Bat Impact Assessment Scoping Report

- For the proposed Camden II Wind Energy Facility, Mpumalanga, South Africa

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07 December 2021

PREPARED FOR:

ENERTRAG South Africa Proprietary Limited

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Ref: R-2112-24

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For:	Bat Impact Assessment Scoping Report

Independence

Animalia Consultants (Pty) Ltd has no connection with the developer. Animalia Consultants (Pty) Ltd is not a subsidiary, legally or financially of the developer; remuneration for services by the developer in relation to this Bat Impact Assessment Scoping Report is not linked to approval by decision-making authorities responsible for permitting this proposal and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project.

Applicable Legislation

Legislation dealing with biodiversity applies to bats and includes the following:
NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 2004 (ACT 10 OF 2004; Especially sections 2, 56 & 97).

The Act calls for the management and conservation of all biological diversity within South Africa. Bats constitute an important component of South African biodiversity and therefore all species receive attention, in addition to those listed as Threatened or Protected.

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Table i. Explanation of abbreviations

Abbreviation	Explanation
ACR	African Chiroptera Report
BESS	Battery Energy Storage System
DEA	Department of Environmental Affairs
DMRE	Department of Mineral Resources and Energy
EIA	Environmental Impact Assessment
GHAF	Green Hydrogen & Ammonia Facility
IRP	Integrated Resource Plan
MM	Meteorological ("Met") Mast
PV	Photo-voltaic (facility)
REC	Renewable Energy Complex
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
SABAA	South African Bat Assessment Association
SEA	Strategic Environmental Assessment
ShM	Short Mast (passive bat detection system)
WEF	Wind Energy Facility

1 OBJECTIVES AND TERMS OF REFERENCE FOR THE STUDY

- A description of the baseline characteristics and conditions of the receiving environment (e.g., site and/or surrounding land uses including urban and agricultural areas).
- An identification of possible impacts on bats and a description of the nature and extent of each identified impact.
- Identifying gaps in knowledge with regards to each identified impact on bats.
- Presentation of no-go areas in the form of bat sensitivity mapping.
- Recommendations to avoid negative impacts, as well as feasible and practical mitigation, management and/or monitoring options to reduce negative impacts, that can be included in the Environmental Impact Assessment (EIA).

2 INTRODUCTION

This document is the Bat Impact Assessment Scoping Report for the proposed Camden II Wind Energy Facility (WEF) completed by Animalia Consultants (Pty) Ltd.

Enertrag South Africa (Pty) Ltd is proposing the development of wind energy facility along with its associated grid connections and infrastructure on a site located approximately 25km south-south-east of Ermelo and 215km east-south-east of Johannesburg, within the Msukaligwa Local Municipality of the Gert Sibande District Municipality, Mpumalanga Province. The below table (Table 2.1) gives the project description and summarises the infrastructure specifications for the development. Figure 2.1 depicts the proposed WEF site boundaries and the current turbine layout.

Table 2.1. Project Summary - Camden II Wind Energy Facility (WEF)

Facility Name	Camden II Wind Energy Facility
Applicant	Camden II Wind Energy Facility (RF) Propriety Limited
Municipalities	Msukaligwa Local Municipality of the Gert Sibande District Municipality
Affected Farms[1]	○ Portion 0 of Adrianople Farm No. 296 ○ Portion 1 of Adrianople Farm No. 296 ○ Portion 2 of Adrianople Farm No. 296 ○ Portion 3 of Adrianople Farm No. 296 ○ Portion 3 of Buhrmansvallei Farm No. 297 ○ Portion 4 of Buhrmansvallei Farm No. 297 ○ Portion 3 of De Emigrate Farm No. 327 ○ Portion 5 of Klipfontein Farm No. 326 ○ Portion 6 of De Emigrate Farm No. 327

[1] Based on the current conceptual layout.

