VOLTALIA 40MW SOLAR PV DWANGWA, MALAWI

ECOLOGICAL IMPACT ASSESSMENT REPORT

CES

ENVIRONMENTAL AND SOCIAL ADVISORY SERVICES

PROPOSED 40MW SOLAR PV FACILITY NEAR DWANGA, MALAWI

ECOLOGICAL IMPACT ASSESSMENT REPORT

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SPECIALIST TEAM

Ms Tarryn Martin, Principal Environmental Consultant and Botanical Specialist *(400018/14)*

Tarryn holds a BSc (Botany and Zoology), a BSc (Hons) in African Vertebrate Biodiversity and an MSc with distinction in Botany from Rhodes University. Tarryn's Master's thesis examined the impact of fire on the recovery of C_3 and C_4 Panicoid and non-Panicoid grasses within the context of climate change for which she won the Junior Captain Scott-Medal (Plant Science) for producing the top MSc of 2010 from the South African Academy of Science and Art as well as an Award for Outstanding Academic Achievement in Range and Forage Science from the Grassland Society of Southern Africa. She conducts vegetation assessments including vegetation and sensitivity mapping to guide developments and thereby minimise their impacts on sensitive vegetation. Tarryn has undertaken several vegetation and impact assessments in Mozambique (to IFC standards) which include the Lurio Forestry Project in Nampula, the Syrah Graphite Mine in Cabo Delgado and the Baobab Iron Ore Mine in Tete, Mozambique. She has undertaken critical habitat assessments, to IFC standards, for a solar farm in Cameroon and a graphite mine in Mozambique. She has co-designed and implemented the Terrestrial Monitoring Program for the Kenmare Namalope heavy minerals mine in Mozambique and has recently developed a Biodiversity Management Plan and monitoring plan for the Kenmare Pilivilli deposit. She has also worked on the Lesotho Highlands Development Authority botanical baseline survey for Phase 2 of the Lesotho Highlands Water Project.

Dr A.M (Ted) Avis Internal Reviewer

Ted Avis is a leading expert in the field of Environmental Impact Assessments and environmental management, having project-managed numerous large-scale ESIAs and ESMPs to International Finance Corporation Performance Standards. Ted has been EIA study leader on numerous large scale ESIA's and ESHIA's for projects with capital investments ranging from US$200m to over US$1billion. He has been study leader for ESIA and related environmental studies completed to international in, Egypt, Kenya, Liberia, Mozambique, Madagascar, Malawi Sierra Leone, South Africa and Zambia. Ted also has experience in large scale Strategic Environmental Assessments in southern Africa and has been engaged by the International Finance Corporation (IFC) on a number of projects.

Most of the ESIA work Ted has been involved in has included the preparation of various Environmental & Social Management Plans, Resettlement Action Plans and Monitoring Plans. These ESIA's cover a range of sectors including infrastructure, mining (heavy minerals, graphite, tin, copper, iron), agri-industrial, forestry, resorts and housing development, energy, ports and coastal developments.

Ted holds a PhD in Botany, and was awarded a bronze medal by the South African Association of Botanists for the best PhD adjudicated in that year, entitled "Coastal Dune Ecology and Management in the Eastern Cape"). He has delivered papers and published in the field of EIA, Strategic Environmental Assessment and Integrated Coastal Zone Management and has been a principal of CES since its inception in 1990 and Managing Director since 1998.

Ted was instrumental in establishing the Environmental Science Department at Rhodes University whilst a Senior lecturer in Botany, based on his experience running honours

modules in EIA practice and environmental management. He was one of the first certified Environmental Assessment Practitioner in South Africa, gaining certification in April 2004. He has been a professional member of the South African Council for Natural Scientific Professionals since 1993.

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ACRONYM LIST

AOO	Area of Occupancy
CBA	Critical Biodiversity Area
CES	Coastal and Environmental Services
CR	Critically Endangered
ECO	Environmental Control Officer
EDGE	Evolutionarily Distinct and Globally Endangered
EN	Endangered
ESIA	Environmental and Social Impact Assessment
EOO	Extent of Occupancy
GBIF	Global Biodiversity Information Facility
GIS	Geographical Information System
IUCN	International Union for Conservation of Nature
LC	Least Concern
NBSAP	National Biodiversity and Strategy Action Plan
NGO	Non-Government Organisation
SCC	Species of Conservation Concern
SCC	Species of Conservation Concern

DEFINITIONS

Alien Invasive Species refers to an exotic species that can spread rapidly and displace native species causing damage to the environment.

Biodiversity is the term that is used to describe the variety of life on Earth and is defined as "*the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems*" (Secretariat of the Convention on Biological Diversity, 2005).

Habitat Fragmentation occurs when large expanses of habitat are transformed into smaller patches of discontinuous habitat units isolated from each other by transformed habitats such as farmland.

Key Biodiversity Area are globally recognised sites that contain significant concentrations of biodiversity.

Natural Habitat refers to habitats 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 function and species composition.

Protected Area is a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values**.** *(IUCN Definition 2008).*

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1 INTRODUCTION AND PROJECT DESCRIPTION

1.1 PROJECT DESCRIPTION AND LOCALITY

Voltalia, a global renewable energy producer and service provider, intend to construct a solar photovoltaic (PV) power plant near Dwangwa town in Central Malawi (Figure 1-1). The electricity produced by the solar PV power plant will be sold to the national grid.

The Dwangwa Solar PV power plant will comprise of photovoltaic solar panels that cover an area of approximately 60ha.It is estimated that the total height of the panels, including the structure, will be 4.7m when tilted. Additional infrastructure on site will include a security guardhouse, an operations and maintenance building, internal gravel roads, a single circuit 132kV powerline and a substation.

Two infrastructure alternatives were assessed for this project (Figure 1-2 and Figure 1-3).

1.2 OBJECTIVES AND TERMS OF REFERENCE

The objectives for the botanical assessment are as follows:

- Describe and map the vegetation types in the study area.
- Describe the biodiversity and ecological state of each vegetation unit.
- Establish and map sensitive vegetation areas showing the suitability for development and no-go areas.
- Identify plant species of conservation concern (IUCN and National Red Data List).
- Identify alien plant species, assess the invasive potential and recommend management procedures.
- Identify and assess the impacts of development on the site's natural vegetation in terms of habitat loss, fragmentation and degradation of key ecosystems and, where feasible, provide mitigation measures to reduce these impacts.

1.3 LIMITATIONS AND ASSUMPTIONS

This report is based on current available information and, as a result, the following limitations and assumptions are implicit:

- The report is based on a project description received from the client.
- Species of Conservation Concern (SCC) are difficult to find and difficult to identify, thus species described in this report do not comprise an exhaustive list. It is almost certain that additional SCCs will be found during construction and operation of the development.
- Sampling could only be carried out at one stage in the annual or seasonal cycle. The survey was conducted during the late wet season when most plants were at the end of the flowering stage. Early flowering species, specifically geophytes could therefore not be identified. However, the time available in the field, and information gathered during the survey was sufficient to provide enough information to determine the status of the affected area.

Figure 1-1: Locality map showing the location of the site in relation to the town of Dwanga.

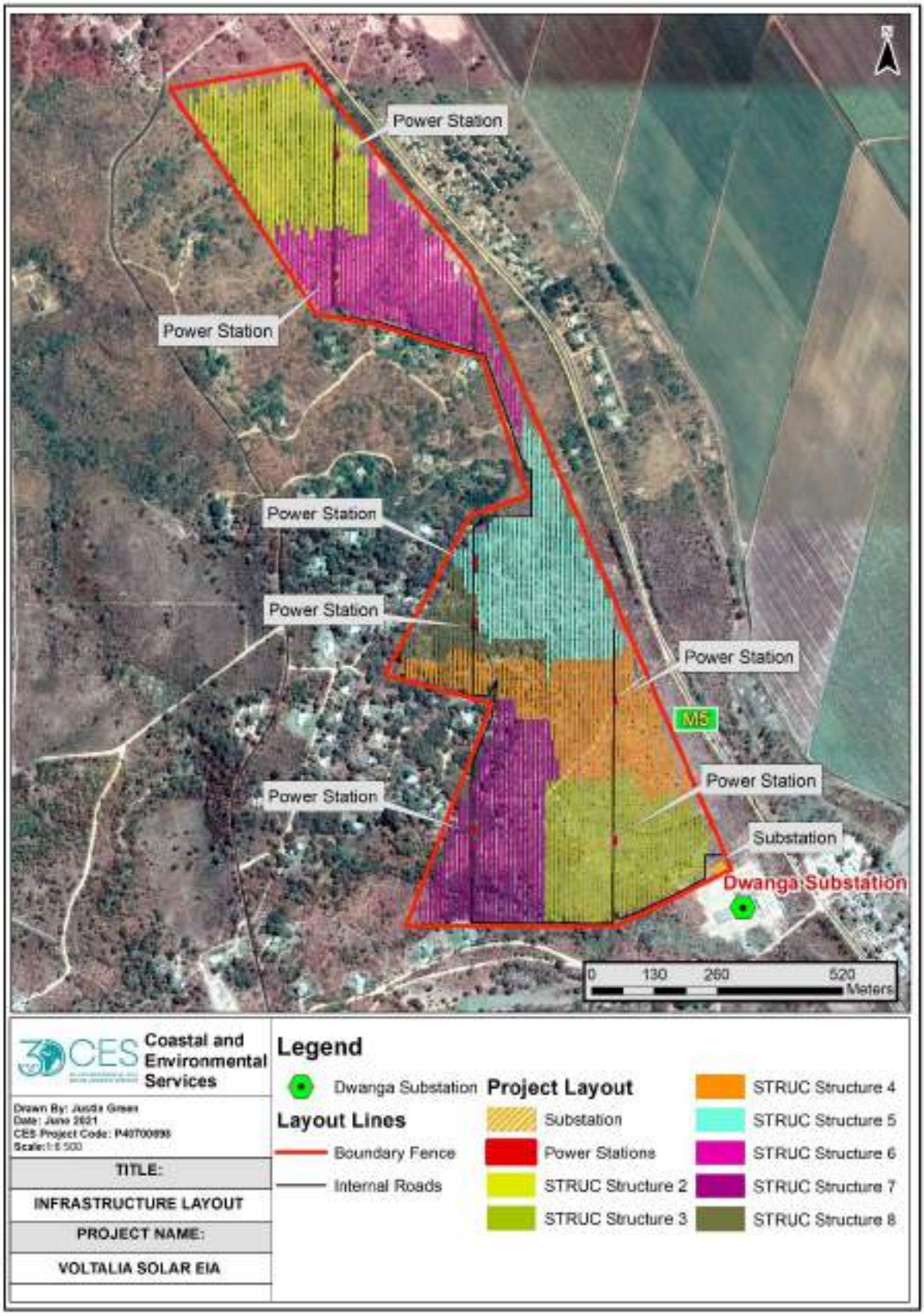

Figure 1-2: Infrastructure map alternative 1

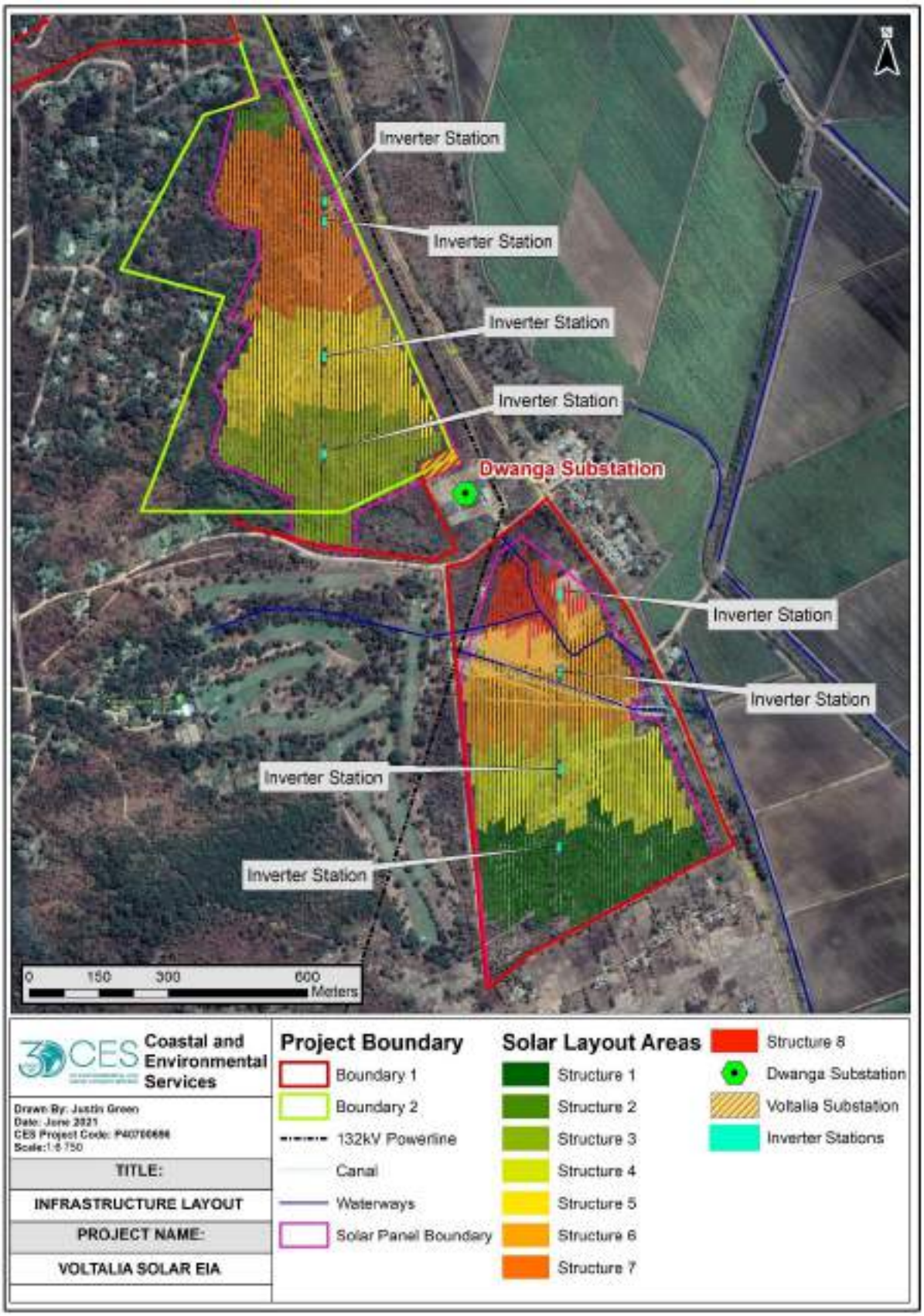

Figure 1-3: Infrastructure map alternative 2

2 LEGISLATION, POLICY AND GUIDELINES

2.1 APPLICABLE MALAWIAN LEGISLATION

A summary of the Malawian legislation applicable to the management of biodiversity is provided below. It should be noted that the list provided is not exhaustive and has been restricted to documents that have direct relevance to the current study. A full list of legislation applicable to the ESIA will be available in the Environmental and Social Impact Assessment Report (ESIR).

National Environmental Policy (2004): The overarching goal of this policy is to promote sustainable social and economic development through the implementation of management strategies focused on the environment and natural resources.

Environment Management Act (No. 23 of 1996): This act acknowledges every person's right to a clean and healthy environment and provides the general environmental legislation to protect this right. The Act provides for the conservation of biological diversity and makes provision for the undertaking of Environmental Impact Assessments.

National Forestry Policy (1996): The overarching goal of this policy is to ensure the sustainable use and conservation of forest resources to the benefit of the nation.

National Forestry Act (No. 4 of 1997): Provides for the conservation and management of forests as well as the protection and rehabilitation of environmentally sensitive areas. It also outlines the utilization of forest produce in forest reserves.

Wildlife Policy (2000): Provides the approach to the management of wildlife in Malawi. The policy seeks to layout objectives for the sustainable use of wildlife resources with emphasis on building constructive relationships between government and local communities in the management of wildlife.

National Parks and Wildlife (Amendment) Act (No. 11 of 2017): This act relates to the management of national parks and wildlife and seeks to establish the Wildlife Research and Management Board. The act was amended in 2017 by redefining "endangered species" and "protected species" in provisions concerning hunting licences, wildlife impact assessments, protected species, illegal possession of and trade in game species, protected species, endangered species or listed species and other offences.

National Land Resources Management Policy and Strategy (2000): The overarching goal of this policy is to promote the sustainable use of land-based resources for agriculture and other uses in order to avoid sectoral land conflicts and ensure socio-economic development. Of relevance to this report is the requirement for an environmental impact assessment that assesses the trade-off between economic development and environmental protection and provides mitigation measures to minimise this.

Plant Protection Act (no. 9 of 1969): This act relates to the eradication of pests and diseases that would negatively impact plant species.

2.2 CONVENTIONS AND PROTOCOLS

Malawi also recognises the following international conventions and protocols that are relevant to this study:

2.2.1 International Union for Conservation of Nature (IUCN): Statutes and Regulations

The objective of the IUCN is to "influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable" (IUCN, Accessed: 27/08/2016).

To achieve this objective, the IUCN implements programmes, administered by the World Conservation Congress, in the form of a number of activities such as:

- Research on species and ecosystem function to ensure sustainable, equitable and ecological utilisation of natural resources;
- Determine biological diversity, identify threats and priority conservation areas;
- Develop sound practices for the conservation and sustainable use of species and ecosystems; and
- Develop tools for effective rehabilitation, mitigation or offsets.

The IUCN data base and principles are used for determining species of conservation concern in the study area.

2.2.2 Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) deals with conservation, sustainable use and the equitable sharing of the benefits of natural resources. The CBD, ratified by Malawi in 1992, encourages the use of the "Ecosystem approach" which is based on the application of scientific methodologies focused on levels of biological organisation including process, functions and interactions between organisms and the environment (Convention on Biological Diversity, Accessed: 25 October 2016). The levels are extended to refer to any functional ecological unit at any scale.

The CBD emphasizes that adaptive management is necessary for complex and dynamic ecosystems. Impact responses of ecosystems are non-linear and often delayed, resulting in unpredictable reactive events. Management must be adaptive in order to respond to these events by incorporating a "lessons-learnt" approach and frequent considerations of "cause-and-effect".

The United Nations Framework Convention on Climate Change (UNFCCC), to which Mozambique is a signatory, recognises the CBD and its objectives.

The objectives and principles outlined in the CBD should be used to assess impacts and develop management and monitoring plans.

2.2.3 African Convention on the Conservation of Nature and Natural Resources

Malawi is a signatory on the African Convention on the Conservation of Nature and Natural Resources which was revised in 2003. The objectives of this Convention are to enhance environmental protection, to foster the conservation and sustainable use of natural resources and to harmonize and coordinate policies in these fields with a view to achieving ecologically rational, economically sound and socially acceptable development policies and programmes.

Specific to this report is Article VIII which relates to vegetation cover and requires the Parties to take all necessary measures for protection, conservation, sustainable use and rehabilitation of vegetation cover.

2.2.4 Convention on International Trade in Endangered Species (CITES)

The Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora was ratified by Malawi 1982. This is an international agreement between governments that aims to control the trade of wild animals and plants to ensure that their survival is not threatened.

3 METHODOLOGY

3.1 LITERATURE REVIEW

A review of the existing literature pertaining to the natural vegetation and plant biodiversity, the presence and status of alien/invasive plant species and the effects the development may have on the surrounding vegetation and ecology was undertaken.

3.2 SITE SURVEY

A site assessment was conducted from the 18-20 May 2021. An initial drive through of the study area was undertaken during the survey to establish habitat diversity and overall ecological state.

Sample sites were located in areas containing natural and modified vegetation (Figure 3-1). Agricultural areas, i.e. those that are currently undergoing cultivation, which are classified as transformed, were noted for mapping purposes but not sampled.

A sampling protocol was developed that would enable us to evaluate the existing desktop interpretations of the vegetation of the study area, to improve on them if necessary, and to add detailed information on the plant communities present. The protocol considered the amount of time available for the study, the accessibility of different parts of the area, and limitations such as the seasonality of the vegetation.

A stratified random sampling approach was adopted, whereby initial assumptions were made about the diversity of vegetation, based on Google Earth, spatial planning tools and available literature and the area stratified into these basic types. In this way the time available was used much more efficiently than in random sampling, but there is a risk of bias and the eventual results may simply ‘prove’ the assumptions.

In general, the stratification of the site was influenced by obvious features of the vegetation, such as the presence of conspicuous species or vegetation structure. These factors may be largely independent of the floristic make-up of the vegetation, and by definition the biological communities present. Sample plots were analysed by determining the dominant species in each plot, as well as any alien invasive species and potential SCC occurring within the plots. Each sample plot was sampled until no new species were recorded. Vegetation communities were then described according to the dominant species recorded from each type, and these were mapped and assigned a sensitivity score.

3.3 SPECIES OF CONSERVATION CONCERN

Data on the known distribution and conservation status for each potential species of conservation concern must be obtained to develop a list of ‘Species of Concern’. These species are those that may be impacted significantly by the proposed activity. In general, these will be species that are already known to be threatened or at risk, or those that have restricted distributions (endemics) with a portion (at least 50%) of their known range falling within the study area i.e. strict endemic and near endemic species.

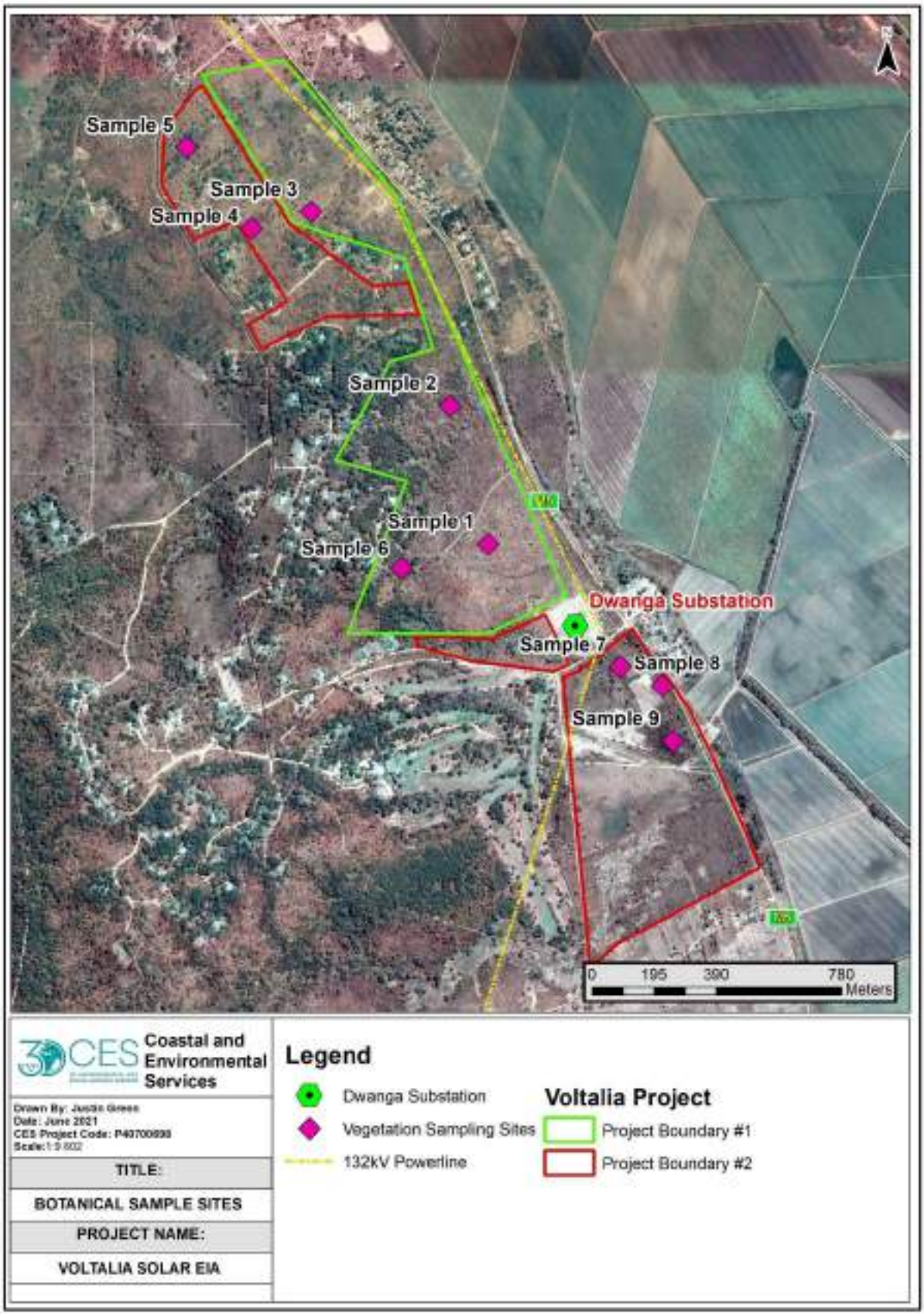

Figure 3-1: Map showing the location of the sample sites

3.4 VEGETATION MAPPING

Vegetation was mapped from satellite imagery and refined using site data gathered on the ground.

3.5 SENSITIVITY ASSESSMENT

The Species Environmental Assessment guideline (SANBI, 2020) was applied to assess the Site Ecological Importance (SEI) of the project area. The habitats and the species of conservation concern in the project area were assessed based on their conservation importance, functional integrity and receptor resilience (Table 3.1). The combination of these results in a rating of SEI and interpretation of mitigation requirements based on the ratings.

This data was then used to develop a sensitivity map.

Table 3-1: Criteria for establishing Site Ecological importance and description of criteria

Criteria	Description
Conservation Importance (CI)	*The importance of a site for supporting biodiversity features of conservation concern present e.g. populations of IUCN Threatened and Near-Threatened species (CR, EN, VU & NT), Rare, range-restricted species, globally significant populations of congregatory species, and areas of threatened ecosystem types, through predominantly natural processes.*
Functional Integrity (FI)	*A measure of the ecological condition of the impact receptor as determined by its remaining intact and functional area, its connectivity to other natural areas and the degree of current persistent ecological impacts.*
Biodiversity Importance (BI) is a function of Conservation Importance (CI) and the Functional Integrity (FI) of a receptor.	
Receptor Resilience (RR)	*The intrinsic capacity of the receptor to resist major damage from disturbance and/or to recover to its original state with limited or no human intervention.*
Site Ecological Importance (SEI) is a function of Biodiversity Importance (BI) and Receptor Resilience (RR)	

3.6 ECOLOGICAL IMPACT ASSESSMENT

3.6.1 Impact rating methodology

To ensure a balanced and objective approach to assessing the significance of potential impacts, a standardized rating scale was adopted which allows for the direct comparison of specialist studies. This rating scale has been included in Appendix 2.

4 LITERATURE REVIEW

4.1 DESCRIPTION OF THE BIOPHYSICAL ENVIRONMENT

The project site is located towards the middle of Lake Malawi, on the western bank, approximately 46km north of Nkhotakota and 120km south of Mzuzu as the crow flies.

Climate, topography, soils and the underlying geology all influence the geographical distribution of species and therefore play a significant role in the type of vegetation present at a site.

4.1.1 Climate

Malawi's climate is described as being subtropical and is strongly seasonal. It is characterised by a warm wet season that stretches from November to April and a cooler, drier season from May to October. The hottest months in Dwangwa are October and November with average temperatures of 29^0C and the coolest months are June and July with average temperatures of 22^0C (World Weather Online, 2021) .

Rainfall is markedly concentrated to the summer months and occurs as a result of the inter-tropical convergence zone which becomes established over the region (Brown and Young, 1965). Associated with the inter-tropical convergence zone are unstable air masses and higher moisture content which results in a high humidity of between 75-80% and heavy convectional storms. The average rainfall for Dwangwa ranges from 339mm in January and February to 5mm in August and September.

During the dry season, the region is covered by a sub-tropical high-pressure belt which is associated with dry south-easterly winds (Brown and Young, 1965). Relative humidity is typically lower during this period (50-60%) and almost no rainfall occurs.

4.1.2 Geology

Malawi lies predominantly within the Mozambique Mobile Belt which comprises of rocks from the late Precambrian to early Palaeozoic age. The underlying geology is typically characterised by reworked metamorphic rock of igneous and sedimentary origin (Mshali, 2009) and collectively known as the Malawi Basement Complex.

The project site is underlain by the Muva Supergroup which forms most of the basement in south-central Malawi. It is characterised by the presence of semi pelitic rocks and pelites (Mica schists, Kyanite and Sillimanite Schist and gneisses) (Haundi *et. al.*, 2021).

4.1.3 Soils

The study area is based in the Nkhotakota region where the main associated soil type are Lixisols (see Figure 4.1 below). Lixisols are the most highly distributed soil profile across Malawi (Dijkshoorn et al. 2016). They are associated with old landscapes and occur in tropical climates that have a distinct dry season. They are comprised of strongly weathered soils where

clay has washed out of an eluvial horizon. This soil type has a subsurface layer of accumulated kaolinitic clays.

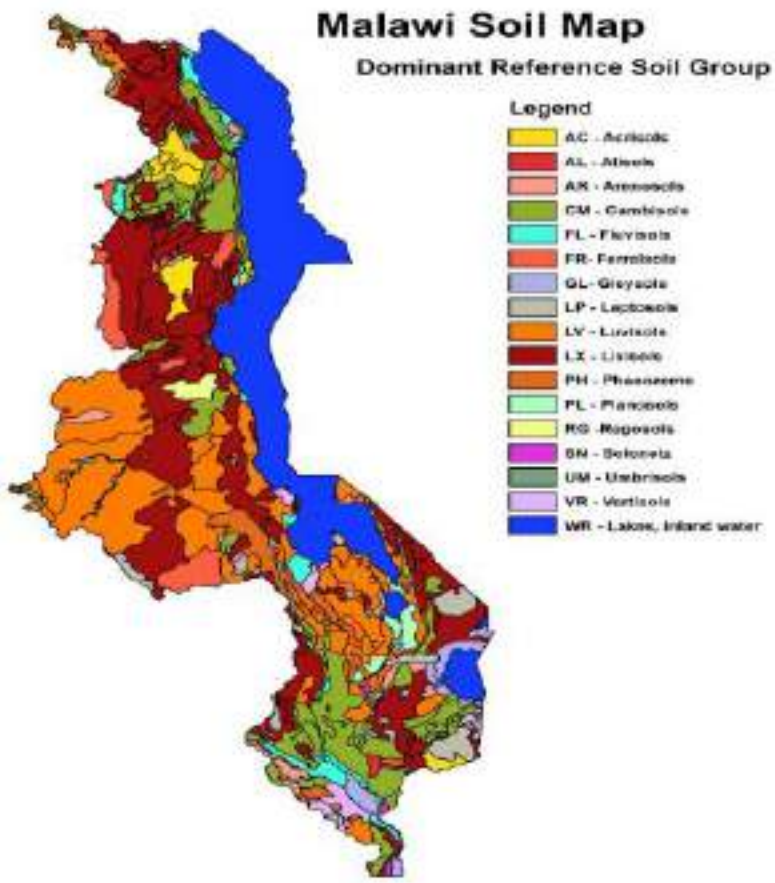

Figure 4-1: Soil distribution throughout the Malawi region (source: Dijkshoorn et al. 2016).

4.1.4 Topography

The site is generally level, with gentle slopes and a small change in elevation.. The northern portion is a horseshoe shape with a depression running from a high point in the West (531m) down the hill to the road in the East (500m), a decrease in elevation of only 31m. Slopes on either side are therefore gentle. The North slope (520m) and South slope (513m) descend into the valley (500m). On a microscale the site can be described as a series of small foothills and depressions on an otherwise level surface.

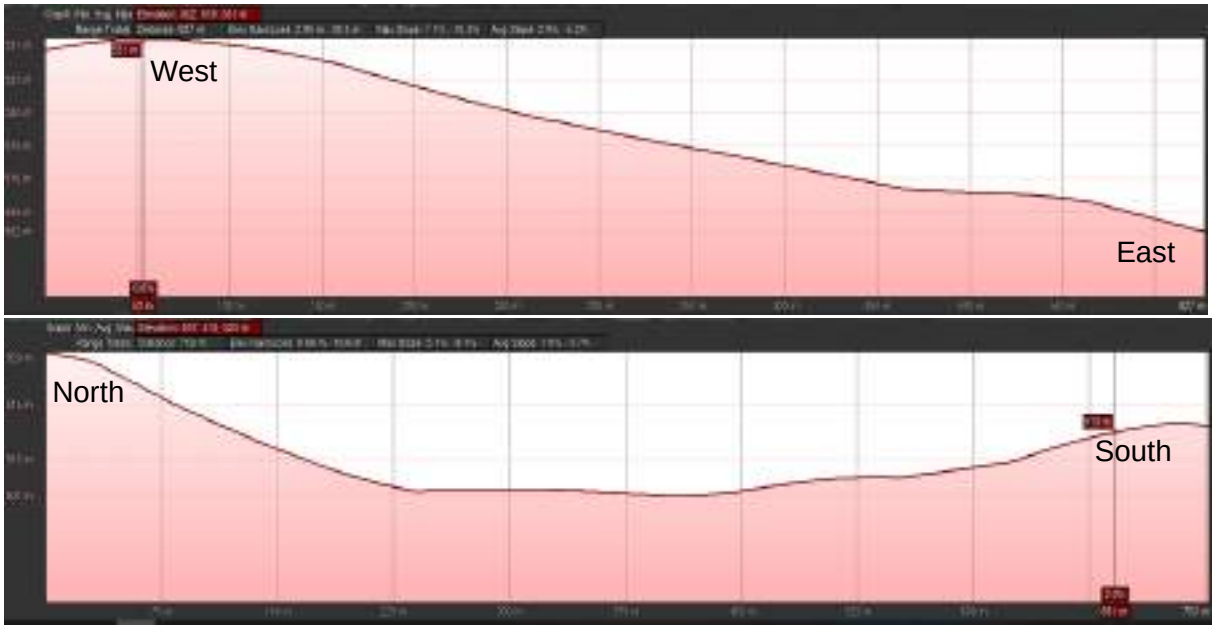

Figure 4-2: Elevation profile of the northern portion of the site.

The central portion is a foothill that slopes downhill from west to east and uphill from north to south. The high point in the west (517m) slopes down from the forest to the road and powerline (495m). From the river in the south (501m) the site slopes uphill to the crest (512m) and then down hill again to the adjacent valley.

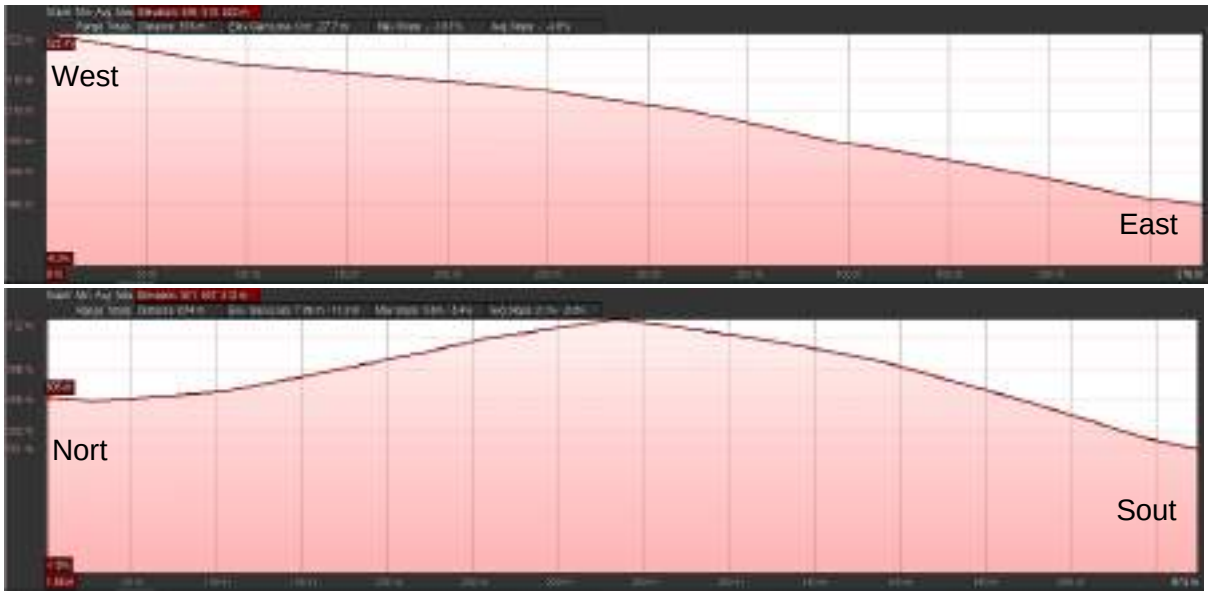

Figure 4-3: Elevation profile of the central portion of the site.

The southern portion is a relatively flat site with slight undulations. It has a shallow depression running from a high point in the West (498m) bordering the golf course down the hill to the road in the East (491m) with slopes on either side. The North slope (499m) and South slope (498m) runs into this depression (493m).

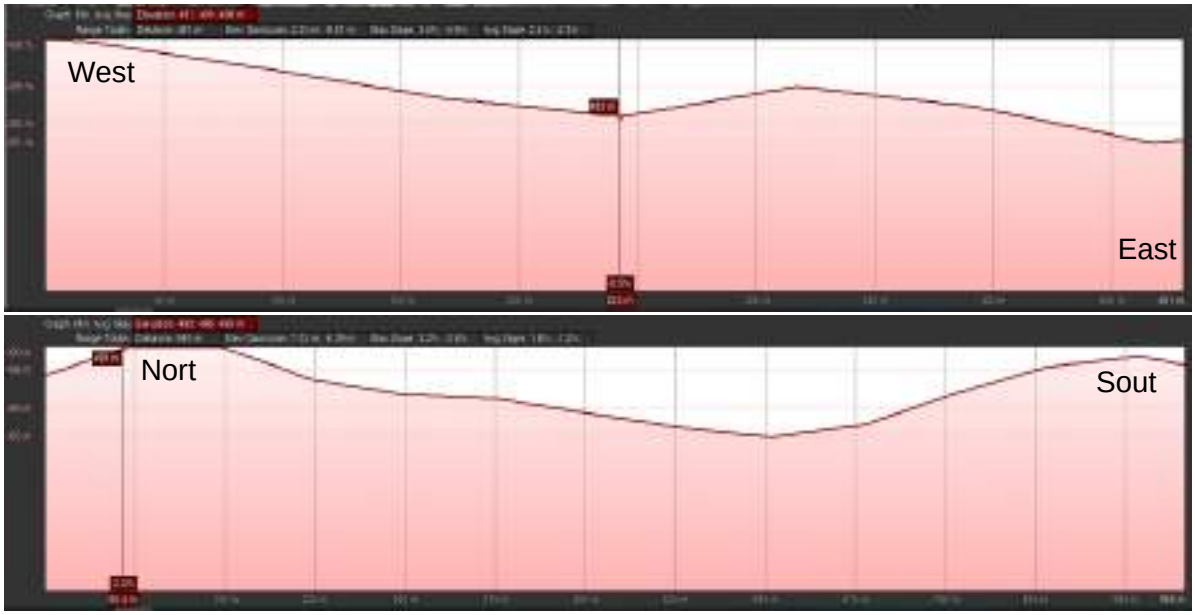

Figure 4-4: Elevation profile of the southern portion of the site.

4.1.5 Current Land use

The majority of the site is natural with some subsistence agriculture and infrastructure. The northern and central site is relatively untouched, and the majority of land is in a natural state. No indigenous trees are harvested, but there is evidence of grass being harvested and small woodlots of Eucalyptus are present. Rice is grown in all the streams on site, and the small river on the southern site has been dammed, and water is pumped from this small dam to feed into the irrigation canal on the other side of the M5 road.

The majority of the southern portion is used for subsistence agriculture, which includes rice paddies, fruit trees and woodlots. The infrastructure on site includes roads, a substation, powerlines, a water tower, buildings and soccer fields. There are also two sand mine areas; one in the southern portion and one on the northern portion. A tree wind break has been planted along the M5 presumably for the neighbouring sugar plantation. Surrounding land use includes the town Bowa, Primary School (Majiga), Golf course (Kasasa SportsClub), Illovo houses and commercial agricultural fields (sugar cane).

Plate 4-1: Grass is harvested from the project area and used as thatch

Plate 4-2: Portions of the site are used as woodlots to grow Eucalyptus trees.

4.2 DESCRIPTION OF THE EXPECTED VEGETATION

4.2.1 Miombo Woodland

The Miombo Ecoregion is defined by Byers (2001) as comprising of multiple vegetation types that reflect differences in species composition and ecological processes, but which are all dominated by one or more species of the Caesalpinioideae family. It is estimated that this ecoregion covers approximately 3.6 million km^2 across eleven countries in central and southern Africa (Figure 4-5) (Timberlake and Chidumayo, 2011). It contains around 8,500 plant species of which 54% are endemic (White, 1984). It also supports a number of faunal species that are endemic or near endemic to the ecoregion. Due to this high level of endemicity and because it is an important habitat for several threatened species[1], it has been identified as one of five global wilderness areas that should be prioritised for conservation (Mittermeier et. al., 2003) (Table 4-1). However, compared to other global ecoregions, to date, this eco region has received little conservation and research attention (Kew et. al., 2015).

Table 4-1: The number of species and endemic/near endemic species in the Miombo Ecoregion

Group	No. Species in ecoregion	No. endemic/near endemic species	% Endemics
Plants	8500	4590	54%
Mammals	318	35	11%
Birds	938	53	6%
Reptiles	284	83	29%
Amphibians	130	36	28%
Fish	200	30	15%
Butterflies	1300	90	7%
Total	11,670	4,915	42%

Although there is a high species diversity and a number of endemic and near endemic species are associated with this ecoregion, according to the Miombo Ecoregion Vision Report (2011), the conservation of the Miombo Ecoregion is more about “conservation of processes operating at a landscape scale across thousands of square kilometres than about conservation of species or individual habitats” (Timberlake and Chidumayo, 2011).

It is estimated that over 100 million people are directly or indirectly dependent on this ecoregion to meet their daily needs (Syampungani et al., 2009). Given that the population of sub-Sahara Africa has grown from 186 million to 856 million people from 1950-2010 and it’s

[1] It is estimated that 100 threatened species are thought to occur in the ecoregion, of which nine are Endangered or Vulnerable

estimated that by 2060, the population of sub-Sahara Africa could be as large as 2.7 billion people (The World Bank, 2015), pressure on this ecoregion is steadily increasing (Cabral et al., 2011; Dewees et al., 2010). However, these woodlands have historically been inhabited by people and the ecological dynamics have therefore been largely shaped by humans (e.g. burning these woodlands during the dry season) (Kew et. al. 2016). This interdependence between humans living in this ecoregion and the impact they have in shaping it led to Campbell (1996) describing the miombo ecoregion as a "social forest". However, despite these links, little is known about the present-day response of biodiversity to land-use change, such as the clearing of land for agriculture and the utilisation of natural resources in the remaining woodland.

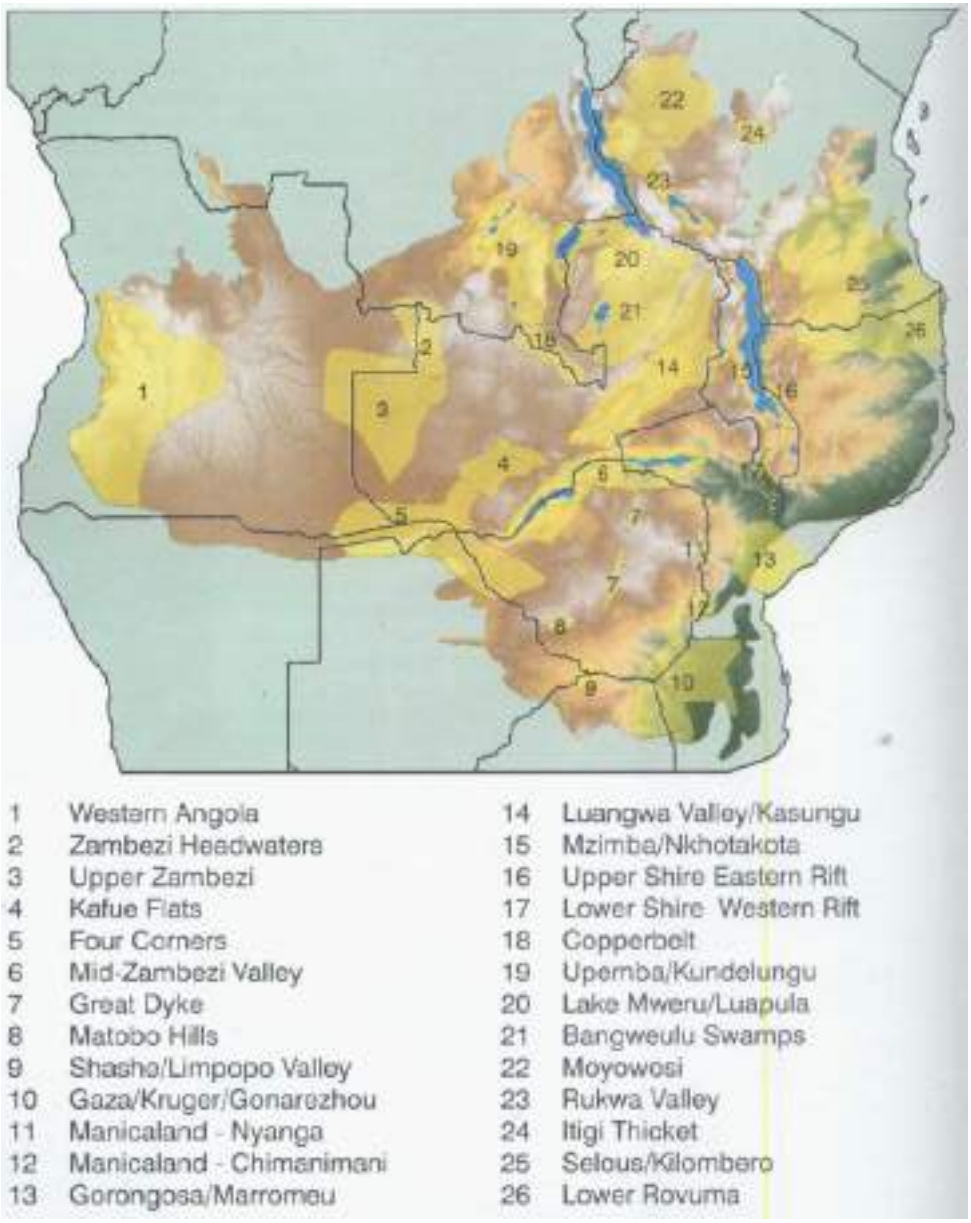

Figure 4-5: The Miombo Ecoregion (from WWF SARPO 2003)

The "*potential natural vegetation" (PNV)* map of eastern and southern Africa was used to determine the vegetation type expected to occur at the project site. The PNV is defined as *"the vegetation that would persist under current conditions without human intervention"* (VECEA, 2020). The map covers Burundi, Ethiopia, Kenya, Malawi, Uganda, Rwanda, Tanzania and Zambia and was created using a combination of historical national and local vegetation maps, available literature and input from leading experts.

The northern portion of the site falls within the vegetation type *Marsh (Edaphic) Grassland* (Figure 4-6). This vegetation type is characterised by the presence of woody species with a canopy cover of <2% within land dominated by grass species and occasional herbs.

The southern section of the site falls within Miombo Woodland which is characterised by the presence of the genus *Brachystegia*, of which there are nineteen species in total. The presence of three other tree species also characterise this vegetation type, namely: *Isoberlinia angloensis, Julbernadia globiflora* and *Julbernadia paniculata*. These species are rarely found outside of Miombo Woodland (Frost 1996).

The VECEA map has mapped four subtypes of Miombo Woodland:

- Drier Miombo Woodland
- Wetter Miombo Woodland
- Miombo Woodland on hills and rocky outcrops
- Zanzibar-Inhambane transition woodland

The southern portion of the project site is located within the *Miombo Woodland on hills and rocky outcrops.* Characteristic species other than *Julbernardia* and *Brachystegia* that are associated with this vegetation type in Malawi include:

- *Afzelia quanzensis*
- *Burkea africana*
- *Dombeya rotundifolia*
- *Erythrophleum africanum*
- *Faurea saligna*
- *Parinari curatellifolia*
- *Pericopsis angolensis*
- *Pseudolachnostylis maprouneifolia*
- *Pterocarpus angolensis*
- *Terminalia sericea*

In Malawi, disturbance such as clearing for agriculture and harvesting of trees for charcoal has resulted in the ongoing degradation of Miombo Woodland, with a significant loss of vegetation outside of protected areas.

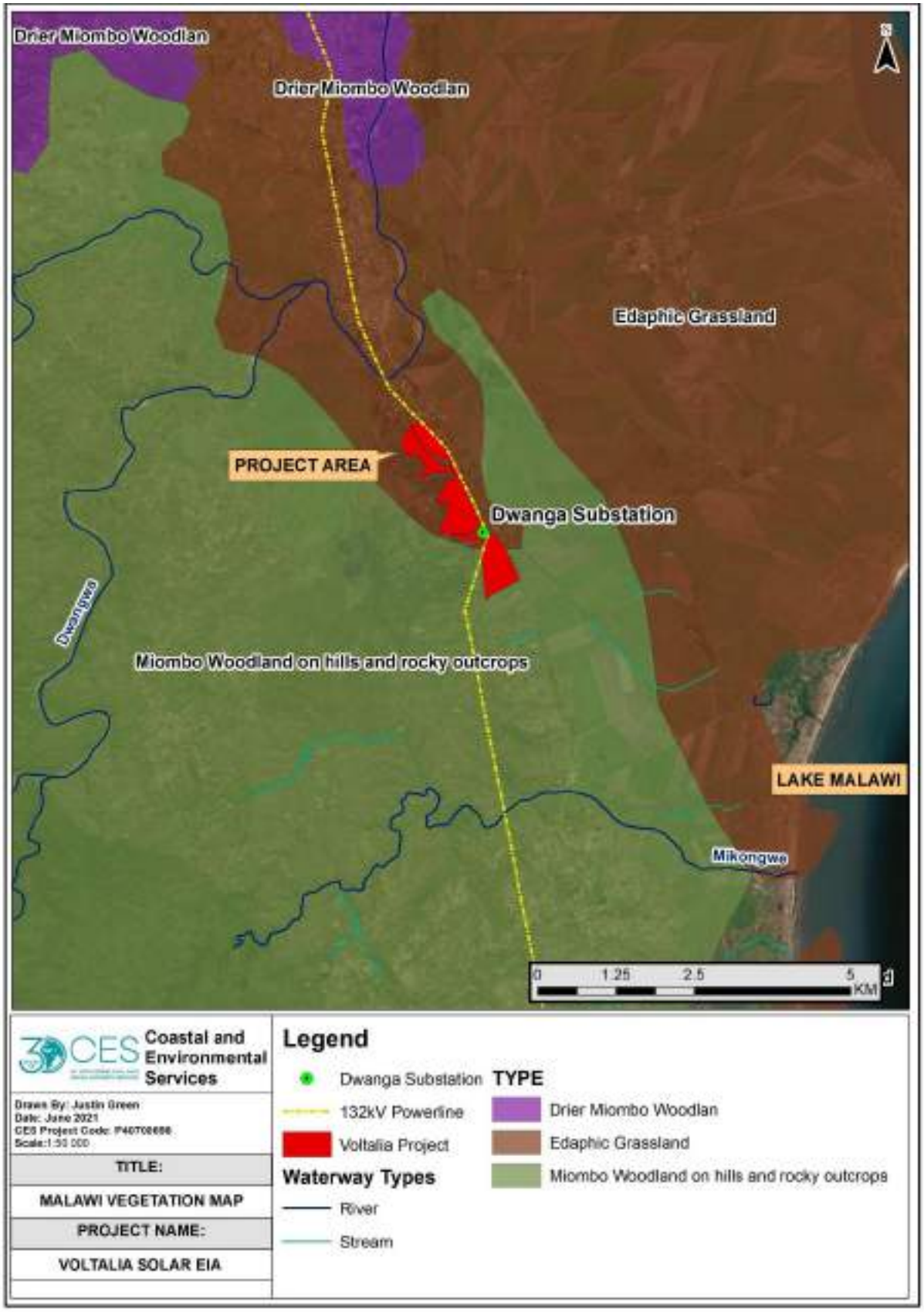

Figure 4-6: VECEA map showing the expected vegetation types present within the project area

5 RESULTS

5.1.1 Vegetation Types

The vegetation present within the study area is a mosaic of Grassland, Savanna, Open Miombo Woodland, Closed Miombo Woodland associated with Riparian areas and transformed land which is comprised of farmland, woodlots, a sand mine, residential areas, a soccer field, sugar plantations and a golf course. Areas that have been transformed have been mapped for the sake of completion, but no further descriptions are provided. The Grassland and Savanna vegetation types were difficult to separate out on the map and as such this has been mapped as “savanna-grassland mosaic” although separate descriptions have been provided below.

The vegetation to the northern section of the site is generally considered to be intact, and while there is evidence of some harvesting of natural resources, this is generally at a low level of intensity, and consequently has not significantly altered the vegetation types. The area to the south is typically more degraded with larger areas that have been transformed.

Each vegetation type has been described below and its distribution illustrated in Figure 6-1.

Grassland

Grassland is confined to the north west portion of the proposed project site and is generally intact in most areas, with little evidence of harvesting by local communities. Dominant species include *Loudetia simplex, Heteropogon contortus, Hyparrhenia nyassae, Cyperus filiformis, Melinis repens and Themeda triandra* among others.

Plate 5-1: Image depicting the grassland on site

Savanna

Savanna is the most common vegetation type occurring throughout the site. It is characterised as a mix of woodland and grassland with an open canopy (10-25%) of woody species. Canopy height ranges from 1-3m and common woodland species include *Terminalia sericea, Brachystegia boehmii, Annona senegalensis, Pseudolachnostylis maprouneifolia, Strychnos innocua, Dichrostachys cinerea, Ozoroa insignis, O. reticulata, Combretum collinum, C. zeyheri, C. molle, Eriosema buchananii, Eriosema englerianum* and *Pterocarpus rotundifolia.* The understory is comprised of the grass species found within the grassland vegetation type i.e. *Loudetia simplex, Heteropogon contortus, Hyparrhenia nyassae, Cyperus filiformis, Melinis repens and Themeda triandra. Gmelina arborea* and *Eucalyptus* have been planted within the site and if not controlled can displace this vegetation.

The Savanna in the northern section of the site is considered near natural and shows evidence of degradation towards the middle and southern sections, with the southern section being the most degraded.

Plate 5-2: Typical example of Savanna

Miombo Woodland

Miombo woodland occurs in the middle of the site along the western border and can be divided into open and closed miombo woodland. Open Miombo Woodland has a canopy cover of 30-50% with an understory of grass species while Closed Miombo Woodland is characterised by a closed canopy of 75-90% with an understory that is typically herbaceous with some grass cover in areas where the canopy is more open. Tree height ranges from 2-4m with emergent's reaching up to 5m. This vegetation type is generally intact within the study area. Common species include shrubs and trees such as *Brachystegia boehmii, Brachystegia utilis, Brachystegia taxifolia, Brachystegia bussei, Julberrnardia paniculata* and *Julbernardia globiflora* as well as herbs and grasses such as *Loudetia simplex, Vernonia melleri, Vernonia glabra, Triumfetta annua* and *Achyranthes aspera.*

The Open Miombo Woodland occurs in the northern section of the site and the closed Miombo Woodland, which in some patches may be considered forest due to the closed nature of the canopy and the herbaceous understory, occurs in the middle section. The Closed Miombo Woodland is associated with a riparian area and as such is of high sensitivity.

Plate 5-3: Closed Miombo Woodland

Transformed Land

Areas classified as transformed land include farmland, woodlots, soccer fields, sand mine, residential areas and commercial plantation. These areas have little to no natural vegetation remaining.

Table 5-1 provides a summary of the extent of vegetation that could potentially be lost under the current project layout. However this is a worst case scenario as the total footprint of the development is 60ha.

Table 5-1: Summary of vegetation types that will be impacted

Vegetation Type	Alternative 1 Area	Alternative 2 Area
Closed Miombo Woodland	10.6 ha	0.57 ha
Open Miombo Woodland	5 ha	2.14 ha
Grassland-Savanna Mosaic	35.9 ha	31.16 ha
Transformed areas	8.7 ha	26.5 ha

Plate 5-4: Transformed land found within the project. Rice paddy (left) and crops under an existing powerline (right)

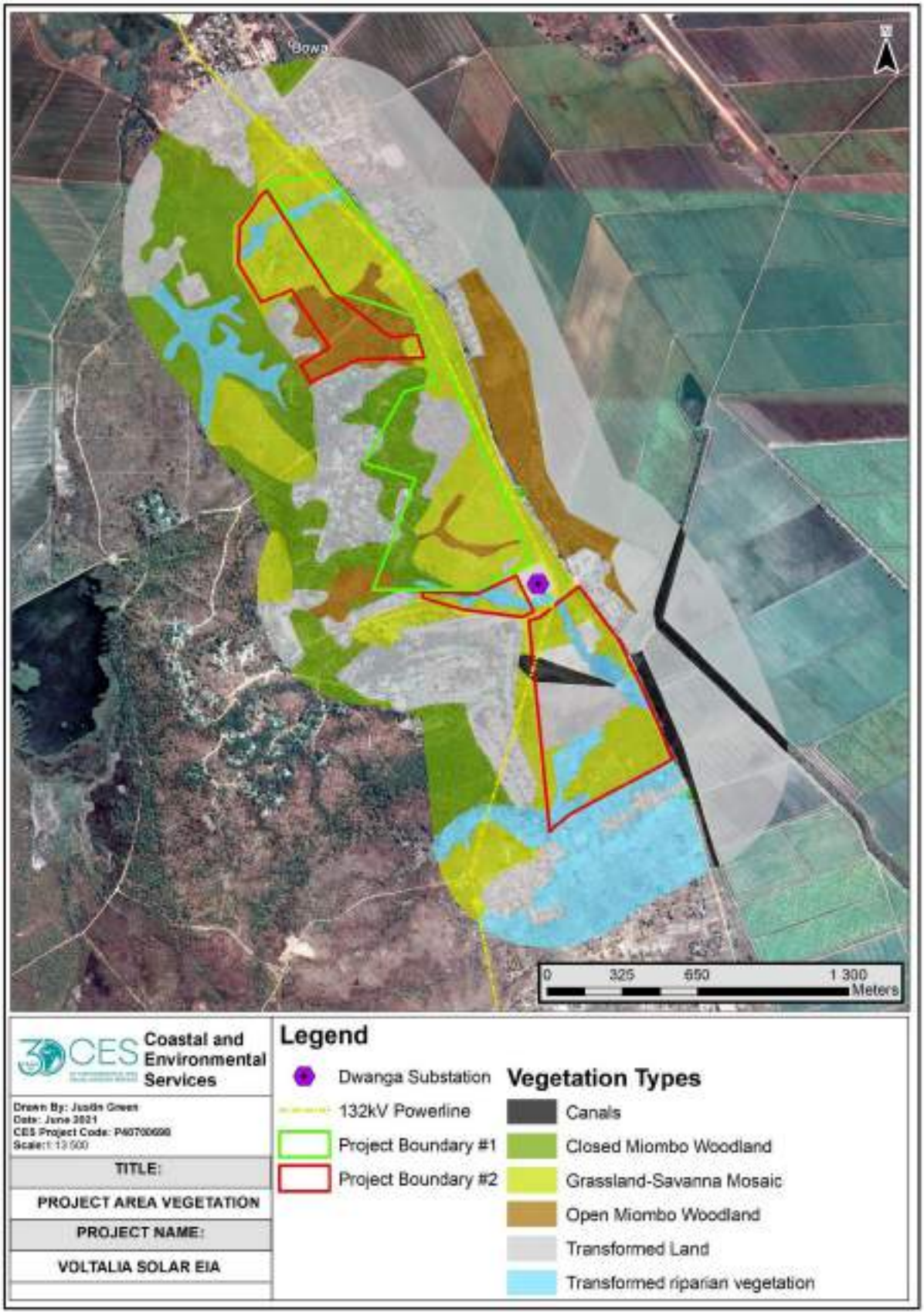

Figure 5.1: Vegetation types and their distribution within the project area (Alternative 1)

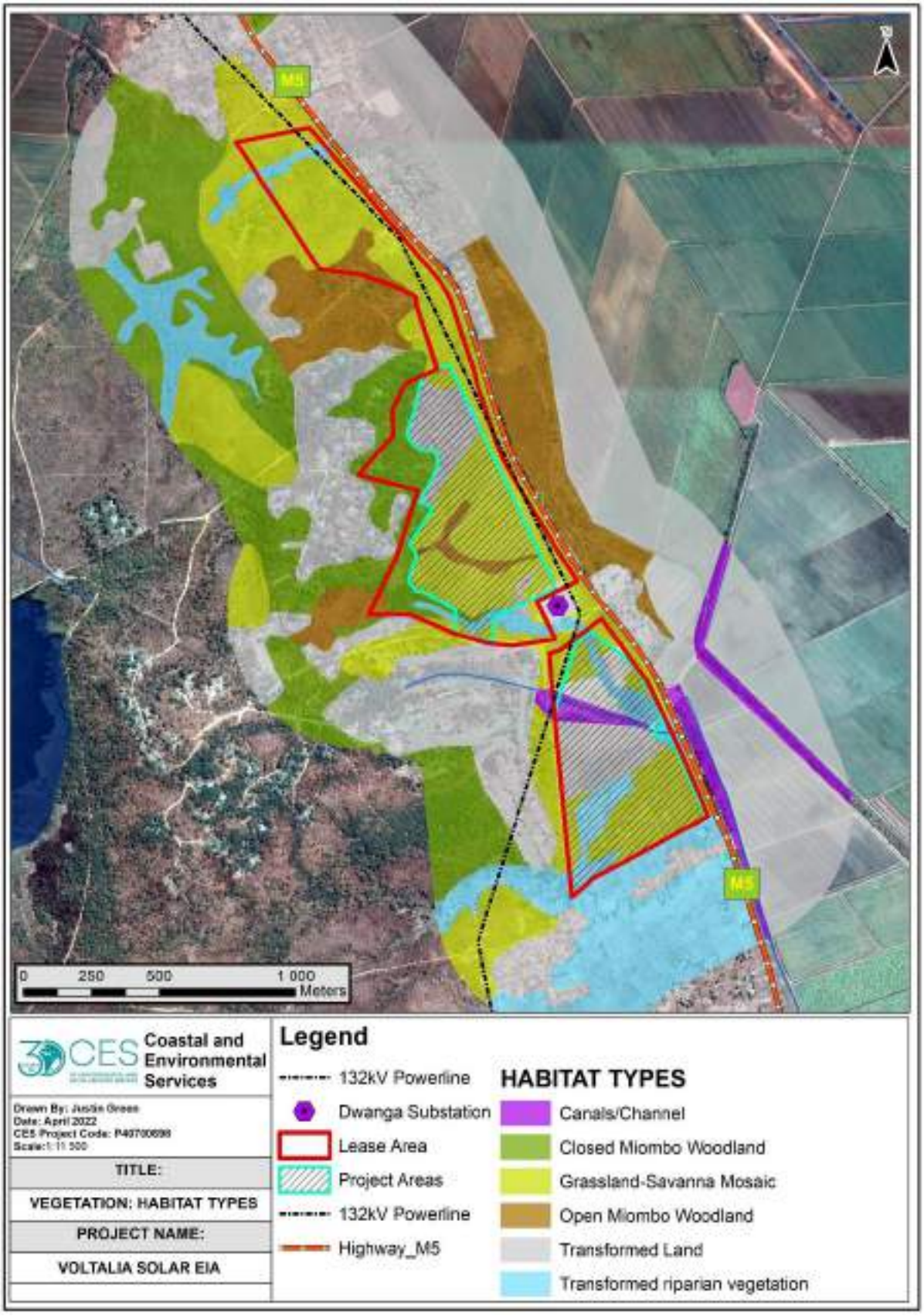

Figure 5.2: Vegetation types and their distribution within the project area (Alternative 2)

5.1.2 Floristic Composition

A total of 152 taxa were recorded within the site, but it is likely that a number of species have gone undetected, as inconspicuous species such as bulbs and geophytes are often present for only short periods of time and therefore difficult to identify when they are not in flower. The majority of the species recorded are dicotyledons which is not surprising as this component has a higher diversity (Table 5-2).

