible.	Included in Contractors costs
			This BMP will be updated with real loss calculations in order to confirm no net loss objective is achieved, including for threatened or protected flora species.	Along the length of the powerline alignment	Implementation and monitoring: PIU	At the end of pre-construction phase	BMP updated at the end of pre-construction phase.	Included in PIU operation costs
			Rehabilitate and revegetate temporary access roads and work areas as soon as possible using native vegetation species that are ecologically associated with local fauna.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Temporary access roads and work areas restored. Native species used for restoration.	Included in Contractors costs
			Restore borrow sites at the end of the work activities with native plant species representative of the initial conditions.	At borrow sites used during construction	Implementation: Contractors Monitoring: Supervising Engineer	At the end of the construction phase	Native vegetation planted and maintained in restored sited.	Included in Contractors costs

Biodiversity feature	Potential impacts addressed	Sources of impact	Management measure	Location	Responsibilities	Implementation timing	Performance indicators	Costs
Natural habitat	Potential introduction of invasive plants species	Site preparation Construction activities Transportation and traffic	Develop and implement the non-native invasive species management plan.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Equipment cleaning protocols implemented and documented. Construction equipment cleared and clear of invasive species as required. Hand clearing used in areas where invasive plant species are present. Non-native invasive flora specimens managed as required.	Included in Contractors costs
Natural habitat	Risk of propagation of uncontrolled fires	Site preparation Construction activities Transportation and traffic	Implement fire risk management at construction camps.	Construction camps	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Fire risk management measures implemented. Nb of bush fires generated by construction camp.	Included in Contractors costs
			Manage cut wood residues in a manner that does not create a risk of uncontrolled fire.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	During vegetation clearing	Cut wood residues adequately managed. No uncontrolled fires generated by cut wood residues.	Included in Contractors costs
Natural habitat	Increased pressure on natural resources.	Site preparation Construction activities Transportation and traffic Purchase of materials, goods, and services Presence of workers	Make chopped woody resources and residues available to local population in order to reduce additional pressure on natural resources.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Chopped woody resources managed as required.	Included in Contractors costs
			Remove timber species of merchantable size in collaboration with the Forestry Department.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	During pre-construction phase	Number of trees of commercial wood species cut down. Consultation with the Forestry Department.	Included in Contractors costs
			Minimize harvesting, destruction, or degradation of vegetation by workers through an environmental protection awareness program.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Number of awareness sessions organized. Existence of minutes of awareness sessions. Environmental protection awareness programme implemented.	Included in Contractors costs
Critical habitat – <i>Disa aequiloba</i>	Potential loss of critical habitat for <i>Disa aequiloba</i>	Site preparation Construction activities	Avoid as much as possible pylons siting within wet grasslands and dambos considered critical for the species. Use longer spans between towers to avoid erecting structures in these habitats.	Along the length of the powerline alignment	Implementation: Supervising Engineer and Contractors Monitoring: PIU	During conception phase	Number pylons or infrastructure in wetlands.	Included in Supervising Engineer and Contractors costs
			Final tower coordinates to be confirmed through pre-construction site walk-through surveys involving engineers and qualified botanists from the Contractors in collaboration with ZESCO to ensure that foundations are positioned outside the most sensitive microhabitats and to avoid direct encroachment into wetland core areas where feasible.	Along the length of the powerline alignment	Implementation: Supervising Engineer and Contractors' Botanist Monitoring: PIU	During conception phase	Number pylons or infrastructure in wetlands.	Included in Contractors costs
			Minimize placing access roads and temporary construction areas within wetlands considered critical for the species.	Along the powerline alignment in critical habitat wetlands	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Minimal access roads and temporary construction areas in wetlands.	Included in Contractors costs
			Undertake <i>Disa aequiloba</i> surveys within a 100 m buffer of all permanent and temporary footprint in critical habitat wetlands and proceed to salvage transplantation of orchid tubers/plants to a pre-identified, secure, and ecologically similar receptor wetland outside the ROW and project influence.	Along the powerline alignment in critical habitat wetlands	Implementation: PIU with the support of orchid specialists Monitoring: Supervising Engineer	During the pre-construction phase	<i>Disa aequiloba</i> surveys completed. Translocation of all specimens completed.	43,125 USD

Biodiversity feature	Potential impacts addressed	Sources of impact	Management measure	Location	Responsibilities	Implementation timing	Performance indicators	Costs
			Implement strict delineation of no-go zones: areas where <i>Disa aequiloba</i> specimens are found will be identified and warning signs will be placed to avoid any impairment of the specimens.	Along the powerline alignment in critical habitat wetlands	Implementation: Contractors Monitoring: Supervising Engineer	Throughout construction phase	Specimens within ROW are protected and maintained. No-Go zones are visible and delineated.	Included in Contractors costs
			Develop and apply construction methods within or in proximity to wetlands and aquatic habitats in order to ensure no modification to local hydrology and drainage associated with wet grassland and dambos.	Along the powerline alignment in wetlands, riparian areas and watercourses	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Construction method developed and strictly implemented by the Contractors.	Included in Contractors costs
			Minimize harvesting, destruction, or degradation of vegetation by workers through an environmental protection awareness program.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	100% of employees receive environmental awareness / induction training.	Included in Contractors costs
			Restoration of temporarily disturbed wetland areas: Post-construction, restore any temporarily disturbed areas in wetlands using native plant species from the associated community to re-establish hydrological function and habitat connectivity.	Along the powerline alignment in wetlands, riparian areas and watercourses	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	All affected wetlands restored with native species as soon as possible following construction activities.	Included in Contractors costs
Critical habitat – <i>Euphorbia perplexa</i> var. <i>kasamana</i>	Potential loss and degradation of rock outcrop habitat, constituting critical habitat for <i>Euphorbia perplexa</i> var. <i>kasamana</i>	Site preparation Construction activities	Undertake <i>Euphorbia perplexa</i> var. <i>kasamana</i> surveys within a 100 m buffer of all permanent and temporary footprint (working areas) in critical habitat rock outcrop and proceed to salvage translocation of specimens to a pre-identified, secure, and ecologically similar receptor rock outcrop outside the ROW and project area of influence.	100 m buffer of footprint in the critical habitat rock outcrop	Implementation and monitoring: PIU with the support of specialists, the NHCC and the Kasama District Forestry Department Monitoring: Supervising Engineer	Before start of construction	Additional targeted surveys completed in 100 m buffer of all permanent and temporary footprint within rock outcrops in and around Kasama Forest Reserve. All individuals within footprint translocated.	11,179 USD
			Implement strict delineation of No-Go Zones: areas where <i>Euphorbia perplexa</i> var. <i>kasamana</i> specimens are found will be identified and warning signs will be placed to avoid any impairment of the specimens.	In the critical habitat rock outcrop	Implementation: Contractors Monitoring: Supervising Engineer	Throughout construction phase	Specimens adjacent to work areas are protected and maintained. No-Go zones are visible and delineated.	Included in Contractors costs
			Apply specific construction methods for critical habitat rock outcrops.	In the critical habitat rock outcrop	Implementation: Contractors Monitoring: Supervising Engineer	Throughout construction phase	Adapted construction method developed and strictly implemented by the Contractors.	Included in Contractors costs
			Minimize encroachment on rock outcrops in proximity and within the Kasama Forest Reserve through micro-siting of tower foundations and workspaces.	In the critical habitat rock outcrop	Implementation: Supervising Engineer and Contractors Monitoring: PIU	During conception phase	Reduced number of affected individuals of <i>Euphorbia perplexa</i> var. <i>kasamana</i> .	Included in Supervising Engineer and Contractors costs
Legally protected area	Permanent loss of natural habitat area and associated flora within Forest Reserves	Site preparation Construction activities	Obtain salvage permit to cut down trees in the he Kasama, Amenshi, Chitimukulu, Mungwi, Nkole Mfumu, Kanona and Nakonde Forest Reserves.	Where the powerline crosses the Forest Reserves	Implementation: Contractors Monitoring: Supervising Engineer in collaboration with Forestry Department	Throughout construction phase	All permits obtained.	Included in Contractors costs
			Reduce width to be cleared in Forest Reserves (width reduced to 50 m and be within 78 m of the Forest Reserves according to the ERB Wayleave Code).	Where the powerline crosses the Forest Reserves	Implementation: Contractors Monitoring: Supervising Engineer	Throughout construction phase	Vegetation clearing performed as required.	Included in Contractors costs

Biodiversity feature	Potential impacts addressed	Sources of impact	Management measure	Location	Responsibilities	Implementation timing	Performance indicators	Costs
			Within crossed Forest Reserves, prohibit any material piling, and reduce to a minimum the working areas (within the Kanona, Nkole Mfulu, Mungwi Chitimukulu, Amenshi, Kasama and Nakonde Forest Reserves). Work areas should be restricted to the ROW.	Where the powerline crosses the Forest Reserves	Implementation: Contractors Monitoring: Supervising Engineer	Throughout construction phase	No material piling within Forest Reserves. Number and area of work areas outside the ROW within Forest Reserves.	Included in Contractors costs
			Avoid construction of permanent and temporary access roads in within Forest Reserves. Optimize the use of the ROW for access.	Where the powerline crosses Forest Reserves	Implementation: Contractors Monitoring: Supervising Engineer	Throughout construction phase	No material piling within Forest Reserves. Number and area of work areas outside the ROW within Forest Reserves.	Included in Contractors costs
Bird habitat and flyways	Displacement as a result of habitat loss	Site preparation Construction activities Transportation and traffic Presence of workers	Undertake a pre-construction inspection (avifaunal walk-through surveys) of the final powerline ROW and access roads to identify Priority species and Red List species that may be breeding, to ensure the impacts to breeding species (if any) are adequately managed.	In high, medium-high, and medium sensitivity areas for birds (see Maps 2-14 to 2-16)	Implementation: Contractors' Avifaunal Specialist Monitoring: PIU	Two weeks prior to clearing in any given area within the ROW and for the duration of the construction process	Bird nest surveys undertaken systematically prior to clearing. Active nests of priority species protected (no clearing/construction until nest is abandoned when chicks are mature).	Included in Contractors costs
			Where a priority species is nesting, no vegetation clearing or tower/pylon construction activity or continuous vehicle/pedestrian activity within a radius of 1 km to ensure minimal disturbance and reduce risk of nest abandonment Consult the avifauna specialist for guidance on actions to be taken. Wait until the nest is deserted. Weekly checks to verify nest activity.	In high, medium-high, and medium sensitivity areas for birds (see Maps 2-14 to 2-16)	Implementation: Contractors' Avifaunal Specialist Monitoring: PIU	Two weeks prior to clearing in any given area within the ROW and for the duration of the construction process Weekly monitoring to verify nest activity; site preparation and construction activities to commence once the chick has fledged	Active nests of priority species protected (no clearing/construction until nest is abandoned when chicks are mature).	Included in Contractors costs
		As part of the NHCP, promote the use of trees that are important for nesting of special status bird species and for nesting/perching of large raptors.	In all habitats (high to low sensitivity)	Implementation: Contractors' Avifaunal Specialist Monitoring: PIU	Throughout the construction phase	Breeding/nesting sites identified in bird survey and impacted by line are compensated.	Included in the NHCP budget	
		Displacement as a result of disturbance	Site preparation Construction activities Transportation and traffic Presence of workers	Avoid, as much as possible, site preparation during peak breeding and nesting seasons for special status bird species present in the project area.	In high sensitivity habitats (see Maps 2-14 to 2-16)	Implementation: Contractors Monitoring: Supervising Engineer	At the start of site preparation and construction phases (inclusive of all project components) to the completion of construction	No site preparation work within high sensitivity habitats in the breeding seasons.
Activities known to create short, intense noise events (i.e. such as blasting, pile-driving, or prolonged heavy machinery operation) will be scheduled to avoid dawn and dusk, when many species conduct peak foraging and movement activities.	In high sensitivity habitats (see Maps 2-14 to 2-16)	Implementation: Contractors' Avifaunal Specialist Monitoring: Supervising Engineer		Pre-construction: targeted nest monitoring and scheduling of vegetation clearing and pylon construction outside of key breeding periods Weekly monitoring to verify nest activity; site preparation and construction activities to commence once the chick has fledged	No short intense noise generating works scheduled during dawn and dusk.	Included in Contractors costs		

Biodiversity feature	Potential impacts addressed	Sources of impact	Management measure	Location	Responsibilities	Implementation timing	Performance indicators	Costs
	Priority species mortality as a result of collisions with motor vehicles.	Construction activities.	Speed restrictions to be enforced for all vehicles within the study area to limit avifaunal collisions. Awareness initiatives to educate road users about the presence of avifaunal species utilizing the roads, particularly during dusk and dawn.	Along the length of the powerline alignment and in the surrounding areas	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Speed restriction enforced and respected.	Included in Contractors costs
			Raise awareness on vehicle speed and collision risks. Speed restrictions to be enforced for all vehicles within the study area to limit avifaunal collisions.	Along the length of the powerline alignment and in the surrounding areas	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Number of awareness-raising sessions. Existence of minutes of awareness-raising sessions.	Included in Contractors costs
	Bird collisions with the powerlines.	Presence and operation of line, substations, and access roads	Apply the same design when two lines are side by side.	When two lines are side by side	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	No bird mortality.	Included in Contractors costs
			Install bird diverters on the earth wire/ground wire spans to make the line more visible to birds.	In high, medium-high, and medium sensitivity areas for birds (see Maps 2-14 to 2-16)	Implementation: Contractors Monitoring: Supervising Engineer	During construction, prior to energizing the power line	Required spans successfully fitted with approved bird flight diverters.	Included in Contractors costs
	Bird risks of electrocution	Presence and operation of line, substations and access roads	Ensure the distance between conductors is above 3 m to avoid electrocution of large birds.	In high, medium-high, and medium sensitivity areas for birds (see Maps 2-14 to 2-16)	Implementation: Contractors Monitoring: Supervising Engineer	During detailed design	Distance between conductors greater than 3 m.	Included in Supervising Engineer costs
Bat habitat and flyways	Disturbance or destruction of bat roosts, particularly of Near Threatened species potentially inside the project area.	Site preparation Construction activities	Undertake a pre-construction inspection on the final route alignment and access roads to identify any major bat roosts within or close to the areas to be cleared.	Along the length of the powerline alignment and in the surrounding areas	Implementation: Contractors' Bat Specialist Monitoring: Supervising Engineer and PIU	Two weeks prior to clearing in any given area within the ROW and for the duration of the construction process	Bat roost surveys undertaken systematically prior to clearing.	Included in Contractors costs
			Where major bat roosts (over 100 bats) of near-threatened species are identified, do not undertake tree clearing within a radius of 1 km. Wait until the roost is deserted. Come monthly to the roosting site to verify, not more often.	Along the length of the powerline alignment and in the surrounding areas	Implementation: Contractors' Bat Specialist Monitoring: Supervising Engineer and PIU	Two weeks prior to clearing in any given area within the ROW and for the duration of the construction process Monthly monitoring to verify roost activity; site preparation and construction activities to commence once roost deserted	No clearing activities near identified bat roosts.	Included in Contractors costs
	Habitat alteration and degradation resulting in reduction of activity of bats, that provide important ecosystem services	Site preparation Construction activities Transport and traffic Presence of workers	As part of the NHCP, promote the use of fruit trees that are important food sources for African Straw-coloured Fruit Bats, including <i>Ficus spp</i> , <i>Magnistipula butayei</i> , <i>Parinari curatellifolia</i> , <i>Syzygium cordatum</i> , <i>Syzygium guineense guineense</i> , <i>Syzygium guineense huillense</i> , <i>Uapaca kirkiana</i> , <i>Uapaca banguelensis</i> , and <i>Uapaca sansibarica</i> .	At habitat compensation sites	Implementation and Monitoring: PIU	Throughout construction phase	Compensation plan developed prior to beginning of construction phase. Compensation completed as per the plan, before the end of the construction phase.	See NHCP associated costs

Biodiversity feature	Potential impacts addressed	Sources of impact	Management measure	Location	Responsibilities	Implementation timing	Performance indicators	Costs
Terrestrial fauna	Terrestrial habitat fragmentation and degradation in some areas along the ROW	Site preparation Construction activities Transportation and traffic Waste and hazardous materials management	Avoid timing of row clearing during seasonal large mammal migration: it is recommended that vegetation clearing within the ROW be conducted during the early dry season, which coincides with low vegetation flush in the Miombo ecoregion, a period where large mammal migration is less likely.	Along the length of the powerline alignment and in the surrounding areas	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	All of vegetation-clearing activities completed within the approved early dry-season window. No large mammal disturbance incidents recorded during ROW clearing.	Included in Contractors costs
			Inform the Contractors' E&S Specialists when endangered fauna species are observed in or close to project sites.	Along the length of the powerline alignment and in the surrounding areas	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	All fauna species siting declared and compiled.	Included in Contractors costs
			Maintain habitat integrity by avoiding as much as possible the disturbance or movement of existing microhabitat features such as large rocks, stumps and logs, local water runoff and other structural elements.	Along the length of the powerline alignment and in the surrounding areas	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Microhabitat features retained or relocated.	Included in Contractors costs
			Ensure the Contractors E&S Specialists are trained in animal handling and are present during clearing to perform incidental salvage of wildlife species (herpetofauna, mammals, etc.). If not comfortable, DNPW officers shall be mobilised.	Along the length of the powerline alignment and in the surrounding areas	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Trained animal handlers present during clearing.	Included in Contractors costs
Increased hunting pressure on local fauna species	Construction activities Transportation and traffic Presence of workers	Implement biodiversity protection awareness program with workers. Prohibit workers from owning firearms and other hunting gear and raise awareness about endangered fauna species and the prohibition to engage in any kind of hunting or poaching through the Code of Conduct.	Along the length of the powerline alignment and in the surrounding areas	Implementation: Contractors Monitoring: Supervising Engineer	Prior to construction phase	Biodiversity Protection Awareness Program developed and approved by Supervising Engineer prior to beginning of construction activities. Workers engaged in poaching activities sanctioned. No bush meat consumed in workers' camp or bought by workers.	Included in Contractors costs	
		Safeguard and clear all construction materials from worksites once construction is completed, particularly those used to reinforce structures, i.e., steel wires, to avoid their use as wire snares.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Development prior to, and implementation during, construction phase	Hazardous materials management plan approved by Supervising Engineer prior to initiation of Construction phase. Implementation of the plan. Worksite inspection at the end of construction works/Absence of residual material in work areas.	Included in Contractors costs	
		Remove cut materials or cut them into pieces small enough not to interfere with animal movements.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	During pre-construction phase	Cut or removed materials handled as prescribed.	Included in Contractors costs	
		Put in place safety and security measures to protect workers from wild animals such as lions.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	During pre-construction phase	Cut or removed materials handled as prescribed.	Included in Contractors costs	
		Attach officers from the DNPW to the project throughout the construction period to ensure worker's safety from wild animals. DNPW officers shall be mobilised whenever endangered or dangerous animals are encountered.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	DNPW officers present at construction site.	Included in Contractors costs	
Potential introduction of pest species.	Site preparation Presence of workers	Prohibit the presence of domestic cats at construction sites for pest control or personal purposes.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	No domestic cats present at construction sites.	Included in Contractors costs	

Biodiversity feature	Potential impacts addressed	Sources of impact	Management measure	Location	Responsibilities	Implementation timing	Performance indicators	Costs
Aquatic habitat	Local degradation of aquatic and semi-aquatic habitats and associated fauna and flora disturbances	Site preparation Construction activities. Transport and traffic Waste and hazardous material management	Apply work methods within or in proximity to wetlands and aquatic habitat.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Throughout construction phase	Management plan for works within or in proximity to wetlands and aquatic habitats developed. Work methods within or in proximity to wetlands and aquatic habitats applied.	Included in Contractors costs
	Potential introduction of invasive alien species in aquatic and semi-aquatic habitats	Site preparation Construction activities Transportation and traffic	Develop and apply the non-native species management plan.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Equipment cleaning protocols implemented and documented. Construction equipment cleared and free of invasive species as required. Hand clearing used in areas where invasive plant species are present. Non-native invasive flora specimens managed as required.	Included in Contractors costs
	Spread of Chytrid fungus	Site preparation Construction activities	Clean all construction equipment and clothing that has contacted water before arriving in work areas and when leaving sites using bleach solution of >1% sodium hypochlorite concentration.	Along the length of the powerline alignment	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Equipment and clothing cleaning protocols established using appropriate bleach solution.	Included in Contractors costs
			Establish designated cleaning stations at key access points to all wetland areas.	Wetland areas	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	Designated cleaning stations set up at key access points.	Included in Contractors costs
			Maintain cleaning station supplies (bleach, brushes, personal protective equipment [PPE]) and ensure all personnel are trained in cleaning protocols.	Wetland areas	Implementation: Contractors Monitoring: Supervising Engineer	Throughout the construction phase	No cross-contamination between wetland sites.	Included in Contractors costs

Table 4-4 Biodiversity Management Measures during the Operation Phase

Biodiversity feature	Potential impacts addressed	Sources of impact	Management measures	Location	Responsibilities	Implementation timing	Performance indicators	Cost (USD)
Natural habitats	Maintenance of vegetation in an early stage of regeneration	Presence and operation of line, substations and access roads materials management Maintenance and repairs	Use mechanical method for vegetation control instead of chemical herbicides inside the ROW.	Along the length of the powerline alignment	ZESCO	During maintenance activities	Mechanical method of vegetation control applied. No herbicides used.	ZESCO operation budget
			Adhere to the stipulated wayleave size when clearing vegetation to avoid cutting trees unnecessarily.	Along the length of the powerline alignment	ZESCO	During maintenance activities	No clearing activities outside of ROW limits.	ZESCO operation budget
			Areas where endangered species are found will be identified and warning signs will be placed to avoid any impairment of the specimens if they do not represent a serious risk to the transmission line. Translocation of individuals should be considered.	Along the length of the powerline alignment	ZESCO	During maintenance activities	Warning signs in place.	ZESCO operation budget
			Undertake selective control of the vegetation in wetland and riparian habitat, including inside the Mungwi Forest Reserve, to keep low shrubby species that do not represent a risk for the powerline. As much as possible, conserve all the vegetation (trees, shrubs, herbaceous plants, and crops) present at the edge of watercourses and in erosion-prone areas.	Along the length of the powerline alignment	ZESCO	During maintenance activities	Selective cutting of vegetation undertaken in wetland and riparian habitat.	ZESCO operation budget
Potential introduction of invasive alien species	Presence and operation of line, substations and access roads Maintenance and repairs Transportation and circulation	Develop and apply the non-native species management plan.	Along the length of the powerline alignment	ZESCO	During maintenance activities	Equipment cleaning protocols implemented and documented. Construction equipment cleared and exempt of invasive species as required. Hand clearing used in areas where invasive plant species are present. Non-native invasive flora specimens managed as required.	ZESCO operation budget	
Impairment of natural habitats and associated flora communities	Presence and operation of line, substations and access roads Maintenance and repairs Transportation and circulation	Undertake selective control of the vegetation in order to keep low shrubby and herbaceous species that do not represent a risk for the power line (species that cannot grow more than 2 m in height).	Along the length of the powerline alignment	ZESCO	During maintenance activities	Selective vegetation control carried out.	ZESCO operation budget	
		Maintain all work inside the access road and ROW footprints to reduce encroachment on natural habitats	Along the length of the powerline alignment	ZESCO	During maintenance activities	No maintenance nor repair works outside ROW and access roads.	ZESCO operation budget	
		Clearly mark the extent of vegetation control in the ROW. Identify and mark the vegetation to be preserved along sections of the ROW.	Along the length of the powerline alignment	ZESCO	During maintenance activities	ROW limits clearly marked.	ZESCO operation budget	
Loss of ecosystem services provided to communities by natural habitats	Presence and operation of line, substations and access roads Maintenance and repairs Transportation and circulation	Coordinate with local authorities to allow local population to benefit from woody material cleared from the ROW in order to reduce additional pressure on natural resources.	Along the length of the powerline alignment	ZESCO	During maintenance activities	Community agreements for the use of wood resources.	ZESCO operation budget	
Increased pressure on natural resources	Maintenance activities Presence of operational staff	Implement a sensitization program in order to educate and increase local communities' awareness on natural resources protection.	Along the length of the powerline alignment	ZESCO	Throughout the operation phase	Number of awareness-raising sessions on natural resource protection. Existence of minutes of awareness-raising sessions.	ZESCO operation budget	

Biodiversity feature	Potential impacts addressed	Sources of impact	Management measures	Location	Responsibilities	Implementation timing	Performance indicators	Cost (USD)
			Dispose of organic material removed from the ROW properly and in collaboration with local communities.	Along the length of the powerline alignment	ZESCO	During maintenance activities	Organic materials removed from the ROW. Evidence of communication with local communities.	ZESCO operation budget
			Minimise harvesting, destruction, or degradation of vegetation by workers through an environmental protection awareness programme.	Along the length of the powerline alignment	ZESCO	Throughout the operation phase	No unauthorised harvesting by operational staff.	ZESCO operation budget
Critical habitat – <i>Disa aequiloba</i>	Potential impacts on endangered <i>Disa aequiloba</i>	Maintenance activities Presence of operational staff	Do not cut or damage specimens of <i>Disa aequiloba</i> . Areas where <i>Disa aequiloba</i> specimens are found will be identified and warning signs will be placed during maintenance and clearing activities in critical habitat wetlands to avoid any impairment of the specimens. Signs removed once work is complete.	Along the powerline alignment in critical habitat wetlands	ZESCO	During maintenance activities	Signs put in place to protect <i>Disa aequiloba</i> during maintenance and clearing activities in critical habitat wetlands.	ZESCO operation budget
			Develop and apply work methods within or in proximity to wetland and aquatic habitats.	Along the powerline alignment in critical habitat wetlands	ZESCO	During maintenance activities	Use and maintenance of appropriate water crossing methods to retain flow and drainage (e.g., culverts). Extent of access routes and construction areas in CH wetlands.	ZESCO operation budget
Critical habitat – <i>Euphorbia perplexa</i> var. <i>kasamana</i>	Potential impacts on endemic <i>Euphorbia</i> sp.	Maintenance activities Presence of operational staff	Do not cut or damage specimens of <i>Euphorbia perplexa</i> var. <i>kasamana</i> . Areas where specimens are found will be identified and warning signs will be placed during maintenance and clearing to avoid any impairment of the specimens.	Along the powerline alignment in critical habitat rock outcrops	ZESCO	During maintenance activities	Signs put in place to protect <i>Euphorbia perplexa</i> var. <i>kasamana</i> during maintenance and clearing activities in critical habitat wetlands.	ZESCO operation budget
Bird habitat and flyways	Displacement as a result of habitat transformation	Maintenance and repairs Transportation and circulation	Train the maintenance teams to recognise priority species and maintain appropriate behavioural buffers around active nests.	Along the length of the powerline alignment	ZESCO	Throughout the operation phase	Percentage of maintenance staff (100%) trained to recognise priority species and nest-related sensitivities.	ZESCO operation budget
			Where operational tasks have the potential to generate short, intense noise or visual disturbance, such as vegetation clearing, earth fault recording, or machinery use, these activities will be scheduled outside peak breeding periods for priority species.	Along the length of the powerline alignment	ZESCO	During maintenance activities	Number (zero) of disturbance incidents recorded near active nests.	ZESCO operation budget
	Bird collisions	Presence and operation of line, substations and access roads	Maintenance of mitigation measures (bird flight diverters) must be realised for the operational life span of the powerlines and associated substations, and the equipment within the substation yards.	Where bird flight diverters are installed	ZESCO	Throughout the operation phase	Mitigation measures in good working order, thereby preventing bird mortality.	ZESCO operation budget
			Request the ZESCO line and servitude managers to maintain records of all bird collisions encountered during routine line patrols of the ZTIP power line, so that the significance of this impact and the effectiveness of mitigation can be accurately evaluated.	Along the length of the powerline alignment	ZESCO	Throughout the operation phase	All collision records captured during routine patrols.	ZESCO operation budget
			Ensure land planning by local authorities avoids the implementation of infrastructure or land uses that may constitute an attraction for birds, such as landfills. To do so, ZESCO will inform local authorities of potential collision risks for birds and encourage the planned transmission line to be integrated into local planning tools.	Along the length of the powerline alignment	ZESCO	Throughout the operation phase	Yearly coordination meetings with local authorities.	ZESCO operation budget
	Priority species mortality as a result of collisions with motor vehicles.	Maintenance and repairs.	Raise awareness on vehicle speed and collision risks. Speed restrictions to be enforced for all vehicles within the study area to limit avifaunal collisions.	Along the length of the powerline alignment and in the surrounding areas	ZESCO	Throughout the operation phase	All employees attend awareness sessions. Speed restrictions enforcement.	ZESCO operation budget

Biodiversity feature	Potential impacts addressed	Sources of impact	Management measures	Location	Responsibilities	Implementation timing	Performance indicators	Cost (USD)
	Modification and alteration of bird habitats, with associated modifications in fauna communities	Maintenance and repairs	Schedule ROW management activities to avoid breeding and nesting seasons of bird species with special status.	Along the length of the powerline alignment and in the surrounding areas	ZESCO Avifaunal specialist	Throughout the operation phase	ROW management activities minimized during nesting seasons of bird species with special status.	ZESCO operation budget
	Bird electrocution	Operation of substations	Monitoring of bird electrocutions encountered during routine inspection of the substation yards ZESCO substation Managers.	At the substations	ZESCO	Throughout the operation phase	Data to be included: number of mortalities, species involved, and location. Mitigation measures developed and implemented if required.	ZESCO operation budget
	Avian induced faulting	Presence and operation of line, substations and access roads	If on-going avian induced faulting is recorded once the electrical infrastructure is operational, have the records assessed by a qualified avifaunal specialist and apply site-specific mitigation reactively.	Along the length of the powerline alignment	ZESCO Avifaunal Specialist Local NGO	Throughout the operation phase	Every avian induced faulting is recorded. Mitigation measures implemented.	ZESCO operation budget
If sustained faults are observed once the power line is energized, install birds guards according to industry standards. All bird guards, if installed reactively, must be maintained.			Along the length of the powerline alignment	ZESCO Avifaunal Specialist Local NGO	Throughout the operation phase	Number of bird guards installed.	ZESCO operation budget	
Develop and maintain a bird nest inventory within the ROW (species involved, active or old nest, number of occupied nests per species, number of unoccupied nests per species etc.).			Along the length of the powerline alignment	ZESCO Avifaunal Specialist Local NGO	Throughout the operation phase	Completeness of the nest inventory.	ZESCO operation budget	
Avoid nest destruction, especially active ones or those of special status species.			Along the length of the powerline alignment and in the surrounding areas	ZESCO Avifaunal Specialist Local NGO	Throughout the operation phase	Nests left undisturbed.	ZESCO operation budget	
Terrestrial fauna	Disturbance of terrestrial fauna	Maintenance and repairs	Minimize ROW maintenance activities along and during seasonal migration routes for large mammals.	Along the length of the powerline alignment	ZESCO	Throughout the operation phase	ROW management activities minimized along migration routes during migration seasons of large mammals.	ZESCO operation budget
			Maintain habitat integrity by avoiding as much as possible the disturbance or movement of existing micro-habitat features such as large rocks, decaying stumps and logs, local water runoff and other structural elements. Avoid removing large rocks, fallen logs, and other microhabitat features.	Along the length of the powerline alignment and in the surrounding areas	ZESCO	Throughout the operation phase	Microhabitat features retained wherever feasible.	ZESCO operation budget
	Potential introduction pest species	Maintenance and repairs	Prohibit the presence of domestic cats at operational sites for pest control or personal purposes.	Along the length of the powerline alignment and in the surrounding areas	ZESCO	Throughout the operation phase	No domestic cats present at operational sites.	ZESCO operation budget
	Increased hunting pressure on local fauna species	Maintenance activities Presence of operational staff Transportation and traffic	Implement biodiversity protection awareness program with workers.	General	ZESCO	Throughout the operation phase	Biodiversity protection awareness program conducted annually for all operational staff.	ZESCO operation budget
Prohibit workers from owning firearms and other hunting gear and raise awareness about endangered fauna species and the prohibition to engage in any kind of hunting or poaching through the Code of Conduct.			Along the length of the powerline alignment and in the surrounding areas	ZESCO	Throughout the operation phase	Workers prohibited from owning firearms and hunting gear. Code of Conduct enforced.	ZESCO operation budget	

Biodiversity feature	Potential impacts addressed	Sources of impact	Management measures	Location	Responsibilities	Implementation timing	Performance indicators	Cost (USD)
			Educate workers against the needless killing of herpetofauna, especially snakes and lizards. If snakes are found on site, have them removed by a trained snake handler.	Along the length of the powerline alignment and in the surrounding areas	ZESCO	Throughout the operation phase	Trained snake handlers available and utilised when needed. Zero incidents of unnecessary killing of herpetofauna by staff.	ZESCO operation budget
			Safeguard all materials from worksites to avoid their use as wire snares.	Along the length of the powerline alignment and in the surrounding areas	ZESCO	Throughout the operation phase	Materials safeguarded to prevent use as snares.	ZESCO operation budget
			Remove cut materials or cut them into pieces small enough not to interfere with animal movements.	Along the length of the powerline alignment and in the surrounding areas	ZESCO	Throughout the operation phase	Cut materials properly managed.	ZESCO operation budget
Aquatic fauna	Disturbances of the water's physical and chemical characteristics causing modifications in aquatic habitats and associated fauna Disturbance of wetlands specialist species and species of conservation interest	Presence and operation of line, substations, and access roads Maintenance and repairs Management of hazardous products and residual materials	Apply work methods within or in proximity to wetlands and aquatic habitat.	Along the length of the powerline alignment	IZESCO	Throughout construction phase	Management plan for works within or in proximity to wetlands and aquatic habitats developed. Work methods within or in proximity to wetlands and aquatic habitats applied.	ZESCO operation budget
			Use mechanical method for vegetation control inside the ROW. Forbid use of chemical pesticides to control vegetation in the ROW	Along the length of the powerline alignment	ZESCO	Throughout the operation phase	No chemical products used in maintenance of ROW and wayleave.	ZESCO operation budget
			Avoid the destabilization of shores, and sediment or other pollutant rejection in watercourses during road and wayleave maintenance.	Watercourses	ZESCO	Throughout the operation phase	Careful road maintenance.	ZESCO operation budget
	Potential introduction of invasive alien species (IAS) in aquatic and semi-aquatic habitats	Maintenance and repairs Transportation and circulation Presence of workers	Develop and implement the non-native invasive species management plan.	Along the length of the powerline alignment	ZESCO	Throughout the operation phase	Equipment cleaning protocols implemented and documented. Construction equipment cleared and free of invasive species as required. Hand clearing used in areas where invasive plant species are present. Non-native invasive flora specimens managed as required.	ZESCO operation budget
	Movement barrier for aquatic fauna within watercourses	Presence and operation of line, substations, and access roads	Ensure regular maintenance of permanent access roads and related ditches and culverts to prevent the water crossings from becoming insurmountable obstacles for the aquatic fauna. Maintenance will also prevent soil erosion leading to sediment input into aquatic habitats.	Aquatic habitat	ZESCO	Throughout the operation phase	Hydrological connectivity maintained in all worksites impacting watercourses. No signs of erosion.	ZESCO operation budget
	Spread of Chytrid fungus	Maintenance activities Work in wetland areas	Clean maintenance equipment and clothing which has been in contact with water properly before arriving in work areas and again when leaving the site. A solution of bleach (concentrations of higher than 1% sodium hypochlorite) is recommended for cleaning.	Along the length of the powerline alignment	ZESCO	Throughout the operation phase	Equipment and clothing cleaning protocols established using appropriate bleach solution. Compliance with cleaning requirements. No cross-contamination between wetland sites.	ZESCO operation budget
			Set up designated cleaning stations at key access points to prevent contamination between different wetland sites.	Wetland areas	ZESCO	Throughout the operation phase	Designated cleaning stations maintained at key access points.	ZESCO operation budget

5. Summary of Residual Impacts

Key risks and impacts on biodiversity described in Chapter 3 of this BMP are managed through an impact avoidance and mitigation strategy based on the mitigation hierarchy presented in Chapter 4. The resulting residual impacts are summarized in Table 5-1 below, which also details what compensation strategies apply. These consider the implementation of all proposed avoidance, reduction and mitigation measures, including those related to the design phase, those requiring additional field work and those related to specific work procedures.