Extent	4300 ha
Buildable area	Approximately 200 ha
Capacity	Up to 250MW
Number of turbines	Up to 50
Turbine hub height:	Up to 200m
Rotor Diameter:	Up to 200m
Foundation	Approximately 25m^2 diameter x 3m deep – 500 – 650m^3 concrete. Excavation approximately 1000m^2, in sandy soils due to access requirements and safe slop stability requirements.
O&M building footprint:	Located near the substation. Septic tanks (operational phase) with portable toilets for construction phase. Typical areas include: - Operations building – 20m x 10m = 200m^2 - Workshop – 15m x 10m = 150m^2 - Stores - 15m x 10m = 150m^2
Construction camp laydown	Typical area 100m x 50m = 5000m^2. Sewage: Portable toilets.
Temporary laydown or staging area:	Typical area 220m x 100m = 22000m^2. Laydown area could increase to 30000m^2 for concrete towers, should they be required.
Cement batching plant (temporary):	Gravel and sand will be stored in separate heaps whilst the cement will be contained in a silo. The footprint will be around 0.5ha. Maximum height of the silo will be 20m.
Internal Roads:	Width of internal road – Between 5m and 6m. this can be increased to 8m on bends. Length of internal road – Approximately 60km.
Cables:	The medium voltage collector system will comprise of cables up to and include 33kV that run underground, except where a technical assessment suggest that overhead lines are required, in the facility connecting the turbines to the onsite substation.
IPP site substation and battery energy storage system (BESS):	Total footprint will be up to 7ha in extent. The substation will consist of a high voltage substation yard to allow for multiple (up to) 275kV feeder bays and transformers, control building, telecommunication infrastructure, access roads, etc. The BESS storage capacity will be up to 200MW/800MWh with up to four hours of storage. It is proposed that Lithium Battery Technologies, such as Lithium Iron Phosphate, Lithium Nickel Manganese Cobalt oxides or Vanadium Redox

	flow technologies will be considered as the preferred battery technology. The main components of the BESS include the batteries, power conversion system and transformer which will all be stored in various rows of containers.

This WEF is proposed in response to the identified objectives of the national and provincial government and local and district municipalities to develop renewable energy facilities for power generation purposes. It is the developer's intention to bid the Camden II Wind Energy Facility (WEF) under the Department of Mineral Resources and Energy's (DMRE's) Renewable Energy Independent Power Producer Procurement (REIPPP) Programme or any similar procurement programme under the IRP, with the aim of evacuating the generated power into the national grid. Third party off-take is also considered, where feasible. This will aid in the diversification and stabilisation of the country's electricity supply, in line with the objectives of the Integrated Resource Plan (IRP), with the Camden II Energy Facility set to inject up to 200MW into the national grid.