Of the monocotyledonous families, only the grass family has more than one species represented. This family is a major constituent of grasslands and the savanna. The dicotyledons have two large families (with more than 10 species each), viz. Fabaceae and Asteraceae, followed by Malvaceae with 7 species and Phyllanthaceae and Anaracdiaceae each with 5 species. The largest family, Fabaceae, has species best adapted to tropical African Savannas and forests, with representatives in all life form categories, and is the dominant family of Miombo Woodlands.

Table 5-2: Number of plant species of different life forms in the major plant communities

Family	Number of Species
Monocotyledons	
POACEAE	19
ASPARAGACEAE	1
CYPERACEAE	1
Dicotyledons	
FABACEAE	36
ASTERACEAE	21
MALVACEAE	7
PHYLLANTHACEAE	5
ANACARDIACEAE	5
CONVOLVULACEAE	4
COMBRETACEAE	4
EBENACEAE	3
MYRTACEAE	3
RUBIACEAE	3
APOCYNACEAE	2
BIGNONIACEAE	2

BORAGINACEAE	2
CAPPARACEAE	2
LAMIACEAE	2
LEGUMINOSAE	2
LOGANIACEAE	2
OCHNACEAE	2
ORCHIDACEAE	2
THYMELAEACEAE	2
VITACEAE	2
ACANTHACEAE	1
AMARANTHACEA	1
ANNONACEAE	1
BURSERACEAE	1
CELASTRACEAE	1
CHRYSOBALANACEAE	1
CLELASTRACEAE	1
CLUSIACEAE	1
COMMELINACEAE	1
CRASSULACEAE	1
EUPHORBIACEAE	1
MELIACEAE	1
MORACEAE	1
PASSIFLORACEAE	1
SALICACEAE	1
SAPINDACEAE	1
SOLANACEAE	1
STERCULIACEAE	1

5.1.3 Species of Conservation Concern

One species of conservation concern, *Pterocarpus angolensis* (African Teak), was recorded within the project site. This species is listed as Vulnerable on the National Red Data List which means that it is not Critically Endangered or Endangered but that it faces a high risk of extinction in the wild in the medium-term future.

Pterocaprus angolensis is a large tree species growing to over 20m in height and is widespread in Miombo Woodland (Barstow and Timberlake, 2018). It has been recorded in Angola, Botswana, The Democratic Republic of the Congo, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe and has an estimated extent of occurrence of 5 million km^2. This species is valued for its timber which has resulted in a number of local populations becoming extinct. The loss of large trees as a consequence of harvesting impacts on seed production. Coupled with poor germination rates and a low seedling survival rate, the unsustainable harvesting of this species is cause for concern (Mojeremane and Lumbile, 2016). Although listed as Least Threatened on the IUCN red data list, Malawi has listed this species as Vulnerable within their country.

5.1.4 Alien Invasive Species Present

Four exotic species were recorded on site:

- *Gmelina arborea* (Gmelina)
- *Eucalyptus globulus* (Southern Bluegum)
- *Eucalyptus saligna* (Bluegum)
- *Psidium guajava* (Guava Tree)

The site must be monitored for the presence of alien[2] invasive species and these must be removed as they appear.

[2] A plant introduced from elsewhere and now more or less naturalised.

6 SITE SENSITIVITY

6.1 SITE SENSITIVITY

The method used to assess site sensitivity has been described in section 2.5 above. Table 6.1 provides a summary of how each vegetation type was assessed.

The overall sensitivity for closed miombo woodland is high due to its level of intactness and the function it plays as an ecological corridor for the movement of fauna and seed dispersal. The open miombo woodland has an overall sensitivity of moderate as there is only one species of conservation concern and it is seemingly able to recover relatively quickly after a disturbance. The grassland-savanna mosaic has an overall sensitivity of low as there are no plant species of conservation concern, and this vegetation type is resilient to disturbance, recovering within 10 years.

It is important to note that the sensitivity of the vegetation types is based on the floral composition and the resilience of the vegetation types to disturbance, and does not take into account faunal species. The faunal assessment is likely to assign different sensitivities to the habitat types present. For the Environmental Impact Assessment (EIA) Report the sensitivity from the two reports must be combined and whichever is the highest sensitivity for a site must be used.

Table 6-1: Evaluation of Site Ecological Importance (SEI) of habitat and SCC

Habitat / Species	Conservation Importance (CI)	Functional Integrity (FI)	Receptor Resilience	SEI
Closed Miombo Woodland	**Medium**	**Very High**	**Medium**	**High**
	One vulnerable species *(Pterocarpus angolensis)* is present within the site. This species is widespread and is known from more than 10 locations. As such the CI is medium rather than high.	Habitat connectivity serves as a functional ecological corridor, particularly along the riparian areas. Limited road network within the habitat and minimal negative ecological impacts occur within this vegetation type	Seedling recruitment is limited by rainfall events, the availability of establishment sites and competition from established plants (Vetter, 2009). Annual species typically recover more quickly from a disturbance than perennial species as they put more energy into reproduction from seed than perennial species do. It would therefore be expected that woodland would take longer to recover and have a low resilience to disturbance. McNicol *et. al.* (2015) however have determined that tree species diversity in Miombo Woodland recovers quickly and within 10 years sample plots were equivalent to that of mature woodland. As such,	

Habitat / Species	Conservation Importance (CI)	Functional Integrity (FI)	Receptor Resilience	SEI
			miombo woodland resilience is considered to be medium.	
Open Miombo Woodland	**Medium**	**High**	**Medium**	**Moderate**
	One vulnerable species *(Pterocarpus angolensis)* is present within the site. This species is widespread and is known from more than 10 locations. As such the CI is medium rather than high.	Good habitat connectivity with potentially functional ecological corridors. Only minor current negative impacts and good rehabilitation potential.	Seedling recruitment is limited by rainfall events, the availability of establishment sites and competition from established plants (Vetter, 2009). Annual species typically recover more quickly from a disturbance than perennial species as they put more energy into reproduction from seed than perennial species do. It would therefore be expected that woodland would take longer to recover and have a low resilience to disturbance. McNicol *et. al.* (2015) however have determined that tree species diversity in Miombo Woodland recovers quickly and within 10 years sample plots were equivalent to that of mature woodland. As such, miombo woodland resilience is considered to be medium.	
Grassland-Savanna Mosaic	**Medium**	**High**	**High**	**Low**
	One vulnerable species *(Pterocarpus angolensis)* is present within the site. This species is widespread and is known from more than 10 locations. As such the CI is medium rather than high.	Good habitat connectivity with potentially functional ecological corridors. Only minor current negative impacts and good rehabilitation potential.	Grassland and savanna is typically a mix of annual and perennial herbs and grasses interspersed with woody vegetation. These species are able to recover relatively quickly after a disturbance ,and as such have been assigned a high resilience.	

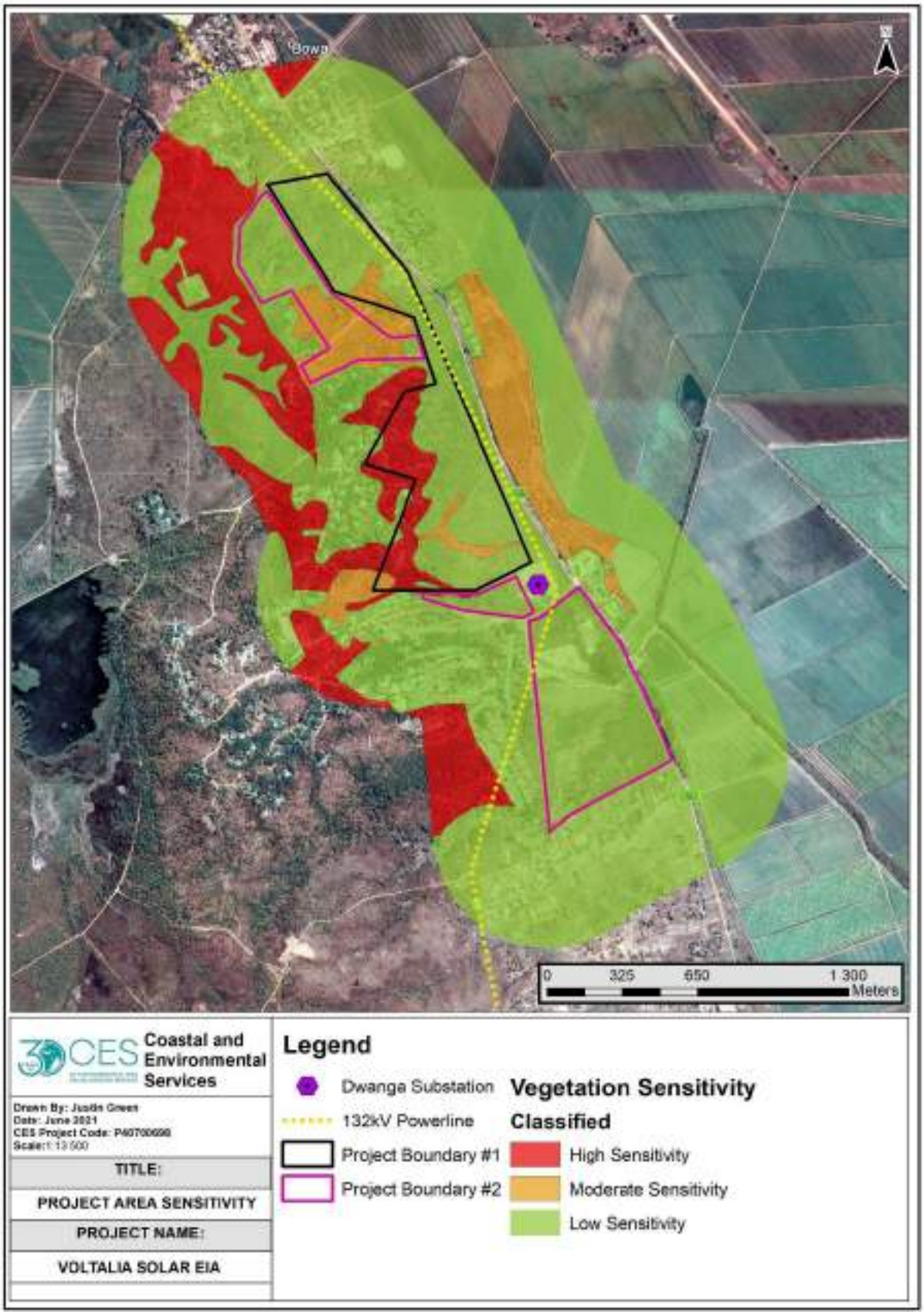

Figure 6-1: Sensitivity map showing areas of high, moderate and low sensitivity (Alternative 1).

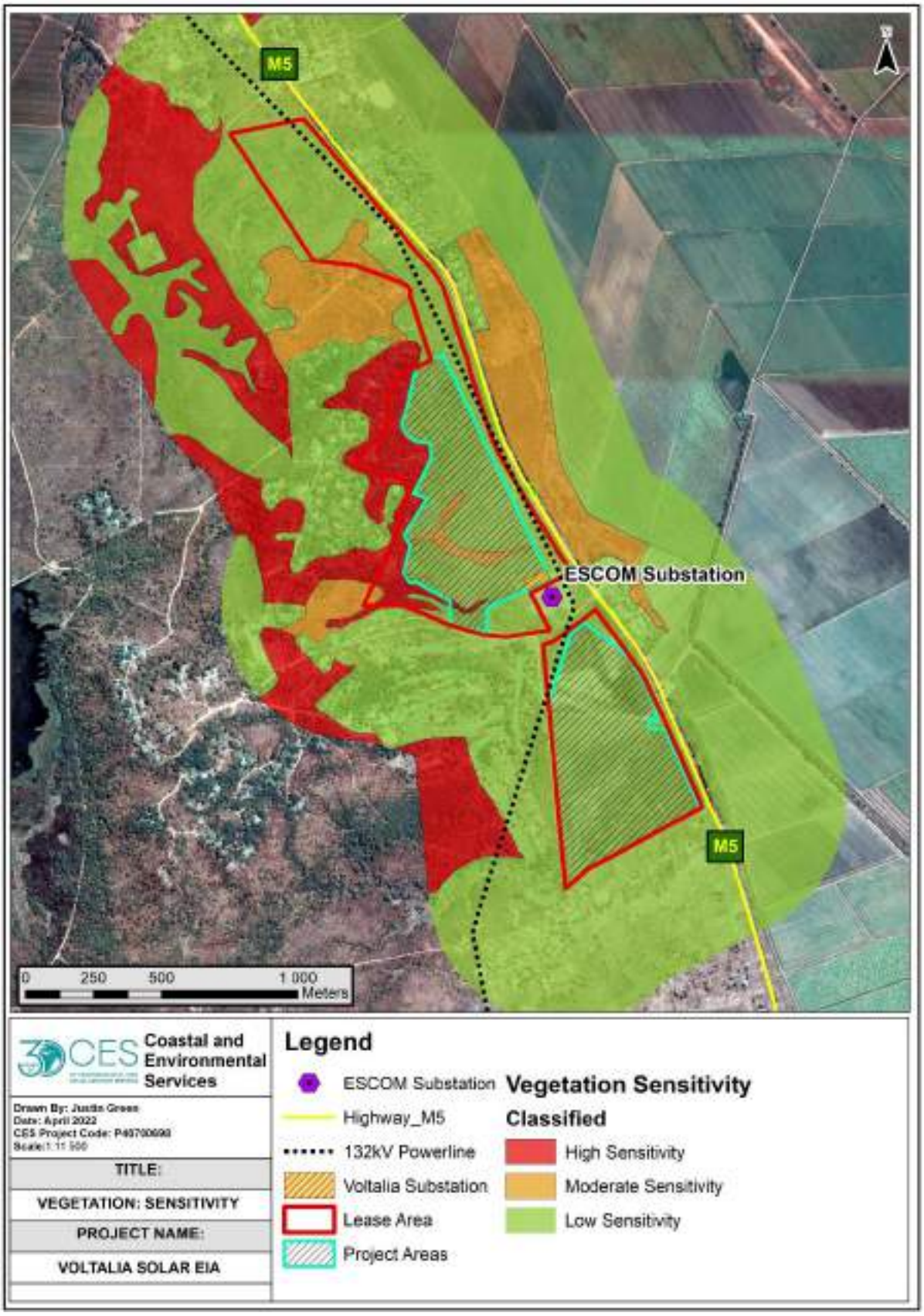

Figure 6-2: Sensitivity map showing areas of high, moderate and low sensitivity (Alternative 2)

7 IMPACT IDENTIFICATION AND ASSESSMENT

The study that has been undertaken provides the necessary information in order to assess the impacts of the proposed project on the vegetation and flora of the area at the appropriate spatial and temporal scales. The impacts identified and described below have been assessed in terms of the criteria presented in Appendix 2 of this report.

Direct impacts, cumulative impacts and the no-go alternative have been assessed for each of the impacts. For the cumulative impacts, the additive effect of the construction and operation in relation to the existing impacts associated with the existing land-uses has been assessed.

7.1 IMPACT ASSESSMENT

Table 7-1: Assessment of impacts associated with the proposed project.

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
CONSTRUCTION PHASE														
Loss of Closed Miombo Woodland	Project Impact Alternative 1	The clearing of land for the construction of the solar PV plant, powerline, access roads and substation will result in the loss of up to 10.6 ha of Closed Miombo Woodland. Since this impact will result in the permanent loss of this vegetation type, the only way to reduce the significance of this impact is to avoid impacting this vegetation type by repositioning the solar panels around this area. If this can't be done the impact will remain high even after mitigation.	Negative	Direct	Severe	Study Area	Permanent	Definite	Irreversible	Resource will be completely lost.	Difficult	HIGH	• Construction vehicles and machinery must not encroach into identified 'no-go' areas or areas outside the project footprint. • Where feasible Closed Miombo Woodland should be avoided as it provides important refugia for faunal species in the area and is an important seedbank for indigenous woody species. • Topsoil (20 cm, where possible) must be collected and stored in an area of low sensitivity and used to rehabilitate impacted areas that are no longer required during the operational phase (e.g. laydown areas). • Only indigenous species must be used for rehabilitation. • Lay down areas must not be located within any watercourses or drainage lines. • Employees must be prohibited from making open fires during the construction phase. • An alien invasive management plan for the site must be created.	HIGH
	Project Impact Alternative 2	Under this alternative, the project infrastructure will only impact 0.57ha of Closed Miombo Woodland and as such the impact will be low.	Negative	Direct	Low	Localised	Permanent	Definite	Irreversible	Resource will be completely lost.	Difficult	LOW		LOW
	Cumulative Impact	Portions of this vegetation type have already been lost due to farming activities to the east, expansion of residential areas to the west, harvesting of vegetation by local communities for building and thatching as well as from grazing of livestock. The additional loss of 10.6 ha of closed miombo woodland will therefore have a moderate cumulative impact.	Negative	Cumulative	Moderate	Local	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	• It is difficult to implement mitigation measures specific to the cumulative impacts as the applicant only has jurisdiction over their development and not over other developments or farming activities in the area. • However, it is imperative that the applicant implement the mitigation measures listed above.	N/A
	No-Go Impact	There is some evidence of harvesting of natural resources within the site. There has also been clearing and planting of woodlots in the middle of the site as well as mining for sand towards the south. These activities are likely to continue under the no-go alternative and will have a low negative impact on the remaining miombo woodland.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	LOW	• N/A	

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
Loss of Open Miombo Woodland	Project Impact Alternative 1	The clearing of land for the construction of the solar PV plant, powerline, access roads and substation will result in the permanent loss of up to 5 ha of Open Miombo Woodland. Since this will be permanently lost, the overall significance will be moderate negative even after mitigation measures have been implemented.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource will be completely lost.	Difficult	MODERATE	• Refer to mitigation measures listed above for closed miombo woodland.	MODERATE
	Project Impact Alternative 2	Under this alternative, the clearing of land for the construction of the solar PV plant, powerline, access roads and substation will result in the permanent loss of up to 2.14 ha of Open Miombo Woodland. Since this will be permanently lost, the overall significance will be moderate negative even after mitigation measures have been implemented.	Negative	Direct	Moderate	Localised	Permanent	Definite	Irreversible	Resource will be completely lost.	Difficult	LOW	• Refer to mitigation measures listed above for closed miombo woodland.	LOW
	Cumulative Impact	Portions of this vegetation type have already been lost due to farming activities to the east, expansion of residential areas to the west, harvesting of vegetation by local communities for building and thatching as well as from grazing of livestock. The additional loss of 5 ha of closed and open miombo woodland will therefore have a moderate cumulative impact.	Negative	Direct	Moderate	Local	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	It is difficult to implement mitigation measures specific to the cumulative impacts as the applicant only has jurisdiction over their development and not over other developments or farming activities in the area. However, it is imperative that the applicant implement the mitigation measures listed above.	N/A
	No-Go Impact	There is some evidence of harvesting of natural resources within the site. There has also been clearing and planting of woodlots in the middle of the site as well as mining for sand towards the south. These activities are likely to continue under the no-go alternative which has a significance of Low Negative.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	LOW	N/A	

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
Loss of Grassland-Savanna Mosaic	Project Impact Alternative 1	The clearing of land for the construction of the solar PV plant, powerline, access roads and substation will result in the loss of up to 35.9 ha of grassland-savanna mosaic. Since this vegetation type is intact and will be permanently lost, the overall significance will be moderate negative even after mitigation measures have been implemented.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource will be completely lost.	Difficult	MODERATE	• Refer to mitigation measures listed above for closed miombo woodland.	MODERATE
	Project Impact Alternative 2	The clearing of land for the construction of the solar PV plant, powerline, access roads and substation will result in the loss of up to 31.16 ha of grassland-savanna mosaic. Since this vegetation type is intact and will be permanently lost, the overall significance will be moderate negative even after mitigation measures have been implemented.	Negative	Direct	Moderate	Localised	Permanent	Definite	Irreversible	Resource will be completely lost.	Difficult	MODERATE	Refer to mitigation measures listed above for closed miombo woodland.	MODERATE
	Cumulative Impact	Portions of this vegetation type have already been lost due to farming activities to the east, expansion of residential areas to the west, harvesting of vegetation by local communities for building and thatching as well as from grazing of livestock. The additional loss of 35.9 ha of this vegetation type will therefore have a moderate cumulative impact.	Negative	Direct	Moderate	Local	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	It is difficult to implement mitigation measures specific to the cumulative impacts as the applicant only has jurisdiction over their development and not over other developments or farming activities in the area. However, it is imperative that the applicant implement the mitigation measures listed above.	N/A
	No-Go Impact	There is some evidence of harvesting of natural resources within the site. There has also been clearing and planting of woodlots in the middle of the site as well as mining for sand towards the south. These activities are likely to continue under the no-go alternative which has a significance of Low Negative.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	LOW	N/A	N/A
Loss of Plant Species of Conservation Concern	Project Impact Alternative 1 and Alternative 2	Only one species (*Pterocarpus angolensis*) was identified as a SCC due its status of Vulnerable on the National Red List. Although the permanent loss of this plant species of conservation concern within the site may occur, it is relatively widespread and the loss will not impact this specie's survival at this stage.	Negative	Direct	Moderate	Localised	Permanent	Definite	Irreversible	Resource will be partially lost.	Achievable	MODERATE	• A botanical walkthrough of the site, by an experienced botanist with knowledge of the SCC that has been identified as occurring within the site, must be undertaken. Where there are groupings of this species, this area must be marked as a no-go area and the placement of infrastructure must avoid this area. • Where there are single individuals with no other individuals within a 50m radius, these may be removed. The wood from these individuals must be given to local communities as it is a valuable resource.	LOW

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
	Cumulative Impact	The additive effect associated with the cumulative loss of *Pterocarpus angolensis* will be of moderate significance.	Negative	Direct	Moderate	Regional	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	If the powerline is positioned to avoid direct impacts on this vegetation type, the cumulative impact will be low.	N/A
	No-Go Impact	As per the above, under the no-go alternative the vegetation will remain unchanged and the current impacts are therefore negligible.	N/A									Negligible	N/A	
Disruption of Ecosystem Function and Process	Project Impact Alternative 1	Fragmentation is one of the most important impacts on vegetation as it creates breaks in previously continuous vegetation, causing a reduction in the gene pool and a decrease in species richness and diversity. It also impacts on fauna as it separates habitats and necessitates fauna having to move across exposed areas like roads to get to another section of their habitat or territory. This impact occurs when more and more areas are cleared, resulting in the isolation of functional ecosystems, which results in reduced biodiversity and reduced movement due to the absence of ecological corridors. Approximately 60 ha of near natural and transformed vegetation will be replaced by solar panels resulting in the loss of this natural ecological corridor that runs from the north to the south between the sugar plantations to the east and the residential area to the west.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	• Rehabilitate laydown areas. • Use existing access roads and upgrade these where necessary. • Where feasible, situate new powerlines adjacent to existing ones. • Faunal species are important for the dispersal of seeds and their movement must therefore not be inhibited. As such it is recommended that an ecological corridor through an area of natural vegetation is included to ensure the continued movement of species from north to south between the existing sugar plantation and residential area. It is recommended that the Closed Miombo Woodland, which forms a natural corridor is used. • Avoid locating panels in riparian areas as these provide natural ecological corridors.	MODERATE
	Project Impact Alternative 2	Approximately 60 ha of near natural and transformed vegetation will be replaced by solar panels resulting in the loss of this natural ecological corridor that runs from the north to the south between the sugar plantations to the east and the residential area to the west.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE		MODERATE
	Cumulative Impact	There is already a fair amount of habitat fragmentation as a result of the surrounding land-uses. The additive affect associated with the loss of natural vegetation will be of moderate significance.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	It is difficult to implement mitigation measures specific to the cumulative impacts as the applicant only has jurisdiction over their development and not over other developments or farming activities in the area. However, it is imperative that the applicant implement the mitigation measures listed above.	N/A

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
	No-Go Impact	Under the no go alternative, habitat fragmentation has already occurred and will continue to do so. However, this will be at a significantly smaller scale than the direct impact.	Negative	Direct	Slight	Localised	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	LOW	N/A	N/A
Establishment of Alien Plant Species	Project Impact Alternative 1 and Alternative 2	Disturbance to habitats often results in the infestation of alien species and displacement of indigenous vegetation unless these are controlled. There are already two species of Eucalyptus on site as well as Gmelina. Should this happen the impact will be of high significance. However, this impact is easily mitigated trough the implementation of an alien invasive management and monitoring plan.	Negative	Direct	Severe	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Achievable	HIGH	• The site must be checked regularly for the presence of alien invasive species. • An alien invasive management and monitoring plan must be incorporated into the EMPr. • The ECO must create a list with accompanying photographs of possible alien invasive species that could occur on site prior to construction. This photo guide must be used to determine if any alien invasive species are present.	LOW
	Cumulative Impact	There is already evidence of alien species on site. These are mostly being grown within woodlots but there is the risk that they could escape into the natural environment if not controlled. The clearing of vegetation for the construction of the solar PV plant could result in the disturbance of the seedbank and establishment of alien species outside of the controlled woodlots. The additive impact will be of moderate significance.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	It is difficult to implement mitigation measures specific to the cumulative impacts as the applicant only has jurisdiction over their development and not over other developments or farming activities in the area. However, it is imperative that the applicant implement the mitigation measures listed above.	N/A
	No-Go Impact	Under the no-go alternative, the infestation of alien species is likely to be controlled and kept within woodlots.	Negative	Direct	Slight	Localised	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	LOW	N/A	N/A
Loss of ecosystem services provided by the plant communities identified in the study area	Project Impact Alternative 1 and Alternative 2	Loss of ecosystems services through the removal of vegetation communities will result in the loss of ecosystem services provided by each vegetation type. This is relevant since the local communities are reliant on these areas as a source of food and medication, for construction materials and fuel wood and as a source of income through activities such as charcoal production. These species, however, are fairly widespread and are also found outside of the footprint of the proposed project area.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	• Allow local communities the opportunity to harvest plants prior to the start of project activities.	MODERATE

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
	Cumulative Impact	The cumulative loss of natural resources as a result of development occurring in the area will mean that communities reliant on the project site for ecosystem services will need to look further afield and possibly travel longer distances to find what they need. Given that there is development on either side of the project site this impact will be of moderate significance.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE		
	No-Go Impact	Under the no-go impact local communities will continue to harvest raw materials from the project site and the ecosystem services provided by the project site will remain uninterrupted. The impact will be negligible.	N/A									N/A	N/A	N/A
Operational Phase														
Infestation of Alien Plant Species	Project Impact Alternative 1 and Alternative 2	If laydown areas and roads are not rehabilitated, these disturbed areas can become places for alien invasive species to become established and if left unmitigated these species can spread and establish themselves in intact vegetation resulting in the displacement of indigenous species.	Negative	Direct	Severe	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Achievable	MODERATE	• The site must be checked regularly for the presence of alien invasive species. When alien invasive species are found, immediate action must be taken to remove them. • An alien invasive management and monitoring plan must be incorporated into the EMPr. • The ECO must create a list with accompanying photographs of possible alien invasive species that could occur on site prior to construction. This photo guide must be used to determine if any alien invasive species are present.	LOW
	Cumulative Impact	The cumulative impact is likely to be of moderate significance.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	It is difficult to implement mitigation measures specific to the cumulative impacts as the applicant only has jurisdiction over their development and not over other developments or farming activities in the area. However, it is imperative that the applicant implement the mitigation measures listed above.	• N/A
	No-Go Impact	Under the no-go alternative, the infestation of alien species is likely to continue.	Negative	Direct	Moderate	Localised	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	MODERATE	N/A	N/A

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
Soil Erosion	Project Impact Alternative 1 and Alternative 2	An increase in hard surfaces (parking area, buildings, solar panels) will result in an increase in stormwater which could lead to erosion.	Negative	Direct	Moderate	Localised	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	MODERATE	• An operational stormwater management plan must be designed and implemented prior to construction. • In terms of minimising discharge of pollutants and run-off quantity requiring treatment, all stormwater run-off must be properly segregated and clean water run-off diverted to prevent it mixing with water containing a high solids content. • All run-off from wash areas must pass through an oil trap and must be treated as hazardous due to the presence of hydrocarbons. All other run-off water must pass through a sediment trap to remove the majority of suspended solids prior to discharge to the environment. All settled material must be disposed of at an assigned landfill. • The quality of all liquid waste streams discharged from the site, including stormwater, must be monitored regularly to ensure compliance with the requirements of relevant legislation and standards.	LOW
	Cumulative Impact	Since there are no existing solar PV plants in the area, the cumulative impact is negligible.	N/A									N/A	N/A	N/A
	No-Go Impact	Soil erosion within the project site is negligible.	N/A									N/A	N/A	N/A
Change in species composition	Project Impact Alternative 1 and Alternative 2	The shading effect of the panels results in a change in species composition. For example, it may favour more herbs and possibly " weeds" or ruderals.	Negative	Direct	Slight	Localised	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	LOW	• Ensure that "weeds" or ruderals do not move into natural habitat.	LOW
	Cumulative Impact	Since there are no existing solar PV plants in the area, the cumulative impact is negligible.	N/A									N/A	• N/A	N/A
	No-Go Impact	Not Applicable	N/A									N/A	• N/A	N/A

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
Decommissioning Phase														
Loss of Indigenous Vegetation	Project Impact Alternative 1 and Alternative 2	The decommissioning of the solar PV plant will require laydown areas and will disrupt vegetation that has re-established around the areas that were disturbed during the construction phase. The loss of vegetation will be similar to the construction phase impacts.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	• Construction vehicles and machinery must not encroach into identified 'no-go' areas or areas outside the project footprint. • Topsoil (20 cm, where possible) must be collected and stored in an area of low sensitivity and used to rehabilitate impacted areas that are no longer required during the operational phase (e.g. laydown areas). • Only indigenous species must be used for rehabilitation. • Lay down areas must not be located within any watercourses or drainage lines. • Employees must be prohibited from making open fires during the construction phase. • An alien invasive management plan for the site must be created.	MODERATE
	Cumulative Impact	Portions of this vegetation type have already been lost due to the current land use that are currently occurring adjacent to the site as well as from grazing of livestock on neighbouring farms. However, the footprint of the powerline is relatively small compared to the adjacent mine. The additional loss of vegetation will have a Moderate cumulative impact.	Negative	Direct	Moderate	Regional	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	It is difficult to implement mitigation measures specific to the cumulative impacts as the applicant only has jurisdiction over their development and not over other developments or farming activities in the area. • However, it is imperative that the applicant implement the mitigation measures listed above.	N/A
	No-Go Impact	N/A										N/A	N/A	N/A
Infestation of Alien Plant Species	Project Impact Alternative 1 and Alternative 2	If laydown areas and roads are not rehabilitated, these disturbed areas can become places for alien invasive species to become established and if left unmitigated these species can spread and establish themselves in intact vegetation resulting in the displacement of indigenous species.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Achievable	MODERATE	• The site must be checked regularly for the presence of alien invasive species. When alien invasive species are found, immediate action must be taken to remove them. • An alien invasive management and monitoring plan must be incorporated into the EMPr. • The ECO must create a list with accompanying photographs of possible alien invasive species that could occur on site prior to construction. This photo guide must be used to determine if any alien invasive species are present.	LOW
	Cumulative	Since there is already evidence of alien species on site, the cumulative impact is likely to be of moderate significance.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	It is difficult to implement mitigation measures specific to the cumulative impacts as the applicant only has jurisdiction over their development and not over other developments or farming activities in the area. However, it is imperative that the applicant implement the mitigation measures listed above.	N/A
	N/A											N/A	N/A	N/A

8 IMPACT STATEMENT, CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

The vegetation and floral communities found within the northern portion of the project site are typically intact with limited evidence of clearing occurring. The middle portion has evidence of the site being used, as areas have been cleared for woodlots and there was evidence of harvesting of natural materials by local communities. The southern portion is the most ecologically degraded portion of the site.

The general biodiversity of the site was relatively good with 152 species of plant being recorded.

Two alternative infrastructure options were assessed. Alternative 2 was designed by the client based on feedback from the specialist studies that were undertaken.

Alternative 1
The project infrastructure for alternative 1 will result in the loss of approximately 10.6 ha of Closed Miombo Woodland, 5 ha of Open Miombo Woodland and 35.9 ha Grassland-Savanna Mosaic and for alternative 2 will result in the loss of 0.57 ha of Closed Miombo Woodland, 2.14 ha of Open Miombo Woodland and 31.16 ha Grassland-Savanna Mosaic. Impacts associated with this development include the following:

- Loss of vegetation communities, biodiversity and species of conservation concern will occur as a result of direct clearing during construction and indirect clearing as a result of the displacement of farmlands. The loss of vegetation in these instances is difficult to mitigate and as such are typically high by their very nature.
- Impacts associated with habitat fragmentation, edge effects and the infestation of alien invasive species are easy to mitigate and are thus not considered to be a concern at this specific site.

A summary of the impacts for the construction and operational phases, pre- and post mitigation, have been included in Figure 8-1 and 8-2. The pie charts illustrate that if the project is managed appropriately and the mitigation measures implemented, most of the impacts can be reduced from high and moderate to moderate and low impacts and that the impacts associated with Alternative 2 are lower than the ones associated with Alternative 1 The preferred alternative, from a botanical perspective, is thus Alternative 2.

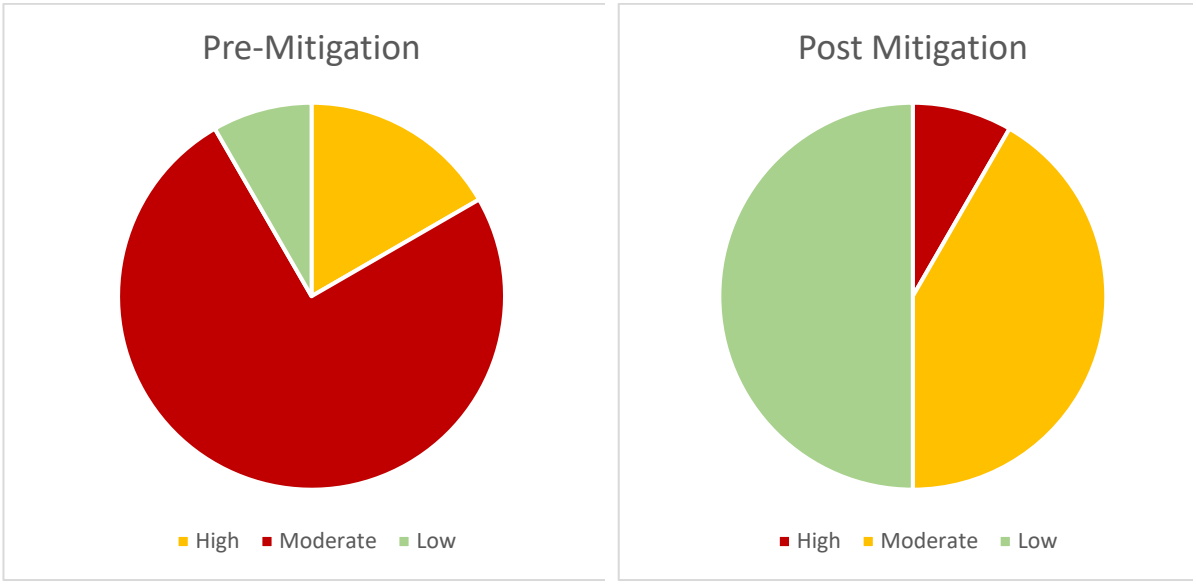

Figure 8-1: Pie charts summarising the number of high, moderate and low impacts before and after mitigation for Alternative 1.

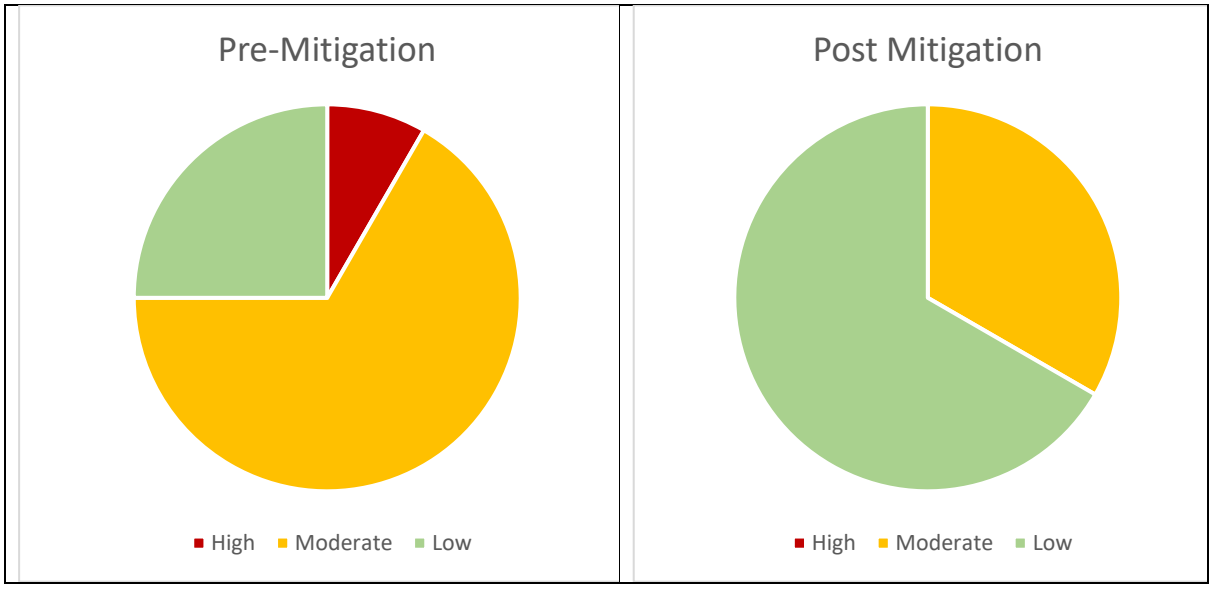

Figure 8-2: Pie charts summarising the number of high, moderate and low impacts before and after mitigation for Alternative 2.

8.2 Conditions of EMPr, Environmental License and Monitoring

It is recommended that the following conditions are included in the Final EMPr as well as the conditions of the Environmental License, if granted:

- All necessary permitting and authorisations must be obtained prior to the commencement of any construction activities;

- A suitably qualified ECO must be appointed prior to the commencement of the construction phase;
- The placement of infrastructure within Closed Miombo Woodland must be avoided and this area should be conserved as an ecological corridor
- An Erosion Management Plan must be developed prior to the commencement of construction activities in order to mitigate the unnecessary loss of topsoil and runoff;
- An Alien Vegetation Management plan should be compiled (for implementation during the phases that follow the Planning and Design Phase);
- A comprehensive Rehabilitation Plan should be compiled and implemented. Only indigenous plant species typical of the local vegetation should be used for rehabilitation purposes.

8.3 RECOMMENDATIONS

Alternative 2 is the preferred layout as the footprint of the proposed development avoids the Closed Miombo Woodland allowing this vegetation unit to continue functioning as an important natural corridor for the dispersal of seed and movement of fauna.

It is recommended that the development footprint of the proposed solar PV plant and associated infrastructure (roads and laydown areas) must be demarcated to prevent any encroachment of construction or operational activities into surrounding natural areas. Minor location deviations from the proposed works is deemed acceptable but the footprint may not be made larger.

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APPENDIX 1: LIST OF PLANT SPECIES OBSERVED FROM THE PROJECT AREA.

Table A.1 Plant species observed at the site.

Family	Scientific Name	Local Name	National Plant Red-List category	IUCN Red-List category	Ecosystem Services
ACANTHACEAE	*Blepharis acanthodioides*		Least Concern	Least Concern	Traditional medicine
AMARANTHACEA	*Achyranthes aspera*	Prickly chaff-flower	Least Concern	Least Concern	Regulating soil erosion
ANACARDIACEAE	*Lannea discolor*	Grape tree	Least Concern	Least Concern	Traditional medicine
ANACARDIACEAE	*Lannea edulis*	Wild grape	Least Concern	Least Concern	Traditional medicine
ANACARDIACEAE	*Mangifera indica*	Mango	Least Concern	Least Concern	Edible fruit, Firewood
ANACARDIACEAE	*Ozoroa insignis*	Tar berry	Least Concern	Least Concern	Firewood
ANACARDIACEAE	*Ozoroa reticulata*	Tar berry	Lower Risk-least concern	Least Concern	Firewood
ANNONACEAE	*Annona senegalensis*	African custard-apple	Least Concern	Least Concern	Firewood, Invasive
APOCYNACEAE	*Diplorhynchus condylocarpon*	Wild rubber	Least Concern	Least Concern	Traditional medicine
APOCYNACEAE	*Trachycalymma cristatum (ASCIEPIAS)*	Milkweed	Least Concern	Least Concern	Regulating soil erosion
ASPARAGACEAE	*Asparagus africana*	Bush asparagus	Least Concern	Least Concern	Traditional medicine. Regulating soil erosion
ASTERACEAE	*Ageratum conyzoides*	Goatweed	Least Concern	Least Concern	Regulating soil erosion
ASTERACEAE	*Bidens pilosa*	Black -jack	Least Concern	Least Concern	Leafy vegetable
ASTERACEAE	*Bidens schimperi*	Mnondo bur-marigold	Least Concern	Least Concern	Leafy vegetable
ASTERACEAE	*Bidens steppia*	Msasa bur-marigold	Least Concern	Least Concern	Leafy vegetable
ASTERACEAE	*Blumea alata*	Blumea star	Least Concern	Least Concern	Firewood. Timber, Firewood
ASTERACEAE	*Conyza bonariensis*	hairy fleabane	Least Concern	Least Concern	Regulating soil erosion, Traditional medicine
ASTERACEAE	*Crassocephalum rubens*	Chinunsi	Least Concern	Least Concern	Regulating soil erosion
ASTERACEAE	*Eclipta prostrata*	False daisy	Least Concern	Least Concern	Regulating soil erosion
ASTERACEAE	*Emilia sonchhifolia*	lilac tassleflower	Least Concern	Least Concern	Regulating soil erosion
ASTERACEAE	*Nidorella resedifolia*	Nidorella	Least Concern	Least Concern	Leafy vegetable, Regulating soil erosion
ASTERACEAE	*Sonchus oleraceus*	Milky tassel	Least Concern	Least Concern	Regulating soil erosion
ASTERACEAE	*Tridax procumbens*	Tridax daisy	Least Concern	Least Concern	Regulating soil erosion

ASTERACEAE	*Vernonia adoensis*	Vernonia	Least Concern	Least Concern	Regulating soil erosion
ASTERACEAE	*Vernonia amygdalina*	Bitter leaf	Least Concern	Least Concern	Traditional medicine
ASTERACEAE	*Vernonia cinerea*	Little ironweed	Least Concern	Least Concern	Regulating soil erosion
ASTERACEAE	*Vernonia colorata*	Lowveld tree vernonia	Least Concern	Least Concern	Traditional medicine
ASTERACEAE	*Vernonia glabra*	Cornflower vernonia	Least Concern	Least Concern	Traditional medicine, Regulating soil erosion
ASTERACEAE	*Vernonia karanguensis*	Bifferleaf	Least Concern	Least Concern	Regulating soil erosion
ASTERACEAE	*Vernonia melleri*	Vernonia	Least Concern	Least Concern	Regulating soil erosion
ASTERACEAE	*Vernonia petersii*	Vernonia	Least Concern	Least Concern	Traditional medicine, Regulating soil erosion
ASTERACEAE	*Vernonia poskeana*	vernonia	Least Concern	Least Concern	Regulating soil erosion
BIGNONIACEAE	*Kigellia africana*	Sausage tree	Least Concern	Least Concern	Firewood, Timber, Traditional medicine
BIGNONIACEAE	*Stereospermum kunthianum*	Pink jacaranda	Least Concern	Least Concern	Traditional medicine
BORAGINACEAE	*Trichodesma physaloides*	Bell's of St. Mary's	Least Concern	Least Concern	Regulating soil erosion
BORAGINACEAE	*Trichodesma zeylanicum*	Camel bush	Least Concern	Least Concern	Traditional medicine
BURSERACEAE	*Commiphora mosambicensis*	Pepper-leaved commiphora	Least Concern	Least Concern	Edible fruit, Resin
CAPPARACEAE	*Boscia angustifolia*	Rough-leaved shepherd tree	Least Concern	Least Concern	Edible fruit, Traditional medicine
CAPPARACEAE	*Cleome monophylla*	Spindle pod	Least Concern	Least Concern	Traditional medicine, Regulating soil erosion
CELASTRACEAE	*Maytenus heretophylla*	Common spike-thorn	Least Concern	Least Concern	Making carvings and household tools
CHRYSOBALANACEAE	*Parinari curatellifolia*	Hissing tree	Least Concern	Least Concern	Edible fruit, Timber, Firewood
CLELASTRACEAE	*Hippocratea indica*	Mopane paddle-pod	Least Concern	Least Concern	Regulating soil erosion
CLUSIACEAE	*Garcinia livingstonei*	Africana mangosteen	Least Concern	Least Concern	Firewood, Art and craft material
COMBRETACEAE	*Combretum collinum*	Bicoloured bushwillow	Least Concern	Least Concern	Firewood, Traditional medicine
COMBRETACEAE	*Combretum molle*	Velvet bushwillow	Least Concern	Least Concern	Firewood, Traditional medicine
COMBRETACEAE	*Combretum zeyheri*	Large-fruit bushwillow	Least Concern	Least Concern	Firewood
COMBRETACEAE	*Terminalia sericea*	Silver terminaria	Least Concern	Least Concern	Traditional medicine, Firewood
COMMELINACEAE	*Commelina benghalensis*	Spreading dayflower	Least Concern	Least Concern	Regulating soil erosion
CONVOLVULACEAE	*Ipomoea aquatica*	River spanish	Least Concern	Least Concern	Regulating soil erosion
CONVOLVULACEAE	*Ipomoea batatas*	sweet potato	Least Concern	Least Concern	Edible tuber
CONVOLVULACEAE	*Ipomoea rubens*	Climbing potato	Least Concern	Least Concern	Regulating soil erosion

CONVOLVULACEAE	*Ipomoea shirambensis*	Zambezi morning-glory	Least Concern	Least Concern	Regulating soil erosion
CRASSULACEAE	*Kalanchoe elizae*	Kalanchoe	Least Concern	Least Concern	Traditional medicine
CYPERACEAE	*Cyperus filiformis*	Wiry flatsedge	Least Concern	Least Concern	Regulating soil erosion
EBENACEAE	*Diospyros kirkiana*	Jackal-berry	Least Concern	Least Concern	Edible fruit, Firewood
EBENACEAE	*Diospyros kirkii*	Large-leaved-jackal berry	Least Concern	Least Concern	Traditional medicine, Firewood
EBENACEAE	*Euclea racemosa*	Bush gurri	Least Concern	Least Concern	Edible fruit
EUPHORBIACEAE	*Euphorbia hirta*	Garden spurge	Least Concern	Least Concern	Traditional medicine
FABACEAE	*Acacia nilotica*	Thorny acacia	Least Concern	Least Concern	Traditional medicine
FABACEAE	*Acacia sieberiana*	Paperbark acacia	Least Concern	Least Concern	Firewood, Firewood
FABACEAE	*Acacia xanthophloea*	Fever tree	Least Concern	Least Concern	Traditional medicine, Timber, Firewood
FABACEAE	*Aeschynomene abyssinica*	Joint-vetch	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Albizia lebbeck*	lebbeck	Least Concern	Least Concern	Firewood, Timber
FABACEAE	*Bauhinia petersiana*	Large white bauhinia	Least Concern	Least Concern	Firewood, Traditional medicine
FABACEAE	*Brachystegia boehmii*	Mombo	Least Concern	Least Concern	Timber, Firewood
FABACEAE	*Brachystegia longifolia*	Mombo	Least Concern	Least Concern	Firewwood, Timber
FABACEAE	*Brachystegia taxifolia*	Mombo	Least Concern	Least Concern	Firewood
FABACEAE	*Brachystegia utilis*	Miombo	Least Concern	Least Concern	Firewood
FABACEAE	*Cacssa abbreviata*	Chinese latern tree	Least Concern	Least Concern	Firewood Traditional medicine
FABACEAE	*Chamaecrista kirkii*	Yellow-flower chamaecrista	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Chamaecrista parva*	Deep yellow-flower chamaecrista	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Crotalaria alata*	Winged-stem rattlepod	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Crotalaria goetzei*	Rattlepod	Least Concern	Least Concern	Traditional medicine, Regulating soil erosion
FABACEAE	*Crotalaria natalitia*	Rattlepod	Least Concern	Least Concern	Traditional medicine, Regulating soil erosion
FABACEAE	*Crotalaria prismatica*	rattle bean	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Desmodium barbatum*	zarzabacoa pelud	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Desmodium intortum*	Green-leaf desmodium	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Dichrostachys cinerea*	Chinese lantern	Least Concern	Least Concern	Traditional medicine, Firewood
FABACEAE	*Dolichos kilimandscharichus*	Veld lupin	Least Concern	Least Concern	Regulating soil erosion

FABACEAE	*Eriosema buchananii*	Yellow-flowered plant	Least Concern	Least Concern	Traditional medicine
FABACEAE	*Eriosema engleriana*	Blue bush fire bdean	Least Concern	Least Concern	Traditional medicine
FABACEAE	*Eriosema psoraleoides*	Canary pea	Least Concern	Least Concern	Traditional medicine
FABACEAE	*Erythrina abyssinica*	Red hot poker tree	Least Concern	Least Concern	Making carvings, Traditional medicine
FABACEAE	*Indigofera antunesiana*	Indigo	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Indigofera emarginata*	True indigo	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Indigofera hilaris*	Gay Indigofera	Vulnerable	Least Concern	Regulating soil erosion
FABACEAE	*Indigofera hirsuta*	Hairy indigo	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Indigofera lyalli*	Red indigo	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Mucuna poggei*	Buffalo bean	Least Concern	Least Concern	Regulating soil erosion
FABACEAE	*Pericopsis angolensis*	East African Afrormosia	Least Concern	Least Concern	Firewood, Traditional medicine
FABACEAE	*Piliostigma thonningii*	Camel's foot tree	Least Concern	Least Concern	Edible fruit, Firewood
FABACEAE	*Pterocarpus angolensis*	African teak	Vulnerable	Least Concern	Traditional medicine, Firewood, Timber
FABACEAE	*Pterocarpus bussei*	Bloodwood	Least Concern	Least Concern	Firewood, Timber, Traditional medicine
FABACEAE	*Pterocarpus rotundifolius*	Round-leaved bloodwood	Least Concern	Least Concern	Firewood, Traditional medicine
LAMIACEAE	*Gmelina arborea*	Gmelina	Least Concern	Least Concern	Firewood, Invasive
LAMIACEAE	*Vitex doniana*	Black plum	Least Concern	Least Concern	Edible fruit, Firewood
LEGUMINOSAE	*Julbernardia globiflora*	Ntondo	Least Concern	Least Concern	Firewood, Construction materials
LEGUMINOSAE	*Julbernardia paniculata*	Mtondo	Least Concern	Least Concern	Timber, Firewood
LOGANIACEAE	*Strychnos cocculoides*	Corky monkey-orange	Least Concern	Least Concern	Edible fruit
LOGANIACEAE	*Strychnos innocua*	Natal tree	Least Concern	Least Concern	Edible fruit, Firewood
MALVACEAE	*Dombeya rotundifolia*	wild pear	Least Concern	Least Concern	Firewood, Poles
MALVACEAE	*Grewia bicolor*	White-leaved resin	Least Concern	Least Concern	Traditional medicine
MALVACEAE	*Hibiscus cannabinus*	Java jute	Least Concern	Least Concern	Leafy vegetable
MALVACEAE	*Hibiscus diversifolius*	Prickly hibiscus plant	Least Concern	Least Concern	Edible leafy vegetable, Construction materials
MALVACEAE	*Sida acuta*	Common wireweed	Least Concern	Least Concern	Making bloom, Regulating soil erosion
STERCULIACEAE	*Sterculia africana*	Tick tree	Least Concern	Least Concern	Regulating soil erosion
MALVACEAE	*Thespesia garckeana*	Snot apple	Least Concern	Least Concern	Edible fruits, Traditional medicine

MALVACEAE	*Triumfetta annua*	Orangen Burr-Bush	Least Concern	Least Concern	Regulating soil erosion
MELIACEAE	*Turraea nilotica*	Bushveld honeysuckle tree	Least Concern	Least Concern	Traditional medicine
MORACEAE	*Ficus sycomorus*	Sycamore fig	Least Concern	Least Concern	Edible fruit, water conservation
MYRTACEAE	*Eucalyptus globulus*	Southern bluegum	Least Concern	Least Concern	Timber, Firewood
MYRTACEAE	*Eucalyptus saligna*	Blue gum	Least Concern	Least Concern	Timber, Firewood
MYRTACEAE	*Psidium guajava*	Gwava	Least Concern	Least Concern	Edible fruit, Firewood
OCHNACEAE	*Ochna schweinfurthiana*	Brick-red ochna	Least Concern	Least Concern	Traditional medicine
OCHNACEAE	*Ochna schweinfurthii*	Red ironwood	Least Concern	Least Concern	Traditional medicine
ORCHIDACEAE	*Calanthe sylvatica*	Christmas orchis	Least Concern	Least Concern	Traditional medicine
ORCHIDACEAE	*Eulophia angolensis*	Banana orchid	Least Concern	Least Concern	Regulating soil erosion
PASSIFLORACEAE	*Adenia gummifera*	Monkey rope	Least Concern	Least Concern	Traditional medicine
PHYLLANTHACEAE	*Antidesma venosum*	Tassel-berry	Least Concern	Least Concern	Regulating soil erosion
PHYLLANTHACEAE	*Bridelia cathartica*	Blue sweetberry	Least Concern	Least Concern	Firewood, Traditional medicine
PHYLLANTHACEAE	*Flueggea virosa*	Common bushweed	Least Concern	Least Concern	Edible fruit, Firewood
PHYLLANTHACEAE	*Pseudolachnostylis maprouneifolia*	Kudu berry	Least Concern	Least Concern	Construction materials, Firewood
PHYLLANTHACEAE	*Uapaca nitida*	Narrow-leaved wild loquat	Least Concern	Least Concern	Edible fruit, Firewood
POACEAE	*Eragrostis ciliaris*	Gophertail lovegrass	Least Concern	Least Concern	Regulating soil erosion
POACEAE	*Exotheca abyssinica*	Abyssinica grass	Least Concern	Least Concern	Thatch grass, Regulating soil erosion
POACEAE	*Heteropogon contortus*	Black spear grass	Least Concern	Least Concern	Thatch grass
POACEAE	*Hyparrhenia filipendula*	Fine-hood grass	Least Concern	Least Concern	Thatch grass
POACEAE	*Hyparrhenia nyassae*	Thatching grass	Least Concern	Least Concern	Thatch grass
POACEAE	*Hyperthelia dissoluta*	Yellow thatch grass	Least Concern	Least Concern	Thatch grass, Regulating soil erosion
POACEAE	*Imperata cylindrica*	Spear grass	Least Concern	Least Concern	Regulating soil erosion
POACEAE	*Kohautia coccinea*	Scarlet snake needle-grass	Least Concern	Least Concern	Regulating soil erosion
POACEAE	*Leersia hexandra*	Southern cut-grass	Least Concern	Least Concern	Regulating soil erosion
POACEAE	*Loudetia simplex*	Russet grass	Least Concern	Least Concern	Thatch grass, Regulating soil erosion
POACEAE	*Melinis repens*	Natal red-top grass	Least Concern	Least Concern	Regulating soil erosion
POACEAE	*Oryza sativa*	Rice	Least Concern	Least Concern	Food

POACEAE	*Oxytenanthera abyssinica*	Savannah bamboo	Least Concern	Least Concern	Firewood, Construction materials
POACEAE	*Pennisetum purpureum*	Elephant grass	Least Concern	Least Concern	Thatch grass, Construction
POACEAE	*Pennisetum setaceum*	Fountain grass	Least Concern	Least Concern	Ornamental grass
POACEAE	*Pennisetum unisetum*	Natal grass	Least Concern	Least Concern	Regulating soil erosion
POACEAE	*Sporobolus pyramidalis*	Narrow-plumed dropseed	Least Concern	Least Concern	Thatch grass, Regulating soil erosion
POACEAE	*Themeda triandra*	Kangaroo grass	Least Concern	Least Concern	Traditional medicine
POACEAE	*Vossia cuspidata*	Hippo grass	Least Concern	Least Concern	Regulating soil erosion
RUBIACEAE	*Fadogia cienkowskii*		Least Concern	Least Concern	Regulating soil erosion
RUBIACEAE	*Pentus purpurea*	Pentas plant	Least Concern	Least Concern	Regulating soil erosion
RUBIACEAE	*Vangueria infausta*	African medlar	Least Concern	Least Concern	Edible fruit, Firewood
SALICACEAE	*Flacourtia indica*	Black plum	Least Concern	Least Concern	Edible fruit, Firewood
SAPINDACEAE	*Zanha africana*	velvet-fruit zanha	Least Concern	Least Concern	Traditional medicine, Firewood
SOLANACEAE	*Solanum panduriforme*	Bitter apple	Least Concern	Least Concern	Traditional medicine
THYMELAEACEAE	*Gnidia buchananii*	Buchananii	Least Concern	Least Concern	Regulating soil erosion
THYMELAEACEAE	*Gnidia involucrata*	Buchananii	Least Concern	Least Concern	Regulating soil erosion
VITACEAE	*Cissus cornifolia*	Mwanamphepo	Least Concern	Least Concern	Traditional medicine
VITACEAE	*Cissus throdae*	Veldt grape	Least Concern	Least Concern	Traditional medicine

APPENDIX 2: IMPACT RATING SCALE

To ensure a balanced and objective approach to assessing the significance of potential impacts, a standardised rating scale was adopted which allows for the direct comparison of specialist studies. This rating scale has been developed in accordance with the requirements outlined in Appendix 1 of the EIA Regulations (2014 and subsequent 2017 amendments).

Impact significance pre-mitigation

This rating scale adopts six key factors to determine the overall significance of the impact prior to mitigation:

1. **Nature of impact:** Defines whether the impact has a negative or positive effect on the receiving environment.
2. **Type of impact:** Defines whether the impact has a direct, indirect or cumulative effect on the environment.
3. **Duration:** defines the relationship of the impact to temporal scales. The temporal scale defines the significance of the impact at various time scales as an indication of the duration of the impact. This may extend from the short-term (less than 5 years, equivalent to the construction phase) to permanent. Generally, the longer the impact occurs the greater the significance of any given impact.
4. **Extent:** describes the relationship of the impact to spatial scales i.e. the physical extent of the impact. This may extend from the local area to an impact that crosses international boundaries. The wider the spatial scale the impact extends, the more significant the impact is considered to be.
5. **Probability:** refers to the likelihood (risk or chance) of the impact occurring. While many impacts generally do occur, there is considerable uncertainty in terms of others. The scale varies from unlikely to definite, with the overall impact significance increasing as the likelihood increases.
6. **Severity or benefits:** the severity/beneficial scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on the receiving environment. The severity of an impact can be evaluated prior and post mitigation to demonstrate the seriousness of the impact if it is not mitigated, as well as the effectiveness of the mitigation measures. The word 'mitigation' does not only refer to 'compensation', but also includes concepts of containment and remedy. For beneficial impacts, optimization refers to any measure that can enhance the benefits. Mitigation or optimisation should be practical, technically feasible and economically viable.

For each impact, the duration, extent and probability are ranked and assigned a score. These scores are combined and used to determine the overall impact significance prior to mitigation. They must then be considered against the severity rating to determine the overall significance of an activity. This is because the severity of the impact is far more important than the other three criteria. The overall significance is either negative or positive (Criterion 1) and direct, indirect or cumulative (Criterion 2).