Quantification of residual impacts is specifically required for natural and critical habitat losses, to ensure compensation strategies are developed to achieve no net loss for natural habitats (miombo woodlands and riverine forests) and net gain for critical habitat qualifying features (*Disa aequiloba*/wetlands and *Euphorbia perplexa* var. *kasamana*/rock outcrops). It is important to note that the quantifications are estimates and will need to be confirmed after construction. Loss of miombo woodland does not include possible loss from access routes, temporary workspaces or borrow pits located outside the ROW. For critical habitat species, the quantification is based on worst case scenario considering translocation techniques are experimental and that success is not guaranteed.

Table 5-1 Summary of Residual Impacts

Biodiversity feature	Impact statement	Quantification of residual impact	Compensation strategy
Natural habitat	<ul style="list-style-type: none"> ■ Permanent loss of natural habitat area and of its associated flora. ■ Potential introduction of non-native invasive species. ■ Risk of propagation of uncontrolled fires. ■ Increased pressure on natural resources. 	<ul style="list-style-type: none"> ■ Loss of 39.4 ha of mature miombo woodland. ■ Loss of 529.0 ha of secondary miombo woodland. ■ Loss of 48.9 ha of riverine forest. ■ Loss of at least 5.5 ha of natural wetlands. 	See NHCP, including expected habitat gain. See Conservation Actions for Critical Habitat triggering species for strategy on wetlands (Section 7.1).
<i>Disa aequiloba</i> critical habitat ¹	<ul style="list-style-type: none"> ■ Loss of critical habitat for the species in wetlands of low and medium disturbance. ■ Loss of specimens in temporary and permanent project footprint. 	<ul style="list-style-type: none"> ■ Permanent loss of 2.91 to 4.96 ha of <i>Disa aequiloba</i> critical habitat. 	See Conservation Actions for Critical Habitat triggering species, including the net gain strategy (Section 7.1).
<i>Euphorbia perplexa</i> var. <i>kasamana</i> critical habitat ¹	<ul style="list-style-type: none"> ■ Loss of critical habitat for the species in rock outcrops. ■ Loss of specimens in temporary and permanent project footprint. 	<ul style="list-style-type: none"> ■ Permanent loss of 0.14 ha of <i>Euphorbia perplexa</i> var. <i>kasamana</i> critical habitat. ■ Zero loss of individuals estimated for tower footprints. ■ Uncertain loss of individuals from temporary workspaces, estimated at 129 individuals (range: 0 to 356 impacted individuals). 	See Conservation Actions for Critical Habitat triggering species, including the net gain strategy (Section 7.2).

Biodiversity feature	Impact statement	Quantification of residual impact	Compensation strategy
Legally protected areas and internationally recognized areas ¹	<ul style="list-style-type: none"> Permanent loss of natural habitat area and associated flora within Forest Reserves. 	<ul style="list-style-type: none"> Loss of 1.85 ha of natural habitat in the Chitimukulu FR. Loss of 61.38 ha of natural habitat in the Kanona FR. Loss of 13.70 ha of natural habitat in the Kasama FR. Loss of 2.15 ha of natural habitat in the Mungwi FR. Loss of 18.58 ha of natural habitat in the Nkole Mfumu FR. 	See NHCP
Bird Habitat and Flyways	<ul style="list-style-type: none"> Displacement as a result of habitat loss. Displacement as a result of disturbance. Collisions. Risks of electrocution. 	<ul style="list-style-type: none"> Impacts overall reduced with mitigation measures, but no specific quantification applies. 	Habitat loss compensated through the NHCP which integrates species of ecological importance for special status and priority species
Bat Habitat and Flyways	<ul style="list-style-type: none"> Disturbance or destruction of bat roosts. Habitat alteration and degradation resulting in reduction of activity of bats. 	<ul style="list-style-type: none"> Impacts overall reduced with mitigation measures, but no specific quantification applies. 	Habitat loss compensated through the NHCP, which integrates species of ecological importance for threatened bat species
Terrestrial fauna	<ul style="list-style-type: none"> Terrestrial habitat fragmentation and degradation. Increased hunting pressure. Potential introduction of invasive alien animal species. 	<ul style="list-style-type: none"> Impacts overall reduced with mitigation measures, but no specific quantification applies. 	Habitat loss compensated through the NHCP
Aquatic fauna	<ul style="list-style-type: none"> Local degradation of aquatic and semi-aquatic habitats and associated fauna. 	<ul style="list-style-type: none"> Impacts overall reduced with mitigation measures, but no specific quantification applies. 	NA

Note: 1 The areas of residual loss of critical habitat for *Disa aequiloba* and *Euphorbia perplexa* var. *kasamana* as well as areas of residual loss of natural habitat in legally protected areas are included in the overall quantified areas of residual impact for loss of natural habitat.

6. Conceptual Natural Habitats Compensation Plan

6.1 Introduction

Compensation of natural habitat lost due to the ZTIP is planned as part of the impact mitigation strategy, in accordance with the mitigation hierarchy. A conceptual Natural Habitats Compensation Plan (NHCP) is developed in this chapter to provide guidance for habitat compensation. It includes a preliminary assessment of habitat loss, identifies appropriate compensation actions and enabling conditions, and proposes candidate sites for these actions.

6.1.1 Requirements for Natural Habitats Compensation

In alignment with the WB ESS 6, the NHCP developed for the ZTIP aims to achieve no net loss³ by proposing compensation measures. Compensation consists of measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development and persisting after appropriate avoidance, minimization, and restoration measures have been taken. In addition to meeting no net loss requirements, compensation action in the NHCP must:

- Be measurable;
- Provide additional outcomes (i.e., provide benefits beyond what would have happened in absence of the NHCP);
- Deliver long-term outcomes; and
- Adhere to the principle of “like for like or better”.

The principle of “like-for-like or better” means that in most cases biodiversity compensation should be designed to conserve the same biodiversity values that are being affected by the project (“in-kind” compensation). In certain situations, however, areas of biodiversity affected by a project may be neither of national nor of local priority, and there may be other biodiversity values that are of higher priority for conservation and sustainable use and that are also under imminent threat or in need of protection or effective management. In these situations, it may be appropriate to consider “out-of-kind” compensation that involves “trading up” (i.e., where the compensation actions target biodiversity of higher priority than that affected by the project).

³ No net loss is defined as the point at which project-related biodiversity losses are balanced by gains resulting from measures taken to avoid and minimize these impacts, to undertake on-site restoration and finally to compensate significant residual impacts, if any, on an appropriate geographic scale.

6.1.2 Objectives

Despite proposed measures in Chapter 4 to avoid and minimize project related impacts in accordance with the mitigation hierarchy, the ZTIP will lead to the loss of at least 622.8 ha of natural habitats (39.4 ha of mature miombo woodland, 529.0 ha of secondary miombo woodland, 48.9 ha of riverine forest and 5.5 ha of natural wetlands) from ROW clearing and tower construction⁴ (see Chapter 5). This is considered a significant residual adverse impact on natural habitats. Because of this residual impact, a NHCP is required to compensate biodiversity impacts in adherence to the principle of “like-for-like or better”. Compensation activities will be located outside the immediate project footprint, but within the BIIA.

As prescribed in the WB ESS 6, compensation will be designed and implemented to:

- Achieve measurable, additional, and long-term conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity.
- Propose a methodology to calculate the actual residual impacts of the ZTIP on natural habitats and ensure they are compensated by activities to protect the same type of biodiversity as that which would be lost or degraded under the project.

The NHCP defines the compensation strategy to address residual impacts associated with the loss of miombo woodlands and riverine forests in accordance with the World Bank’s Biodiversity Conservation and Sustainable Management of Living Natural Resources Standard (ESS 6).

6.2 Habitat Loss Assessment

Establishing an appropriate metric to quantify biodiversity loss and gain is a core requirement of a compensation program (Business and Biodiversity Offset Programme [BBOP], 2012a, 2012b; IUCN, 2016; WBG, 2016). The metric establishes the compensation ‘currency’, allowing for transparent accounting that demonstrates how biodiversity loss from the project will be balanced by an equivalent biodiversity gain from compensation actions.

The following sections define the methods used to quantify natural forested habitat loss, provide estimates of natural habitat loss, and establish initial compensation targets for natural habitats.

6.2.1 Methods for Quantification of Habitat Loss

A habitat-based metric was applied to quantify habitat loss. The metric integrates the area of habitat loss (in ha) and its relative ecological quality (q), to produce a quality-hectare (q-ha) measure. Specifically, a quality ratio was applied to adjust the area of impact to account for differences in ecological condition, structural complexity and functional value among patches of the same habitat type.

⁴ The estimated loss of natural habitats does not include temporary workspaces, access routes, or borrow pits because the location of these features has not been defined.

The q-ha metric was applied to quantify the residual loss of miombo woodlands, wetlands, and riverine forest. The quality ratio was devised using professional judgement, based on satellite image interpretation that distinguished three quality classes for miombo woodlands and wetlands, as described below.

6.2.1.1 Miombo Woodlands

Three types of miombo woodlands were defined:

- **Mature miombo woodlands:** these are late seral stage woodlands with a mature structure and composition. Mature miombo woodlands were assigned a quality ratio of 1.0.
- **Secondary miombo woodlands:** areas that have regenerated following deforestation or other human disturbance. Woodland largely contains the principal characteristics, species richness and functions of a native ecosystem. Secondary miombo woodlands were assigned a quality ratio of 0.5 to account for a moderate amount of anthropogenic influence in the habitat.
- **Degraded miombo woodlands:** treed areas that have been damaged or altered from their natural state. Human activity has substantially modified the primary ecological functions and species composition. These areas are considered highly disturbed, typically containing compacted soil and non-vegetated bare patches. Although some remnant trees remain, these areas are transitioning towards a deforested state, as evidence by ongoing human pressure. Degraded woodlands were assigned a quality score of 0.2.

Among the above woodland classes, mature and secondary miombo woodlands are considered natural habitats whereas degraded woodlands constitute modified habitat. Satellite imagery and photos associated with each type of miombo woodlands are shown in Section 2.3.1.

6.2.1.2 Wetlands

Three types of dambo wetlands were defined:

- **Low disturbance wetland:** these are relatively intact wetlands with little evidence of human disturbance. Low disturbance wetlands were assigned a quality score of 1.0.
- **Moderate disturbance wetlands:** these wetlands have obvious signs of human disturbance; however, their function and species composition remain representative of a natural system. Moderate disturbance wetlands were assigned a quality score of 0.5.
- **High disturbance wetlands:** wetlands with a high degree of anthropogenic disturbance. The extent of disturbance has altered the functioning and/or species composition such that it no longer corresponds to a natural system. High disturbance wetlands were assigned a quality score of 0.2.

Among the above wetland classes, low and moderate disturbance wetlands are considered natural habitats whereas highly disturbed wetlands constitute modified habitat.

6.2.1.3 Riverine Forest

For riverine forest, there was insufficient information available to assign habitat condition. Using a precautionary approach, areas of riverine forest in the project area were assumed to be in relatively good condition and were assigned a quality score of 1.0.

6.2.2 Quantification of Habitat Loss

Quantification of residual natural habitat loss assumed the effective implementation of the first three steps of the mitigation hierarchy (avoid, minimize, and restore). To measure the area of natural habitat loss, the following assumptions were applied:

- Loss of forested habitat was quantified as the area of natural woodlands inside the boundaries of the wayleave corridor and substations.
- Loss of wetlands was quantified as the area of natural wetlands inside the footprint of the transmission line towers. This footprint for each tower was estimated at 410 m² (0.041 ha), which includes the physical dimensions of the tower and its foundation excavation (185 m²) and a small amount of workspace around the tower (225 m²).
- Access routes in wetlands will be temporary, consisting of construction mats or wooded paths, to avoid ground disturbance and minimize soil compaction. Although some localized degradation may occur, it is assumed that the herbaceous wetlands will recover within a growing season following the removal of mats or paths, and as needed, decompaction and revegetation. Assuming effective rehabilitation and recovery, wetland degradation from access trails would constitute a negligible temporal loss.

The locations of temporary work areas, access routes, and borrow pits outside the wayleave corridor have not yet been defined; therefore, it was not possible to accurately quantify the potential loss of forested natural habitats associated with these components. The mitigation strategy for these components is to avoid placing them in natural habitats, to the extent feasible. Notably, the project committed to no access road construction in riverine forests as the cleared ROW corridor will be used for access in these habitat types. However, given the prevalence of miombo woodlands in the region, it was assumed that access requirements will necessitate a small amount of additional clearing. The plan assumed that an extra 20% of miombo woodland clearing could occur (115.7 ha) and that this loss would be restricted to areas in secondary woodland. This assumption is considered precautionary given that most of the ROW parallels an existing transmission line that can be used for access. It is anticipated that all construction sites, including work camps and temporary access roads, will be restored by the Contractors after the completion of works. Calculation of losses will need to be updated after the completion of site restoration in order to confirm habitat losses from construction activities.

Table 6-1 summarizes the residual loss of natural habitats. Residual losses include 366.8 q-ha of miombo woodlands, 48.9 q-ha of riverine forest, and 3.4 q-ha of wetlands.

Table 6-1 Quantification of Natural Habitat Loss

Natural habitat type	Area (ha)	Quality (q)	Quality-hectares (q-ha)
Loss from ROW clearing and tower construction			
Miombo woodland – mature	39.4	1.0	39.4
Miombo woodland – secondary	539.0	0.5	269.5
Riverine forest	48.9	1.0	48.9
Wetland – with low disturbance ¹	1.2	1.0	1.2
Wetland – with moderate disturbance ²	4.3	0.5	2.2
Estimated loss from undefined temporary work areas, access roads, and borrow pits			
Miombo woodland – mature	0	1.0	0
Miombo woodland – secondary	115.7	0.5	57.9
Riverine forest	0	1.0	0

Notes: 1 Loss of habitat associated with 30 towers.
 2 Loss of habitat associated with 104 towers.

6.2.3 Compensation Targets

Compensation actions should be designed to generate:

- A minimum gain of 366.8 q-ha of miombo woodland;
- A minimum gain of 3.4 q-ha of dambo wetlands; and
- A minimum gain of 48.9 q-ha of riverine forest.

The above targets represent the minimum required to achieve no net loss of natural habitats. These targets do not include discounting factors (i.e., multipliers) that could be applicable, depending on the type of compensation actions proposed and the time lags involved (refer to Section 6.7.2 for more information). The achievement of no net loss will be evaluated over a time horizon sufficient to capture habitat recovery and maturation and will be verified through periodic independent audits as part of the Biodiversity Monitoring Program (see Section 8.0). Compensation requirements for loss of rock outcrop habitat are addressed in the mitigation strategy for *Euphorbia perplexa* var. *kasamana* (Section 7.2). Compensation requirements for loss of wetlands are addressed in the mitigation strategy for *Disa aequiloba* (Section 7.1).

6.3 Compensation Approach

The compensation approach relies on guiding principles that support all compensation actions (Section 6.3.1), existing conservation and reforestation initiatives within the project landscape (see Appendix 6-1), and opportunities in existing managed forests as highlighted during stakeholder engagement (Section 6.3.3). This has led to a selection of appropriate compensation actions (Section 6.3.4).

6.3.1 Guiding Principles for Natural Habitats Compensation

The proposed guiding principles establish a framework for designing and implementing the NHCP and assessing its success. The proposed guiding principles have been elaborated in consideration of good international industry practice (GIIP) for biodiversity offsets (BBOP, 2018 and IUCN, 2026) and are the following:

1. **Adherence to the mitigation hierarchy:** Compensation for biodiversity loss is a commitment to compensate for significant residual adverse impacts on biodiversity identified after appropriate avoidance, minimization and on-site rehabilitation measures have been taken according to the mitigation hierarchy. The environmental and social management strategy developed for the project, including the BMP, aims to avoid, minimize, and restore impacted features where possible. The NHCP is designed to compensate for the anticipated residual impacts of the project, only after these other mitigation actions described in the BMP have been applied.
2. **‘Like-for-like or better’:** The most desirable outcome is generally to compensate for the loss of biodiversity with gains in ecologically equivalent biodiversity elsewhere (an ‘in-kind’ compensation). Compensation actions will target the same affected natural habitats: miombo woodlands and riverine forest. When reforestation actions are applied, they shall be done with native species typical of these natural habitats.
3. **Additionality:** The NHCP should achieve conservation outcomes above and beyond results that would have occurred if the planned implementation had not taken place. Importantly, compensation efforts must not duplicate or replace existing and adequately functioning restoration or conservation actions/projects/programs by governmental and non-governmental organizations.
4. **Landscape context:** The compensation activities should be designed and implemented in a landscape context to achieve the expected measurable conservation outcomes considering available information on the full range of biological and social values of biodiversity and supporting an ecosystem approach. Compensation actions should be planned in habitats ecologically linked with the impacted areas and, preferably in the surrounding environment. Conditions under which compensation measures are implemented should be as close as possible to the impacted site(s), and in all cases within functional proximity to the area affected by the project.

5. **Contribution to regional planning and sustainability objectives:** Compensation should be in line with regional-level landscape planning. Measures implemented as part of the NHCP should contribute to regional sustainable development priorities including connectivity between habitats, buffer zones around natural habitats, and areas of importance for climate change adaptation.
6. **Stakeholder participation:** In areas affected by the project and in those targeted for compensation actions, ensure effective participation of stakeholders in decision-making about proposed actions, including their evaluation, selection, design, implementation and monitoring. The design and implementation of biodiversity compensation actions, and communication of their results to stakeholders, should be undertaken in a transparent and timely manner.
7. **Equity:** Compensation should be designed and implemented in an equitable manner, which means sharing among stakeholders of the rights and responsibilities, and risks and rewards associated with a project and compensation measures in a fair and balanced way, respecting legal and customary arrangements. Compensation actions will not lead to involuntary resettlement. Physical displacement will be avoided and economic displacement will be reduced as much as possible. Where resettlement is inevitable, affected assets will be compensated based on eligibility criteria defined in the ZTIP Resettlement Action Plan (WSP, 2025).
8. **Feasible and adapted to local context:** Alignment with national biodiversity strategies, national regulations and respect of current practices from national actors active in conservation and reforestation are important to ensure feasibility of compensation actions. It is also essential to assess and leverage local capacities and available resources to ensure the effectiveness and sustainability of the compensation actions. The proposed actions should be ecologically, technically, economically, and socially feasible and adapted to the local context.
9. **Measurable:** The proposed compensation actions should be designed and implemented to achieve in situ, measurable conservation outcomes that can reasonably be expected to result in no net loss or net gain of biodiversity. To verify this, compensation measures must be accompanied by clear, measurable and time-bound objectives and monitoring procedures are implemented to assess their effectiveness and confirm that the anticipated outcomes have been met.
10. **Long-term outcomes:** The design and implementation of the NHCP should be based on an adaptive management approach, incorporating monitoring and evaluation, with the objective of securing sustainable biodiversity outcomes that last at least as long as the project's impacts and preferably in perpetuity.

6.3.2 Opportunities in Existing Managed Forests

As detailed in Section 2.2, there are 15 Forest Reserves in the BIIA, seven (7) of which are crossed by the line route. There are also 20 Community Forests in the BIIA but none of them are affected by the ROW clearing.

6.3.2.1 Forest Reserves

Habitats in the Forest Reserves crossed by the line route were assessed in detail. Satellite imagery analysis, walkover surveys and expert and stakeholder consultations were carried out to better understand land uses within these areas and to describe habitat type and quality. Generally, most of these Forest Reserves are impacted by encroachment of human settlements and agricultural activities, which result in habitat degradation. The Forestry Department, through offices at provincial and district levels, oversees forest management in these areas and confirmed that habitat degradation is a challenge.

Indeed, although Zambia has an extensive network of legislated protected areas, the current management and conservation outcomes in several of these areas are weak and ineffective.

The following challenges, highlighted by Forestry Department offices during consultation activities and confirmed through a literature review, are encountered in Forest Reserves:

- Significant lack of funding and appropriate financial management and transparency: Forestry Department offices often lack funding for their activities; a challenge which is emphasized by all government revenue being deposited in a common basket account, Control 99, with funds rarely making it to provincial offices (WB, 2020). Such insufficient funding undermines the implementation of activities aimed to reduce deforestation (Kalaba, 2016).
- Few validated management plans and clear work plans: the lack of funding often results in few management plans being developed, implemented and updated to include clear work plans, specific conservation measures and initiatives, and adaptive management.
- Insufficient staffing and poor capacity: many offices have fewer staff members than they should according to the official Forestry Department structure and management plans. This leads to poor capacity for conservation actions and enforcement of land use restrictions within the Forest Reserves.
- Lack of equipment: the capacity of forestry officers is also limited by a lack of means of transportation, uniforms, signage and beacons, seeds and nurseries as well as protective gear and field equipment. This further hinders the capacity to implement conservation and restoration actions and enforce land use restrictions.
- Little monitoring, surveillance and law enforcement activities: limited staffing and lack of transportation lead to little monitoring, surveillance and law enforcement activities which, over time, have resulted in extensive areas of encroachment for agricultural activities and, in some cases, even settlements.

- Limited compliance of local communities with conservation objectives: Limited capacity for monitoring and enforcement leads to encroachment within Forest Reserves. Without clear commitments from local chiefs and no apparent consequences for non-compliance with conservation restrictions, it is difficult to have local communities adhere to conservation objectives as livelihoods are often intertwined with forest resources.

Without strengthening these capacities, the legal authority granted under Zambia's Regulations remains largely symbolic. As a result, there is considerable potential for compensation actions to increase biodiversity value in Forest Reserves because they contain extensive areas of degraded habitats where positive actions could be implemented. Although the Forest Reserves technically constitute legally protected areas, there is evidence of a substantial lack of financial resources and lack of capacity to achieve the sites' conservation objectives, which means that actions implemented within these sites would likely meet the principle of additionality. It should be noted that the primary objectives of Forest Reserves are to manage forest resources and timber supply. Compensation actions aimed at reforestation would generally align with sustainable forest management. However, careful planning and management of harvest operations would be needed as timber harvesting does not always align with biodiversity conservation objectives. Nonetheless, the Forest Reserves have a management structure in place that could implement monitoring and enforcement actions, provided they have proper resources and support.

6.3.2.2 Community Forests

Community Forests, managed by Community Forest Management Groups (CFMGs), also have a high potential for conservation and reforestation actions. As detailed in Section 2.2.2, CFMGs are created to encourage the coexistence of sustainable income-generating activities and conservation objectives. CFMGs work with supporting partners, such as NGOs, who provide resources, funds and training to implement conservation initiatives and foster sustainable management of these demarcated forests.

Though challenges in Community Forests are similar to those in Forest Reserves (lack of funding, equipment and capacity), the involvement of local communities and the benefits they receive from livelihood activities associated with forest resources increases the likelihood of compliance with conservation measures. There are many examples of successfully implemented Community Forests with promising results, both in terms of conservation and livelihood outcomes, including as part of Transforming Landscapes for Resilience and Development (TRALARD), Zambia Integrated Forest Landscape Project (ZIFLP) and Lavushimanda Community Conservation Project (see Appendix 6-1).

Additionally, some of these Community Forests are in the buffer zones of protected areas, such as Lavushi Manda National Park, or are within known wildlife migration corridors and could simultaneously contribute to enhance ecological connectivity at a landscape level. As such, Community Forests present good opportunities for compensation activities.

6.3.3 Options for Compensation Actions

There are two main approaches to generating biodiversity gains via compensation activities: restoration actions and averted loss actions. Owing to the complexity and uncertainty in quantifying averted losses, the NHCP has proposed restoration actions only. Nonetheless, additional compensation actions are already planned as part of the ZTIP and are expected to contribute qualitatively to improved biodiversity conservation and sustainable land-use. These additional actions are explained below.

6.3.3.1 Restoration Actions

Restoration actions, including assisted natural regeneration (ANR) and active reforestation, repair past damage to biodiversity that was not caused by the project. Restoration actions produce habitat gains that are estimated by calculating the difference between: (i) the baseline habitat quality in restoration area, and (ii) the habitat quality in the same area at the end of restoration activities.

The following sections detail the restoration actions retained as part of the NHCP.

Assisted Natural Regeneration

Following deforestation or other human or natural disturbances, new forest cover can emerge, either spontaneously or with assistance, from ecological memory of the former forest ecosystem and the surrounding landscape (FAO, 2019). ANR is a targeted strategy aimed at supporting this natural process to achieve forest recovery. In areas where ecosystems are showing signs of natural regeneration, ANR is more effective than tree planting to recover biodiversity and forest structure and requires less funds, labor and seed resources than traditional reforestation initiatives (FAO, 2019).

ANR speeds up the natural successional process by protecting specific areas against disturbances and reducing competition from species that can impede the growth of natural trees. According to the FAO (2019), contingent on appropriate rains and good implementation, ANR results can be seen in less than three (3) years.

To foster better results, ANR is often paired with enrichment planting (infill planting) of indigenous trees to meet restoration objectives and help natural regeneration. ANR can be considered in ecosystems with an adequate density of naturally regenerated tree seedlings (FAO, 2019). Miombo woodlands and riverine forests will be targeted for ANR, in areas where natural regeneration has been confirmed, It can be assisted to improve regeneration success. Expected habitat gains from these actions are discussed in Section 6.7.

Reforestation

Reforestation consists of re-establishing forest cover by planting indigenous trees. Site-specific planting prescriptions are designed to return forests with species assemblages and densities that resemble those of undisturbed forests. Reforestation efforts will target various degraded areas, including those affected by natural processes and human activity (including agriculture).

Reforestation activities exclusively use indigenous species to avoid introducing exotic plants that can alter the ecosystem's natural balance. Preferred species for reforestation in miombo woodlands and riverine forests were selected based on several criteria and in collaboration with stakeholders (see Sections 6.5.1.2 and 6.5.2.2). Project nurseries will be established to ensure adequate seedling stock and varieties. However, due to the large number of required seedlings, existing nurseries will be required to source most of the seedlings. Project nurseries will also be used to germinate locally collected indigenous seeds or propagate plant cuttings, and to grow and prepare seedlings for planting. Stakeholder engagement activities have outlined that water supply is often a challenge when developing nurseries, so the location of nurseries and water supply strategy will require careful evaluation prior to site selection.

Reforestation has a high potential in terms of generating habitat gain as it can be implemented in highly degraded areas where the current score for quality of natural habitat is very low. However, relative to ANR, reforestation requires more investment, monitoring, and adaptive management to result in long-term benefits. Reforestation has also the strongest potential to result in physical and economic resettlement because it targets heavily disturbed areas currently or previously used by local people. As such, candidate reforestation areas will need to be carefully selected to ensure a reasonable likelihood of achieving the desired outcomes. Expected habitat gains from reforestation actions are discussed in Section 6.7.

6.3.3.2 Additional Compensation Actions

Additional conservation actions will be implemented as part of the BMP, but they cannot be included in the habitat gain assessment due to complexity in quantifying related habitat gains within the quality-hectare framework. However, these additional conservation actions are expected to have beneficial effects on habitats and ecosystems within the BIIA. As such, they are considered additional benefits.

Compensation through Statutory Fees

Biomass assessments were conducted by the Forestry Department in Central and Northern Provinces to measure and quantify the volume of wood and other forest resources that will be impacted by the ZTIP within Forest Reserves to determine the economic value of lost resources and support restoration and conservation efforts. Compensation fees were established based on the quantified forest losses, in compliance with the process mandated in the Forest Act, 2015. It should be noted that no biomass assessment was conducted in Nakonde Forest Reserve as it is a commercial plantation managed by ZAFFICO.