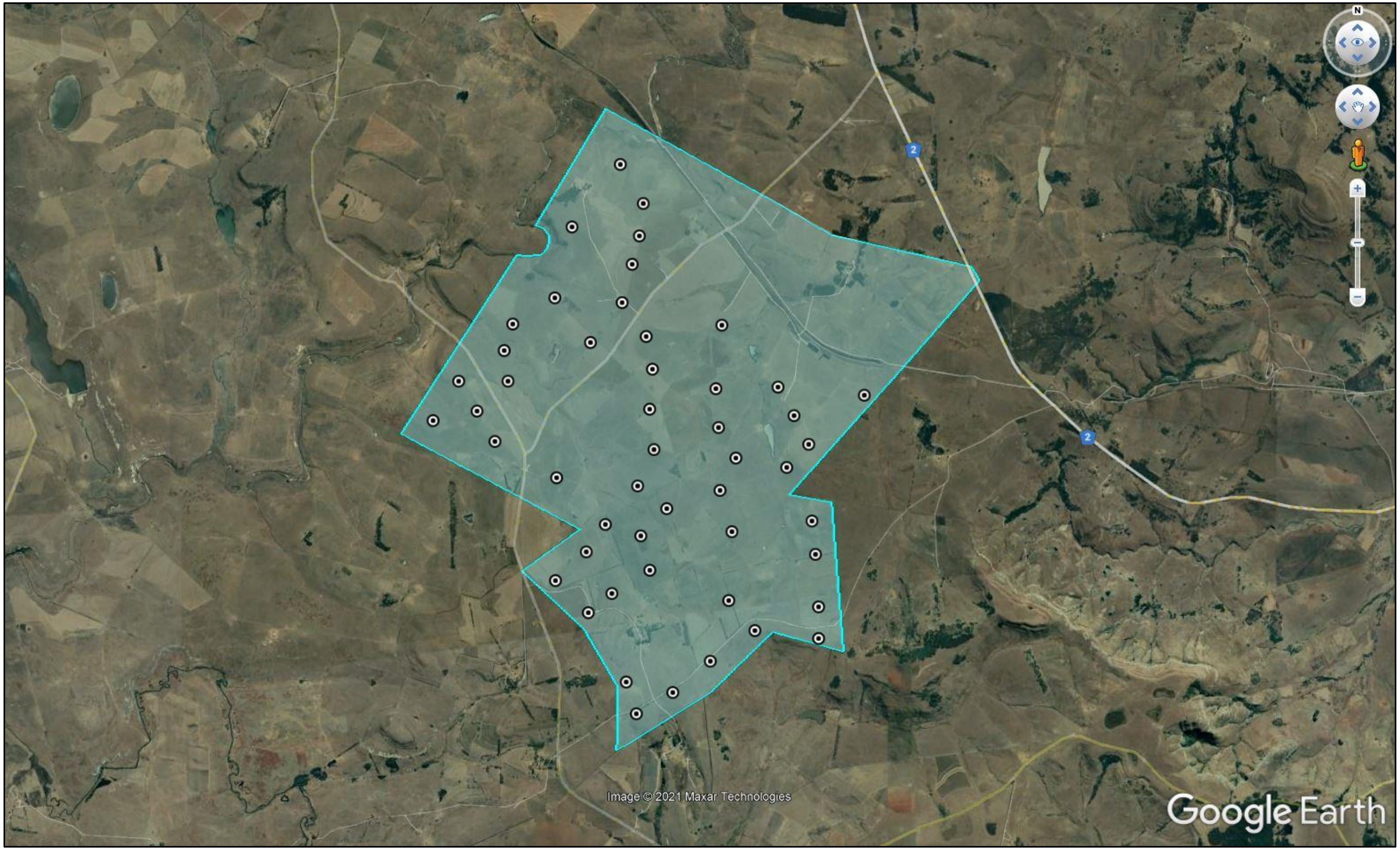

Figure 2.1. Layout of the proposed Camden II WEF: Site boundary (blue outline) and current turbine layout (white circles)

2.1 The Bats of South Africa

Bats form part of the Order Chiroptera and are the second largest group of mammals after rodents. They are the only mammals to have developed true powered flight and have undergone various skeletal changes to accommodate this. The forelimbs are elongated, whereas the hind limbs are compact and light, thereby reducing the total body weight. This unique wing profile allows for the manipulation of wing camber and shape, exploiting functions such as agility and manoeuvrability. This adaption surpasses the static design of the bird wings in function and enables bats to utilise a wide variety of food sources, including, but not limited to, a large diversity of insects (Neuweiler 2000). Species-based facial features may differ considerably as a result of differing lifestyles, particularly in relation to various feeding and echolocation navigation strategies. Most South African bats are insectivorous and are capable of consuming vast quantities of insects on a nightly basis (Taylor 2000, Tuttle and Hensley 2001) however, they have also been found to feed on amphibians, fruit, nectar and other invertebrates. As a result, insectivorous bats are the predominant predators of nocturnal flying insects in South Africa and contribute greatly to the suppression of these numbers. Their prey also includes agricultural pests such as moths and vectors for diseases such as mosquitoes (Rautenbach 1982, Taylor 2000).

Urban development and agricultural practices have contributed to the deterioration of bat populations on a global scale. Public participation and funding of bat conservation are often hindered by negative public perceptions and unawareness of the ecological importance of bats. Some species choose to roost in domestic residences, causing disturbance and thereby decreasing any esteem that bats may have established. Other species may occur in large communities in buildings, posing as a potential health hazard to residents in addition to their nuisance value. Unfortunately, the negative association with bats obscures their importance as an essential component of ecological systems and their value as natural pest control agents, which actually serves as an advantage to humans.

Many species of bats roost in large communities and congregate in small areas. Therefore, any major disturbances within and around the roosting areas may adversely impact individuals of different communities concurrently (Hester and Grenier 2005). Secondly, nativity rates of bats are much lower than those of most other small mammals. This is because, for the most part, only one or two pups are born per female per annum. Under natural circumstances, a population's numbers may accumulate over long periods of time. This is due to the longevity of up to 30 years (O'Shea *et al*. 2003) and the relatively low predation of bats when compared to other small mammals. However, bat populations are not able to adequately recover after mass mortalities and major roost disturbances.

2.2 Bats and Wind Turbines

Although most bats are highly capable of advanced navigation through the use of echolocation and excellent sight, they are still at risk of physical impact with the blades of wind turbines. The corpses of bats have been found in close proximity to wind turbines and, in a case-study conducted by Johnson *et al*. (2003), were found to be directly related to collisions. The incident of bat fatalities for migrating species has been found to be directly related to turbine height, increasing exponentially with altitude, as this disrupts the migratory flight paths (Howe *et al*. 2002, Barclay *et al*. 2007). Although the number of fatalities of migrating species increased with turbine height, this correlation was not found for increased rotor sweep (Howe *et al*. 2002, Barclay *et al*. 2007). In the USA it was hypothesized that migrating bats may navigate without the use of echolocation, rather using vision as their main sense for long distance orientation (Johnson *et al*. 2003, Barclay *et al*. 2007). Despite the high incidence of deaths caused by direct impact with the blades, most bat mortalities have been found to be caused by barotrauma (Baerwald *et al*. 2008). This is a condition where low air pressure found around the moving blades of wind turbines causes the lungs of a bat to collapse, resulting in fatal internal haemorrhaging (Kunz *et al*. 2007). Baerwald *et al*. (2008) found that 90% of bat fatalities around wind turbines involved internal haemorrhaging consistent with barotrauma.