Table D1: Evaluation Criteria.

Duration (Temporal Scale)		
Short term	*Less than 5 years*	
Medium term	*Between 5-20 years*	
Long term	*Between 20 and 40 years (a generation) and from a human perspective also permanent*	
Permanent	*Over 40 years and resulting in a permanent and lasting change that will always be there*	
Extent (Spatial Scale)		
Localised	*At localised scale and a few hectares in extent*	
Study Area	*The proposed site and its immediate environs*	
Regional	*District and Provincial level*	
National	*Country*	
International	*Internationally*	
Probability (Likelihood)		
Unlikely	*The likelihood of these impacts occurring is slight*	
May Occur	*The likelihood of these impacts occurring is possible*	
Probable	*The likelihood of these impacts occurring is probable*	
Definite	*The likelihood is that this impact will definitely occur*	
Severity Scale	*Severity*	*Benefit*
Very Severe/ Beneficial	An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated.	A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit.
Severe/ Beneficial	Long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming, or some combination of these.	A long-term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these.
Moderately severe/Beneficial	Medium to long term impacts on the affected system(s) or party (ies), which could be mitigated.	A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way.
Slight	Medium- or short-term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary.	A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and

		quicker, or some combination of these.
No effect/don't or can't know	The system(s) or party(ies) is not affected by the proposed development.	In certain cases, it may not be possible to determine the severity of an impact.

** In certain cases, it may not be possible to determine the severity of an impact thus it may be determined: Don't know/Can't know.*

Table D2: Description of Overall Significance Rating

Significance Rate		*Description*
Don't Know		*In certain cases, it may not be possible to determine the significance of an impact. For example, the primary or secondary impacts on the social or natural environment given the available information.*
NO SIGNIFICANCE		*There are no primary or secondary effects at all that are important to scientists or the public.*
LOW NEGATIVE	***LOW POSITIVE***	*Impacts of low significance are typically acceptable impacts for which mitigation is desirable but not essential. The impact by itself is insufficient, even in combination with other low impacts, to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural environment or on social systems.*
MODERATE NEGATIVE	**MODERATE POSITIVE**	*Impacts of moderate significance are impacts that require mitigation. The impact is insufficient by itself to prevent the implementation of the project but in conjunction with other impacts may prevent its implementation. These impacts will usually result in a negative medium to long-term effect on the natural environment or on social systems.*
HIGH NEGATIVE	***HIGH POSITIVE***	*Impacts that are rated as being high are serious impacts and may prevent the implementation of the project if no mitigation measures are implemented, or the impact is very difficult to mitigate. These impacts would be considered by society as constituting a major and usually long-term change to the environment or social systems and result in severe effects.*
VERY HIGH NEGATIVE	***VERY HIGH POSITIVE***	*Impacts that are rated as very high are very serious impact which may be sufficient by itself to prevent the implementation of the project. The impact may result in permanent change. Very often these impacts are unmitigable and usually result in very severe effects or very beneficial effects.*

Impact significance post-mitigation

Once mitigation measures are proposed, the following three factors are then considered to determine the overall significance of the impact after mitigation.

1. **Reversibility Scale**: This scale defines the degree to which an environment can be returned to its original/partially original state.

2. **Irreplaceable loss Scale:** This scale defines the degree of loss which an impact may cause.

3. **Mitigation potential Scale:** This scale defines the degree of difficulty of reversing and/or mitigating the various impacts ranges from very difficult to easily achievable. Both the practical feasibility of the measure, the potential cost and the potential effectiveness is taken into consideration when determining the appropriate degree of difficulty.

Table D3: Post-mitigation Evaluation Criteria

Reversibility	
Reversible	*The activity will lead to an impact that can be reversed provided appropriate mitigation measures are implemented.*
Irreversible	*The activity will lead to an impact that is permanent regardless of the implementation of mitigation measures.*
Irreplaceable loss	
Resource will not be lost	*The resource will not be lost/destroyed provided mitigation measures are implemented.*
Resource will be partly lost	*The resource will be partially destroyed even though mitigation measures are implemented.*
Resource will be lost	*The resource will be lost despite the implementation of mitigation measures.*
Mitigation potential	
Easily achievable	*The impact can be easily, effectively and cost effectively mitigated/reversed.*
Achievable	*The impact can be effectively mitigated/reversed without much difficulty or cost.*
Difficult	*The impact could be mitigated/reversed but there will be some difficultly in ensuring effectiveness and/or implementation, and significant costs.*
Very Difficult	*The impact could be mitigated/reversed but it would be very difficult to ensure effectiveness, technically very challenging and financially very costly.*

The following assumptions and limitations are inherent in the rating methodology:

- Value Judgements: Although this scale attempts to provide a balance and rigor to assessing the significance of impacts, the evaluation relies heavily on the values of the person making the judgment.
- Cumulative Impacts: These affect the significance ranking of an impact because it considers the impact in terms of both on-site and off-site sources. This is particularly problematic in terms of impacts beyond the scope of the proposed development. For this reason, it is important to consider impacts in terms of their cumulative nature.
- Seasonality: Certain impacts will vary in significance based on seasonal change. Thus, it is difficult to provide a static assessment. Seasonality will need to be implicit in the temporal scale, with management measures being imposed accordingly (e.g. dust suppression measures being implemented during the dry season).

VOLTALIA 40MW SOLAR PV DWANGWA, MALAWI

FAUNAL IMPACT ASSESSMENT REPORT

CES

ENVIRONMENTAL AND SOCIAL ADVISORY SERVICES

PROPOSED 40MW SOLAR PV FACILITY NEAR DWANGA, MALAWI

FAUNAL IMPACT ASSESSMENT REPORT

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REVISIONS TRACKING TABLE

CES Report Revision and Tracking Schedule

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SPECIALIST TEAM

Ms Amber Jackson (Faunal Specialist)

Amber is a Principal Environmental Consultant and has been employed with CES since September 2011. She holds a Masters in Environmental Management and has a background in both Social and Ecological work. Her honours and undergraduate degree focused on Ecology, Conservation and Environment with particular reference to landscape effects on Herpetofauna, while her masters focused on the environmental management of social and ecological systems. With a dissertation in food security that investigated the complex food system of informal and formal distribution markets. During her time at CES Amber has worked extensively in Mozambique managing a number of Environmental and Social Impact Assessment. Amongst which she has conducted large scale faunal impact assessments in the both South Africa and northern of Mozambique to both national standards and international lenders standards (AfDB, EIB and IFC), alone and assisted by and to Prof Bill Branch. Her interests include, lenders requirements, range limitation, island biogeography, ecology as well as land use and natural resource management.

Dr A.M (Ted) Avis (Reviewer)

Ted Avis is a leading expert in the field of Environmental Impact Assessments and environmental management, having project-managed numerous large-scale ESIAs and ESMPs to International Finance Corporation Performance Standards. Ted has been EIA study leader on numerous large scale ESIA's and ESHIA's for projects with capital investments ranging from US$200m to over US$1billion. He has been study leader for ESIA and related environmental studies completed to international in, Egypt, Kenya, Liberia, Mozambique, Madagascar, Malawi Sierra Leone, South Africa and Zambia. Ted also has experience in large scale Strategic Environmental Assessments in southern Africa and has been engaged by the International Finance Corporation (IFC) on a number of projects.

Most of the ESIA work Ted has been involved in has included the preparation of various Environmental & Social Management Plans, Resettlement Action Plans and Monitoring Plans. These ESIA's cover a range of sectors including infrastructure, mining (heavy minerals, graphite, tin, copper, iron), agri-industrial, forestry, resorts and housing development, energy, ports and coastal developments.

Ted holds a PhD in Botany, and was awarded a bronze medal by the South African Association of Botanists for the best PhD adjudicated in that year, entitled "Coastal Dune Ecology and Management in the Eastern Cape"). He has delivered papers and published in the field of EIA, Strategic Environmental Assessment and Integrated Coastal Zone Management and has been a principal of CES since its inception in 1990 and Managing Director since 1998.

Ted was instrumental in establishing the Environmental Science Department at Rhodes University whilst a Senior lecturer in Botany, based on his experience running honours modules in EIA practice and environmental management. He was one of the first certified Environmental Assessment Practitioner in South Africa, gaining certification in April 2004. He has been a professional member of the South African Council for Natural Scientific Professionals since 1993.

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ACRONYM LIST

ABS	Above Sea Lever
CES	Coastal and Environmental Services
CI	Conservation Importance
CITES	Convention of International Trade in Endangered Species
CR	Critically Endangered
DD	Data Deficient
ECO	Environmental Control Officer
EN	Endangered
ESIA	Environmental and Social Impact Assessment
ESIR	Environmental and Social Impact Assessment Report
FI	Functional Integrity
GBIF	Global Biodiversity Information Facility
IBA	Important Bird Area
IUCN	International Union for Conservation of Nature
INT.	International
KM	Kilometre
LC	Least Concern
M	Meter
NBSAP	National Biodiversity and Strategy Action Plan
NT	Near Threatened
RR	Receptor Resilience
SCC	Species of Conservation Concern
SEI	Site Ecological Importance
SOER	State of The Environment Report
SP.	Species
VU	Vulnerable

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1 INTRODUCTION AND PROJECT DESCRIPTION

1.1 PROJECT DESCRIPTION AND LOCALITY

Voltalia, a global renewable energy producer and service provider, intend to construct a solar photovoltaic (PV) power plant near Dwangwa town in Central Malawi (Figure 1-1). The electricity produced by the solar PV power plant will be sold to the national grid.

The Dwangwa Solar PV power plant will comprise of photovoltaic solar panels that cover an area of approximately 60ha . It is estimated that the total height of the panels, including the structure, will be 4.7m when tilted. Additional infrastructure on site will include a security guardhouse, an operations and maintenance building, internal gravel roads, a single circuit 132kV powerline and a substation.

Two infrastructure alternatives were assessed for this project (Figure 1-2 and Figure 1-3).

1.2 OBJECTIVES AND TERMS OF REFERENCE

The objectives for the botanical assessment are as follows:

- Identify the fauna likely to be present in the project area.
- Describe and map the habitat types in the study area.
- Establish and map the project area faunal sensitivity including no-go areas.
- Identify faunal species of conservation concern (IUCN and National Red Data List).
- Identify and assess the impacts of development on the site's fauna and faunal habitats and, where feasible, provide mitigation measures to reduce these impacts.

1.3 LIMITATIONS AND ASSUMPTIONS

This report is based on current available information and, as a result, the following limitations and assumptions are implicit:

- The report is based on a project description received from the client.
- Species of Conservation Concern (SCC) are often difficult to find and thus some of these species are described on a desktop level in this report.
- No trapping was done which may have confirmed additional faunal species using the site. In addition, sampling could only be carried out at one stage in the annual or seasonal cycle. The survey was conducted during the late wet season. However, the time available in the field, and information gathered during the survey was sufficient to provide enough information to determine the status of the affected area.

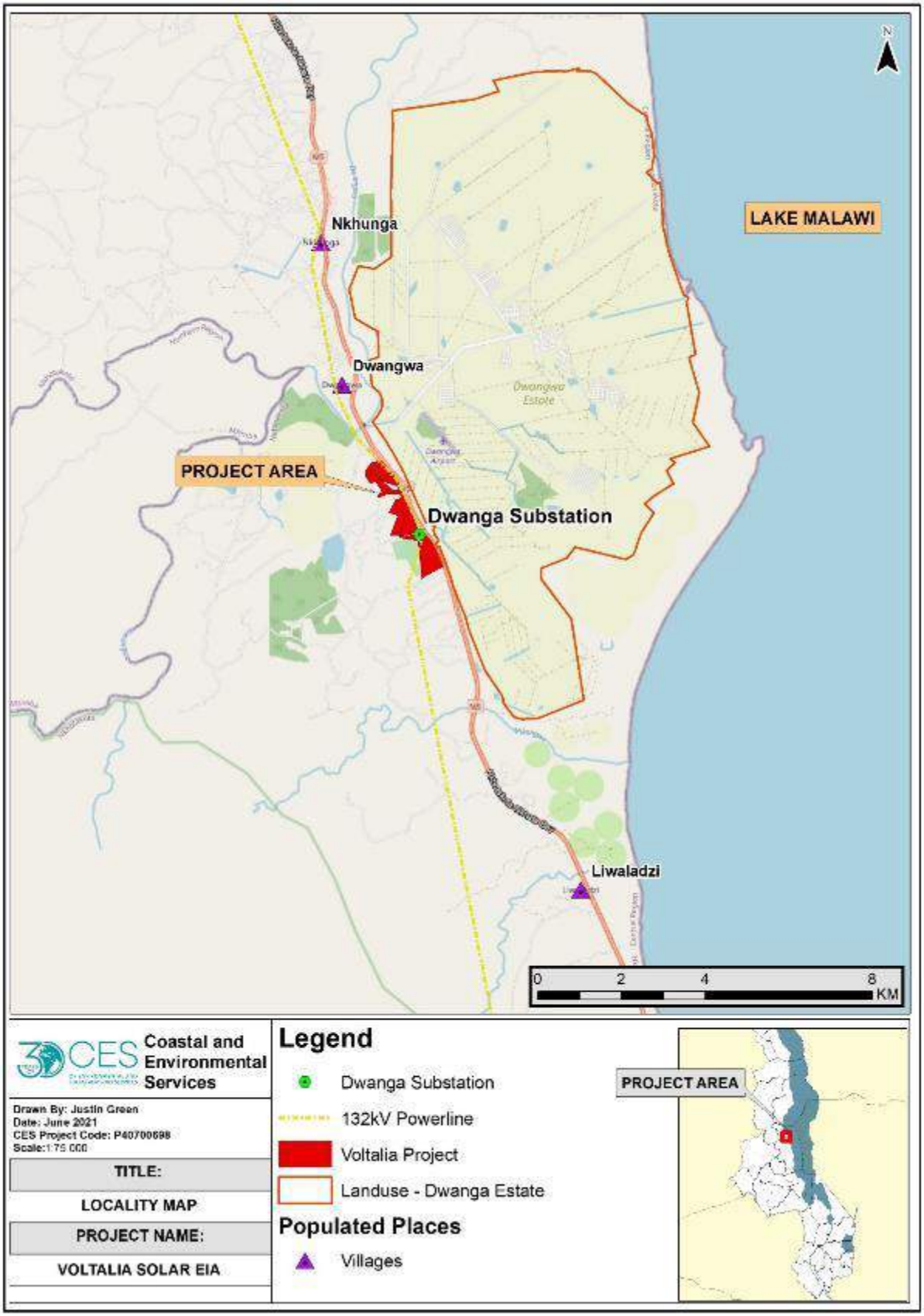


Figure 1-1: Locality map showing the location of the site in relation to the town of Dwanga.

Figure 1-2: Infrastructure map (alternative 1)

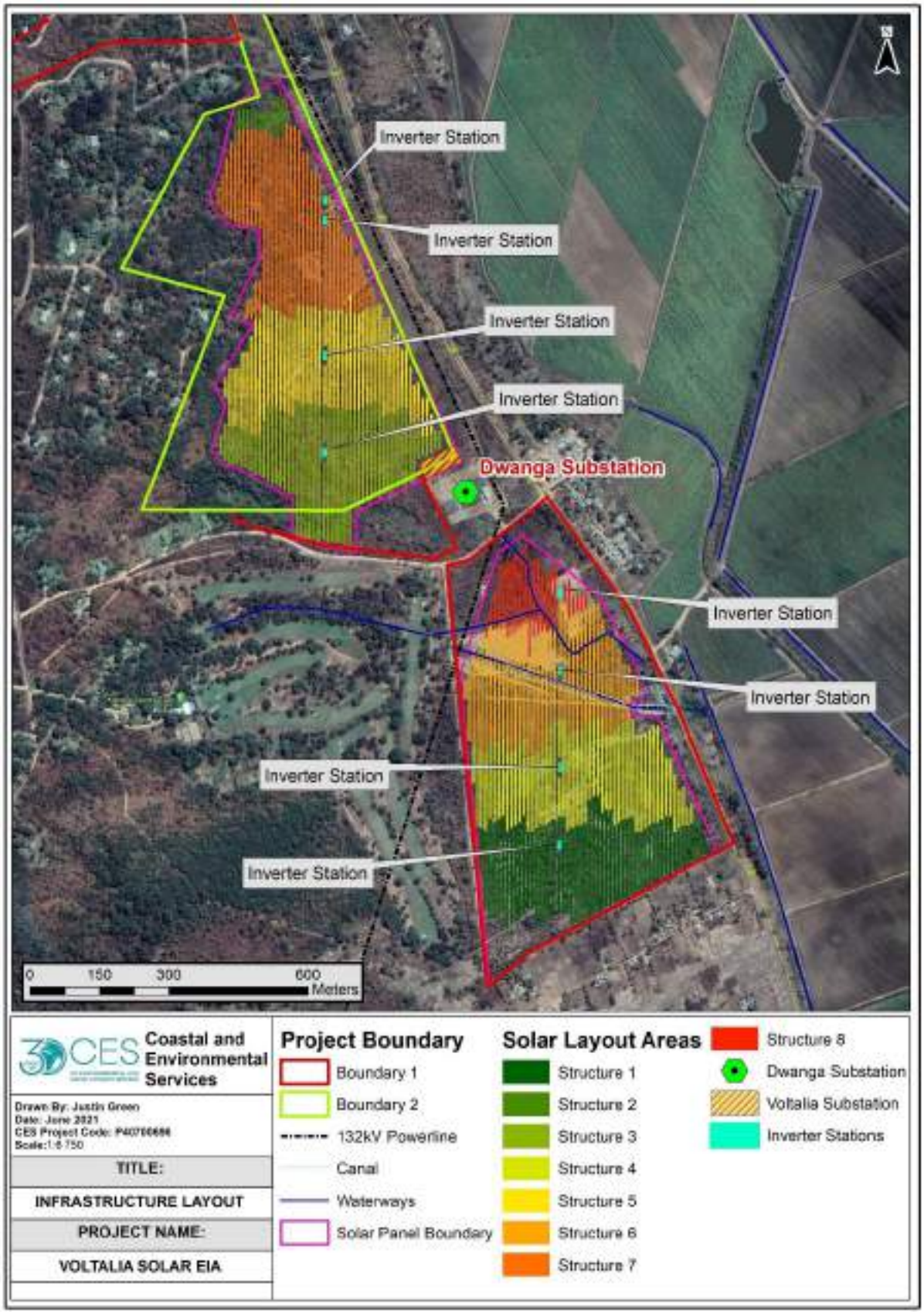


Figure 1-3: Infrastructure map alternative 2

2 LEGISLATION, POLICY AND GUIDELINES

2.1 APPLICABLE MALAWIAN LEGISLATION

A summary of the Malawian legislation applicable to the management of biodiversity is provided below. It should be noted that the list provided is not exhaustive and has been restricted to documents that have direct relevance to the current study. A full list of legislation applicable to the ESIA will be available in the Environmental and Social Impact Assessment Report (ESIR).

National Environmental Policy (2004): The overarching goal of this policy is to promote sustainable social and economic development through the implementation of management strategies focused on the environment and natural resources.

Environment Management Act (No. 23 of 1996): This act acknowledges every person's right to a clean and healthy environment and provides the general environmental legislation to protect this right. The Act provides for the conservation of biological diversity and makes provision for the undertaking of Environmental Impact Assessments.

National Forestry Policy (1996): The overarching goal of this policy is to ensure the sustainable use and conservation of forest resources to the benefit of the nation.

National Forestry Act (No. 4 of 1997): Provides for the conservation and management of forests as well as the protection and rehabilitation of environmentally sensitive areas. It also outlines the utilization of forest produce in forest reserves.

Wildlife Policy (2000): Provides the approach to the management of wildlife in Malawi. The policy seeks to layout objectives for the sustainable use of wildlife resources with emphasis on building constructive relationships between government and local communities in the management of wildlife.

National Parks and Wildlife (Amendment) Act (No. 11 of 2017): This act relates to the management of national parks and wildlife and seeks to establish the Wildlife Research and Management Board. The act was amended in 2017 by redefining "endangered species" and "protected species" in provisions concerning hunting licences, wildlife impact assessments, protected species, illegal possession of and trade in game species, protected species, endangered species or listed species and other offences.

National Land Resources Management Policy and Strategy (2000): The overarching goal of this policy is to promote the sustainable use of land-based resources for agriculture and other uses in order to avoid sectoral land conflicts and ensure socio-economic development. Of relevance to this report is the requirement for an environmental impact assessment that assesses the trade-off between economic development and environmental protection and provides mitigation measures to minimise this.

Plant Protection Act (no. 9 of 1969): This act relates to the eradication of pests and diseases that would negatively impact plant species.

2.2 CONVENTIONS AND PROTOCOLS

Malawi also recognises the following international conventions and protocols that are relevant to this study:

2.2.1 International Union for Conservation of Nature (IUCN): Statutes and Regulations

The objective of the IUCN is to "influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable" (IUCN, Accessed: 27/08/2016).

To achieve this objective, the IUCN implements programmes, administered by the World Conservation Congress, in the form of a number of activities such as:

- Research on species and ecosystem function to ensure sustainable, equitable and ecological utilisation of natural resources;
- Determine biological diversity, identify threats and priority conservation areas;
- Develop sound practices for the conservation and sustainable use of species and ecosystems; and
- Develop tools for effective rehabilitation, mitigation or offsets.

The IUCN data base and principles are used for determining species of conservation concern in the study area.

2.2.2 Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) deals with conservation, sustainable use and the equitable sharing of the benefits of natural resources. The CBD, ratified by Malawi in 1992, encourages the use of the "Ecosystem approach" which is based on the application of scientific methodologies focused on levels of biological organisation including process, functions and interactions between organisms and the environment (Convention on Biological Diversity, Accessed: 25 October 2016). The levels are extended to refer to any functional ecological unit at any scale.

The CBD emphasizes that adaptive management is necessary for complex and dynamic ecosystems. Impact responses of ecosystems are non-linear and often delayed, resulting in unpredictable reactive events. Management must be adaptive in order to respond to these events by incorporating a "lessons-learnt" approach and frequent considerations of "cause-and-effect".

The United Nations Framework Convention on Climate Change (UNFCCC), to which Mozambique is a signatory, recognises the CBD and its objectives.

The objectives and principles outlined in the CBD should be used to assess impacts and develop management and monitoring plans.

2.2.3 African Convention on the Conservation of Nature and Natural Resources

Malawi is a signatory on the African Convention on the Conservation of Nature and Natural Resources which was revised in 2003. The objectives of this Convention are to enhance environmental protection, to foster the conservation and sustainable use of natural resources and to harmonize and coordinate policies in these fields with a view to achieving ecologically rational, economically sound and socially acceptable development policies and programmes.

Specific to this report is Article VIII which relates to vegetation cover and requires the Parties to take all necessary measures for protection, conservation, sustainable use and rehabilitation of vegetation cover.

2.2.4 Convention on International Trade in Endangered Species (CITES)

The Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora was ratified by Malawi 1982. This is an international agreement between governments that aims to control the trade of wild animals and plants to ensure that their survival is not threatened.

3 METHODOLOGY

3.1 DESKTOP ASSESSMENT AND LITERATURE REVIEW

A literature review of published and unpublished work was completed to assess the known diversity of the terrestrial fauna and terrestrial faunal habitats in and adjacent to the project area.

The IUCN database was used to extract amphibian, reptile and mammal species distributions within which the project area occurs and Avibase was used to generate a bird species list for Nkhotakota and Mzimba Regions to generate a likely species list for the study area. These lists were then refined using the relevant field guides and point count data from the iNaturalist and GBIF.

This species list was used to establish which species likely to occur in the project area are Species of Conservation Concern (SCC) by checking it against various source including the:

- International Union for Conservation of Nature (IUCN) and
- Convention of International Trade in Endangered Species (CITES).

Species of Conservation Concern are defined as:

- species listed in the Critically endangered, Endangered or Vulnerable categories;
- possible threatened species (i.e. taxa currently not assessed in the IUCN Red List whose conservation status has been highlighted subsequently);
- those species listed in the Data Deficient or Near Threatened categories of the IUCN Red List; and
- Endemic and range restricted species with a portion (at least 50%) of their known range falling within the study area i.e. strict endemic and near endemic species.

The faunal data compiled during this initial desktop assessment was supplemented by the field data to produce a consolidated faunal species checklist.

3.2 FIELD SURVEY

A wet season site survey was conducted from the 18-20 May 2021 at the end of the wet season.

Sample sites were based in areas containing natural and modified habitat (Figure 2-1). Agricultural areas, i.e. those that are currently undergoing cultivation, which are classified as transformed, were noted for mapping purposes but not sampled.

The project area was surveyed using active searching (visual encounter survey) for avifauna, mammals, reptiles and amphibian individuals and evidence of scat, spoor, nests and feathers was also collected. An acoustic survey was conducted at night followed by active searching.

Table 3-1: Faunal Survey Methods

Avifauna	• Observations of scat, regurgitated pellets, nests, feathers, bird calls and birds in flight.

	• Bird transects recording all the birds seen and heard along a 200m walked transect in the early mornings and late afternoon when birds are most active.
Mammals	• Active searching at day and night • Observations of scats, tracks, traces and skeletons • Observations of opportunistic sightings • Acoustic surveys at night.
Amphibians and reptiles	• Active searching at day and night, • Acoustic surveys at night. • Identify suitable habitats and search for certain herpetofauna associated with those habitats.

The following sample sites were surveyed. The below table provides the location co-ordinates for the birding transects, active searching points, acoustic survey and night search. Figure 3-1 presents these on a map of the study area.

Figure 3-1: Sampling Map

Table 3-1: Sampling points

Sample site	Method	Start	End
B1	Bird Transect	12°32'16.56"S; 34° 7'23.04"E	12°32'17.15"S; 34°7'29.50"E
B2	Bird Transect	12°32'13.26"S; 34° 7'28.59"E	12°32'7.13"S; 34°7'26.45"E
B3	Bird Transect	12°32'12.17"S; 34° 7'33.66"E	12°32'13.59"S; 34°7'27.09"E
B4	Bird Transect	12°32'8.16"S; 34° 7'20.99"E	12°32'2.94"S; 34°7'20.01"E
B5	Bird Transect	12°32'15.26"S; 34° 7'22.24"E	12°32'20.60"S; 34°7'25.36"E
B6	Bird Transect	12°32'26.97"S; 34° 7'37.94"E	12°32'32.16"S; 34°7'40.18"E
B7	Bird Transect	12°32'31.61"S; 34° 7'37.13"E	12°32'33.49"S; 34°7'43.53"E;
B8	Bird Transect	12°32'39.27"S; 34° 7'44.38"E	12°32'44.32"S; 34°7'48.53"E
B9	Bird Transect	12°31'37.26"S; 34° 6'58.28"E	12°31'35.81"S; 34°7'4.51"E
B10	Bird Transect	12°31'34.91"S; 34° 7'2.66"E	12°31'30.35"S; 34°6'59.10"E

		Latitude	Longitude
A1	Active searching	12°32'14.08"S	34°7'28.94"E
A2	Active searching	12°32'13.17"S	34°7'24.04"E
A3	Active searching	12°32'16.29"S	34°7'33.03"E
A4	Active searching	12°32'18.48"S	34°7'40.85"E
A5	Active searching	12°32'9.88"S	34°7'23.48"E
A6	Active searching	12°32'1.89"S	34°7'21.04"E
A7	Active searching	12°32'13.28"S	34°7'19.86"E
A8	Active searching	12°32'20.65"S	34°7'25.70"E
A9	Active searching	12°32'6.64"S	34°7'26.38"E
A10	Active searching	12°31'52.17"S	34°7'22.56"E
A11	Active searching	12°31'42.38"S	34°7'21.89"E
A12	Active searching	12°31'34.98"S	34°7'4.26"E
A13	Active searching	12°31'31.35"S	34°6'58.87"E
A14	Active searching	12°31'37.92"S	34°6'56.94"E
A15	Active searching	12°32'33.43"S	34°7'45.97"E
A16	Active searching	12°32'37.58"S	34°7'43.53"E
A17	Active searching	12°32'42.70"S	34°7'38.69"E
AM1	Amphibian acoustic survey & active searching	12°32'20.51"S	34°7'23.32"E
AM2	Amphibian acoustic survey & active searching	12°32'19.92"S	34°7'20.97"E

3.3 HABITAT MAPPING

Habitat was mapped from satellite imagery and refined using site data gathered on the ground.

3.4 IMPACT ASSESSMENT METHODOLOGY

To ensure a balanced and objective approach to assessing the significance of potential impacts, a standardized rating scale was adopted which allows for the direct comparison of specialist studies. This rating scale has been included in Appendix 1.

4 BIOPHYSICAL DESCRIPTION OF THE SITE

The project site is located on the western bank towards the middle of Lake Malawi, approximately 46km north of Nkhotakota and 120km south of Mzuzu as the crow flies.

Climate, hydrology, topography, vegetation and current land use all influence the geographical distribution of species and therefore play a significant role in the type of habitat and fauna present at a site.

4.1.1 Climate

Malawi's climate is described as being subtropical and is strongly seasonal. It is characterised by a warm wet season that stretches from November to April and a cooler, drier season from May to October. The hottest months in Dwangwa are October and November with average temperatures of 29^{0}C and the coolest months are June and July with average temperatures of 22^{0}C (World Weather Online, 2021).

Rainfall is markedly concentrated to the summer months and occurs as a result of the inter-tropical convergence zone which becomes established over the region (Brown and Young, 1965). Associated with the inter-tropical convergence zone are unstable air masses and higher moisture content which results in a high humidity of between 75-80% and heavy convectional storms. The average rainfall for Dwangwa ranges from 339mm in January and February to 5mm in August and September.

During the dry season, the region is covered by a sub-tropical high-pressure belt which is associated with dry south-easterly winds (Brown and Young, 1965). Relative humidity is typically lower during this period (50-60%) and almost no rainfall occurs.

4.1.2 Hydrology

The project area has a number of drainage lines running across it from east to west. There are two perennial rivers and a number of annual rivers (Figure 4.1). The rivers in the southern portion flowing from the golf course have been augmented and flow into a channel under the M5 into a cannel.

4.1.3 Vegetation

The northern portion of the site falls within the vegetation type *Marsh (Edaphic) Grassland* (Figure 4-2). This vegetation type is characterised by the presence of woody species with a canopy cover of <2% within land dominated by grass species and occasional herbs (VECEA, 2020). The southern section of the site falls within Miombo Woodland which is characterised by the presence of the genus *Brachystegia*, of which there are nineteen species in total. The VECEA map has mapped four subtypes of Miombo Woodland, namely, Drier Miombo Woodland, Wetter Miombo Woodland, Miombo Woodland on hills and rocky outcrops and Zanzibar-Inhambane transition woodland (VECEA, 2020). The southern portion of the project site is located within the *Miombo Woodland on hills and rocky outcrops.*

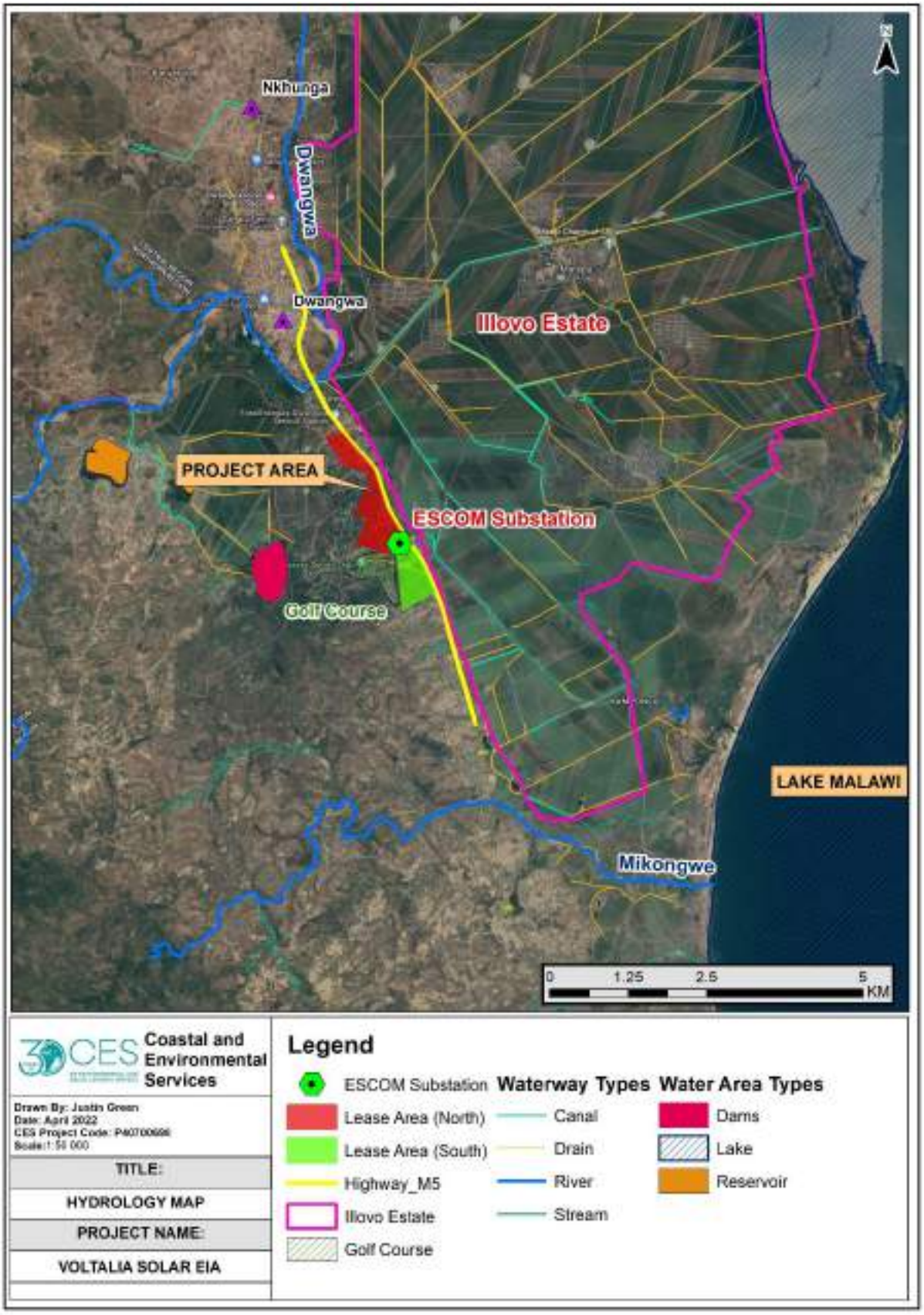


Figure 4-1: Hydrology Map

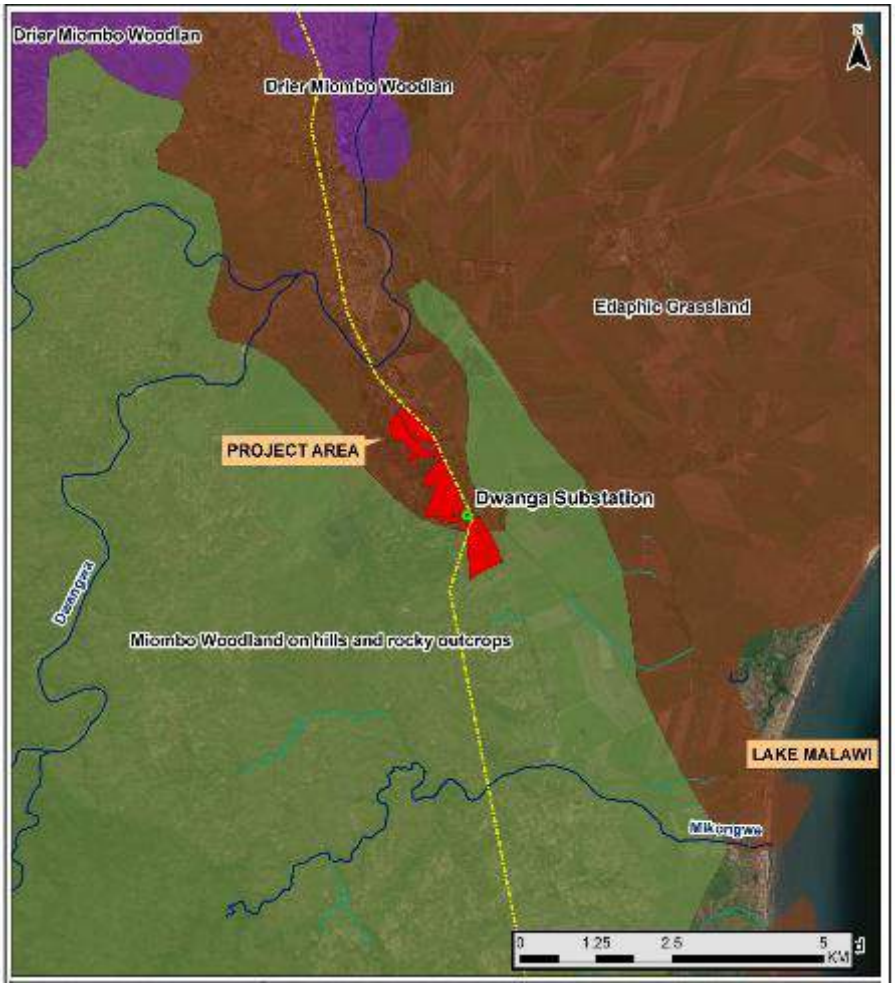


Figure 4-2: VECEA map showing the expected vegetation types present within the project area

4.1.4 Topography

There is a 25m elevation change over 2km. The northern portion is the steepest and the southern portion relatively plat.

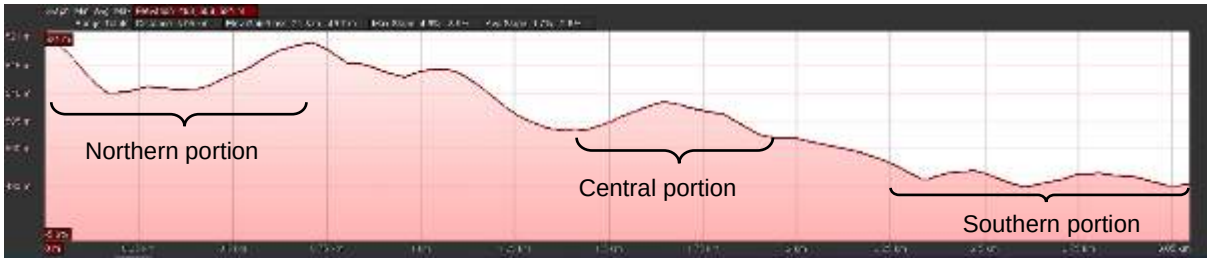


Figure 4-3: Elevation profile of the northern portion of the site.

The northern portion is a horseshoe shape with a depression running from a high point in the West (531m) down the hill to the road in the East (500m), a decrease in elevation of only 31m. Slopes on either side are therefore gentle. The North slope (520m) and South slope (513m) descend into the valley (500m). On a microscale the site can be described as a series of small foothills and depressions.

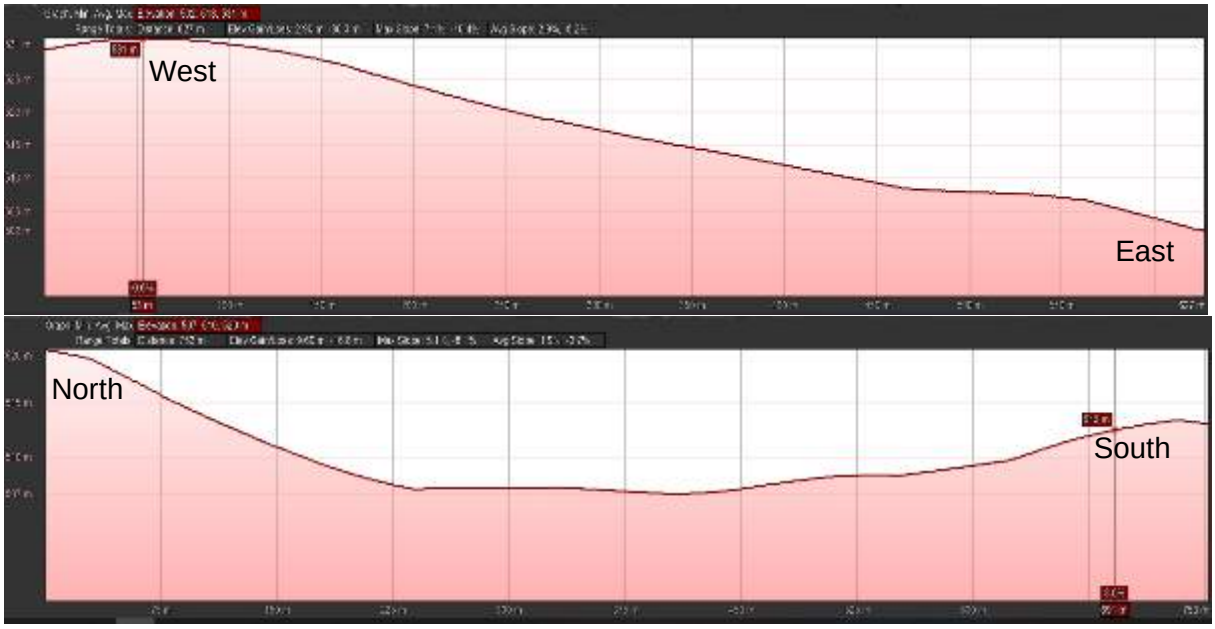


Figure 4-4: Elevation profile of the northern portion of the site.

The central portion is a foothill that slopes downhill from west to east and uphill from north to south. The high point in the west (517m) slopes down from the forest to the road and powerline (495m). From the river in the south (501m) the site slopes uphill to the crest (512m) and then downhill again to the adjacent valley.

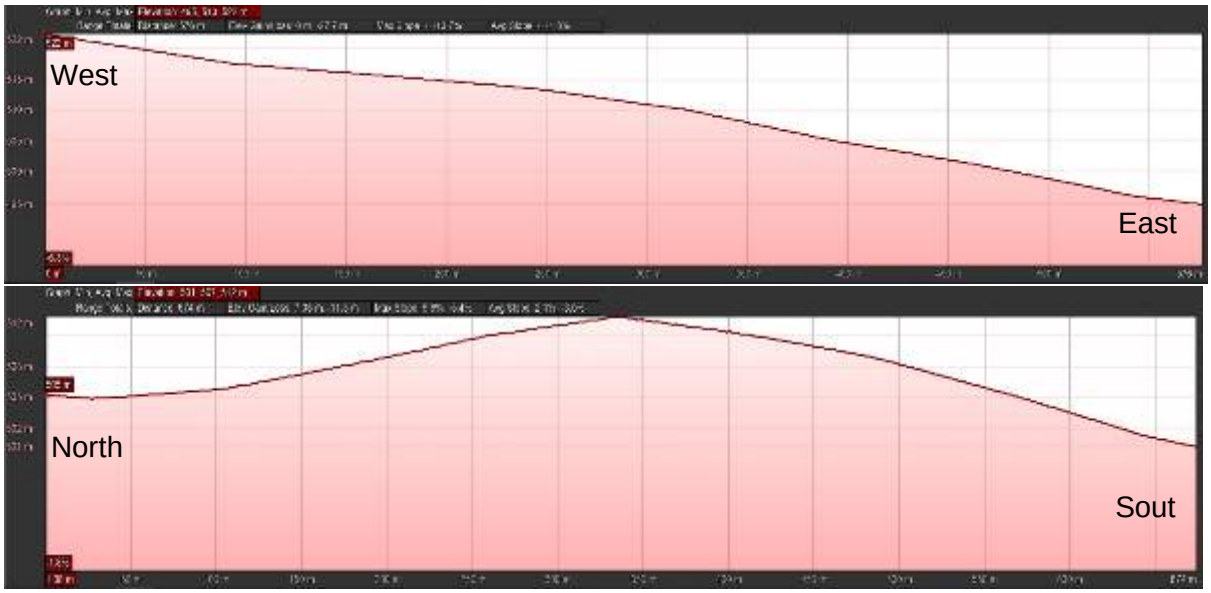


Figure 4-5: Elevation profile of the central portion of the site.

The southern portion is a relatively flat site with slight undulations. It has a shallow depression running from a high point in the West (498m) bordering the golf course down the hill to the road in the East (491m) with slopes on either side. The North slope (499m) and South slope (498m) runs into this depression (493m).

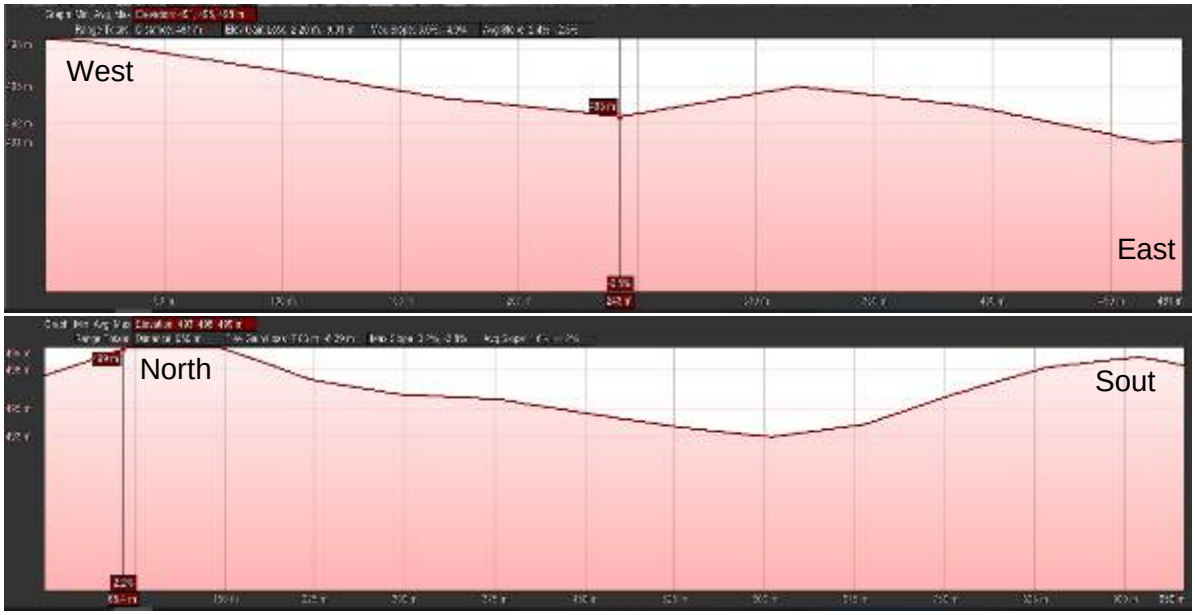


Figure 4-6: Elevation profile of the southern portion of the site.

4.1.5 Current Land use

The majority of the site is natural with some subsistence agriculture and infrastructure. The northern and central site is relatively untouched, and the majority of land is in a natural state. No indigenous trees are harvested, but there is evidence of grass being harvested and small woodlots of Eucalyptus are present. Rice is grown in all the streams on site, and the small river on the southern site has been dammed, and water is pumped from this small dam to feed into the irrigation canal on the other side of the M5 road.

The majority of the southern portion is used for subsistence agriculture, which includes rice paddies, fruit trees and woodlots. The infrastructure on site includes roads, a substation, powerlines, a water tower, buildings and soccer fields. There are also two sand mine areas; one in the southern portion and one on the northern portion. A tree wind break has been planted along the M5 presumably for the neighbouring sugar plantation. Surrounding land use includes the town Bowa, Primary School (Majiga), Golf course (Kasasa SportsClub), Illovo houses and commercial agricultural fields (sugar cane).

5 RESULTS

5.1 HABITATS

Habitats are defined as the natural environment or place where an organism, population or species lives, breeds and/or forages. Each habitat type has different environmental conditions which influences a species distribution range. Eight faunal habitats were identified and mapped (Figure 5.1) in the study area, namely:

1. Grassland
2. Savanna
3. Miombo woodland
4. Riparian Woodland
5. Rivers (annual and perennial), wetlands and incidental pools
6. Rocky outcrop
7. Agricultural and Woodlots
8. Manmade

Grassland

Grassland is confined to the north west portion of the proposed project site and is generally intact in most areas, with little evidence of harvesting by local communities. Dominant species include.

Plate 5-1: Grassland Habitat

Savanna

Savanna is the most common vegetation type occurring throughout the site. It is characterised as a mix of woodland and grassland with an open canopy (10-25%) of woody

species. Canopy height ranges from 1-3m and common woodland species include. The understory is comprised of the grass species found within the grassland vegetation type. The Savanna in the northern section of the site is considered near natural and shows evidence of degradation towards the middle and southern sections, with the southern section being the most degraded.

Miombo Woodland

Miombo woodland occurs in the middle of the site along the western border and can be divided into open and closed miombo woodland. Open Miombo Woodland has a canopy cover of 30-50% with an understory of grass species while Closed Miombo Woodland is characterised by a closed canopy of 75-90% with an understory that is typically herbaceous with some grass cover in areas where the canopy is more open. Tree height ranges from 2-4m with emergent's reaching up to 5m. This vegetation type is generally intact within the study area. Common species include shrubs and trees.

The Open Miombo Woodland occurs in the northern section of the site and the closed Miombo Woodland, which in some patches may be considered forest due to the closed nature of the canopy and the herbaceous understory, occurs in the middle section. The Closed Miombo Woodland is associated with a riparian area and as such is of high sensitivity.

Plate 5-2: Woodland with grass understory

Plate 5-3: Woodland with herbaceous understory

Riparian Woodland

The Riparian Woodlands within the study area are characterised by a closed canopy of 75-100% cover with a tree canopy of up to 20m and emergents that reach up to 40m. The understorey is typically comprised of an herbaceous layer with some grass cover in areas where the canopy is more open. This vegetation type occurs in the central site river system and is considered intact with little to no natural harvesting.

Plate 5-4: Riverine vegetation

Riverine systems, Wetlands and incidental pools

Watercourses are contained within a channel except in time of flooding. When there is no water flow the natural channel still exists. The project site experiences high levels of summer rainfall and limited winter rainfall. The majority of riverbeds are dry for most of the year, with

the exception of sparsely scattered pools of water concentrated in depressions within the annual streams and rivers. The slow-moving sections of the river wetland characteristics with vegetation running across the riverbed and in some sections has been planted with rice paddies.

Plate 5-5: River with vegetation and pool of water

Plate 5-6: River planted with rice

Plate 5-7: River in the southern portion running under the M5 into a canal

Plate 5-8: Dry vegetated stream

Rocky Outcrops

Geologically the project site is underlain by the Muva Supergroup which forms most of the basement in south-central Malawi. It is characterised by the presence of semi pelitic rocks and pelites (Mica schists, Kyanite and Sillimanite Schist and gneisses) (Haundi *et. al.*, 2021). These small outcrops form important habitat for many reptiles, and also some birds.

Plate 5-9: Rocky outcrop in Savanna Vegetation

Agricultural and Woodlots

Farmland, woodlots, and commercial plantation have little to no natural vegetation remaining.

Plate 5-10: Agricultural field

Plate 5-11: Woodlot

Manmade

Substation, residential buildings, soccer fields and sand mines.

Plate 5-12: Erosion in the southern site into the southern river looking onto the sand mine.

Plate 5-13: Buildings and paved areas– Dwagwana substation in the background

The habitat present within the study area is a mosaic of vegetation types Grassland, Savanna, Open Miombo Woodland, Closed Miombo Woodland associated with Riparian areas and transformed land which is comprised of farmland, woodlots, a sand mine, residential areas, a soccer field, sugar plantations and a golf course. The Grassland and Savanna vegetation types were difficult to separate out on the map and as such this has been mapped as “savanna-grassland mosaic”.

The northern section of the site is generally considered to be intact, and while there is evidence of some harvesting of natural resources, this is generally at a low level of intensity, and consequently has not been significantly altered. The area to the south is typically more degraded with larger areas that have been transformed.

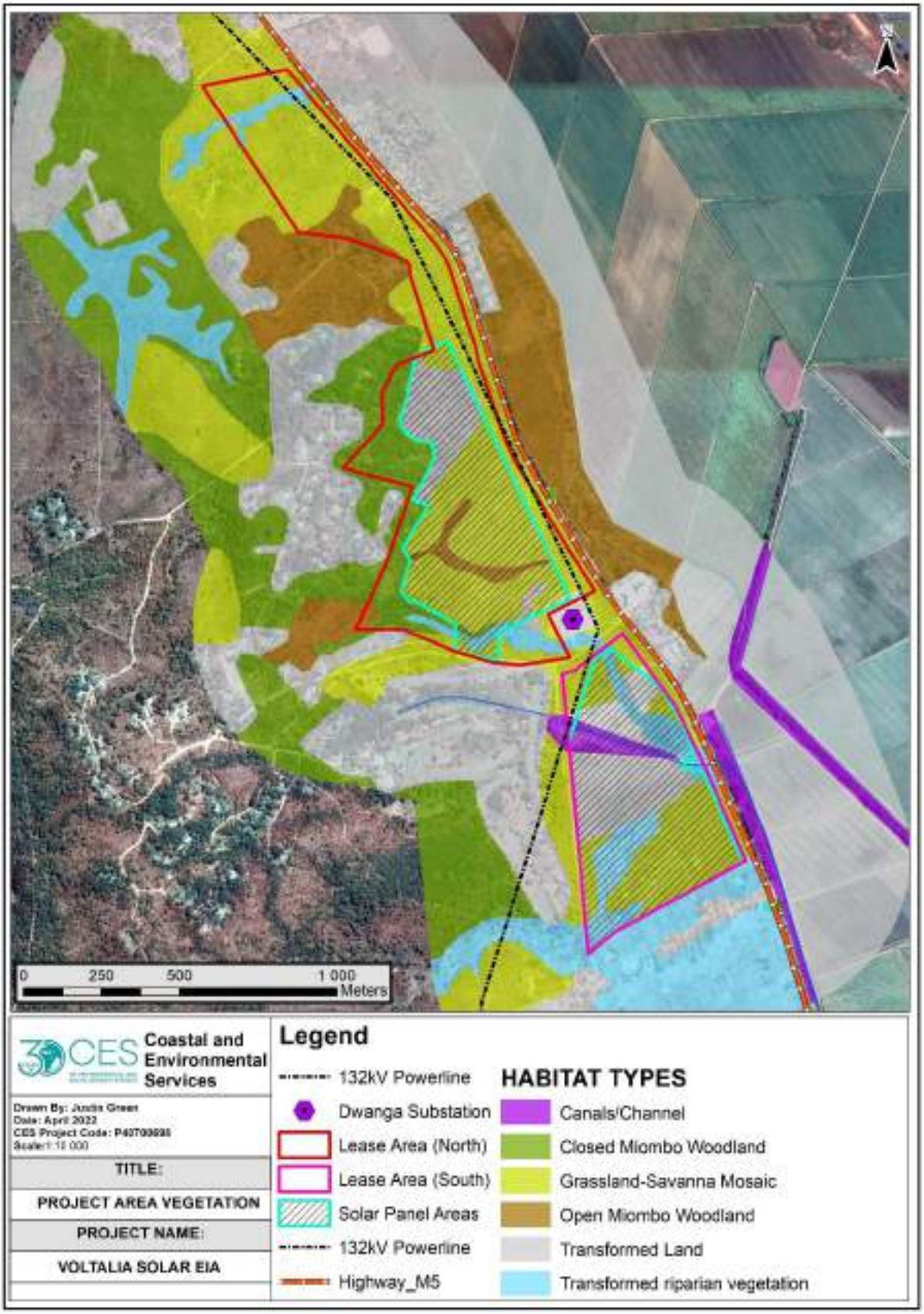


Figure 5.1: Habitats and their distribution within the project area.

5.2 AMPHIBIANS

The number of amphibian species in Malawi ranges from 82 to 88 species, the variation depends on the source consulted (IUCN, 2021; IBAT, 2021; NBSAP, 2015). The Bowa Region likely hosts up to 58 species of amphibian (Annexure 2).

Eleven species were recorded in and around the project area, namely, the Common Reed Frog (*Hyperolius viridiflavus*), Mitchell's Reed Frog (*Hyperolius mitchelli*), Fornasini's Spiny Reed Frog (*Afrixalus fornasini*), Mascarene Grass Frog (*Ptychadena mascareniensis*), Plain Grass Frog (*Ptychadena anchietae*), Guibes Grass Frog (*Ptychadena guibei*), Mozambique Grass Frog (*Ptychadena mossambica*), Southern Flat-Backed Toad (*Sclerophrys pusilla*), Mababe Puddle Frog (*Phrynobatrachus mababiensis*); East African Puddle Frog (*Phrynobatrachus acridoides*) and Muller's Clawed Toad (*Xenopus muelleri*).

The majority of amphibians were recorded from various points along the perennial river running through the central site past the Dwanga Substation.

5.2.1 Amphibian Species of Conservation Concern

Malawi hosts 12 amphibian species of conservation concern (SCC) of which four are threatened and two near-threatened, four endemic and eight range-restricted (Table 5.1). None of the amphibian SCC have a range distribution which includes the project area.

Table 5.1: Amphibian species of conservation concern in Malawi

Common name	Scientific Name	Conservation status (IUCN)	Endemic
Johnston's River Frog	*Amietia johnstoni*	Endangered	Endemic
Mulanje Mongrel Frog	*Nothophryne broadleyi*	Endangered	Endemic
France's Squeaker	*Arthroleptis francei*	Vulnerable	RR
Spiny Throated Reed Frog	*Hyperolius spinigularis*	Vulnerable	RR
Broadley's Ridged Frog	*Ptychadena broadleyi*	Near-Threatened	Endemic
Nyika Dwarf Toad	*Mertensophryne nyikae*	Near-Threatened	RR
Eiche's Squeaker	*Arthroleptis reichei*	Least concern	RR
Kirk's Caecilian	*Scolecomorphus kirkii*	Least concern	RR
Variable Reed Frog	*Hyperolius pictus*	Least concern	RR
Ukinga Puddle Frog	*Phrynobatrachus ukingensis*	Least concern	RR
Stewart's Puddle Frog	*Phrybobatrachus stewartae*	Least concern	RR
Friedemanns Long Reed Frog	*Hyperolius friedemanni*	Data Deficient	Endemic

*RR- Range Restricted/Near-Endemic

Plate 5-14: Amphibians recorded in the study area

Top left to bottom right – *Hyperolius viridiflavus, .Afrixalus fornasini*, *Phrynobatrachus acridoides, Hyperolius mitchelli*, *Ptychadena anchietae, Ptychadena guibei*, *Sclerophrys pusilla*, *Ptychadena mossambica* and *Ptychadena mascareniensis.*

5.3 REPTILES

As with amphibians the number of reptile species in Malawi varies depending the source consulted IUCN (2021) states Malawi hosts 48, whereas, the NBSAP (2015) states 145 reptile species inhabit Malawi.

The Bowa Region likely hosts up to 16 species of reptile (Annexure 3). Three reptiles were observed onsite. The Variable Skink (*Trachylepis varia*) was recorded from the dry riverbed in the central portion, the Striped Skink (*Trachylepis striata*) was observed at the substation and the Agama sp. (*Acanthocercus branchi*) was observed on the westerner boundary on the northern portion in the Miombo woodland.

Plate 5-15: Reptile species recorded in the project area
Top left to bottom right: Variable Skink (*Trachylepis varia*), Striped Skink (*Trachylepis striata*) and Agama sp. (*Acanthocercus branchi*)

5.3.1 Reptile Species of Conservation Concern

Malawi hosts 14 reptile species of conservation concern (SCC) of which four are threatened and two near-threatened, five are endemic and seven are range-restricted (Table 5.2). Only one of these SCC has a range distribution which includes the project area, the Zambezi Flapshell Terrapin (*Cycloderma frenatum*) which is listed as Endangered (Van Dijk, 2016). *C. frenatum* occurs at altitudes between sea level and 1,000m (Spawls, *et al*, 2018). Although not much is known about its usage of habitat adults have been recorded mainly from large rivers and lakes while hatchlings apparently inhabit floodplain marshes (Van Dijk, 2016). It is known to occur in Lake Malawi (Spawls, *et al*, 2018). *C. frenatum* is carnivorous and feeds on fish, aquatic insects, crabs, crustaceans, clams, snails and amphibians (Spawls, *et al*,

2018; Van Dijk, 2016).It is preyed on by Otters and Crocodiles and people living around Lake Malawi eat the eggs. *C. frenatum* was not recorded in the project area and is considered shy and difficult to catch. *C. frenatum* is fairly widespread (Figure 5.1) and may occur on site in the riverine habitat.

Figure 5-2: Distribution of Zambezi Flapshell Terrapin (*Cycloderma frenatum*) in relation to the project area (star) (Van Dijk, 2016).

Table 5.1: Amphibian species of conservation concern in Malawi

Common name	Scientific Name	Conservation status (IUCN)	Endemic
Chapman's Pygmy Chameleon	*Rhampholeon chapmanorum*	CE	Endemic
Zambezi Flapshell Terrapin	*Cycloderma frenatum*	EN	-
Mount Mulanje Chameleon	*Nadzikambia mlanjensis*	EN	Endemic
Mount Mulanje Pygymy Chameleon	*Rhampholeon platyceps*	EN	Endemic
King Dwarf Gecko	*Lygodactylus rex*	NT	RR
Braun's Skink	*Tetradactylus brauni*	NT	RR
Bons' Dwarf Gecko	*Lygodactylus bonsi*	LC	Endemic
Mulanje Skink	*Trachylepis mlanjensis*	LC	Endemic
Mitchell's Flat Lizard	*Cordylus nyikae*	LC	RR
Whyte's Water Snake	*Lycodonomorphus whytii*	LC	RR
Black Limbless Skink	*Melanoseps ater*	LC	RR
Nyika Girdled Lizard	*Platysaurus mitchelli*	LC	RR
Ukinga Hornless Chameleon	*Trioceris incornutus*	LC	RR
Nyika Serpentiform Skink	*Eumecia johnstoni*	D	-

*RR- Range Restricted/Near-Endemc

5.4 MAMMALS

Malawi host approximately 200 mammal species and has experienced a severe decline in population due to poaching and habitat loss. The NBSAP (2015-2025) has attributed this to threats such as habitat loss through transformation to agriculture, bushfires, exploitation of natural resources (charcoal, timber, food and medicine), alien invasive species and pollution. The majority of large mammal (e.g. elephants) only occur in national parks and wildlife reserves. The SOER () states that an essential part of the overall biodiversity programme for Malawi is the conservation and management of semi-natural habitats.