Table 6-2 summarizes the results of the biomass assessments. Supporting technical reports are available in Appendix 2-2.

Table 6-2 Biomass Assessment Results

Province	District	Forest Reserve	Affected area (ha)	Affected tree volume	Statutory fee (Kwacha)
Central	Serenje	Kanona	108.0	1.9 m ³ for trees > 30 cm 130,634 poles of various diameter classes	2,725,983.00
Northern	Kasama	Nkole Mfumu	22.5	4,127.7 m ³	1,160,626.46
		Kasama	12.5	102.6 m ³	
		Amenshi	1.5	68.3 m ³	
	Mungwi	Mungwi	1.5	361.6 m ³	251,674.02
		Chiti Mukulu	15.0	570.5 m ³	
Total amount to be paid by ZESCO					4,138,283.48

Source: Biomass Assessment Reports (Appendix 2-2).

Based on the biomass assessments in affected Forest Reserves, ZESCO must pay a statutory fee of 4,138,283.48 Kwacha to fulfill legal requirements. These fees, that should be distributed to the affected districts are intended to support sustainable management of forest resources and mitigate ecological impacts of the ZTIP within Forest Reserves.

Though this compensation amount is aimed at funding conservation actions by the Forestry Department within affected Forest Reserves, stakeholder engagement activities have revealed that there is a lack of transparency in fund allocation, with funds often staying in national accounts. As such, it will be difficult to assess and measure the benefits of this compensation payment in terms of biodiversity gains in the BIIA. Any gains will thus be considered additional benefits and will not be quantified as part of the NHCP's contributions towards no net loss. The PIU will try to collaborate with the Forestry Department for these funds to be allocated to supporting actions whenever possible.

Livelihood-Based Reforestation Program

As part of the RAP for the Pensulo-Kasama section of the ZTIP (WSP, 2025), several indigenous trees and natural areas associated with livelihood activities were inventoried within the ROW. Under the Forests Act, 2015, ownership of indigenous trees is vested in the President (article 3), so cash compensation was not paid to individuals for their loss. However, as they are linked to livelihood and ecosystem services, they must be restored to mitigate the impacts of the project on local communities. In this context, the RAP proposed a livelihood-based reforestation program for indigenous trees associated with livelihoods to be compensated at the community-level.

Indigenous trees associated with livelihoods were inventoried on individualized parcels as well as in natural communal areas within the ROW. A total of 28,930 indigenous trees used for fruit or timber, including 16,160 mature and 12,770 immature trees, were recorded on individual parcels between Pensulo and Kasama. Additionally, 22 natural communal areas were identified within the wayleave, covering a total area of 117.92 ha, where indigenous trees are used by communities for livelihood purposes. Based on an estimated density of 213 stems/ha (see ESMP, stand-alone report), the affected communal areas would include about 25,117 trees.

The livelihood-based reforestation program aims to restore livelihoods associated with the loss of these indigenous trees. The program will be implemented by the ZTIP PIU in close collaboration with affected communities who will receive seedlings to plant in appropriate areas. Those areas should be accessible to affected community members and could include communal areas and agricultural areas. Indigenous trees will be planted, and their growth will be monitored to ensure proper restoration of livelihoods associated with natural forest resources.

This program is considered an additional conservation action because quantification and monitoring of the long-term biodiversity gains would be nearly impossible and likely cost prohibitive. Indeed, the main objective of this program is to restore livelihoods and species of use value will be prioritized. Planted trees are expected to be exploited, at least partially, for fruit and timber by local communities as part of their livelihoods. As such, planting as part of this program is unlikely to align with the compensation plan's guiding principle of producing measurable, long-term gains for natural habitats. However, tree planting is expected to benefit biodiversity by increasing tree cover in the area and is thus considered as an additional conservation action.

6.4 Candidate Compensation Sites Selection

Preliminary candidate sites for compensation were identified considering the types of biodiversity features requiring compensation and the preliminary estimate of the magnitude of compensation area needed to deliver no net loss for natural habitats.

Site selection criteria and the methodology for identifying and selecting candidate sites are presented below. Preliminary candidate compensation sites for miombo woodlands and riverine forests are presented in Sections 6.5.1.1 and 6.5.2.1, respectively. Final site selection will require validation and confirmation through a feasibility assessment (see Section 6.8).

6.4.1 Criteria for the Selection of Candidate Sites

Selection criteria to identify potential candidate sites for the natural habitats compensation actions were determined in consideration of the guiding principles defined in Section 6.3.1. Table 6-3 presents the selection criteria, the rationale behind their selection, as well as their relative importance (i.e., weighting) in the candidate site identification process.

Importance was defined as follows:

- **High** importance criteria identify mandatory site characteristics. Sites that did not meet these criteria were eliminated and not considered further.
- **Medium** importance criteria are criteria that correspond to desirable site characteristics. These criteria guided the selection process by emphasizing candidate sites that are most likely to achieve compensation objectives.
- **Low** importance criteria are criteria that guided the overall selection of candidate sites but did not play a decisive role in the process. Candidate sites that did not meet low importance criteria could still be selected if they met other medium or high importance criteria.

Table 6-3 Selection Criteria for Candidate Compensation Sites

ID	Criteria	Rationale and association with guiding principles	Importance
General			
G1	Inside designated Forest Reserves or Community Forests	Compensation activities in Forest Reserves or Community Forests are likely to produce long-term outcomes. Additionality can be achieved by targeting areas that are not currently part of reforestation initiatives. Reforestation in these sites is considered more likely to succeed than similar actions implemented outside of designated areas.	High
G2	No resulting physical displacement	In line with the equity principle, compensation activities will not lead to physical resettlement.	High
G3	No high-density agricultural areas	To achieve long-term outcomes and in compliance with the equity principle, high-density agricultural areas should be avoided as compensation actions will negatively impact livelihoods, and anthropogenic activities are likely to resume. Relocating farmers in high-density agricultural areas is also likely to result in loss of habitat elsewhere due to land clearing to establish new farms.	High
G4	Geographical distribution	All affected provinces and districts should be targeted by compensation activities to ensure a geographical distribution of benefits.	Medium
G5	Contribution to ecological connectivity	Sites where compensation actions contribute to improving ecological connectivity provide higher biodiversity value in a landscape context.	Medium
G6	Sites suggested by stakeholders	In alignment with the stakeholder participation guiding principle, sites identified by stakeholders during consultation activities were considered. These areas are likely adapted to the local context and can contribute to regional planning and sustainability objectives.	Medium
G7	Flat topography	Compensation activities in areas with flat topography are easier to implement and are more likely to lead to durable results.	Medium
G8	Far from human settlements	Within the BIIA, sites located further from human settlements were considered to have a lower risk of future anthropogenic disturbance and therefore a higher likelihood of achieving long-term outcomes.	Medium
G9	Total potential area for compensation	Implementation is easier in a single larger area than across several smaller areas. Biodiversity benefits may be greater if larger patches of natural habitat are recreated.	Low

ID	Criteria	Rationale and association with guiding principles	Importance
Specific to miombo woodlands			
M1	Avoidance of rock art paintings (in Kasama Forest Reserve only)	Rock art paintings in the Kasama Forest Reserve have cultural and archaeological value and, as such, will be avoided to respect the local landscape and conservation objectives. Compensation actions should not be located in proximity to these areas.	High
M2	Patches of degraded areas in proximity to mature miombo areas	Reforestation in degraded areas surrounded by mature, well-preserved habitat is more likely to produce long-term outcomes. Compensation activities in those areas will also contribute to habitat connectivity.	Medium
M3	Degraded/secondary miombo areas	As part of the like-for-like or better principle, areas of degraded miombo or secondary miombo woodlands will be preferred to compensate affected miombo woodlands, with the aim of replacing them with mature miombo.	Low
Specific to riverine forests			
R1	Patches of degraded riverine forests	As part of the like-for-like or better principle, patches of degraded riverine forest are favored over other land cover types to improve likelihood of reforestation success in ecologically adapted areas for riverine species.	Medium
R2	Patches without vegetation along streams between riverine forests	Patches without vegetation between well preserved riverine forests are more likely to produce long-term outcomes while contributing to improved connectivity.	Low

6.4.2 Methodology for Selecting Candidate Sites

The selection of candidate sites involved two steps. First, a long list of potential designated areas was screened to identify candidate Forest Reserves and Community Reserves. Then, discrete sites for restoration actions were delineated within the boundaries of the identified Forest Reserves and Community Forests. The methodology for candidate site selection is detailed below.

6.4.2.1 Selection of Forest Reserves and Community Forests

As stated in the selection criteria, only candidate sites within designated areas were considered. However, based on consultation activities, analysis of satellite imagery and land uses, some delineated areas within the BIIA are not considered suitable for compensation activities and do not correspond to the criteria listed above. Forest Reserves intersected by the line route were preferred. As none of the Community Forests in the BIIA are crossed by the line route, all Community Forests within 7.5 km of the project corridor were considered. Community Forests located within the buffer area of Lavushi Manda National Park were also considered, including those further than 7.5 km from the line route, due to the ecological importance of the buffer zone and potential project impacts on this protected area.

Table 6-4 presents the evaluation of Forest Reserves and Community Forests. The assessment screened 17 designated areas and retained four (4) Forest Reserves and five (5) Community Forests for further analysis and identification of candidate compensation sites.

Table 6-4 Screening of Potential Forest Reserves and Community Forests

Name	District	Selection	Rationale
Forest Reserves			
Nakonde	Nakonde	No	The Nakonde Forest Reserve is almost entirely used for plantations that are managed by ZAFFICO, under authorization of the Forestry Department. As such, treed habitats in this Forest Reserve are not natural and the forest management regime is unlikely to be compatible with compensation activities that seek long-term, sustainable results.
Chitimukulu	Mungwi	No	The Mungwi District Office of the Forestry Department mentioned during consultation activities that legal charcoal burning takes place in this Forest Reserve, as well as illegal charcoal burning. This was confirmed by land use interpretation, which identified heavily modified habitats within this Forest Reserve. As such, anthropogenic pressures seem too important and are likely to preclude sustainable results in this Forest Reserve.
Mungwi	Mungwi	Yes	There is a high potential for compensation of riverine forest habitat in the Mungwi Forest Reserve.
Kasama	Kasama	Yes	The Kasama Forest Reserve is protected by the National Heritage Conservation Commission (NHCC) for the cultural importance of rock paintings and it contains critical habitat. It is an important ecological area in the local landscape and stakeholders communicated support for compensation activities in this reserve.
Amenshi	Kasama	No	The Amenshi Forest Reserve includes several patches of riverine forest habitat, but most are highly degraded and used for agricultural activities. It is then assumed that these forests are exposed to intensive human pressures, which may negatively affect long-term success of reforestation activities. Scarce patches of small size may also complicate the implementation of the planned activities.
Nkole Mfumu	Kasama	Yes	The Nkole Mfumu Forest Reserve has great potential for compensation activities as it is generally well preserved, except for small patches of degraded woodlands and cultivated areas, especially along its boundary. The northern part of the Forest Reserve is very encroached with large agricultural areas, but other areas have high potential for compensation to improve ecological integrity and connectivity by creating a larger patch of miombo woodland.
Kanona	Chitambo	Yes	The Kanona Forest Reserve is the only designated area within Chitambo District. Though it is largely used for agricultural purposes, it was retained to achieve a geographic distribution of habitat compensation benefits. Reforestation efforts would need to target better preserved areas of the reserve.
Community Forests			
Isalala	Nakonde	Yes	Best potential area for compensation activities in the Nakonde District. This Community Forest overlaps the global extent of occurrence for the Pancake tortoise (<i>Malacochersus tornieri</i>), a critically endangered species.
Nankungu	Mungwi	No	This Community Forest is close to the Kasama Forest Reserve, which was identified for compensation activities. To ensure geographical distribution, this Community Forest was not selected.
Kaseke	Mungwi	No	Satellite imagery shows that this Community Forest is very degraded and was assumed to have low potential for reforestation success.

Name	District	Selection	Rationale
Swiswi	Mungwi	No	Remnant patches of natural habitats are very degraded based on satellite imagery. The site was assumed to have low potential for reforestation success.
Kaloswe	Mpika	Yes	Strategically located within an ecological corridor for lions and contributes to connectivity between Lavushi Manda and South Luangwa National Parks.
Ilumbwe	Mpika	Yes	Contributes to ecological connectivity between Mpika Boma, Lwitikila and Luangwa Forest Reserves. Northern sector is degraded, but there are potential areas that would be suitable for compensation activities.
Salamo	Lavushimanda	No	It is in the buffer area for Lavushi Manda National Park and is very well preserved, making it difficult to identify areas where compensation activities could generate biodiversity gains.
Mwenda Chipalabwe	Lavushimanda	Yes	It is in the buffer area for Lavushi Manda National Park and has a few areas that have potential for compensation activities.
Mabonga Kosapo	Lavushimanda	No	Though it is in the buffer area for Lavushi Manda National Park, the land use is mostly agricultural, with many high-density cultivated areas. The site was assumed to have low potential for reforestation success without important economic resettlement.
Kapambwa	Serenje / Chitambo	Yes	Provides connectivity with the Kanona Forest Reserve and has a lot of potential for compensation activities.

6.4.2.2 Identification of Potential Candidate Sites and Preliminary Quantification of Available Compensation Area

The identification of potential candidate sites consisted of spatially delineating preliminary assessment areas in managed forests identified in Section 6.4.2.1 as having high potential for compensation activities. Potential candidate compensation sites were then selected in these preliminary assessment areas based on a high-level land use analysis. Specifically, sites were delineated in a GIS using the criteria defined in Section 6.4.1, relying on land use data and satellite imagery to inform the criteria. Those candidate sites were then further analyzed in a GIS with more detailed land use interpretation and mapping.

Using detailed land use mapping, the available surface area for potential compensation actions for miombo woodland and riverine forest habitats were quantified within each candidate site. This quantification constitutes a preliminary assessment of potential gains in each managed forest. The goal was to determine whether the candidate sites (in combination) provide enough potential gains to balance the estimated natural habitat loss from the project. Once this was confirmed, the delineation of candidate sites was optimized based on land use results and specific objectives for each site. The resulting candidate sites and associated compensation actions are characterized in Section 6.5.1 for miombo woodlands and Section 6.5.2 for riverine forests.

6.5 Description of Compensation Actions

Anticipated compensation actions for miombo woodlands and riverine forests are detailed in the following sections, including the available surface area for implementation of each action. Preferred species for reforestation in both habitat types are also presented.

6.5.1 Miombo Woodlands

6.5.1.1 Candidate Sites and Associated Actions

Based on criteria established in Section 6.4.1, a total of 35 potential candidate sites were identified for miombo woodlands and are presented in Table 6-5. It should be noted that these are preliminary candidate compensation sites, and a final selection will be completed following the feasibility study conducted by the PIU, based on the guidelines in Section 6.8. Maps showing the extent of each candidate site, as well as the current land use are presented in Appendix 6-2.

It should be noted that some candidate sites were selected for compensation activities for both miombo woodland and riverine forest. These candidate sites are presented in Tables 6-5 and 6-7, focusing on compensation potential for miombo woodland and riverine forest, respectively. In these cases, specific areas were delineated for compensation actions associated with miombo woodlands and riverine forests (see Appendix 6-2).

Compensation actions implemented at each candidate site will depend on the current land use class and current habitat quality. ANR will be implemented in secondary forests while reforestation will be preferred on fallow and agricultural land. Compensation actions in degraded miombo woodlands will be context-specific and will depend on adjoining habitat. For instance, degraded miombo woodlands that are surrounded by mature miombo and that already show signs of natural regeneration may be candidate sites for ANR. Degraded miombo woodlands surrounded by fallow or agricultural land will be reforested to ensure better long-term results.

Table 6-5 shows the estimated area for ANR and reforestation in each candidate site based on the above guidelines for miombo woodland. Specific actions will be further detailed at the feasibility stage once site assessments are conducted (see Section 6.8).

As shown in Table 6-5, a total area of 1,524.51 ha is identified for compensation actions for miombo woodland habitat within the candidate sites identified to date. Of this total area, 1,257.86 ha are in Forest Reserves and 266.65 ha are in Community Forests. There is potential for 528.76 ha of ANR and 995.76 ha of reforestation across all sites. The location of candidate sites is shown on Maps 6-1 to 6-3, presented after Table 6-5.

Table 6-5 Overview of Candidate Sites for Compensation in Miombo Woodlands

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Forest Reserves (FR)							
Kasama 1 (31.2520631, -10.2019421)	Kasama	This site is adjacent to the ROW and a rock outcrop area, which is critical habitat for <i>Euphorbia perplexa</i> var. <i>kasamana</i> (see Section 2.9). It is a patch of degraded miombo within undisturbed woodland habitat.	Secondary miombo: 1.62 Degraded miombo: 1.21 Mature miombo: 0.32	ANR actions can be completed in secondary miombo to restore mature miombo. In degraded miombo, satellite imagery analysis reveals some level of natural regeneration so ANR actions could aim to restore secondary miombo.	2.83	-	2.83
Kasama 2 (31.2510533, -10.1892793)	Kasama	This site is located next to a stream and wetland area and aims to compensate miombo woodlands and riverine forests. There are two main patches of agricultural land where miombo could be restored. A narrow path leads to the southern agricultural land, providing access to the site.	Agricultural: 1.52 Secondary miombo: 0.46 Degraded miombo: 0.26 Wetland: 0.17 Riverine forest: 0.03	Reforestation can be completed in agricultural land and adjacent degraded miombo to restore secondary miombo habitat. Existing secondary miombo woodlands can be targeted by ANR actions to restore mature miombo.	0.46	1.79	2.25
Kasama 3 (31.2399180, -10.1952049)	Kasama	This site is located among patches of rock outcrop area, which is critical habitat for <i>Euphorbia perplexa</i> var. <i>kasamana</i> (see Section 2.9), and wetlands. It is composed of degraded miombo within woodland habitat. Existing tracks provide access to this site. Reforestation would increase habitat connectivity and benefit biodiversity in this ecologically sensitive area.	Degraded miombo: 5.73 Secondary miombo: 1.70 Wetland: 0.04	Degraded miombo areas are extensive and show very limited tree coverage, so reforestation could be completed to restore secondary miombo. Secondary miombo could be targeted by ANR actions to restore mature miombo.	1.70	5.73	7.42

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Kasama 4 (31.2546411, -10.1977687)	Kasama	Sites Kasama 4, 5 and 6 are similar both in terms of their location and characteristics. All three sites are located along the ROW and consist of degraded miombo areas among woodland areas. Those sites are located near (between 0.5 and 0.8 km) a wetland that is high sensitivity bird habitat (see Section 2.4.9) and critical habitat for <i>Disa aequiloba</i> (see Section 2.9). They are also near (less than 0.5 km) critical habitat for <i>Euphorbia perplexa</i> var. <i>kasamana</i> (see Section 2.9). They provide opportunity for reforestation near the immediate project footprint in an ecologically sensitive area.	Mature miombo: 0.57 Secondary miombo: 0.43 Degraded miombo: 0.32	ANR actions can target degraded and secondary miombo to restore secondary and mature miombo, respectively.	0.75	-	0.75
Kasama 5 (31.2559458, -10.1956448)	Kasama		Secondary miombo: 1.84 Mature miombo: 1.34 Degraded miombo: 0.73	This site has the largest area of degraded miombo between Kasama 4, 5 and 6, where reforestation can be completed to restore secondary miombo. Existing secondary miombo can be targeted by ANR actions to restore mature miombo.	1.84	0.73	2.57
Kasama 6 (31.2561102, -10.1984979)	Kasama	These sites were selected for their proximity to the immediate project footprint and were delineated to include patches of degraded miombos within the existing mature woodland habitat.	Secondary miombo: 0.70 Degraded miombo: 0.56 Mature miombo: 0.41	ANR actions can target degraded and secondary miombo to restore secondary and mature miombo, respectively.	1.26	-	1.26
Nkole Mfumu 1 (31.1896741, -10.6644094)	Kasama	This site is located at the edge of the FR where encroachment for agricultural activity is visible. An undisturbed wetland area that is a medium sensitivity bird habitat (see Section 2.4.9) and potential critical habitat for <i>Disa aequiloba</i> (see Section 2.9) is located less than 1 km south. Compensation actions at this site, especially if supported by improved demarcation (beacons and signage) of the FR boundary, could help decrease encroachment and preserve large mature miombo and secondary miombo habitats that extend to the south. This site is connected to the ZTIP ROW, so no additional access roads will be required.	Secondary miombo: 53.15 Agricultural: 29.87 Degraded miombo: 29.33 Fallow: 28.60 Mature miombo: 0.09	Agricultural and fallow land can be reforested to restore secondary miombo woodlands. Reforestation can also be completed in degraded miombo areas as they present low tree density and are adjacent to agricultural and fallow land. This is expected to result in secondary miombo. ANR actions can be implemented in secondary miombo areas to restore mature miombo. The northern edge of this site along the FR boundary would be a potential site for designing a green firebreak, protecting from fire from adjacent agricultural areas.	53.15	87.80	140.95

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Nkole Mfumu 2 (31.2178517, -10.6650731)	Kasama	Also located at the edge of the FR, reforestation, especially if supported by improved demarcation of the FR boundary, can limit encroachment and preserve natural habitats. The site is located on either side of a stream and offers potential for miombo woodland and riverine forest. Along with Nkole Mfumu 1, this site is the only encroachment visible in the southern part of the FR. There are existing tracks providing access to the site.	Mature miombo: 162.61 Degraded miombo: 39.98 Fallow: 24.54 Secondary miombo: 12.23 Agricultural: 7.35 Riverine forest: 1.05	Agricultural and fallow land as well as degraded miombo in the north-west sector of this site can be reforested to restore secondary miombo. Degraded miombo areas elsewhere at this site are mostly scattered across mature miombo habitat. As such, ANR actions can be implemented to increase habitat quality by generating secondary miombo. ANR actions can also be implemented in secondary miombo to restore mature miombo.	25.55	58.56	84.10
Nkole Mfumu 3 (31.2262328, -10.6095536)	Kasama	This is the largest site proposed in Nkole Mfumu FR. It is located near a wetland and along the western edge of the FR. There are signs of encroachment from agricultural activities, especially along the stream. Surrounding areas are well preserved natural habitats with large patches of undisturbed mature miombo. The site presents opportunity for compensation of miombo woodland and riverine forest. Reforestation, especially if supported by better signage in this area, could help prevent encroachment from settlements located along the M1 road west of the FR. Existing tracks provide access to this site.	Mature miombo: 239.06 Fallow: 90.77 Degraded miombo: 78.64 Secondary miombo: 52.49 Agricultural: 7.32 Riverine forest: 2.97 Wetland: 0.32	Reforestation can be completed in agricultural areas, fallow land and degraded miombo to restore secondary miombo woodlands. In secondary woodland, ANR actions would aim to restore mature miombo woodland habitat.	52.49	176.73	229.22

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Nkole Mfumu 4 (31.2172690, -10.6242995)	Kasama	This site is also located along the edge of the FR and mainly contains degraded miombo and fallow land patches among a large area of well-preserved mature miombo woodland. Small existing tracks provide access to the site. As for other sites in Nkole Mfumu, reforestation and better signage could help preserve miombo habitats and limit encroachment in the FR.	Degraded miombo: 82.54 Mature miombo: 72.82 Secondary miombo: 21.90 Fallow: 9.16	Fallow land can be reforested to restore secondary miombo. Degraded forest on the western side of the site could undergo reforestation (to restore secondary miombo) as tree cover is currently limited. On the eastern side, degraded miombo is scattered across miombo woodland, so ANR actions should be preferred to restore secondary miombo. Existing secondary miombo areas can be targeted by ANR actions to restore mature miombo.	37.49	76.11	113.60
Nkole Mfumu 5 (31.2399473, -10.5190160)	Kasama	This site is located along the western edge of the FR and extends east around a stream and wetland, providing opportunity for compensation of miombo woodland and riverine forest. The site shows a few patches of agricultural land, fallow, and degraded miombo area among a large area of miombo woodland. It is crossed by a track, used for accessing agricultural fields along the stream.	Degraded miombo: 144.21 Mature miombo: 100.95 Fallow: 52.10 Secondary miombo: 41.09 Agricultural: 11.20 Wetland: 3.95	Fallow and agricultural land can be reforested to restore secondary miombo. Degraded miombo in the western sector of the site could be reforested (representing an area of 72.58 ha), while degraded miombo in the eastern sector, scattered across mature miombo, could be targeted by ANR actions. These actions in degraded miombo will restore secondary miombo. Existing secondary miombo can be targeted by ANR actions to restore mature miombo.	112.72	135.87	248.59

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Nkole Mfumu 6 (31.2336818, -10.4954162)	Kasama	This site is a mosaic of degraded miombo, secondary miombo and mature miombo located along the western edge, just south of an extensively encroached and cultivated sector of the FR. Compensation at this site, especially along with increased demarcation of FR boundaries, could help slow agricultural encroachment, which has highly degraded the north-western sector of the FR. Existing tracks provide access to the site.	Degraded miombo: 301.42 Mature miombo: 171.11 Secondary miombo: 34.77	Areas of degraded miombo are extensive, so reforestation should be completed to restore secondary miombo. ANR actions can be completed in secondary miombo to restore mature miombo.	34.77	301.42	336.19
Nkole Mfumu 7 (31.228802, -10.536817)	Kasama	This site is mainly targeted for riverine forest compensation, but restoration of miombo woodland could be completed to provide a good quality habitat buffer around the riverine forest. It is located on the western edge of the FR and is accessible via small agricultural tracks. Mature miombo habitats is spread over the northern side of the candidate site while the southern side is a mosaic of mature and secondary miombo.	Fallow: 14.50 Degraded miombo: 10.56 Mature miombo: 8.26 Secondary miombo: 1.13 Riverine forest: 0.08	Reforestation can be completed in fallow land and on 1.70 ha of degraded miombo. This patch of degraded miombo is located on the north-western sector of the candidate site, between two large fallow areas, so it could benefit from reforestation. The remaining degraded miombo areas are small patches spread across mature and secondary miombo. These, and existing secondary miombo, will be targeted by ANR actions.	9.99	16.20	26.19
Nkole Mfumu 8 (31.254144, -10.560458)	Kasama	As Nkole Mfumu 7, this site mainly targets riverine forest habitat, but specific actions can be completed in miombo woodlands to increase the quality of habitats surrounding the riverine forest. This site is located around a large wetland area and is the only candidate site in this FR not to be located immediately along its western boundary. The forest cover being quite dense in the area, the nearest track that could be identified through satellite imagery is located slightly over 1 km away from the site.	Mature miombo: 57.02 Degraded miombo: 29.97 Fallow: 25.06 Riverine forest: 0.29	Reforestation can be completed in fallow land to restore secondary miombo. Degraded miombo can be targeted by ANR actions as it is part of a patchwork of degraded and mature miombo woodlands. It is expected that ANR actions in degraded miombo will return secondary miombo.	29.97	25.06	55.03

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Kanona 1 (30.4966548, -13.0036209)	Chitambo	The site includes isolated patches of agricultural land and degraded miombo within mature miombo. It is located as far as possible from densely cultivated areas within the FR. It is located between two streams, making it a more isolated area though there are access tracks nearby, limiting the need for new access roads.	Degraded miombo: 1.66 Secondary miombo: 1.51 Agricultural: 0.34 Mature miombo: 0.16	Agricultural land and degraded miombos can be reforested to restore secondary miombo woodlands. ANR actions can be implemented in secondary miombo areas to restore mature miombo woodlands.	1.51	2.00	3.51
Kanona 2 (30.4974793, -13.0015939)	Chitambo	The site is located next to two streams and is mainly degraded miombos within some areas of mature miombo. As such, there is a potential for compensation of miombo woodlands and riverine forests. As for site Kanona 1, it is located in a more remote area of the FR but benefits from the presence of some access tracks.	Degraded miombo: 0.67 Secondary miombo: 0.47 Riverine forest: 0.03 Agricultural: 0.03	Agricultural land and degraded miombos can be reforested to restore secondary miombo woodlands. ANR actions can be implemented in secondary miombo areas to restore mature miombo woodlands.	0.47	0.70	1.18
Kanona 3 (30.4897910, -13.0081735)	Chitambo	The site is located next to a stream in a large patch of miombo with limited encroachment. The site is mainly agricultural and is the only agricultural development along that sector of the stream. Reforestation could help preserve this area from additional land conversion. The site is approximately 400 m from the nearest existing access track.	Agricultural: 1.13 Secondary miombo: 0.63 Degraded miombo: 0.46 Riverine forest: 0.03	Agricultural land and degraded miombos can be reforested to restore secondary miombo woodlands. ANR actions can be implemented in secondary miombo areas to restore mature miombo woodlands.	0.63	1.59	2.22

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Community Forests (CF)							
Isalala 1 (32.7780594, -9.3712182)	Nakonde	This site is located directly south of a large patch of mature miombo woodland. The site is west of a track that provides access. Habitats on the west side of the track are better preserved while the east side contains many disturbed areas, mainly due to agricultural activities. The site, west of the track, is one area with few patches that are highly disrupted by agricultural activity, with areas of degraded miombos. It presents potential for compensation of miombo woodland.	Agricultural: 1.62 Degraded miombo: 0.59 Secondary miombo: 0.24 Mature miombo: 0.09	Reforestation in alternating agricultural areas and degraded miombo habitat, adjacent to mature miombo habitat. This could restore secondary miombo. Targeted ANR actions in existing secondary miombo could restore mature miombo.	0.24	2.21	2.44
Isalala 2 (32.7745008, -9.3705458)	Nakonde	This site is a large patch of fallow land amongst a well-preserved mosaic of mature and secondary miombos. A small track provides access to the site.	Fallow: 1.14	Reforestation can be implemented in fallow land areas to restore secondary miombo habitat.	-	1.14	1.14
Isalala 3 (32.7764359, -9.3687538)	Nakonde	This site is located at the junction of two small streams and has patches of agricultural land and degraded miombo within secondary miombo habitat. It is located 225 m from the nearest track.	Degraded miombo: 0.57 Secondary miombo: 0.16 Agricultural: 0.07	Reforestation in the large patch of degraded forest and adjacent agricultural area could restore secondary miombo. ANR actions could target existing secondary miombo to return mature miombo.	0.16	0.64	0.80

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Isalala 4 (32.7791012, -9.3695058)	Nakonde	This site is located just north of Isalala 1, directly west of the track separating degraded habitats, mostly agriculture (to the east) and a mosaic of secondary and mature miombo with limited disturbance (to the west). The agricultural land is one of the only disturbances on the east side of the track, along with the Isalala 1 site. It provides a good opportunity for compensation of miombo woodland habitat.	Agricultural: 0.64 Secondary miombo: 0.02	Reforestation could be implemented in agricultural areas to restore secondary miombo habitat. Small-scale targeted ANR actions could be applied in secondary miombo habitat to restore mature miombo.	0.02	0.64	0.66
Ilumbwe 1 (31.3017408, -12.0817845)	Mpika	Located in the southern tip of this CF, this site is mainly composed of a mosaic of degraded and secondary miombos next to an area of mature miombo. A patch of fallow land where reforestation can be done is present at the southern edge of this site. Existing tracks provide access to the site.	Degraded miombo: 32.43 Secondary miombo: 16.60 Mature miombo: 1.61 Fallow: 1.31	Fallow land can be reforested to restore secondary miombo habitat. ANR actions can target degraded and secondary miombo to restore secondary and mature miombo, respectively.	49.03	1.31	50.34
Ilumbwe 2 (31.3303960, -12.0754945)	Mpika	This site is located on the edge of a wetland, providing opportunity for compensation of miombo woodland and riverine forest. The surroundings are mainly composed of a mosaic of mature miombo and secondary miombos. The site has a high proportion of agricultural and degraded miombo land that could be reforested and well-integrated into the surrounding natural habitat. An existing track leading to agricultural lands could provide access to this site.	Agricultural: 9.17 Degraded miombo: 8.30 Secondary miombo: 5.30 Mature miombo: 2.47 Riverine forest: 0.25 Wetland: 0.04	Agricultural land and adjacent degraded miombo areas can be reforested to restore secondary miombo. Secondary miombo can be targeted with ANR actions to restore mature miombo.	5.30	17.47	22.77