The project area intersects with the distribution range of 120 mammal species, 45 of which are bat species, many of the larger herbivours and large carnivours are unlikely to occur in the project area but may occur 6.3 km southwest of the site at the Nkotakhoto Wildlife Reserve. The project area likely hosts bat and rodent species, some of the smaller antelope and small carnivores (Annexure 4).

The mammals recorded in the project area include the Yellow Baboon (*Papio cynocephalus*), Vervet Monkey (*Chlorocebus pygerythrus*) (Plate 5.16), African Savanna Hare (*Lepus victoriae*), Sharpe's Grysbok (*Raphicerus sharpie*), Mongoose sp. and Fruit Bat sp.

Plate 5-16: Vervet Monkey recorded in the project area

5.4.1 Mammal SCC

There are 11 threatened, eight near-threatened and three endemic mammal species in Malawi. Of these five threatened and seven near-threatened mammal species have a distribution which includes the project area. The three bat species are likely to occur in the project area and the two otter species may occasionally use the riverine area. The Temminck's Pangolin is unlikely to occur in the project area, however, its preferred habitat (Grassland, woodland and rocky hills) is present.

Table 5.2: Mammal SCC with a distribution which includes the project area

Common Name	Species	Threat status (IUCN)	Likelihood of occurrence
Black Rhino	*Diceros bicornis*	Critically Endangered	Nil
African Savanna Elephant	*Loxodonta africana*	Endangered	Nil
Temminck's Pangolin	*Smutsia temminckii*	Vulnerable	Unlikely
Lion	*Panthera leo*	Vulnerable	Nil
Leopard	*Panthera pardus*	Vulnerable	Nil
Spotted-necked Otter	*Hydrictis maculicollis*	Near-Threatened	Possible
African Clawless Otter	*Aonyx capensis*	Near-Threatened	Possible
African Straw-coloured Fruit-bat	*Eidolon helvum*	Near-Threatened	Probable
Striped Leaf-nosed Bat	*Macronycteris vittatus*	Near-Threatened	Probable
Large-eared Free-tailed Bat	*Otomops martiensseni*	Near-Threatened	Probable
African Buffalo	*Syncerus caffer*	Near-Threatened	Nil
Plains Zebra	*Equus quagga*	Near-Threatened	Nil

5.5 BIRDS

The number of bird species in Malawi ranges from 630 to 662 species depending on the source consulted (IUCN, 2021; IBAT, 2021; NBSAP, 2015). Of these approximately 467 bird species have a distribution which includes the project area (Appendix 5). During the field survey 37 bird species were recorded (Plate 16 and 17) (Appendix 5). Nightjars were prevalent across the site with the majority in the grassland habitat on the central site. There was a conspicuous lack of ground fowl which is not unusual in locations that may rely party on hunting. A Francolin species was however recorded from the savanna habitat in the northern portion of the project site which hosted the most intact vegetation. Of note is the presence of predatory birds including Hawks, Goshawks and Falcons which hunt for their prey indicting a healthy system. The Black Herons were seen hunting at multiple locations along the river in the central site. The most abundant species were the Swallows, Bee eaters and sunbirds which were seen on forest and woodland edges (ecotone).

5.5.1 Bird SCC

There are 22 threatened and 18 near-threatened bird species in Malawi. Of these 14 threatened and eight threatened bird species have a distribution which includes the project area. Based on habitat preference and behaviour (migration, nesting and foraging) requirements the likelihood of occurrence of each species was determined (Table 5.3). One SCC was confirmed onsite, the Blue Swallow (*Hirundo atrocaerulea*) listed as Vulnerable was observed in the northern portion of the site in the savanna habitat. Although the bird SCC in Table 5.3 may occur on site none are range restricted and all have a large a much large distribution range than the site (Table 5.4). There is only one endemic species in Malawi, the Yellow-throated Apalis (*Apalis flavigularis*) and does not have a distribution which includes the project area.

Table 5.3: Bird SCC with a distribution which includes the project area

Common name	Scientific name	Threat Status (IUCN)	Likelihood of occurrence
White-backed Vulture	*Gyps africanus*	CE	Unlikely

Hooded Vulture	*Necrosyrtes monachus*	CE	Nil
White-headed Vulture	*Trigonoceps occipitalis*	CE	Nil
Grey Crowned-Crane	*Balearica regulorum*	EN	Unlikely
Madagascar Pond-Heron	*Ardeola idea*	EN	Possible (non-breeding)
Secretarybird	*Sagittarius serpentarius*	EN	Unlikely
Steppe Eagle	*Aquila nipalensis*	EN	Possible, unlikely permanent
Martial Eagle	*Polemaetus bellicosus*	EN	Possible
Bateleur	*Terathopius ecaudatus*	EN	Probable, disturbance tolerant
Lappet-faced Vulture	*Torgos tracheliotos*	EN	Unlikely
Tawny Eagle	*Aquila rapax*	VU	Possible
Southern Ground-Hornbill	*Bucorvus leadbeateri*	VU	Unlikely
Taita Falcon	*Falco fasciinucha*	VU	Nil
Blue Swallow	*Hirundo atrocaerulea*	VU	Confirmed
Denham's Bustard	*Neotis denhami*	NT	Unlikely
Curlew Sandpiper	*Calidris ferruginea*	NT	Unlikely
Great Snipe	*Gallinago media*	NT	Possible, unlikely permanent
Eurasian Curlew	*Numenius arquata*	NT	Unlikely
African Skimmer	*Rynchops flavirostris*	NT	Unlikely
Pallid Harrier	*Circus macrourus*	NT	Possible, unlikely permanent
Crowned Eagle	*Stephanoaetus coronatus*	NT	Possible
Olive-headed Weaver	*Ploceus olivaceiceps*	NT	Possible

5.5.2 Important Bird Area

The nearest Important Bird Areas to the project area are the Nkhotakota Wildlife Reserve 7.4 km southwest and the South Viphya IBA more than 36 km northwest (BirdLife Int., 2021) (Figure 5.3).

The Nkhotakota Wildlife Reserve IBA and covers a huge area of escarpment wilderness 180,000ha in size. The reserve vegetation type is primarily woodland with riparian forests running the length of its rivers and includes the Chipata Mountain mid-altitude rainforest (44 ha). The IBA hosts 21 SCC including the Taita Falcon (*Falco fasciinucha*) (VU) and the Olive-headed Weaver (*Ploceus olivaceiceps*) (NT) (BirdLife Int., 2021).

South Viphya Forest Reserve is the second largest montane complex in Malawi extends for 160,000 ha with half the area above 1550 to 1600 m. The vegetation in the IBA is compiled of forests, plantations (48,000ha) and primarily rank montane grassland and shrubland. Down the eastern escarpment the vegetation becomes miombo woodland with dambos in drainage channels (BirdLife Int., 2021). This IBA hosts 287 bird species that rely on the area hosts 39 SCC, namely, Wattled Crane (*Grus carnculatus*), Blue Swallow (*Hirundo atrocaerulea*) (VU), East Coast Akalat (*Sheppardia gunningi*) (NT), Olive-headed Weaver (*Ploceus olivaceiceps*) (NT) and most notable is the endemic population of Scaly Spurfow (*Francolinus squamatus*) (BirdLife Int., 2021).

Plate 5-17: Birds recorded within the project area

Top left to bottom right: Black-headed Heron (*Ardea melanocephala*), Square-tailed Nightjar (Caprimulgus fossii), Common Waxbill (Estrilda astrild), Common Bulbul (Pycnonotus barbatus), Red-backed Mannikin (Spermestes nigriceps) and Variable Sunbird (Cinnyris venustus).

Plate 5-18: Birds recorded within the project area

Top left to bottom right: Little Bee-eater (*Merops pusillus*), African Pied Wagtail (*Motacilla aguimp*), Brimstone Canary (*Crithagra sulphurate*), Black-winged Bishop (*Euplectes hordeaceus*), Lesser Striped Swallow (*Cecropis abyssinica*), Gabar Goshawk (*Micronisus gabar*), Striped Kingfisher (*Halcyon chelicuti*) and Cardinal Woodpecker (*Chloropicus fuscescens*).

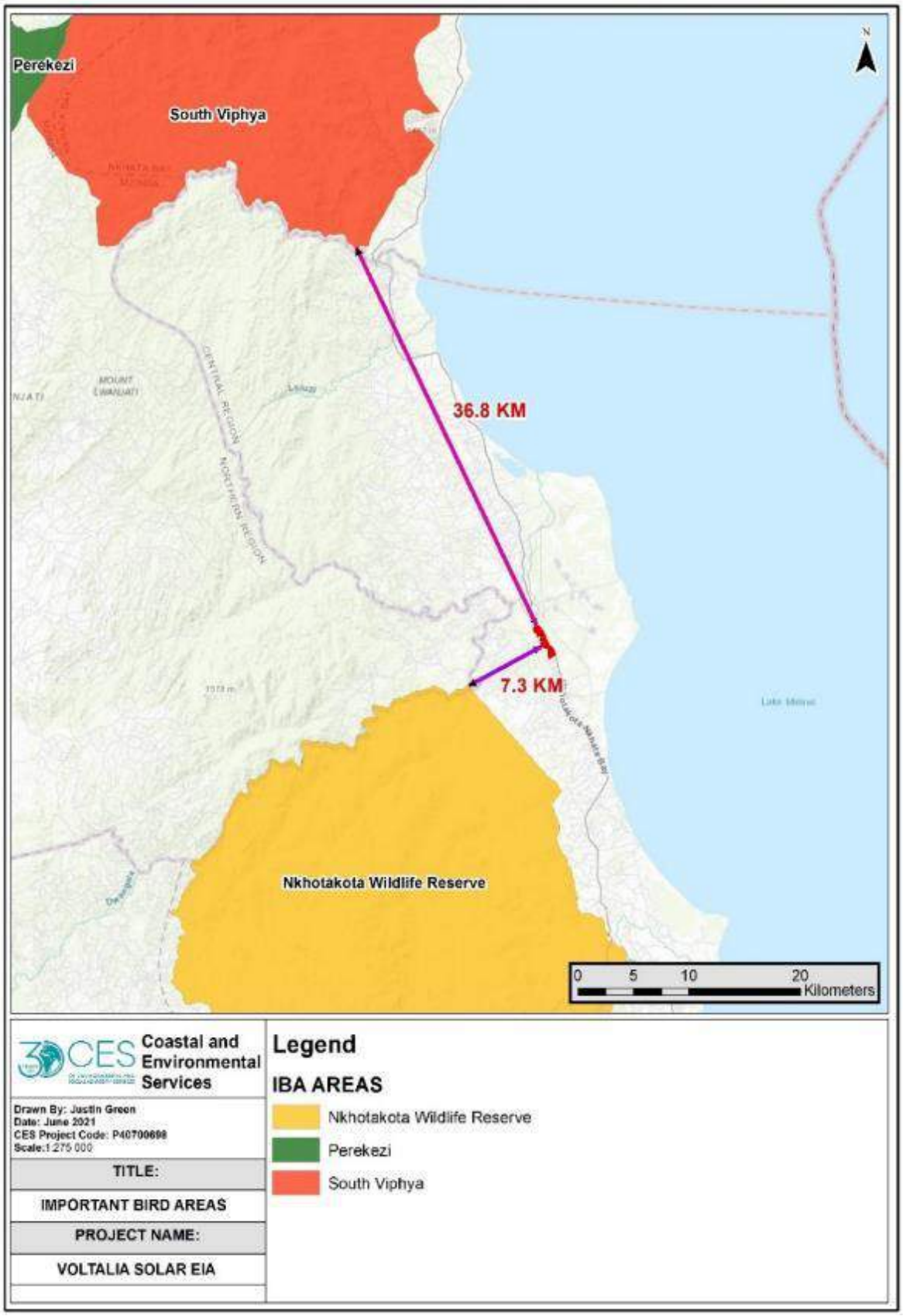
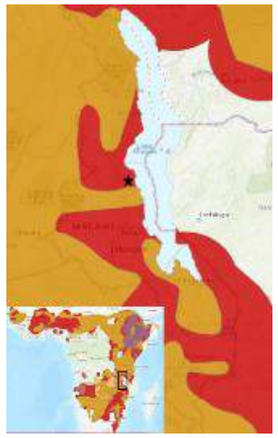
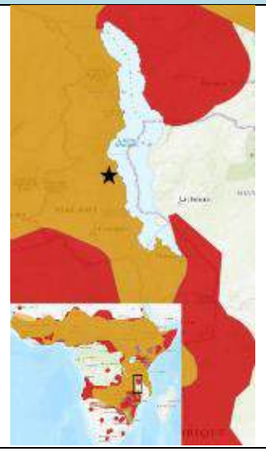
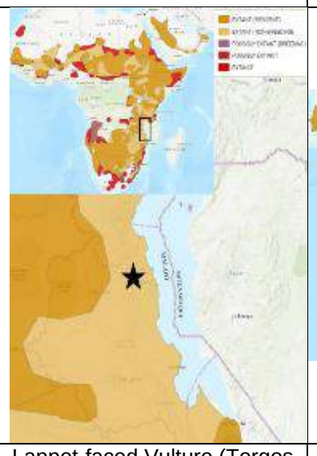
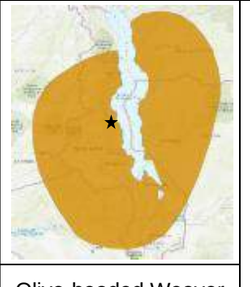


Figure 5-3: IBA's of Malawi and their associated distant from the proposed project development

Table 5.4: Bird SCC distribution range in relation to the project area

Common name	Distribution						
							
White-backed Vulture (Gyps africanus)	Hooded Vulture (Necrosyrtes monachus)	White-headed Vulture (Trigonoceps occipitalis)	Grey Crowned-Crane (Balearica regulorum)	Madagascar Pond-Heron (Ardeola idea)	Secretarybird (Sagittarius serpentarius)	Steppe Eagle (Aquila nipalensis)	Martial Eagle (Polemaetus bellicosus)
							
Bateleur (Terathopius ecaudatus)	Lappet-faced Vulture (Torgos tracheliotos)	Tawny Eagle (Aquila rapax)	Southern Ground-Hornbill (Bucorvus leadbeateri)	Taita Falcon (Falco fasciinucha)	Blue Swallow	Denham's Bustard (Neotis denhami)	Curlew Sandpiper (Calidris ferruginea)
							
Great Snipe (Gallinago media)	Eurasian Curlew (Numenius arquata)	African Skimmer (Rynchops flavirostris)	Crowned Eagle (Stephanoaetus coronatus)	Pallid Harrier (Circus macrourus)	Olive-headed Weaver (Ploceus olivaceiceps)		

6 SITE SENSITIVITY AND IMPACT ASSESSMENT

6.1 SITE SENSITIVITY

The transformed land includes agricultural fields, woodlots, recreational areas, buildings and substation. All faunal species (amphibians, reptiles, mammals and birds) utilise these areas despite the disturbance. However, the majority of faunal species will be generalist species and fairly common. Non-generalist species may move through these areas to access other intact areas or to access water and will do so predominantly at night to avoid human interaction. The Sharpe's Grysbok (*Raphicerus sharpie*) spoor was recorded from the southern portion of the site on the road towards the river. This species requires good vegetation cover adjacent to open patches of grass and will likely be hunted if found was likely moving through the area rather than utilising it as it's primary habitat. Transformed habitat is rated as having a LOW sensitivity due to the lack of primary use by non-generalist faunal species.

The majority of wetlands in the area have been transformed into rice paddies. Although the vegetation has been transformed the faunal habitat essentially remains the same. The structure that the sedges and reeds would have offered, and still exists in parts, is now offered by the rice stalks and leave. Wetlands an important habitat for the amphibian breeding, foraging and shelter, terrapins, snakes and lizards for hunting as and well as wetland and river adapted mammals (e.g. shrews, rodents, otters etc.) and bird species that may use the wetland for shelter, nesting and foraging. Wetlands offer an important food source in the form of insect for many bat species. Other faunal species likely rely on the wetlands as a source of water. The wetland habitats are rating as having a HIGH faunal sensitivity.

The Woodland (Open and Closed) and Forest habitat will host a different set of faunal species to the grassland and wetland habitat species. However, this habitat type is likely used by all faunal species as it acts as an ecological corridor for fauna to move through as it offers a high level of shelter from predators. The majority of raptors rely on large trees for nesting and there are a number of bird SCC that possibly occur in the project area and thus may use this habitat type for nesting as well as Fruit Bat species which were heard and seen feeding in the trees near the substation. When the local community was asked why they do not harvest the established trees in this habitat type they responded that it belongs to ILovo Sugar and they are prohibited. It is possible that these areas are protected as an offset and should be looked into. The Woodland and Forest habitats are rating as having a HIGH faunal sensitivity.

As with the above habitat types the Grassland adapted faunal species rely on his habitat for foraging, shelter and breeding. The grassland habitat on the project site is likely majority used for foraging by nocturnal species such as Hares, small antelope and rodents due to the potential for human exposure. The grassland is heavily harvested and appears in varying degrees of intactness. The northern site being most intact and the southern site the least. Grassland is rated as having a MODERATE sensitivity as it is a faunal foraging area.

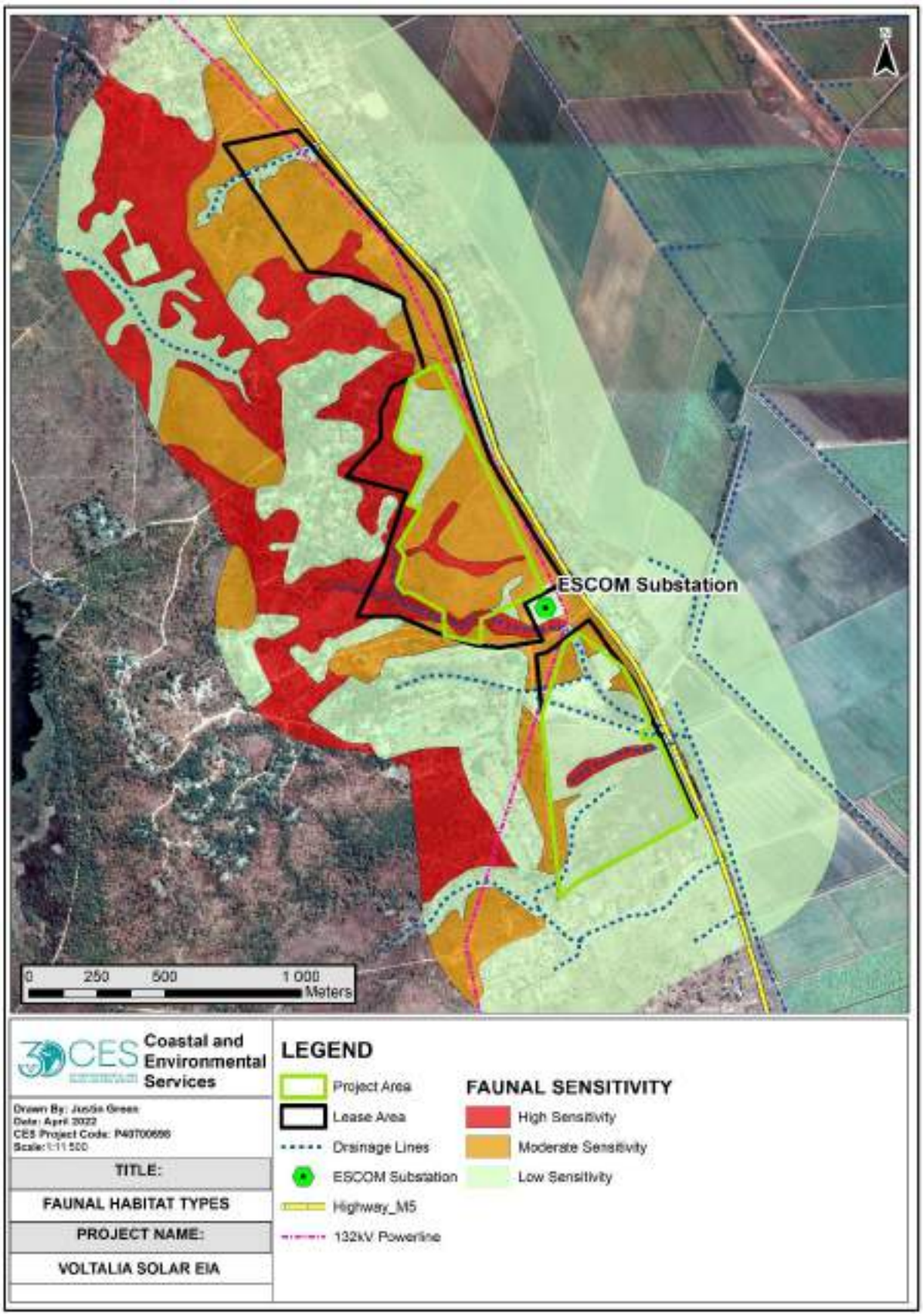


Figure 6-1: Sensitivity map showing areas of high, moderate and low sensitivity.

6.2 IMPACT ASSESSMENT

The study that has been undertaken provides the necessary information in order to assess the impacts of the proposed project on the fauna and their habitats of the area at the appropriate spatial and temporal scales. The impacts identified and described below have been assessed in terms of the criteria presented in Appendix 1 of this report.

Direct impacts, cumulative impacts and the no-go alternative have been assessed for each of the impacts. For the cumulative impacts, the additive effect of the construction and operation in relation to the existing impacts associated with the existing land-uses has been assessed.

6.3 IMPACT ASSESSMENT

Table 6-1: Assessment of impacts associated with the proposed project.

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
CONSTRUCTION PHASE														
Loss of extent of faunal habitat (feeding, breeding, shelter and roosting sites) resulting in a reduction in species diversity	Project Impact (Alternative 1 and 2)	The clearing of land for the construction of the solar PV plant, powerline, access roads and substation will result in the loss of up to 10.6 ha of Closed Miombo Woodland, 5 ha of open miombo woodland and 35.9ha of grassland-Savanna mosaic under alternative 1 and up to 0.57ha of Closed Miombo Woodland, 2.14ha of Open Miombo Woodland and 31.16ha of Grassland - Savanna Mosaic. These all provide important habitat for a range of faunal species. The loss of extent of faunal habitat will result in the loss of feeding, breeding, shelter and roosting sites for faunal species and the impact associated with this loss, will be a reduction in species diversity. However, to place this impact in context, it should be noted that the habitat that will be lost is directly adjacent to large plantations of sugar cane along the eastern border and there is already likely to be a lower species diversity due to existing habitat fragmentation and edge effects. The further loss of habitat will result in faunal species being displaced to the east, north and south. . This impact is difficult to mitigate since the loss of extent of faunal habitat will be permanent and as such the impact significance remains the same even after mitigation.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource will be completely lost.	Difficult	MODERATE-	• Construction vehicles and machinery must not encroach into identified 'no-go' areas or areas outside the project footprint. • Where feasible Closed Miombo Woodland as identified in the Botanical report, should be avoided as it provides important refugia for faunal species in the area. • Lay down areas must not be located within any watercourses or drainage lines. • Employees must be prohibited from making open fires during the construction phase. • Employees must be prohibited from poaching wild animals within or adjacent to the site. • The development footprint of the proposed solar PV plant and associated infrastructure (roads and laydown areas) must be demarcated to prevent any encroachment of construction or operational activities into surrounding natural areas. • Edges of roads, sidewalks and any elevated area must not have steep sides and must have a gentle slope. • Any fencing required must be wildlife permeable especially at strategic places such as along drainage lines or other areas of dense vegetation. This allows for small and medium sized animals to move between their natural habitat unencumbered. If electrified strands are to be use, there are to be no strands within 30 cm of the ground. As an example, if a tortoise touches this strand it automatically retreats into its shell and does not move because it senses danger, and the repeated shocks eventually kill it (Arnot & Moteno, 2017). • Create additional faunal micro habitats e.g. rocky outcrops, corridors of shrubbery, stumperies.	MODERATE-

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
Loss of Faunal Species of Conservation Concern	Cumulative Impact	Portions of faunal habitat have already been lost due to farming activities to the east, expansion of residential areas to the west, harvesting of vegetation by local communities for building and thatching as well as from grazing of livestock. The additional loss of faunal habitat will therefore have a moderate cumulative impact.	Negative	Cumulative	Moderate	Local	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	• It is difficult to implement mitigation measures specific to the cumulative impacts as the applicant only has jurisdiction over their development and not over other developments or farming activities in the area. • However, it is imperative that the applicant implement the mitigation measures listed above.	N/A
	No-Go Impact	There is some evidence of harvesting of natural resources within the site. There has also been clearing and planting of woodlots in the middle of the site as well as mining for sand towards the south. These activities are likely to continue under the no-go alternative and will have a low negative impact on the remaining faunal habitat.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	LOW	• N/A	
	Project Impact (Alternative 1 and Alternative 2)	The SCC that possibly occur on the project area include bat species which may utilise the woodland/forest habitat for shelter as well as the nearby buildings and forage over the wetland and grassland. It is possible that the terrapin and occasionally otters may utilise the river channels and wetland areas. Migrant species may utilise habitats on the project area but not exclusively and raptors may nest on existing powerlines and well-established trees in the woodland/riparian forest. The blue swallow was confirmed on the northern site in the savanna habitat trees.	Negative	Direct	Moderate	Localised	Permanent	Definite	Irreversible	Resource will be partially lost.	Achievable	MODERATE	• The facility layout should avoid the identified wetland on site and place a no-go buffer around them. • Removal of any trees must only occur after fledging's have left the nest. • All lighting must be kept to a minimum, only down lighting is to be used and low UV emitting lights (LED). • A clause must be included in contracts stating that: "no wild animals will be hunted, killed, poisoned or captured. No wild animals will be imported into, exported from or transported in or through the Province. No wild animals will be sold, bought, donated and no person associated with the development will be in possession of any live wild animal, carcass or anything manufactured from the carcass." A clause relating to fines, possible dismissal and legal prosecution must be included should any of the above transgressions occur.	LOW
	Cumulative Impact	The project area borders an urban area and already experiences a level of disturbance. SCC are often sensitive to disturbance (except the Bateleur) and probably have already moved away from the area. The project will be removing the eastern extent of the natural area decreasing it in site but not necessary creating fragmentation.	Negative	Direct	Moderate	Regional	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE		N/A
	No-Go Impact	As per the above, under the no-go alternative the vegetation will remain unchanged and the current impacts are therefore negligible.	N/A									Negligible	N/A	

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
Faunal mortalities as a result of construction activities including road collisions	Project Impact (Alternative 1 and 2)	The movement of heavy machinery and an increased number of vehicles during the construction phase may result in the accidental mortality of faunal species, specifically fossorial species and slow moving species.	Negative	Direct	Moderate	Study Area	Short Term	Definite	Reversible	Resource could be partially lost	Achievable	MODERATE	• Staff and contractors' vehicles must comply with speed limits of 40km/hr • Project must start and be completed within the minimum timeframe. i.e. may not be started and left incomplete. • ECO to walk ahead of clearing construction machinery and move slow moving species e.g. tortoises out of harms way and into suitable neighbouring habitat. • Any faunal species that may die as a result of construction must be recorded (photographed, gps co-ord) and if somewhat intact preserved and donated to a Malawian University equipped to preserve the remains. • Any faunal species observed onsite must be recorded (photographed, gps co-ord) and loaded onto iNaturalist. • Staff and contractors are not permitted to capture, collect or eat any faunal species onsite.	MODERATE
	Cumulative Impact	There are no similar construction activities in the area and as such there is unlikely to be a cumulative impact.	N/A									N/A	N/A	N/A
	No-Go Impact	Under the no go alternative, faunal mortality from construction activities will not occur.	Negative	Direct	Slight	Localised	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	LOW	N/A	N/A
Displacement of faunal species as a result of disturbances such as noise, increased activity and fugitive dust	Project Impact (Alternative 1 and 2)	Construction activities will result in an increase in noise in the study area, increased activity levels and increased levels of fugitive dust. These disturbances are likely to result in the displacement of faunal species as they vacate the area to avoid the disturbances. These disturbances may also disrupt breeding cycles of faunal species resulting in the loss cohorts for the year.	Negative	Direct	Moderate	Study Area	Short Term	Definite	Reversible	Resource could be partially lost	Achievable	MODERATE	• Vehicles and machinery must meet best practice standards. • Staff and contractors' vehicles must comply with speed limits of 40km/hr • Project must start and be completed within the minimum timeframe. i.e. may not be started and left incomplete. • Staff and contractors are not permitted to capture, collect or eat any faunal species onsite. • Dust suppression measures must be implemented during the construction phase to reduce fugitive dust levels.	LOW
	Cumulative Impact	There are no similar construction activities in the area and as such there is unlikely to be a cumulative impact.	N/A									N/A	N/A	N/A
	No-Go Impact	Under the no go alternative, disturbance to faunal species from construction activities will not occur and the impact is therefore negligible.	N/A									N/A	N/A	N/A

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
Increased Human-animal conflict	Project Impact (Alternative 1 and 2)	There are existing troops of baboons and monkeys which may cause damage to equipment and may raid any living quarters and waste disposal sites.	Negative	Direct	Moderate	Localised	Short Term	Probable	Reversible	Resource could be partially lost	Achievable	MODERATE -	• Refuse should be isolate to one area. • Consider separating organic refuse out and store in baboon proof bins. • All refuse bins must be baboon proof. • Project related staff must not feed wildlife. Include in Code of Conduct. • Print the following notice board and place within mixed-use development: https://www.kbrc.org.za/imgs/biodiversity/baboons/understanding-baboons-a3-leaflet.pdf • Project employees must be made aware of the risks associated with encountering potentially dangerous animals (venomous snakes and baboons). If a snake is encountered development staff and residents are to contact the designated snake handler for removal and relocation.	LOW -
Operational Phase														
Introduction of Alien Faunal Species	Project Impact (Alternative 1 and 2)	Developments that introduce domestic waste streams create suitable habitats for the introduction of alien species. Introduced urban rodent pests such as the house mouse (*Mus musculus*), house rat (*Rattus rattus)* and the Norwegian rat (*Rattus norvegicus*) are likely to occur in populated areas such as construction camps and office buildings. These species generally tend to survive alongside human habitation, and don't spread in natural areas. The most widespread and common alien bird is the House Sparrow (*Passer domesticus*) and the Pied Crow (*Corvus albus*) which is now distributed almost worldwide and was recorded on site. The introduction of alien species will not only displace existing fauna but also create a nuisance.	Negative	Direct	Moderate	Study Area	Long Term	Probable	Reversible	Resource could be partially lost	Achievable	MODERATE	• The site must be checked regularly for the presence of alien invasive species. When alien invasive species are found, immediate action must be taken to remove them. • An alien invasive management and monitoring plan must be incorporated into the EMPr. • The ECO must create a list with accompanying photographs of possible alien invasive species that could occur on site prior to construction. This photo guide must be used to determine if any alien invasive species are present. • If cats are brought in to assist with any alien species control they must be logged and identifiable and all must be sterilised	LOW
	Cumulative Impact	The project area is located near an existing town and sugarcane planation. There are likely already alien fauna around and the impacts from this project are likely to insignificant when compared to the surrounding impacts.	Negative	Direct	Moderate	Study Area	Permanent	Definite	Irreversible	Resource could be partially lost	Difficult	MODERATE	It is difficult to implement mitigation measures specific to the cumulative impacts as the applicant only has jurisdiction over their development and not over other developments or farming activities in the area. However, it is imperative that the applicant implement the mitigation measures listed above.	• N/A

POTENTIAL ISSUES	TYPE OF IMPACT	SOURCE OF ISSUE	NATURE	TYPE	CONSEQUENCE OF IMPACT	EXTENT OF IMPACT	DURATION OF IMPACT	PROBABILITY OF IMPACT	REVERSIBILITY	IRREPLACEABLE LOSS	MITIGATION POTENTIAL	SIGNIFICANCE WITHOUT MITIGATION	MITIGATION MEASURES	SIGNIFICANCE OF IMPACT WITH MITIGATION
	No-Go Impact	Under the no-go alternative, the current level of infestation of alien species is likely to remain the same.	Negative	Direct	Moderate	Localised	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	MODERATE	N/A	N/A
Collision and electrocution of birds on powerlines	Project Impact (Alternative 1 and 2)	Bird fatalities could occur at the site through a number of mechanisms, including collision with PV panels, entanglement in perimeter fence and others. Electrocution generally occurs on the pylons when birds use it for nesting.	Negative	Direct	Moderate	Localised	Permanent	Definite	Reversible	Resource could be partially lost	Difficult	MODERATE	• The risk of electrocution of large birds on the power line pylons must be mitigated by using a bird friendly design with sufficient phase-phase and phase-earth clearance All staff, vehicle and machinery activities should be strictly controlled at all times so as to ensure that the absolute minimum of surface area is impacted. • A carefully considered surface water/drainage management plan must be developed for the site including attention to the use of environmentally friendly cleaning chemicals.	LOW
	Cumulative Impact	The project site already has a number of powerlines running along the eastern boundary of the northern and central site to the substations and from the substation through the top end of the southern site. It is unclear where the additional powerline will be located but the impact due to the addition of another powerline is insignificant compared to the existing infrastructure.	N/A									N/A	N/A	N/A
	No-Go Impact	The project site already has a number of powerlines running along the eastern boundary of the northern and central site to the substations and from the substation through the top end of the southern site.	N/A									N/A	N/A	N/A
Decommissioning Phase														
Displacement of faunal species as a result of disturbances such as noise, increased activity and fugitive dust	Project Impact (Alternative 1 and 2)	Decomissioning activities are similar to construction activities and will result in an increase in noise in the study area, increased activity levels and increased levels of fugitive dust. These disturbances are likely to result in the displacement of faunal species as they vacate the area to avoid the disturbances. These disturbances may also disrupt breeding cycles of faunal species resulting in the loss cohorts for the year.	Negative	Direct	Moderate	Study Area	Short Term	Definite	Reversible	Resource could be partially lost	Achievable	MODERATE -	• Vehicles and machinery must meet best practice standards. • Staff and contractors' vehicles must comply with speed limits of 40km/hr • Project must start and be completed within the minimum timeframe. i.e. may not be started and left incomplete. • Staff and contractors are not permitted to capture, collect or eat any faunal species onsite. • Dust suppression measures must be implemented during the construction phase to reduce fugitive dust levels. •	LOW -

7 CONCLUSIONS

The project area is on the eastern extent of any remaining natural habitat since across the M5 (towards Lake Malawi) are vast tracks of sugar cane and as such the natural habitat available on the project area is important for faunal species currently inhabiting it. The northern portion of the project site is intact, the middle portion is less intact due to some use of the lower lying areas for woodlots and agriculture and the southern portion is degraded. The habitat available in the project area is not unique and occurs west and south of the project area. The project area borders a town and urban expansion is considered inevitable. However, the development should be cognisant of this and design the project to incorporate faunal habitats as far as possible rather that blanket removal.

Impacts on fauna and associated habitat for the two alternative layouts were assessed. Impacts associated with fauna were determined to be the same for both layout options. Eight impacts were identified, all of which are moderate prior to mitigation. Of these eight impacts, six can be reduced to low negative provided mitigation measures are implemented. Impacts associated with this development are summarised in table 7.1 below.

Table 7.1: Project related impacts and significance rating

POTENTIAL ISSUES	SIGNIFICANCE OF IMPACT	
	WITHOUT MITIGATION	WITH MITIGATION
CONSTRUCTION PHASE		
Loss of extent of faunal habitat (feeding, breeding, shelter and roosting sites) resulting in a reduction in species diversity	Moderate -	Moderate-
Loss of Faunal Species of Conservation Concern	Moderate -	Low -
Faunal mortalities as a result of construction activities including road collisions	Moderate -	Moderate -
Displacement of faunal species as a result of disturbances such as noise, increased activity and fugitive dust	Moderate -	Low -
Increased Human-animal conflict	Moderate -	Low -
OPERATIONAL PHASE		
Introduction of Alien Faunal Species	Moderate -	Low -
Collision and electrocution of birds on powerlines	Moderate -	Low -
DECOMMISSIONING PHASE		
Displacement of faunal species as a result of disturbances such as noise, increased activity and fugitive dust	Moderate -	Low -

7.1 RECOMMENDATIONS

Alternative 2 is the preferred layout as the footprint of the proposed development avoids the Closed Miombo Woodland allowing this vegetation unit to continue functioning as an important habitat and natural corridor for faunal species.

It is recommended that the development footprint of the proposed solar PV plant and associated infrastructure (roads and laydown areas) must be demarcated to prevent any encroachment of construction or operational activities into surrounding natural areas. Minor location deviations from the proposed works is deemed acceptable but the footprint may not be made larger.

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APPENDIX 1: IMPACT RATING SCALE

To ensure a balanced and objective approach to assessing the significance of potential impacts, a standardised rating scale was adopted which allows for the direct comparison of specialist studies. This rating scale has been developed in accordance with the requirements outlined in Appendix 1 of the EIA Regulations (2014 and subsequent 2017 amendments).

Impact significance pre-mitigation

This rating scale adopts six key factors to determine the overall significance of the impact prior to mitigation:

1. **Nature of impact:** Defines whether the impact has a negative or positive effect on the receiving environment.
2. **Type of impact:** Defines whether the impact has a direct, indirect or cumulative effect on the environment.
3. **Duration:** defines the relationship of the impact to temporal scales. The temporal scale defines the significance of the impact at various time scales as an indication of the duration of the impact. This may extend from the short-term (less than 5 years, equivalent to the construction phase) to permanent. Generally, the longer the impact occurs the greater the significance of any given impact.
4. **Extent:** describes the relationship of the impact to spatial scales i.e. the physical extent of the impact. This may extend from the local area to an impact that crosses international boundaries. The wider the spatial scale the impact extends, the more significant the impact is considered to be.
5. **Probability:** refers to the likelihood (risk or chance) of the impact occurring. While many impacts generally do occur, there is considerable uncertainty in terms of others. The scale varies from unlikely to definite, with the overall impact significance increasing as the likelihood increases.
6. **Severity or benefits:** the severity/beneficial scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on the receiving environment. The severity of an impact can be evaluated prior and post mitigation to demonstrate the seriousness of the impact if it is not mitigated, as well as the effectiveness of the mitigation measures. The word 'mitigation' does not only refer to 'compensation', but also includes concepts of containment and remedy. For beneficial impacts, optimization refers to any measure that can enhance the benefits. Mitigation or optimisation should be practical, technically feasible and economically viable.

For each impact, the duration, extent and probability are ranked and assigned a score. These scores are combined and used to determine the overall impact significance prior to mitigation. They must then be considered against the severity rating to determine the overall significance of an activity. This is because the severity of the impact is far more important than the other three criteria. The overall significance is either negative or positive (Criterion 1) and direct, indirect or cumulative (Criterion 2).

Table D1: Evaluation Criteria.

Duration (Temporal Scale)	
Short term	*Less than 5 years*

Medium term	*Between 5-20 years*	
Long term	*Between 20 and 40 years (a generation) and from a human perspective also permanent*	
Permanent	*Over 40 years and resulting in a permanent and lasting change that will always be there*	
Extent (Spatial Scale)		
Localised	*At localised scale and a few hectares in extent*	
Study Area	*The proposed site and its immediate environs*	
Regional	*District and Provincial level*	
National	*Country*	
International	*Internationally*	
Probability (Likelihood)		
Unlikely	*The likelihood of these impacts occurring is slight*	
May Occur	*The likelihood of these impacts occurring is possible*	
Probable	*The likelihood of these impacts occurring is probable*	
Definite	*The likelihood is that this impact will definitely occur*	
Severity Scale	*Severity*	*Benefit*
Very Severe/ Beneficial	An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated.	A permanent and very substantial benefit to the affected system(s) or party(ies), with no real alternative to achieving this benefit.
Severe/ Beneficial	Long term impacts on the affected system(s) or party(ies) that could be mitigated. However, this mitigation would be difficult, expensive or time consuming, or some combination of these.	A long-term impact and substantial benefit to the affected system(s) or party(ies). Alternative ways of achieving this benefit would be difficult, expensive or time consuming, or some combination of these.
Moderately severe/Beneficial	Medium to long term impacts on the affected system(s) or party (ies), which could be mitigated.	A medium to long term impact of real benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are equally difficult, expensive and time consuming (or some combination of these), as achieving them in this way.
Slight	Medium- or short-term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary.	A short to medium term impact and negligible benefit to the affected system(s) or party(ies). Other ways of optimising the beneficial effects are easier, cheaper and quicker, or some combination of these.
No effect/don't or can't know	The system(s) or party(ies) is not affected by the proposed development.	In certain cases, it may not be possible to determine the severity of an impact.

** In certain cases, it may not be possible to determine the severity of an impact thus it may be determined: Don't know/Can't know.*

Table D2: Description of Overall Significance Rating

Significance Rate	***Description***
Don't Know	*In certain cases, it may not be possible to determine the significance of an impact. For example, the primary or secondary impacts on the social or natural environment given the available information.*
NO SIGNIFICANCE	*There are no primary or secondary effects at all that are important to*

		scientists or the public.
LOW NEGATIVE	***LOW POSITIVE***	*Impacts of low significance are typically acceptable impacts for which mitigation is desirable but not essential. The impact by itself is insufficient, even in combination with other low impacts, to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural environment or on social systems.*
MODERATE NEGATIVE	**MODERATE POSITIVE**	*Impacts of moderate significance are impacts that require mitigation. The impact is insufficient by itself to prevent the implementation of the project but in conjunction with other impacts may prevent its implementation. These impacts will usually result in a negative medium to long-term effect on the natural environment or on social systems.*
HIGH NEGATIVE	***HIGH POSITIVE***	*Impacts that are rated as being high are serious impacts and may prevent the implementation of the project if no mitigation measures are implemented, or the impact is very difficult to mitigate. These impacts would be considered by society as constituting a major and usually long-term change to the environment or social systems and result in severe effects.*
VERY HIGH NEGATIVE	***VERY HIGH POSITIVE***	*Impacts that are rated as very high are very serious impact which may be sufficient by itself to prevent the implementation of the project. The impact may result in permanent change. Very often these impacts are unmitigable and usually result in very severe effects or very beneficial effects.*

Impact significance post-mitigation

Once mitigation measures are proposed, the following three factors are then considered to determine the overall significance of the impact after mitigation.

1. **Reversibility Scale**: This scale defines the degree to which an environment can be returned to its original/partially original state.
2. **Irreplaceable loss Scale:** This scale defines the degree of loss which an impact may cause.
3. **Mitigation potential Scale:** This scale defines the degree of difficulty of reversing and/or mitigating the various impacts ranges from very difficult to easily achievable. Both the practical feasibility of the measure, the potential cost and the potential effectiveness is taken into consideration when determining the appropriate degree of difficulty.

Table D3: Post-mitigation Evaluation Criteria

Reversibility	
Reversible	*The activity will lead to an impact that can be reversed provided appropriate mitigation measures are implemented.*
Irreversible	*The activity will lead to an impact that is permanent regardless of the implementation of mitigation measures.*
Irreplaceable loss	
Resource will not be lost	*The resource will not be lost/destroyed provided mitigation measures are implemented.*
Resource will be partly lost	*The resource will be partially destroyed even though mitigation measures are implemented.*
Resource will be lost	*The resource will be lost despite the implementation of mitigation measures.*
Mitigation potential	
Easily achievable	*The impact can be easily, effectively and cost effectively mitigated/reversed.*
Achievable	*The impact can be effectively mitigated/reversed without much difficulty or*

	cost.
Difficult	*The impact could be mitigated/reversed but there will be some difficultly in ensuring effectiveness and/or implementation, and significant costs.*
Very Difficult	*The impact could be mitigated/reversed but it would be very difficult to ensure effectiveness, technically very challenging and financially very costly.*

The following assumptions and limitations are inherent in the rating methodology:

- Value Judgements: Although this scale attempts to provide a balance and rigor to assessing the significance of impacts, the evaluation relies heavily on the values of the person making the judgment.
- Cumulative Impacts: These affect the significance ranking of an impact because it considers the impact in terms of both on-site and off-site sources. This is particularly problematic in terms of impacts beyond the scope of the proposed development. For this reason, it is important to consider impacts in terms of their cumulative nature.
- Seasonality: Certain impacts will vary in significance based on seasonal change. Thus, it is difficult to provide a static assessment. Seasonality will need to be implicit in the temporal scale, with management measures being imposed accordingly (e.g. dust suppression measures being implemented during the dry season).

APPENDIX 2: AMPHIBIAN SPECIES LIST

Species	Common Name	Threat status (IUCN)	Recorded
Afrixalus crotalus	Snoring Spiny Reed Frog	Least Concern	
Afrixalus brachycnemis	Lessor Spiny Reed Frog	Least Concern	
Afrixalus delicatus	Delicate Spiny Reed Frog	Least Concern	
Afrixalus fornasini	Fornasini's Spiny Reed Frog	Least Concern	1
Amietia delalandii	Delalande's River Frog	Least Concern	
Amnirana galamensis	Golden White Lipped Frog	Least Concern	
Arthroleptis stenodactylus	Long-fingered Squeaker	Least Concern	
Arthroleptis xenodactyloides	Drawf Squeaker	Least Concern	
Arthroleptis xenochirus	Plain Squeaker	Least Concern	
Breviceps mossambicus	Mozambique Rain Frog	Least Concern	
Chiromantis xerampelina	Southern Foam-Nest Frog	Least Concern	
Hemisus marmoratus	Marbled Snout-burrower	Least Concern	
Hildebrantia ornata	African Ornate Frog	Least Concern	
Hyperolius acuticeps	Sharp-headed Long Reed Frog	Least Concern	
Hyperolius kivuensis	Kivu Reed Frog	Least Concern	
Hyperolius marginatus	Marginated Reed Frog	Least Concern	
Hyperolius microps	Sharp-Headed Reed Frog	Least Concern	
Hyperolius mitchelli	Mitchell's Reed Frog	Least Concern	1
Hyperolius quinquevuttatus	five striped reed frog	Least Concern	
Hyperolius pusillus	Water Lily Reed Frog	Least Concern	
Hyperolius substriatus	Mainland Reed Frog	Least Concern	
Hyperolius tuberilinguis	Tinker Reed Frog	Least Concern	
Hyperolius viridiflavus	Common Reed Frog	Least Concern	1
Hyperolius viridis	Green Reed Frog	Least Concern	
Kassina senegalensis	Senegal Land Frog	Least Concern	
Leptopelis argenteus	Silvery Tree Frog	Least Concern	
Leptopelis bocaggi	Bocage's Tree Frog	Least Concern	
Leptopelis flavomaculatus	Yellow-spotted Tree Frog	Least Concern	
Leptopelis parbocagii	Cryptic Tree Frog	Least Concern	
Mertensophryne taitana	Taita Forest Toad	Least Concern	
Phrynobatrachus acridoides	East African Puddle Frog	Least Concern	1
Phrynobatrachus perpalmatus	Webbed Puddle Frog	Least Concern	
Phrynobatrachus mababiensis	Mababe Puddle Frog	Least Concern	1
Phrynobatrachus natalensis	Natal Puddle Frog	Least Concern	
Phrynobatrachus parvulus	Little Puddle Frog	Least Concern	
Phrynobatrachus ukingensis	Ukinga Puddle Frog	Least Concern	
Phrynobatrachus rungwensis	Rungwe Puddle Frog	Least Concern	
Phrynomantis bifasciatus	Banded Rubber Frog	Least Concern	

Ptchadena taenioscelis	Dwarf Grass Frog	Least Concern	
Ptychadena anchietae	Plain Grass Frog	Least Concern	1
Ptychadena guibei	Guibes Grass Frog	Least Concern	1
Ptychadena mascareniensis	Mascarene Grass Frog	Least Concern	1
Ptychadena mossambica	Mozambique Grass Frog	Least Concern	1
Ptychadena oxyrhynchus	Sharp-nosed Grass Frog	Least Concern	
Ptychadena porosissima	Striped Grass Frog	Least Concern	
Ptychadena schillukorum	Schilluk Grass Frog	Least Concern	
Ptychadena taenioscelis	Southern Dwarf Grass Frog	Least Concern	
Ptychadena upembae	Upemba Grass Frog	Least Concern	
Ptychadena uzungwensis	Udzungwa Grass Frog	Least Concern	
Pyxicephalus adspersus	Giant Bull Frog	Least Concern	
Pyxicephalus edulis	Lesser (Edible) Bull-frog	Least Concern	
Schismaderma carens	Red Toad	Least Concern	
Sclerophrys gutturalis	Gutteral Toad	Least Concern	
Sclerophrys pusilla	Southern Flat-Backed Toad	Least Concern	1
Strongylopes merumontanus	Mount Meru Stream Frog	Least Concern	
Tomopterna tuberculosa	Rough Sand Frog	Least Concern	
Xenopus laevis	African Clawed Frog	Least Concern	
Xenopus muelleri	Muller's Clawed Toad	Least Concern	1
		58	**11**

APPENDIX 3: REPTILE SPECIES LIST

Scientific Name	Common name	Conservation status	Recorded
Lizards (Squamata)			
Acanthocercus branchi	Agama sp.		1
Pachydactylus oshaughnessti	O'Shaughnessy's Thicktoed Gecko	Least Concern	
Chemaeleop dilepis	Common African Flapnecked Chameleon	Least Concern	
Trachylepis varia	Variable Skink	Least Concern	1
Trachylepis striata	Striped Skink	Least Concern	1
Melanoseps ater	Black Limbless Skink	Least Concern (RR)	
Lygosoma sundevallii	Sundevall's Writhing Skink	Least Concern	
Snakes (Squamata)			
Dasypeltis scabra	Rhombic Egg Eater	Least Concern	
Gracililima nyassae	Black File Snake	Least Concern	
Naja mossambica	Mozambique Spitting Cobra	Least Concern	
Natriciteres olivacea	Olive Marsh Snake	Least Concern	
Philothamnus ornatus	Ornate Green Snake	Least Concern	
Psammophis angolensis	Dwarf Sand Snake	Least Concern	
Psammophylax tritaeniatus	Striped Grass Snake	Least Concern	
Thelotornis capensis	Southern Twig Snake	Least Concern	
Prosymna ambigua	East African Shovelsnout Snake	Least Concern	
Crocodylia			
Crocodylus niloticus	Nile Crocodile	Least Concern	
Testudines			
Cycloderma frenatum	Zambia Flapshell Turtle	Endangered	
		17	**3**

APPENDIX 4: MAMMAL SPECIES LIST

Species	Common Name	Threat status (IUCN)	Recorded
Artiodactyla			
Phacochoerus africanus	Common Warthog	Least Concern	
Potamochoerus larvatus	Bushpig	Least Concern	
Carnivora			
Aonyx capensis	African Clawless Otter	Near-Threatened	
Hydrictis maculicollis	Spotted-necked Otter	Near-Threatened	
Canis adustus	Side-striped Jackal	Least Concern	
Caracal caracal	Caracal	Least Concern	
Felis silvestris	Wild Cat	Least Concern	
Leptailurus serval	Serval	Least Concern	
Genetta maculata	Large-spotted Genet	Least Concern	
Civettictis civetta	African Civet	Least Concern	
Nandinia binotata	African Palm Civet	Least Concern	
Ictonyx striatus	Zorilla	Least Concern	
Mungos mungo	Banded Mongoose	Least Concern	
Atilax paludinosus	Marsh Mongoose	Least Concern	
Helogale parvula	Common Dwarf Mongoose	Least Concern	
Herpestes ichneumon	Egyptian Mongoose	Least Concern	
Paracynictis selousi	Selous's Mongoose	Least Concern	
Rhynchogale melleri	Meller's Mongoose	Least Concern	
Cetartiodactyla			
Cephalophus harveyi	Harvey's Duiker	Least Concern	
Oreotragus oreotragus	Klipspringer	Least Concern	
Philantomba monticola	Blue Duiker	Least Concern	
Raphicerus sharpei	Sharpe's Grysbok	Least Concern	
Redunca arundinum	Southern Reedbuck	Least Concern	
Sylvicapra grimmia	Common Duiker	Least Concern	
Tragelaphus scriptus	Bushbuck	Least Concern	
Chiroptera			
Chaerephon bivittatus	Spotted Wrinkle-lipped Bat	Least Concern	
Chaerephon pumilus	Little Free-tailed Bat	Least Concern	
Eidolon helvum	African Straw-coloured Fruit-bat	Near-Threatened	
Epomophorus crypturus	Peters's Epauletted Fruit Bat	Least Concern	
Epomophorus minor	Minor Epauletted Fruit Bat	Least Concern	
Epomophorus wahlbergi	Wahlberg's Epauletted Fruit Bat	Least Concern	
Glauconycteris variegata	Variegated Butterfly Bat	Least Concern	
Hipposideros caffer	Cape Leaf-nosed bat	Least Concern	
Kerivoula argentata	Damara Woolly Bat	Least Concern	
Kerivoula lanosa	Lesser Woolly Bat	Least Concern	
Laephotis botswanae	Botswanan Long-eared Bat	Least Concern	
Lissonycteris angolensis	Angolan Soft-furred Fruit Bat	Least Concern	

Lophuromys machangui	Machangu's Brush Furred Rat	Data Deficient	
Macronycteris vittatus	Striped Leaf-nosed Bat	Near-Threatened	
Mimetillus moloneyi	Moloney's Mimic Bat	Least Concern	
Miniopterus natalensis	Natal Long-fingered Bat	Least Concern	
Mops condylurus	Angolan Mops Bat	Least Concern	
Myotis tricolor	Cape Hairy Bat	Least Concern	
Myotis welwitschii	Welwitsch's Bat	Least Concern	
Neoromicia capensis	Cape Bat	Least Concern	
Neoromicia melckorum	Melck's Pipistrelle Bat	Data Deficient	
Neoromicia nana	Banana Pipistrelle Bat	Least Concern	
Neoromicia rendalli	Rendall's Serotine	Least Concern	
Nycteris grandis	Large Slit-faced Bat	Least Concern	
Nycteris hispida	Hairy Slit-faced Bat	Least Concern	
Nycteris macrotis	Large-eared Slit-faced Bat	Least Concern	
Nycteris thebaica	Cape Long-eared Bat	Least Concern	
Nycteris woodi	Wood's Slit-faced Bat	Least Concern	
Nycticeinops schlieffeni	Schlieffen's Bat	Least Concern	
Otomops martiensseni	Large-eared Free-tailed Bat	Near-Threatened	
Pipistrellus hesperidus	African pipistrelle	Least Concern	
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	Least Concern	
Rhinolophus fumigatus	Rüppell's Horseshoe Bat	Least Concern	
Rhinolophus hildebrandtii	Hildebrandt's Horseshoe Bat	Least Concern	
Rhinolophus landeri	Lander's Horseshoe Bat	Least Concern	
Rhinolophus mossambicus	Mozambican Horseshoe Bat	Least Concern	
Rhinolophus swinnyi	Swinny's Horseshoe Bat	Least Concern	
Rousettus lanosus	Long-haired Rousette	Least Concern	
Scotoecus albofuscus	Light-winged Lesser House Bat	Data Deficient	
Scotoecus hirundo	Dark-winged Lesser House Bat	Least Concern	
Scotophilus dinganii	African Yellow Bat	Least Concern	
Scotophilus nigrita	Giant House Bat	Least Concern	
Scotophilus viridis	Greenish Yellow Bat	Least Concern	
Tadarida ventralis	African Giant Free-tailed Bat	Data Deficient	
Taphozous mauritianus	Mauritian Tomb Bat	Least Concern	
Eulipotyphla			
Atelerix albiventris	Four-toed Hedgehog	Least Concern	
Crocidura fuscomurina	Bicoloured Musk Shrew	Least Concern	
Crocidura hirta	Lesser Red Musk Shrew	Least Concern	
Suncus megalura	Climbing Shrew	Least Concern	
Hyracoidea			
Dendrohyrax arboreus	Southern Tree Hyrax	Least Concern	
Heterohyrax brucei	Bush Hyrax	Least Concern	
Lagomorpha			
Lepus victoriae	African Savanna Hare	Least Concern	1
Macroscelidea			

Elephantulus brachyrhynchus	Short-snouted Sengi	Least Concern	
Petrodromus tetradactylus	Four-toed Sengi	Least Concern	
Pholidota			
Smutsia temminckii	Temminck's Pangolin	Vulnerable	
Primates			
Cercopithecus mitis	Blue Monkey	Least Concern	
Chlorocebus pygerythrus	Vervet Monkey	Least Concern	1
Galago moholi	Southern Lesser Galago	Least Concern	
Papio cynocephalus	Yellow Baboon	Least Concern	1
Rotentia			
Gerbilliscus boehmi	Boehm's Gerbil	Least Concern	
Gerbilliscus leucogaster	Bushveld Gerbil	Least Concern	
Graphiurus microtis	Small-eared Dormouse	Least Concern	
Hystrix africaeaustralis	Cape Porcupine	Least Concern	
Dendromus mystacalis	Chestnut Climbing Mouse	Least Concern	
Dendromus nyikae	Nyika Climbing Mouse	Least Concern	
Mastomys natalensis	Natal Multimammate Mouse	Least Concern	
Mus minutoides	African Pygmy Mouse	Least Concern	
Mus musculus	House Mouse	Least Concern	
Mus triton	Gray-bellied Pygmy Mouse	Least Concern	
Anomalurus derbianus	Lord Derby's Scaly-tailed Squirrel	Least Concern	
Heliosciurus mutabilis	Mutable Sun Squirrel	Least Concern	
Paraxerus cepapi	Smith's Bush Squirrel	Least Concern	
Paraxerus palliatus	Red Bush Squirrel	Least Concern	
Aethomys chrysophilus	Red Rock Rat	Least Concern	
Grammomys dolichurus	Woodland Thicket Rat	Least Concern	
Grammomys ibeanus	Ruwenzori Thicket Rat	Least Concern	
Rattus rattus	House Rat	Least Concern	
Thallomys paedulcus	Acacia Rat	Least Concern	
Thryonomys gregorianus	Lesser Cane Rat	Least Concern	
Thryonomys swinderianus	Greater Cane Rat	Least Concern	
Uranomys ruddi	Rudd's Rat	Least Concern	
Tubulidentata			
Orycteropus afer	Aardvark	Least Concern	
		120	3

APPENDIX 5: BIRD SPECIES LIST

Common name	Scientific name	Threat Status (IUCN)	Recorded
ANSERIFORMES: Anatidae			
Egyptian Goose	*Alopochen aegyptiaca*	Least Concern	
Red-billed Duck	*Anas erythrorhyncha*	Least Concern	
African Black Duck	*Anas sparsa*	Least Concern	
Yellow-billed Duck	*Anas undulata*	Least Concern	
Fulvous Whistling-Duck	*Dendrocygna bicolor*	Least Concern	
White-faced Whistling-Duck	*Dendrocygna viduata*	Least Concern	
Southern Pochard	*Netta erythrophthalma*	Least Concern	
African Pygmy-Goose	*Nettapus auritus*	Least Concern	
Spur-winged Goose	*Plectropterus gambensis*	Least Concern	
Knob-billed Duck	*Sarkidiornis melanotos*	Least Concern	
Hottentot Teal	*Spatula hottentota*	Least Concern	
White-backed Duck	*Thalassornis leuconotus*	Least Concern	
GALLIFORMES: Numididae			
Crested Guineafowl	*Guttera pucherani*	Least Concern	
Helmeted Guineafowl	*Numida meleagris*	Least Concern	
GALLIFORMES: Phasianidae			
Francolin sp.			1
Common Quail	*Coturnix coturnix*	Least Concern	
Harlequin Quail	*Coturnix delegorguei*	Least Concern	
Coqui Francolin	*Peliperdix coqui*	Least Concern	
Red-necked Francolin	*Pternistis afer*	Least Concern	
Hildebrandt's Francolin	*Pternistis hildebrandti*	Least Concern	
Scaly Francolin	*Pternistis squamatus*	Least Concern	
Swainson's Francolin	*Pternistis swainsonii*	Least Concern	
Red-winged Francolin	*Scleroptila levaillantii*	Least Concern	
Shelley's Francolin	*Scleroptila shelleyi*	Least Concern	
Blue Quail	*Synoicus adansonii*	Least Concern	
PODICIPEDIFORMES: Podicipedidae			
Little Grebe	*Tachybaptus ruficollis*	Least Concern	
COLUMBIFORMES: Columbidae			
Rameron Pigeon	*Columba arquatrix*	Least Concern	
Lemon Dove	*Columba larvata*	Least Concern	
Namaqua Dove	*Oena capensis*	Least Concern	
Ring-necked Dove	*Streptopelia capicola*	Least Concern	
Mourning Collared-Dove	*Streptopelia decipiens*	Least Concern	
Red-eyed Dove	*Streptopelia semitorquata*	Least Concern	
Laughing Dove	*Streptopelia senegalensis*	Least Concern	1
African Green-Pigeon	*Treron calvus*	Least Concern	
Blue-spotted Wood-Dove	*Turtur afer*	Least Concern	
Emerald-spotted Wood-Dove	*Turtur chalcospilos*	Least Concern	1

Common name	Scientific name	Threat Status (IUCN)	Recorded
Tambourine Dove	*Turtur tympanistria*	Least Concern	1
OTIDIFORMES: Otididae			
Black-bellied Bustard	*Lissotis melanogaster*	Least Concern	
Denham's Bustard	*Neotis denhami*	Near-Threatened	
MUSOPHAGIFORMES: Musophagidae			
Grey Go-away-bird	*Corythaixoides concolor*	Least Concern	
Livingstone's Turaco	*Tauraco livingstonii*	Least Concern	
Purple-crested Turaco	*Tauraco porphyreolophus*	Least Concern	
Schalow's Turaco	*Tauraco schalowi*	Least Concern	
CUCULIFORMES: Cuculidae			
Coppery-tailed Coucal	*Centropus cupreicaudus*	Least Concern	
Black Coucal	*Centropus grillii*	Least Concern	
Senegal Coucal	*Centropus senegalensis*	Least Concern	
White-browed Coucal	*Centropus superciliosus*	Least Concern	
Barred Long-tailed Cuckoo	*Cercococcyx montanus*	Least Concern	
Green Malkoha	*Ceuthmochares australis*	Least Concern	
Dideric Cuckoo	*Chrysococcyx caprius*	Least Concern	
African Emerald Cuckoo	*Chrysococcyx cupreus*	Least Concern	
Klaas's Cuckoo	*Chrysococcyx klaas*	Least Concern	
Great Spotted Cuckoo	*Clamator glandarius*	Least Concern	
Pied Cuckoo	*Clamator jacobinus*	Least Concern	
Levaillant's Cuckoo	*Clamator levaillantii*	Least Concern	
Common Cuckoo	*Cuculus canorus*	Least Concern	
Black Cuckoo	*Cuculus clamosus*	Least Concern	
African Cuckoo	*Cuculus gularis*	Least Concern	
Red-chested Cuckoo	*Cuculus solitarius*	Least Concern	
Thick-billed Cuckoo	*Pachycoccyx audeberti*	Least Concern	
CAPRIMULGIFORMES: Caprimulgidae			
Eurasian Nightjar	*Caprimulgus europaeus*	Least Concern	
Square-tailed Nightjar	*Caprimulgus fossii*	Least Concern	1
Fiery-necked Nightjar	*Caprimulgus pectoralis*	Least Concern	1
Rwenzori Nightjar	*Caprimulgus ruwenzorii*	Least Concern	
Freckled Nightjar	*Caprimulgus tristigma*	Least Concern	
Pennant-winged Nightjar	*Caprimulgus vexillarius*	Least Concern	
CAPRIMULGIFORMES: Apodidae			
Mottled Swift	*Apus aequatorialis*	Least Concern	
Little Swift	*Apus affinis*	Least Concern	
Common Swift	*Apus apus*	Least Concern	
African Black Swift	*Apus barbatus*	Least Concern	
White-rumped Swift	*Apus caffer*	Least Concern	
African Palm-Swift	*Cypsiurus parvus*	Least Concern	
Mottled Spinetail	*Telacanthura ussheri*	Least Concern	1
GRUIFORMES: Sarothruridae			
Striped Flufftail	*Sarothrura affinis*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
Streaky-breasted Flufftail	*Sarothrura boehmi*	Least Concern	
Red-chested Flufftail	*Sarothrura rufa*	Least Concern	
GRUIFORMES: Rallidae			
Striped Crake	*Amaurornis marginalis*	Least Concern	
Corn Crake	*Crex crex*	Least Concern	
African Crake	*Crex egregia*	Least Concern	
Red-knobbed Coot	*Fulica cristata*	Least Concern	
Eurasian Moorhen	*Gallinula chloropus*	Least Concern	
Lesser Moorhen	*Paragallinula angulata*	Least Concern	
Allen's Gallinule	*Porphyrio alleni*	Least Concern	
African Swamphen	*Porphyrio madagascariensis*	Least Concern	
Spotted Crake	*Porzana porzana*	Least Concern	
African Rail	*Rallus caerulescens*	Least Concern	
Black Crake	*Zapornia flavirostra*	Least Concern	
Baillon's Crake	*Zapornia pusilla*	Least Concern	
GRUIFORMES: Heliornithidae			
African Finfoot	*Podica senegalensis*	Least Concern	
GRUIFORMES: Gruidae			
Grey Crowned-Crane	*Balearica regulorum*	Endangered	
Wattled Crane	*Bugeranus carunculatus*	Least Concern	
CHARADRIIFORMES: Burhinidae			
Spotted Thick-knee	*Burhinus capensis*	Least Concern	
Water Thick-knee	*Burhinus vermiculatus*	Least Concern	
CHARADRIIFORMES: Recurvirostridae			
Black-winged Stilt	*Himantopus himantopus*	Least Concern	
Pied Avocet	*Recurvirostra avosetta*	Least Concern	
CHARADRIIFORMES: Charadriidae			
Caspian Plover	*Charadrius asiaticus*	Least Concern	
Common Ringed Plover	*Charadrius hiaticula*	Least Concern	
White-fronted Plover	*Charadrius marginatus*	Least Concern	
Kittlitz's Plover	*Charadrius pecuarius*	Least Concern	
Three-banded Plover	*Charadrius tricollaris*	Least Concern	
Blacksmith Lapwing	*Vanellus armatus*	Least Concern	
Long-toed Lapwing	*Vanellus crassirostris*	Least Concern	
Senegal Lapwing	*Vanellus lugubris*	Least Concern	
Wattled Lapwing	*Vanellus senegallus*	Least Concern	
Spur-winged	*Vanellus spinosus*	Least Concern	
CHARADRIIFORMES: Rostratulidae			
Greater Painted-Snipe	*Rostratula benghalensis*	Least Concern	
CHARADRIIFORMES: Jacanidae			
African Jacana	*Actophilornis africanus*	Least Concern	
Lesser Jacana	*Microparra capensis*	Least Concern	
CHARADRIIFORMES: Scolopacidae			
Common Sandpiper	*Actitis hypoleucos*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
Curlew Sandpiper	*Calidris ferruginea*	Near-Threatened	
Little Stint	*Calidris minuta*	Least Concern	
Ruff	*Calidris pugnax*	Least Concern	
Common Snipe	*Gallinago gallinago*	Least Concern	
Great Snipe	*Gallinago media*	Near-Threatened	
African Snipe	*Gallinago nigripennis*	Least Concern	
Eurasian Curlew	*Numenius arquata*	Near-Threatened	
Wood Sandpiper	*Tringa glareola*	Least Concern	
Common Greenshank	*Tringa nebularia*	Least Concern	
Green Sandpiper	*Tringa ochropus*	Least Concern	
Marsh Sandpiper	*Tringa stagnatilis*	Least Concern	
CHARADRIIFORMES: Turnicidae			
Black-rumped Buttonquail	*Turnix nanus*	Least Concern	
Small Buttonquail	*Turnix sylvaticus*	Least Concern	
CHARADRIIFORMES: Glareolidae			
Temminck's Courser	*Cursorius temminckii*	Least Concern	
Rock Pratincole	*Glareola nuchalis*	Least Concern	
Collared Pratincole	*Glareola pratincola*	Least Concern	
Bronze-winged Courser	*Rhinoptilus chalcopterus*	Least Concern	
CHARADRIIFORMES: Laridae			
Whiskered Tern	*Chlidonias hybrida*	Least Concern	
White-winged Tern	*Chlidonias leucopterus*	Least Concern	
Gray-hooded Gull	*Chroicocephalus cirrocephalus*	Least Concern	
Gull-billed Tern	*Gelochelidon nilotica*	Least Concern	
CICONIIFORMES: Ciconiidae			
African Openbill	*Anastomus lamelligerus*	Least Concern	
Abdim's Stork	*Ciconia abdimii*	Least Concern	
White Stork	*Ciconia ciconia*	Least Concern	
Woolly-necked Stork	*Ciconia episcopus*	Least Concern	
Black Stork	*Ciconia nigra*	Least Concern	
Saddle-billed Stork	*Ephippiorhynchus senegalensis*	Least Concern	
Marabou Stork	*Leptoptilos crumenifer*	Least Concern	
Yellow-billed Stork	*Mycteria ibis*	Least Concern	
SULIFORMES: Anhingidae			
African Darter	*Anhinga rufa*	Least Concern	
SULIFORMES: Phalacrocoracidae			
Long-tailed Cormorant	*Microcarbo africanus*	Least Concern	
Great Cormorant	*Phalacrocorax carbo*	Least Concern	
PELECANIFORMES: Scopidae			
Hamerkop	*Scopus umbretta*	Least Concern	
PELECANIFORMES: Ardeidae			
Great Egret	*Ardea alba*	Least Concern	
Gray Heron	*Ardea cinerea*	Least Concern	
Goliath Heron	*Ardea goliath*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
Intermediate Egret	*Ardea intermedia*	Least Concern	
Black-headed Heron	*Ardea melanocephala*	Least Concern	1
Purple Heron	*Ardea purpurea*	Least Concern	
Madagascar Pond-Heron	*Ardeola idae*	Endangered	
Squacco Heron	*Ardeola ralloides*	Least Concern	
Rufous-bellied Heron	*Ardeola rufiventris*	Least Concern	
Cattle Egret	*Bubulcus ibis*	Least Concern	
Striated Heron	*Butorides striata*	Least Concern	
Black Heron	*Egretta ardesiaca*	Least Concern	
Little Egret	*Egretta garzetta*	Least Concern	
White-backed Night-Heron	*Gorsachius leuconotus*	Least Concern	
Little Bittern	*Ixobrychus minutus*	Least Concern	
Dwarf Bittern	*Ixobrychus sturmii*	Least Concern	
Black-crowned Night-Heron	*Nycticorax nycticorax*	Least Concern	
PELECANIFORMES: Threskiornithidae			
Hadada Ibis	*Bostrychia hagedash*	Least Concern	
African Spoonbill	*Platalea alba*	Least Concern	
Glossy Ibis	*Plegadis falcinellus*	Least Concern	
African Sacred Ibis	*Threskiornis aethiopicus*	Least Concern	
ACCIPITRIFORMES: Sagittariidae			
Secretarybird	*Sagittarius serpentarius*	Endangered	
ACCIPITRIFORMES: Pandionidae			
Osprey	*Pandion haliaetus*	Least Concern	
ACCIPITRIFORMES: Accipitridae			
Shikra	*Accipiter badius*	Least Concern	
Black Goshawk	*Accipiter melanoleucus*	Least Concern	
Little Sparrowhawk	*Accipiter minullus*	Least Concern	
Ovambo Sparrowhawk	*Accipiter ovampensis*	Least Concern	
African Goshawk	*Accipiter tachiro*	Least Concern	
Steppe Eagle	*Aquila nipalensis*	Endangered	
Tawny Eagle	*Aquila rapax*	Vulnerable	
African Hawk-Eagle	*Aquila spilogaster*	Least Concern	
Verreaux's Eagle	*Aquila verreauxii*	Least Concern	
African Cuckoo-Hawk	*Aviceda cuculoides*	Least Concern	
Augur Buzzard	*Buteo augur*	Least Concern	
Common Buzzard	*Buteo buteo*	Least Concern	
Mountain Buzzard	*Buteo oreophilus*	Least Concern	
Banded Snake-Eagle	*Circaetus cinerascens*	Least Concern	
Brown Snake-Eagle	*Circaetus cinereus*	Least Concern	
Black-chested Snake-Eagle	*Circaetus pectoralis*	Least Concern	
Eurasian Marsh-Harrier	*Circus aeruginosus*	Least Concern	
Pallid Harrier	*Circus macrourus*	Near-Threatened	
Montagu's Harrier	*Circus pygargus*	Least Concern	
African Marsh-Harrier	*Circus ranivorus*	Least Concern	
Lesser Spotted Eagle	*Clanga pomarina*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
Black-winged Kite	*Elanus caeruleus*	Least Concern	
Palm-nut Vulture	*Gypohierax angolensis*	Least Concern	
White-backed Vulture	*Gyps africanus*	Critically Endangered	
African Fish-Eagle	*Haliaeetus vocifer*	Least Concern	
Ayres's Hawk-Eagle	*Hieraaetus ayresii*	Least Concern	
Booted Eagle	*Hieraaetus pennatus*	Least Concern	
Wahlberg's Eagle	*Hieraaetus wahlbergi*	Least Concern	
Lizard Buzzard	*Kaupifalco monogrammicus*	Least Concern	
Long-crested Eagle	*Lophaetus occipitalis*	Least Concern	
Bat Hawk	*Macheiramphus alcinus*	Least Concern	
Dark Chanting-Goshawk	*Melierax metabates*	Least Concern	
Gabar Goshawk	*Micronisus gabar*	Least Concern	1
Black Kite	*Milvus migrans*	Least Concern	
Hooded Vulture	*Necrosyrtes monachus*	Critically Endangered	
European Honey-buzzard	*Pernis apivorus*	Least Concern	
Martial Eagle	*Polemaetus bellicosus*	Endangered	
African Harrier-Hawk	*Polyboroides typus*	Least Concern	1
Crowned Eagle	*Stephanoaetus coronatus*	Near-Threatened	
Bateleur	*Terathopius ecaudatus*	Endangered	
Lappet-faced Vulture	*Torgos tracheliotos*	Endangered	
White-headed Vulture	*Trigonoceps occipitalis*	Critically Endangered	
STRIGIFORMES: Tytonidae			
Barn Owl	*Tyto alba*	Least Concern	
African Grass-Owl	*Tyto capensis*	Least Concern	
STRIGIFORMES: Strigidae			
Marsh Owl	*Asio capensis*	Least Concern	
Spotted Eagle-Owl	*Bubo africanus*	Least Concern	
Verreaux's Eagle-Owl	*Bubo lacteus*	Least Concern	
African Barred Owlet	*Glaucidium capense*	Least Concern	
Pearl-spotted Owlet	*Glaucidium perlatum*	Least Concern	
African Scops-Owl	*Otus senegalensis*	Least Concern	
Southern White-faced Owl	*Ptilopsis granti*	Least Concern	
Pel's Fishing-Owl	*Scotopelia peli*	Least Concern	
African Wood-Owl	*Strix woodfordii*	Least Concern	
COLIIFORMES: Coliidae			
Speckled Mousebird	*Colius striatus*	Least Concern	1
Red-faced Mousebird	*Urocolius indicus*	Least Concern	
TROGONIFORMES: Trogonidae			
Narina Trogon	*Apaloderma narina*	Least Concern	
Bar-tailed Trogon	*Apaloderma vittatum*	Least Concern	
BUCEROTIFORMES: Upupidae			
Eurasian Hoopoe	*Upupa epops*	Least Concern	
BUCEROTIFORMES: Phoeniculidae			
Green Woodhoopoe	*Phoeniculus purpureus*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
Common Scimitarbill	*Rhinopomastus cyanomelas*	Least Concern	
BUCEROTIFORMES: Bucorvidae			
Southern Ground-Hornbill	*Bucorvus leadbeateri*	Vulnerable	
BUCEROTIFORMES: Bucerotidae			
Trumpeter Hornbill	*Bycanistes bucinator*	Least Concern	
Crowned Hornbill	*Lophoceros alboterminatus*	Least Concern	
African Grey Hornbill	*Lophoceros nasutus*	Least Concern	
Pale-billed Hornbill	*Lophoceros pallidirostris*	Least Concern	
Southern Red-billed Hornbill	*Tockus rufirostris*	Least Concern	
CORACIIFORMES: Alcedinidae			
Half-collared Kingfisher	*Alcedo semitorquata*	Least Concern	
Malachite Kingfisher	*Corythornis cristatus*	Least Concern	
Brown-hooded Kingfisher	*Halcyon albiventris*	Least Concern	1
Striped Kingfisher	*Halcyon chelicuti*	Least Concern	1
Grey-headed Kingfisher	*Halcyon leucocephala*	Least Concern	
Woodland Kingfisher	*Halcyon senegalensis*	Least Concern	
African Pygmy-Kingfisher	*Ispidina picta*	Least Concern	
CORACIIFORMES: Meropidae			
European Bee-eater	*Merops apiaster*	Least Concern	
Böhm's Bee-eater	*Merops boehmi*	Least Concern	
White-fronted Bee-eater	*Merops bullockoides*	Least Concern	
Swallow-tailed Bee-eater	*Merops hirundineus*	Least Concern	
Southern Carmine Bee-eater	*Merops nubicoides*	Least Concern	
Blue-cheeked Bee-eater	*Merops persicus*	Least Concern	
Little Bee-eater	*Merops pusillus*	Least Concern	1
Madagascar Bee-eater	*Merops superciliosus*	Least Concern	
CORACIIFORMES: Coraciidae			
Lilac-breasted Roller	*Coracias caudatus*	Least Concern	
European Roller	*Coracias garrulus*	Least Concern	
Rufous-crowned Roller	*Coracias naevius*	Least Concern	
Racket-tailed Roller	*Coracias spatulatus*	Least Concern	
Broad-billed Roller	*Eurystomus glaucurus*	Least Concern	
PICIFORMES: Lybiidae			
Black-backed Barbet	*Lybius minor*	Least Concern	
Black-collared Barbet	*Lybius torquatus*	Least Concern	
Yellow-rumped Tinkerbird	*Pogoniulus bilineatus*	Least Concern	
Yellow-fronted Tinkerbird	*Pogoniulus chrysoconus*	Least Concern	
Moustached Tinkerbird	*Pogoniulus leucomystax*	Least Concern	
Green Tinkerbird	*Pogoniulus simplex*	Least Concern	
Whyte's Barbet	*Stactolaema whytii*	Least Concern	
Crested Barbet	*Trachyphonus vaillantii*	Least Concern	
Miombo Barbet	*Tricholaema frontata*	Least Concern	
PICIFORMES: Indicatoridae			
Greater Honeyguide	*Indicator indicator*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
Pallid Honeyguide	*Indicator meliphilus*	Least Concern	
Lesser Honeyguide	*Indicator minor*	Least Concern	
Scaly-throated Honeyguide	*Indicator variegatus*	Least Concern	
Wahlberg's Honeyguide	*Prodotiscus regulus*	Least Concern	
Green-backed Honeyguide	*Prodotiscus zambesiae*	Least Concern	
PICIFORMES: Picidae			
Golden-tailed Woodpecker	*Campethera abingoni*	Least Concern	
Bennett's Woodpecker	*Campethera bennettii*	Least Concern	
Green-backed Woodpecker	*Campethera cailliautii*	Least Concern	
Cardinal Woodpecker	*Chloropicus fuscescens*	Least Concern	1
Olive Woodpecker	*Chloropicus griseocephalus*	Least Concern	
Bearded Woodpecker	*Chloropicus namaquus*	Least Concern	
FALCONIFORMES: Falconidae			
Falcon	*Falco sp.*		1
Amur Falcon	*Falco amurensis*	Least Concern	
Lanner Falcon	*Falco biarmicus*	Least Concern	
Red-necked Falcon	*Falco chicquera*	Least Concern	
Dickinson's Kestrel	*Falco dickinsoni*	Least Concern	
Taita Falcon	*Falco fasciinucha*	Vulnerable	
Lesser Kestrel	*Falco naumanni*	Least Concern	
Peregrine Falcon	*Falco peregrinus*	Least Concern	
Rock Kestrel	*Falco rupicolus*	Least Concern	
Eurasian Hobby	*Falco subbuteo*	Least Concern	
Red-footed Falcon	*Falco vespertinus*	Least Concern	
PSITTACIFORMES: Psittaculidae			
Lilian's Lovebird	*Agapornis lilianae*	Least Concern	
PSITTACIFORMES: Psittacidae			
Brown-necked Parrot	*Poicephalus fuscicollis*	Least Concern	
Meyer's Parrot	*Poicephalus meyeri*	Least Concern	
PASSERIFORMES: Calyptomenidae			
African Broadbill	*Smithornis capensis*	Least Concern	
PASSERIFORMES: Pittidae			
African Pitta	*Pitta angolensis*	Least Concern	
PASSERIFORMES: Campephagidae			
Black Cuckooshrike	*Campephaga flava*	Least Concern	
White-breasted Cuckooshrike	*Coracina pectoralis*	Least Concern	
PASSERIFORMES: Oriolidae			
African Golden Oriole	*Oriolus auratus*	Least Concern	
African Black-headed Oriole	*Oriolus larvatus*	Least Concern	
Eurasian Golden Oriole	*Oriolus oriolus*	Least Concern	
PASSERIFORMES: Platysteiridae			
Cape Batis	*Batis capensis*	Least Concern	
Chinspot Batis	*Batis molitor*	Least Concern	
Pale Batis	*Batis soror*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
Black-throated Wattle-eye	*Platysteira peltata*	Least Concern	
PASSERIFORMES: Vangidae			
White Helmetshrike	*Prionops plumatus*	Least Concern	
Retz's Helmetshrike	*Prionops retzii*	Least Concern	
PASSERIFORMES: Malaconotidae			
Black-backed Puffback	*Dryoscopus cubla*	Least Concern	
Tropical Boubou	*Laniarius major*	Least Concern	
Grey-headed Bushshrike	*Malaconotus blanchoti*	Least Concern	
Brubru	*Nilaus afer*	Least Concern	
Brown-crowned Tchagra	*Tchagra australis*	Least Concern	
Black-crowned Tchagra	*Tchagra senegalus*	Least Concern	1
Orange-breasted Bushshrike	*Telophorus sulfureopectus*	Least Concern	
PASSERIFORMES: Dicruridae			
Fork-tailed Drongo	*Dicrurus adsimilis*	Least Concern	
PASSERIFORMES: Monarchidae			
African Crested-Flycatcher	*Trochocercus cyanomelas*	Least Concern	
African Paradise-Flycatcher	*Terpsiphone viridis*	Least Concern	
PASSERIFORMES: Laniidae			
Red-backed Shrike	*Lanius collurio*	Least Concern	
Common Fiscal	*Lanius collaris*	Least Concern	1
Lessor Grey Shrike	*Lanius minor*	Least Concern	
Northern Fiscal	*Lanius humeralis*	Least Concern	
Souza's Shrike	*Lanius souzae*	Least Concern	
PASSERIFORMES: Corvidae			
Pied Crow	*Corvus albus*	Least Concern	1
White-necked Raven	*Corvus albicollis*	Least Concern	
PASSERIFORMES: Hyliotidae			
Yellow-bellied Hyliota	*Hyliota flavigaster*	Least Concern	
Southern Hyliota	*Hyliota australis*	Least Concern	
PASSERIFORMES: Stenostiridae			
White-tailed Blue Flycatcher	*Elminia albicauda*	Least Concern	
White-tailed Crested-Flycatcher	*Elminia albonotata*	Least Concern	
PASSERIFORMES: Paridae			
Miombo Tit	*Melaniparus griseiventris*	Least Concern	
White-winged Black-Tit	*Melaniparus leucomelas*	Least Concern	
Southern Black-Tit	*Melaniparus niger*	Least Concern	
Rufous-bellied Tit	*Melaniparus rufiventris*	Least Concern	
PASSERIFORMES: Remizidae			
African Penduline-Tit	*Anthoscopus caroli*	Least Concern	
PASSERIFORMES: Alaudidae			
Red-capped Lark	*Calandrella cinerea*	Least Concern	
Fischer's Sparrow-Lark	*Eremopterix leucopareia*	Least Concern	
Chestnut-backed Sparrow-Lark	*Eremopterix leucotis*	Least Concern	
Flappet Lark	*Mirafra rufocinnamomea*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
PASSERIFORMES: Nicatoridae			
Eastern Nicator	*Nicator gularis*	Least Concern	
PASSERIFORMES: Macrosphenidae			
Moustached Grass-Warbler	*Melocichla mentalis*	Least Concern	
Cape Crombec	*Sylvietta rufescens*	Least Concern	
Red-capped Crombec	*Sylvietta ruficapilla*	Least Concern	
Red-faced Crombec	*Sylvietta whytii*	Least Concern	
PASSERIFORMES: Cisticolidae			
Chapin's Apalis	*Apalis chapini*	Least Concern	
Yellow-breasted Apalis	*Apalis flavida*	Least Concern	
Yellow-throated Apalis	*Apalis flavigularis*	Least Concern	
Bar-throated Apalis	*Apalis thoracica*	Least Concern	
Stierling's Wren-Warbler	*Calamonastes stierlingi*	Least Concern	
Miombo Wren-Warbler	*Calamonastes undosus*	Least Concern	
Green-backed Camaroptera	*Camaroptera brachyura*	Least Concern	
Rock-loving Cisticola	*Cisticola aberrans*	Least Concern	
Wing-snapping Cisticola	*Cisticola ayresii*	Least Concern	
Siffling Cisticola	*Cisticola brachypterus*	Least Concern	
Singing Cisticola	*Cisticola cantans*	Least Concern	
Rattling Cisticola	*Cisticola chiniana*	Least Concern	
Red-faced Cisticola	*Cisticola erythrops*	Least Concern	
Piping Cisticola	*Cisticola fulvicapilla*	Least Concern	
Rufous-winged Cisticola	*Cisticola galactotes*	Least Concern	
Zitting Cisticola	*Cisticola juncidis*	Least Concern	
Wailing Cisticola	*Cisticola lais*	Least Concern	
Croaking Cisticola	*Cisticola natalensis*	Least Concern	
Black-lored Cisticola	*Cisticola nigriloris*	Least Concern	
Tinkling Cisticola	*Cisticola rufilatus*	Least Concern	
Trilling Cisticola	*Cisticola woosnami*	Least Concern	
Yellow-bellied Eremomela	*Eremomela icteropygialis*	Least Concern	
Greencap Eremomela	*Eremomela scotops*	Least Concern	
Burnt-neck Eremomela	*Eremomela usticollis*	Least Concern	
Red-winged Prinia	*Prinia erythroptera*	Least Concern	
Tawny-flanked Prinia	*Prinia subflava*	Least Concern	1
PASSERIFORMES: Acrocephalidae			
Great Reed Warbler	*Acrocephalus arundinaceus*	Least Concern	
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	Least Concern	
Marsh Warbler	*Acrocephalus palustris*	Least Concern	
Sedge Warbler	*Acrocephalus schoenobaenus*	Least Concern	
Eurasian Reed Warbler	*Acrocephalus scirpaceus*	Least Concern	
Icterine Warbler	*Hippolais icterina*	Least Concern	
Olive-tree Warbler	*Hippolais olivetorum*	Least Concern	
African Yellow-Warbler	*Iduna natalensis*	Least Concern	
Mountain Yellow-Warbler	*Iduna similis*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
PASSERIFORMES: Locustellidae			
Little Rush-Warbler	*Bradypterus baboecala*	Least Concern	
Cinnamon Bracken-Warbler	*Bradypterus cinnamomeus*	Least Concern	
Evergreen-forest Warbler	*Bradypterus lopezi*	Least Concern	
River Warbler	*Locustella fluviatilis*	Least Concern	
Fan-tailed Grassbird	*Schoenicola brevirostris*	Least Concern	
PASSERIFORMES: Hirundinidae			
Lesser Striped Swallow	*Cecropis abyssinica*	Least Concern	1
Red-rumped Swallow	*Cecropis daurica*	Least Concern	
Rufous-chested Swallow	*Cecropis semirufa*	Least Concern	
Mosque Swallow	*Cecropis senegalensis*	Least Concern	
Common House-Martin	*Delichon urbicum*	Least Concern	
White-throated Swallow	*Hirundo albigularis*	Least Concern	1
Blue Swallow	*Hirundo atrocaerulea*	Vulnerable	1
Pearl-breasted Swallow	*Hirundo dimidiata*	Least Concern	
Barn Swallow	*Hirundo rustica*	Least Concern	1
Wire-tailed Swallow	*Hirundo smithii*	Least Concern	
White-headed Sawwing	*Psalidoprocne albiceps*	Least Concern	
Eastern Saw-wing	*Psalidoprocne orientalis*	Least Concern	
Grey-rumped Swallow	*Pseudhirundo griseopyga*	Least Concern	
Rock Martin	*Ptyonoprogne fuligula*	Least Concern	
Banded Martin	*Riparia cincta*	Least Concern	
Plain Martin	*Riparia paludicola*	Least Concern	
Bank Swallow	*Riparia riparia*	Least Concern	
PASSERIFORMES: Pycnonotidae			
Sombre Greenbul	*Andropadus importunus*	Least Concern	
Black-browed Mountain Greenbul	*Arizelocichla fusciceps*	Least Concern	
Shelley's Greenbul	*Arizelocichla masukuensis*	Least Concern	
Stripe-cheeked Greenbul	*Arizelocichla milanjensis*	Least Concern	
Yellow-bellied Greenbul	*Chlorocichla flaviventris*	Least Concern	
Little Greenbul	*Eurillas virens*	Least Concern	
Cabanis's Greenbul	*Phyllastrephus cabanisi*	Least Concern	
Gray-olive Greenbul	*Phyllastrephus cerviniventris*	Least Concern	
Yellow-streaked Greenbul	*Phyllastrephus flavostriatus*	Least Concern	
Terrestrial Brownbul	*Phyllastrephus terrestris*	Least Concern	
Common Bulbul	*Pycnonotus barbatus*	Least Concern	1
PASSERIFORMES: Phylloscopidae			
Yellow-throated Woodland-Warbler	*Phylloscopus ruficapilla*	Least Concern	
Willow Warbler	*Phylloscopus trochilus*	Least Concern	
PASSERIFORMES: Sylviidae			
African Hill Babbler	*Sylvia abyssinica*	Least Concern	
Eurasian Blackcap	*Sylvia atricapilla*	Least Concern	
Garden Warbler	*Sylvia borin*	Least Concern	
Greater Whitethroat	*Sylvia communis*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
Brown Parisoma	*Sylvia lugens*	Least Concern	
PASSERIFORMES: Zosteropidae			
African Yellow White-eye	*Zosterops senegalensis*	Least Concern	
PASSERIFORMES: Pellorneidae			
Mountain Illadopsis	*Illadopsis pyrrhoptera*	Least Concern	
PASSERIFORMES: Leiothrichidae			
Arrow-marked Babbler	*Turdoides jardineii*	Least Concern	
PASSERIFORMES: Certhiidae			
African Spotted Creeper	*Salpornis salvadori*	Least Concern	
PASSERIFORMES: Buphagidae			
Yellow-billed Oxpecker	*Buphagus africanus*	Least Concern	
PASSERIFORMES: Sturnidae			
Violet-backed Starling	*Cinnyricinclus leucogaster*	Least Concern	
Wattled Starling	*Creatophora cinerea*	Least Concern	
Greater Blue-eared Starling	*Lamprotornis chalybaeus*	Least Concern	
Lesser Blue-eared Starling	*Lamprotornis chloropterus*	Least Concern	
Babbling Starling	*Neocichla gutturalis*	Least Concern	
Red-winged Starling	*Onychognathus morio*	Least Concern	
Slender-billed Starling	*Onychognathus tenuirostris*	Least Concern	
PASSERIFORMES: Turdidae			
Orange Ground-Thrush	*Geokichla gurneyi*	Least Concern	
Groundscraper Thrush	*Psophocichla litsitsirupa*	Least Concern	
Abyssinian Thrush	*Turdus abyssinicus*	Least Concern	
Kurrichane Thrush	*Turdus libonyana*	Least Concern	
Olive Thrush	*Turdus olivaceus*	Least Concern	
PASSERIFORMES: Muscicapidae			
Pale Flycatcher	*Agricola pallidus*	Least Concern	
Böhm's Flycatcher	*Bradornis boehmi*	Least Concern	
Miombo Scrub-Robin	*Cercotrichas barbata*	Least Concern	
Red-backed Scrub-Robin	*Cercotrichas leucophrys*	Least Concern	
Bearded Scrub-Robin	*Cercotrichas quadrivirgata*	Least Concern	
White-chested Alethe	*Chamaetylas fuelleborni*	Least Concern	
Collared Palm-Thrush	*Cichladusa arquata*	Least Concern	
Olive-flanked Robin-Chat	*Cossypha anomala*	Least Concern	
Cape Robin-Chat	*Cossypha caffra*	Least Concern	
White-browed Robin-Chat	*Cossypha heuglini*	Least Concern	
Red-capped Robin-Chat	*Cossypha natalensis*	Least Concern	
Collared Flycatcher	*Ficedula albicollis*	Least Concern	
Ashy Flycatcher	*Fraseria caerulescens*	Least Concern	
Gray Tit-Flycatcher	*Fraseria plumbea*	Least Concern	
Thrush Nightingale	*Luscinia luscinia*	Least Concern	
White-eyed Slaty-Flycatcher	*Melaenornis fischeri*	Least Concern	
Southern Black-Flycatcher	*Melaenornis pammelaina*	Least Concern	
Miombo Rock-Thrush	*Monticola angolensis*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
African Dusky Flycatcher	*Muscicapa adusta*	Least Concern	
Spotted Flycatcher	*Muscicapa striata*	Least Concern	
Arnot's Chat	*Myrmecocichla arnotti*	Least Concern	
Ruaha Chat	*Myrmecocichla collaris*	Least Concern	
Familiar Chat	*Oenanthe familiaris*	Least Concern	
Northern Wheatear	*Oenanthe oenanthe*	Least Concern	
Capped Wheatear	*Oenanthe pileata*	Least Concern	
White-starred Robin	*Pogonocichla stellata*	Least Concern	
Whinchat	*Saxicola rubetra*	Least Concern	
African Stonechat	*Saxicola torquatus*	Least Concern	
East Coast Akalat	*Sheppardia gunningi*	Least Concern	
Sharpe's Akalat	*Sheppardia sharpei*	Least Concern	
Mocking Cliff-Chat	*Thamnolaea cinnamomeiventris*	Least Concern	
PASSERIFORMES: Nectariniidae			
Anchieta's Sunbird	*Anthreptes anchietae*	Least Concern	
Western Violet-backed Sunbird	*Anthreptes longuemarei*	Least Concern	
Amethyst Sunbird	*Chalcomitra amethystina*	Least Concern	1
Scarlet-chested Sunbird	*Chalcomitra senegalensis*	Least Concern	
Purple-banded Sunbird	*Cinnyris bifasciatus*	Least Concern	1
Copper Sunbird	*Cinnyris cupreus*	Least Concern	
Forest Double-collared Sunbird	*Cinnyris fuelleborni*	Least Concern	
Western Miombo Sunbird	*Cinnyris gertrudis*	Least Concern	
Montane Double-collared Sunbird	*Cinnyris ludovicensis*	Least Concern	
Eastern Miombo Sunbird	*Cinnyris manoensis*	Least Concern	
Shelley's Sunbird	*Cinnyris shelleyi*	Least Concern	
Stuhlmann's Sunbird	*Cinnyris stuhlmanni*	Least Concern	
White-breasted Sunbird	*Cinnyris talatala*	Least Concern	
Variable Sunbird	*Cinnyris venustus*	Least Concern	1
Olive Sunbird	*Cyanomitra olivacea*	Least Concern	
Green-headed Sunbird	*Cyanomitra verticalis*	Least Concern	
Collared Sunbird	*Hedydipna collaris*	Least Concern	
Malachite Sunbird	*Nectarinia famosa*	Least Concern	
Red-tufted Sunbird	*Nectarinia johnstoni*	Least Concern	
Bronze Sunbird	*Nectarinia kilimensis*	Least Concern	
PASSERIFORMES: Ploceidae			
Grosbeak Weaver	*Amblyospiza albifrons*	Least Concern	
Red-headed Weaver	*Anaplectes rubriceps*	Least Concern	
White-winged Widowbird	*Euplectes albonotatus*	Least Concern	
Red-collared Widowbird	*Euplectes ardens*	Least Concern	
Fan-tailed Widowbird	*Euplectes axillaris*	Least Concern	
Yellow Bishop	*Euplectes capensis*	Least Concern	
Black-winged Bishop	*Euplectes hordeaceus*	Least Concern	1
Yellow-mantled Widowbird	*Euplectes macroura*	Least Concern	
Southern Red Bishop	*Euplectes orix*	Least Concern	
Chestnut-backed Sparrow-Weaver	*Plocepasser rufoscapulatus*	Least Concern	

Common name	Scientific name	Threat Status (IUCN)	Recorded
Baglafecht Weaver	*Ploceus baglafecht*	Least Concern	
Bertram's Weaver	*Ploceus bertrandi*	Least Concern	
Village Weaver	*Ploceus cucullatus*	Least Concern	
Lesser Masked-Weaver	*Ploceus intermedius*	Least Concern	
Spectacled Weaver	*Ploceus ocularis*	Least Concern	
Olive-headed Weaver	*Ploceus olivaceiceps*	Near-Threatened	
African Golden-Weaver	*Ploceus subaureus*	Least Concern	
Southern Masked-Weaver	*Ploceus velatus*	Least Concern	
Holub's Golden-Weaver	*Ploceus xanthops*	Least Concern	
Southern Brown-throated Weaver	*Ploceus xanthopterus*	Least Concern	
Red-headed Quelea	*Quelea erythrops*	Least Concern	
Red-billed Quelea	*Quelea quelea*	Least Concern	
PASSERIFORMES: Estrildidae			
Cut-throat	*Amadina fasciata*	Least Concern	
Yellow-bellied Waxbill	*Coccopygia quartinia*	Least Concern	
Red-faced Crimsonwing	*Cryptospiza reichenovii*	Least Concern	
Common Waxbill	*Estrilda astrild*	Least Concern	1
Black-tailed Waxbill	*Estrilda perreini*	Least Concern	
Crimson-rumped Waxbill	*Estrilda rhodopyga*	Least Concern	
Peters's Twinspot	*Hypargos niveoguttatus*	Least Concern	
Jameson's Firefinch	*Lagonosticta rhodopareia*	Least Concern	
African Firefinch	*Lagonosticta rubricata*	Least Concern	
Red-billed Firefinch	*Lagonosticta senegala*	Least Concern	
Green-backed Twinspot	*Mandingoa nitidula*	Least Concern	
Locustfinch	*Paludipasser locustella*	Least Concern	
Lesser Seedcracker	*Pyrenestes minor*	Least Concern	
Orange-winged Pytilia	*Pytilia afra*	Least Concern	
Green-winged Pytilia	*Pytilia melba*	Least Concern	
Black-and-white Mannikin	*Spermestes bicolor*	Least Concern	
Bronze Mannikin	*Spermestes cucullata*	Least Concern	1
Magpie Mannikin	*Spermestes fringilloides*	Least Concern	
Red-backed Mannikin	*Spermestes nigriceps*	Least Concern	1
Zebra Waxbill	*Sporaeginthus subflavus*	Least Concern	
Blue Waxbill	*Uraeginthus angolensis*	Least Concern	1
PASSERIFORMES: Viduidae			
Parasitic Weaver	*Anomalospiza imberbis*	Least Concern	
Village Indigobird	*Vidua chalybeata*	Least Concern	
Variable Indigobird	*Vidua funerea*	Least Concern	
Pin-tailed Whydah	*Vidua macroura*	Least Concern	
Broad-tailed Paradise-Whydah	*Vidua obtusa*	Least Concern	
Eastern Paradise-Whydah	*Vidua paradisaea*	Least Concern	
Purple Indigobird	*Vidua purpurascens*	Least Concern	
PASSERIFORMES: Passeridae			
Yellow-throated Bush Sparrow	*Gymnoris superciliaris*	Least Concern	
House Sparrow	*Passer domesticus*	Least Concern	1

Common name	Scientific name	Threat Status (IUCN)	Recorded
Northern Grey-headed Sparrow	*Passer griseus*	Least Concern	
PASSERIFORMES: Motacillidae			
African Pipit	*Anthus cinnamomeus*	Least Concern	
Plain-backed Pipit	*Anthus leucophrys*	Least Concern	
Striped Pipit	*Anthus lineiventris*	Least Concern	
Woodland Pipit	*Anthus nyassae*	Least Concern	
Long-billed Pipit	*Anthus similis*	Least Concern	
Tree Pipit	*Anthus trivialis*	Least Concern	
Buffy Pipit	*Anthus vaalensis*	Least Concern	
Yellow-throated Longclaw	*Macronyx croceus*	Least Concern	
African Pied Wagtail	*Motacilla aguimp*	Least Concern	
Mountain Wagtail	*Motacilla clara*	Least Concern	
Western Yellow Wagtail	*Motacilla flava*	Least Concern	
PASSERIFORMES: Fringillidae			
Southern Citril	*Crithagra hyposticta*	Least Concern	
Black-eared Seedeater	*Crithagra mennelli*	Least Concern	
Yellow-fronted Canary	*Crithagra mozambica*	Least Concern	1
Reichard's Seedeater	*Crithagra reichardi*	Least Concern	
Brimstone Canary	*Crithagra sulphurata*	Least Concern	1
Yellow-browed Seedeater	*Crithagra whytii*	Least Concern	
Yellow-crowned Canary	*Serinus flavivertex*	Least Concern	
PASSERIFORMES: Emberizidae			
Cabanis's Bunting	*Emberiza cabanisi*	Least Concern	
Golden-breasted Bunting	*Emberiza flaviventris*	Least Concern	
Cinnamon-breasted Bunting	*Emberiza tahapisi*	Least Concern	1
Vincent's Bunting	*Emberiza vincenti*	Least Concern	
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DEPARTMENT OF MUSEUMS AND MONUMENTS

DWANGWA SOLAR PV POWER PROJECT

Heritage Impact Assessment Report

Dwangwa, Nkhotakota

VOLTALIA

Heritage Impact Assessment: Dwangwa Solar PV Power Plant

Acknowledgement

The team sincerely acknowledges the services rendered to it by individuals, chiefs and Group Village Headmen: their company and information was and is invaluable.

EXECUTIVE SUMMARY

This report summarizes the findings of the Heritage Impact Assessment (CHIA) carried out by the Department of Museums and Monuments (DMM) for the proposed development of a 40 MW Solar PV Power Plant in Dwangwa, Nkhotakota District.

The Dwangwa Solar PV power plant will comprise of photovoltaic solar panels that will cover an area of approximately 60 ha. It is estimated that the total height of the panels, including the structure, will be 4.7 m when tilted. Additional infrastructure on site will include a security guardhouse, an operations and maintenance building, internal gravel roads, a single circuit 132kV powerline and a substation.

The proposed area is natural site with some subsistence agriculture and infrastructure. The northern and central areas of the site are relatively untouched, and the majority of land is in a natural state. No natural trees are harvested but grass is. Rice is grown in all rivers onsite and in addition the river on the southern site is dammed and pumped, it also feeds into the canal on the other side of the M5 road. The majority of the southern portion is subsistence agriculture, rice paddies, fruit trees and woodlots. The infrastructure on site includes roads, substation, powerlines, water tower, buildings and soccer fields. There are also two sand mine areas one in the southern portion and one on the northern portion. A tree wind break has been planted along the M5. Surrounding land use includes the town Bowa, Primary School (Majiga), Golf course (Kasasa Sports Club), Illovo houses and commercial agricultural fields (sugar cane).

As required by law, before conducting projects of such magnitude the Voltalia, a project proponent, engaged CES and C12 Consultants to conduct an Environmental and Social Impact Assessments (ESIAs) in the proposed project area. Therefore, the Department of Museums and Monuments was requested to conduct a Cultural Heritage Impact Assessment (CHIA) within and around the project area as part of the ESIA study. It should be noted that the Monuments and Relics Act (1990) stipulates that CHIA needs to be carried out before any large scale development that would result in permanent alteration of the landscape and disturbance to the relics buried in the ground.

In light of this, a team of archaeological surveyors from the Department assessed the impact this project will have on the cultural heritage sites of the project area. The study involved assessing the direct and indirect impacts of the proposed Solar Power Project will have on archaeological and cultural heritage resources found in the project area.

This work has identified 5 sites of archaeological and cultural interest, and 1 grave site relatively outside the project impact zone. Given the methodological constraints and disturbance of the landscape by overgrown vegetation and poor accessibility, the landscape might have yielded more cultural heritage sites than the ones contained in this report. Although none of these heritage sites would prevent the continuation of the project, mitigation measures are required on all sites to avoid their destruction as threatened by the project.

CULTURAL HERITAGE IMPACT ASSESSMENT REPORT

Report Title	Heritage Impact Assessment Report: Dwangwa Solar PV Power Project
Version Info	Ver2
Type	Final
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Date	06-04-2022

Authorized Signature

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Acronyms and Abbreviations

CHIA	Cultural Heritage Impact Assessment
LSA	Late Stone Age
LIA	Late Iron Age
MGDS	Malawi Growth and Development Strategy
Ha	Hectares
DMM	Department of Museums and Monuments

1.0. INTRODUCTION

Voltalia, a French based International Integrated Renewable Energy Player is intending to develop a 40 MW Solar PV Power Plant in Dwangwa, Nkhotakota District. The solar power plant will contribute to the generation and availability of electrical energy for the Republic of Malawi. The Dwangwa Solar PV power plant will comprise of photovoltaic solar panels that will cover an area of approximately 60 ha. It is estimated that the total height of the panels, including the structure, will be 4.7 m when tilted. Additional infrastructure on site will include a security guardhouse, an operations and maintenance building, internal gravel roads, a single circuit 132kV powerline and a substation.

CES and C12 consultants have been contracted to conduct the Environmental and Social Impact Assessment, and Department of Museums and Monuments has been sub-contracted to carry out an assessment of the project impact on cultural heritage resources within the area. This is line with Malawi Monuments and Relics Act (1990) which stipulates that Cultural Heritage Impact Assessment needs to be carried out before any large-scale development that would result in permanent alteration of the landscape and disturbance to the relics buried in the ground. Therefore, a team of archaeological surveyors from the Department assessed the impact this project will have on the cultural heritage sites of the project area. The study involved assessing the direct and indirect impacts of the proposed Solar Power Project on archaeological and cultural heritage resources found in the project area.

The work has identified 5 sites of archaeological and cultural interest, and 1 grave site relatively outside the project impact zone. Given the methodological constraints and disturbance of the landscape by overgrown vegetation and poor accessibility, the landscape might have yielded more cultural heritage sites than the ones contained in this report. Although none of these heritage sites would prevent the continuation of the project, mitigation measures are required on all sites to avoid their destruction as threatened by the project.

This report, therefore, presents the potential cultural heritage that may occur in the project area and identifies potential impacts that may result from the proposed

clearing and construction activities. The report further provides recommendations for a comprehensive cultural heritage impact assessment and monitoring activities to be conducted at a later stage as a mitigation measure in safeguarding the cultural resources on the site.

2.0. SITE DESCRIPTION

The proposed area is natural site with some subsistence agriculture and infrastructure. The northern and central areas of the site are relatively untouched, and the majority of land is in a natural state. No natural trees are harvested but grass is. Rice is grown in all rivers onsite and in addition the river on the southern site is dammed and pumped, it also feeds into the canal on the other side of the M5 road. The majority of the southern portion is subsistence agriculture, rice paddies, fruit trees and woodlots. The infrastructure on site includes roads, substation, powerlines, water tower, buildings and soccer fields. There are also two sand mine areas one in the southern portion and one on the northern portion. A tree wind break has been planted along the M5. Surrounding land use includes the town Bowa, Primary School (Majiga), Golf course (Kasasa Sports Club), Illovo houses and commercial agricultural fields (sugar cane).

Figure 1: Map showing the project area

3.0. SCOPE OF WORK

The following were the scope of work:

- Undertake a Heritage Impact Assessment which complies with national and international cultural heritage management and preservation standards;
- Describe the existing environment associated with the proposed development in terms of its cultural heritage and archaeology as well as the sensitivity of the surrounding areas to any change;
- Describe the likely scope, scale and significance of cultural heritage impacts associated with the project. This included reference to primary, secondary and/or cumulative impacts;
- Make recommendations on the scope of mitigation measures that may be applied during the project to avoid/reduce the significance of the identified construction-related impacts;
- Identify and broadly describe the likely implications of any abnormal construction or operating conditions that have been identified, if at all;
- Confirm if there are any outright fatal flaws to the establishment of the proposed solar power project from an archaeological heritage perspective.

3.1. Specific Actions

a. Collate, review and document baseline archaeological and cultural heritage information relating to the project area. This included identifying potential sites of archaeological and cultural significance by taking the coordinates.
b. Consult with the local communities with regard to archaeological and cultural heritage sites and their management.
c. Consult and meet with the client, design and ESIA consultant and other representatives as required.
d. At the end of the project, prepare heritage impact study report that includes:
    i. Baseline archaeological and cultural conditions within the study area.
    ii. Project impacts on the cultural heritage sites. This include any direct or indirect impacts associated with proceeding with the solar project.

iii. Identification of suitable mitigation and management planning strategies. This include management planning strategies for significant archaeological and cultural sites that will be affected.

3.2. Expected Deliverables

A Heritage Impact Assessment report containing:

- An introduction to the study;
- Description of the study methodology;
- An overview of the local and regional heritage, cultural and archaeological context applicable to the project area;
- A detailed description of the sites/resources of heritage, cultural and archaeological significance identified during the desk research and field surveys within and around the solar power project area;
- A description of the potential impacts and an assessment of the significance of such impacts associated with the solar power project (and all alternatives) on heritage, cultural and archaeological resources identified within the project area.
- Any assumptions, limitations and/or constraints associated with the study
- Detailed guideline measures to manage and mitigate the impacts identified during the CHIA process for all phases of the project but in particular the development phase.
- A sensitivity map indicating any sites/resources of heritage, cultural and archaeological significance;
- Negotiation with regard to areas of sensitivity and planning responses which might arise;
- Recommendations and conclusions of the study.

4.0. DEFINITION OF CULTURAL HERITAGE

For the purpose of this report, cultural heritage refers to tangible forms of cultural heritage such as movable or immovable objects, property, sites, structures, groups of structures, having archaeological (prehistoric), palaeontological,

historical, cultural, artistic, and religious values; and unique natural features of tangible objects that embody cultural values, such as sacred sites, rocks, lakes and waterfalls.

Cultural heritage is well understood in the context of its uniqueness and values. Consistent with national and international heritage laws, it is the mandate of Malawi through the Department of Museums and Monuments to protect its irreplaceable cultural heritage and guide the developer to avoid or mitigate adverse impacts on cultural heritage in the course of development activities. The heritage impact assessment is required in respect of the laws of Malawi as provided for in the Monuments and Relics Act of 1990 and Malawi's Cultural Policy of 2015. This Act and the policy define cultural heritage in its tangible and intangible forms. The tangible cultural heritage comprises the physical cultural heritage resources both movable and immovable including but not limited to the following: -

- Places, buildings, structures of cultural significance
- Places to which oral traditions are attached
- Historical settlements and townscapes
- Landscapes and natural features of cultural significance
- Geological sites of scientific or cultural importance
- Archaeological and paleontological sites
- Graves and burial grounds.

Intangible Cultural Heritage is the type of heritage that is manifested in the following:

- Oral traditions and expressions, Performing arts;
- Social practices, rituals, and festive events;
- Knowledge and practices concerning nature and the universe;
- Traditional craftsmanship and skills transmitted from generation to generation.

5.0. LEGAL AND POLICY FRAMEWORK

5.1. National Legal Frameworks

3.1.1 Monuments and Relics Act (1990)

The Monuments and Relics Act (1990) provides statutory protection against all kinds of threats on all cultural resources as defined in it. One such threat is development that might alter the use of a landscape. The Dwangwa Solar Power Project has high likelihood of impacting cultural resources in the area.

Section 29 of the Monuments and Relics Act (1990) (Cap. 29:01 Laws of Malawi) states as follows in relation to development:

(1) *A person in charge of any survey, excavation, exploration, construction or new development shall, at the earliest stages of planning for such activities, give notice to the Minister to enable, where necessary, rescue archaeology to be carried out* (…)

(2)(…) *The cost of such work shall … be borne by the person in charge of any survey, excavation, exploration, construction or other development.*

3.1.2 Cultural Policy (2014)

Section 5.7.8, Objective 8, in the Cultural Policy demands taking "…into account cultural factors in development projects, policies and programmes for the nation". Its first strategy calls for "…a cultural heritage impact assessment" for all development projects.

5.2. International Safeguard Policies

Besides these national legal and policy requirements, project donors have their own safeguarding policies to adhere to. For instance, World Bank-funded ESIA study has to go by the Bank's safeguarding operational policy 4.11 on physical cultural resources and the IFC performance standard 8 on cultural heritage. Projects that are implemented with financial assistance from the European Union and the African Development Bank, need also to observe safeguard policies concerning cultural heritage protection. The African Development Bank has provisions for heritage protection in its operational safeguard policy. It stipulates

that projects must avoid significant damage to cultural heritage, which includes both tangible and intangible cultural heritage.

The European Union acknowledged the value of archaeology and the critical role of the archaeologist in development projects in its Malta Convention (1992) which followed the ICOMOS Charter on Archaeological Heritage Management (1990).

Finally, Malawi is a signatory to the 1972 UNESCO World Heritage Convention concerning the Protection of the World Cultural and Natural Heritage and the 2003 UNESCO Convention on Safeguarding of the Intangible Cultural Heritage. Malawi thus has an international obligation to preserve its heritage.

6.0. METHODOLOGY

6.1. Desk Research

The research team first consulted a number of sources at its disposal. The desk-based assessment started with the of documentary records comprising reports, articles, maps, photos, national inventory of archaeological, historical and cultural sites.

6.2. Field Survey

The survey team surveyed the proposed project area and the surrounding area starting from the northern side near Total filling station. During the field survey heterogeneous purposive sampling was adopted in which much of the time was dedicated in searching for ceramics and stone tools sites or a particular kind of archaeological sites such as rock shelters, rock paintings, caves and other sites of cultural importance. This method was adopted because of time constraint for sample creation and was justifiable based on the skills and confident of the sample team understanding of the subject. The main objective of survey archaeology was the large-scale area mapping of antiquities in the landscape. To achieve this, archaeologists did not walk the entire landscape systematically, but chose their survey locations mainly on existing knowledge (i.e. known archaeological find spots) among the local population and/or expectations based on the topographical or geo-morphological characteristics of the landscape.

The survey involved systematic screening of the surface area, natural gullies cut by rivers and rivulets, eroded pedestrian pathways and cultivated fields. Cultural artifacts such as pottery and iron slags were observed and samples were collected for analysis at the Department's repository. The locations of the identified sites were recorded with GPSs. However, the efficacy of the survey was hindered by poor visibility as a result of vegetative cover in some areas and poor accessibility in most of the areas.

Fieldwalking (Transects)

Fieldwalking was adopted as a methodology of gathering data in the area. It involved walking across open areas in collection units, gathering information about the artefacts such as pottery and stone tools. The survey teams walked slowly with a spacing between walkers of approximately 5-10 meters through the target area looking for artefacts or any archaeological indicator on the surface, while recording aspects of the environment at the same time. The method worked well in areas with little vegetation, whilst those with tall vegetation were not surveyed.

6.3. Public Consultations

Public consultations took many methods and tools appropriate to the respondents to source their views. Among the people consulted were the traditional leaders, local village elders, Illovo as land owners and some other people who were randomly selected. The community consultations mainly focused on finding out their knowledge on some other aspects of sacred spaces within the project area and how they value the cultural heritage sites in the proposed project area.

Local knowledge

Three local people from the surrounding villages accompanied the experts in the survey. This was deliberate as locals know where to find something of interest to archaeologists. Locals led the experts in areas with potential archaeological materials and cultural heritage sites.

7.0 LIMITATIONS

The field surveys were hindered in some places due to poor visibility and accessibility. Besides, the past settlement and farming activities have displaced artifacts from their primary contexts.

8.0. FINDINGS

8.1. Desk Research

A study of relevant literature was conducted with the aim of reviewing previous research done and determining the potential of the area. Nothing specifically on Dwangwa was found in the preliminary desk research. Nkhotakota as a District is nonetheless rich with cultural heritage studies both anthropological and archaeological research. Past archaeological research works in Nkhotakota have identified Later Stone Age (LSA) sites, Iron Age (IA) sites and rich rock paintings. The main documents/ research that were used for the purposes of this work which outline the archaeology of Nkhotakota with closer affinities to Dwangwa were few (Cole-King, 1973; Robinson, 1975; Mgomezulu, 1978; Juwayeyi, 2010; Boucher, 2012).

8.2 Field Surveys

These historical demarcations should be known as used in this report.

Stone Age:

Early Stone Age	2million – 150 000 BP
Middle Stone Age	150 000 – 30 000 BP
Late Stone Age	30 000 – until 200 AD

Iron Age:

Early Iron Age	AD 200 – AD 900
Middle Iron Age	AD 900 – AD 1300
Late Iron Age	AD 1300 – AD 1859

Historic Period: from the time of contact with whites or any sites of commemorations.

The team identified only 5 archaeological sites after its field survey, and 1 grave yard close to the project site.

The presence of these sites is not surprising considering that the area was previously inhabited before Illovo bought the land and relocate the villagers aware from the site.

These findings give light to the dispersion of early settlements in the area, their material culture and their affinities. The most common field work findings that point to settlement of early people are pottery fragments. Analysis of these fragments has shown that there were distinct types during different time periods.

8.2.1. Pottery

The site has numerous clusters of pot sherds. Most of the pot sherds that were found were undiagnostic. Nonetheless, among the sherds, a few were noted to be decorated. The area yielded a lot of undecorated Mawudzu pottery. Mawudzu ware is characterised with vessels that are usually simple. The pot vessels are spherical pots with constricted mouths and sometimes shouldered with conical or concave necks. Other pots are large U-shaped pots while most bowls are hemispherical or open and may have flat or pedestal bases, though less usual than rounded ones. Mawudzu ware is characterized by impressed chevrons and

scallops; tooth patterns that run around the very slightly shouldered u- part of the pot; incised herringbone; dentate motif in false relief; incised festoons around the slight and pendant arc and stamping, though it is rare. The finish is normally a polychrome burnish which sometimes occurs with an outline of incision. Most of the pot sherds out of the surface finds at Dwangwa were undecorated, both as rim sherds and body sherds.

Given the poor ground visibility and inaccessibility of some areas, the team might have left several sites undiscovered. This is more so, since no subsurface testing was done. Therefore, material that might have pointed the team to the existence of sites may thus lie below the 30cm plough zone. The identified sites have been numbered as KK-DW (referred to as Nkhotakota-Dwangwa Site).

8.2.2. Identified Archaeological/Historical Sites

a. KK-DW 1 – Archaeological Site

UTM Coordinate: 36L 622195 E 8614069 S

Potential stone age site in an eroded river gully. Pieces of stone flakes are exposed on the eroded stratigraphic units. Detailed surveys are recommended during dry season to validate and ascertain the archaeological deposits along this exposed gully. Archaeological monitoring is also recommended during land clearing activities along this area.

Figure 2: Exposed gully with embeded archaeolgical artefacts

b. KK-DW 2 – Archaeological Site

UTM Coordinate: 36L 621899 E 8614930 S

An Iron Age Site and a historic settlement along a footpath leading to an existing Water Tank. Recorded a high concentration of embedded potsherds, some decorated with rims intact. Detailed surveys and test excavations is required. Further, it also recommended to rescue the archaeological materials at this site before land clearing activities.

Figure 3: Scatters of embeded pottery along a pathway

Figure 4: Scatters of embeded pottery along a pathway

c. KK-DW 3 – Archaeological Site

UTM Coordinate: 36L 621279 E 8615351 S

A historical settlement/potential iron age site, with presence of pottery fragments scattered on the ground. The site is close to Total Filling Station. The area has been planted with trees. Other cultural materials present included rugs, old metal implements, old house foundations, mounds and dagga. There is need for detailed surveys and test excavations before the project commence.

Figure 5: Scatters of pottery recorded at the site

d. KK-DW 4 – Archaeological Site

UTM Coordinate: 36L 621949 E 8614671 N

A historical settlement/potential iron age site close to residential houses with high concentration of pottery fragments scattered on the ground. Other cultural materials present included old metal implements and dagga. There is need for detailed surveys and rescue the archaeological remains before land clearing work starts.

Figure 6: pottery and metal fragments recorded at the site

e. KK-DW 5 – Archaeological Site

UTM Coordinate: 36L 622194 E 8614220 N

An iron age site, with presence of pottery and old metal fragments scattered on the ground covered with thick grasses. Situated about 50m from the main road. It is recommended to carry out detailed surveys and test excavations before the project commence.

Figure 7: pottery fragments with rims recorded at the site

Figure 8: decorated pottery fragments recorded at the site

f. Graveyard (Manda a Jodi)

UTM Coordinate: 36L 622321 E 8613415 N

A graveyard locally known as *Manda a Jodi* has been recorded in proximity to the project area, the Dwangwa sub-station. This graveyard is fenced together with the Kasasa Golf Club. Currently, the graveyard is no longer used. It used to save Bowa Village. Since it is outside the project area and fenced, it will not be affected by land clearing activities. Avoidance is recommended as a mitigation measure.

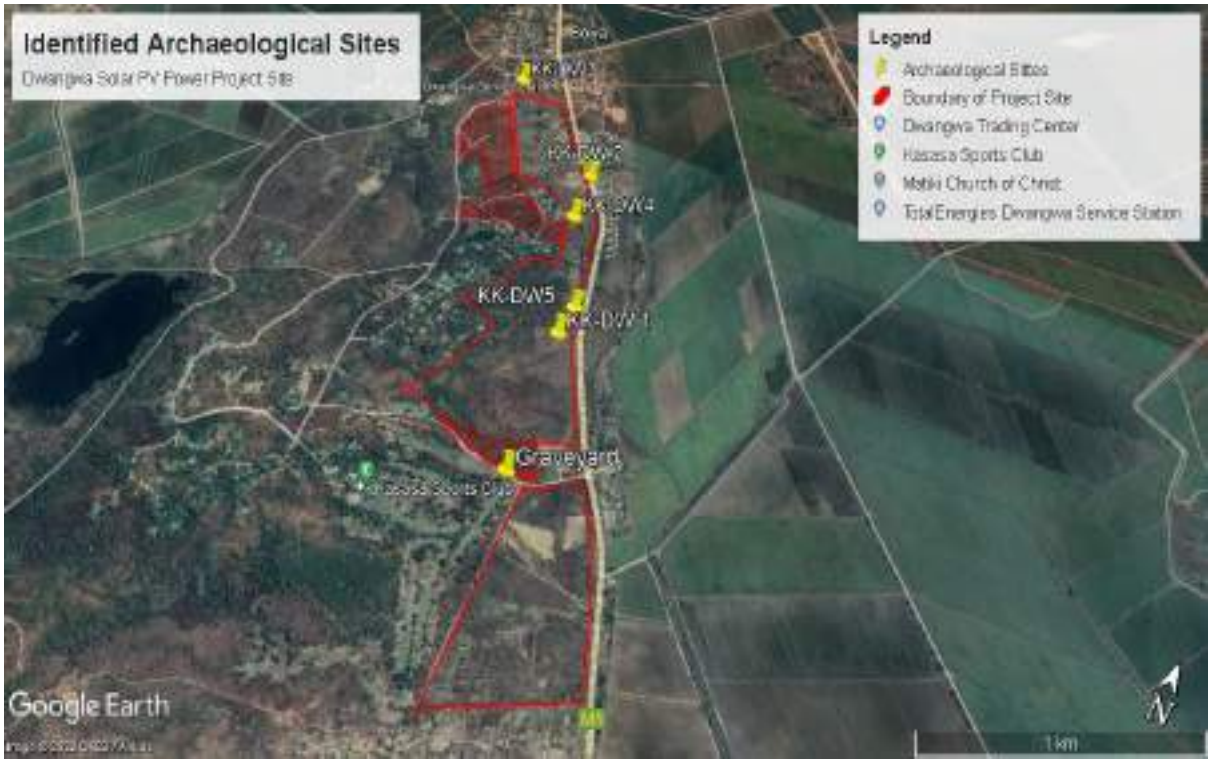

Figure 9: Map showing the identified archaeological sites

These cultural/historical and archaeological sites are evidence of human occupation in the study area in varying periods. The cultural/historical sites seem to be very recent and likely to have no scientific significance based on their size, age, function and integrity. The archaeological sites have great value to both the historian and the archaeologist of Central Africa. Given the short-written history of the region, the task of the historian is fraught with difficulties. The only references to Central Africa before the 16th century are the occasional comments in the writings of Arab geographers and other travelers. As such, it is to archaeology that one must turn, to uncover the story of the long period which precedes that of history.