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Ilumbwe 3 (31.3340518, -12.0509830)	Mpika	Similar to Ilumbwe 1, this site is composed of degraded and secondary miombos as well as patches of fallow land and is surrounded by mature miombo. Compensation could increase the quality of the habitat in this area of the CF with limited encroachment. An existing track leads to the site.	Secondary miombo: 17.31 Degraded miombo: 14.93 Mature miombo: 3.22 Fallow: 1.62	Fallow land can be reforested to restore secondary miombo habitat. ANR actions can target degraded and secondary miombo to restore secondary and mature miombo, respectively.	32.24	1.62	33.87
Ilumbwe 4 (31.3680949, -12.0614596)	Mpika	This site is the largest in this CF and includes areas for compensation of miombo woodlands and riverine forests. The site is along a wetland and is currently largely used for agriculture, with some areas left as fallow. The degraded area is surrounded by large areas of miombo woodlands, so compensation at this site has good potential for miombo woodlands. An existing track crosses the site, providing good access.	Agricultural: 29.64 Fallow: 18.19 Secondary miombo: 8.00 Degraded miombo: 2.88 Mature miombo: 5.04 Riverine forest: 0.55	Agricultural and fallow land can be reforested, as well as adjacent degraded miombo habitat, to restore secondary miombo. ANR actions can target existing secondary miombo habitat to restore mature miombo.	8.00	50.72	58.72
Ilumbwe 5 (31.3282419, -12.0468835)	Mpika	This site is located close to the edge of the CF, which is near road T2 and human settlements. However, the miombo woodland in this area is well-preserved and there is no agricultural encroachment. There is a high potential for compensation of miombo habitat, specifically in large patches of degraded miombos across the mature miombo. A network of small tracks located outside the CF provide access to the northern edge of this compensation site.	Mature miombo: 18.99 Degraded miombo: 16.38 Secondary miombo: 11.10	ANR actions can target degraded and secondary miombo to restore secondary and mature miombo, respectively.	27.48	-	27.48

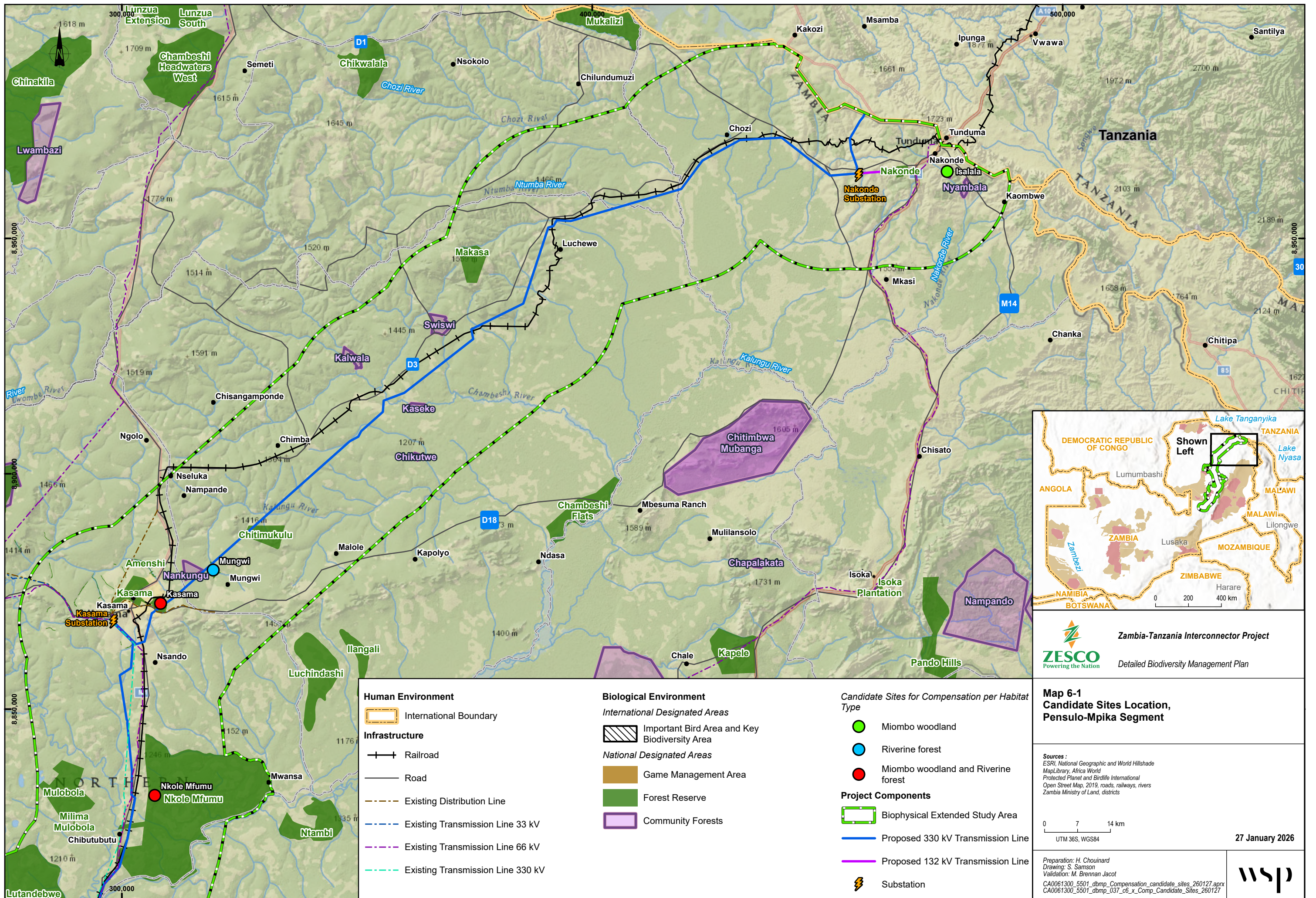
Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Kaloswe 1 (31.1836236, -12.2517661)	Mpika	This site is a large, isolated agricultural field among a well-preserved sector of the CF with very little encroachment and anthropogenic pressures. A track leads to the agricultural field, which could facilitate access. Reforestation at this site could increase the integrity of woodland within the CF.	Agricultural: 3.72 Secondary miombo: 0.38 Degraded miombo: 0.07	This site is largely agricultural, and land could be reforested, including small, isolated patches of degraded miombo to restore secondary miombo. ANR actions will target existing secondary miombo to restore mature miombo.	0.38	3.79	4.17
Kaloswe 2 (31.1981173, -12.2704941)	Mpika	This site is along a wetland at the southern edge of the CF and presents potential for compensation of miombo woodland and riverine forest. There are a few patches of agricultural land and fallow land along the wetland. On the eastern side of the wetland, these patches are among a large area of mature miombo and on the western side, they are located among a mosaic of secondary, degraded, and mature miombo woodlands. An existing track could provide access to the site.	Agricultural: 4.37 Mature miombo: 3.23 Fallow: 2.69 Degraded miombo: 2.45 Secondary miombo: 1.38 Riverine forest: 0.40	Agricultural and fallow land can be reforested to restore secondary miombo habitat. Secondary miombo can be targeted by ANR actions to restore mature miombo. In the case of degraded miombo, the section of the site west of the wetland area, representing 1.8 ha could be reforested because degraded miombo is scattered across agricultural and fallow land. On the eastern site of the wetland, degraded miombo is part of a mosaic with secondary and mature miombo, so ANR actions should be implemented. In both cases, secondary miombo would be restored.	2.03	8.87	10.89

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Mwenda 1 (30.9075368, -12.5152324)	Lavushi- manda	Sites Mwenda 1, 2 and 3 have similar characteristics and were targeted for similar reasons. Mwenda Chipalabwe CF is connected to Lavushi Manda National Park, a critical habitat (see Section 2.9), and, as such, contributes to habitat connectivity. Anthropogenic disturbances are not widespread in this CF. However, satellite imagery analysis indicates that these three sites were previously cultivated, and natural habitat is slowly returning. Mwenda 2 is located about 220 m from an existing track while the two other sites are nearly 1 km from access roads.	Degraded miombo: 4.59 Mature miombo: 2.40 Secondary miombo: 2.35	ANR actions can target degraded miombo and secondary miombo across these sites to restore secondary and mature miombo, respectively. The sites' habitats show signs of natural regeneration (agricultural activities appear to be abandoned) and could benefit from ANR and other supporting activities to create large areas of undisturbed miombo woodland.	6.94	-	6.94
Mwenda 2 (30.9142712, -12.5189983)	Lavushi- manda		Degraded miombo: 3.20 Secondary miombo: 0.82 Mature miombo: 0.02		4.02	-	4.02
Mwenda 3 (30.9045541, -12.5258226)	Lavushi- manda		Degraded miombo: 11.48 Secondary miombo: 10.57 Mature miombo: 0.48		22.05	-	22.05
Mwenda 4 (30.9138068, -12.5353032)	Lavushi- manda	This site is a patch of degraded miombo and fallow land along a small stream and wetland area in a well-preserved woodland. As such, it offers potential for both woodland and riverine forest compensation. The site is about 600 m from the nearest track. It is located in a sector of the CF with low disturbance and compensation at this site could help support biodiversity by increasing habitat connectivity.	Degraded miombo: 2.78 Fallow: 1.56 Secondary miombo: 1.20	Fallow land and adjacent degraded miombo habitat can be reforested to restore secondary miombo. Patches of existing secondary miombo can be targeted by ANR actions to restore mature miombo.	1.20	4.34	5.55
Kapambwa 1 (30.5217107, -13.2205948)	Serenje ²	This site is an isolated agricultural area surrounded by woodland. The nearest track is about 600 m west of the site. Reforestation at this site would support restoration of natural habitat in this sector of the CF. With limited anthropogenic pressure around this site, it is anticipated that long-term results can be achieved.	Fallow: 1.98 Secondary miombo: 0.36 Mature miombo: 0.17 Degraded miombo: 0.12	Secondary miombo can be targeted by ANR actions to restore mature miombo. Degraded miombo can be reforested, as can adjacent fallow land, to restore secondary miombo.	0.36	2.10	2.46

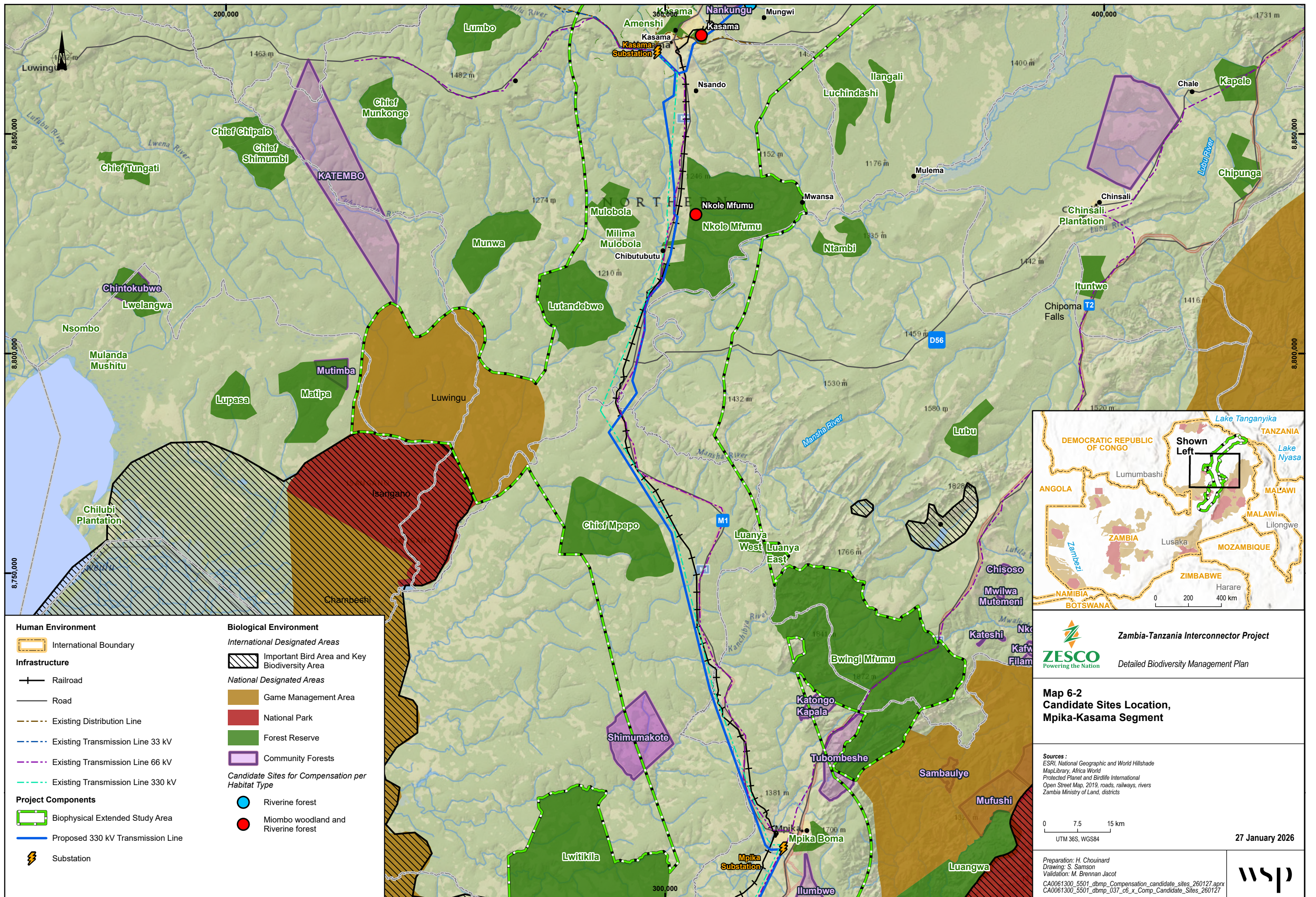
Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed miombo woodlands compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Kapambwa 2 (30.5411792, -13.1647979)	Chitambo	This site includes degraded miombo areas as well as a mosaic of agricultural fields and fallow land near a wetland at the edge of the CF. Due to its location and characteristics, this site has potential for restoration of woodland and riverine forest. One of the advantages of this site is the restoration of an encroached area to improve the integrity of habitat in the CF. The site is crossed by an access track. This site was suggested by stakeholders during engagement activities.	Degraded miombo: 2.77 Fallow: 2.27 Secondary miombo: 1.66 Agricultural: 1.23	Reforestation can target fallow and agricultural land, as well as degraded miombo that stretches over a large area with small, isolated patches of secondary miombo. Reforestation in these areas could restore secondary miombo. ANR actions can be implemented in secondary miombo to increase habitat quality and restore mature miombo.	1.66	6.26	7.93
Kapambwa 3 (30.5308815, -13.1798022)	Serenje	This site is an agricultural area surrounded by woodland. It is located in a sector of the CF that has limited encroachment and disturbances. The site is crossed by a track, facilitating access.	Agricultural: 4.35 Secondary miombo: 0.07 Degraded miombo: 0.02	This site is largely agricultural, and land can be reforested, including small, isolated patches of degraded miombo to restore secondary miombo. ANR actions can target secondary miombo to restore mature miombo.	0.07	4.37	4.43
Total compensation area					528.76	995.76	1,524.51

Notes: 1 Total may not add up due to rounding.

2 Kapambwa Community Forest spans over Serenje and Chitambo Districts. Candidate sites Kapambwa 1 and 3 are located in Serenje and Kapambwa 2 is located in Chitambo.



Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



Human Environment

International Boundary

Infrastructure

- Railroad
- Road
- Existing Distribution Line
- Existing Transmission Line 33 kV
- Existing Transmission Line 66 kV
- Existing Transmission Line 330 kV

Project Components

- Biophysical Extended Study Area
- Proposed 330 kV Transmission Line
- Substation

Biological Environment

- International Designated Areas
- Important Bird Area and Key Biodiversity Area
- National Designated Areas
- Game Management Area
- National Park
- Forest Reserve
- Community Forests
- Candidate Sites for Compensation per Habitat Type
- Riverine forest
- Miombo woodland and Riverine forest

Zambia-Tanzania Interconnector Project

ZESCO
Powering the Nation

Detailed Biodiversity Management Plan

**Map 6-2
Candidate Sites Location,
Mpika-Kasama Segment**

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts

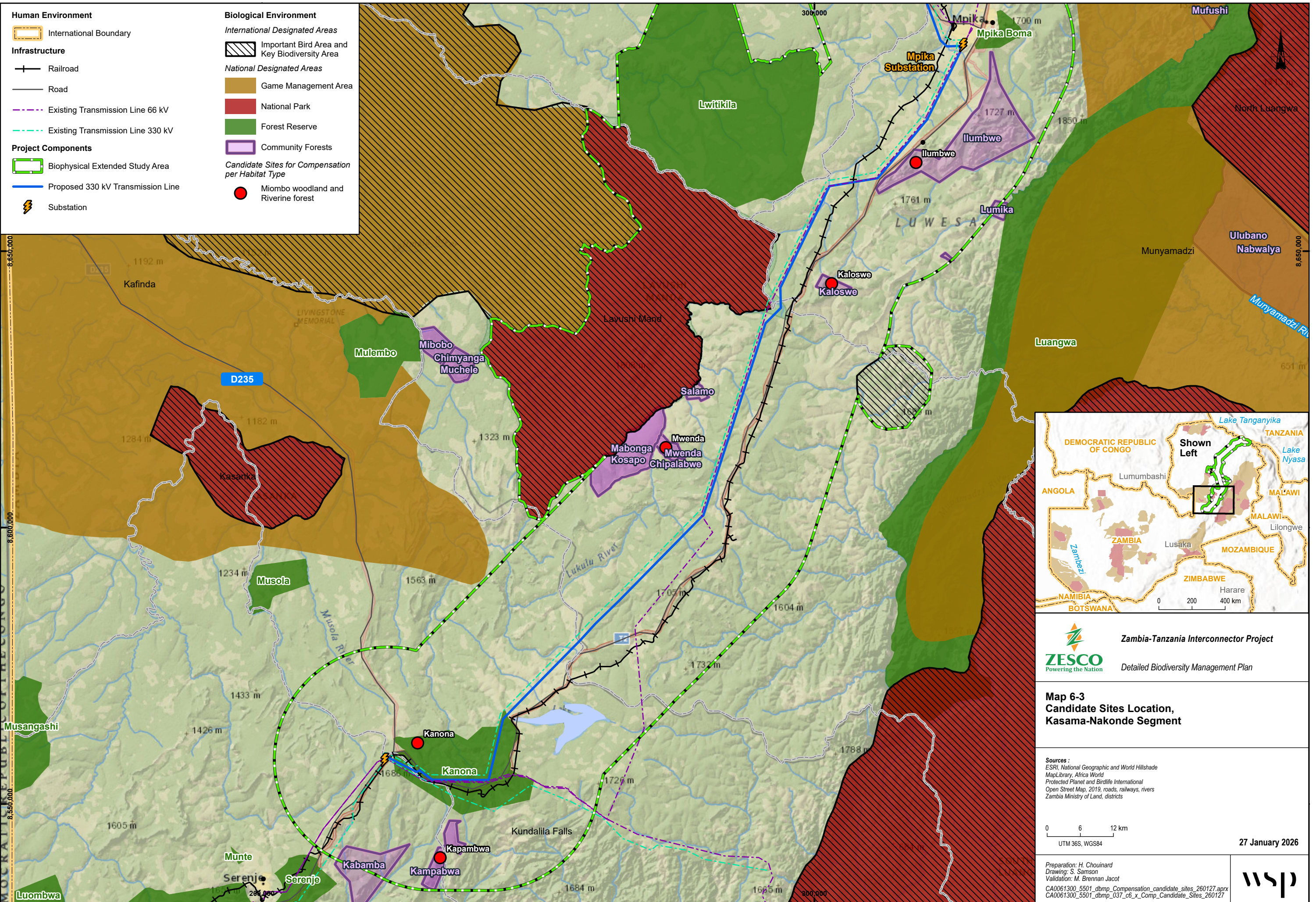
0 7.5 15 km
 UTM 36S, WGS84

27 January 2026

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
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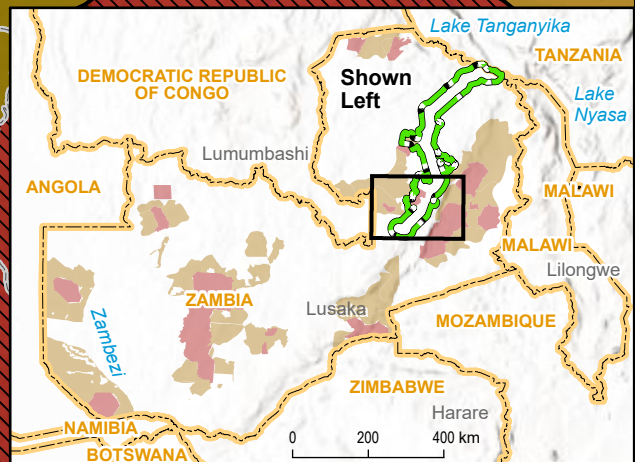


Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.



- Human Environment**
- International Boundary
- Infrastructure**
- Railroad
 - Road
 - Existing Transmission Line 66 kV
 - Existing Transmission Line 330 kV
- Project Components**
- Biophysical Extended Study Area
 - Proposed 330 kV Transmission Line
 - Substation

- Biological Environment**
- International Designated Areas*
- Important Bird Area and Key Biodiversity Area
- National Designated Areas*
- Game Management Area
 - National Park
 - Forest Reserve
 - Community Forests
- Candidate Sites for Compensation per Habitat Type*
- Miombo woodland and Riverine forest



Zambia-Tanzania Interconnector Project
ZESCO Powering the Nation
 Detailed Biodiversity Management Plan

Map 6-3
Candidate Sites Location,
Kasama-Nakonde Segment

Sources :
 ESRI, National Geographic and World Hillshade
 MapLibrary, Africa World
 Protected Planet and Birdlife International
 Open Street Map, 2019, roads, railways, rivers
 Zambia Ministry of Land, districts

0 6 12 km
 UTM 36S, WGS84
 27 January 2026

Preparation: H. Chouinard
 Drawing: S. Samson
 Validation: M. Brennan Jacot
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Boundaries and measurements shown on this document must not be used for engineering or land survey delineation. A land register analysis conducted by a land surveyor was not undertaken.

6.5.1.2 Preferred Species for Reforestation and ANR

Both reforestation and ANR will involve tree planting. Preferred tree species for reforestation and ANR in miombo woodlands were identified based on species abundance and ecological representativity in affected habitats, use value for local communities, compatibility with current reforestation practices by the Forestry Department and CFMGs (as discussed during consultation activities), conservation value of species and ecological requirements for bird and bat species of conservation value. Table 6-6 presents tree species that are suggested for reforestation activities in miombo woodlands as well as the reason for selection, the type of seed and remarks on propagation where relevant. Species selection will vary based on site characteristics and compensation actions. The list of preferred species will be reviewed with botanists to confirm ecological feasibility and validate suitability at proposed compensation sites.

Seed supply needs will require further assessment, based on the required numbers of seedlings per species, local availability of seeds within the managed forests (seeds can be collected and propagated in the targeted area) and the surroundings, as well as availability of seedlings from local nurseries. It is anticipated that only a portion of the seedlings required for compensation activities can be produced from the collection of seeds locally and raised in project-dedicated nurseries managed by implementing partners. The rest of the seedlings will need to be obtained either by purchasing seeds and raising seedlings in project-dedicated nurseries or by purchasing viable seedlings from suppliers. In case seeds or seedlings from rare and endangered species are not found from suppliers, they could be produced in partnership with the Department and/or the Copperbelt University. Water availability and water supply were raised as critical issues for the development of nurseries during stakeholder engagement. These aspects will be assessed in detail during the feasibility phase to confirm the required conditions for seed germination and for production of viable seedlings.

Table 6-6 Preferred Species for Reforestation in Miombo Woodlands

Species	Abundance rank ¹	IUCN status	Reason for selection	Seed type	Propagation ²
<i>Brachystegia glaberrima</i>	1	NA	Most widespread in this habitat, habitat for the Bar-winged Weaver (<i>Ploceus angolensis</i>) on the regional Red List, support hunting landscapes for large raptors.	Orthodox	Propagation through seed
<i>Brachystegia bussei</i>	2	LC	Most widespread in this habitat, habitat for the Bar-winged Weaver (<i>Ploceus angolensis</i>) on the regional Red List, support hunting landscapes for large raptors.	Orthodox	Propagation through seed
<i>Monotes adenophyllus</i>	2	LC	Most widespread in this habitat.	Orthodox	Propagation through seed
<i>Brachystegia microphylla</i>	3	NA	Most widespread in this habitat, habitat for the Bar-winged Weaver (<i>Ploceus angolensis</i>) on the regional Red List, support hunting landscapes for large raptors.	Orthodox	Propagation through seed
<i>Brachystegia boehmii</i>	4	LC	Most widespread in this habitat, habitat for the Bar-winged Weaver (<i>Ploceus angolensis</i>) on the regional Red List, support hunting landscapes for large raptors.	Orthodox	Propagation through seed
<i>Marquesia macroura</i>	4	LC	Most widespread in this habitat, excellent nesting/perching tree for large raptors.	Orthodox	Propagation through seed in greenhouse
<i>Uapaca nitida</i>	4	LC	Most widespread in this habitat and fruit tree.	Recalcitrant	Propagation through seed in greenhouse
<i>Uapaca kirkiana</i>	6	LC	Fruit tree, eaten by near threatened African Straw-coloured Fruit Bat (<i>Eidolon helvum</i>), used by Forestry Department and Community Forest Management Groups for reforestation activities.	Recalcitrant	Seed sown directly after fruit ripen
<i>Azelia quanzensis</i>	6	LC	Used by Forestry Department for reforestation activities, very common in nurseries, highly suitable cavity-forming or future cavity tree for birds, excellent nesting/perching tree for large raptors.	Orthodox	-
<i>Magnistipula butayei</i>	7	LC	Eaten by near threatened African Straw-coloured Fruit Bat (<i>Eidolon helvum</i>).	Orthodox	Propagation through seed
<i>Parinari curatellifolia</i>	8	LC	Fruit tree, eaten by near threatened African Straw-coloured Fruit Bat (<i>Eidolon helvum</i>), used by Forestry Department for reforestation activities, highly suitable cavity-forming or future cavity tree for birds, excellent nesting/perching tree for large raptors.	Non-available (NA)	Propagation through seed

Species	Abundance rank ¹	IUCN status	Reason for selection	Seed type	Propagation ²
<i>Isoberlinia angolensis</i>	9	LC	Edible caterpillars, very common in nurseries, support hunting landscapes for large raptors.	Orthodox	-
<i>Syzygium cordatum</i>	10	LC	Fruit tree, eaten by near threatened African Straw-coloured Fruit Bat (<i>Eidolon helvum</i>), highly suitable cavity-forming or future cavity tree for birds, excellent nesting/perching tree for large raptors.	Recalcitrant	Seed to be sown immediately after collection
<i>Syzygium guineense</i>	11	LC	Fruit tree, eaten by near threatened African Straw-coloured Fruit Bat (<i>Eidolon helvum</i>), used by Forestry Department for reforestation activities, highly suitable cavity-forming or future cavity tree for birds, excellent nesting/perching tree for large raptors.	Recalcitrant	Seed to be sown immediately after collection
<i>Pericopsis angolensis</i>	13	LC	Used by Forestry Department for reforestation activities, highly suitable cavity-forming or future cavity tree for birds, excellent nesting/perching tree for large raptors.	Orthodox	Propagation by seed
<i>Ficus capreifolia</i>	13	NA	Fruit tree, eaten by near threatened African Straw-coloured Fruit Bat (<i>Eidolon helvum</i>), nesting tree for vulnerable Southern Ground Hornbill (<i>Bucorvus leadbeateri</i>), highly suitable cavity-forming or future cavity tree, very important nesting/perching tree due to its large crown and long lifespan.	Recalcitrant	Seed denatures quickly
<i>Uapaca benguelensis</i>	-	NA	Eaten by near threatened African Straw-coloured Fruit Bat (<i>Eidolon helvum</i>).	Recalcitrant	Seed to be sown immediately after collection
<i>Uapaca sansibarica</i>	-	LC	Fruit tree, eaten by near threatened African Straw-coloured Fruit Bat (<i>Eidolon helvum</i>).	Recalcitrant	Seed to be sown immediately after collection
<i>Prunus africana</i>	Rare	VU	Conservation concern.	NA	No data on nursery seedlings
<i>Encephalartos schmitzii</i>	Rare	VU	Conservation concern.	NA	Translocation may be possible

Notes: 1 Abundance ranks were established based on relative abundance during flora and habitat surveys and biomass assessments.

2 Propagation remarks were provided by Copperbelt University as part of consultation activities.

6.5.2 Riverine Forests

6.5.2.1 Candidate Sites and Associated Actions

Based on criteria established in Section 6.4.1, a total of 18 candidate compensation sites were identified for riverine forests and are presented in Table 6-7. These are preliminary candidate compensation sites, and a final selection will be completed following the feasibility study conducted by the PIU, based on the guidelines in Section 6.8. Maps showing the extent of each candidate site, as well as the current land use are presented in Appendix 6-2.

Some candidate sites were selected for compensation activities for both miombo woodland and riverine forest. These candidate sites are listed in both Tables 6-5 and 6-7, with information specific to riverine forest presented in Table 6-7. For these sites, specific areas were delineated to distinguish compensation actions for miombo woodlands and those for riverine forests (see Appendix 6-2).

As for compensation in miombo woodland, compensation actions for riverine forest implemented at each candidate site will depend on the current land use class and current habitat condition. ANR will be conducted in patches of degraded forests that are located among existing riverine forest habitat while reforestation will be preferred on fallow and agricultural land.

Table 6-7 shows the estimated area available for ANR and reforestation in each candidate site. Specific actions will be further detailed at the feasibility stage once site assessments are conducted (see Section 6.8).

As shown in Table 6-5, a total area of 364.23 ha is identified for compensation actions for riverine forest habitat across candidate sites identified to date. Within this total area, 338.94 ha are in Forest Reserves and 25.29 ha are in Community Forests. Compensation for this habitat could include 220.07 ha of ANR and 144.16 ha of reforestation across all sites.

Table 6-7 Overview of Candidate Sites for Compensation in Riverine Forests

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed riverine forest compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Forest Reserves							
Mungwi 1 (31.3578237, -10.1375557)	Mungwi	This site is in the most disturbed part of Mungwi FR, which is heavily encroached from agricultural activities in and around the wetland. It is located at the junction between two streams and wetlands where agricultural land, fallow land and degraded forests are within well preserved riverine forests. As with sites Mungwi 2 and 3, it is in a high sensitivity bird habitat (see Section 2.4.9) and potential critical habitat for <i>Disa aequiloba</i> (see Section 2.9).	Fallow: 5.03 Agricultural: 2.47 Degraded forest: 1.40 Riverine forest: 0.55	Fallow, agricultural and degraded forest can be targeted by reforestation to restore riverine forest and improve connectivity to existing habitat.	-	8.90	8.90
Mungwi 2 (31.3495836, -10.1241666)	Mungwi	Both Mungwi 2 and 3 are isolated agricultural areas among well preserved riverine forest in the Mungwi FR. They are in high sensitivity bird habitat (see Section 2.4.9) and potential critical habitat for <i>Disa aequiloba</i> (see Section 2.9).	Agricultural: 0.58 Wetland: 0.04 Riverine forest: 0.03	At both sites, reforestation could be completed in agricultural and fallow land (where applicable) to restore the riverine forest and improve connectivity to adjacent habitat.	-	0.58	0.58
Mungwi 3 (31.3541984, -10.1309279)	Mungwi		Agricultural: 0.44 Riverine forest: 0.13 Fallow: 0.08		-	0.51	0.51
Nkole Mfumu 2 (31.2178517, -10.6650731)	Kasama	As detailed in Table 6-5, the site is located on either side of a stream and offers potential for miombo woodland and riverine forest. Most of the southern sectors of this FR being well preserved, this is one of the only areas showing signs of encroachment along streams in this sector. Reforestation could benefit biodiversity and help hinder agricultural encroachment in wetlands and riverine forest. Access to the site is possible through existing tracks.	Wetland: 75.01 Riverine forest: 22.65 Mature forest: 10.69 Fallow: 8.22 Degraded forest: 6.45 Secondary miombo: 4.44 Agricultural: 0.06	Riverine forest habitat being fragmented, with several small, isolated areas, it should be targeted by ANR actions to increase habitat quality. ANR actions can also be completed in secondary forest. In fallow, agricultural land and degraded forest, reforestation should be preferred.	27.09	14.74	41.83

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed riverine forest compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Nkole Mfumu 3 (31.2262328, -10.6095536)	Kasama	This site is located near a wetland and along the western edge of the FR. There are signs of agricultural encroachment along the stream, which provides potential for compensation for riverine forest. Existing tracks provide access to this site. Aside from agricultural activities visible on satellite imagery, the stream is well preserved with a large patch of forest along its bank.	Wetland: 117.01 Riverine forest: 42.14 Fallow: 10.83 Secondary forest: 7.96 Degraded forest: 7.76 Mature forest: 4.09 Agricultural: 3.10	As in Nkole Mfumu 2, riverine forest habitat is highly fragmented and can be targeted by ANR actions, as can secondary forest. Reforestation can target fallow, agricultural land and degraded forest.	50.10	21.68	71.79
Nkole Mfumu 5 (31.2399473, -10.5190160)	Kasama	This site is located along the western edge of the FR and extends east around a stream and wetland, providing opportunity for compensation of riverine forest. Agricultural activity is limited in and around the wetland and compensation activities at this site could help limit encroachment while benefiting biodiversity and increasing connectivity with other wetlands in the FR. Tracks provide access to this site.	Wetland: 115.56 Secondary forest: 18.41 Mature forest: 13.40 Degraded forest: 13.23 Fallow: 9.96 Agricultural: 4.69	Reforestation can be implemented at this site in degraded forest, fallow and agricultural land areas (on the edges of wetland habitat) to restore riverine forest. Secondary forest can be targeted by ANR actions.	18.41	27.88	46.28
Nkole Mfumu 7 (31.228802, -10.536817)	Kasama	This site targets a wetland with degraded riverine forest habitat. It is located on the western edge of the FR and is accessible via small agricultural tracks. Satellite imagery shows that degradation of natural habitat is recent.	Wetland: 22.69 Degraded forest: 15.60 Riverine forest: 15.31 Fallow: 6.95 Mature forest: 4.07 Secondary forest: 2.44	Reforestation can be implemented in fallow land and in two adjacent, large patches of degraded forest. ANR actions can target the remaining area of degraded forest as well as secondary forest and the existing riverine forest habitat which is highly fragmented.	26.97	13.33	40.30

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed riverine forest compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Nkole Mfumu 8 (31.254144, -10.560458)	Kasama	This site is located around a large wetland area and is the only candidate site in this FR not immediately along its western boundary. Agricultural activity in and around the wetland has contributed to degradation of the natural habitat at this site. The forest cover being quite dense in the area, the nearest track that could be identified through satellite imagery is located slightly over 1 km away from the site.	Wetland: 246.46 Degraded forest: 40.17 Riverine forest: 39.10 Fallow: 38.32 Mature forest: 34.11 Agricultural: 2.44	Reforestation can be implemented in fallow and agricultural land. ANR actions can target the mosaic of degraded forest and riverine forest along the wetland. ANR is expected to increase the quality of existing riverine forest because it is fragmented.	79.27	40.76	120.03
Kasama 2 (31.2510533, -10.1892793)	Kasama	This site is located between rock outcrop areas, which are critical habitat for <i>Euphorbia perplexa</i> var. <i>kasamana</i> (see Section 2.9). The site is along a network of wetlands and streams with well-preserved riverine forests. These wetlands are connected to a larger wetland, less than 400 m away, that is high sensitivity bird habitat (see Section 2.4.9) and critical habitat for <i>Disa aequiloba</i> (see Section 2.9). Agricultural fields are cultivated at this site in areas where riverine forest could be restored.	Wetland: 0.30 Degraded forest: 0.12 Riverine forest: 0.06 Agricultural: 0.06 Secondary forest: 0.03	Patches of agricultural land and adjoining degraded forest can be reforested to restore riverine forest and improve connectivity to the existing dense patch of riverine forest west of this site. Small areas of secondary forest can be targeted by ANR actions.	0.03	0.18	0.21
Kanona 2 (30.4974793, -13.0015939)	Chitambo	This site is located at the junction of two streams and presents good potential for riverine forests and mature miombo. Riverine habitat is currently a mosaic of degraded and secondary forests with isolated patches of riverine forest. The site is in the least disturbed and encroached sector of the FR. There are tracks nearby to access the site.	Degraded forest: 0.78 Riverine forest: 0.66 Secondary forest: 0.08 Wetland: 0.02	ANR actions can target the entire riverine habitat, including degraded and secondary forest as well as isolated patches of riverine forest whose quality can be improved with targeted intervention.	1.52	-	1.52

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed riverine forest compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Kanona 3 (30.4897910, -13.0081735)	Chitambo	This site is located next to a stream and has an isolated agricultural patch within the floodplain. Reforestation could expand riverine forest while minimizing agricultural development in the area. The site is approximately 400 m from the nearest existing access track.	Agricultural: 0.18 Riverine forest: 0.09 Degraded forest: 0.07	Agricultural areas and degraded forest can be targeted by reforestation to restore riverine forest and increase connectivity within existing habitat.	-	0.24	0.24
Kanona 4 (30.500410, -13.001824)	Chitambo	This site is located across the stream from Kanona 1, 2 and 3 and is characterized by a large area of fallow land along the stream. This part of the bank is not largely used for agricultural purposes based on satellite imagery analysis. The site is less than 200 m from an existing track.	Fallow: 5.28 Mature forest: 1.56 Wetland: 1.23 Secondary forest: 0.76 Degraded forest: 0.76	Reforestation can be implemented in fallow land and adjacent degraded forest. ANR actions can target secondary forest to restore riverine forest.	0.76	5.99	6.75
Community Forests							
Ilumbwe 2 (31.3303960, -12.0754945)	Mpika	This site is located on the edge of a wetland, providing opportunity for compensation of riverine forest. The immediate buffer area around the wetland has large patches of riverine forests. Restoration of degraded forests and agricultural areas could increase the riverine forest area in this sector. An existing track leading to agricultural lands could provide access to this site.	Riverine forest: 4.46 Wetland: 4.17 Degraded forest: 2.31 Agricultural: 0.76 Secondary forest: 0.38 Mature forest: 0.26	Reforestation can be implemented in agricultural land and degraded forest. Secondary forest and fragmented riverine forest habitat can be targeted by ANR actions to increase overall habitat quality.	4.84	3.07	7.91
Ilumbwe 4 (31.3680949, -12.0614596)	Mpika	This site is the largest in this CF and includes areas for compensation of riverine forests. The site is along a wetland and is currently largely used for agriculture, with some areas left as fallow. Areas located next to the wetland and stream could be restored into riverine forests. This site can be accessed with existing tracks.	Riverine forest: 4.34 Agricultural: 1.80 Secondary forest: 0.48 Degraded forest: 0.46 Fallow: 0.03	Agricultural and fallow land can be reforested while small isolated patches of degraded and secondary forest can be targeted by ANR actions.	0.94	1.83	2.77

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed riverine forest compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Kaloswe 2 (31.1981173, -12.2704941)	Mpika	This site is along a wetland at the southern edge of the CF and presents potential for compensation of riverine forest. Riverine habitat along other streams in this CF are not encroached and show limited disturbance. Compensation actions at this site could help improve the quality and extend the area of riverine forests in this sector. An existing track provides access to the site.	Wetland: 12.90 Riverine forest: 3.45 Degraded forest: 1.78 Mature forest: 1.38 Agricultural: 0.60 Fallow: 0.41 Secondary forest: 0.15	Degraded forest can be reforested as it covers large areas with limited tree cover. Agricultural and fallow land can also be targeted by reforestation. ANR actions can be applied in secondary forest.	0.15	2.78	2.93
Mwenda 4 (30.9138068, -12.5353032)	Lavushi- manda	This site is a patch of degraded forest and fallow land along a small stream and wetland area in a well-preserved woodland. As such, it offers potential for both woodland and riverine forest compensation. There are only few patches of riverine forests left on the southern side of the stream. Reforestation in degraded areas could help restore riverine forest in this sector. The site is about 600 m from the nearest track.	Secondary miombo: 0.82 Degraded forest: 0.63 Wetland: 0.25 Riverine forest: 0.17	ANR actions can target the mosaic of secondary and degraded forest as well as the existing riverine forest habitat, which is currently isolated. ANR is expected to increase habitat quality.	1.62	-	1.62
Mwenda 5 (30.918950, -12.521127)	Lavushi- manda	This site is located along a wetland area where the bank was extensively cleared for agricultural purposes in the past decade. However, the latest satellite imagery shows a return of natural vegetation in most disturbed areas. A track provides access to the site.	Wetland: 8.12 Degraded forest: 5.34 Riverine forest: 2.20 Mature forest: 0.74 Secondary forest: 0.47	ANR actions can target the mosaic of secondary, mature and degraded forest as well as the existing fragmented riverine forest habitat.	8.02	-	8.02

Candidate site	District	Site description and selection rationale	Current land use (ha)	Proposed riverine forest compensation actions	Compensation area (ha)		
					ANR	Reforestation	Total ¹
Kapambwa 2 (30.5411792, -13.1647979)	Chitambo ²	This site includes degraded forest areas as well as a mosaic of agricultural fields and fallow land near a wetland at the edge of the CF. Due to its location and characteristics, this site has potential for compensation of riverine forest. Riverine forest can be restored along the wetland and improve connectivity to neighbouring patches of riverine forests and woodland within the CF.	Agricultural: 1.05 Riverine forest: 0.53 Fallow: 0.51 Wetland: 0.25 Secondary forest: 0.25 Degraded forest: 0.21	Fallow and agricultural land and an adjacent 0.10 ha patch of degraded forest along the wetland can be reforested. The rest of degraded forest habitat being interspersed between secondary forest and riverine forest, it can be targeted by ANR actions, as would secondary forest.	0.36	1.66	2.03
Total compensation area					220.07	144.16	364.23

Notes: 1 Total may not add up due to rounding.

2 Kapambwa Community Forest spans over Serenje and Chitambo Districts. Candidate site Kapambwa 2 is located in Chitambo.

6.5.2.2 Preferred Species for Reforestation and ANR

Preferred species for reforestation in riverine forests were identified based on species abundance and ecological representation in affected habitats, use value for local communities, compatibility with current reforestation practices by the Forestry Department and CFMGs (as discussed during consultation activities), and conservation value of species. Table 6-8 presents tree species that are suggested for reforestation activities in riverine forests as well as the reason for selection, the type of seed and remarks on propagation where relevant.

Species selection will vary based on the site characteristics compensation actions.

Table 6-8 Preferred Species for Reforestation in Riverine Forests

Species	Abundance rank ¹	IUCN status	Reason for selection	Seed type	Propagation ²
<i>Julbernardia paniculata</i>	1	LC	Edible caterpillars, support hunting landscapes for large raptors.	Orthodox	Propagate by seed; ensure proper scarification for improved germination.
<i>Brachystegia glaberrima</i>	2	NA	Most widespread in this habitat, support hunting landscapes for large raptors.	Orthodox	Propagate by seed; seedlings establish well under partial shade.
<i>Terminalia stulmannii</i>	2	NA	Most widespread in this habitat, nesting tree for the endangered Bateleur (<i>Terathopius ecaudatus</i>), highly suitable cavity-forming or future cavity tree for birds, excellent nesting/perching tree for large raptors.	NA	Propagation successful through cuttings; semi-hardwood cuttings recommended.
<i>Acacia polyacantha</i>	3	NA	Most widespread in this habitat, nesting tree for the endangered Bateleur (<i>Terathopius ecaudatus</i>) and Martial Eagle (<i>Polemaetus bellicosus</i>), the vulnerable Southern Ground Hornbill (<i>Bucorvus leadbeateri</i>) and the Bar-winged Weaver (<i>Ploceus angolensis</i>) on the Regional Red-List.	Orthodox	Propagate by seed; pre-treatments (hot water or scarification) enhance germination.
<i>Afzelia quanzensis</i>	4	LC	Used by Forestry Department for reforestation activities, highly suitable cavity-forming or future cavity tree for birds, excellent nesting/perching tree for large raptors.	Orthodox	Propagate by seed; seeds remain viable for long periods if stored dry.
<i>Pericopsis angolensis</i>	4	LC	Used by Forestry Department for reforestation activities, highly suitable cavity-forming or future cavity tree for birds, excellent nesting/perching tree for large raptors.	Orthodox	Propagate by seed; seedlings require well-drained soils.
<i>Piliostigma thonningii</i>	4	LC	Fruit tree.	Orthodox	Propagate by seed; scarification improves germination success.
<i>Syzygium guineense subsp guineense</i>	4	NA	Used by Forestry Department for reforestation activities, highly suitable cavity-forming or future cavity tree for birds, excellent nesting/perching tree for large raptors.	Recalcitrant	Sow seeds immediately after collection; viability drops rapidly if delayed.
<i>Khaya nyasica</i>	Rare	VU	Conservation concern, highly suitable cavity-forming or future cavity tree for birds, excellent nesting/perching tree for large raptors.	Orthodox	Propagate by seed; seedlings benefit from nursery shade during early growth.

Species	Abundance rank ¹	IUCN status	Reason for selection	Seed type	Propagation ²
<i>Burkea africana</i>	1	LC	Most widespread in this habitat, edible caterpillars, support hunting landscapes for large raptors.	Orthodox	Propagation by seed; dormancy may require scarification or soaking.
<i>Senna singueana</i>	1	LC	Most widespread in this habitat	NA	Propagation by seed and wildlings; wildlings establish faster.
<i>Inula glomerata</i>	1	NA	Most widespread in this habitat	NA	Propagate by seed; direct sowing recommended for best establishment.
<i>Erythrina abyssinica</i>	1	LC	Most widespread in this habitat	Orthodox	Propagate by seed; germination improved by soaking overnight.

Notes: 1 Abundance ranks were established based on relative abundance during flora and habitat surveys and biomass assessments.

2 Propagation remarks were provided by Copperbelt University as part of consultation activities.

6.6 Enabling Conditions to Support Compensation Actions

Compensation programs generally require a set of enabling mechanisms to ensure they are properly supported and positioned for success. To ensure that the actions outlined in Section 6.5 are effective, the enabling conditions and associated supporting actions described below should be implemented. Some will be implemented by the PIU as part of the NHCP, while relevant parties will be encouraged to implement others.

Enabling conditions and associated actions are based on stakeholder engagement results and best practice for compensation. They are divided into four categories: increased capacity for enforcement and monitoring, community commitment and participation, development of alternative livelihoods to reduce anthropogenic pressures and increased habitat protection through firebreaks.

6.6.1 Increased Capacity for Enforcement and Monitoring

Consultation activities highlighted the need for additional resources to enable District Forestry Departments and CFMGs to adequately protect and monitor the designated areas they manage. As outlined in Section 6.3.2, there are important challenges in terms of transportation and a lack of resources and equipment for officers to adequately enforce and monitor conservation objectives in managed forests. This translates into a high level of encroachment in some designated areas, especially those located close to human settlements. To ensure long-term outcomes in compensated areas, the following actions should be implemented to support compensation efforts:

- Provide transportation to Forestry Department District Offices and CFMGs to allow officers to conduct their duties and responsibilities as part of the NHCP. A transportation allowance will be paid, and motorcycles and/or bicycles will be provided to applicable District Forestry Departments and CFMGs for the duration of the feasibility and implementation phases. A budget is provided as part of the NHCP (see Section 9.5). Field training on efficient patrol scheduling and route planning will be provided as part of the capacity-building program to enhance vehicle utilization (see Section 9.2).
- Provide personal protective equipment (PPE) and field equipment to support officers in their implementation and monitoring work. The current budget provides for the distribution of boots, gloves, and gaiters to all involved officers as well as a GPS device and first aid kit to management groups for forests with candidate sites (see Section 9.5). Stakeholders will be further engaged to validate specific needs as part of their responsibilities related to the NHCP. Training will be provided to ensure proper use of PPEs and equipment. This will be done through the capacity-building program (see Section 9.2).

- Increase the presence of signage and beacons to delineate the extent of managed forests. Stakeholder engagement has indicated that encroachment is a challenge in Forest Reserves and Community Forests. As part of the NHCP, managing authorities will be encouraged to improve the delineation of managed forest boundaries with beacons and signage. Though this will not be funded directly as part of the NHCP, the PIU will work closely with involved Forestry Departments and CFMGs to increase the presence of signage and beacons, which could be funded by the statutory fees paid by ZESCO for encroachment within Forest Reserves (see Section 6.3.3.2). Specific areas for compensation actions will also be delineated to inform communities of ongoing ANR and reforestation efforts.
- Supply uniforms to forest officers and honorary forest officers from the CFMGs to empower them to regulate access, prevent illegal activities, and exclude unauthorized users. A budget is provided for supplying uniforms to all involved officers (see Section 9.5). This will be supported by training on the enforcement of forest protection as part of the capacity-building program (see Section 9.2).
- Provide monetary incentives to honorary forest officers and other relevant actors in CFMGs. While forest officers of District Forestry Department are state employees, honorary forest officers and CFMG members do not have a salary. Monetary incentives would be necessary to ensure their participation and to maintain their commitment. The budget also takes into consideration the payment of stipends for casual workers involved in seed collection, production of seedlings (in project-dedicated nurseries), land clearing and/or plantation activities, which will be done by CFMG members when possible.
- Collaborate with District Forestry Departments and CFMGs to update management plans to ensure candidate sites are properly designated and recognized as compensation areas.

As mentioned above, some of these measures will be implemented as part of the capacity-building program (see Section 9.2), while others will be designed as supporting measures aimed at enabling favorable conditions for the success of the NHCP.

6.6.2 Community Commitment and Participation

Commitment from local chiefs and local communities has led to fewer cases of encroachment within managed forests. As such, engaging traditional authorities and local communities about compensation actions and objectives is considered an enabling condition for the successful implementation of the NHCP. The following measures will be implemented to foster community commitment and participation throughout the feasibility and implementation phases:

- Engage traditional authorities, including local chiefs, during the preliminary assessment, validation and final selection of candidate sites. Early engagement with chiefs can provide a sense of ownership over the process and can result in increased enforcement of land use restrictions in these areas by traditional authorities.

- Implement a sensitization campaign in local communities to clearly communicate objectives, benefits and responsibilities associated with the NHCP. The objective will be to build trust and promote transparency. Local chiefs, having been engaged for preliminary assessment and final selection of sites, could support sensitization activities. Sensitization will include the following topics:
 - Forest conservation, including the impact of deforestation on water sources and livelihoods;
 - Manual plotting as a safe alternative to slash-and-burn practices;
 - Fire management;
 - Agroforestry and its benefits for both livelihoods and biodiversity (this topic will be further explored during dedicated training for farmers in local communities, as detailed in Section 6.6.3).

Stakeholders have highlighted the importance of having repeated rounds of sensitization activities with local communities to increase the potential benefits of such activities. A specific stakeholder information and engagement program should be developed by the PIU to ensure efficient and transparent engagement along the NHCP implementation and to follow up on NHCP challenges and results at communities level.

6.6.3 Development of Alternative Livelihoods to Reduce Anthropogenic Pressures

Encroachment within Forest Reserves and Community Forests is mainly associated with livelihood activities such as agriculture, charcoal production and collection of forest products (edible caterpillars, wood, etc.). Community livelihoods are largely associated with forest resources; providing alternatives is thus necessary to ensure long-term outcomes of compensation actions. Alternative livelihoods include beekeeping and honey processing, agroforestry and sustainable farming techniques, as well as mushroom and caterpillar sustainable harvesting. Supporting the development of these alternative livelihoods will help steer communities away from ecologically damaging practices and livelihoods associated with unsustainable collection of forest resources.

Agroforestry can be implemented in various ways such as intercropping, planting trees on field boundaries, multi-strata or multi-species gardens, and cropping using bush or tree fallows. Agroforestry, which integrates trees into agricultural systems, plays a vital role in biodiversity conservation, especially along the margins of natural forests. By creating diverse landscapes where trees and crops coexist, agroforestry provides additional habitats for wildlife and plants, reducing ecosystem fragmentation. Forests in the BIIA are partly threatened by expanding agriculture; therefore, agroforestry could be beneficial as it would allow to combine livelihood and conservation objectives by planting indigenous trees through herbaceous crop areas to increase the tree cover without excluding human activity. This approach, developed in collaboration with local communities, could generate averted loss of adjacent natural habitats.

It should be noted that, as averted loss is complex to quantify, increased tree cover associated with agroforestry is not included in the no net loss calculation but rather is considered an additional benefit resulting from the NHCP.

Alternative livelihoods should also be encouraged and supported to entice community members to participate in conservation and compensation efforts. As such, the following measures will be implemented as part of the NHCP:

- Collaborate with District Forestry Departments and CFMGs to stop the distribution of charcoal production permits within managed forests, especially in and near candidate sites for compensation actions.
- Provide training on agroforestry to local communities to support more sustainable agricultural practices around Forest Reserves and Community Forests. Training will include practical skills training and value-chain development workshops as well as case studies to demonstrate the benefits of agroforestry for agriculture as well as biodiversity. Seedlings will be distributed for planting on cultivated land. Trees will also be provided to contribute to the implementation of agroforestry areas in proximity to selected sites for conservation activities. While providing alternative livelihoods with more sustainable agricultural practices, it will also contribute to the reduction of fire events during land plowing. Distribute beehives and provide training on honey production and processing (including the production of value-added items such as candles, propolis, shampoo, etc.) to develop alternative, sustainable livelihoods in communities.
- Provide training to communities on the sustainable collection of edible caterpillars and mushrooms without damaging forest ecosystems.

Communities' specific needs in terms of alternative livelihood development will be further assessed during sensitization campaigns and traditional authorities' engagement. This will allow the proposed actions to be refined based on the local context and needs.

6.6.4 Increased Habitat Protection Through Firebreaks

Firebreaks were widely mentioned by stakeholders during consultation activities as a potential solution to reduce biodiversity loss in Forest Reserves and Community Forests. Fires are often purposely started by neighboring communities to clear the land for agriculture as part of the chitimene traditional practice (see Section 2.2).

Firebreaks are "ploughed, open or unplanted gaps of land around the perimeters of, or spaced within, areas of forest, grassland or farmland intended to prevent the spread of fire, thereby protecting important habitats" (Sainsbury et al., 2021). Combustible matter (i.e., fuel stock) is removed from those areas. When placed in strategic areas, firebreaks can avert the loss of biodiversity, especially when they reduce the risk of forest degradation from fires of anthropogenic origin. Natural or green firebreaks made of fire-resistant species have also shown promising results in fire prevention (Cardoso, Beckett & Bond, 2023; Cui et al., 2019), though ploughed, unplanted firebreaks are more widespread. To avoid inducing more loss of habitat and land clearing while reducing vulnerability of habitats to fires, the following measures will be considered:

- Plant native fire-tolerant species⁵ in a 10 to 15-meter buffer area around vulnerable, targeted compensation sites.
- Sensitize communities to sustainable fire management. This will be done through the capacity-building program (see Section 9.2).

Targeted areas will be identified based on a fire risk assessment during the feasibility and forest-specific planning phases. Candidate sites located along the edges of managed forests and close to agricultural areas that are deemed vulnerable to chitimene-induced fires will be targeted. A preliminary identification of potential areas for green firebreaks was completed as part of the identification of candidate sites and associated actions and for budgetary purposes (Section 9.5).

6.7 Expected Habitat Gain

6.7.1 Habitat Gain from Proposed Compensation Measures

Table 6-9 summarizes the estimated habitat gains that can be generated from compensation actions across the 40 candidate sites. Detailed quantification is included in Appendix 6-3. Quantification of potential gains assumed that compensation actions will be implemented effectively, including any site preparation activities needed to create the biophysical conditions needed to support reforestation success (e.g., soil decompaction, soil amendments). Other assumptions included the following:

- Areas considered modified habitat, including degraded woodland, fallow land, and agricultural land, will be returned to secondary forest (miombo or riverine, depending on the context). It can take 20 to 35 years to re-establish woody species diversity, species richness, soil properties, and floristic structure (i.e., height and diameter at breast height) (Montfort et al., 2021). On the other hand, it takes much longer, between 60 and 120 years, to return species composition and above-ground biomass similar to the original ecosystem (i.e., mature woodland) (Montfort et al., 2021; Poorter et al., 2021). The time lag to achieve secondary forest status is considered a reasonable timeframe whereas the time needed to reach a mature woodland is too long in the context of project activities.
- Areas of existing secondary woodland (miombo or riverine) are naturally regenerating and evolving towards a mature forest stand. ANR will provide the protection needed to allow the regeneration process to continue, undisturbed. As needed, infill planting will be used to accelerate the recovery of species composition and density. Weeding can also reduce competition for desired native trees and accelerate regeneration. As such, compensation actions in secondary woodlands were assumed to return mature forest cover.

⁵ According to Cauldwell & Zieger (2000), fire-tolerant woody species of miombo woodlands and reported in the BIA include *Albizia antunesiana* and *Pseudolachnostylis maprouneifolia*, while *Burkea africana*, *Diplorhynchus condylocarpon*, *Multidentia crassa* and *Strychnos spinosa* are semi fire-tolerant. Collaboration with Forestry Departments and CFMGs will be required to identify relevant fire-tolerant species to be used.

- Some potential for habitat enhancement was identified in existing riverine forests, where assisted natural regeneration could improve the condition of riverine forests that are distributed in small, fragmented patches. Within these sites, natural regeneration of trees and targeted infill planting where needed were assumed to improve the quality score by a value of 0.2 as a result of increased canopy cover and crown closure, increased forest patch size, and improved ecological functioning of the habitat. The initial and final quality value were arbitrarily assigned as 0.5 and 0.7, respectively, to capture an increase in value of 0.2; however, the actual start and end point of these quality scores will require validation in the field.

Estimates presented in Table 6-9 were informed mainly by satellite image interpretation and will need to be revised once data from field inventories are available. Total potential gain achievable across all 40 candidate sites is 595.9 q-ha for miombo woodlands and 124.7 q-ha for riverine forest.

Table 6-9 Estimated Habitat Gains in Candidate Compensation Sites

Managed forest	Number of candidate sites	Compensation action	Area (ha)	Pre-compensation		Post-compensation		Estimated gain (q-ha) ¹
				Quality (q)	Value (q-ha)	Quality (q)	Value (q-ha)	
Forest Reserves								
Mungwi Forest Reserve	3	Restore degraded forest to secondary riverine forest	1.40	0.2	0.28	0.5	0.70	0.42
		Restore fallow land to secondary riverine forest	5.11	0	0.00	0.5	2.56	2.56
		Restore agricultural land to secondary riverine forest	3.49	0	0.00	0.5	1.75	1.75
		Total gain - riverine forest						4.72
Kasama Forest Reserve	6	Restore degraded woodland to secondary miombo woodland	8.81	0.2	1.76	0.5	4.41	2.64
		Restore secondary woodland to mature miombo woodland	6.75	0.5	3.38	1	6.75	3.38
		Restore agricultural land to secondary miombo woodland	1.52	0	0.00	0.5	0.76	0.76
		Total gain - miombo woodland						6.78
		Restore degraded forest to secondary riverine forest	0.12	0.2	0.02	0.5	0.06	0.04
		Restore secondary forest to mature riverine forest	0.03	0.5	0.02	1	0.03	0.02
		Restore agricultural land to secondary riverine forest	0.06	0	0.00	0.5	0.03	0.03
Total gain - riverine forest						0.08		
Nkole Mfumu Forest Reserve	8	Restore degraded woodland to secondary miombo woodland	716.65	0.2	143.33	0.5	358.33	215.00
		Restore secondary woodland to mature miombo woodland	216.76	0.5	108.38	1	216.76	108.38
		Restore fallow land to secondary miombo woodland	244.73	0	0.00	0.5	122.37	122.37
		Restore agricultural land to secondary miombo woodland	55.74	0	0.00	0.5	27.87	27.87
		Total gain - miombo woodland						473.61
		Restore degraded forest to secondary riverine forest	83.21	0.2	16.64	0.5	41.61	24.96
		Restore secondary forest to mature riverine forest	33.25	0.5	16.63	1	33.25	16.63

Managed forest	Number of candidate sites	Compensation action	Area (ha)	Pre-compensation		Post-compensation		Estimated gain (q-ha) ¹
				Quality (q)	Value (q-ha)	Quality (q)	Value (q-ha)	
		Restore fallow land to secondary riverine forest	74.28	0	0.00	0.5	37.14	37.14
		Restore agricultural land to secondary riverine forest	10.29	0	0.00	0.5	5.15	5.15
		ANR to improve condition of existing riverine forest	119.20	0.5	59.60	0.7	83.44	23.84
		Total gain - riverine forest						107.71
Kanona Forest Reserve	4	Restore degraded woodland to secondary miombo woodland	2.79	0.2	0.56	0.5	1.40	0.84
		Restore secondary woodland to mature miombo woodland	2.61	0.5	1.31	1	2.61	1.31
		Restore agricultural land to secondary miombo woodland	1.50	0	0.00	0.5	0.75	0.75
		Total gain - miombo woodland						2.89
		Restore degraded woodland to secondary riverine forest	1.56	0.2	0.31	0.5	0.78	0.47
		Restore secondary woodland to mature riverine forest	0.84	0.5	0.42	1	0.84	0.42
		Restore fallow land to secondary riverine forest	5.28	0	0.00	0.5	2.64	2.64
		Restore agricultural land to secondary riverine forest	0.18	0	0.00	0.5	0.09	0.09
		ANR to improve condition of existing riverine forest	0.66	0.5	0.33	0.7	0.46	0.13
		Total gain - riverine forest						3.75
Community Forests								
Isalala Community Forest	4	Restore degraded woodland to secondary miombo woodland	1.16	0.2	0.23	0.5	0.58	0.35
		Restore secondary woodland to mature miombo woodland	0.42	0.5	0.21	1	0.42	0.21
		Restore fallow land to secondary miombo woodland	1.77	0	0.00	0.5	0.89	0.89
		Restore agricultural land to secondary miombo woodland	1.69	0	0.00	0.5	0.85	0.85
		Total gain - miombo woodland						2.29

Managed forest	Number of candidate sites	Compensation action	Area (ha)	Pre-compensation		Post-compensation		Estimated gain (q-ha) ¹	
				Quality (q)	Value (q-ha)	Quality (q)	Value (q-ha)		
Ilumbwe Community Forest	5	Restore degraded woodland to secondary miombo woodland	74.92	0.2	14.98	0.5	37.46	22.48	
		Restore secondary woodland to mature miombo woodland	58.31	0.5	29.16	1	58.31	29.16	
		Restore fallow land to secondary miombo woodland	21.12	0	0.00	0.5	10.56	10.56	
		Restore agricultural land to secondary miombo woodland	38.81	0	0.00	0.5	19.41	19.41	
		Total gain - miombo woodland							81.60
		Restore degraded forest to secondary riverine forest	2.77	0.2	0.55	0.5	1.39	0.83	
		Restore secondary forest to mature riverine forest	0.80	0.5	0.40	1	0.80	0.40	
		Restore fallow land to secondary riverine forest	0.03	0	0.00	0.5	0.02	0.02	
		Restore agricultural land to secondary riverine forest	2.56	0	0.00	0.5	1.28	1.28	
		ANR to improve condition of existing riverine forest	4.46	0.5	2.23	0.7	3.12	0.89	
		Total gain - riverine forest							3.42
		Kaloswe Community Forest	2	Restore degraded woodland to secondary miombo woodland	2.52	0.2	0.50	0.5	1.26
Restore secondary woodland to mature miombo woodland	1.76			0.5	0.88	1	1.76	0.88	
Restore fallow land to secondary miombo woodland	2.69			0	0.00	0.5	1.35	1.35	
Restore agricultural land to secondary miombo woodland	8.09			0	0.00	0.5	4.05	4.05	
Total gain - miombo woodland									7.03
Restore degraded forest to secondary riverine forest	1.78			0.2	0.36	0.5	0.89	0.53	
Restore secondary forest to mature riverine forest	0.15			0.5	0.08	1	0.15	0.08	
Restore fallow land to secondary riverine forest	0.41			0	0.00	0.5	0.21	0.21	
Restore agricultural land to secondary riverine forest	0.60			0	0.00	0.5	0.30	0.30	
Total gain - riverine forest									1.11

Managed forest	Number of candidate sites	Compensation action	Area (ha)	Pre-compensation		Post-compensation		Estimated gain (q-ha) ¹
				Quality (q)	Value (q-ha)	Quality (q)	Value (q-ha)	
Mwenda Chipalabwe Community Forest	5	Restore degraded woodland to secondary miombo woodland	22.05	0.2	4.41	0.5	11.03	6.62
		Restore secondary woodland to mature miombo woodland	14.94	0.5	7.47	1	14.94	7.47
		Restore fallow land to secondary miombo woodland	1.56	0	0.00	0.5	0.78	0.78
		Total gain - miombo woodland						14.87
		Restore degraded forest to secondary riverine forest	5.97	0.2	1.19	0.5	2.99	1.79
		Restore secondary forest to mature riverine forest	1.29	0.5	0.65	1	1.29	0.65
		ANR to improve condition of existing riverine forest	2.37	0.5	1.19	0.7	1.66	0.47
		Total gain - riverine forest						2.91
Kapambwa Community Forest	3	Restore degraded woodland to secondary miombo woodland	2.91	0.2	0.58	0.5	1.46	0.87
		Restore secondary woodland to mature miombo woodland	2.09	0.5	1.05	1	2.09	1.05
		Restore fallow land to secondary miombo woodland	4.25	0	0.00	0.5	2.13	2.13
		Restore agricultural land to secondary miombo woodland	5.58	0	0.00	0.5	2.79	2.79
		Total gain - miombo woodland						6.83
		Restore degraded forest to secondary riverine forest	0.21	0.2	0.04	0.5	0.11	0.06
		Restore secondary forest to mature riverine forest	0.25	0.5	0.13	1	0.25	0.13
		Restore fallow land to secondary riverine forest	0.51	0	0.00	0.5	0.26	0.26
		Restore agricultural land to secondary riverine forest	1.05	0	0.00	0.5	0.53	0.53
		Total gain - riverine forest						0.97

Note: ha = hectare; q = quality ratio; q-ha = quality-hectares.