8.3. Community Consultations

The team consulted the village heads and some of their subjects within the study area. From these accounts the team learnt that the study area was inhabited by the chewa ethnic group. Later other ethnic groups have settled within the area.

Figure 9: Community meeting with local chiefs and elders

9.0. DETERMINATION OF SITE SIGNIFICANCE AND VALUES

In order to define the mitigation measures of the sites located within the project area, the threatened cultural heritage sites need to be classified according to their importance and the required appropriate intervention. The following categories have been defined for the cultural heritage resources identified in this project area (each category implies specific mitigation measures to be taken):

- *Low Priority Site*: No further treatment;
- *Medium Priority Site*: Further monitoring during project development and other construction works to ascertain final priority/importance;
- *High Priority Site*: Further treatment warranted.

The prioritization of a site is not a definite measure of its scientific importance but rather a temporary classification regarding potential and further treatment requirements. In this regard, some high priority sites may well be re-evaluated as non-important after further study. The criteria used to define the value of a site are multiple and complex. However, regarding the area's archaeological and historical sites, the aim is to understand both the history of the region and the way of life of past populations. In this context these criteria would be summarized as follows:

- Age of the finds,
- Density and/or
- variety of the finds,

- Context of the finds,
- Social significance of the finds,
- Precursory archaeological knowledge of the area.

a) ***Age*** is a self-explanatory criterion: the older a site is, the more important it is. This is because old sites are rare and finding one is an opportunity to understand the distant past of an area. Most often, sites more than 15,000 years old (Early or Middle Stone Age) are found during major construction works (dams, roads, mines, and pipelines) because they are buried deep underground.

b) To be considered important, a site must also present a high ***density*** **and/or** ***variety*** of artefacts. Isolated finds are very difficult to interpret since a representative sample of the material is needed in order to be able to understand the activities carried out at the site by prehistoric peoples.

c) Artefacts must also be in ***primary context*** (i.e., as the prehistoric people left them) in order to be exploitable from a scientific standpoint. If natural (erosion, digging animals) or anthropological phenomena have disturbed a site too heavily, the association and position of artefacts cannot be interpreted. Most of the time a site is discovered because part of it is unearthed by erosion or digging; archaeological interventions will, therefore, focus on the part of the site that is still undisturbed.

d) Recent sites (graves/tombstones, monuments, sacred shrines) can be of high ***social significance*** (i.e., be "sacred") to local populations and, in that case, should not be damaged by project development activities unless proper compensation is negotiated. In this regard, burial sites or any other sites considered as sacred by local communities are always classified as 'High priority sites that must not be lost at all costs.

e) ***Prior archaeological knowledge of the area*** where a site is found is also an important criterion. Medium Priority sites could eventually be re-classified as High Priority sites if no High Priority sites are discovered in a region that was previously unexplored.

When taken together, a preliminary site prioritization classification has been illustrated as shown in table 3 below:

Table 3. Site prioritization classification

Old Age	Primary Context	High Artefact Density or variety	High Social Significance	Priority
Yes	Yes	Yes	Yes	High
Yes	Yes	Yes	No	High
No	Yes	Yes	Yes	High
No	Yes	No	Yes	High
Yes	Yes	No	No	Medium
No	No	No	Yes	Medium
No	No	Yes	No	Low

As no excavations were carried out, it has been difficult to make any preliminary interpretations on age ranges of the identified sites. Furthermore, the pottery found on the surface has shown considerable signs of wear and erosion. This has made it difficult to identify characteristic decoration types, representative of distinct periods. The criteria of *Age of Finds* is therefore difficult to apply in this preliminary stage of the study. However, the other two criteria such as *Primary Context* and *High Artefact Density or Variety* have been /useful to determine whether an archaeological site can be classified as High, Medium or Low Priority.

10. ASSESSING CULTURAL SIGNIFICANCE

The following criteria was used to assess sites within the project area:

a. Site integrity (or the degree to which an archaeological site has been impaired or disturbed as a result of past land alteration) is an important consideration in evaluating site significance.
b. Archaeological resources may be of scientific value in two respects. The potential to yield information which, if properly recovered, could contribute to scientific research. Scientific significance also refers to the potential for relevant contributions to other academic disciplines or to industry.

c. Public significance refers to the potential a site has for enhancing the public's understanding and appreciation of the past. The interpretive, educational and recreational potential of a site are valid indications of public value.
d. Ethnic significance applies to archaeological sites which have value to an ethnically distinct community or group of people. Determining the ethnic significance of an archaeological site may require consultation with persons having special knowledge of a particular site.
e. Historic archaeological sites may relate to individuals or events that made an important, lasting contribution to the development of a particular locality or the province.
f. The economic or monetary value of an archaeological site, where calculable, is also an important indication of significance.

11. ASSESSMENT AND EVALUATION OF PROJECT IMPACT AND THEIR MITIGATION MEASURES

11.1. Impact Assessment

The Dwangwa Solar Power Project will have destructive and irreversible effects on the archaeological and cultural/historical heritage sites identified in the project area. The land transformation activities during the development will directly destroy the identified sites.

However, it is impossible at this stage to provide a quantitative assessment of the extent of sites that might be damaged during the project as no subsurface investigations have been conducted. Without full understanding of this aspect, any impact assessment remains tentative. As no subsurface testing was conducted at this stage of the assessment of the project at hand, the impacts are preliminary. However, surface disturbance and preliminary clearing has already brought to light the recorded sites. This project has, therefore, the potential to cause significant damage to heritage resources if no management and mitigation measures are implemented.

11.2. Impact Evaluation

The archaeological heritage resources within the study area are at risk of being damaged through direct impacts, especially the direct loss of archaeological and historical sites due to permanent removal from their original setting as a result of land clearing activities that will happen in the area. The timing of those impacts would be immediate and their duration permanent if no management or mitigation measures are implemented.

It has therefore been decided that all sites that are in the range of 0 to 30m from the project boundary or any other project infrastructure are at risk of being impacted, whereas the ones located between 30 to 100m outside the direct impact zone have been put in the category of uncertain impact. It should be re-emphasized that there is a high probability that more archaeological sites buried underneath the surface will be uncovered during the land clearing activities.

12. RECOMMENDATION FOR MITIGATION MEASURES AND HERITAGE MANAGEMENT PLAN

12.1. Mitigation Measures

Mitigation measure in a form of a cultural heritage management plan is recommended in order to avoid or limit adverse impacts of the project.

The fact that some sites have been discovered and many more sites may be buried underneath the surface, constitutes another important finding of this study, indicating the high probability that the sites buried underneath the surface will be revealed once land-clearing activities commence. The project's cultural heritage management plan, therefore, needs to address those issues accordingly.

Among others, the plan will have to address the following issues:

- Comply with national legislation concerning heritage protection;
- Identify appropriate mitigation measures that take into account the area's identified archaeological resources and the ones that may be buried underneath the surface;

- Provide training in cultural heritage management and undertake possible heritage research programs in the area;
- Implement internationally recognized practices for the protection of cultural heritage resources.

At this early stage, a number of mitigation measures are recommended, which comply with national heritage legislation and internationally recognized practices concerning heritage protection. The Malawi Department of Museums and Monuments should be directly involved in the implementation of the project's cultural heritage management plan.

12.1.1. Phase 1: Pre-Development Data Collection

- Data collection may include: hand excavated shovel pits or augers to assess the depth of sites and range of artefacts and controlled excavation of site categorized as a high priority;
- All artefacts collected should be catalogued and described, and curated at the Department of Museums and Monuments;
- Appropriate analyses of collected artefacts such as ceramics, metals objects, and iron slags, etc should be completed as they are collected;
- A final report (complemented by monthly updates) should be issued describing and interpreting the cultural resources found and placing them within a broader cultural-historical framework.

11.1.2. Phase 2: Mitigation Plan during Project Development

- Contractor Training and Awareness Program;
- Selective archaeological monitoring of surface clearing and trenching activities during development in areas with poor surface visibility and/or a high probability for cultural resources buried below the surface;
- Assessment of artefacts recovered during land transformation activities;
- Rescue archaeology at sites deemed as of high priority;
- Once the initial period of archaeological monitoring and salvage excavations is over, the project need to apply Chance Find Procedures. Personnel from the Malawi Department of Museums and Monuments will decide about necessary management measures.

11.2. Cultural Heritage Management Plan (CHMP)

The Project's CHMP consist of two phases:

- Phase 1: Pre-Development Data Collection
- Phase 2: Mitigation Plan during Project Development

11.2.1. Phase 1: Pre-Project Development Data Collection

Due to the project's wide area that is earmarked for the solar power project and associated project infrastructure, it has not been possible to cover all impact zones. It will, therefore, be necessary to complete surface surveys in locations, which have not yet been investigated. Once the entire impact area has been surveyed, the site prioritization classification should be used in order to decide which high priority sites should be excavated before project launch.

Shovel Test Pitting

Five archaeological sites require subsurface probing (test pitting at intervals) to adequately assess their significance and integrity. Shovel test pits or augers will be used to excavate small holes to a depth of approximately 1 meter below the surface during sub-surface survey activities. The purpose of these test excavations will be to rapidly verify the horizontal and vertical extent of a site's cultural properties and its scientific importance. If sites are found that can be categorized as of high priority, they should undergo controlled archaeological rescue excavations.

The main purposes of rescue excavations are to:

- Determine the depth of cultural deposits;
- Determine the presence/absence of various kinds of artefacts, charcoal, structural remains, and human remains;
- Delineate further site boundaries;
- Delineate further site age;
- Collect special samples (radiocarbon, slag, pollen *etc.*).

Rescue Excavations

Archaeological sites that will be impacted negatively by the project's future activities and that indicate a high scientific value for study and analysis should undergo controlled rescue excavations before any land-transformation activities commence.

The reason for this is that Malawi's national heritage legislation requires rescue excavations of sites at risk of destruction from development.

The identified archaeological sites are considered as high priority for controlled archaeological excavations as they exhibit material embedded in the soil in its primary context. Test pits have to be sunk at all identified sites. The reason for choosing more than one site for systematic excavations is that it is impossible at this point to ascertain which site will yield an undisturbed stratigraphic sequence for purposes of site reconstruction and dating. This preliminary study has indeed highlighted the wealth of the project's area archaeological resources but has also shown its fragile state if no adequate measures will be taken to study and thus save some of this region's cultural and social history.

Two weeks for archaeological excavations would be necessary. The high priority sites will be excavated by hand using trowels, hand mattocks, shovels, etc. All soils will be screened with sieves. During the course of the excavations, artefacts such as pottery, chipped stone, and iron slags will be collected for further analysis. Soil samples may be collected for later processing for extraction of datable carbon or to assist in the identification of various stratigraphic levels. Complete and accurate notes of field procedures and results should be maintained and excavations documented with photographs, maps, profiles, and plan drawings.

Laboratory Processing and Curation

Laboratory analysis is an interpretive step in an archaeological investigation. While on-site evaluation collects data, laboratory processing and analysis summarizes this data and allows meaningful statements regarding the site. Laboratory processing usually includes washing, sorting, cataloguing, and tabulation of collected materials. These may be considered preliminary steps to analysis. All artefacts and copies of all site forms, notes, reports, photographs, and maps generated from the identification, management, and analysis of cultural properties should be deposited at the Department of Museums and Monuments.

11.2.2. Phase 2: Mitigation Plan during Project Development

The following is recommended during the project development activities:

- Contractor training and awareness program;
- Archaeological monitoring of land transformation activities during the development phases;
- Salvage excavations;
- Chance Find Procedures;
- Avoidance of construction-related impacts to important cultural resources.

Contractor Training and Awareness Program

As part of the overall cultural heritage management plan, contractors and subcontractors should be sensitized on the future presence of an archaeological monitoring team during land-clearance and mechanical excavation activities. They should equally be given training on the identification of artifactual materials and bones, which might be found on the project area and procedures for reporting the discovery to supervisory personnel. Any artefacts discovered should be considered the property of Malawi Government and after recording, analysis, and cataloguing prepared for curation at a national heritage institution.

Archaeological Monitoring of Land Transformation Activities

Recognizing archaeological features poses a great challenge to the untrained eye, hence the importance of engaging a professional team of cultural heritage specialists to carry out an initial one to two weeks period of archaeological monitoring. The following list provides an idea of the types of remains that might be uncovered during land-transformation activities:

- **Burial Places**: They often have negligible surface visibility and can be encountered in many locations. Human bones, in an archaeological context, are normally light brown to dark brown, and are often easily distinguishable from surrounding sediments. In contrast to most of the animal bones that would be present in a deposit, human bones are usually intact. However, many human burials can be incomplete or contain scattered, partially decayed bones that fragment easily. Also present may be funerary objects associated with the burial. All burial sites must be reported immediately and avoided.
- **Archaeological Deposits:** Archaeological deposits can be darker than surrounding sediments and can be distinguished from natural soils by the

following attributes, individually or in combination: black soil, patches of reddish brown or yellow-brown fire stained (oxidized) sediments, scatters or concentrations of archaeological material such as pottery, stone tools, metal implements and slag. Monitoring land-clearing activities will assist in determining if deeply buried subsurface deposits are present within the project area. Monitoring is defined as active observation of earth-moving or other work that could adversely affect cultural heritage resources within the project area and includes, as warranted by circumstances: observation, data recording, data recovery, archaeological excavation, photography, laboratory analysis and cataloguing, ancillary special studies, and production of a written report that meets current professional archaeological standards. Such monitoring activities are conducted by qualified heritage personnel. During surface clearing, trenching, etc. large volumes of soil will be excavated, and may result in the identification of:

- Buried sites with no surface component, and earlier occupation periods of sites which have a surface manifestation.
- Monitoring, by appropriately qualified heritage specialists, may occur to achieve several objectives:
  - To ensure that a site is avoided (including checking to ensure the boundaries of a site are properly fenced or marked) and/or not inadvertently damaged if it is buried;
  - During and just after surface clearing activities to collect surface artefacts and record features uncovered during clearing, and during earthmoving activities (grading, trenching) to assess if buried sites are present.
  - To facilitate this assessment specified information must be furnished by the client:
    (1) Layout plans showing all developments, detailing proposed impacts to the project area and;
    (2) The proposed construction schedule or activity to be monitored, with types of excavation and/or earth-moving identified.

If potentially important cultural materials are encountered during project construction activities, work should be halted in the area until the project archaeologist evaluates the finds. If the project archaeologist determines that the discovery is important, appropriate salvage excavations should be formulated and implemented.

The site supervisor, foreman, or similar onsite authority, should be informed of the archaeological monitor's presence and authority to halt and/or relocate construction work. The supervisor should inform all construction personnel of the archaeological monitor's role. The monitor will follow excavations and construction as closely as conditions require, making all reasonable efforts for safety and non-interference with construction. An initial one or two weeks of archaeological monitoring period (or until excavations have reached the maximum depth at which important remains could be expected to occur) is suggested.

Salvage Excavations during Monitoring from Mechanically Excavated Trenches

During the course of the project, it is anticipated that sites may be discovered during surface clearing and other land transformation activities deemed as a high priority. Under controlled circumstances, data collection during excavation can provide important information concerning a site. Examination of the pit excavation profile often reveals a range of features, which may not be obvious in smaller excavation units. Cleaning and examination of the excavation profile can reveal buried sites, features (*e.g.*, hearths, pits), and concentrations of artefacts. Based on the type of artefacts and features found, samples of artefacts, and soils may be removed for further analysis and processing; detailed photographs should be made, and profile drawings completed. Sites deemed as of high priority should be tagged and any land-clearing activity needs should continue at a neighbouring area to allow the archaeological monitoring team enough time to salvage-excavate the discovered features. This activity requires that the individuals performing such work be experienced in salvage excavations.

Chance Finds or "Unforeseen Discoveries" Procedures

Considering the considerable volume of soil that will be excavated, the project will have to apply 'Chance Finds Procedures', which set out what is to be done when cultural heritage objects are unexpectedly uncovered during operational activities, especially during the absence of an archaeological monitoring team. The following procedures have to be followed:

- Work should be stopped in the vicinity of the find at once (very often work can be continued at another part of the project to avoid costly delays).
- Notify the accountable operations manager or relevant authority. The find should be treated as a cultural heritage incident and reported.
- Notify the Malawi Department of Museums and Monuments in the case of any archaeological or palaeontological finds.
- Use heritage experts and relevant community members to assess the significance of the find, and report it if required by law.
- Decide on the right way to manage the find in consultation with the relevant community groups and/or archaeologists. Resume work if permitted and agreed.

Avoidance of construction-related impacts

A number of methods may be implemented to avoid direct impacts to a cultural resource. Depending upon the type of resource, implementation of one or more of the following methods may be recommended. Avoidance of important sites is generally the preferred option since potential direct site impacts are completely averted. If a heritage site cannot be avoided, then steps are generally implemented to reduce direct impacts. Depending on the context, avoidance or data recovery may be most appropriate.

Avoidance is one of the primary methods to mitigate direct impacts to important cultural resources. In the case of this project, avoidance of impacts can often be most easily accomplished by adjusting the project activity, if possible, to the outside of the boundaries of the cultural heritage resource.

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DWANGWA SOLAR PV

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DWANGWA SOLAR PV
DRAFT REPORT HYDROLOGICAL AND HYDRAULIC ANALYSES
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REPORT

PROJECT	**Dwangwa Solar PV**	DOCUMENT CODE	
SUBJECT	Draft Report: Hydrological and Hydraulic analyses	ACCESSIBILITY	CONFIDENTIAL
CLIENT	**Get.Invest**	TEAM LEADER	Azadeh Kopp-Moini
CONTACT	Marcio Matos, Voltalia	PREPARED BY	Thea C. Wang Sigurd Sørås

SUMMARY

Voltalia plans the development, financing, construction, and operation of a 40 MWAC Solar power plant in Dwangwa in Malawi. The Project is located in the District of Nkhotakota, which not only offers one of the best solar irradiation levels in Malawi but is also in deficit of power supply.

The proposed site has two separate potential flood threats; the first being flooding from the Dwangwa River where flood from the river could potentially exceed the river bank level and flows towards the proposed project site, and the second being the impact of local rainfall and runoff on the proposed project site and areas adjacent to the proposed sites.

A flood analysis has been carried out to assess the flood risk from the Dwangwa River on the proposed Dwangwa Solar PV project. Based on the statistical analysis from available data series, a 100-year flood of 1250 m^3/s (daily value) is estimated for the Dwangwa River by Dwangwa Village. There is no clear indication that rainfall and floods will increase or decrease in the future, therefore a climate add- on for future climate projections is not considered in the analyses. The modelling results show that the proposed Dwangwa Solar PV project site is not flood prone from the Dwangwa River for this return period.

There is a large degree of uncertainty related to the hydrological data and terrain/ topographical data. However, conservative assumptions have been used throughout the analyses and model sensitivity has also been carried out. None of the considered scenarios indicate a flooding threat from the Dwangwa River to the proposed project site. Based on the available data and the flood analysis carried out, it is not considered necessary to implement flood mitigation measures to protect the proposed Dwangwa Polar SV site from flood threats from the Dwangwa river. However, since the underlying terrain has large uncertainties, we recommend that Voltalia obtains a topographical survey of the terrain in areas adjacent to the Dwangwa river by the M5 Bridge to validate analyses results and conclusions.

The local runoff analysis clearly shows that flood water will accumulate towards the proposed project site, mostly towards to the southern plot. This can potentially cause local flooding problems for the planned Dwangwa Solar PV site, and potential flood protection measures should be considered. The northern plot is less prone to flooding issues, but can potentially experience surface erosion in areas where flood water accumulates as well as in areas where the surface material is easily erodible.

00	18.01.2022	Draft report Dwangwa Solar PV: Hydrological and Hydraulic analyses	Thea C. Wang and Sigurd Sørås	Mulugeta B. Zelelew	Azadeh Kopp- Moini
REV.	DATE	DESCRIPTION	PREPARED BY	CHECKED BY	APPROVED BY

1 Background

Voltalia, founded in 2005, is an international renewable energy producer and service provider, that has been listed on the Euronext regulated market in Paris since July 2014. The company focuses on renewable energies (wind, solar, hydro and biomass) and operates nearly 600 MW of renewable energy assets in several countries, with major focus in France and Brazil, and now strongly expanding its investment in Africa and Latin America. Voltalia also engages in the development, construction, operation and maintenance of power plants.

Voltalia plans the development, financing, construction, and operation of a 40 MWAC Solar power plant in Dwangwa in Malawi. The Project is located at the District of Nkhotakota, which not only offers one of the best solar irradiation levels in Malawi but is also in deficit of power supply.

Voltalia has requested hydrological and hydraulic studies of the site as part of the process of planning and designing of the project. The proposed project site has two separate potential flood threats; the first relates to flooding from the Dwangwa River where flood from the river could potentially exceed the riverbank level, thus flows towards the proposed project site, which lies approximately one kilometre south of the river of the potential breach point. The second risk considers the impact of local rainfall and runoff on the proposed project site and areas adjacent to the proposed sites. For site location see Figure **1-1**.

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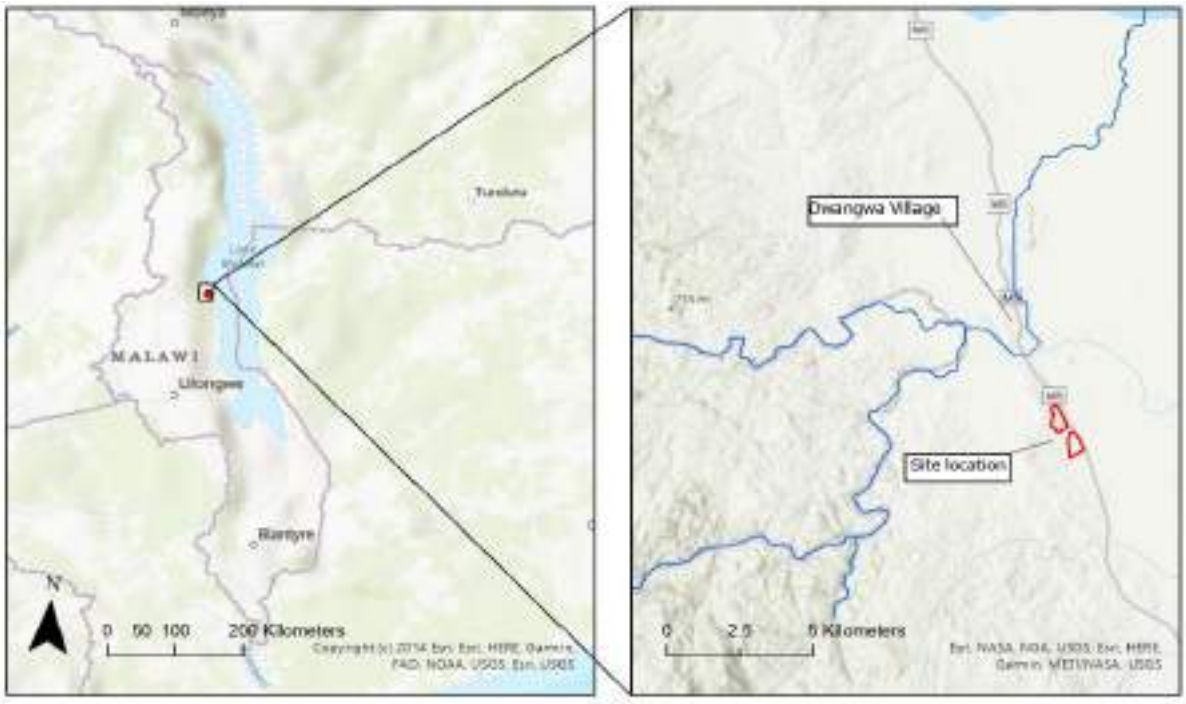

FIGURE 1-1: Location of The Dwangwa Site in Malawi

2 Project site description

The proposed project site for the Dwangwa solar power plant is situated in the District of Nkhotakota in the Central Region of Malawi. The site location is just south of the Dwangwa Village and lies adjacent to the M5 Lakeshore Road. Lake Malawi lies approximately 8 km east of the site. The Dwangwa River passes through the area, approximately 1 km north of the proposed project site. The river flows from Kasungu National Park and to the river mouth in Lake Malawi.

An overview of the proposed project site is shown in Figure **1-1** and a detailed overview of the proposed project site is shown in Figure **2-1**.

FIGURE 2-1: Site delineation for proposed project site (October 2021), marked in red.

2.1 Catchment Characteristics and Topography

The Dwangwa catchment is located in the central region of Malawi with approximately 15 % of the catchment area situated in the Mzimba District, 65% in the Kasungu District and 20 % in the Nkhotakota District. The Dwangwa River is approximately 160 km long and drains in an easterly direction towards Lake Malawi. The catchment size of the Dwangwa river by the proposed project site and to the outlet, Lake Malawi, is respectively about 7525 km² and 7800 km².

The source of the Dwangwa river is Kasungu National Park in Malawi's Central Plateau. The western and central part of the catchment consists mainly of the plateau, sitting about 1000 m.a.s.l, with the highest point at 1788 m.a.s.l. From the plateau, the river flows in a north-easterly direction. As the river nears Lake Malawi it drops sharply into an escarped area and the river flows through the lakeshore lowland before entering into the Lake Malawi (Ferreira, 2013). A large part of the plateau is covered by the National Park which consists mainly of well-preserved Miombo forest. In the lower lying part of the catchment, most of the wetlands have been converted to irrigated sugar cane cultivation. The primary water demand in the catchment is irrigation, and there are no hydropower plants in the catchment (JICA, 2014).

An overview of Dwangwa river catchment is shown in Figure **2-2**.

FIGURE 2-2: The Dwangwa catchment

TABLE 2-1: Catchment characteristics (JICA 2014)

AREA (TO OUTLET IN LAKE MALAWI)	ELEVATION	FOREST	RAINFED FARMLAND	WETLAND
7768	477-1788 m.a.s.l.	40.8%	52.7%	5.4%

2.2 Climate and Climate Change

2.2.1 Climatic conditions

The climate of Malawi is categorized as sub-tropical and the climate conditions are influenced by the Intertropical Convergence Zone (ITCZ) where the prevailing winds of the Northern and Southern Hemisphere come together. In general, the annual variations are divided into three weather variations; warm-wet (November to April), cool-dry winter (May to August) and hot-dry seasons (September to October). Approximately 95% of the annual rainfall occurs during the warm-wet season. For the country, annual rainfall varies from 700 – 1200 mm, averaging at 970 mm (see Figure **2-3** a) (JICA, 2014).

Maximum yearly rainfalls by Water Resources Unit has been calculated, and a relatively large amount of rainfall occurs in the narrow area between Lake Malawi and the mountainous area to the west. In the rainy season the runoff yield is approximately 20% of the rainfall depth (JICA, 2014).

Mean annual precipitation of the Dwangwa basin is 931 mm (JICA, 2014). Most of the rainfall is received in the lower lying part of the catchment. The majority of catchment lies in an area that receives around 700-800 mm rainfall a year, and many of the main tributaries have their source in these regions. In the eastern and lower lying parts of the catchment, rainfall increases and reaches approximately 1300 mm/ year (Figure **2-3** a) (Laisi, 2016).

The average mean annual temperature in this region varies between approximately 20 ^{o}C and 27 ^{o}C (Figure **2-3** b).

Most of the river flow in Dwangwa river occurs during the rainy season, and the river is nearly dry during the dry season. The rainy season in the central region commences in November, and ends in April the following year, with the rainfall peaking in March. According to (Chisale, Chikabvumbwa, & Chisanu, 2020), the average flow rate of Dwangwa River in January is 112 m^3/s, whilst in September it is as low as 0,17 m^3/s. Thus, there is a high degree of annual flow variability.

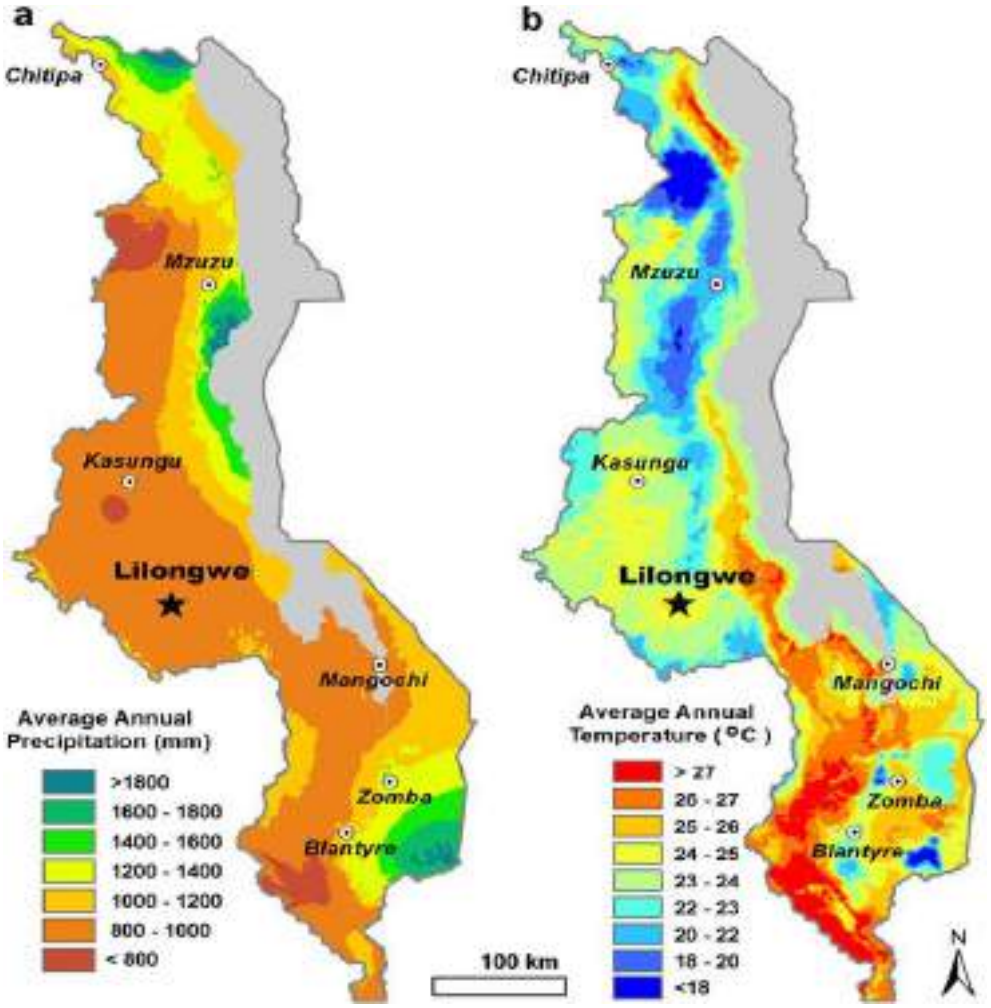

FIGURE 2-3: a) Average annual precipitation and b) Average temperature in Malawi (Li, Messina, Peter, & Snapp, 2017)

2.2.2 Observed climate change

Data from across Malawi indicates a temperature increase of 0.9 °C between 1960 and 2006. The increase in temperature has been most rapid in mid-summer (December- February), and less during early summer (September – November).

Observations show a significant increase in frequency trends of hot days and nights, and the average number of 'hot' days per year in Malawi has increased by 30.5 between 1960 and 2003.

As year-to-year variability in rainfall is very high in Malawi, long-term trends are difficult to identify. In 2006, wet-season (December-February) rainfall over Malawi was markedly low. There is possibly a

decreasing trend in December-February rainfall; however, evidence does not reveal consistent decreases (The World Bank Group, 2011).

2.2.3 Future climate

Global Climate Models indicate that annual temperatures are projected to increase by 1,1 to 3 °C by 2060, and, 1,5 to 5 °C by 2090. All projections indicate a substantial increase in hot days and nights. (The World Bank Group, 2011). The clear temperature trends may lead to increase in evaporation losses and decrease in annual runoff.

The climate models indicate that there is no substantial change in rainfall from June to October. Indications for monthly rainfall changes from November through May are inconsistent, with some climate models indicating increases while other showing decreases. However, there are strong indications that a larger proportion of rainfall will occur during heavy events (19 % by 2090) (The World Bank Group, 2011).

2.2.4 Climate add- on for flood calculations

Based on the above information, there are indications of an increased climate variability in the future and likely increased temperatures. However, it appears difficult to identify clear trends for an increase or decrease in annual rainfall and runoff yields. Therefore, the flood analysis will be performed without climate add- on or reduction to compensate for predicted future climate change. However, due to the uncertainty of rainfall and runoff amounts in the future, a sensitivity test including a 20% increase in flood values in the Dwangwa river is included in the report. To illustrate the uncertainty in the local runoff analysis at the proposed project site, a 10% and 20% increase on extreme precipitations is included.

3 Scope of the Analysis

This report summarizes the hydrological and hydraulic analyses carried out to evaluate the impacts of the two potential flood threats for proposed project site and adjacent areas; flooding from the Dwangwa river and local rainfall analysis.

For the assessment of flood threat from the Dwangwa River the analysis has been carried out for a 100-year flood occurrence interval. Local rainfall and floods risk analysis for the project site has been estimated based on 20, 50 and 100-year return period.

The study is carried out as a desktop review utilizing existing information and data from available global datasets. This includes both hydrological records (river flow) and climatological (i.e. precipitation, temperature, etc. records). The terrain analysis is based on available global topographic data, supplemented with a topographical survey of the proposed project site, provided by Voltalia

Erosion risk assessments are not carried out as part of the analysis.

4 Flood Risk from the Dwangwa River

4.1 Flood Frequency Analysis

4.1.1 Available data and data quality

Data from the Global Data Runoff Centre (GDRC) has been the main source for retrieving flood data for the flood frequency analysis for Dwangwa River.

Available data has been reviewed and 11 stations were identified as possible representative river flow gauging stations for flood frequency analysis in the Dwangwa catchment. The geographical placement of these stations is shown in Figure **4-1**.

FIGURE 4-1: Location of representative gauging stations from the GDRC and additional station Khwengwere (6C1) in the Dwangwa catchment.

For Malawi, the Global Runoff Data sets contain data from early 1950s to 1991. Many stations have later been vandalized or damaged by flood, and flow records at several stations were discontinued in the 1990s as the country was transitioning to democracy. As such the available hydrological data is relatively old. The selected data series vary in length from 1-38 years of recordings. Based on the data series' length and catchment characteristics, 4 stations were discarded from further analysis.

- From available literature it was discovered that the Dwangwa catchment has two streamflow gauges in the catchment.
- 6C1 (Dwangwa at Khwengwere): monitored period; 50 years, drainage area; 2,980 km^2, average dry season flows: Q_{75} = 0.013 m^3/s & Q_{97} = 0.001 m^3/s
- 6D10 (Dwangwa at S53 Road bridge (D/S)): monitored period; 25 years, drainage area; 7,610 km^2, average dry season flows: Q_{75} = 1.260 m^3/s & Q_{97} = 0.130 m^3/s

Unfortunately, data from these flow gauging stations are not available in the Global Data set and we have not been able to retrieve the series in full. For the station 6C1 (Dwangwa at Khwengwere), yearly absolute flows from 1970 to 2009 are provided in (Laisi, 2016), and the station is, therefore, included in the flood frequency analysis.

TABLE 4-1: The considered data series for flood frequency analysis. Flood frequency analysis is only performed for the series marked in light green.

GRDC NO	RIVER	STATION	AREA KM²	DATE START	DATE END	YEARS	MISSING DATA %
1993480	BUA RIVER	S53-ROADBRIDGE	10 659	1975	1991	17	27.8
1993490	BUA RIVER	OLD BUA BRIDGE/ KASESE	6 737	1954	1991	29	28.0
1993481	BUA RIVER	BUA DRIFT	9 075	1960	1978	19	0.4
1993450	DWAMBAZI RIVER	NTHANDA	794	1982	1991	10	1.7
1993400	SOUTH RUKURU RIVER	CHIMSEWEZO	977	1976	1991	16	4.6
1993401	SOUTH RUKURU RIVER	PHEWZI	11 132	1958	1991	34	0.4
1993320	LUWEWYA	MAJIKAPOTWE/ ZAYUKA	2 320	1953	1990	38	3.9
1993325	LICHELEMU	MAZAMBE D/S	294	1959	1991	28	15.1
1993300	LIMPHASA	TIMBIRI	287	1983	1991	8	3.6

1993495	MTITI RIVER	MITTI	228	1987	1988	1	-
1993330	MZIMBA	MUWERU BUKULUTI	263	1981	1991	10	3.8
	DWANGWA	DWANGWA AT KHWENGWERE	2 980	1971	2009	36	N/A

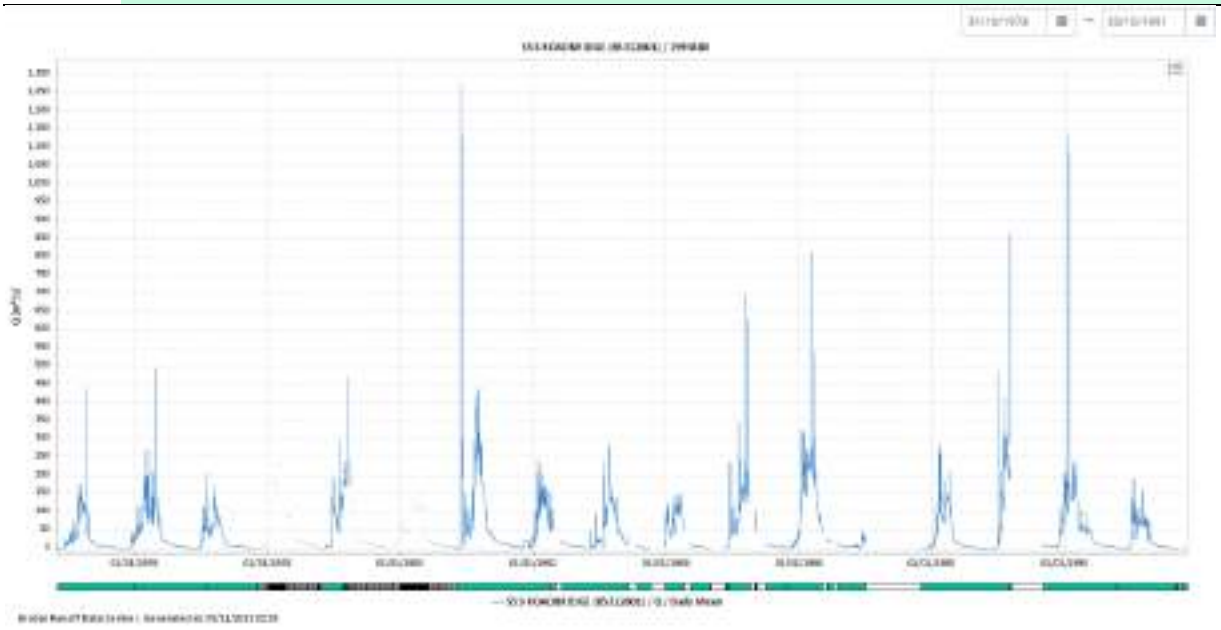

FIGURE 4-2: River flow from S53 Road bridge, Bua river: Source: GDRC 2021

The gauging station 6C1 Dwangwa at Khwengwere records streamflow from a sub-catchment (2980 km^2) of the total Dwangwa watershed. The sub-catchment drains the highlands which have a lower annual runoff than the wetland areas. The specific runoff from the total catchment will likely be significantly higher, however it is useful to consider the station for comparison and catchment trends.

The Bua River Catchment is the neighboring watershed to Dwangwa. It has a catchment area of 10 659 km^2 and similar average annual rainfall (944 mm) to the Dwangwa river catchment. Land use in the catchment is mainly rainfed farmland and wetland. Although the land use at Bua river catchment has a slightly different composition from the Dwangwa catchment, the Bua catchment is considered comparable to Dwangwa due to its geographic proximity, flow direction and location. The Bua catchment contains three gauging stations; two in the upper part of the catchment and one further downstream (10 659 km^2), which is the most representable for the Dwangwa catchment. The three streamflow gauging stations have time series lengths between 17-29 years. Unfortunately, almost 30% of the data at two of the stations is missing, thus the data quality from these stations is limited.

The stations Nthanda, Majikapotwe/Zayuka, Mazambe D/S are situated to the north of Dwangwa river catchment. These all represent smaller catchments, with a lower elevation than the Dwangwa

catchment. However, they have more complete and longer data series than for the Bua Catchment, and it is therefore useful to include the data from these streamflow gauging stations in the flood frequency analysis to verify flood estimates.

The two remaining streamflow gauging stations included in the flood frequency analysis, are part of the South Rukuku Catchment. Although these catchments drain in a more northernly direction, they have relatively long and complete timeseries and are useful for comparison of flood estimates.

4.1.2 Data analysis and flood estimation

Statistical analysis has been carried out based on annual maximum river flows, applying the statistical distribution function that fits the data best. The results from the flood frequency analysis is shown in the table below.

The analysis shows a large variation in the specific flood index (Q_M in l/s/km^2), from 15 l/s/km^2 – 95 l/s/km^2. The lower values correspond with the catchments where the majority of the area is situated at higher elevations, whilst the highest flood values are found where almost the entire catchment is situated in the lowlands, with an average rainfall of more than 1200 mm.

TABLE 4-2: Results from flood frequency analysis, daily average flood values

GRDC NO	STATION	AREA	QM	QM	Q_{10}/QM	Q_{25}/QM	Q_{100}/QM	Q100	STATISTICS
		km^2	l/s/km^2	m^3/s				m^3/s	
1993480	S53-ROADBRIDGE	10659	49	526	1.9	2.3	3.1	1609	Gumbel
1993490	OLD BUA BRIDGE/KASESE	6737	15	104	1.7	2.1	2.7	276	Gumbel
1993481	BUA DRIFT	9075	17	153	1.7	2.1	2.7	418	Gumbel
1993450	NTHANDA	794	81	64	1.5	1.8	2.2	139	Gumbel
1993400	CHIMSEWEZO	977	66	64	2.3	3.0	4.0	257	Gumbel
1993401	PHEWZI	11132	16	173	1.6	1.9	2.4	406	LP3
1993320	MAJIKAPOTWE/ ZAYUKA	2320	95	220	1.6	1.8	2.0	431	LP3

1993325	MAZAMBE D/S	294	42	12	1.7	2.2	2.9	36	LogNormal
	DWANGWA AT KHWENGWERE	2980	33	97	1.8	2.2	2.7	264	LP3
	SELECTED FOR DWANGWA	**7525**	**54**	**409**	**1.9**	**2.3**	**3.1**	**1250**	

Results from the upper part of the Bua catchment (Old Bua Bridge and Bua Drift) have relatively low values of specific flood index. Both of these streamflow gauging stations measure streamflow from smaller sub-catchments with the majority of the terrain lying in higher altitudes, and are therefore considered less representative for the total Dwangwa catchment.

The South Rukuku Catchment (Chimsewezo and Phewzi stations) drains in a more northernly direction than the Dwangwa catchment. The gauging station Phewzi has a long data series with few missing data, and has a reliable data series for flood frequency analysis. However, the data series indicates relatively low flow values in comparison to other representative data series in the region (see Table **4-2**). Chimsewezo is situated on the plateau and it has a relatively high flood index and a frequency growth curve which is significantly higher than the remaining gauging stations. The values are, therefore, considered less representative for the Dwangwa catchment.

Majikapotwe/Zayuka and Mazambe D/S, though the gauging stations represent smaller catchments, have long data series and could be used for estimating floods for the lower part of the Dwangwa catchment, however, Nthanda gauging station is considered more comparable to the Dwangwa river catchment due to its geographic proximity.

The results from the flood frequency analyses from the gauging station within the catchment (6C1 Dwangwa at Khwengwere) indicate an annual index flood of 33 l/s/km^2. However, this is estimated from a sub-catchment where the majority of the catchment lies in higher altitudes with less rain, and is therefore only considered representative for the upper part of the Dwangwa catchment. The runoff at Dwangwa Village is expected to be significantly higher. The neighboring catchment (Bua Catchment, gauging station S53 Road bridge) has a similar size catchment and flow direction to the Dwangwa catchment and the gauging station is situated at the same elevation as our study area. It is, therefore, considered a representative catchment to the Dwangwa catchment, though the data quality is poor since 28% of the data is missing. The gauging station for Nhtanda represents a relatively small catchment and the stream gauge is situated in the lowlands. The lower part of catchment border to the Dwangwa catchment and will therefore have similar catchment characteristics as the lower part of the Dwangwa catchment.

Based on the above considerations, an average flood value for a 100-year return period for the Dwangwa river catchment by the proposed project site is estimated based on the specific flood index

from Dwangwa at Khwengwere, S53- Road bridge and Nhtanda. As the S53- Road bridge is considered the most similar catchment, the same frequency curve has been chosen for the Dwangwa river catchment. This results in an estimated **100 years return period flood of 1250 m³/s.**

4.1.3 Flood hydrograph

A flood hydrograph has been designed as input to the hydraulic model. Just upstream the Dwangwa Village a tributary enters the main river, and the river course of the tributary can potentially impact the flooded area. Therefore, separate hydrographs have been developed for the main river and the tributary. The hydrographs are based on the total derived flood value for the 100-year flood by Dwangwa Village and have been scaled using area ratio between the respective river catchment areas and the total catchment to Dwangwa village.

Flood duration has been set to 5 days (120 hours) and the hydrographs have been designed so that the maximum daily average (24h) corresponds to the estimated daily value for the 100 years return period flood for Dwangwa River by Dwangwa Village. Due to the size of the main catchment the daily flood value is likely to be similar to the peak value. The flood characteristics are as such more dependent on the flood volume rather than the peak value within a 24 h period. The flood hydrograph is designed to generate a flood volume that maintains a daily average (24 hours) of approximately 1250 m³/s.

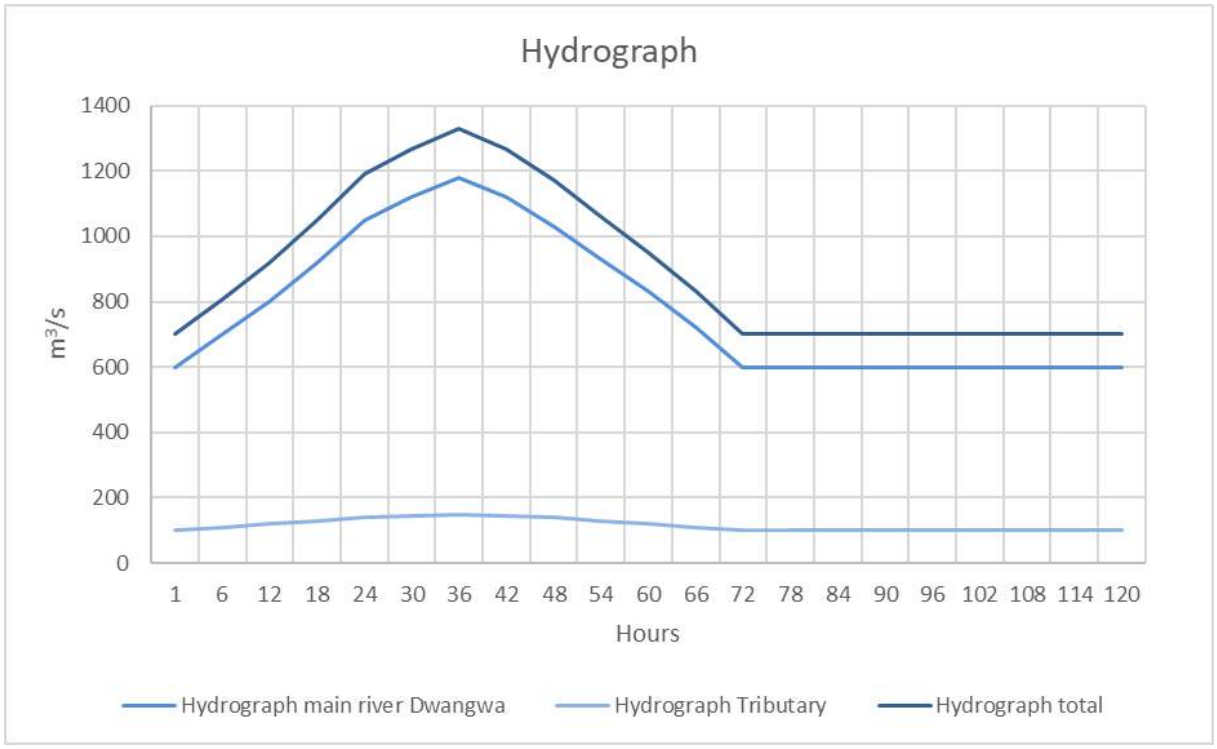

FIGURE 4-3: Flood hydrograph for the main river Dwangwa.

4.2 Hydraulic modelling

4.2.1 Model Structure

4.2.1.1 Modelling tool

To assess the flood potential from the Dwangwa River, hydraulic simulations have been carried out with HEC-RAS v.5.0.7 (Brunner, 2021). The hydraulic calculations are performed in a two-dimensional (2D) hydraulic model, and computation area is shown in Figure **4-4**. A flood with 100 years return period has been modelled. A 2D model is considered as the best choice for modelling the area, because the area is relatively flat, which signifies that the flood water exceeding the main riverbank levels may have multiple flow directions.

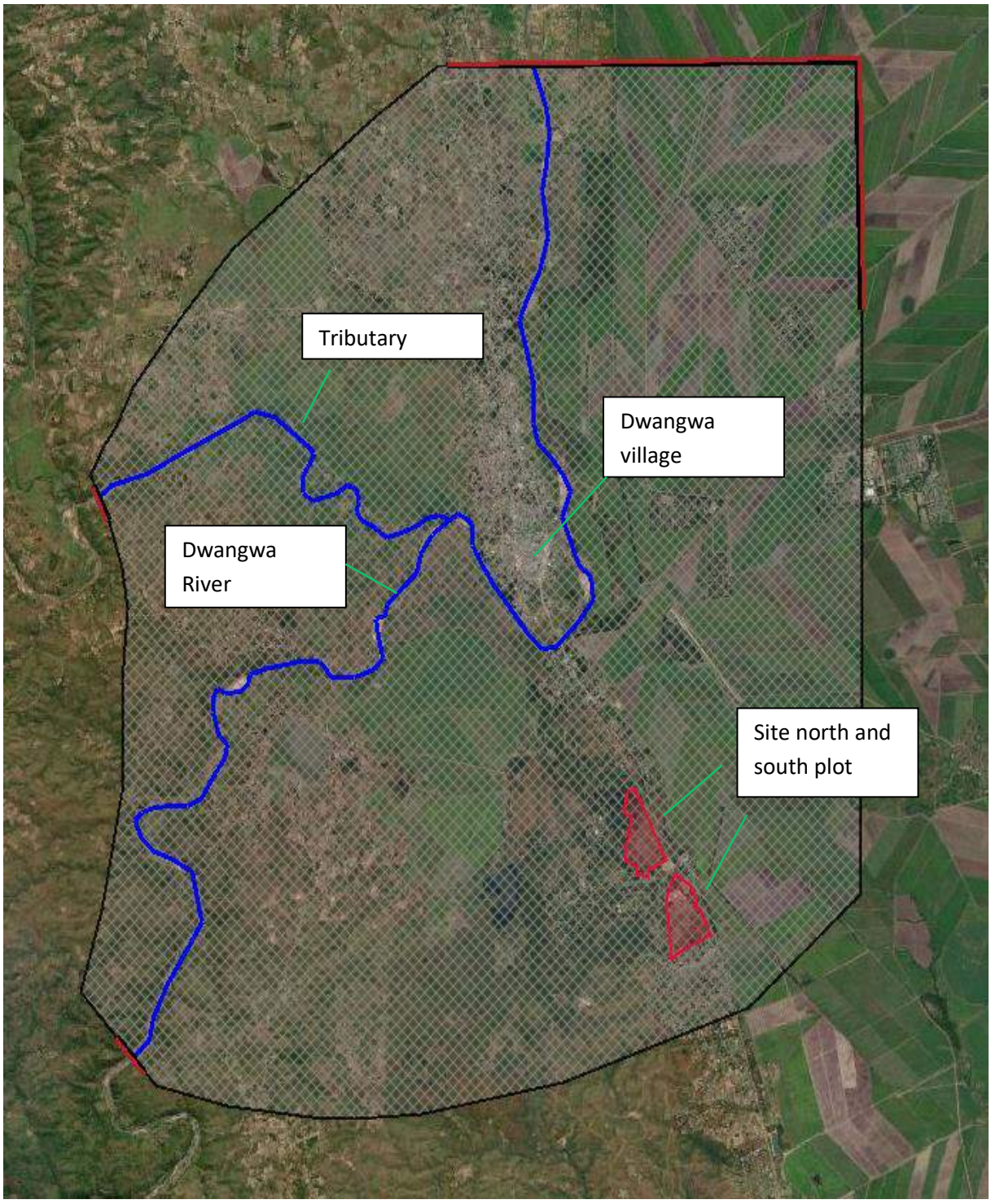

FIGURE 4-4: 2D model area. Current site location marked in red,

4.2.1.2 *Topographical data*

The topographical data is the foundation for developing the geometry applied in the hydraulic analyses. Topographical data from different global DEMs have been considered for the analyses; DEM from The Advanced Land Observing Satellite (ALOS) and DEM from the Shuttle Radar Topography Mission (SRTM). Specifications for these topographic data are provided in the table below. Grid size used for the model calculation is 30m.

TABLE 4-3: Specifications for considered DEMs

	SRTM	ALOS
Spatial Resolution	1 arc-second for global coverage (~30 meters)	1 arc-second for global coverage (~30 meters)
Primary Source	C band radar	Stereo pan imagery
Producer	NASA	JAXA
Horizontal Datum	WGS84	WGS84
Vertical Datum	Orthometric EGM96	Orthometric EGM96
Acquired	2000	2006-2011

Both DEMs have a resolution of 30x30 m (1 arc second); it is thus a relatively coarse resolution topographic data to carry out hydraulic modelling and analyses for small sized plots like the proposed project site. Based on visual inspection, the topographical features of the two DEMs vary. The elevation differences based on the two DEMs are up to 2m in some of the areas we have modelled. Based on contours developed from the ALOS DEM, the topographic features are better defined and the Dwangwa river course and its banks are visible. We have therefore used the ALOS DEM as basis for the hydraulic analyses.

4.2.1.3 *Flow area and boundary conditions*

The 2D flow area for the model is shown in Figure **4-4** and stretches for approximately 20 km of the river course, and covers an area of 100 km^2 including the proposed project site. The slope of the river is gentle, and the adjacent areas are relatively flat. The flow area is adjusted to incorporate the extent of flood water overtopping the riverbanks and flowing on the adjacent flood plain. The river stretch is mainly covered by bushes and the surrounding areas are agricultural areas. Based on satellite images, the river channel by the proposed project site meanders and appears to be less distinguishable from the

surrounding areas. A Manning's n value of 0.05 is therefore considered reasonable for the hydraulic analyses.

Two boundary conditions are set in the upstream area, one for the main river Dwangwa and one for the tributary entering Dwangwa just upstream of the Dwangwa Village. Upstream boundary conditions are set as the 100-years return period Flood Hydrographs described in chapter 4.1.3.

In the downstream area, the boundary condition is set along the border of the modelled area, as the flow during flooding situations will have multiple outlets. The downstream boundary condition is set to Normal Depth with a slope of 0.003. This is estimated from the underlying terrain model used in the analyses.

4.2.1.4 Terrain alterations

Initial simulations indicated that the flood water from the tributary entering the main river upstream of Dwangwa Village would flow in a northernly direction rather than joining the main Dwangwa river course. For large flood volumes this may be a likely flood scenario. However, due to the coarse resolution terrain model used in the analyses, there are uncertainties related to the flow direction. As a conservative assumption, we have, therefore, modelled scenarios with altered terrain to consider circumstances where all flood water from the tributary enters the main Dwangwa river. An elevated embankment along the northern edge of the tributary is, thus added on the DEM. See the difference in flood inundation levels without and with terrain modification in Figure **4-5**, Figure **4-6** and Figure **4-7**.

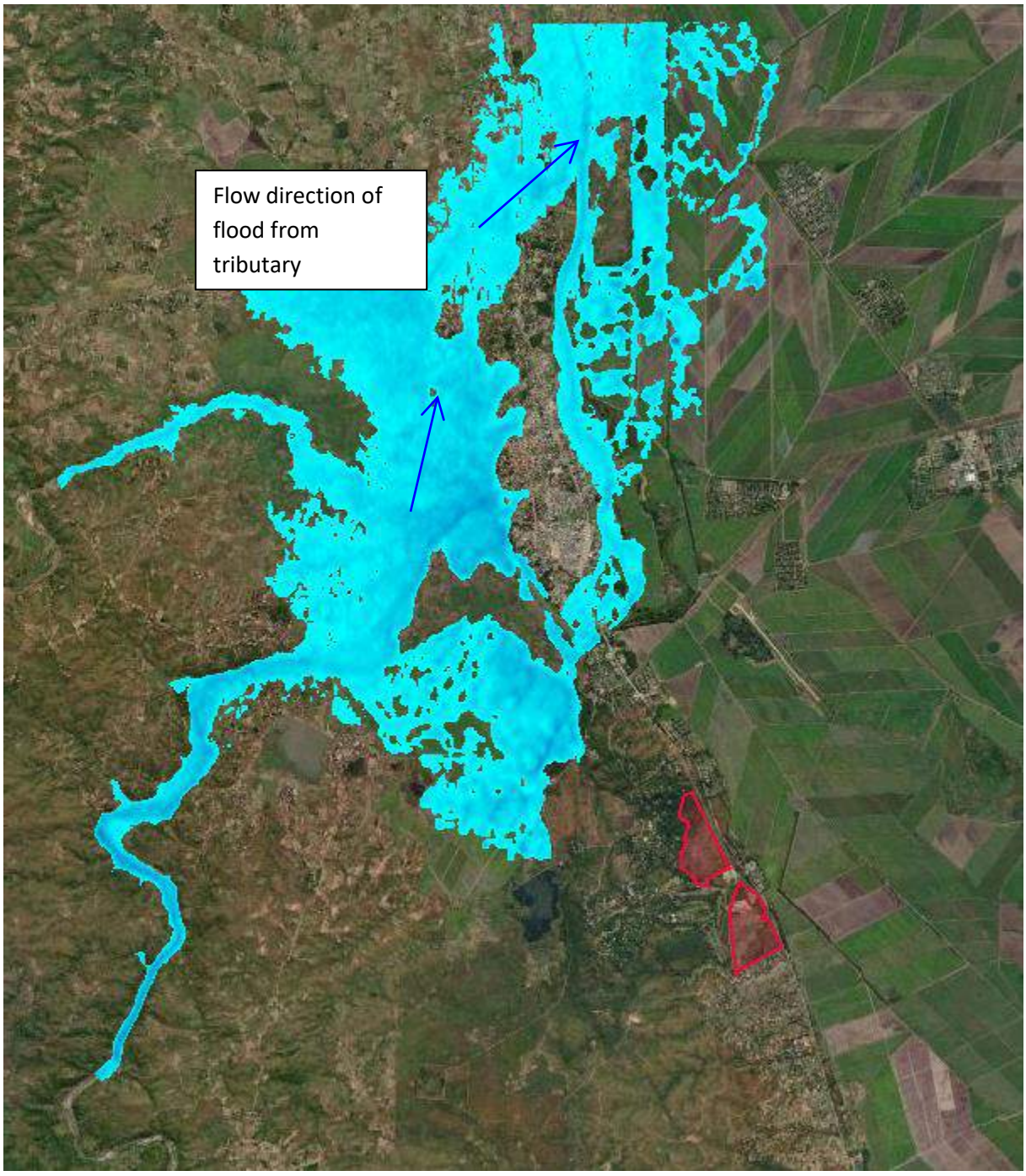

FIGURE 4-5: Preliminary flood analyses indicating that the flood water from the tributary may flow to the north

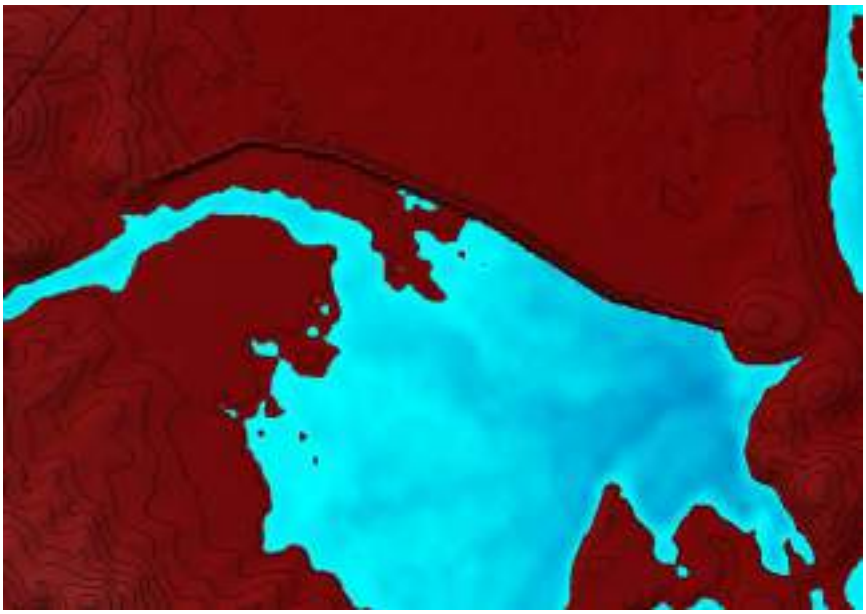

FIGURE 4-6: Terrain alteration to ensure all the water from the tributary enters into the main Dwangwa river.