1 Estimated gain is calculated as follows: Post compensation value (q-ha) – Pre-compensation value (q-ha) = Estimated gain (q-ha).

6.7.2 Loss-Gain Accounting

Based on the preliminary identification of candidate compensation sites, there are sufficient potential gains to achieve no net loss for miombo woodlands and riverine forest. The following loss-gain comparisons can be made:

- A loss of 366.8 q-ha of miombo woodland was estimated while a potential gain of up to 595.9 q-ha was estimated. The balance is a net gain of 229.1 q-ha, which provides sufficient contingency to integrate discounting factors (or multipliers) for technical risks (i.e., the actions do not perform as planned) and temporal risks (i.e., a lag of 20 to 30 years between impact realization and compensation action maturity). The available compensation options are sufficient to integrate 15% contingency for technical risk (55.02 q-ha) and a 25% discounting factor to account for a temporal loss of 20 to 30 years (91.7 q-ha).
- A loss of 48.9 q-ha of riverine forest was estimated while a potential gain of up to 124.7 q-ha was estimated. The balance is a net gain of 75.8 q-ha, which provides sufficient contingency to integrate discounting factors for technical risks (i.e., 15% or 7.3 q-ha) and temporal risks associated with a time lag of 20 to 30 years (i.e., 25% or 12.2 q-ha).

The discounting factors identified above are indicative and should be further evaluated in feasibility study, as part of the consideration of ecological feasibility. Final candidate site selection will be informed by further stakeholder engagement and detailed feasibility studies, which may change the sites identified in this BMP. Regardless of which sites are selected, they should generate a minimum of 513.52 q-ha of miombo woodlands and 68.40 q-ha of riverine forest to deliver no net loss.

6.8 Feasibility, Planning and Implementation Phases

The preparation of this preliminary NHCP provides the foundation for moving on to the next steps in the compensation process, which are feasibility studies, forest-specific planning as well as implementation and monitoring.

Section 6.8.1 details the tasks associated with feasibility phase, Section 6.8.2 provides an overview of steps associated with forest-specific planning, and Section 6.8.3 describes the sequence of steps involved in the implementation and monitoring phase.

6.8.1 Feasibility Phase

The feasibility phase consists of completing a compensation feasibility study. The goal of the feasibility study is to confirm the viability of candidate compensation actions and sites, which were identified as part of this plan. The feasibility study should consider:

- Ecological feasibility;

- Technical and implementation feasibility;
- Social and cultural feasibility;
- Legal and political feasibility; and
- Financial feasibility.

The feasibility study will be informed by existing information (e.g., Detailed BMP, ESIA studies, RAP studies), additional stakeholder engagement activities, and site investigations. Following the completion of feasibility assessment, ZESCO will prepare a revised Compensation Strategy to document, at a minimum, the following components:

- Final site selection and associated compensation actions;
- Final loss-gain accounting to demonstrate that no net loss will be achieved;
- Selection of implementing partners and identification of mechanism(s) to ensure long-term management and protection of compensation sites; and
- Revised budget and long-term sustainable financing mechanism(s) to be established.

Ecological Feasibility

The assessment of ecological feasibility will seek to confirm the sites' potential to generate habitat gains for miombo woodlands and riverine forests. This assessment will require a field visit to validate information generated to date with satellite image interpretation. Specifically, the objective will be to perform an ecological condition assessment to confirm habitat types, habitat condition (e.g., species assemblages, soil quality), and restoration potential at each potential candidate site. The site assessment will provide the information needed to confirm which type of compensation action is most appropriate (ANR or reforestation). This information will eventually inform the preparation of site-specific treatment plans to be included in Forest-Specific Compensation Plans. Ecological feasibility criteria include:

- Soil depth and soil quality;
- Flora species assemblage and habitat type;
- Identification and severity of local threats as well as disturbance regime intensity and risk of failure for compensation actions;
- Slope and terrain;
- Hydrological conditions and proximity of water;
- Validation of floodplain delimitations for riverine forests; and
- Potential to contribute to landscape connectivity in proximity to mature forest patches.

Using validated field data, the loss-gain calculation will be updated to confirm that achieving no net loss of miombo woodlands and riverine forests is possible. The assessment will provide final confirmation that the proposed compensation actions meet the principle of ecological equivalence (i.e., “like for like or better”).

Technical and Implementation Feasibility

The assessment of technical and implementation feasibility will consider:

- Logistical and technical requirements and constraints, such as site accessibility, seasonality, seedling sourcing, and water sourcing.
- Existing governance structures and management capacity of potential implementing partner.
- Alignment with the compensation principles of additionality and assessment of leakage risk. This will require both an evaluation of existing and planned conservation efforts in managed forests as well as an evaluation of threats to understand the likelihood that threats may be displaced elsewhere if enforcement capacity is bolstered through the NHCP’s implementation.
- Identification and confirmation of enabling conditions needed to avoid leakage and ensure long-term outcomes.

The above components can largely be informed by existing knowledge of the candidate sites and will be bolstered by additional stakeholder engagement. Because the candidate sites fall within the BIIA covered by the ESIA, threats to the candidate sites are well understood. Threats mainly include the risk of forest conversion for agriculture, the risk of habitat degradation from frequent fires associated with slash and burn agricultural practices, and the risk of habitat degradation and loss from charcoal production. Information gathered from stakeholder engagement (see social and cultural feasibility, below) will allow for the identification of site-specific enabling conditions needed to address the risk of leakage and provide a reasonable likelihood that compensation sites will achieve long-term outcomes.

Social and Cultural Feasibility

The assessment of social and cultural feasibility will evaluate the challenges and opportunities associated with the presence and activities of nearby local communities. Critically, this will involve confirming that no dwellings are located inside candidate compensation sites to avoid the need for physical relocation. The assessment will also provide a brief socio-economic context around the site, to describe the number and location of communities around each candidate site. Additional stakeholder engagement and a site visit will confirm the number and identity of farmers involved in annual and perennial crops inside the identified candidate sites. Perennial crops and economic trees and associated extent should be identified.

Current land uses by communities and the approximate number of users of the site should be validated to assess potential impact to livelihoods. As all resettlement for compensation actions should be voluntary, communities and users willingness to relocate their activities should be assessed to identify any potential conflicts and disproportionate impacts to vulnerable persons and/or groups.

The assessment of social and cultural feasibility will rely heavily on information gathered from stakeholder engagement. Methods such as key informant interviews, focus group discussions, and open public meetings can be used to understand:

- The communities' views on the implications of implementing reforestation actions and strengthening the protection of compensation site(s).
- The communities' views on how current impacts can be managed, and what type of social interventions could facilitate protection of the site(s).
- The level of interest in, knowledge of, and capacity to participate in community-based conservation. This element is particularly relevant for actions proposed in Community Forests.
- Knowledge of other conservation initiatives being sponsored by donors or other parties.

This information should allow to assess communities' willingness to participate and support compensation actions. Indeed, without communities' commitment, long-term outcomes are unlikely.

Political and Legal Feasibility

The assessment of political and legal feasibility will rely heavily on information gathered from stakeholder engagement with national, regional, and local authorities. This would include engagement with local authorities, involved Forestry Departments and CFMGs. The assessment would include additional consultation to gather site-specific information about the identified candidate sites. The assessment of political and legal feasibility will describe:

- Legal status of the candidate compensation sites, with a description of permissible activities and management objectives (availability of a management plan should be confirmed).
- Alignment of compensation actions with national strategies, forest management practices (for Forest Reserves), and conservation and management objectives of Community Forests in alignment with the developed management plan for each managed forest.
- Views of local, regional and national governments as well as traditional authorities and local communities on the proposed compensation sites, and potential compensation actions.
- Risks of compensation failure (e.g., local resistance, land).

- Possible mechanisms to structure long-term partnerships with institutions for implementation and long-term management of compensation sites.

The overarching goal will be to assess the legal and/or political challenges and opportunities associated with the candidate compensation sites, and identify viable mechanisms to ensure long-term management and protection of compensation sites.

Financial Feasibility

Based on information gathered as part of the assessment of ecological, technical, implementation, social, cultural, political, and legal feasibility, a revised budget will be prepared for the compensation program. This will allow the PIU to confirm financing needs for compensation. Budget allocation and mechanisms will be identified based on the context of the candidate sites and the proposed actions and implementing partners.

Activities associated with the Feasibility Phase, as well as responsible entities for compensation in Forest Reserves and Community Forests, are presented in Table 6-10.

6.8.2 Forest-Specific Planning Phase

After completing the Feasibility Study and selecting compensation sites, a detailed compensation plan will be developed for each managed forest where compensation activities will be implemented. This plan will be developed by the implementation partners in said managed forest, mainly the Forestry Department and CFMGs, in collaboration with the PIU and District Forestry Department for each district where compensation actions are implemented. The goal is to detail the compensation strategy for each Forest Reserve and Community Forest where compensation sites were selected. This strategy should be supported by a detailed characterization of each compensation site, maps and photographs of targeted areas, and a clear plan for the implementation phase. Planning should consider compensation actions as well as enabling conditions and seedling production. Required support, enabling conditions, components for capacity building, and detailed indicators for monitoring specific to each managed forest should be identified in the plan.

Negotiations between the PIU and implementing partners (i.e., District Forestry Department and CFMGs) should occur at this stage so that each party's roles and responsibilities are clearly established and agreed upon before the implementation phase.

Table 6-10 shows the sequence of activities for the Forest-Specific Planning Phase, as well as responsible entities.

6.8.3 Implementation and Monitoring Phase

During the implementation phase, compensation actions and supporting measures will be implemented. project-dedicated nurseries will also be established and seedlings produced. Monitoring will be conducted during the implementation and monitoring phase along the guidelines presented in Chapter 8 and detailed monitoring indicators, as defined during the Forest-Specific Planning Phase.

The implementation and monitoring phase will end when the PIU can demonstrate that no net loss has been achieved.

Table 6-10 details the activities associated with the implementation and monitoring phase as well as responsible entities.

Table 6-10 Description of Activities for the Feasibility, Forest-Specific Planning and Implementation Phases

No.	Activity	Description	Responsibilities	
			In Forest Reserves	In Community Forests
A – Feasibility Phase				
A1	Preliminary assessment of potential candidate sites	<p>A preliminary assessment of potential candidate sites will be conducted by the PIU in collaboration with relevant District Forestry Departments, CFMGs and traditional authorities. The preliminary assessment will include:</p> <ul style="list-style-type: none"> ■ Field visit to confirm site conditions as preliminarily assessed using satellite imagery. ■ Appraisal of technical and implementation as well as political and legal feasibility with relevant stakeholders. ■ Refinement of candidate site limits based on site constraints, local context and existing conservation objectives. ■ Addition of new candidate sites as suggested by stakeholders. 	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs, Traditional authorities
A2	Validation of potential candidate sites with stakeholders	Based on the preliminary field assessment, the list of candidate sites to further assess as part of the feasibility study will be validated with stakeholders. Some sites may be set aside at this stage based on various considerations. After the no net loss calculation (activity A7), these sites could be revisited if gain objectives are not achieved.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs, Traditional authorities
A3	Ecological feasibility assessment to confirm suitability of compensation sites and identify relevant supporting actions	Each potential candidate site validated after activity A2 will undergo further site characterization of environmental features (including soil sampling, hydrological analysis, species assemblage, specific threat analysis, etc.) to confirm ecological feasibility. The assessment will also rely on past experiences of compensation or reforestation activities.	District Forestry Department	District Forestry Department

No.	Activity	Description	Responsibilities	
			In Forest Reserves	In Community Forests
A4	Social and cultural feasibility assessment to confirm suitability of compensation sites and identify relevant supporting actions	<p>Each potential candidate site validated after activity A2 will undergo an assessment of socio-economic realities including:</p> <ul style="list-style-type: none"> ■ Validation that no dwellings or titled lands or individualized customary lands are located within the site perimeter. ■ Identification of local communities' use of land and resources. ■ Preliminary inventory of affected households, perennial and annual crops, including crop types and harvesting periods. <p>Traditional authorities will be involved in this activity, and results can lead to identifying relevant supporting actions such as alternative livelihood development and stakeholder engagement and sensitization activities.</p>	PIU, District Forestry Department, Traditional authorities	PIU, District Forestry Department, Traditional authorities
A5	Confirmation of compensation sites	<p>After the feasibility assessment, suitable compensation sites will be validated in collaboration with relevant stakeholders.</p> <p>It is recommended that an assessment sheet be completed for each candidate site to assess feasibility and document potential habitat gain.</p>	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs, Traditional authorities
A6	Confirmation of site-specific objectives and actions	For each site, specific objectives and actions will be established based on the results of the feasibility assessment and site characterization. This should result in specific compensation actions (and associated areas) as well as preliminary enabling conditions for each site.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
A7	No net loss calculation	<p>Based on the selected compensation sites and associated compensation actions, potential habitat gain will be quantified to ensure no net loss can be achieved based on initial habitat quality and compensation areas.</p> <p>If the no net loss calculation is <u>not balanced</u>, additional compensation sites will need to be identified and activities A1 to A7 will be repeated until the final calculation demonstrates that no net loss is possible and that the principle of ecological equivalence is respected.</p>	PIU	PIU
A8	Confirmation of species to be used for compensation and restoration actions at each site	The list of preferred species for each habitat (see Sections 6.5.1.2 and 6.5.2.2) will be reviewed with botanists to confirm ecological feasibility (identified species are appropriate to selected compensation sites) and based on local availability of required seeds and seedlings.	Copperbelt University, District Forestry Department, PIU	Copperbelt University, District Forestry Department, PIU

No.	Activity	Description	Responsibilities	
			In Forest Reserves	In Community Forests
A9	Validation of the availability of seeds and seedlings locally	Technical and implementation feasibility Based on the required numbers of seedlings per species, local availability of seeds within the managed forests (seeds can be collected and propagated in the targeted area) and the surroundings as well as availability of seedlings from local nurseries will be assessed in collaboration with District Forestry Departments and CFMGs for each managed forest where compensation actions are planned.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
A10	Identification of suppliers for required seeds and seedlings	It is anticipated that only a portion of the seedlings required for the compensation activities can be produced from the collection of seeds locally and grown in nurseries implemented by the implementing partners. Remaining seedlings will need to be obtained either through purchase of seeds from suppliers and germination and growth in implemented nurseries; or through purchase of seedlings from suppliers. Availability of required seeds and seedlings from suppliers will be assessed and quotations obtained from these suppliers to develop a tentative budget that will inform financial feasibility . Activities A8, A9 and A10 should result in a refined list of species to be used for conservation actions in miombo woodlands and riverine forests with specificities for some managed forests where relevant and identified suppliers for some seeds and seedlings.	PIU	PIU
A11	Identify partners and clarify roles and responsibilities	Responsibilities for the implementation of the NHCP will be confirmed and responsibilities for each actor will be detailed to finalize confirmation of technical and implementation feasibility of the overall plan. At this stage, the PIU is responsible for ensuring that partners have sufficient capacity to implement and monitor compensation and supporting actions.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
A12	Identification of implementation risks and associated mitigation measures	Potential risks for the overall implementation of the NHCP will be identified, and mitigation measures will be explored. Where relevant, site-specific risks can be preliminarily assessed. Risks and associated mitigation measures will be taken into consideration to develop the preliminary schedule and budget as part of the feasibility study.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
A13	Development of a preliminary schedule	An overall implementation schedule will be developed including all compensation and supporting actions at all sites as well as seedling production and the development of Forest-Specific Compensation Plans.	PIU	PIU
A14	Development of a refined preliminary budget	Based on the feasibility assessment results and identified compensation and supporting actions at selected sites, the preliminary NHCP budget will be refined to confirm financial feasibility .	PIU	PIU

No.	Activity	Description	Responsibilities	
			In Forest Reserves	In Community Forests
B – Forest-Specific Planning Phase				
B1	Complete a detailed characterization of compensation sites	<p>As part of the development of Forest-Specific Compensation Plans, each site will be mapped out to inform the treatment plan, including detailed delineation of current habitat types and conditions, assignment of the number and type of required seedlings in each habitat type based on planned compensation actions, and description of access requirements (e.g., need for new access roads or opportunities to use existing trails).</p> <p>It should be noted that new access roads should not lead to physical resettlement under any circumstance. If economic displacement results from access roads, it should be voluntary and affected assets should be compensated according to the entitlement matrix detailed in the RAP Report for the ZTIP (WSP, 2025). Additionally, any habitat loss associated with access roads will need to be considered in the no net loss calculation. As such, existing access will be prioritized as possible.</p>	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
B2	Define the required compensation actions in each targeted area	Specific compensation actions for each site will be detailed, including the targeted species and site preparation requirements.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
B3	Identify the number of required seedlings per species	The number of required seedlings will be quantified based on the detailed characterization of each compensation site and associated actions. This will guide the establishment of nurseries.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs

No.	Activity	Description	Responsibilities	
			In Forest Reserves	In Community Forests
B4	Selection of project dedicated nurseries' location	<p>The location of project dedicated nurseries will be selected for each managed forest. In some cases, district nurseries could be established to supply more than one managed forest based on the local context. These guidelines should be considered as part of site selection for nurseries:</p> <ul style="list-style-type: none"> ■ Nurseries should be located close to sustainable water sources to facilitate water supply. ■ Establishment of nurseries should, in no case, lead to physical resettlement. If economic displacement results from nurseries, it should be voluntary and affected assets should be compensated according to the entitlement matrix detailed in the RAP Report for the ZTIP (WSP, 2025). ■ Sites should be easily accessible to reduce the need for new access roads. ■ Preferentially sites should be located in modified habitats as natural habitat loss associated with the establishment of nurseries will need to be considered in the no net loss calculation. 	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
B5	Identify appropriate supporting actions to strengthen enabling conditions	Based on forest-specific risks and challenges and identified enabling conditions, appropriate supporting actions will be identified and detailed.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
B6	Identification of monitoring indicators	For each site within a given managed forest, specific monitoring indicators will be identified based on the specific compensation and supporting actions selected.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
B7	Development of a detailed implementation schedule	For each managed forest, a detailed implementation schedule will be developed in collaboration with implementing partners to clearly establish the implementation timeline of actions on all compensation sites.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
B8	Development of a detailed budget	For each managed forest, a detailed budget will be developed including all conservation actions as well as relevant supporting actions (see Section 6.6).	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs

No.	Activity	Description	Responsibilities	
			In Forest Reserves	In Community Forests
B9	Collaboration with District Forestry Departments and CFMGs to update their management plans to define compensation objectives in selection sites	Following the preparation of Forest-Specific Compensation Plans, the relevant authorities should be supported in updating their management plans to reflect compensation objectives and actions in selected compensation sites. This will support long-lasting results.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
C – Implementation and Monitoring Phase				
C1	Letter of notification to implementing partners	A letter of notification that formally outlines the expected roles and responsibilities from the involved Forestry Departments and CFMGs, timelines and level of efforts, and planned supporting actions will be shared in order to formalize their commitment and ensure required resources and budget allocation from the Ministry of Green Economy and Environment.	PIU, District Forestry Department	PIU,
C2	Land marking of selected sites	Once the implementation phase begins, selected sites will be marked (land markers and signage).	District Forestry Department	District Forestry Department, CFMGs
C3	Official disclosure of selected compensation sites	An official letter, signed by ZESCO, will be communicated at all levels (province, district, and chiefdoms) to disclose the selected compensation sites. Information sharing meetings will also be organized in neighboring communities to disclose anticipated activities at each site.	PIU	PIU
C4	Implementation of supporting actions	Relevant supporting actions, as identified in Forest-Specific Compensation Plans, will be implemented. As many supporting actions aim at bolstering enabling conditions for the successful implementation of compensation plans, early implementation is key.	PIU, District Forestry Department, Traditional authorities	PIU, District Forestry Department, CFMGs, Traditional authorities
C5	Training of actors involved in seedling production	Stakeholders involved in seed collection, propagation and seedling growth in project dedicated nurseries will be trained by specialists to ensure successful results.	Copperbelt University	Copperbelt University, District Forestry Department
C6	Seed collection (seasonal) and purchase	Part of the seeds will be collected in targeted areas during the ecological window for each species. Most of the seeds will be purchased from local suppliers.	District Forestry Department	CFMGs
C7	Establish project dedicated tree nurseries	Project-dedicated tree nurseries will be established at designated locations (as identified at activity B4). The necessary equipment to support activities at the nurseries will be supplied including input/fertilizers/compost, water sprayers, water tanks, machetes, brush cutters, shovels, etc.	District Forestry Department	District Forestry Department, CFMGs

No.	Activity	Description	Responsibilities	
			In Forest Reserves	In Community Forests
C8	Production of seedlings	Project-dedicated nurseries will operate to produce seedlings from seeds collected or purchased.	District Forestry Department	District Forestry Department, CFMGs
C9	Procurement of required seedlings from suppliers	In the case of species for which required seedlings cannot be produced in project dedicated tree nurseries, seedlings will be supplied from identified suppliers.	PIU	PIU
C10	Valuation and compensation of affected crops	Crops located on compensation sites will preferably be harvested by farmers before habitat compensation actions are implemented. However, if harvesting is not possible (crops are not mature at the time of compensation actions implementation) or affected crops are perennial, affected crops will be formally identified and valued by the District Agricultural Coordinator (DACO) and affected persons will be eligible to livelihood restoration. The land use analysis results do not indicate that tree plantations will be affected on candidate sites. However, if such plantations were affected, they would be adequately identified, valued, and compensated.	DACO, District Forestry Department PIU	DACO, District Forestry Department PIU
C11	Implementation of compensation actions	Based on the identified compensation actions for each site, ANR and/or reforestation will be implemented. ANR will include manual removal of invasive and exotic species. Reforestation will include soil preparation (manual removal of crops, invasive and exotic species, ploughing, etc.), planting of seedlings, application of input, fertilizer or compost, watering, etc. Specific activities at each site will be detailed in Forest-Specific Compensation Plans.	District Forestry Department	District Forestry Department, CFMGs
C12	Monitoring of site-specific indicators	Based on site-specific monitoring indicators defined at activity B6, monitoring will be conducted. Based on monitoring results, corrective measures may be identified and implemented as part of the adaptive management strategy.	PIU, District Forestry Department	PIU, District Forestry Department, CFMGs
C13	Validation of natural habitats losses and calculation of no net loss	The PIU will be responsible for ensuring no net loss is achieved as a result of implemented compensation actions. Monitoring should track specific indicators that will allow to conclude if no net loss is achieved. Additional habitat loss associated with construction activities or the NHCP implementation itself (e.g. access roads) should be considered in the calculation. Monitoring should be planned over a sufficiently long timeframe to confirm that no net loss objectives have been achieved. More frequent monitoring will be required during the early stages of compensation to confirm seedling survival and that habitats are on a trajectory to reach a forested condition.	PIU	PIU

7. Conservation Actions for Critical Habitat Triggering Species

7.1 *Disa aequiloba* and Wetlands

Conservation actions for *Disa aequiloba* aim to contribute towards conservation and management of *Disa aequiloba* and achieve net gain for its critical habitat. Table 7-1 summarizes the net gain strategy for *Disa aequiloba*. The following actions will be implemented as part of the project:

- Ex-situ Conservation – Collect seed and tuber samples from representative genetic populations for propagation and safeguarding at the Copperbelt University research facility. To achieve this, develop a nursery specifically for the species in collaboration with orchid specialists to grow plants that can be used in reintroduction efforts. Develop a protocol for ex-situ propagation of *Disa aequiloba* in a nursery setting.
- Translocation/Reintroduction of Specimens – In collaboration with orchid specialists, trial and monitor the success of different methods for translocating salvaged individuals and reintroducing individuals grown in a nursery setting. Develop optimized protocols for *Disa aequiloba* translocation and reintroduction.
- Community-Based Habitat Protection – Collaborate with local communities and traditional authorities to integrate key orchid-hosting wetlands into community-based conservation programs. Encourage the adoption of beneficial practices identified during previous orchid surveys, such as prescribed early burning, sustainable harvesting techniques, and burial of roots after tuber collection. This measure will also include collaborative efforts to preserve unimpacted wetlands in the ROW, with a focus on wetlands that have low levels of anthropogenic disturbance. Given the potential importance of chikanda orchid sales as a livelihood for some households (Kwenye et al., 2025), and wetland conversion patterns that are largely driven by agricultural expansion, community-based approaches are critical to ensure long-term conservation outcomes.
- Increase Awareness – Implement an awareness raising campaign in local communities to increase knowledge and awareness of natural resources protection and overharvesting.
- Conduct Long-term Monitoring and Adaptive Management: Pre-operation data shall be collected, and regular monitoring of population size, density, flowering success, tuber health, and hydrological conditions in monitored wetlands shall be completed to confirm long-term establishment of self-sustaining plants and persistence of undisturbed receptor wetlands throughout the life of the project.

Table 7-1 Net Gain Strategy for *Disa aequiloba*

Impact	Quantification of residual impact	Net Gain Strategy	Monitoring and Other Supporting Actions
Loss of specimens in the permanent and temporary footprints	To be confirmed from pre-construction surveys	<ul style="list-style-type: none"> ■ Salvage and transplant individuals from the footprint to secure receptor wetlands. ■ Reintroduce individual plants grown ex-situ into secure receptor wetlands. ■ Monitor survival of plants in receptor wetlands to confirm that more plants persist on those sites than were lost inside the project footprint. 	<ul style="list-style-type: none"> ■ Apply monitoring and adaptive management to address uncertainty in the success of ex situ propagation, and the survival rates of transplanted and reintroduced individuals. Depending on the magnitude of translocations required, monitor using complete census of plants or implement a survey of representative samples to establish an average survival rate used to estimate the number of surviving individuals. ■ Repeat monitoring efforts over time to confirm long-term establishment of self-sustaining plants and persistence of undisturbed receptor wetlands over the life of the project. ■ Partner with orchid specialists to ensure the team has the required technical competencies to ensure an effective adaptive management strategy. Specialists will develop and adapt species-specific protocols for transplantation and propagation, which currently do not exist.
Loss of <i>Disa aequiloba</i> critical habitat.	Permanent loss of 2.91 to 4.96 ha of critical habitat ^(a) .	<ul style="list-style-type: none"> ■ Averted wetland loss resulting from in situ protection of wetlands, in collaboration with communities. This will be a combination of maintaining: (1) wetlands outside the wayleave corridor selected as receptor wetlands for plant translocations and reintroductions, and (2) unimpacted low disturbance wetlands inside the wayleave corridor. ■ Two percent of the transmission line corridor consists of low disturbance wetlands. Assuming an annual rate of wetland loss of 1%(b), the in-situ protection of 50 ha of low disturbance wetlands in the wayleave would generate an averted loss of about 10 ha over a 20-year period. Receptor wetlands would further increase the averted loss gains. The anticipated gains should be sufficient to compensate permanent loss of critical habitat; however, it remains uncertain if additional efforts will be required to address impacts from temporary project disturbances. 	<ul style="list-style-type: none"> ■ Get community buy-in for the protection and management of wetlands. The success of achieving averted loss gains will largely depend on this because wetland encroachment for agriculture is a key driver of local wetland loss. Collaborate with traditional authorities and increase community awareness about species protection and the project's conservation initiatives to secure community support. ■ Adjust averted loss estimates to include gains from off-site receptor wetlands, once required information is available. Determine the need for additional wetland compensation based on the extent of temporary footprint impacts. ■ Conduct long-term monitoring, consisting mainly of satellite image interpretation, to detect changes in land cover and wetland condition in areas targeted for averted loss.

Notes: (a) Location of temporary footprint components (e.g., access roads, work areas) has not been identified; therefore, it is not yet possible to quantify the extent of residual impacts attributable to these elements. (b) The rate of wetland loss was selected by considering a range of published values, including 0.78% loss per year reported by Banda et al. (2022) for the Barotse floodplain in Zambia (1980-2020), 4.27% loss per year reported by Changwe (2020) for the Lukanga swamp in Zambia (1997-2017), and 0.82% loss per year by Dixon et al. (2016) for inland wetland losses across Africa (1970-2008).

7.2 *Euphorbia perplexa* var. *kasamana* and Rock Outcrops

Conservation actions for *Euphorbia perplexa* var. *kasamana* aim to contribute towards the conservation and management of *Euphorbia perplexa* var. *kasamana* and achieve net gain for its critical habitat. Table 7-2 summarizes the net gain strategy for *Euphorbia perplexa* var. *kasamana*. As for *Disa aequiloba*, monitoring of the success of these proposed conservation actions for *Euphorbia perplexa* var. *kasamana* will be key to ensure net gain is achieved with the proposed approach. Monitoring is even more important in this context where knowledge on this species is limited, and translocation and reintroduction success for the species is highly uncertain. The following actions will be implemented as part of the project:

- Habitat Protection and Enforcement – Collaborate with the Kasama District Forest Department authorities and the NHCC to strengthen the protection of rock outcrops, particularly those supporting large populations (e.g., Rocks 2, 5, 8, 13, 48). Measures will be agreed with the Kasama District Forest Department and NHCC may include increased patrols and community engagement to prevent quarrying and fires.
- Support the NHCC in showcasing the biodiversity of rock outcrops at the interpretation center.
- Ex-situ Conservation – Collect seeds and/or cuttings from a representative genetic sample of the impacted populations to establish a population at a recognized national botanical garden, such as Munda Wanga and/or the Copperbelt University botanical garden. The ex-situ population is to be maintained as a safeguard for the local population, and may be used for research or future re-introductions to enhance local populations. Develop a protocol for ex-situ propagation of *Euphorbia perplexa* var. *kasamana* in a nursery setting.
- Translocation/Reintroduction of Specimens – In collaboration with *Euphorbia* specialists, trial and monitor the success of different methods for translocating salvaged individuals and reintroducing individuals grown in a nursery setting. Develop optimized protocols for *Euphorbia perplexa* var. *kasamana* translocation and reintroduction.
- Conduct Long-term Monitoring and Adaptive Management: Pre-operation data shall be collected, and regular monitoring of population structure, individual plant health, recruitment (seedling survival), and substrate stability shall be carried out to track operational impacts and confirm long-term establishment of self-sustaining plants and persistence of undisturbed receptor rock outcrops throughout the life of the project.

Protection of rock outcrop habitats and existing local populations is considered a key action because rock outcrop habitats cannot be restored after an important physical disturbance, such as quarrying. Attempting to restore highly disturbed sites would be an experimental process with a low likelihood of success.

Table 7-2 Net Gain Strategy for *Euphorbia perplexa* var. *kasamana*

Impact	Quantification of residual impact	Net Gain Strategy	Monitoring and Other Supporting Actions
Loss of specimens in the permanent and temporary footprints	<ul style="list-style-type: none"> ■ Permanent footprint is not expected to result in individual plant loss. ■ Loss from temporary footprint is estimated at 129 individuals (range: 0 to 297 individuals) ■ Final residual impact to be confirmed from pre-construction surveys 	<ul style="list-style-type: none"> ■ Experimental salvage and transplant of individuals from the footprint to secure receptor sites. ■ Ex-situ conservation of individuals in a nursery setting. ■ Experimental reintroduction of individual plants grown ex-situ to secure receptor sites. ■ Averted loss of individuals from strengthened protection of rock outcrops, with a focus on those supporting large populations (e.g., Rocks 2, 5, 8, 13, 48). 	<ul style="list-style-type: none"> ■ Apply monitoring and adaptive management to address uncertainty in the success of ex situ propagation, and the survival rates of transplanted and reintroduced individuals. Depending on the magnitude of translocations required, monitor using complete census of plants or implement a survey of representative samples to establish an average survival rate used to estimate the number of surviving individuals. ■ Repeat monitoring efforts over time to confirm long-term establishment of self-sustaining plants and persistence of undisturbed receptor sites over the life of the project. ■ Partner with <i>Euphorbia</i> specialists to ensure the team has the required technical competencies to ensure an effective adaptive management strategy. Specialists will develop and adapt species-specific protocols for transplantation and propagation, which currently do not exist. ■ Partner with Kasama District Forest Department authorities and the NHCC to document and monitor averted loss efforts.
Loss of <i>Euphorbia perplexa</i> var. <i>kasamana</i> critical habitat.	<ul style="list-style-type: none"> ■ Permanent loss of 0.14 ha of critical habitat, including estimates for temporary workspaces. 	<ul style="list-style-type: none"> ■ Collaborate with the Forestry Department and the NHCC to generate averted losses of rock outcrop by strengthening protection of existing rock outcrops in the Kasama Forest Reserve. ■ Assess and estimate baseline loss of rock outcrop habitat loss in the region to confirm that averted loss will exceed 0.14 ha. ■ Confirm priority areas/sites to target for averted loss and record their spatial extent. 	<ul style="list-style-type: none"> ■ Formalize and document the collaboration and roles of parties (ZTIP, Kasama District Forest Department, and NHCC) to strengthen the protection of rock outcrops. This could be through a Memorandum of Agreement among parties. ■ Collaborate with partners to document and monitor averted loss efforts and demonstrate that targeted areas of rock outcrop habitat remain undisturbed.

8. Biodiversity Monitoring Program

Environmental and social monitoring, and if required, implementation of corrective actions, are carried out to ensure the proposed environmental and social management strategy is being implemented as planned and desired targets and outcomes are being achieved.

More precisely, the aim of this Biodiversity Monitoring Program is to monitor the nature, extent, quality, and spatial configuration of the biodiversity features identified in relation to project impacts, and to validate the efficiency of biodiversity management measures, conservation actions for critical habitat triggering species, and natural habitats compensation actions to be applied. The Biodiversity Monitoring Program objective is to track project performance in terms of biodiversity protection and compensation. It involves these elements:

- Monitoring of the implementation of the planned management measures on the basis of the identified indicators in Tables 4-3 and 4-4.
- Monitoring of the resulting and residual impacts on biodiversity components (see Table 8-1).
- Monitoring of the success of implemented conservation actions for critical habitat triggering species (see Table 8-1).
- Monitoring of the success of the implementation of the Natural Habitats Compensation Plan (see Table 8-1).

The BMP proposes a detailed list of actions meant to compensate residual impacts on critical and natural habitats. The success of these actions is measured based on various indicators meant to ensure the implementation of all proposed actions, the validation of the survival rates of any individuals translocated or planted as well as the validation of the no net loss and net gain respectively on natural habitats and critical habitats. Annual compensation monitoring reports summarizing progress and results of the natural habitats compensation program will be prepared annually during planning, implementation and for the first five years following implementation. The main objective of the reports will be to update loss-gain calculations as the project progresses and as more information is collected. Reporting frequency may be adjusted after the first five years of monitoring. Preliminary monitoring indicators are described in Table 8-1; however, long-term monitoring efforts will be further detailed in Forest-Specific Compensation Plans once planning and implementation is complete to ensure that the monitoring program adequately tracks and evaluates the effectiveness of site-specific actions.

The Biodiversity Monitoring Program integrates components specific to both construction and operation phases or allows for the assessment of the proposed conservation and compensation actions over a long-term period. During construction phase, monitoring is aimed at ensuring all recommended mitigation measures and the Contractors Environmental and Social Management Plan (C-ESMP) are implemented, all activities are documented, and any glitches in the system are rapidly identified and adjusted. The responsibility for these activities lies with the Contractors and their implementation will be monitored and controlled by the Supervising Engineer and the PIU. During the operation phase all monitoring activities as well as related documentation and reporting will be carried out by ZESCO.

The monitoring program is meant to evolve and be adapted over time to address any unexpected changes, impacts or inefficiency. Results of the bird mortalities program should also lead to alternative specific mitigation measures for species that are continually affected or sections of the line particularly sensitive. Biodiversity monitoring is based on:

- Site inspections.
- Verification of the effectiveness of mitigation measures, conservation actions, and compensation activities.
- Analysis of collected data to ensure efficiency of the biodiversity management strategy as well as validation of the no net loss and net gain respectively on natural habitats and critical habitats.
- Reviews and updates, as required, based on observations and potential changes in construction or operation activities. The program will also enable the review of mitigation measures according to their efficacy and durability, and the development of alternative specific mitigation measures for species that are continually affected.

Economic resettlement resulting from the implementation of the Natural Habitats Compensation Plan and livelihood restoration for affected households will need to be monitored based on the specific program detailed in the ZTIP Resettlement Action Plan (Pensulo-Kasama) (WSP, 2025). Table 8-1 lists the monitoring measures for biodiversity to be applied during the construction and operation phases.

Table 8-1 Biodiversity Monitoring Program

Biodiversity feature	Monitored component	Supervision method	Indicators	Standards / targets	Location	Frequency	Responsibility
Natural habitat	Vegetation management practices	Inspection of clearing activities and techniques used. Review of clearing schedules.	Vegetation cutting with the supervision of a botanist. Vegetation integrity outside the ROW. Integrity of protective barriers (fences) limiting access to sensitive areas. Vegetation types removed. Retention of shrubby vegetation in riparian areas and dambo. Selective cutting implemented. Timing of clearing activities. Affected habitat areas outside the ROW. Extent of access routes and construction areas in wetlands.	Avoid significant degradation outside the ROW. Protection of flora species with conservation status. Selective cutting implemented in dambos and riparian habitats. Tree strata only cut in riparian areas within ROW. Shrubby vegetation maintained. No clearing during warm wet months. Vegetation at watercourse edges and erosion-prone areas conserved.	ROW and substation site.	Weekly during pre-construction clearing activities. Weekly during all maintenance clearing activities.	Construction phase: Contractors EHS Manager Operation phase: ZESCO
	Plant communities	Evaluation of the composition of plant communities via flora surveys (diversity and composition).	Plant communities' evolution after eventual degradation from openings and border effects. Presence of non-native invasive species.	Avoid significant degradation outside the ROW. Avoid introduction of non-native invasive species.	In areas of high ecological integrity adjacent to the ROW.	Annually for the first five years of operation, then once every two years.	ZESCO supported by botanist(s)
	Natural habitat loss	Assess the total area of natural habitat loss once construction is completed. Field observations with the support of satellite imagery in forested habitats. Description and pictures of habitats prior to impact and after.	Additional affected areas from construction facilities in natural habitat. Lost area of natural habitat by habitat type. Natural habitat integrity outside the ROW.	All natural habitat loss accounted.	Along ROW, where mature and secondary miombo as well as riverine forests and wetland habitats are found.	Continuously during pre-construction and construction activities. Final reporting at the end of the construction phase.	Contractors supported by botanist(s)
	Non-native invasive species	Assessment of the presence and introduction of non-native invasive species.	Presence of non-native invasive species. Habitat modification that may have led to their introduction. Effect on native species and species of conservation interest.	No introduction or spread of non-native invasive species attributable to project activities. No increase in non-native invasive species coverage along ROW. Identify appropriate suppression and control measures if problematic presence of non-native invasive species are recorded.	In sensitive habitats within or adjacent to the ROW. In restored areas. In reforested areas as part of the NHCP.	Quarterly during construction and at the end of construction. Annually for the first 5 years, then once every 2 years during operation.	Construction: Contractors supported by botanist(s) Operation: ZESCO supported by botanist(s)
	Natural resource management	Monitoring of fuel wood distribution. Review of timber removal coordination.	Volume of fuel wood made available to local communities. Distribution records. Collaboration with Forestry Department. Volume of merchantable timber removed. Authorizations obtained.	Fuel wood residues made available to communities. Timber removal coordinated with Forestry Department. No unauthorized harvesting by workers.	Areas where vegetation clearing generates fuel wood, areas with merchantable timber species.	Weekly during pre-construction clearing activities. Weekly during maintenance clearing activities. Records maintained throughout.	Construction: Contractors supported by botanist(s) Operation: ZESCO supported by botanist(s)
	Restoration of temporary work areas	Field observations in restored areas and flora surveys.	Vegetation density. Flora species diversity. Time between end of work and restoration.	Exposed soils rehabilitated as soon as possible following construction activities. Success of the habitat restoration. Area returned to original natural state.	In rehabilitated temporary work areas.	Monthly during restoration activities. Quarterly for 2 years post-restoration of borrow sites.	Construction: Contractors supported by botanist(s) Post-restoration: ZESCO supported by botanist(s)

Biodiversity feature	Monitored component	Supervision method	Indicators	Standards / targets	Location	Frequency	Responsibility
Natural habitats compensation – miombo woodlands and riverine forest	Habitat compensation feasibility study	Verification of document.	Completed feasibility study report.	The feasibility study addresses the elements described in Section 6.7.1 and Table 6-10.	NA.	Once, during pre-construction/ construction.	PIU E&S Manager
	Forest-Specific Compensation Plans	Verification of documents.	Completed Forest-Specific Compensation Plan for each managed forest identified in the feasibility study.	The Forest-Specific Compensation Plans include the elements described in Section 6.7.2 and Table 6-10.	NA.	Once for each plan, during construction.	PIU E&S Manager
	Nursery sites identified and evaluated	Verification of documents. Site visit.	A nursery management plan is developed for each nursery site to record its location and confirm operational details in accordance with site specific characteristics.	The plan identifies the location of each nursery and includes a screening of potential E&S risks. As appropriate, mitigation measures are defined to address identified risks. The plan defines the management structure for nursery oversight, assigns responsibilities for day-to day operation, and lists the equipment and materials needs, including water needs and sourcing.	Expected at each proposed managed forest and at district level.	Once for each nursery, during construction.	PIU E&S Manager in collaboration with compensation partners (Forestry Department or Community Forest management Group)
	Nursery establishment	Site visit.	Nursery is established and operational. Conditions for seedlings survival and growth are in place.	All required nurseries are established during year one of construction.	Expected at each proposed managed forest and at district level.	Once for each nursery, during construction.	PIU E&S Manager in collaboration with compensation partners (Forestry Department or Community Forest management Group)
	Seed and seedling stock	Review and verification of nursery logs.	Number of seeds collected by species per nursery. Number and quality of the seedlings	Sufficient seed stock has been collected to produce the number of seedling (by species) identified in the Forest-Specific Compensation Plans.	Nurseries sites	Twice annually during planning and implementation (during construction and operation, until sufficient seedlings have been produced).	PIU E&S Manager in collaboration with compensation partners (Forestry Department or Community Forest management Group)
	Agreements with implementing partners	Document verification.	Letters of notification (or similar documents) sent to Forestry Department and CFMGs.	Letters of notification are sent before the end of year one of construction.	NA.	Once.	ZESCO and PIU E&S Manager
	Physical demarcation of compensation sites is in place and maintained	Field observations at compensation sites.	Physical markers are present to define the boundaries of compensation sites.	Markers are visible and in place by the end of year one of construction. Markers remain in good condition and are replaced as needed over the duration of the program.	Habitat compensation sites.	Once following implementation (for initial verification), then monthly after implementation of compensation actions (during construction and operation).	PIU E&S Manager in collaboration with Forestry Department or Community Forest management Group
	Compensation Site Preparation	Field observations at compensation sites.	Hectares of land with site preparation activities.	To be defined in more detail in Forest-Specific Compensation Plans. Activities should be completed per the standards defined in Forest-Specific Compensation Plans and completed prior to the end of construction.	Habitat compensation sites.	Quarterly during implementation.	PIU E&S Manager

Biodiversity feature	Monitored component	Supervision method	Indicators	Standards / targets	Location	Frequency	Responsibility
	Implementation of compensation actions	Field observations at compensation sites.	Percent (%) of area with planned compensation activities implemented per site. Planted Tree density Survival rate of planted seedlings per species	To be defined in more detail in Forest-Specific Compensation Plans. Activities should be completed per the standards defined in Forest-Specific Compensation Plans (e.g., species planted, densities planted, survival rate per species). Activities should preferably be completed prior to the end of construction, and no later than early operation.	Habitat compensation sites.	Quarterly during implementation.	Construction: PIU E&S Manager Operation: ZESCO
	Implement enabling conditions for the compensation program – capacity for enforcement and monitoring	To be defined in more detail in Forest-Specific Compensation Plans, but may include: <ul style="list-style-type: none"> Equipment audits; Field audits; Review of annual program budgets; Verification of management plans. 	To be defined in more detail in Forest-Specific Compensation Plans, but may include: <ul style="list-style-type: none"> Audit reports with photographic evidence showing equipment purchased (e.g., bicycles, motorcycle, PPE, field equipment, uniforms). Photographic evidence of signage and beacons installed to delineate managed forest boundaries. Annual budgets with funds allocated for transportation and stipends for CFMGs. Updated management plans that reflect the land management strategy for areas designated as compensation sites. 	To be defined in more detail in Forest-Specific Compensation Plans as different sites will require different enabling conditions.	Habitat compensation sites.	To be defined in Forest-Specific Compensation Plans.	Construction: PIU E&S Manager Operation: ZESCO
	Implement enabling conditions for the compensation program – community commitment and participation	To be defined in more detail in Forest-Specific Compensation Plans, but may include: <ul style="list-style-type: none"> Engagement with traditional authorities, including for final compensation site selection. Community awareness sessions about the NHCP– its objectives, its benefits, roles and responsibilities, and actions that can promote its success. 	To be defined in more detail in Forest-Specific Compensation Plans, but may include: <ul style="list-style-type: none"> Meeting minutes and attendance sheets. Photographic logs documenting community awareness sessions. Verification of materials prepared for us in community awareness sessions. 	To be defined in more detail in Forest-Specific Compensation Plans as different sites will require different enabling conditions.	Surrounding communities TBD	At least one meeting with traditional authorities in each affected community during feasibility studies. Initial awareness sessions to be conducted prior to implementing compensation actions. Regular community sessions following implementation (at least annually) to keep communities informed of progress and results.	Construction: PIU E&S Manager Operation: ZESCO
	Implement enabling conditions for the compensation program – alternative livelihoods to reduce anthropogenic pressures	<ul style="list-style-type: none"> Field audits and interviews to confirm that authorities have stopped issuing charcoal production permits in managed forests with compensation sites. Verification of training records. Audits to confirm the distribution of equipment or materials (e.g., seedlings for agroforestry, beehives). 	To be defined in more detail in Forest-Specific Compensation Plans, but may include: <ul style="list-style-type: none"> Audit reports documenting site observations and implemented actions. Log of participants for training sessions, copy of training materials, photographs of training sessions. 	To be defined in more detail in Forest-Specific Compensation Plans as different sites will require different enabling conditions.	Surrounding communities TBD.	Ongoing during the implementation phase of the compensation program.	Construction: PIU E&S Manager Operation: ZESCO

Biodiversity feature	Monitored component	Supervision method	Indicators	Standards / targets	Location	Frequency	Responsibility
Critical habitat – <i>Disa aequiloba</i>	Translocation of <i>Disa aequiloba</i> specimens	Field observations at work sites and at host wetlands.	Number of specimens translocated. Survival rate of translocated specimens. Regular watering completed.	All areas of project footprint within critical habitat visited. All specimens in the project footprint removed. >75% survival rate of translocated specimens, one growing season after translocation.	Project footprint in <i>Disa aequiloba</i> critical habitat. Host wetlands identified for community-based habitat protection for <i>Disa aequiloba</i> .	Translocation during wet season, before construction in critical habitat wetlands. Monthly monitoring at host wetlands during first growing season, then two times a year during subsequent growing seasons.	Construction: PIU in collaboration with Copperbelt University Operation: ZESCO in collaboration with Copperbelt University
	Ex-situ Conservation and reintroduction of <i>Disa aequiloba</i>	Monitoring of specimens in nurseries. Field observations at reintroduction sites.	Established ex-situ population of <i>Disa aequiloba</i> in nurseries. Number of individuals reintroduced. Number of reintroduced individuals surviving one year after reintroduction.	Secure, healthy population persisting in nurseries. Reintroduction of more specimens than were lost from project construction. Net gain is demonstrated one growing season after reintroduction of specimens.	Ex-situ nurseries. Reintroduction sites in host wetlands identified for community-based habitat protection.	Weekly monitoring in nurseries. Monthly visits of host wetlands for the first growing season, then two times a year during subsequent growing seasons.	Construction: PIU in collaboration with Copperbelt University Operation: ZESCO in collaboration with Copperbelt University
	Community Based Habitat Protection	Field observations in protected wetlands. Meetings with community leaders. Patrols and inspections of harvesting areas. GIS-based habitat mapping.	Population size, density, flowering success, tuber health, hydrological conditions. Number of community meetings. Prescribed burns implemented. Area of protected wetlands.	Edible orchid tubers protected. Stable or increased population size. At least one community meeting per year, for each community involved in the program. Area of prescribed burn documented. No change or an increase in area of protected wetlands.	In host wetlands identified for community-based habitat protection.	Monthly visits of protected host wetlands for the first year, then two times a year. Annual community meetings. Yearly prescribed burning. Annual mapping of protected wetland.	Construction: PIU in collaboration with Copperbelt University and local communities Operation: ZESCO in collaboration with Copperbelt University and local communities
Critical habitat – <i>Euphorbia perplexa</i> var. <i>kasamana</i>	Translocation of <i>Euphorbia perplexa</i> var. <i>kasamana</i> specimens	Field observations at work sites and at host sites.	Number of <i>Euphorbia perplexa</i> var. <i>kasamana</i> specimens within project footprint. Number of specimens translocated with ecological conditions of the receiving environment detailed. Survival rate of translocated specimens.	All areas of project footprint within critical habitat visited. All specimens in the project footprint removed. Minimal impact on <i>Euphorbia perplexa</i> var. <i>kasamana</i> habitat and individuals. Documented annual survival rate by translocation method.	Project footprint in <i>Euphorbia perplexa</i> var. <i>kasamana</i> critical habitat. Host sites for <i>Euphorbia perplexa</i> var. <i>kasamana</i> .	Translocation during dry season, before construction in critical habitat rock outcrop. Monthly visits of protected host sites for six months after translocation, then four times a year.	Construction: PIU in collaboration with Copperbelt University, the Forestry Department and the NHCC Operation: ZESCO in collaboration with Copperbelt University, the Forestry Department and the NHCC
	Ex-situ Conservation and Reintroduction of <i>Euphorbia perplexa</i> var. <i>kasamana</i>	Monitoring of specimens in nurseries. Field observations at reintroduction sites.	Established ex-situ population of <i>Euphorbia perplexa</i> var. <i>kasamana</i> in nurseries. Number of individuals reintroduced.	Secure, healthy population persisting in nurseries. Reintroduction of more specimens than were lost from project construction. Net gain is demonstrated one growing season after reintroduction of specimens.	Kasama Forestry Department ex-situ nurseries. Host sites for reintroduction in the Kasama Forest Reserve.	Weekly monitoring in nurseries. Monthly monitoring at host sites for the first two years, then four times a year.	Construction: PIU in collaboration with Copperbelt University, the Forestry Department and the NHCC Operation: ZESCO in collaboration with Copperbelt University, the Forestry Department and the NHCC
	In situ protection of rock outcrops and individual plants	Field observations in rock outcrops targeted for averted loss protection. GIS-based habitat mapping.	Number of <i>Euphorbia perplexa</i> var. <i>kasamana</i> specimens per protected rock outcrop. Area of rock outcrop under protection.	Stable or increasing number of <i>Euphorbia perplexa</i> var. <i>kasamana</i> specimens in each protected rock outcrop. No change or an increase in area of protected rock outcrops.	Rock outcrops targeted for averted loss.	Annual monitoring of protected rock outcrops. Annual mapping of protected rock outcrops.	Construction: PIU in collaboration with Copperbelt University, the Forestry Department and the NHCC Operation: ZESCO in collaboration with Copperbelt University, the Forestry Department and the NHCC

Biodiversity feature	Monitored component	Supervision method	Indicators	Standards / targets	Location	Frequency	Responsibility
Bird habitats and flyways	Bird conservation	Planning of the construction avifauna walk-through surveys. Regular inspections of priority species nesting sites identified.	Bird nest surveys undertaken systematically prior to clearing. Number of active nests of identified species protected (no clearing/construction until nest is abandoned when chicks are mature).	Avoid nest destruction, especially destruction of active nests or those of threatened species.	ROW and substation sites.	Two weeks prior to clearing in any given area within the ROW and for the duration of the construction process. Monthly visits of nesting sites.	Contractors with the support of specialists
	Estimates of bird activity along the ZTIP power line alignment during operation	Dedicated surveys along the power line alignment.	Species richness and abundance. Flight patterns i.e. flight altitude, flight passage relative to the conductors/earthwires and the presence or absence of reactions to the overhead wires i.e. avoidance behaviour. Observable avoidance response.	Species richness and relative abundance should remain within $\pm 20\%$ of pre-construction baseline values (per season), with no sustained downward trend over three consecutive monitoring periods. $\geq 80\%$ of birds approaching the power line exhibit clear avoidance behaviour.	ZTIP power line alignment, particularly those areas where bird activity is likely to be more prevalent i.e. High, Medium-High and Medium Sensitivity zones.	Quarterly for the first two years of operation, thereafter, twice a year during peak periods of activity	ZESCO Avifaunal Specialist Local Monitors/NGO
	Use of power line towers as a roost or nesting substrate during operation	Field observation (in parallel to bird mortality monitoring).	Number & occupancy status of nests and roosts on power line structures, including species identification and signs of breeding activity. Percentage of active nests left undisturbed.	No net loss in active nests and roosts of priority or sensitive species on monitored towers compared to baseline, with $\geq 90\%$ of active nests successfully fledging chicks where feasible.	ZTIP power line alignment.	Quarterly surveys for the first five years. If nests are active, monthly surveys to assess breeding success.	ZESCO Avifaunal Specialist Local Monitors/NGO
	Use of rehabilitated areas by birds	Dedicated bird surveys in rehabilitated and reforested areas.	Species richness and abundance of birds recorded using rehabilitated areas, including frequency of visits and evidence of foraging or nesting behavior.	Gradual increase in bird species richness and abundance within rehabilitated areas, aiming for at least 70–80% of the species composition and activity levels observed in adjacent undisturbed habitats within five years of rehabilitation.	Rehabilitated and reforested areas.	Five years after the rehabilitation, twice a year during peak periods of activity.	ZESCO Avifaunal Specialist Local Monitors/NGO
	Bird mortality as a result of collisions with the power line and electrocution within the substations during operation	Bird mortality monitoring program with dedicated surveys. Photograph of each mortality (indicating injuries and position of the carcass in relation to the power line).	Number and species of bird carcasses detected per survey event/ per section and with identified location. GPS coordinates of the carcass location. Description of the carcass' position relative to the power line servitude (i.e., outer conductor). Distance from each tower/pylon. Description of the tower/pylon type and configuration. Presence, or absence of bird flight diverters. Notes on surrounding topography, vegetation type, and land-use. Species, age, and sex (where possible). Approximate age and composition of remains – e.g. fresh, intact carcass, or old, long bones only.	No significant bird mortality recorded along marked sections demonstrating the effectiveness of pre-energization marking in preventing initial collision events. Fewer than 5 collision mortalities per quarter along sections of power line without BFDs, with adaptive mitigation measures applied if repeated incidents occur for any priority species. Fewer than 5 electrocution mortalities per quarter within substations, with adaptive mitigation measures applied if repeated incidents occur for any priority species.	Along the powerline in areas where bird activities are likely to be more significant i.e. High, Medium-High and Medium Sensitivity zones. Sample sites of unmitigated sections of power line and substation yards.	A minimum of 4 times/year in first 5 years of operation, thereafter ongoing monitoring to be negotiated with ZESCO.	ZESCO Avifaunal Specialist Local communities

Biodiversity feature	Monitored component	Supervision method	Indicators	Standards / targets	Location	Frequency	Responsibility
Bat habitats and flyways	Bat conservation	Planning of the pre-construction inspection for bat roosts. Regular inspections of bat roosts identified.	Bat roosts inspection undertaken systematically prior to clearing. Number of bat roosts identified Number of bat roosts of identified species protected (no clearing/construction until roost is deserted).	Avoid roost destruction, especially destruction of active nests or those of threatened species.	ROW and substation sites.	Two weeks prior to clearing in any given area within the ROW and for the duration of the construction process: Monthly visits of roost sites.	Contractors with the support of specialists
	Bat activity near the powerline during operation	Recording bat activity using mobile and static bat detectors at selected locations along the powerline (acoustic monitoring). Record bat numbers using visual observation at two major roost sites.	Abundance and diversity of bat species Roost occupancy Activity levels Disturbance incidents	Use of project area and rehabilitated areas by bats.	Along the powerline and in rehabilitated areas.	Twice a year in different seasons (combined with bat mortality).	ZESCO
Terrestrial fauna	Fauna protection	Visual inspection of construction sites and access roads. Incidental salvage of wildlife species prior to clearing.	Number of species present Species observed. Number of individuals relocated. Microhabitat features (rocks, logs) retained or relocated.	No direct mortality of fauna during clearing. Microhabitat features retained wherever practical. Trained animal handlers present during clearing.	ROW and substation sites.	Prior to all vegetation clearing during pre-construction and during maintenance.	Contractors EHS Manager
	Biodiversity protection awareness	Review of training records. Assessment of worker knowledge. Code of Conduct compliance monitoring.	Number of workers trained, training content delivered. Worker knowledge assessments. Code of Conduct compliance. Number of sanctions applied.	Biodiversity Protection Awareness Program developed and approved prior to construction. All staff trained before site access. Annual refresher training conducted. Code of Conduct enforced.	All construction sites, workers' camps, operational facilities.	Prior to start of construction.	Contractors EHS Manager
	Wildlife-vehicle collisions	Monitoring of access roads and recording of wildlife mortality incidents. Inspection of warning signage and speed limit compliance.	Number of incidents reported Species killed, cause of death, location, date. Condition and visibility of warning signs. Vehicle speeds and compliance rates.	Wildlife mortality incidents reduced by 50% within one year of operation. Speed limits enforced. Warning signs maintained in good condition.	Access roads through suitable fauna habitats, particularly near wetlands and riparian zones.	Weekly during construction phase. Monthly during operation phase.	Construction phase: Contractors EHS Manager Operation phase: ZESCO Contractors
	Worker safety from wild animals	Incident reporting and review. Monitoring of safety measures.	Number of incidents involving wild animals (e.g., lions, snakes). Safety measures implemented. Presence of DNPW officers, worker injuries. Snake handler interventions.	Zero worker injuries from wild animal encounters. Safety protocols established and implemented. DNPW officers attached during critical periods. Trained snake handlers available and utilized.	All project sites, particularly in remote areas and where dangerous wildlife present.	Continuous during construction and operation phases. All incidents documented and reviewed.	Construction phase: Contractors EHS Manager Operation phase: ZESCO
	Wildlife poaching	Validate the intensity of hunting for meat markets along the ROW with wildlife officers.	Number of poaching records. Species targeted.	Avoid trafficking of bush meat hunted from the line's ROW and access roads. No increase in illegal harvest of mammal species	In areas within a 5 km distance from the ROW.	Annual assessment and report to be compiled.	ZESCO, DNPW

Biodiversity feature	Monitored component	Supervision method	Indicators	Standards / targets	Location	Frequency	Responsibility
	Mammal communities	Indirect survey methods for large mammals, i.e., spoor and scat counting along tracks and roads in the ROW (presence/absence and abundance). Direct survey methods for surrogate or indicator taxa in the ROW.	Presence, abundance, and distribution of large mammal species utilizing habitats in the ROW. Community composition and structure of surrogate taxa in important ecological habitats in the ROW.	Mammal communities continue using the project area. No increase in illegal harvest of mammal species.	Along the powerline in important ecological habitats.	During the wet and dry seasons, biennially.	ZESCO
Aquatic habitat and fauna	Integrity of aquatic habitats	Visual inspection of water quality around the activities performed near watercourses or wetlands.	Work methods within or in proximity to wetlands and aquatic habitats applied. Signs of degradation, including turbidity siltation and apparent signs of pollution. Inspections completed.	Avoid significant degradation of water quality. No signs of erosion or excess of sediment in watercourses. Adequate water crossing installed. Aquatic and riverine environment's integrity preserved. Free passage to fishes preserved.	At construction sites in wetlands or aquatic habitat. Zones where streams and wetlands are crossed.	Daily during construction activities or maintenance activities in aquatic habitat.	Construction phase: Contractors EHS Manager Operation phase: ZESCO
	Aquatic habitat protection	Inspection of water crossings and works in wetland and aquatic habitat.	Functionality of crossing structures. Structural condition, maintenance needs, condition.	No signs of erosion or excess of sediment in watercourses. Adequate water crossing installed. Aquatic and riverine environment's integrity preserved. Free passage to fishes preserved.	At permanent water crossings.	Quarterly inspection of watercourse crossings during construction. Yearly inspections during operation.	Construction phase: Contractors EHS Manager Operation phase: ZESCO

9. Implementation Framework

9.1 Roles and Responsibilities

The proper implementation of the BMP falls under the responsibilities of the PIU but involves the collaboration of multiple actors. A number of mitigation measures required to avoid or reduce impacts on biodiversity for both construction and operation phases are related to design recommendations, specific work procedures, required field work and a detailed list of management measures. Prior and during construction, the biodiversity management strategy will involve an important role from the Supervising Engineer and Contractors. The PIU will ensure that all relevant BMP requirements, including the Natural Habitats Compensation Plan and species-specific measures, are incorporated into bidding documents, works contracts, and Contractor's Environmental and Social Management Plans (C-ESMPs). The Supervising Engineer will verify that these requirements are reflected in Contractors' method statements and implemented on site and will report non-compliances to the PIU with time-bound corrective actions.