4.2.2 Results

The result from the flooding scenarios are provided in the figure below. The results show that even with a conservative assumption that all flood water will enter into the main river, the proposed project site is not flood prone to a 100-year return period flood. Water gathers in the flood plain to the north-west of the site, and due to the flat terrain, it is likely that the water will flow in either a northernly or a southernly direction, limiting the flood water passing in the main river course to the east. For a 100-year return period flood, the water depth just upstream of the M5 bridge is estimated to approximately 4 m. (terrain being at approximately 493 masl.) The elevation difference between the calculated 100-years return period water level and the proposed project site is around 5 m according to the DEM derived by satellite data. The proposed Dwangwa Solar PV project site will therefore not be affected by the 100-years return period flood level at Dwangwa river.

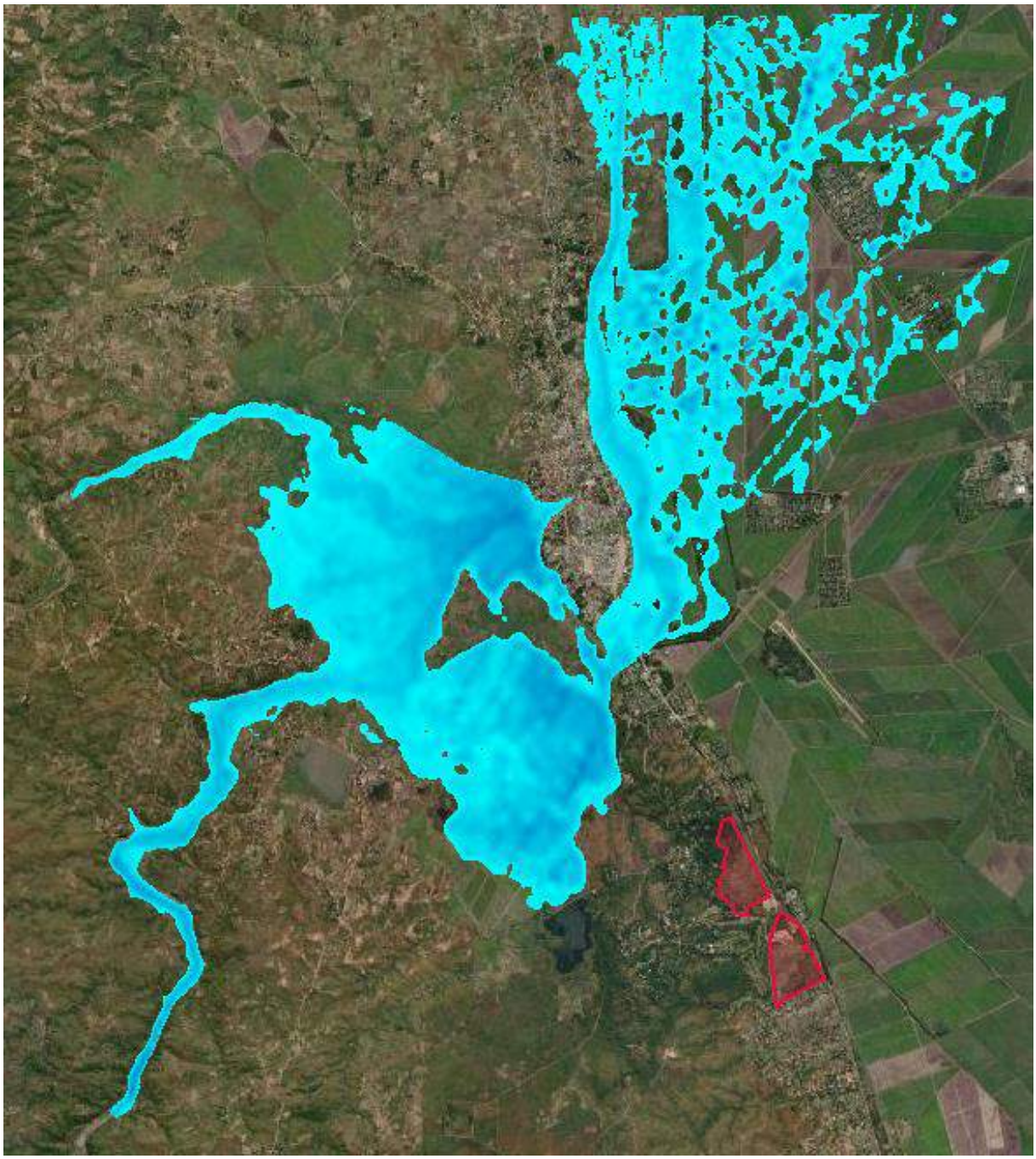

FIGURE 4-7: Results from flood analysis, including conservative assumption that all water flow in the main river. Proposed site marked in red.

4.3 Sensitivity analysis

Since the calculated 100-years return period flood level and choice of the Manning's n value is somewhat uncertain, a sensitivity analysis was performed to evaluate uncertainties of the model results. The parameters investigated are increased flow (+20%) and changes in friction Manning's n value (+/- 0.02).

The results are shown in the table below. As a point of reference, the water level upstream the Dwangwa bridge is presented. Note that the bridge structure is not implemented in the model and can influence the water level in reality.

TABLE 4-4: Results from sensitivity analysis. The table indicates the flood water upstream the Dwangwa bridge.

VARIABLE	ORIGINAL WATER LEVEL	RESULTS FROM SENSITIVITY TEST	WATER LEVEL CHANGE FROM ORIGINAL	COMMENT
	[masl]	*[masl]*	*[m]*	-
100 yr return period	*496,8*	-	-	Q= 1250 m^3/s
100 yr return period +20%	*496,8*	*497,0*	+0,2	Q= 1500 m^3/s
Increased Manning's n +0,02	*496,8*	*497,1*	+0,3	Q=1250 m^3/s
Decrease Manning's n -0,02	*496,8*	*496,3*	-0,5	Q=1250 m^3/s

The sensitivity analyses show that the model results for this specific river stretch is slightly sensitive to an increase in flood value. Increased peak flows up to 20 %, resulted in a 0,2 m increase in water surface elevation for the modelled area upstream the bridge. The results show that increasing the Manning's n value can influence the modelled flood level. An increase of Manning's n with 0,02 resulted in a water level increase of 0.3 m. The largest uncertainty related to the model is likely to be the DEM since the DEM applied for the analyses has a very coarse resolution.

5 Local rainfall and flooding risks

In addition to identifying flood risks from the Dwangwa river, an analysis of local drainage lines and runoff estimations from and around the proposed project site has been carried out. This has been done to identify areas and potential flood values where water will accumulate and form streams during an extreme precipitation event occurring on or near the site.

5.1 Description of local terrain and DEM

To define terrain and elevation around the proposed project site, two different sources have been used. A topographical survey is carried out for the proposed project site and some adjacent areas as shown in Figure **5-1**. This survey data is used to create a gridded terrain model (DEM) with cell size 0,5x0,5 m. To define areas which are not covered by the topographic survey, a resampled terrain (0,5x0,5 m) from the coarse resolution terrain model described in chapter 4.2.1 is used. In the areas where the two terrain models are overlapping, there are some differences in elevation values for the two datasets. The survey data is on average around 3 meters lower than the satellite terrain data. To accommodate this difference, and to avoid potential errors in the analysis, the terrain model derived from the survey data has been raised by the average difference before merging the two terrain models. The result is a smoother, more realistic, merged DEM, even though the absolute elevations can potentially differ somewhat from reality.

FIGURE 5-1 Data collected in the topographical study

The site is located at the foot of local hills, where the elevation difference from the crest of the hill (catchment borders) to the lower parts of the proposed project site is around 80-90 meters. Rainfall that falls on the upper parts of this hill will accumulate and potentially flow through the project site from west to east (Figure **5-2**).

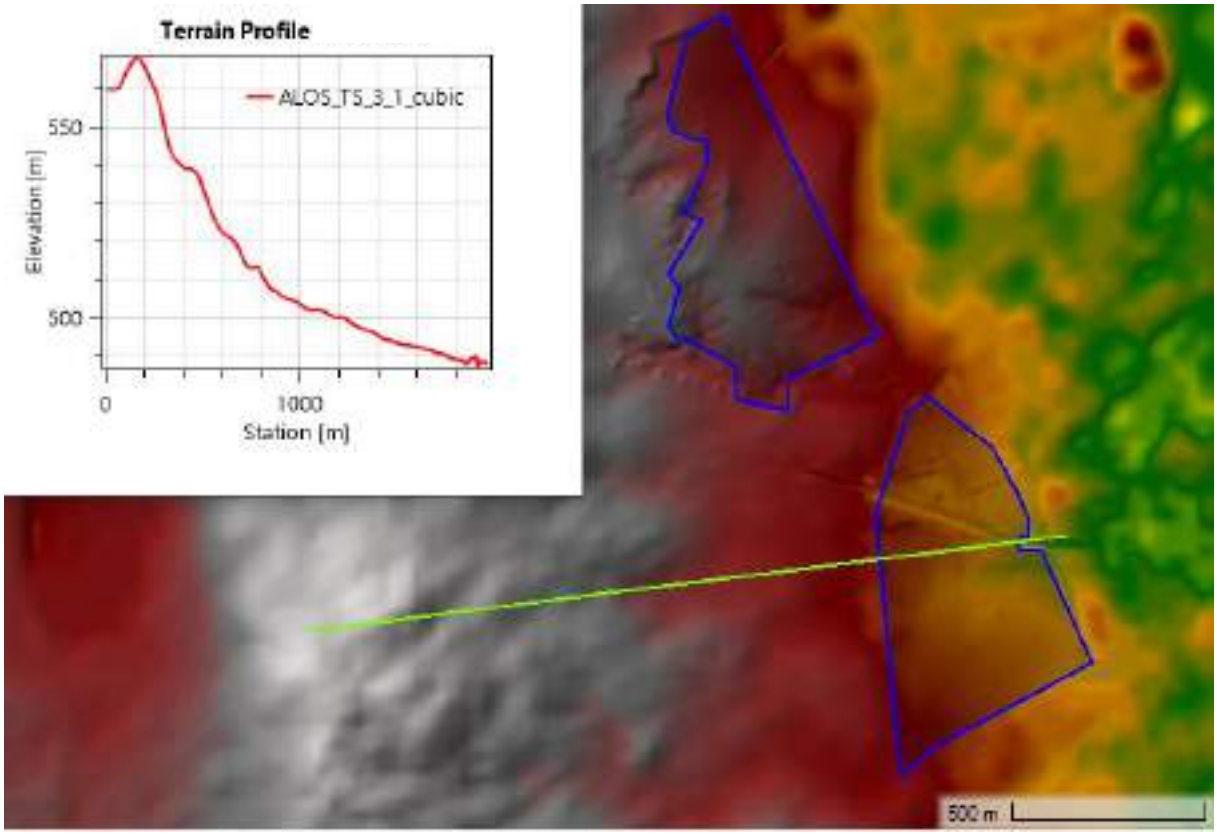

FIGURE 5-2 Terrain around the planned site. Elevation profile for the green line (west to east)

The terrain around and on the project site is influenced by man made changes due to irrigation and agricultural activities, as well as other permanent and temporary infrastructure (i.e. roads) in general. These systems can potentially influence the direction of flood flow and volume of calculated runoffs at specific locations at the project site. In areas where the detailed topographical survey is carried out, the terrain modifications are sufficiently included in the DEM, while in the areas around the project site where the DEM has a coarser resolution, such details are not included.

5.2 GIS-analysis and local catchment delineation

To delineate drainage lines for the proposed project site and adjacent areas, a GIS-analysis is carried out. The analysis is done using the watershed delineation tools (i.e., ArcHydro and Spatial Analyst tools) in ArcGIS Pro (2.8.2) The input for the analysis is the DEM described in the previous sub-chapter.

The results from the GIS-analysis are shown in Figure **5-3** and Figure **5-4**, as well as in appendix B.

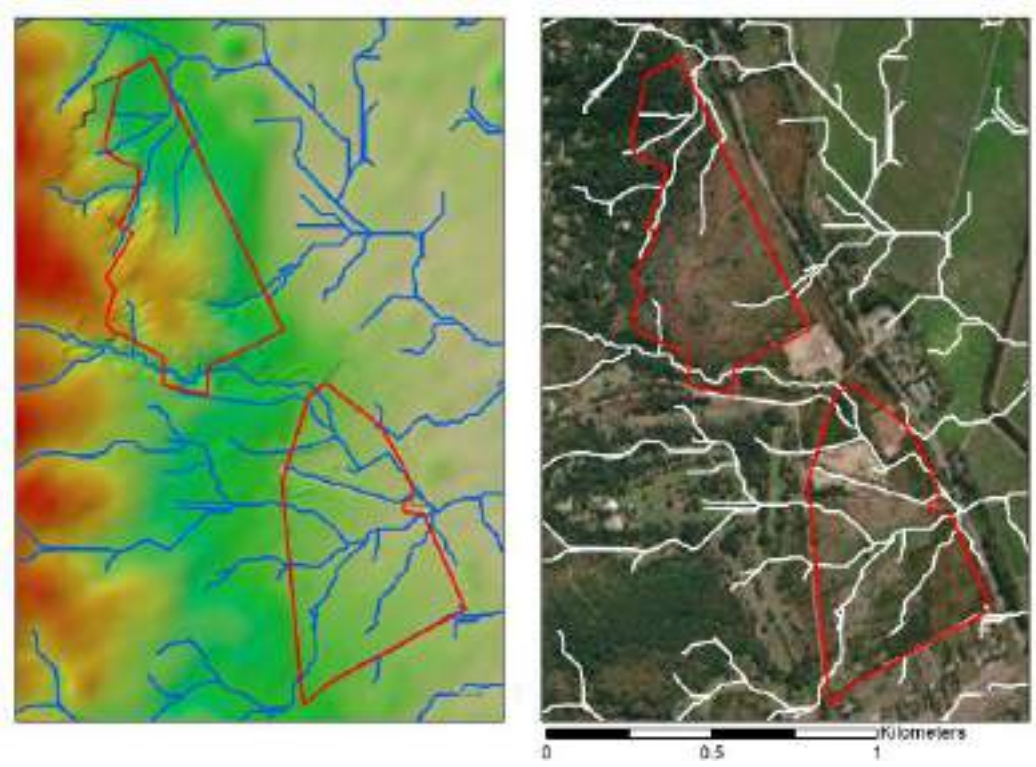

FIGURE 5-3 Calculated flow accumulation (drainage lines) on and around the proposed project site (blue and white lines). Left: shown with DEM. Right: shown with aerial images. The proposed project site is shown with the polygon with red line color.

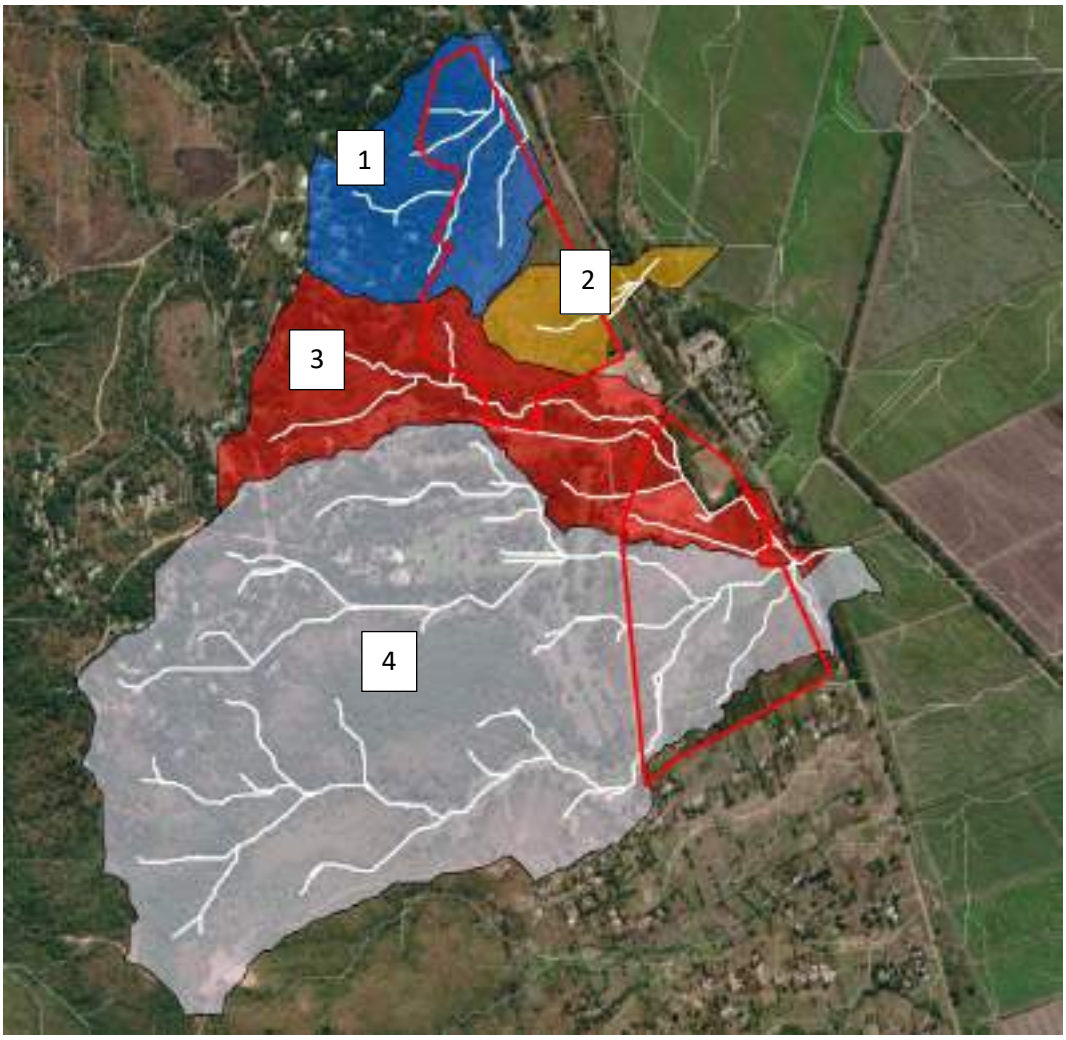

FIGURE 5-4 Drainage lines and catchments by the proposed project site. The proposed project site is shown with the polygon with red line color.

Areas for the different sub-catchments by the proposed project site are presented in the table below.

TABLE 5-1 Catchment area by the proposed project site.

SUB CATCHMENT	COLOR *(in Figure 5-4)*	DRAINAGE DIRECTION	AREA *[Ha]*
Nr. 1	*Blue*	*North-east*	*31,1*
Nr. 2	*Orange*	*North-East*	*10,6*
Nr. 3	*Red*	*South-east*	*48,0*
Nr. 4	*White*	*East*	*180,0*

The GIS-analysis shows that most of the water will accumulate and flow towards the southern edge of the proposed project site towards the irrigation pond and its crossing below the M5 highway. In areas where the DEM is detailed (due to topographical survey), the influence of channels is clearly visible in the results from the GIS-analysis. Some water will also gather and flow through the northern plot.

FIGURE 5-5 Drainage lines, shown for parts of the southern plot where the water accumulates towards the irrigation pond. Both the red (3) and white (4) catchment drains towards this area

5.3 Hydraulic and hydrological simulations

To define the amounts of water that will flow towards and through the project site, a combined hydrological and hydraulic model has been developed with the software HEC-RAS 6.1. Rainfall intensities with return periods 20, 50 and 100 have been simulated.

5.3.1 Rainfall intensity

The analysis is based on the IDF curves published in the article "Impact of modelling scale on probabilistic flood risk assessment: the Malawi case" (Rudari, Beckers, De Angeli, & Rossi, 2016) shown in Figure **5-6**.

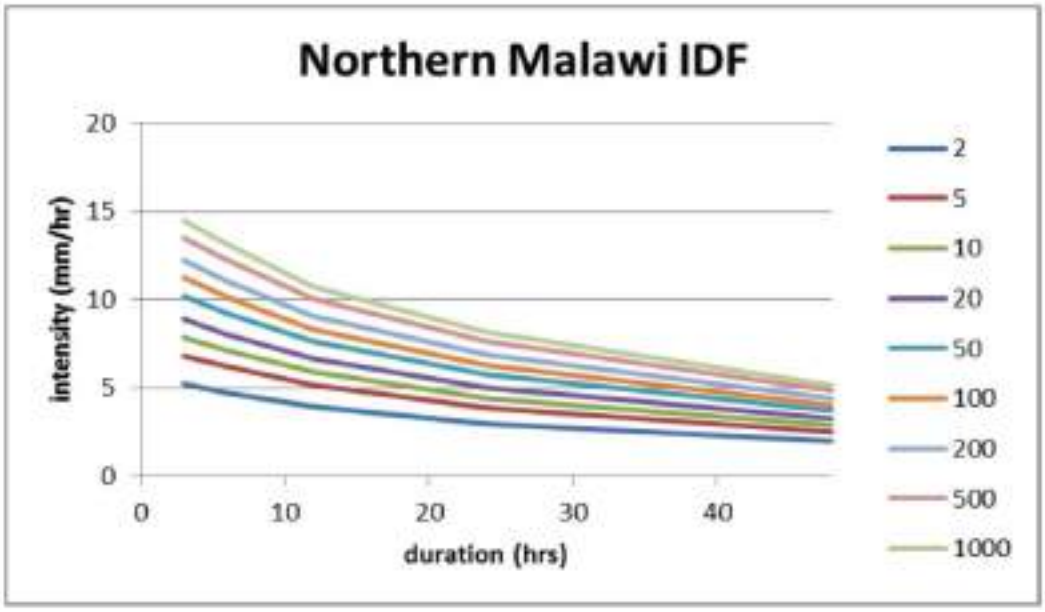

FIGURE 5-6 Average IDF curves for Northern Malawi. The lines represent IDF curves for different return periods.

The duration of the rainfall event by the project site is expected to be significantly lower than the duration shown in the IDF-curves above. To find IDF values for durations lower than the presented IDF values in Figure **5-6**, an extrapolation has been carried out.

To create a synthetic hyetograph, a time of concentration for the proposed project site must be defined. In this case, the value has been calculated to less than 1 hour, based on catchment length for the largest catchment (catchment 4 shown in Figure **5-4**), and an average runoff velocity of around 1 m/s. Rainfall hyetographs with 1-minute intervals and a total rainfall duration of 2 hours for 20-, 50- and 100- years return periods are therefore developed for the hydrological simulations by the proposed project site. The developed rainfall hyetographs are shown in Figure **5-7** and Table **5-2**, as well as in appendix C.

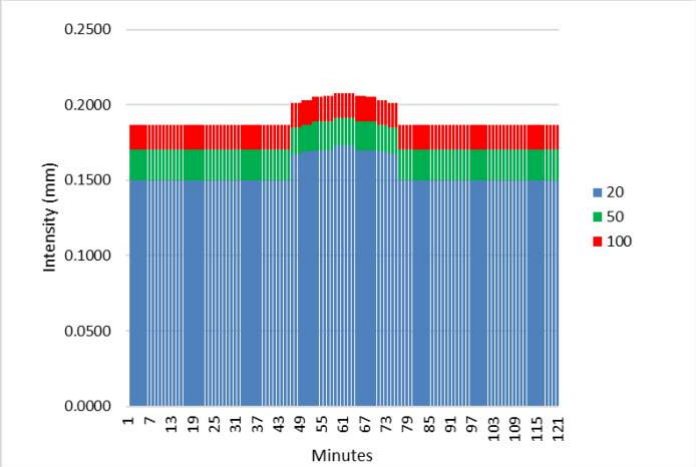

FIGURE 5-7 Hyetograph for 20-, 50- and 100-year return periods with 1-minute interval.

TABLE 5-2 Maximum rainfall intensity obtained from a 1-minute interval

RETURN PERIOD	MAXIMUM VALUE
[years]	*[mm/minute]*
20	*0,17*
50	*0,19*
100	*0,21*

5.3.2 Modelling tool and computation parameters

The hydraulic simulations are carried out using the hydraulic modelling tool HEC-RAS 6.1. The hydraulic model uses 2D-modelling techniques, where the precipitation described in the previous sub-chapter is distributed equally throughout the computation area. The model is based on the following assumptions and computation parameters:

- Computation cell size 4x4 m
- Uniform Manning's roughness, n=0,04
- Normal depth at model outlet towards the east (friction slope 0.001 estimated from the underlying terrain model)
- All precipitation will contribute to the overland flow (no infiltration)
- Computational time step is set at 4 seconds
- The crossings under the M5 highway are fully open and have sufficient capacity to lead flood water away from the proposed project site

The assumptions are chosen based on an optimization of computation time, as well as to minimize effects of error on the simulation results. A conservative approach for the effect of soil infiltration has been chosen; as a detailed, spatial, description of infiltration for the site is not available.

An example of the computational grid is shown in Figure **5-8**.

FIGURE 5-8 Extent of modelled area (left), including details of computational grids and underlying terrain used in the hydraulic simulations

5.3.3 Modelling results

The result map and the hydrographs from the runoff simulations is provided in the figure below, as well as in appendix D and E. The inundation maps are manually edited to only include the streams that accumulate towards the proposed project site, as well as to fill in small depressions within the project site with water. The results show that the southern plot is most likely prone to flooding during heavy rainfalls. The inundated area on this plot is somehow similar for rainfall intensities of all the return periods, where flood water will mostly like follow the main drainage lines described in the GIS-analysis section.

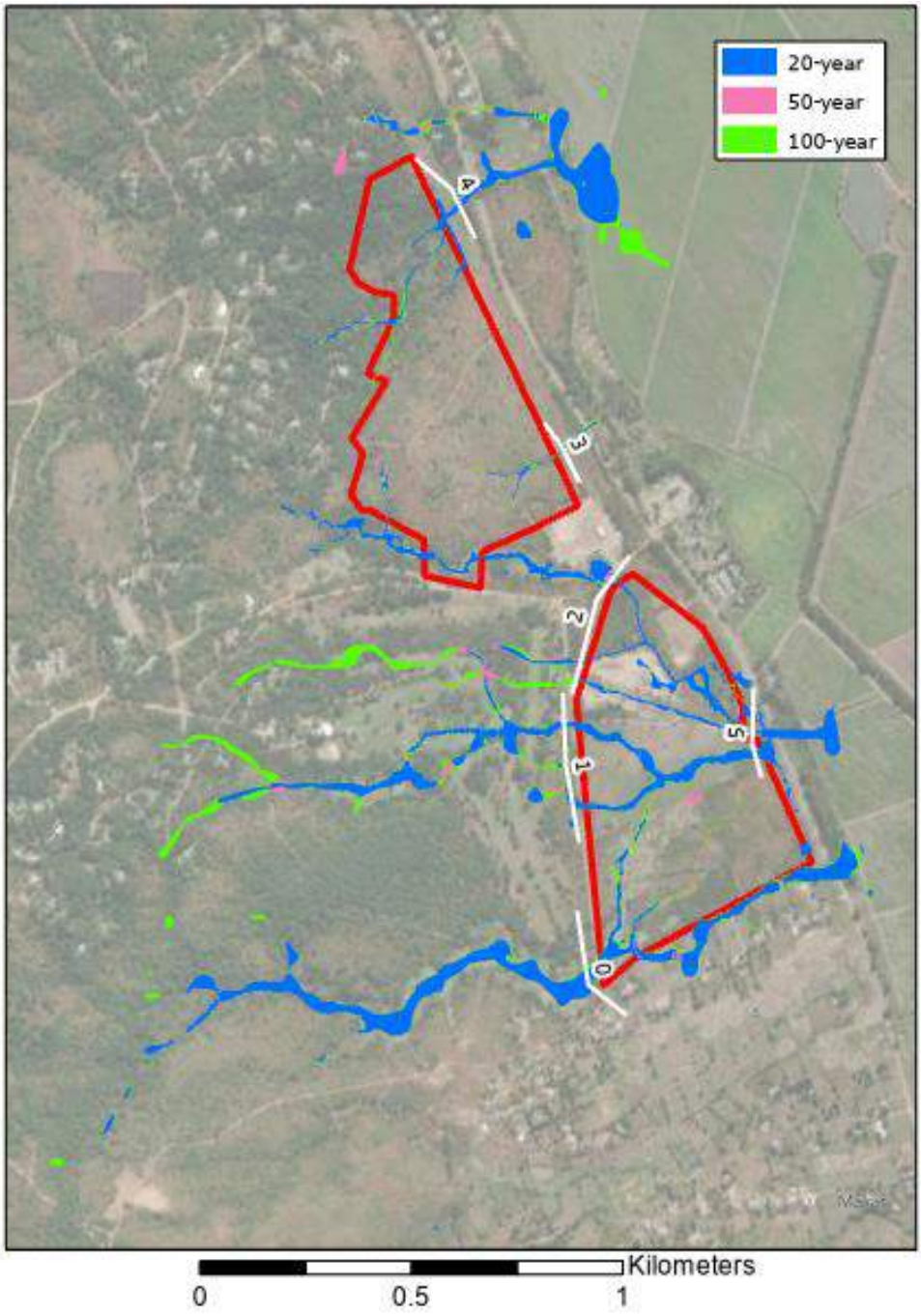

FIGURE 5-9 Inundated areas due to extreme rainfalls for different return periods, and placement of profiles for presenting simulation results

For a 100-year rainfall event, one can expect a maximum discharge of around 4,2 m³/s at the highway crossing downstream of the irrigation pond (Figure **5-10**) (runoff from catchments 4 and 3 shown in Figure **5-9** described by profile 5).

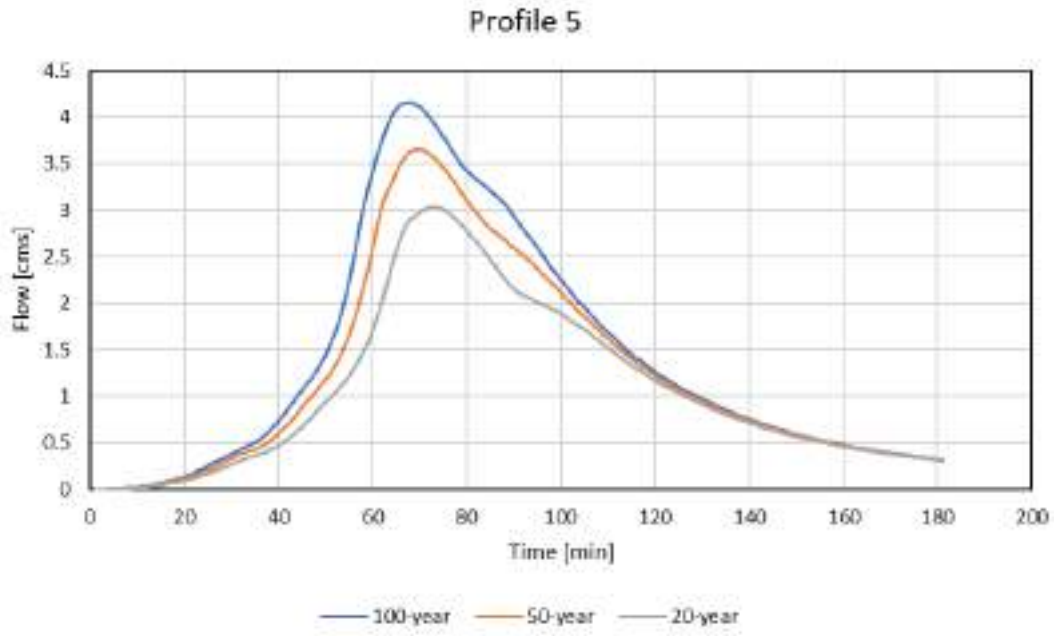

FIGURE 5-10 Simulated runoff at profile 5 for the 3 different return periods

Profile 0 shows the maximum calculated runoff upstream of the plot (this profile is also located at the outlet of the largest catchment upstream of the proposed project site). The flow described by this profile will however most likely follow the path along the southern border of the southern plot. The two stretches that contribute maximum runoff from extreme rainfall events towards the plot will hence be the streams upstream of profile 1 and 2 shown in Figure **5-9**.

TABLE 5-3 Calculated maximum flood values for profiles 0-5 shown in FIGURE **5-9**.

PROFILE	20-YEAR	50-YEAR	100-YEAR
	[cms]	***[cms]***	***[cms]***
0	1.48	1.85	2.17
1	1.48	1.71	1.90

2	1.22	1.44	1.62
3	0.19	0.21	0.22
4	0.90	1.00	1.09
5	3.04	3.65	4.16

The flood water can potentially cause erosion on the site, especially in areas where the ground cover is easily erodible.

5.3.4 Sensitivity analysis

To illustrate the uncertainty of the calculation results, a sensitivity analysis has been carried out. The parameters investigated include an increase and decrease of model roughness (Manning's n) (+/-0,01) as well as increased rainfall intensity (10% and 20%).

The results are shown in Figure **5-11** and Figure **5-12**, as well as in Table **5-4** and Table **5-5**. An increase in rainfall intensity will not result in a linear increase in discharge values, the biggest difference is for rainfall events with lower return periods. A 20% increase in rainfall intensity for a 20-year return period will result in a 34 % increase in discharge at profile 5 (see Figure **5-11** and Table **5-4** for detailed results).

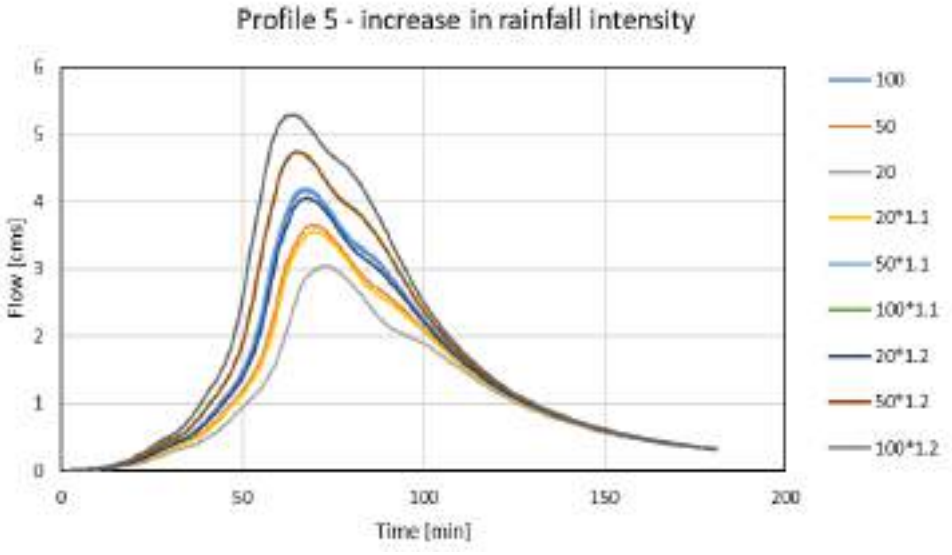

FIGURE 5-11 Sensitivity analysis for rainfall intensity

TABLE 5-4 Sensitivity analysis for rainfall intensity

		10% INCREASE			20% INCREASE		
Return period	**Q**	**Q**	**Diff**	**%-diff**	**Q**	**Diff**	**%-diff**
[years]	***[cms]***	***[cms]***	***[cms]***	***[%]***	***[cms]***	***[cms]***	***[%]***
100	4,2	4,7	0,6	14%	5,3	1,1	27%
50	3,7	4,2	0,5	15%	4,7	1,1	30%
20	3,0	3,6	0,5	17%	4,1	1,0	34%

A change in model roughness will lead to a change in model response time. A rougher model will give a lower maximum discharge, compared to a smoother model (see Figure **5-12** for details).

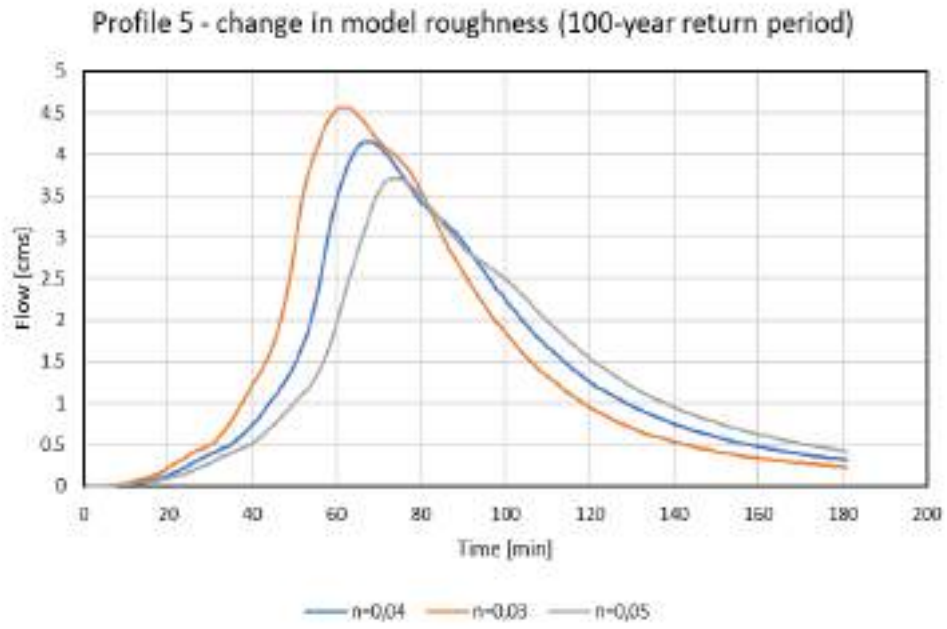

FIGURE 5-12 Sensitivity analysis for model roughness

TABLE 5-5 Sensitivity analysis for rainfall intensity

	Q	DIFF	%-DIFF
	[cms]	***[cms]***	***[%]***
n=0,04	4,16	-	-
n=0,03	4,57	0,41	10%
n=0,05	3,71	-0,44	-11%

5.4 Design of flood preventative measures

To prevent excessive flooding of the site, preventative mitigation measures can be carried out. One of these mitigation measures can be to channel water through the proposed project site, either by a closed pipe or a channel designed to accommodate the design flood. Because the flood water will flow from different directions/sources upstream of the proposed project site, a diversion of the water from these areas is necessary to ensure that the water will reach the desired inlet points. This diversion (channeling) can be designed by a more detailed GIS-analysis, where the upstream areas outside of the currently surveyed area are also surveyed and included in a new topographical analysis. This will improve the current DEM used for the analysis and give a more detailed indication of drainage lines outside of the proposed project site.

If the water is sufficiently channeled towards a common outlet point, a culvert inlet for example, the water can be led past the site. To indicate necessary culvert diameters, a simplified calculation is carried out with the design tool HY-8 7.6. The following assumptions have been made:

- The culverts have a length of 400 m
- The culverts have an incline of approximately 3%
- Downstream areas and hydraulic properties will not be affected by the culvert capacity
- Concrete culverts free of debris and sediments (n=0,012)
- The culvert does not have capacity to lead away design discharge when the headwater depth > inlet diameter

FIGURE 5-13 Culvert alternatives shown with yellow lines

Three different culvert alternatives have been examined, as illustrated in Figure **5-13**. Alternative 1 is leading all the water from profile 1 to the irrigation pond, alternative 2 is leading all the water from profile 2 to the irrigation pond, and alternative 3 is leading all the water from both profiles in a shared culvert to the irrigation pond.

TABLE 5-6 Culvert diameter (D) for the different alternatives and return periods

	20-YEARS		50-YEARS		100-YEARS	
Alt.	**Q**	**D**	**Q**	**D**	**Q**	**D**
	[cms]	***[m]***	***[cms]***	***[m]***	***[cms]***	***[m]***
1	1,48	1,1	1,71	1,2	1,90	1,2
2	1,22	1,0	1,44	1,1	1,62	1,2
3	2,70	1,4	3,15	1,5	3,52	1,6

The suggested culvert diameters are presented solely to give an indication of necessary dimensions. Further design of potential flood preventative measures should take into consideration in a more detailed analyses, which also includes potential effect of downstream conditions, final culvert lengths and inlet constructions (for example influence from grating/trash racks). Note that the suggested culvert diameters in Table **5-6** are only for the base condition, i.e., without considerations for potential climate change impacts on future runoffs by the proposed project site.

6 Uncertainty

6.1 Hydrological Data

There is considerable uncertainty related to the available hydrological data. There is limited information on the quality of the time series data at the gauging stations, e.g. associated with rating curves and gauge locations. Several of the time series have a considerable amount of missing data and some have relatively short time series which significantly reduces the foundation of the statistical analysis. The data series available mostly have end date around 1990. Therefore, changes in trends to the river flow after this period are not represented in this flood analysis.

6.2 Topographical Data and Terrain

The two global terrain models considered have a resolution of 30x30 m, which is a relatively coarse resolution to do topographical and hydraulic analyses for a small sized catchment like the proposed project site. The terrain and thus the basis for the geometry of the model will therefore not be able to represent smaller variations and depressions in the terrain which in reality will influence the flow direction and accumulated runoff at a location within the proposed project site. In addition, based on a comparison of the terrain model and satellite images, the terrain does not always clearly indicate the Dwangwa river channel. The river channel is likely to be more distinguishable than what the available DEMs indicate. Variations in the two considered global DEMs also reveal that there are quite large differences in the results from the surveys, meaning there is potentially a large degree of inaccuracy in one or both DEMs for the considered area. The topographical survey of the proposed site does not cover the terrain by Dwangwa River, and no additional survey has been carried out to confirm the terrain adjacent to the river.

The topographical survey carried out for the proposed site has higher precision and accuracy than what is available for the surrounding areas from the global DEMs, and the results from the topographical survey and the available global DEMs diverge. This is the case for elevations derived from both global DEM and the topographical survey. Effort has not been made to correct or alter the terrain model according to the more accurate data from the Topographical Survey for the flood analysis from the Dwangwa river. The calculated water levels from the hydraulic analysis are around 5 m lower than the project site when assessed against the DEM derived by satellite data. The difference is somewhat lower when compared to the elevations found in the topographical survey, which indicates a difference of around 2-3 m.

For the runoff analysis, where the underlying DEM used for the analyses is derived by combining the terrain from the topographical survey and the ALOS DEM described in chapter 5.1, some uncertainty can arise due to the modifications done to merge the two terrain models. This uncertainty is mainly linked to the absolute calculated water levels, and not necessarily to the actual flow patterns.

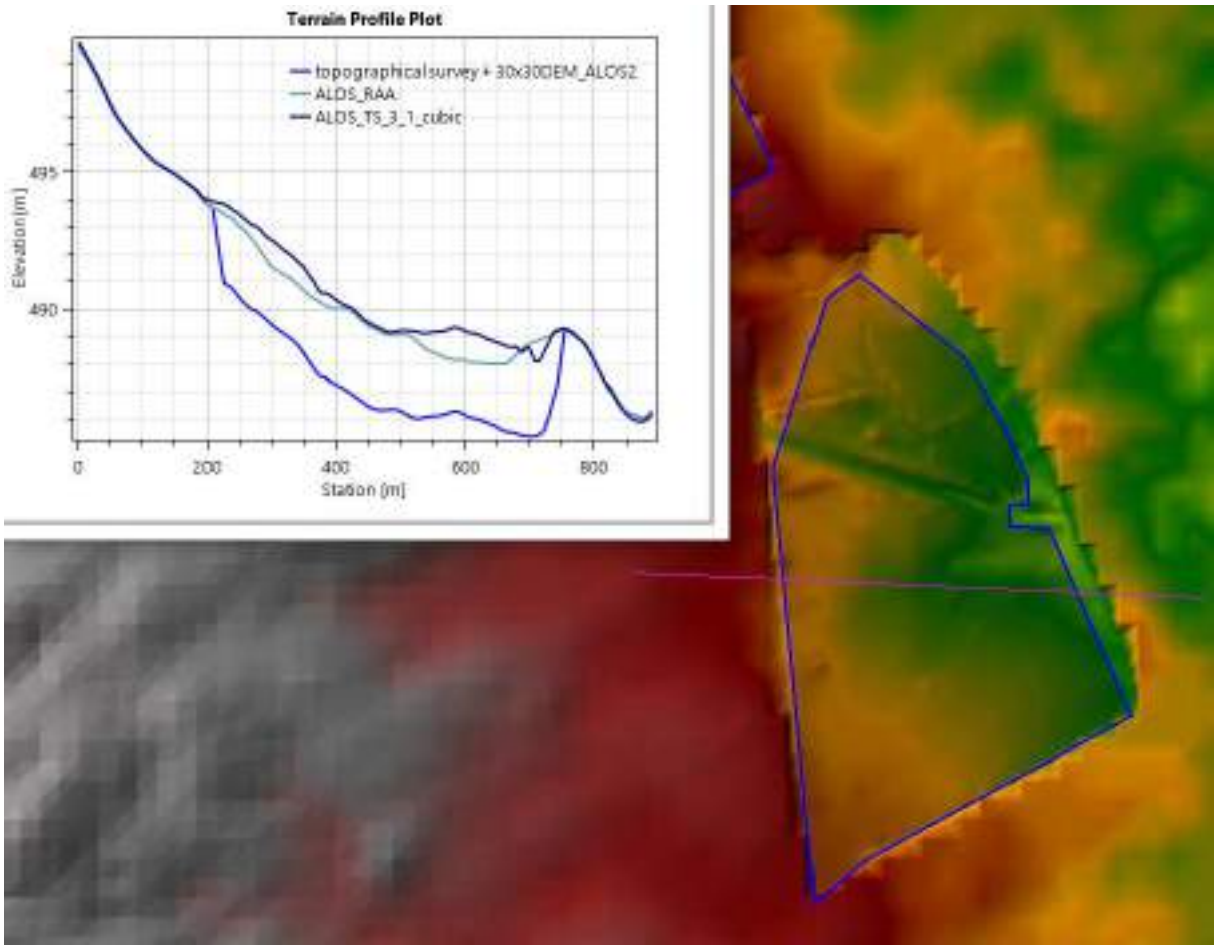

FIGURE 6-1 Difference between 30x30 DEM (ALOS_RAA) and the topographical survey data (topographical survey + 30x30DEM_ALSO2) before modification, and after modification (ALOS_TS_3_1_cubic)

The runoff and GIS calculations are also partly subjected to uncertainty due to the coarse DEM resolution outside of the proposed project site. Channels and other terrain geometries are not clearly defined in the DEM outside of the coverage of the topographical survey. This may cause the calculated flow paths to differ somewhat from the reality, and the final design of flood mitigation measures should take these uncertainties into consideration.

6.3 Infrastructure

Due to the coarse resolution terrain data and uncertainties related to this, infrastructure such as the Dwangwa Bridge has not been implemented in the model. In a flood situation, structure like bridges and culverts, will affect flood water levels. Just downstream of the Dwangwa bridge, a weir is placed, distributing water for agricultural purposes. This can potentially influence the flooding situation in the

area. However, it is expected that for floods with higher return periods, the weir will have less impact on the water level in comparison to the water flood volume in the area during large floods.

FIGURE 6-2: Weir downstream the Dwangwa Bridge

7 Conclusions and Recommendations

The proposed site for the Dwangwa Solar PV has two separate potential flood threats; the first concerns flooding from the Dwangwa River where flood from the river could potentially exceeds the river bank level and flows towards the proposed project site, and the second relates to the impact of local rainfall and runoff on the proposed project site and areas adjacent to the proposed sites.

A flood analysis has been carried out to assess the flood risk from the Dwangwa River on the proposed Dwangwa Solar PV project. Based on the statistical analysis from available data series, a 100-year flood of 1250 m^3/s (daily values) is estimated for the Dwangwa River by Dwangwa Village. There is no clear indication that rainfall and floods will increase or decrease in the future, therefore a climate add- on for future climate projections is not considered in the analyses. The modelling results show that the proposed Dwangwa Solar PV project site is not flood prone from the Dwangwa River for this return period.

There is a large degree of uncertainty related to the hydrological data and terrain/ topographical data. However, conservative assumptions have been used throughout the analyses and model sensitivity has also been carried out. None of the considered scenarios indicate a flooding threat from the Dwangwa River to the proposed project site. Based on the available data and the flood analysis carried, we do not recommend implementing flood mitigation measures to protect the proposed Dwangwa Polar SV site from flood threats from the Dwangwa river. However, since the underlying terrain for the analysis has large uncertainties, we recommend that Voltalia obtains a topographical survey of the terrain in areas adjacent to the Dwangwa river by the M5 Bridge to validate the analyses results and conclusions.

The local runoff analysis clearly shows that flood water will accumulate towards the proposed project site, mostly likely towards to the southern plot during local rainfall events. This can potentially cause local flooding problems for the planned Dwangwa Solar PV site, and potential flood protection measures should be considered. The northern plot is less prone to large floods but can potentially experience surface erosion in areas where flood water accumulates and in areas where the surface material is easily erodible during rainfall events.

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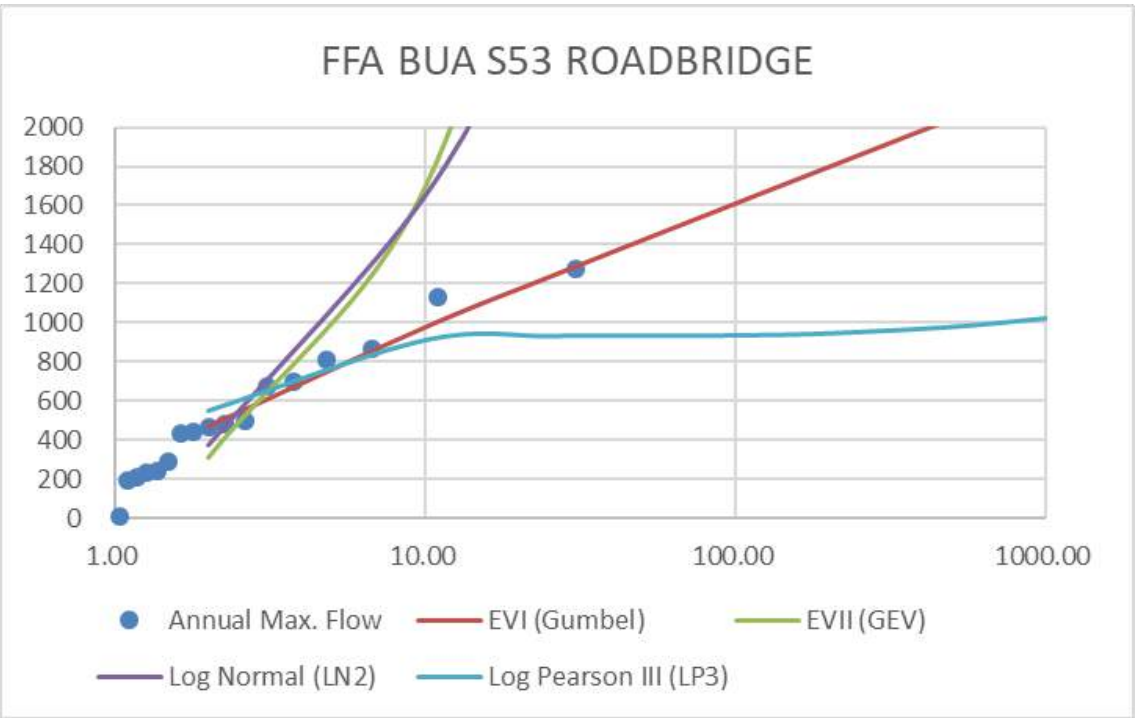
Appendix A. Results Flood Frequency Analysis

Bua - S53 Road bridge

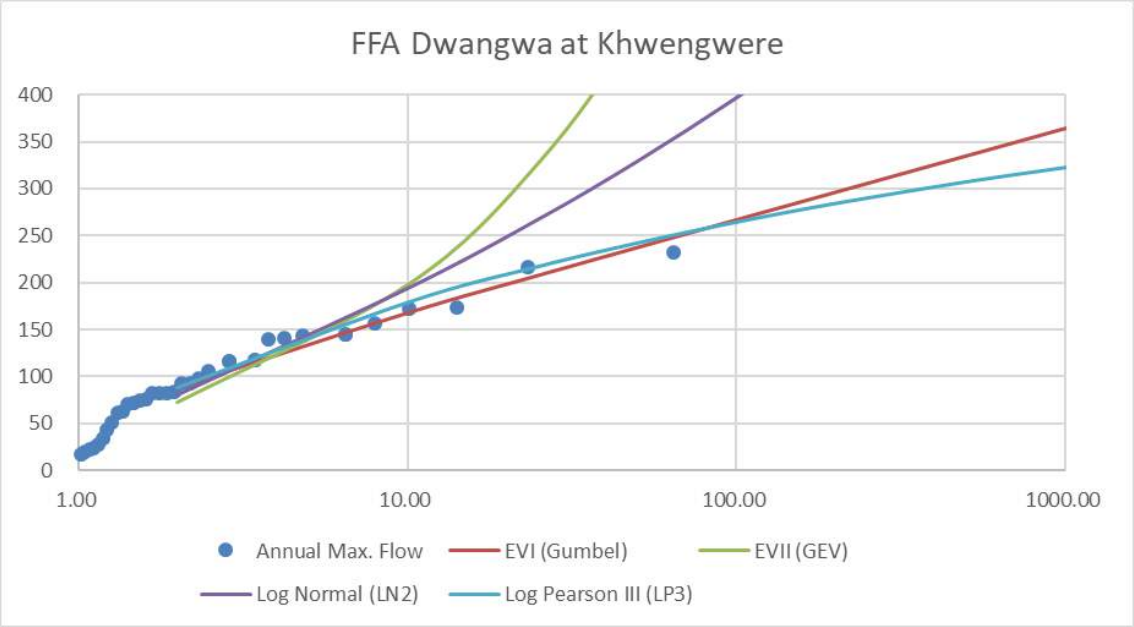


EVI (GUMBEL)

Return Period (ys)	Peak Flood m^3/s	QT/QM
QM	526	
2	469	0.89
10	976	1.86
25	1231	2.34
50	1421	2.70
100	1609	3.06
200	1796	3.42

	500	2043	3.89
	1000	2230	4.24
	10000	2850	5.42

Dwangwa at Khwengwere

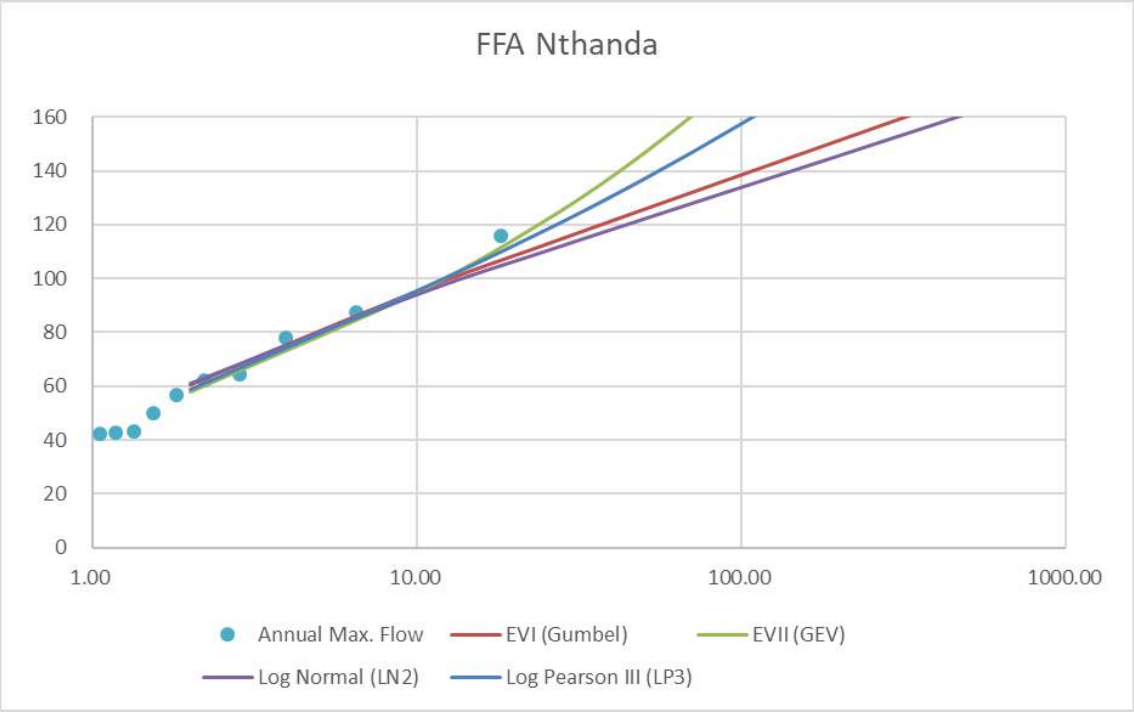


LOG PEARSON III (LP3)

T	Peak Flood	QT/QM
years	m^3/s	
QM	97	
2	88	0.91
10	179	1.84
25	217	2.23

50	242	2.49
100	264	2.71
200	284	2.92
500	307	3.15
1000	322	3.31
10000	362	3.72

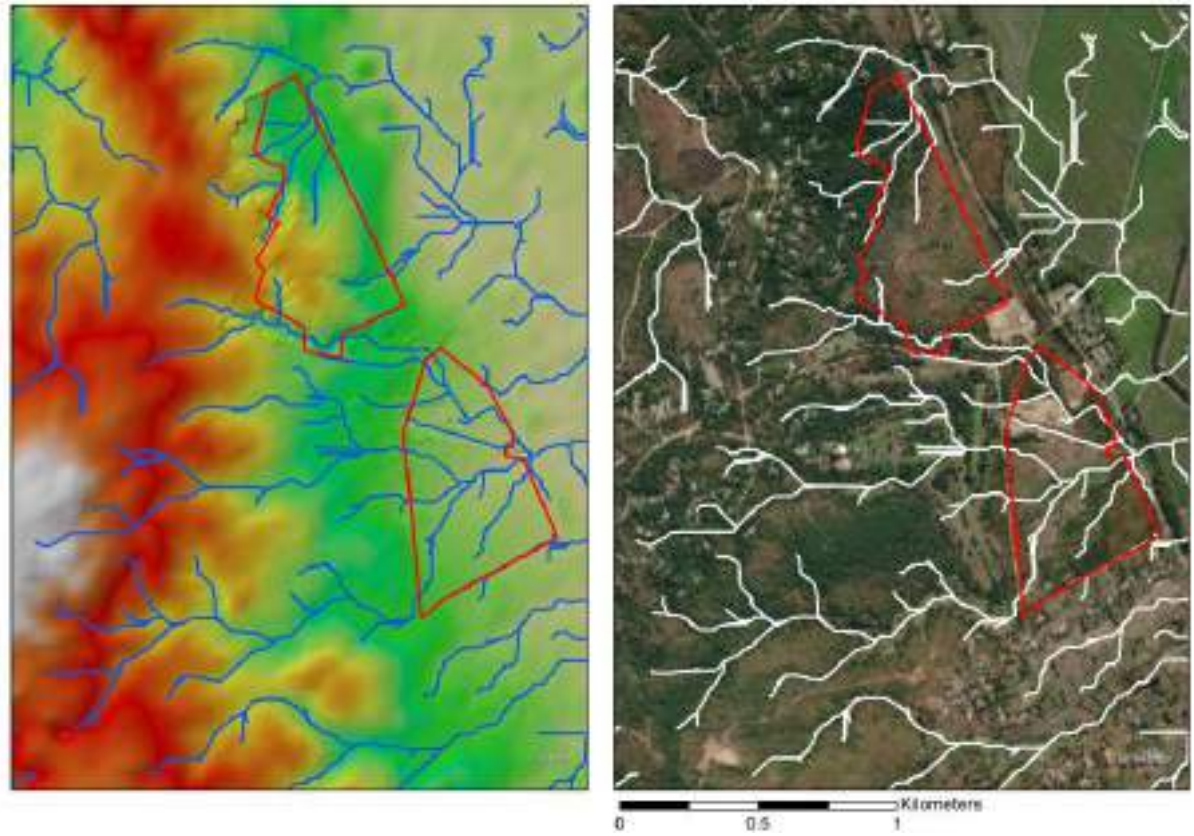
Nthanda

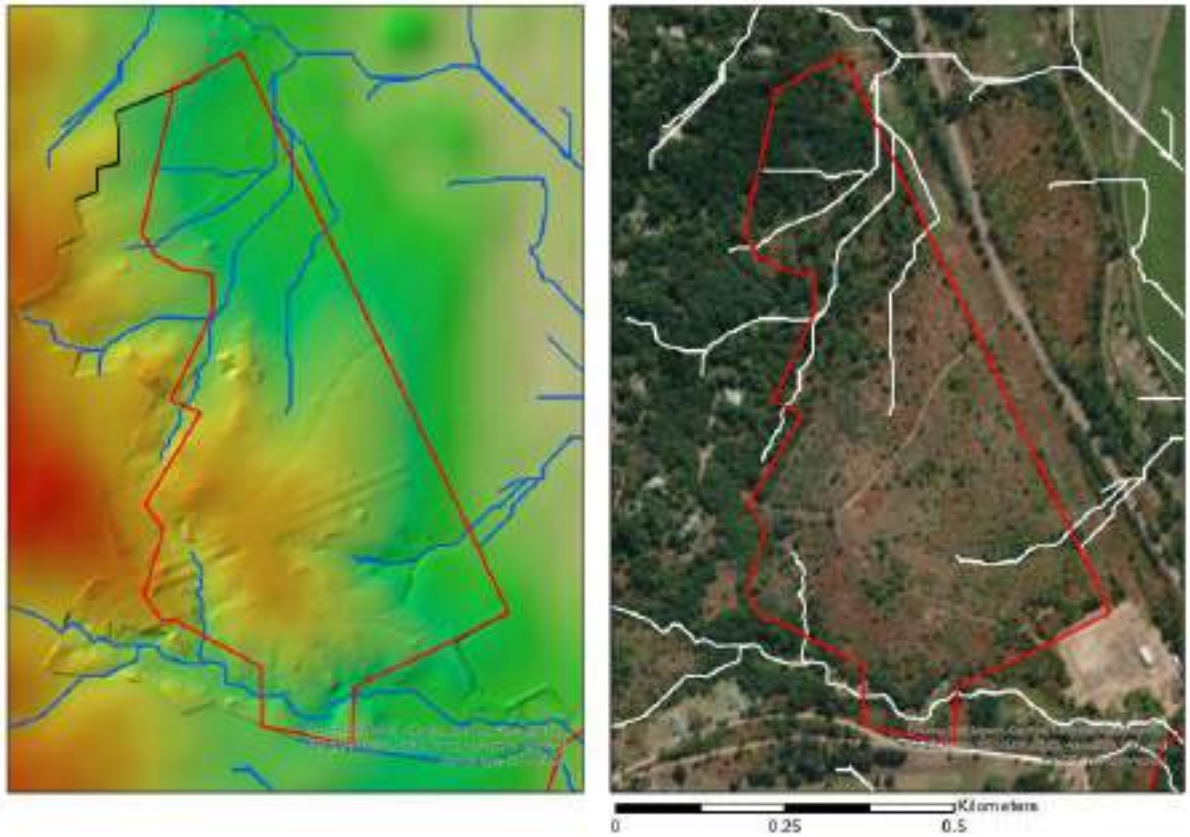


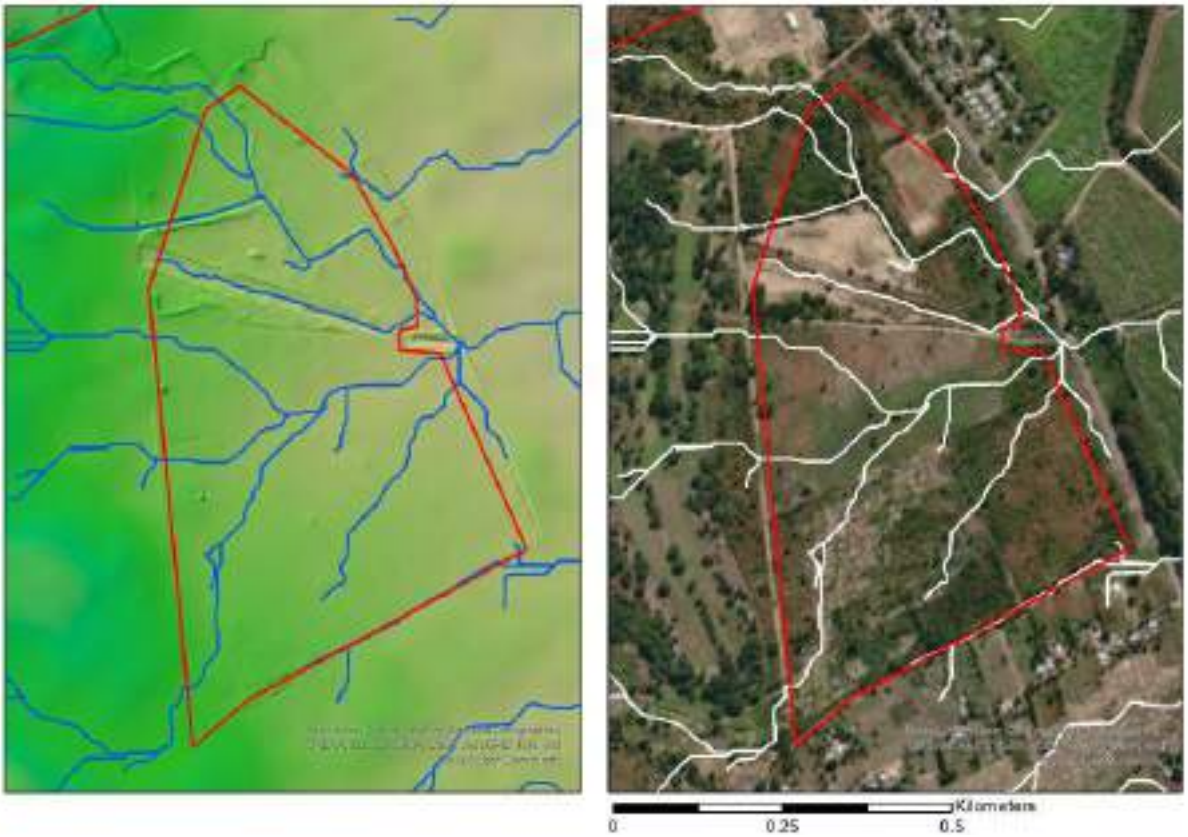
LOG PEARSON III (LP3)