The PIU E&S Manager and a PIU dedicated environmental specialist will be responsible for implementation of compensation measures for natural habitat loss and additional conservation actions for critical habitat triggering species for impacts resulting from the critical and natural habitat loss, including:

- Implementation of the Natural Habitats Compensation Plan (NHCP);
- Translocation of critical habitat species during pre-construction phase;
- Ex-situ conservation and translocation/reintroduction research program for critical habitat species;
- Community-based Wetland Habitat Protection Program; and
- Research support on genetics and population viability for critical habitat species.

The implementation of these actions will require collaboration with various institutions and organizations. Prior to the BMP implementation, ZESCO will share with the involved actors, letters of notification to formally inform them about their involvement and responsibilities. The letters of notification should identify specific capacity-building needs and resources that will be provided by the PIU to ensure that partners have the capacity to implement actions and monitor results. This could, for instance, help with issues that were identified during consultations regarding staff turnover and limited capacities. These organizations include:

- District Forestry Departments;
- Community Forest Management Groups;

- National Heritage Conservation Commission (NHCC);
- Copperbelt University; and
- NGOs and other academic institutions could also support some activities, as needed.

During operation, the implementation of biodiversity management strategy and monitoring activities will be under the responsibility of ZESCO. The following sections describe the roles and responsibilities of the main actors involved in the BMP implementation.

9.1.1 Project Implementation Unit

The PIU E&S Manager will be supported by a dedicated environmental specialist from the PIU and additional support from ZESCO with the required field of expertise. Together, they will be in charge of supervising all activities related to biodiversity monitoring and follow-up during construction and operation. This environmental specialist will work in close collaboration with the Supervising Engineer, in charge of managing activities related to biodiversity management and monitoring during construction.

At PIU level, the environmental specialist's responsibilities will include:

- Provide any support in relation to biodiversity;
- Supervise the implementation of the BMP in accordance with the BMP schedule;
- Ensure a proper coordination of all actors;
- Complete any required updates of the BMP, notably the validation of natural and critical habitats loss post-construction;
- Ensure that the Contractors complies with their respective commitments under the BMP;
- Ensure the implementation of the capacities building program for all the actors in accordance to their responsibilities;
- Supervise all activities related to biodiversity monitoring and follow-up during construction;
- Make sure that all environmental incidents/claims are properly reported (as per the contractual obligations) and addressed by the Contractors;
- Ensure that all biodiversity activities are properly implemented;
- Monitor and report on the biodiversity activities;
- Ensure adapted management and modifications in the BMP based on the monitoring results;
- Assist in the preparation of various reports and publications on biodiversity;
- Look out for environmental non-conformity and assist in corrective actions.

The implementation of some mitigation measures under the PIU's responsibility may also require external experts for support, such as orchid and *Euphorbia* specialists for conservation actions for critical habitat triggering species (Section 7).

In addition to the above tasks, the PIU will assume the ultimate responsibilities over the planning, implementation and monitoring of the NHCP as well as conservation actions for critical habitat triggering species. The PIU will be in charge of demonstrating that no net loss for natural habitats and net gain for critical habitat are achieved. The environmental specialist from the PIU will notably be in charge of the following tasks:

- Implement actions to contribute towards scientific knowledge, conservation and management of *Disa aequiloba* and *Euphorbia perplexa* var. *kasamana*.
- Conduct the feasibility study associated with the NHCP and liaise with appropriate actors to receive their inputs.
- Ensure the supply of seedlings that cannot be propagated within the project area.
- Support the development of detailed Forest-Specific Compensation Plans.
- Collaborate with DACO for the identification and valuation of affected crops and payment of compensation to affected persons.
- Ensure District Forestry Departments and CFMGs have the necessary capacity for implementing and monitoring compensation and supporting actions in selected compensation sites.

9.1.2 Supervising Engineer

The Supervising Engineer's role is to represent the PIU in monitoring project implementation. As such, the Supervising Engineer will monitor implementation of the project's technical, environmental, and social aspects, including biodiversity management, during the pre-construction and construction phases. Generally, the role would include verification and approval of technical execution studies and drawings, as well as supervision and monitoring of the project construction works and all environmental, social, security, health and safety topics.

The Supervising Engineer will appoint qualified Environmental specialists with expertise in biodiversity who will be responsible for the following main tasks:

- Prior to initiation of construction:
 - Verification and approval of Lead Contractors' candidates as EHS Manager and supporting biodiversity specialists, including botanist(s), avifauna specialist (s) and bat specialist(s).
 - Review and approval of the detailed Contractors' ESMP (C-ESMP) during the project construction phase to ensure biodiversity risks are assessed and all measures in this BMP are integrated in the Contractors' C-ESMP.

- Review and approval of the Contractors' various specific management plans and work procedures in line with Contractors' scope of works.
- Ensure design recommendations are integrated in the project design.
- Ensure pre-construction inspections and surveys (threatened or protected flora, critical habitat triggering species, avifauna and bats) are completed.
- Liaise with and supervise the activities of all biodiversity external experts who could be used by the Contractors.
- Review and approval of training provided to the Contractors' and subcontractors' staff.
- During construction:
 - Ensure Contractors updates C-ESMP to reflect changes to construction management plans, methodologies, measures or schedules in relation to biodiversity management. Monitor implementation of the C-ESMP and specific management plans by the Contractors and subcontractors, using audit tools.
 - Review and approve E&S reports delivered by the Contractors, including monitoring of biodiversity indicators.
 - Manage project's potential environmental and social impacts with the Contractors' involvement when required.
 - Produce biweekly E&S monitoring reports for the PIU, including:
 - Review and approve the Contractors' E&S performance management reports.
 - Integrate results from audits to ensure the Contractors' implementation of approved ESMPs.
 - Manage unanticipated E&S impacts (not identified in the ESMP) with applied management measures.
 - Liaise with and supervise the activities of all biodiversity external experts who could be used by the Contractors.
 - Manage Contractors performance.
 - Review and approve root cause analysis reports and approve adopted management measures.

The Supervising Engineer's assignment will end at the end of the project's construction phases.

9.1.3 Contractors

Several Contractors will be selected, three for the line (working in different sections), one for the Nakonde substation and one for the Dynamic Voltage Support Device (DVSD). In addition, land preparation (e.g., clearing of trees, leveling, etc.) may require additional Contractors.

The tender documents will require each Contractors to appoint an Environment, Health and Safety (EHS) Manager. Also, Contractors will be required to appoint an Environmental and Social (E&S) Specialist who will be in charge of all biodiversity aspects and will report to the EHS Manager. Contractors shall prepare, implement, and periodically update C-ESMP sub-plans (including invasive species management, wetland works procedures, rock outcrop work methods, and fauna/flora protection plans) consistent with this BMP and subject to review and approval by the PIU and Supervising Engineer prior to commencement of related works.

After approval of their qualifications, the Contractors' E&S Specialists will be responsible for daily implementation and management of all relevant measures provided in the BMP and will be responsible for integrating and adapting these in their C-ESMP. The E&S Specialists will ensure the implementation of the following tasks:

- Develop C-ESMP and include all biodiversity management measures set in the BMP that fall under the Contractors' responsibilities.
- Ensure implementation of all measures set regarding biodiversity.
- Monitor the activities related to biodiversity under the Contractors' responsibilities and report on all indicators.
- Prepare relevant data base and reporting integrating monitoring results.
- Evaluate the effectiveness of the actions.
- Conduct site inspections and document verifications.
- Participate in the dynamic improvement of the Contractors performance.
- Assist the Supervising Engineer and the PIU in any other duties required by the PIU E&S Manager.
- Report to the Supervising Engineer and the PIU.

The Contractors will be supported by experts with the following qualifications to implement BMP measures that require field work and specific expertise:

- **Botanist:** this expert must be familiar with the flora of northern Zambia, associated species of conservation concern, and have field experience in Zambia. He or she should have an advanced degree and at least five years' experience in conducting field surveys for flora species of conservation concern. Prior to construction works, the Contractors' botanist will be involved in site walk-through surveys to ensure that foundations are positioned outside the most sensitive wetlands microhabitats and to avoid direct encroachment into wetland core areas where feasible. Contractor's botanist from Design Package 3 will undertake *Euphorbia perplexa* var. *kasamana* to validate specimens locations within the ROW and in proximity to work areas to validate the location of the temporary areas and implementation strict delineation of No-Go Zones. The Contractor's botanist will supervise ROW clearing throughout the pre-construction phase and will be involved in the identification and counting of affected species, the confirmation of habitat loss areas and the relocation of specimens of species of conservation concern.
- **Avifauna Specialist:** this expert must have an advanced degree and at least five years of experience in conducting rapid bird surveys and should be familiar with the avifauna of eastern and southern Africa, including regional and global migratory species, and with bird migration patterns in the region. Familiarity with the avifauna of northern Zambia or southern Tanzania is a plus. The Contractor's avifauna specialist will be involved during the pre-construction phase for avifaunal walk-through surveys and then punctually throughout construction to monitor eventual breeding sites and ensure impacts on birds are adequately managed.
- **Bat Specialist.** This expert must be familiar with the bat species found in northern Zambia, their habitats, flight patterns, and migrations. These experts must have advanced degrees and at least five years of experience in rapid field surveys and risk assessment. The Contractor's bat specialist will be involved during the pre-construction inspection of the final route alignment and access roads to identify major bat roosts and then punctually throughout the construction phase to monitor eventual roosting sites and ensure impacts on bats are adequately managed.

It is recommended that these experts be sought by contacting local NGOs (such as Birdlife Zambia) and local academic institutions.

9.1.4 Implementation Partners for the Natural Habitats Compensation Plan

The planning, implementation and monitoring of the NHCP will involve multiple supporting partners. Implementation will be supported by different actors whether sites are located within Forest Reserves or Community Forests as the managing authority for these managed forests are the Forestry Department and CFMGs respectively. Table 9-1 provides an overview of supporting actors' responsibilities.

Table 9-1 Overview of Responsibilities

Stakeholder	Specific actors	Responsibilities
Forestry Department	National Office	<ul style="list-style-type: none"> Provide necessary resources to District Offices, including by ensuring that statutory fees paid for encroachment in Forest Reserves are transferred to District Offices for financing of relevant mitigation and supporting actions.
	Affected District Offices	<ul style="list-style-type: none"> Support the assessment and selection of candidate sites in Forest Reserves. Assess the ecological feasibility of all candidate sites. Develop Forest-Specific Compensation Plans in Forest Reserves and Community Forests where compensation sites were selected. Implement Forest-Specific Compensation Plans in Forest Reserves under their authority. Establish nurseries dedicated to producing the necessary seedlings. Monitor compensation activities in Forest Reserves and Community Forests under their authority.
Community Forest Management Groups (CFMGs)	CFMGs in relevant Community Forests	<ul style="list-style-type: none"> Support the assessment and selection of candidate sites in Community Forests. Support the Forestry Department for the development of Forest-Specific Compensation Plans. Implement Forest-Specific Compensation Plans in Community Forests under their authority. Establish nurseries dedicated to producing the necessary seedlings. Monitor compensation activities in Community Forests under their authority in close collaboration with District Forestry Department.
Copperbelt University	Botanists	<ul style="list-style-type: none"> Support the feasibility assessment regarding species to be used for compensation actions. Provide training to the Forestry Department and CFMGs for the propagation of seeds, production of seedlings and reforestation.
Department of Agriculture	District Agricultural Coordinator (DACO)	<ul style="list-style-type: none"> Identify and value affected crops within compensation sites.
Traditional authorities and local communities	Headmen and chiefs in villages neighboring compensation sites	<ul style="list-style-type: none"> Support the feasibility assessment and selection of candidate sites in Community Forests. Participate in the assessment of social and cultural feasibility for all compensation sites. Facilitate entry in villages around compensation sites for sensitization and information activities. Contribute to the implementation of identified reforestation and supporting actions.
NGOs	Supporting partners in relevant Community Forests	<ul style="list-style-type: none"> Support the feasibility assessment and selection of candidate sites in Community Forests. Contribute to compensation actions in Community Forests for which they are supporting partners.

Letters of notification should be sent to partners, especially District Forestry Departments and CFMGs, to clearly define their involvement and responsibilities. The letter of notification should identify specific capacity-building needs and resources that will be provided by the PIU to ensure that partners have the capacity to implement compensation actions and monitor results.

9.1.5 ZESCO

The PIU will be dismantled once the construction phase is finalized. The PIU responsibilities will then be passed on to ZESCO. As Project Owner and Operator, ZESCO will consequently be the only proponent directly responsible for the BMP implementation during the project's operation phase.

ZESCO will therefore be responsible for developing and implementing all required mitigation and monitoring measures provided in the BMP for the Operational Phase. ZESCO's E&S Manager can be supported by an environmental specialist and various experts to complete activities needing specific expertise. It will be important to be supported by experts with the following qualifications to implement BMP measures that require field surveys and specific expertise:

- **Botanist:** this expert must be familiar with the flora of northern Zambia and have field experience in Zambia. He or she should have an advanced degree and at least five years' experience in conducting field surveys for flora species of conservation concern.
- **Avifauna Specialist:** this expert must have an advanced degree and at least five years of experience in conducting rapid bird surveys and should be familiar with the avifauna of eastern and southern Africa, including regional and global migratory species, and with bird migration patterns in the region. Familiarity with the avifauna of northern Zambia or southern Tanzania is a plus. This expert will need to be able to assess collision and electrocution risks posed by powerlines.
- **Bat Specialist.** This expert must be familiar with the bat species found in northern Zambia, their habitats, flight patterns, and migrations. These experts must have advanced degrees and at least five years of experience in rapid field surveys and risk assessment.

9.2 Capacity Building

Effective implementation of the BMP relies on a collaborative approach involving shared responsibilities among a variety of actors. These actors need to have a clear understanding of the project commitments and requirements in terms of biodiversity conservation and should also be aware of their own roles and responsibilities in this regard. Successful implementation of the BMP will be in large part dependent on the capacities of the actors in charge of its implementation. A dedicated Capacity Building Program is then proposed for the BMP implementation. It targets the main actors identified in Section 9.1.

Capacity building will prioritize: (i) implementation and enforcement of the Natural Habitats Compensation Plan; (ii) monitoring and management of critical habitats and associated species; and (iii) data management and reporting to demonstrate compliance with ESS 6 and achievement of NNL/NG outcomes.

Specific trainings are proposed to support the implementation of the NHCP. It covers requested skills which will need to be mastered by involved actors to implement identified actions and to monitor the NHCP success. The program also addresses critical challenges which need to be addressed notably to support enabling conditions for a successful implementation of the activities associated with the NHCP and to ensure long-term results and benefits for biodiversity (see Section 6.5). The program also integrated solutions for some of the current challenges identified within the targeted managed forests.

Table 9-2 Capacity-Building Program

Recipient	Theme	Training method	Topics	Material capacities	Entity in charge of providing training	Timeline	Estimated cost (USD)
PIU	Monitoring	Three-day workshop with practical training	<ul style="list-style-type: none"> ■ Using GIS tools for planning and monitoring ■ Remote sensing ■ Data collection and monitoring using drones 	Drone	External GIS expert hired by the PIU	Prior to pre-construction	20,000
Contractors, Supervising Engineer, ZEMA	BMP implementation during construction	One day workshop	<ul style="list-style-type: none"> ■ Anticipated impacts on biodiversity ■ Impact avoidance and mitigation strategy ■ Conservation Actions for Critical Habitat triggering species ■ Natural Habitats Compensation Plan ■ Monitoring ■ Roles and Responsibility ■ Implementation Schedule 	Not applicable (NA)	PIU	Prior to pre-construction	Included in PIU operational costs
All Contractors' staff	Biodiversity protection awareness	As part of induction training	<ul style="list-style-type: none"> ■ Presence of endangered and sensitive species ■ Critical habitats and identification of triggering species ■ Minimization of affected habitats areas ■ Appropriate behaviour near wildlife ■ Prohibition of harvesting, destruction, or degradation of vegetation ■ Prohibition of hunting or poaching ■ Vehicle speed and collision risks with fauna ■ Consequences of disturbance during breeding periods 	NA	Biodiversity Specialist hired by the Contractor	During induction training	Included in Contractors' Costs

Recipient	Theme	Training method	Topics	Material capacities	Entity in charge of providing training	Timeline	Estimated cost (USD)
DNPW attached officer, Contractors E&S Specialist, ZESCO Environmental Specialists	Animal handling	One day workshop and one day field exercise	<ul style="list-style-type: none"> ■ Safe animal handling techniques ■ Incidental salvage of wildlife species ■ Species-specific behavior and emergency response 	<ul style="list-style-type: none"> ■ Snake hook ■ Control pole ■ Animal nets ■ Snake bag and transport crates ■ Protective clothing 	Expert hired by the PIU	Prior to pre-construction	16,100
Local NGO representatives, PIU, ZESCO Environmental Specialists, local communities involved in mortalities monitoring	Bird and bat power line interactions	One day workshop and one day field exercise	<ul style="list-style-type: none"> ■ Bird and bat collision risks ■ Bird electrocution risks ■ Avian induced faulting ■ Collision mortality data collection and registry 	<ul style="list-style-type: none"> ■ Range Finder ■ Birds of Zambia Handbook 	Avifauna and bat expert hired by the PIU	During the construction phase	20,000
ZESCO operation and line maintenance staff, ZEMA	BMP implementation during operation	One day workshop	<ul style="list-style-type: none"> ■ Anticipated impacts on Biodiversity ■ Impact avoidance and mitigation strategy ■ Conservation Actions for Critical Habitat triggering species ■ Monitoring ■ Roles and Responsibility ■ Implementation Schedule 	NA	PIU expert or expert hired by the PIU	During the construction phase	4,000

Recipient	Theme	Training method	Topics	Material capacities	Entity in charge of providing training	Timeline	Estimated cost (USD)
Communities targeted for community-based wetland habitat protection	Community-based wetland habitat protection	Community meetings	<ul style="list-style-type: none"> ■ Community-based conservation program objectives ■ Beneficial practices identified during previous orchid surveys, such as prescribed early burning, sustainable harvesting techniques, and burial of roots after tuber collection ■ Local resource use regulations 	NA	PIU expert or expert hired by the PIU	Biannual for the first two years, starting during pre-construction	27,000
District Forestry Officers, CFMGs	Seed collection, seed conservation and nurseries guidance	<ul style="list-style-type: none"> ■ Development of a field guide ■ One day training session ■ Nurseries visits 	<ul style="list-style-type: none"> ■ Species identification, seed collection, soil collection, seed conservation and seedling production for each species ■ Nurseries techniques including watering and input schedules 	NA	Botanist hired by the PIU	During the NHCP implementation phase	15,000
District Forestry Officers, CFMGs	Compensation activities	<p>Training sessions supported by Forest-Specific Compensation Plans</p> <p>Field training</p>	<p>Field practices for each planned compensation and supporting actions:</p> <ul style="list-style-type: none"> ■ ANR (identification and protection of natural seedlings, management of competing vegetation, soil protection and improvement, etc.) ■ Reforestation (site preparation, planting methods and schemes, seedlings maintenance, etc.) ■ Agroforestry (techniques, plantation schemes, associated benefits) 	NA	PIU expert or expert hired by the PIU	Prior to NHCP implementation phase	15,000

Recipient	Theme	Training method	Topics	Material capacities	Entity in charge of providing training	Timeline	Estimated cost (USD)
District Forestry Officers, CFMGs	Safe forestry practices	Practical exercises	<ul style="list-style-type: none"> Correct use of personal protective equipment (PPE) Safe handling of tools (machetes, hoes, shovels) Basic first aid for most common injuries associated with forestry operations 	PPEs and field equipment will be provided. <i>Further engagement will be conducted to specify the needs.</i>	PIU expert or expert hired by the PIU	Prior to the NHCP implementation phase	20,000
District Forestry Officers, CFMGs	Enforcement of forest protection	Practical exercises	<ul style="list-style-type: none"> Forest law enforcement and patrol techniques Community advocacy and rights awareness 	Uniforms to increase forest officers' legitimacy in enforcing forest protection.	PIU expert or expert hired by the PIU	During NHCP implementation phase	
District Forestry Officers, CFMGs	Monitoring of the reforestation success	Field training	<ul style="list-style-type: none"> Efficient patrol scheduling and route planning Community-led monitoring protocols 	Transportation (bicycles or motorcycles).	PIU expert or expert hired by the PIU	During NHCP implementation phase	
District Forestry Officers, CFMGs	Alternatives to Slash-and-Burn Practices – manual plotting Fire management	Demonstration-based training on firebreak creation and early burning techniques. Seasonal refresher courses before fire season.	<ul style="list-style-type: none"> Fire prevention strategies Fire management strategies and safe burning practices Implementation and maintenance of firebreaks Climate-smart agriculture alternatives to slash-and-burn Emergency fire response and community fire brigades 	NA	PIU expert or expert hired by the PIU	During NHCP implementation phase	18,000
CFMGs	Opportunities associated with conservation activities	Workshops and case studies.	<ul style="list-style-type: none"> Budget planning for conservation projects Accessing grants and carbon credit opportunities Community cooperatives 	NA	PIU expert or expert hired by the PIU	During NHCP implementation phase	5,000

Recipient	Theme	Training method	Topics	Material capacities	Entity in charge of providing training	Timeline	Estimated cost (USD)
Local communities	Alternative livelihood Fire prevention Forest conservation	Communities sessions	<ul style="list-style-type: none"> ■ Forest based livelihood (bees, mushrooms, plants, etc.) ■ Fire prevention and alternative techniques for land preparation ■ Agroforestry (techniques, plantation schemes, associated benefits) ■ Importance of forest conservation and ecosystem services 	NA	PIU expert in collaboration with Forestry Department	During NHCP implementation phase	15,000
Provincial & District Forestry Officers; CFMGs	Forest patrol	On-site workshops and peer-to-peer mentoring for forest officers and community patrollers. Use role-based practical sessions for enforcement and monitoring.	<ul style="list-style-type: none"> ■ Monitoring and reporting systems (including use of GPS and mobile apps) ■ Leadership and conflict resolution for Community Forest committees ■ Emergency response coordination 	NA	PIU expert or expert hired by the PIU	During NHCP implementation phase	6,500

9.3 Grievance Redress Mechanism

A cross-cutting Grievance Redress Mechanism (GRM) covering both project preparation and construction phases and all components of the ESMP was developed by ZESCO in April 2024 as part of the Project Stakeholder Engagement Plan. Grievances related to the implementation of the BMP will be addressed through that GRM. The GRM has already been rolled out in the project area.

Local Focal Point (LFP) persons are a central feature of the GRM and are in charge of liaising with the PIU and other stakeholders to address grievances. Pairs (one male and one female) of LFP persons were appointed in affected communities along the ZTIP, each covering a 5-km radius to be easily accessible to local stakeholders without needing to travel long distances to convey grievances. Training and capacity building were provided as well as resources to ensure proper functioning of the GRM (including communication methods, etc.).

This GRM, including the LFP persons, will be extended as part of the NHCP. Communities located near compensation sites will have elected LFP persons to receive grievances and liaise with the PIU regarding grievance resolution. A budget item is provided in the NHCP budget to cover LFP persons' expenses.

9.4 Implementation Schedule

As for the overall project implementation schedule, activities are divided into five separate packages. Each package is planned to require 24 months, starting from the start-up meeting of the construction contract to commissioning. Package 1 is for the Pensulo-Mpika Section, Package 2 is for the Mpika-Kasama Section, Package 3 is for the Kasama-Nakonde Section, Package 4 is for the new Nakonde Substation and Package 5 is for the DVSDs at Pensulo and Nakonde Substations. For each of these packages, the first months will be dedicated to preparation activities such as detailed survey, preparation of construction schedule, detailed design, etc. Field construction activities are planned to begin 6 months after contract effectiveness and therefore will last 18 months. It is assumed that packages 1 and 2 will run concurrently, same for packages 3, 4 and 5, three months later. Activities' timing that are specific to packages 1 and 2 or packages 3, 4 and 5 are shown in red and grey respectively in Table 9-3.

An implementation schedule is proposed for the key biodiversity management activities to be implemented during pre-construction and construction phases, as well as during the operation phase (Table 9-3), considering the planned timing of construction and other project activities. Other biodiversity management measures to be implemented during construction and operation phases must be carried out continuously during the respective phases and are thus not included herein. Monitoring measures are presented for the first two years of operations but must continue being implemented throughout the project lifetime or as indicated in the monitoring program in Chapter 8.

The detailed schedule for the Natural Habitats Compensation Plan is provided in Appendix 9-1 and the timeline for its three phases is shown in the overall implementation schedule below.

Activities	Months before construction starts							Start of construction – Year 1												Construction – Year 2 (9 months)									Operation																						
	-7	-6	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	10	11	12											
Construction phase (18 month per work package, total of 21 months)																																																			
Construction works Packages 1 and 2							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																											
Construction works Packages 3, 4 and 5										X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X																									
C-ESMP implementation							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X										
Implementation of specific management plans and work procedures for the construction phase							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X										
Implementation of biodiversity monitoring program during construction							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
BMP update with real loss calculation																										X																									
Natural Habitats Compensation Plan – Implementation Phase							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
Natural Habitats Compensation Plan – Monitoring Phase																										X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
Installation of bird flight diverters (during stringing and sagging)													X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
Community-based habitat protection (<i>Disa aequiloba</i> wetlands)							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
Ex-situ conservation of <i>Disa aequiloba</i> samples							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
Contribution to research – <i>Disa aequiloba</i>					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
Ex-situ conservation of <i>Euphorbia perplexa</i> var. <i>kasamana</i> samples							X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
Contribution to research – <i>Euphorbia perplexa</i> var. <i>kasamana</i>					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X									
Operation and maintenance phase under ZESCO																																																			
Implementation of BMP measures																																							X	X	X	X	X	X	X	X	X	X	X	X	
Implementation of specific management plans and work procedures																																								X	X	X	X	X	X	X	X	X	X	X	X
Implementation biodiversity monitoring program during operation																																								X	X	X	X	X	X	X	X	X	X	X	X
Natural Habitats Compensation Plan – Monitoring Phase																																								X	X	X	X	X	X	X	X	X	X	X	X
Community-based habitat protection (<i>Disa aequiloba</i> wetlands)																																								X	X	X	X	X	X	X	X	X	X	X	X
Contribution to research – <i>Disa aequiloba</i>																																								X	X	X	X	X	X	X	X	X	X	X	X
Contribution to research – <i>Euphorbia perplexa</i> var. <i>kasamana</i>																																								X	X	X	X	X	X	X	X	X	X	X	X

9.5 Cost Estimate

The implementation of the BMP with the proposed biodiversity management strategy and associated monitoring will involve multiple actions resulting in costs. Some of these costs associated with the implementation of mitigation measures particularly under the Contractors' responsibility cannot be specified at that stage. Those costs will be integrated with other construction costs within the Contractors' budget. It should be mentioned that it is imperative for the BMP recommendations to be integrated within the construction tender documents to be published and integrated during contracts negotiations to ensure that those measures become the responsibility of the Project Contractor(s) and included in their costs.

Since the implementation of certain measures will be under ZESCO's and PIU's responsibility, part of the operational budget to be applied to the application of measures is not yet known. Table 9-4 provides a summary of the main costs for the implementation of biodiversity management strategy proposed in this BMP.

The estimated detailed budget for the Natural Habitats Compensation Plan is included in the overall cost estimate below based on estimated costs for its three phases. It should be noted that the budget for the NHCP is an estimate that will be revised after completion of the feasibility assessment and final site selection.

Table 9-4 BMP Budget Estimate

Activity	Cost estimate (USD)	
	Lump sum	Yearly
Pre-construction phase		
Implementation of Training/Capacity Building program	181,600.00	-
Natural Habitats Compensation Plan Feasibility	86,442.39	-
Final Natural Habitats Compensation Plan and Planning	79,442.39	-
Identification of host wetlands for <i>Disa aequiloba</i> , targeted for community-based protection	7,715.69	-
<i>Disa aequiloba</i> surveys in project footprint + translocation (Wet season - October to December)	76,704.49	-
<i>Euphorbia perplexa</i> var. <i>kasamana</i> surveys + translocation (Dry season - July and August)	32,668.46	-
ROW and no-go zones marking	Included in Contractors costs	
Pre-construction inspection for nesting birds	Included in Contractors costs	
Pre-construction inspection for bat roosts	Included in Contractors costs	
Supervision of clearing by a botanist	Included in Contractors costs	
Implementation of biodiversity monitoring measures during pre-construction	Included in Contractors costs	
Subtotal for pre-construction phase	464,573.42	-
Construction phase (18 months per work package, total 21 month)		
C-ESMP implementation	Included in Contractors costs	
Implementation of specific management plans and work procedures for the construction phase	Included in Contractors costs	
Implementation of biodiversity monitoring measures during construction	Included in Contractors costs	
BMP update with real loss calculation	Included in the PIU operational costs	
Natural Habitats Compensation Plan Implementation and Monitoring	1,568,798.25	-
Installation of Bird Flight Diverters (during stringing and Sagging)	Included in Contractors costs	
Community based Habitat Protection (<i>Disa aequiloba</i> wetlands)	29,011.00	-
Ex-situ conservation of <i>Disa aequiloba</i> samples	76,642.54	-
Ex-situ conservation of <i>Euphorbia perplexa</i> var. <i>kasamana</i> samples	9,251.11	-
Monitoring expenses (PIU)	Included in the PIU operational costs	
Subtotal for construction phase	1,683,702.91	-

Activity	Cost estimate (USD)	
	Lump sum	Yearly
Operation and maintenance phase		
Implementation of BMP measures	Included in ZESCO's operational budget	
Implementation of specific management plans and work procedures	Included in ZESCO's operational budget	
Implementation of biodiversity monitoring program	-	18,200.00
Plant communities (annually for first 5 years, then once every 2 years)	-	14,000.00
Invasive alien flora species (annually for first 5 years, then once every 2 years)	5,000.00	14,000.00
Bird diversity and abundance, bird activity along powerline, use of pylons (quarterly first two years, then twice a year)	-	39,200.00
Use of rehabilitated areas by birds	-	14,000.00
Bird and bat mortality as a result of collisions with the powerline and electrocution within substations	-	72,800.00
Wildlife poaching	-	4,000.00
Mammal communities	-	14,000.00
<i>Euphorbia perplexa</i> var. <i>kasamana</i> monitoring	-	8,230.07
<i>Disa aequiloba</i> monitoring + community-based habitat protection	-	15,842.89
Natural Habitats Compensation Plan monitoring	-	27,776.49
Subtotal for operation and maintenance phase	5,000.00	242,049.45
Total BMP budget	2,153,276.33	242,049.45

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