T	Peak Flood	QT/QM
years	m^3/s	
QM	97	
2	88	0.91
10	179	1.84
25	217	2.23
50	242	2.49
100	264	2.71
200	284	2.92
500	307	3.15
1000	322	3.31
10000	362	3.72

Appendix B. Drainage lines




Kilometers
0
0.25
0.5


Kilometers
0
0.25
0.5

Appendix C. Rainfall intensity

	20-YEARS	50-YEARS	100-YEARS
minute	**mm**	**mm**	**mm**
0	-	-	-
1	0.1499	0.1703	0.1869
2	0.1499	0.1703	0.1869
3	0.1499	0.1703	0.1869
4	0.1499	0.1703	0.1869
5	0.1499	0.1703	0.1869
6	0.1499	0.1703	0.1869
7	0.1499	0.1703	0.1869
8	0.1499	0.1703	0.1869
9	0.1499	0.1703	0.1869
10	0.1499	0.1703	0.1869
11	0.1499	0.1703	0.1869
12	0.1499	0.1703	0.1869
13	0.1499	0.1703	0.1869
14	0.1499	0.1703	0.1869
15	0.1499	0.1703	0.1869
16	0.1499	0.1703	0.1869
17	0.1499	0.1703	0.1869
18	0.1499	0.1703	0.1869
19	0.1499	0.1703	0.1869
20	0.1499	0.1703	0.1869
21	0.1499	0.1703	0.1869
22	0.1499	0.1703	0.1869
23	0.1499	0.1703	0.1869
24	0.1499	0.1703	0.1869
25	0.1499	0.1703	0.1869
26	0.1499	0.1703	0.1869

27	0.1499	0.1703	0.1869
28	0.1499	0.1703	0.1869
29	0.1499	0.1703	0.1869
30	0.1499	0.1703	0.1869
31	0.1499	0.1703	0.1869
32	0.1499	0.1703	0.1869
33	0.1499	0.1703	0.1869
34	0.1499	0.1703	0.1869
35	0.1499	0.1703	0.1869
36	0.1499	0.1703	0.1869
37	0.1499	0.1703	0.1869
38	0.1499	0.1703	0.1869
39	0.1499	0.1703	0.1869
40	0.1499	0.1703	0.1869
41	0.1499	0.1703	0.1869
42	0.1499	0.1703	0.1869
43	0.1499	0.1703	0.1869
44	0.1499	0.1703	0.1869
45	0.1499	0.1703	0.1869
46	0.1672	0.1849	0.2016
47	0.1672	0.1849	0.2016
48	0.1672	0.1849	0.2016
49	0.1691	0.1865	0.2032
50	0.1691	0.1865	0.2032
51	0.1691	0.1865	0.2032
52	0.1700	0.1889	0.2055
53	0.1700	0.1889	0.2055
54	0.1700	0.1889	0.2055
55	0.1699	0.1892	0.2058
56	0.1699	0.1892	0.2058
57	0.1699	0.1892	0.2058
58	0.1731	0.1914	0.2080
59	0.1731	0.1914	0.2080

60	0.1731	0.1914	0.2080
61	0.17	0.19	0.21
62	0.17	0.19	0.21
63	0.17	0.19	0.21
64	0.17	0.19	0.21
65	0.17	0.19	0.21
66	0.17	0.19	0.21
67	0.17	0.19	0.21
68	0.17	0.19	0.21
69	0.17	0.19	0.21
70	0.17	0.19	0.20
71	0.17	0.19	0.20
72	0.17	0.19	0.20
73	0.17	0.18	0.20
74	0.17	0.18	0.20
75	0.17	0.18	0.20
76	0.15	0.17	0.19
77	0.15	0.17	0.19
78	0.15	0.17	0.19
79	0.15	0.17	0.19
80	0.15	0.17	0.19
81	0.15	0.17	0.19
82	0.15	0.17	0.19
83	0.15	0.17	0.19
84	0.15	0.17	0.19
85	0.15	0.17	0.19
86	0.15	0.17	0.19
87	0.15	0.17	0.19
88	0.15	0.17	0.19
89	0.15	0.17	0.19
90	0.15	0.17	0.19
91	0.15	0.17	0.19
92	0.15	0.17	0.19

93	0.15	0.17	0.19
94	0.15	0.17	0.19
95	0.15	0.17	0.19
96	0.15	0.17	0.19
97	0.15	0.17	0.19
98	0.15	0.17	0.19
99	0.15	0.17	0.19
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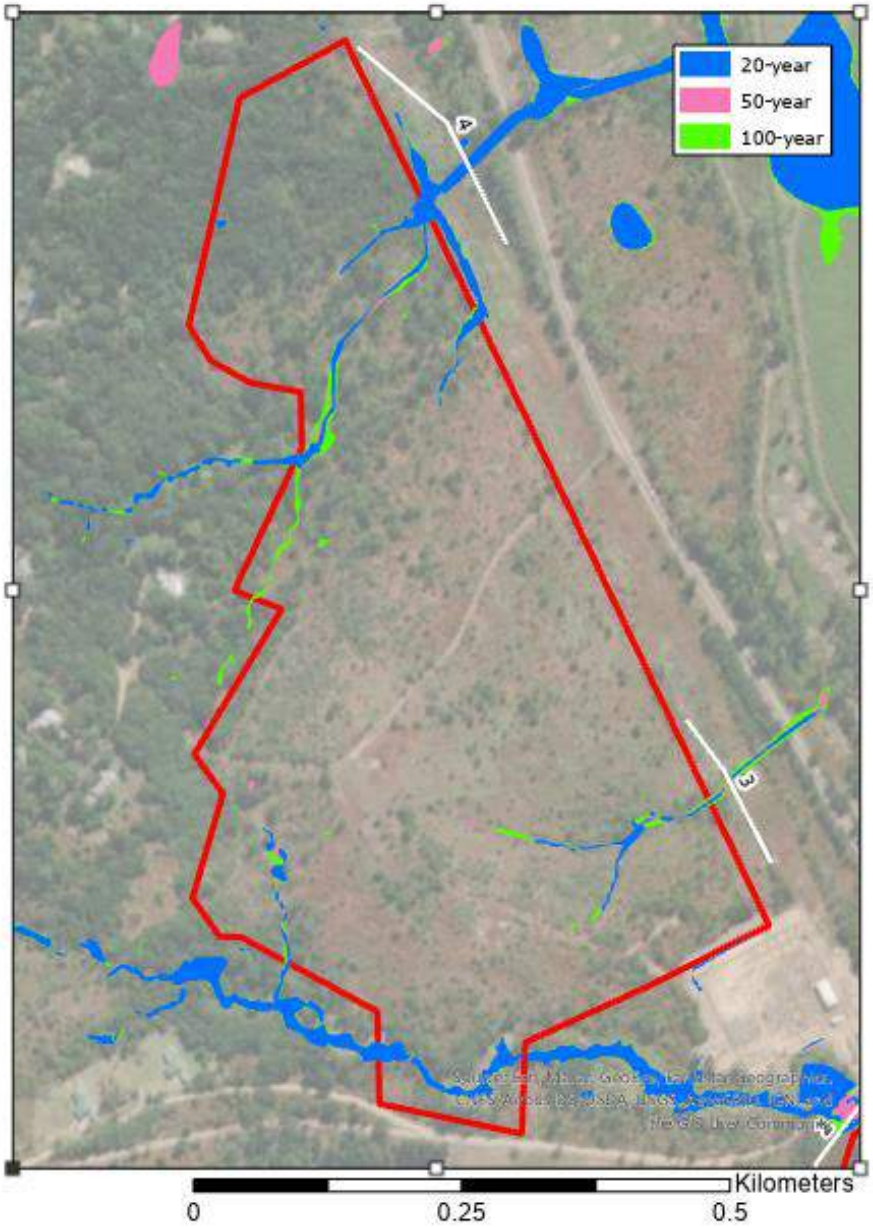
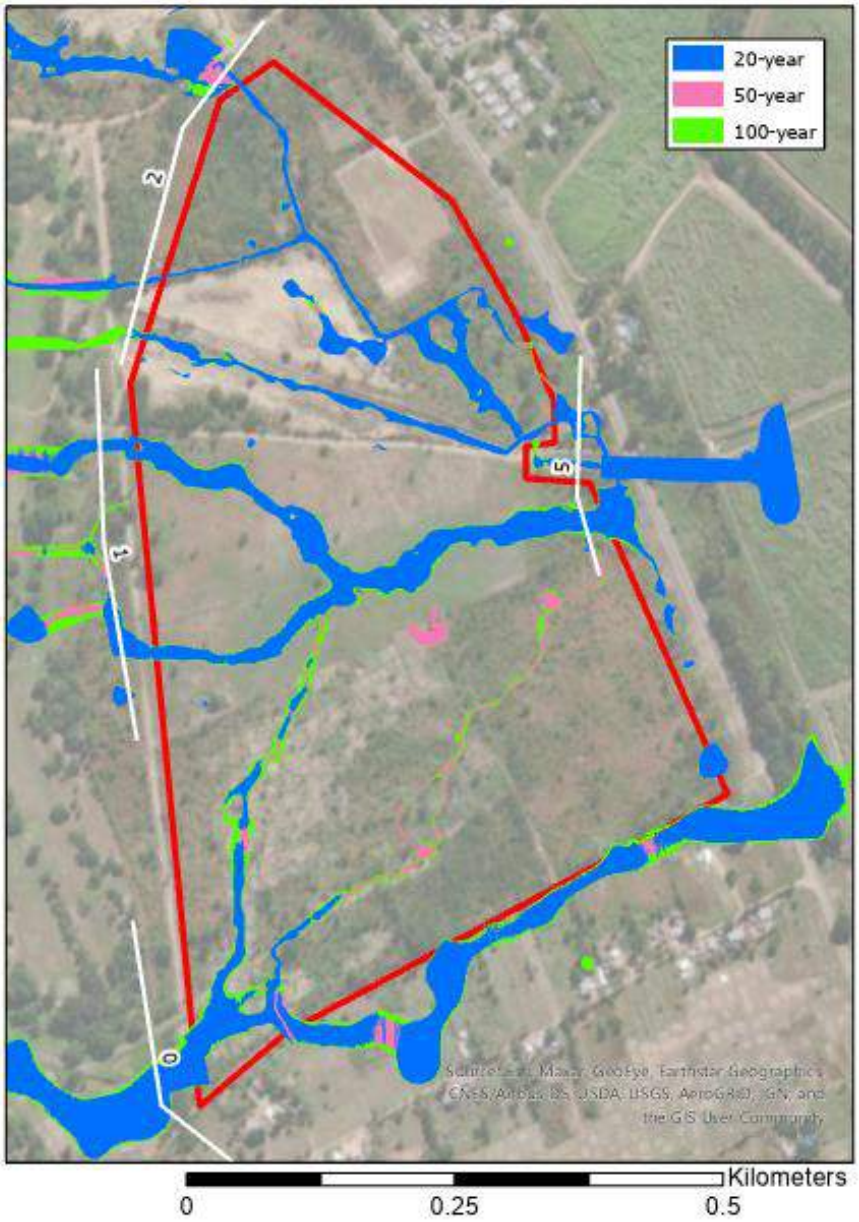
105	0.15	0.17	0.19
106	0.15	0.17	0.19
107	0.15	0.17	0.19
108	0.15	0.17	0.19
109	0.15	0.17	0.19
110	0.15	0.17	0.19
111	0.15	0.17	0.19
112	0.15	0.17	0.19
113	0.15	0.17	0.19
114	0.15	0.17	0.19
115	0.15	0.17	0.19
116	0.15	0.17	0.19
117	0.15	0.17	0.19
118	0.15	0.17	0.19
119	0.15	0.17	0.19
120	0.15	0.17	0.19

Appendix D. Runoff analysis, inundation maps

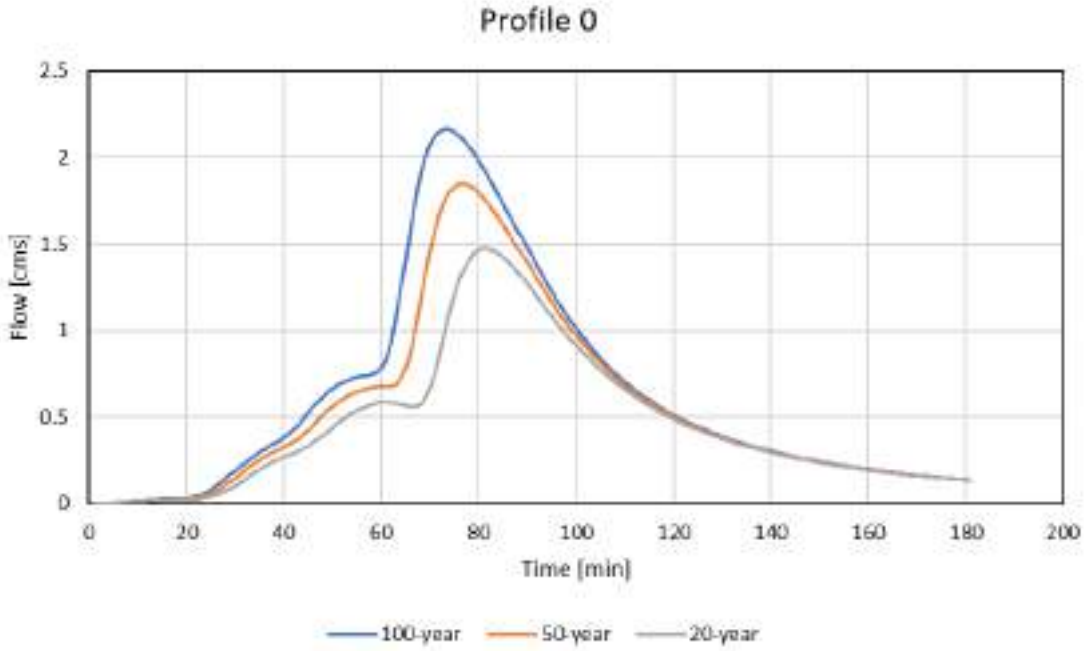
Northern plot

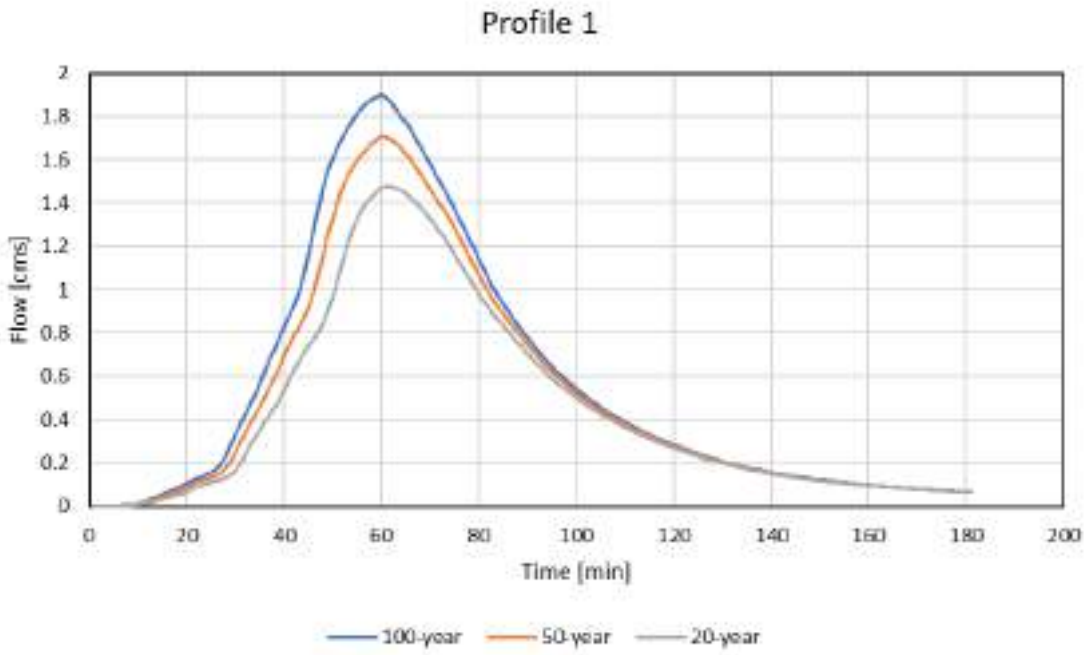


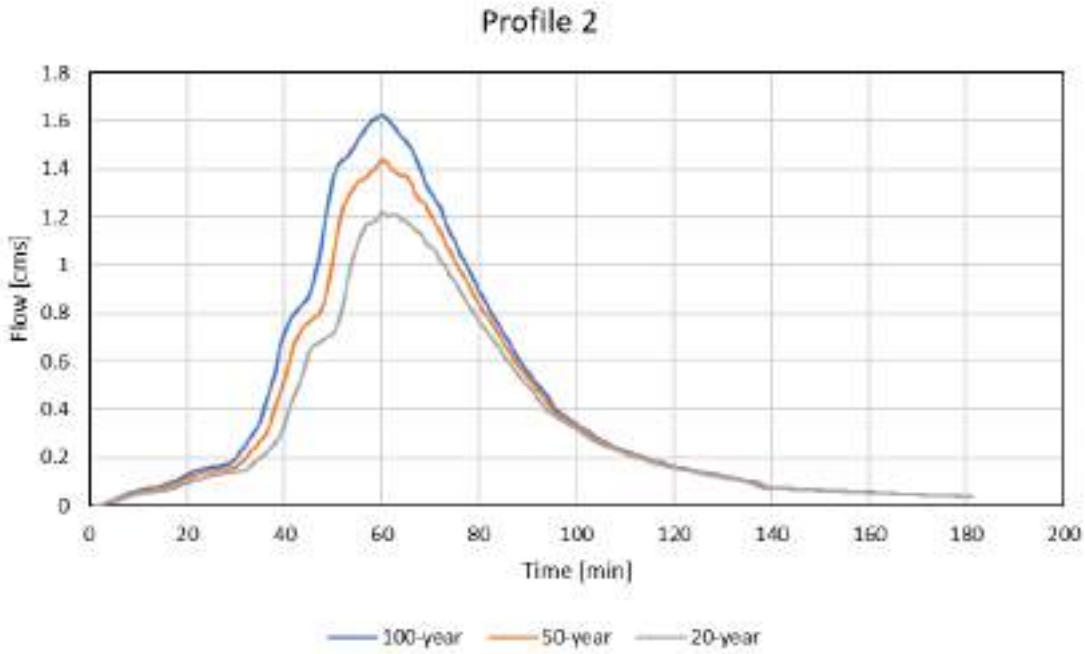
Southern plot

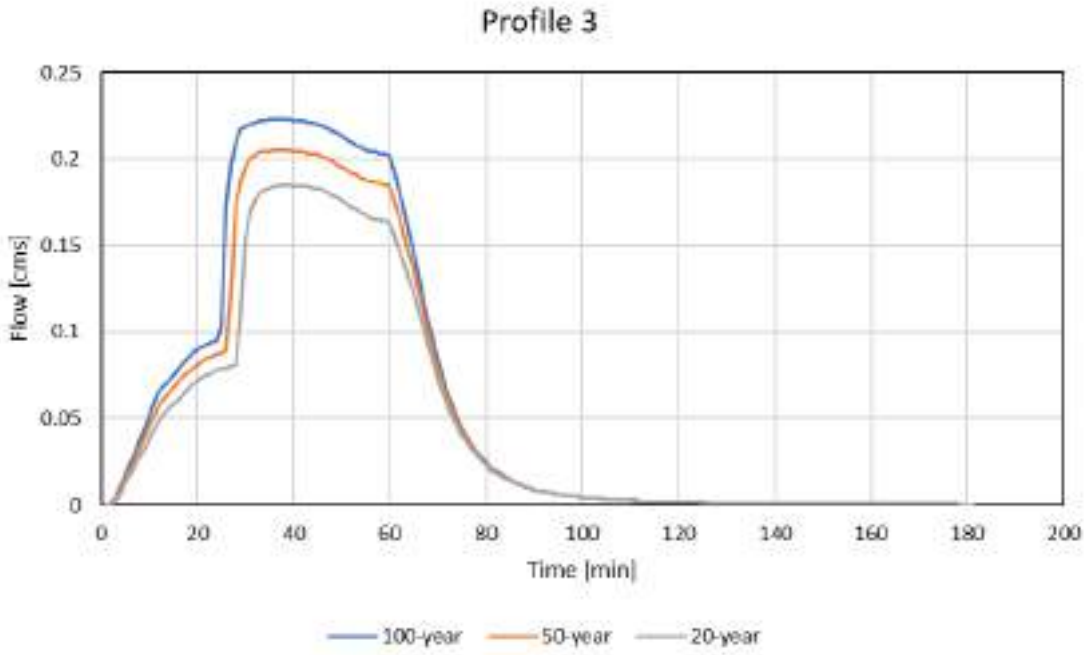


Appendix E. Flood values for profile 0-5






Profile 2
Flow [cms]
Time [min]
100-year
50-year
20-year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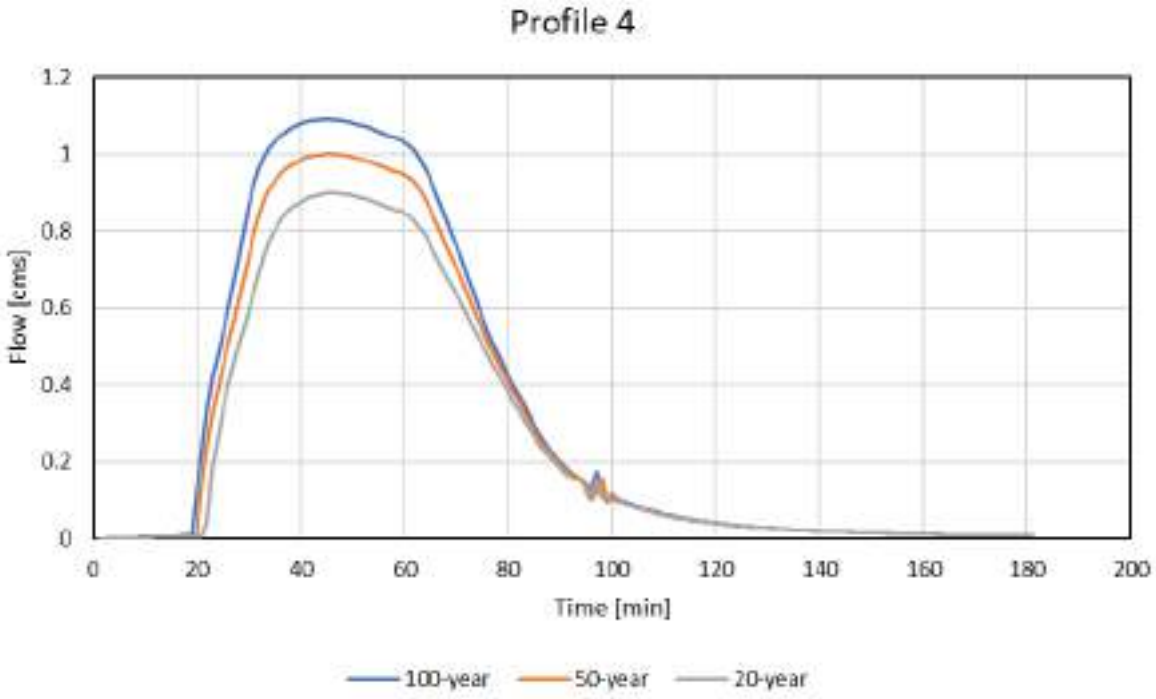
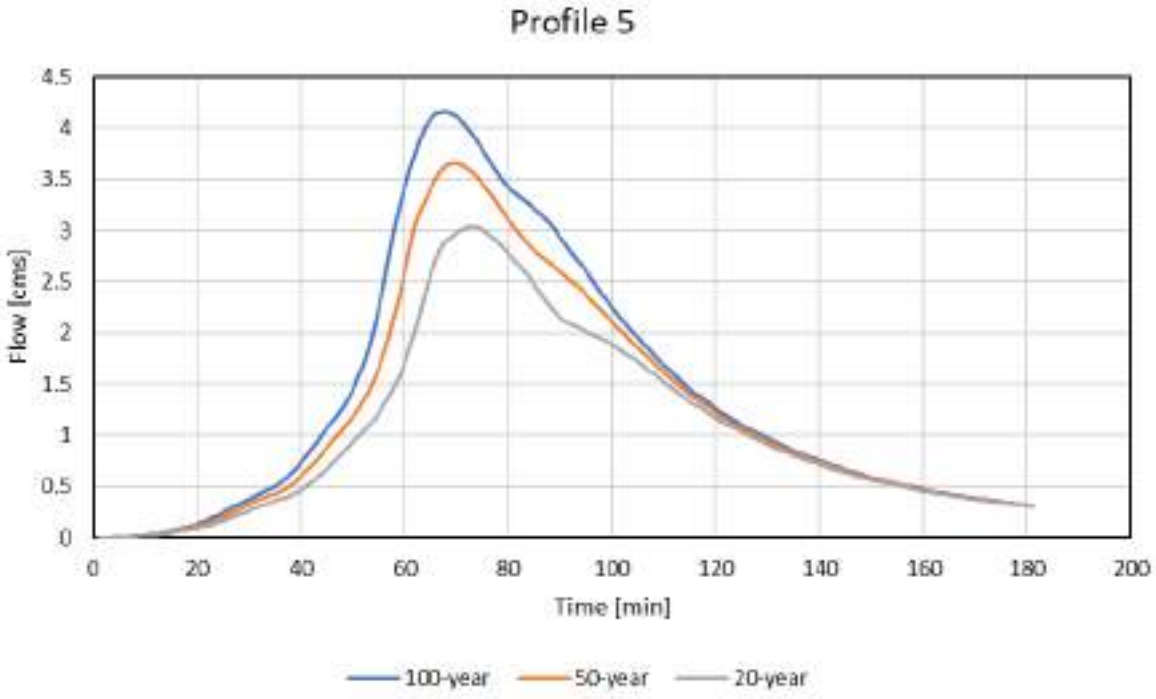
Flow [cms]
Time [min]
100-year
50-year
20-year


Profile 4
Flow [cms]
Time [min]
100-year
50-year
20-year


Profile 5
Flow [cms]
Time [min]
100-year
50-year
20-year

Voltalia-Dwangwa Solar Panel PV
Stakeholder Engagement Matrix – Updated
March 3, 2022

Stakeholder Category	Stakeholder Name	Connection to the Project	C12 Contact	Contact Details	Date of Consultation	Note/Comment
National Regulators	MEPA	GoM ESIA Regulatory Authority	Tiyamike Malinja – Environmental Inspector	0999346466	28 January 2022	Completed
Government	Ministry of Energy, Including the Alternative Energy Division (AED)	Responsible for national level energy policy, and renewable grid integration.	Saidi Banda Chief Director of Alt. Energy Division	saibanda@hotmail.com	10 February 2022	Completed
	Malawi Energy Regulatory Authority (MERA)	Energy Regulatory Body	**Wilfred Kasakula** – Senior Renewable Specialist **Wongani Mvula** – Senior legal officer	wkasakula@mera.mw wmvula@mera.mw	10 February 2022	Completed
	Department of Forestry and Natural Resources	Responsible for national forestry resource management.	**Patricia Masupayi** Assistant Director	0999667801	28 January 2022	Completed
	Department of Water Resources	Responsible for national water resource management.	Kanjaye Director of Department of Water Resources	-	-	This meeting was cancelled because the project will not involve extensive water abstraction

Voltalia-Dwangwa Solar Panel PV
Stakeholder Engagement Matrix – Updated
March 3, 2022

Stakeholder Category	Stakeholder Name	Connection to the Project	C12 Contact	Contact Details	Date of Consultation	Note/Comment
	Ministry of Lands	Responsible for compensation and land tenure management.	**Robins Lukasi** Acting Commissioner for Physical Planning **Ackford Mkundira** Principal Physical Planner Officer	0999662722	24/02/2022	Completed
	Ministry of Agriculture, Irrigation, and Water	Responsible for agricultural production and management.	**Gertrude Kambauwa** Director of Dept of Land Resources Conservation	gkambauwa@gmail.com	14 February 2022 at 10:30	Completed
	Department of Museums and Monuments	Responsible for monitoring cultural heritage conservation.	**Dr Oris Malinjani** Principal Geo-Archaeologist	0886389777	10 February 2022	Completed
	Department of National Parks and Wildlife	Responsible for monitoring wildlife, and the nearby Nkhotakota Reserve	**William Mgoola** Deputy director of national parks **Davis Kalima** Deputy Director **Andrew Kataya** Planning officer **Catherine Chunga** Senior Parks and Wildlife officer	0999915411	28 February 2022	Completed
	Ministry of Gender, Children,	Responsible for monitoring social welfare, and vulnerable groups.	Ronald Phiri Director of Dept. Gender Affairs	0999233599	28 February 2022	Completed

Voltalia-Dwangwa Solar Panel PV
Stakeholder Engagement Matrix – Updated
March 3, 2022

Stakeholder Category	Stakeholder Name	Connection to the Project	C12 Contact	Contact Details	Date of Consultation	Note/Comment
	Disability, and Social Welfare					
District Level Government	Nkhotakota District Council, District Commissioner (DC)	Head of Nkhotakota district	Edward Harold	0999278385	8 February 2022	Completed
	District Environmental Sub-Committee (DESC)	Responsible for managing environmental decision making in the district.	Alick Munthali	0995432959	26 January 2022	Completed
	Nkhotakota Regional Lands Office	Responsible for land rights in the district, and will be involved in assessing property values if compensation is required.	Jong Malikula	0999378961	26 January 2022	Completed
	Nkhotakota Regional Forestry Office	Responsible for managing forest resources, and clearance permits in the district.	George Zibophe	0999609739	26 January 2022	Completed
	Nkhotakota District Environmental Officer	Responsible for managing district level environmental compliance.	Jane Kayira	0888742690	26 January 2022	Completed
	Nkhotakota District Labour Office	Responsible for labour disputes and data collection in the district.	Charity Mwambira	0993831542	26 January 2022	Completed
	Nkhotakota District Medical Officer	Key source of district level data and understanding on health.	Dr Wezi Mumba	0996254645	26 January 2022	Completed
Community Level	Representing the Traditional	Traditional leadership for the project area	T/A Kanyenda: Edward	0888379538	9 February 2022	Completed

Voltalia-Dwangwa Solar Panel PV
Stakeholder Engagement Matrix – Updated
March 3, 2022

Stakeholder Category	Stakeholder Name	Connection to the Project	C12 Contact	Contact Details	Date of Consultation	Note/Comment
	Authority (TA), Senior Group Village heads (SGVH), Group Village Heads (GVH), and Village Heads (VH).	Communities are: Kasasa; Majiga; Mowe; DCGL Village..	Takwondwa Harlod			
			SGVH Nkhongo: Monica Kamdambo	0994975108	25 January 2022	Completed
	Community members affected by the project.	Local community members impacted by the project or who have useful insight into proposed activities.	Taza Biza	0999277401	26 January 2022 (AM)	Completed
NGO	African Parks (Nkhotakota Wildlife Reserve)	International conservation non-profit with local engagement.	-	-	-	Information retrieved from meeting with Department of National Parks and Wildlife
	WESM	Coordinating Wildlife, Environmental activities in Nkhotakota	Rashid	0999324743	-	Postponed to an in person meeting as contact expressed being busy for a phone call.
	Foundation for Community and Capacity Development (FOCCAD)	Malawian NGO engaged with health and inclusiveness issues, based in Nkhotakota.	Dan Nthara	dan.nthara@foccad.org	-	Postponed to an in person meeting as contact expressed being

Voltalia-Dwangwa Solar Panel PV
Stakeholder Engagement Matrix – Updated
March 3, 2022

Stakeholder Category	Stakeholder Name	Connection to the Project	C12 Contact	Contact Details	Date of Consultation	Note/Comment
						busy for a phone call.
Civil Society Groups	Civil Society Organizations	Groups who may be impacted by the project or could benefit from mitigation/enhancement measures.	Mavuto Jowabu, chair and secretary of Nkhotakota CSO	mavutojowabu@gmail.com	25th Jan. 2022	Completed
Commerce and Industry	Energy Generation Company Malawi (EGENCO)	Company formed when ESCOM was unbundled responsible for the generation of the majority of Malawi's electricity.	Lawrence Chilimampunga	0888879555		Information retrieved from meeting with ESCOM
	Electricity Supply Corporation of Malawi (ESCOM)	Responsible for the national transmission and distribution of electricity in Malawi.	Evilasio Mwale	emwale@escom.mw	28 Feb. 2022	Completed
	Electricity Supply Corporation of Malawi (ESCOM) SUBSTATION	Responsible for the national transmission and distribution of electricity in Malawi.	Getrude Malulu	0888838231	26 January 2022	Completed
	Illovo	Local business	Jeromy Ngolombe – farm manager	0888897077	27 January 2022	Completed
	Kasasa Sports Club	Local business	Justin Zinkambani	0888959222	27 January 2022	Completed
	Ethonal Company Limited	Local business	Dickson Chakala	dicksonchakala@gmail.com	27 January 2022	Completed
	Dwangwa Cane Growers	Local business	Felix Lungu – agricultural	flungu@dcgl.mw	27 January 2022	Completed

Voltalia-Dwangwa Solar Panel PV
Stakeholder Engagement Matrix – Updated
March 3, 2022

Stakeholder Category	Stakeholder Name	Connection to the Project	C12 Contact	Contact Details	Date of Consultation	Note/Comment
	Limited		manager			
	Nkhungu Essential Services	Local business	Harvey Mphatso HR Admin Manager	harveymphatso@gmail.com	27 January 2022	Completed

Issues and Responses Trail (IRT)

The Issues and Response Trail (IRT) includes comments collected for the duration of the project.

The columns in the table provide a response from the ESIA team (and Proponent) to those raised during the stakeholder engagement process. As additional information has been made available during the EIR the comment has been updated / added to where necessary in a second column. This is to facilitate the understanding of how the stakeholders comments were addressed throughout the process.

Table 1 Comments received during the Scoping Phase

STAKEHOLDER DETAILS	COMMENT	RESPONSE
NATIONAL AND DISTRICT LEVEL		
Malawi Environmental Protection Agency (MEPA)	How many people do you intend to employ?	We tend to employ 3 Voltalia experts, and the rest will be Malawian contractors, and Dwangwa residents for unskilled labour
	You should consider employing locals to avoid the spread of STDs. When it comes to the abstraction of water, I would also use water near local communities to avoid conflicts, either you use boreholes or you can buy water from Illovo.	Noted
	You should also consider issues around waste management. Consider the disposal of waste produced, assuming the waste construction phase will be from daily workers and guards.	Noted
	So we do not anticipate any chemical waste since the batteries being used are not toxic. However, any other waste we do produce we will recycle here in Lilongwe. The batteries will be replaced every couple of years, and we will not leave them at the facility. The panels are not going to be changed. PV Cycle organization will manage the recycling of the materials	Just remember you need a license to store hazardous waste should you end up with hazardous waste. As well as regulatory licenses
	I also suggest when you cut down trees to engage with the local communities on programs to replant them.	
District Council Officers (DESC)	Where will employees dispose of their waste?	Subcontractors will be contracted, a large percentage of them will come from Malawi. These employees will be lodged with houses near and around the site. People will not leave/sleep inside the sites. Meals - a canteen will be available for the employers of local restaurants are not available. Therefore, we expect there will not be an issue with human waste on the site
	In past experiences, we have seen it necessary to have a tanker to deposit the human waste. Have you considered this?	Voltalia will provide toilets on site

STAKEHOLDER DETAILS	COMMENT	RESPONSE
	This is important to consider because Nkhotakota does not have a solid waste management system or plan.	
	I suggest Voltalia brings mobile toilets and/or tanks.	
	In the rural setting, employees can expose local communities especially girls to harassment, abuse, and similar issues. What is Votalia's plan to mitigate such issues?	Voltalia is going to include an Environmental Management Plan. We are planning to raise awareness on issues like STDs, pregnancies, gender-based violence, and there will also be a need for an induction process for the contractors on site.
		This will also be incorporated into a grievance mechanism
	Do you intend to abstract water for the project?	Water abstraction is going to be minimal. Voltalia might bring a borehole or buy water tanks from Lilongwe. Overall, we expect that the amounts of water will be minimal even during the construction phase of the project.
		We also want to explore buying water from Illovo
	We suggest you look through the National Water Resources Authority. There are regulations when it comes to water abstraction even if it is minimal.	Noted
	How does Voltalia expect to incorporate gender based violence into the grievance mechanism?	We are also open to suggest on what measures you have found to be effective in the past.
	I would suggest having a community victim support unit. This often includes people within the community people know and are comfortable to share their grievances with. I suggest such a unit should be incorporated into the mechanism.	Noted
	Voltalia should be aware that the minimum wage for employees is 1923.00 MWK for unskilled workers per day. All employees are expected to wear PPEs that Voltalia should also provide. Furthermore, an average working day is eight hours long.	Voltalia will ensure that their employees and contractors oblige to its values and social responsibility.
	Waste deposits should also be placed on appropriate dump sites. The EMP should include Voltalia's plan to dispose of waste for the next 25 years that they will be running it.	Voltalia understands your concern. We aim to recycle our waste in Lilongwe.
	You should also categorize your waste for better management and disposal of it. A landfill is available in Nkhotakota but it is temporary. Voltalia needs to agree with Illovo on the waste management. We would also like to have access to Voltalia's waste management plan once it is written	Noted
	Dwangwa is facing land pressure issues of encroachment. Mass lands are idle right now. How does Voltalia plan to approach issues of encroachment on the land?	Voltalia will lease all of the land, approximately 120 ha, and will only use 60 ha. The remaining 40 ha will be discussed with Illovo on how best to use or manage the land.

STAKEHOLDER DETAILS	COMMENT	RESPONSE
	You need to think of ways to utilize the idle land to avoid illegal use and to also protect the flora, fauna or biodiversity that is there	
	What do you think is the best mechanism to educate local residents about habitats around the site?	The best way is to incorporate a joint management plan of managing the particular area. Land demarcations also need to be understood.
	I would also suggest coming up with a restoration program for all the trees you might potentially cut down. Illovo planted trees to make use as fuel. We have seen them be very involved in the management of plans especially with communities.	Noted
	A reminder that the grave pits have to be reinstated. Voltalia needs to rehabilitate the area to avoid breeding mosquitoes	Voltalia is not flattening the land. We will follow the existing terrain so we don't anticipate a pit to be an issue.
	We (as a district) need to be included in future site meetings. The district commissioner office should be sending monthly reports during the construction phase, including hosting monthly meetings. We would like to see site managers of the project working closely with the DC office on the ground.	Noted
	What corporate social responsibility has Voltalia undertaken?	Voltatia has implemented social responsibility worldwide. In Malawi alone, it is implementing Mangochi Orphanage Training School. Our social responsibility is based on the needs of the community. In such a case, there is potential for a project, but this will depend on the needs of Dwangwa residents. We will consult once more before deciding on what project to do.
Department of National Parks and Wildlife	We want to find out the boundary of the forest reserve in relation to the project.	Boundaries of the forest reserve are best obtained through African Parks.
	So we are also concerned about soil erosion and run off. Will that be an impact on the project?	The project will manage the storm water runoff, but Voltalia also plans to present specifics of the plans during the draft phase as well.
	Be cognizant of the fact that these are often migratory routes for birds. The lakeshore is a migratory route, and the birds are crossing to reach the Shire river during this time. Therefore, make sure the infrastructure does not interfere with the migratory route. Malawi is signatory to the Convention of Migratory Species of Wildlife and African Eurasian Water bill agreement, both of which obligate Malawi to protect bird species.	Noted

STAKEHOLDER DETAILS	COMMENT	RESPONSE
	The damage of Miombo woodlands is resting place for species. It is important to remember that Malawi is also signatory to the Convention of Wetlands of International Importance. Malawi's key species are listed and identified. It is important for Voltalia to crosscheck which of these species might be found in the site.	Voltalia is planning to take steps toward minimizing the impact on vegetation. We are in the process of developing an Environmental Management Plan, and we recognise that the contractors need to be thoroughly briefed.
	Contractors should also stick to the proposed measures. Do not cut trees for the sake of clearing the area. We believe a rehabilitation approach is necessary where clearing is not just for the sake of clearing.	Noted
	Is the proponent thinking of extending the hectares of land?	It is indefinite at the moment. However, it is highly likely that the proponent will not extend the ha of land because what is remaining is not conducive to installing a panel.
	I suggest Voltalia also includes extension and education campaigns of the project within the communities.	
Department of Gender Affairs	What are the management strategies to mitigate the impacts?	We will include the need for an inductive process to train contractors on preventing the harassment, abuse of young children and women for example
	The grievance mechanism should include the following areas `) community needs, district committee, contact person for gender abuse and child protection officer, awareness plan of HIV and COVID-19, as well as a plan to target local leaders to raise awareness of GBV, sexual exploitation, child marriage, and early pregnancies.	We are planning to raise awareness through community meetings, but also through information materials in chichewa that we can physically hand out to the community members.
	Yes, that is a good idea. In communities, there are often what we call mother groups. These are groups that focus not only on preventative but also methods on how to tackle these issues for both men and women.	Noted
	I also suggest contractors be equipped with condoms to teach them responsibility.	Noted
	Will there be issues of resettlement and compensation?	We are noticing some cultivated lands, so we anticipate that we might draw up an economic displacement plan
	I also suggest you include a community development structure to help with household resource management should compensation be part of the overall plan. This is to ensure that they do not squander the money, but rather put it to good use.	Noted

STAKEHOLDER DETAILS	COMMENT	RESPONSE
	Phiri: Voltalia needs to invest in child protection, including safeguards methods to avoid sexual abuse of women and other vulnerable groups. Safeguards can include the Mother Groups I mentioned earlier.	
	Mother groups work to sensitize families against child labour. Build experts and role models to raise awareness. Voltalia can lobby a meeting as the project is starting and talk to parents on the rights of a child and how to prevent exploitation.	Noted
Mavuto Jowabu – secretary of CSO Nkhotakota	Does Voltalia have a social responsibility plan they will implement in Dwangwa?	There is such a plan, and Voltalia operations are held accountable to high standards for social responsibility. A percentage of operation costs are dedicated to social responsibility through community projects in energy.
	Are there seasonal workers in Dwangwa?	There are seasonal workers in Dwangwa. There are commercial activities near the center of Dwangwa such as stalls, grocery stores, pubs and bars, restaurants, which also invite a number of buyers
	Environmental issues be included when Voltalia starts to implement projects under their social responsibility plan	Noted
	Communities rely on the farms for subsistence farming to grow cassava, rice, and sweet potatoes.	Noted
	Advises against extending the project in the southern region as there are more subsistence farmers.	Noted
	Meeting with district council officers, interest groups representing vulnerable groups like women, persons who have disabilities, young children etc…	Noted
Department of Museums and Monuments	I commend this project. While it may not have a lot of social impacts, it may also have archeological impacts especially with the community.	Noted
	What was the land use type before illovo owned it?	We should be able to identify whether it's an old burial ground, settlement sites or settlement history, before illovo ownership during the colonial period just to verify the land use type.
		I suggest a rapid assessment around the area
	Considering it is a solar panel, will it not affect the shade of the trees?	No, the panel are at the height of the trees, and also the panels will not be close to the trees.
	Do you have coordinates of the site, as well as some buildings?	We will share the XML shape files
	What is the distance between substation and the hectares?	They are right next to each other.

STAKEHOLDER DETAILS	COMMENT	RESPONSE
Malawi Energy Regulatory Authority	We had a social expert go up in the site in January, she identified the area between the golf course and the northern portion, as an important site to consider in terms of potential impact. However, there is relatively low impact on the community because there are no houses on the site.	MERA is most concerned with How the facility affects the grid and the community. This is why I was interested from the immediate community boundary to the plant site, what are some of the impacts expected.
	More than welcome to harvest the crops on the areas already there, but people cannot plant anything else once the project starts tentatively in October	
	C12 wants to do an access survey to see how many people use the road between the substation and the plant site.	
	Are there any risks of flooding?	Dam only goes across the southern part, but a biodiversity assessment has been conducted to find that there are no risks of flooding. While it does get a bit muddy, there are no risks of flooding. From that assessment, we found no signs of life.
	Does it have battery storage? What is the capacity?	We are not sure. We will ask the proponent and get back to you.
	Of the impacts you have identified, what are some of the mitigation factors you have considered? For example, the spread of disease?	We are considering this as part of the ESIA process, we are also looking to reduce the negative. We are hoping to have the report done in two months, so we can share the report with you via e-mail.
	From your professional expertise, is there anything critical that comes from the site?	This is one of the least impact sites I have seen. The key thing is because it is owned by Illovo, and previously it was used as agricultural purpose before Illovo. In our assessments, we have identified sensitive sites that Voltalia aims to leave alone, and not disturb during construction phase. We anticipate the football field and the cultivation lands will be the most impacted.
	We haven't assessed cultural heritage yet, but we are planning to carry out a cultural heritage study in this month.	
	Considering it is a solar panel, will it not affect the shade of the trees?	No, the panel are at the height of the trees, and also the panels will not be close to the trees. There are some blue gum trees, but there is an agreement with illovo that Voltalia will not be touching the trees especially those next to the manager's houses. The design of the solar panel will have a seasonal movement of panels, but there will be a distance between the trees and the panel.
	What model of solar panel might they be using?	Voltalia has not decided on the final design, but we can get back to you
	Is Voltalia building another pitch from the existing one?	The existing one is within the site, so it may be moved.
	There should be a clear understanding between the chiefs and facility owners who owns the pitch once it is developed.	Noted

STAKEHOLDER DETAILS	COMMENT	RESPONSE
Ministry of Energy (Alternative Energy Division)	Use of water within the project	Clarified that it is within the illovo estate
	Disposal of the batteries in the site area. Would like to see the issue of disposal in the ESIA	Voltalia will be recycling using Pv Cycle
	REIAMA is missing on the stakeholder list, but they are key when it comes to the ESIA	Noted
	Security bodies need to be consulted since these kind of projects attract security issues	Noted
	What are the considering for CSR?	Voltalia wants to compliment with illovo
	Would recommend considering CSR activities that increase electricity within the communities.	Noted
	Need to consider regulatory policies/guidelines and facilities around management and disposal of hazardous waste.	Noted
Ministry of Agriculture (Department of Land Resource Conservation)	Your ESIA should address how you intend to mitigate gender based violence	Noted
	Our department is often concerned with soil erosions, specifically the level of damage.	During the construction phase, the top layer will be disturbed. So we do anticipate temporary land degradation
	ESIA should highlight status of land use and land ownership, these issues should be highlighted.	Noted
	Current soil loss rates need to be considered and mentioned in the ESIA report	Noted
	Include policies such as Agricultural Policy and Natural Land Resource Management Policy should be listed in the ESIA as well as the Biodiversity Management Action Plan.	Noted
	How does the client plan to dispose its batteries?	Voltalia will have a backup storage of about 10%. However, the client has mentioned that they will engage with a recycling institution called PvCycle in France to recycle the batteries. Furthermore, the batteries are lithium, so it is unlikely that the waste is hazardous to the environment and surrounding communities.
	The Dept. also likes to view topographic maps in the ESIA	We usually produce a soil map, but we have never seen a soil report before.
		There is a recent soil report from 2015.
	Is there an alternative method you can suggest of removing the top layer that is less damaging	I don't anticipate there will be any harm to the soil from removing the top layer. I anticipate improvement in soil

STAKEHOLDER DETAILS	COMMENT	RESPONSE
Ministry of Lands	Have you completed the leasing agreement?	Initial engagements have been done. Right now, all the contractual parts have been discussed, including the lease agreement with Illovo discussed few months ago, since then the Cadastral survey is completed currently we have the plot number and deed number, now we have a power purchase agreement completed in October, Contract between Ministry of Energy and Finance and it has to be approved in Parliament in Feb. In terms of documents we are ready, we are waiting to complete technical studies the ESIA..
		Application for change of use Application for cadastral survey Application for sub-division, the surveyor needs to be followed up with. The first processes that need to be completed. Approval for actual development from Planning Authority/Planning Committee, permission to do the construction which acts as one of the conditions under the assessments for ESIA
	How are the panels going to be disposed?	Panels last around 20 -25 years and then their efficiency drops. Following that point, the panels are taken back by manufactures. Silicon is recycled.
		ESIA has to address how to recycle/dispose batteries and panels after their expiration.
	How will the surface ground underneath the solar panel be treated?	Remove the top layer of fauna to level the land. We are going to recommend they decompress the area, and maintain the flora to a low level. We are also looking into the solution of planting underneath the panel to give the soil a chance to regenerate. However, you do not let trees or flora to grow too high because it can disturb the functioning of the panel.
		Need to come up with mitigation measures on what the land is going to be used for.
	Recommend measures that the drainage system is up to date.	ESMP addresses this issue for the client to install a proper drainage system. We will recommend to client to complete a drainage assessment.
		The ESIA has to look into how the community can benefit in the surrounding area. SCR needs to be considered.
	Where are the substation located?	Adjacent to the existing Dwangwa substation.
	Why is the degradation of the landscape temporary?	It is temporary because it occurs mostly during the construction phase. The land will not be the same, but the idea is to plant trees in the right place to recover the degradation. At the end of the construction phase, it will be cleaned up.

STAKEHOLDER DETAILS	COMMENT	RESPONSE
	Would the land restoration plan/project be enough to satisfy the moving current people who are cultivating on the land?	If they working for illovo, then there is no problem. But if they are not working with Illovo, they are encroachers. There should be mechanism to address encroachers. Unless there is an outstanding land issue that becomes known at a later stage.
		ESIA is being done to IFC standard, in that case, people will be compensated even if they are encroaching for the crops.
		There is concern that compensating people for encroachment of land can encourage further encroachment of public land in the future.
ESCOM	When are you finishing the ESIA report?	We are writing the ESIA in March. We hope to finish in May or before the first MEPA meeting of the week.
		Want feedback on whether Voltalia has done any assessments on the construction of a cable alongside the road. ESCOM requires the cable to be in a trench, construct a channel, cable trench with concrete. The road which crosses between the plant and substation, the cable should be accessed.
COMMUNITY LEVEL		
Village Head Groups and Area Development Committee	How many megawatts will the solar panels produce, and how much money is being invested into the project?	The project is 40MW, and clarified that Voltalia is funding the entire costs (approximately 60 million USD or 40 billion MWK) of operation and construction with the financial aid of a development bank. He also shared that a % of operation costs are dedicated to social responsibility through community projects in energy.
	What is the expected date of commencement and duration of the project?	the project is expected to commence in October 2022 depending on the outcome of the ESIA. Voltalia will manage and lead the project for 25 years after which the Government of Malawi is going to take over the management of the solar panel.
	Where will the employees be sourced from?	The employees will be locally sourced. A minimum of three experts will come from Voltalia for the technical expertise. Malawian organizations will be contracted for the construction of the panels. And all manual labor during the construction phase will be sourced from local residents of Dwangwa or Nkhotakota. This is not only cost efficient, but is also aligned with Voltalia's social responsibility mandate
	What are other benefits you expect to derive from the project?	Some of the positive impacts we expect will derive from this project include Employment opportunities for local residents Voltalia will prioritize employing Malawian contractors for the construction of the project. Local manpower is expected to be used in which case Dwangwa residents will be prioritized. Stability of jobs

STAKEHOLDER DETAILS	COMMENT	RESPONSE
		During the operation phase the project will require local man power to cut the grass, clean panels, for example. These employment opportunities will exist for as long as the solar panels remain (25+ years). For as long as Voltaia operates and manages the solar panels, it can guarantee to employ local residents of Dwangwa/Nkhotakota for local man power. Thereafter, Voltalia cannot guarantee that the Malawi Government will do Efficient generation of electricity The solar panels will generate 40 MW. This is ¼ of the total electricity Malawi is able to generate. This is an improvement from current conditions in Dwangwa.
	What is the title of the proposed project?	Voltalia- Dwangwa Dzuwa Limited
	How can Voltalia guarantee that the solar panel will alst twenty-five years?	Voltalia is directly funding the project with the assistance of another international or regional bank. Therefore, Voltalia has a sole interest in ensuring the project operates efficiently for the duration they manage it (25 years). The fact that Voltalia is funding a majority of the project is how it can guarantee that the project will operate for at least 25 years. Voltalia wants the absolute best result. However, they can guarantee the maintenance of that result after the 25 years because management will be transferred to the Malawi government
	Do you have all the funds available? Can you assure that it will run continuously?	Voltalia runs 1.5 GW of electricity around the world. We are assured that the funds for the project are available. Additionally, Voltalia will be applying for funding from Banks which are also shareholders of Voltalia
	Is Voltalia selling its electricity like it does with EGENCO?	2016 -2017 ESCOM controlled everything from generation, distribution, etc of electricity. Voltalia is selling its electricity to the Malawi Government
Local business	We are aware of the concerns around the influx of workers, as well as the spread of disease that comes as a result the solar panel installation. We are interested in what the businesses in the area can be concerned about.	
	Where is the project located exactly?	M5 Road, behind the Kasasa Golf Club, southern and northern substation. The northern parts will be after the substation.
	Have you taken the time to engage with the surrounding communities in the area?	Yes, we have started with the consultations with the VGH and district council.

STAKEHOLDER DETAILS	COMMENT	RESPONSE
	Have you taken into account the safety and security of the surrounding communities?	Safety issues is a huge concern. Before starting any operations, Voltalia will fence the construction site to avoid kids going inside. We will also hire security guards to ensure children cannot go inside, but to also curb theft.
	What is the timeline of the project?	Initial engagements have been done. Right now, all the contractual parts have been discussed, including the lease agreement with Illovo discussed few months ago, since then the Cadastral survey is completed currently we have the plot number and deed number, now we have a power purchase agreement completed in October, Contract between Ministry of Energy and Finance and it has to be approved in Parliament in Feb. In terms of documents we are ready, we are waiting to complete technical studies the ESIA.
	We commend the project, it will be very welcome in the area. When do you expect to start?	We expect to finish the studies and have access to the fund available we expect to start the projects in September/October we will start construction. Construction will take about a year. Construction phase will employ people outside of Dwangwa for skilled labor, but for unskilled labor, we will engage with the local residents. We will bring 7-10 Voltalia people maximum to cover knowledge gaps. The rest will be Malawian people. The end of 2023, the plant will be in the operation phase. We will therefore employ a significant number of people from skilled to unskilled laborers. The operations stage is not a labor intensive activity, it is more preventative maintenance than anything. We will be conducting checks every six months.
	How do you plan to design your operations to protect or mitigate impacts in the surrounding communities?	We will ensure to have fencing and security cameras in the area to protect the surrounding areas from intentional or accidental trespassing.
	What is your plan for preserving trees in the area? How many trees will you be clearing?	This panel is facing North, the sun rises in the East and sets in the West, so when the sun is in the North, it is very high. So it does not matter that we have trees in the area. Everything that is in the sensitivity area is not going to be touched including the trees. The sun sets high, so it will not be necessary to cut the trees.
		The Forest reserve is also not near the site. As far as we know, the boundaries are not bordering the site.
	This is a commendable project. I have concerns over the project boundary being too close to houses and the golf course. Will it not impact the nearby houses?	They will be identified during the screening process during construction process. There will be limited impact on the houses and the golf course because the houses are located near sensitive areas (Miombo trees) that will not be touched. The beacons might be close to their homes, which may raise concerns, but the construction will not start from the beacon, but rather after the Miombo woodlands.

STAKEHOLDER DETAILS	COMMENT	RESPONSE
		During operation, there will not be any noise. The working hours is also during reasonable times during the day, for example 08:00 – 16:00, the construction will not be disturbing nearby houses. There will not be any smoke hazard, or air pollutants from the construction.
	Has the proponent considered issues of encroachment? If so, what is your plan for addressing this?	Was not answered.
	Will the access road, between the boundary line and the Water Board substation, leading into the M5 be intact?	Yes. The access road will not be affected.
	Substation safety – how do you plan to deal with vandalism in the substation?	The substation will be closed from the public. There is a fence and security guards. Then Voltalia will have the main station that will also be equipped with security guards and cameras that is also fenced.
	Can you explain how you plan to employ individuals?	Voltalia will subcontract Malawian contractors. These subcontractors will have to follow Malawi regulations of employment for example child labor laws, minimum wage, working hours etc. However, Voltalia cannot guarantee these Malawian subcontractors will employ local residents. However, it is cost-effective to do so. Therefore, Voltalia will present a strong case for them to do so.
Dwangwa Traditional Authority	How many people do you intend to employ?	Voltalia will subcontract Malawian contractors. These subcontractors will have to follow Malawi regulations of employment for example child labor laws, minimum wage, working hours etc. However, Voltalia cannot guarantee these Malawian subcontractors will employ local residents. However, it is cost-effective to do so. Therefore, Voltalia will present a strong case for them to do so
	Where is the project located exactly?	M5 Road, behind the Kasasa Golf Club, southern and northern substation. The northern parts will be after the substation.
	How do you plan to mitigate spread of diseases due to the influx of workers?	Voltalia is advocating for local employment. When people are employed in the local community, there is a less likely chance of spreading diseases.
	You should also consider engaging with Mother groups work to sensitize families against child labour. Build experts and role models to raise awareness. Voltalia can lobby a meeting as the project is starting and talk to parents on the rights of a child and how to prevent exploitation.	Noted
	This is a welcome project of the community. We are happy to know there are such developments, especially in a small region like Dwangwa,	Noted

STAKEHOLDER DETAILS	COMMENT	RESPONSE
	What are the management strategies to mitigate the impacts?	We will include the need for an inductive process to train contractors on preventing the harassment, abuse of young children and women for example