Three factors need to be present for most South African bats to be prevalent in an area: availability of roosting space, food (insects/arthropods or fruit), and accessible open water sources. However, the dependency of a bat on each of these factors is subject to the species, its behaviour and ecology. Nevertheless, bat activity, abundance and diversity are likely to be higher in areas supporting all three above-mentioned factors. Although bats are predominately found roosting and foraging in areas near trees, rocky outcrops, human dwellings and water; in conditions where valleys are foggy, warmer air is drawn to hilltops through thermal inversion which may result in increased concentrations of insects and consequently bats at hilltops, where wind turbines are often placed (Kunz *et al*. 2007). Some studies (Horn *et al*. 2008) suggest that bats may be attracted to the large turbine structure as roosting spaces or that swarms of insects may get trapped in low pressure air pockets around turbines, also encouraging the presence of bats. The presence of lights on wind turbines has also been identified as a possible cause for increased bat fatalities for non-cave roosting species. This is thought to be due to increased insect activity and subsequent increased foraging activity of bats (Johnson *et al*. 2003). Clearings around wind turbines, in previously forested areas, may also improve conditions for insects, thereby attracting bats to the area. The swishing sound of turbine blades has also been proposed as a possible source for disorientation in bats (Kunz *et al*. 2007). Electromagnetic fields generated by the turbine may additionally affect bats which are sensitive to magnetic fields (Kunz *et al*. 2007). It could also be hypothesized, from personal observations that the echolocation capabilities of bats are designed to locate smaller insect prey or avoid stationary objects, and may not be primarily focused on the detection of unnatural objects moving sideways across the flight path.

South African operational monitoring studies currently point to South African bats being just as vulnerable to mortality from turbines as international studies have previously indicated. The main species of concern are *Laephotis capensis*, *Tadarida aegyptiaca* and *Miniopterus natalensis,* on this site and in general. They will be discussed in depth in this report (Section 4.3).

Whatever the reason for bat fatalities in relation to wind turbines, it is clearly a significant ecological problem which requires attention. Most bat species only reproduce once per year, bearing one young per female, thus their numbers are slow to recover from mass mortalities. It is very difficult to assess the true number of bat deaths in relation to wind turbines, due to carcasses being removed from sites through predation, the rate of which differs from site to site as a result of habitat type, species of predator and their numbers (Howe *et al*. 2002, Johnson *et al*. 2003). Various mitigation measures are being researched and experimented with globally. The implementation of curtailment processes, where the turbine cut-in speed is raised to a higher wind speed, has been proven to be the most effective mitigation measure currently. This relies on the principle that the prey of bats will not be found in areas of strong winds and more energy is required for the bats to fly under these conditions anyways. The impact on bats foraging in the area will be higher when uncurtailed turbine blades are left to turn slowly in low wind speeds; it is a misperception that faster turning blades present a higher mortality risk.

3 METHODOLOGY

3.1 Literature-based and On-site Inspections

The site is evaluated by comparing the amount of surface rock (possible roosting space), topography (influencing surface rock in most cases), vegetation (possible roosting spaces and foraging sites), climate (can influence insect numbers and availability of fruit), and presence of surface water (influences insects and acts as a source of drinking water) to identify bat species that may be impacted by wind turbines. These comparisons are done principally by briefly studying the geographic literature of each site, available satellite imagery and by ground-truthing with site visits. The probability of occurrence based on the above-mentioned factors are estimated for the species both expected and confirmed on site as well as the larger surrounding area.

3.2 Active & Passive Monitoring

Several site visits were made to the Camden II WEF between November 2020 and October 2021 to ground truth bat sensitivity features and habitats delineated in the bat sensitivity constraints map, and to collect passive data from bat detection systems.

Passive bat detection systems (Figure 3.1) were set up on a meteorological mast with microphones at 10m, 55m and 110m. Additionally, two short mast bat detection systems were also set up, with microphones at 7m (referred to as C2-ShM1 & C2-ShM2). These systems were set to gather bat activity data every night for 12 months to form part of the long-term pre-construction monitoring and inform the EIA study.

The data is analysed by classifying (as near to species level as possible) and counting positive bat passes detected by the systems. A bat pass is defined as a sequence of ≥1 echolocation calls where the duration of each pulse is ≥2ms (one echolocation call can consist of numerous pulses). A new bat pass is identified by a >1 000ms period between pulses. These bat passes are summed into hourly intervals which are used to calculate nocturnal distribution patterns over time. Times of sunset and sunrise are automatically adjusted with the time of year.
Nightly bat totals over time are useful for displaying abrupt peaks in activity on specific nights or short time periods, and to visually represent the spread of bat activity over the monitoring period. This may assist in developing mitigation schedules, if required.

The data from the four passive systems will be fully analysed and discussed in Animalia Consultant’s Final EIA Report for Camden II WEF.

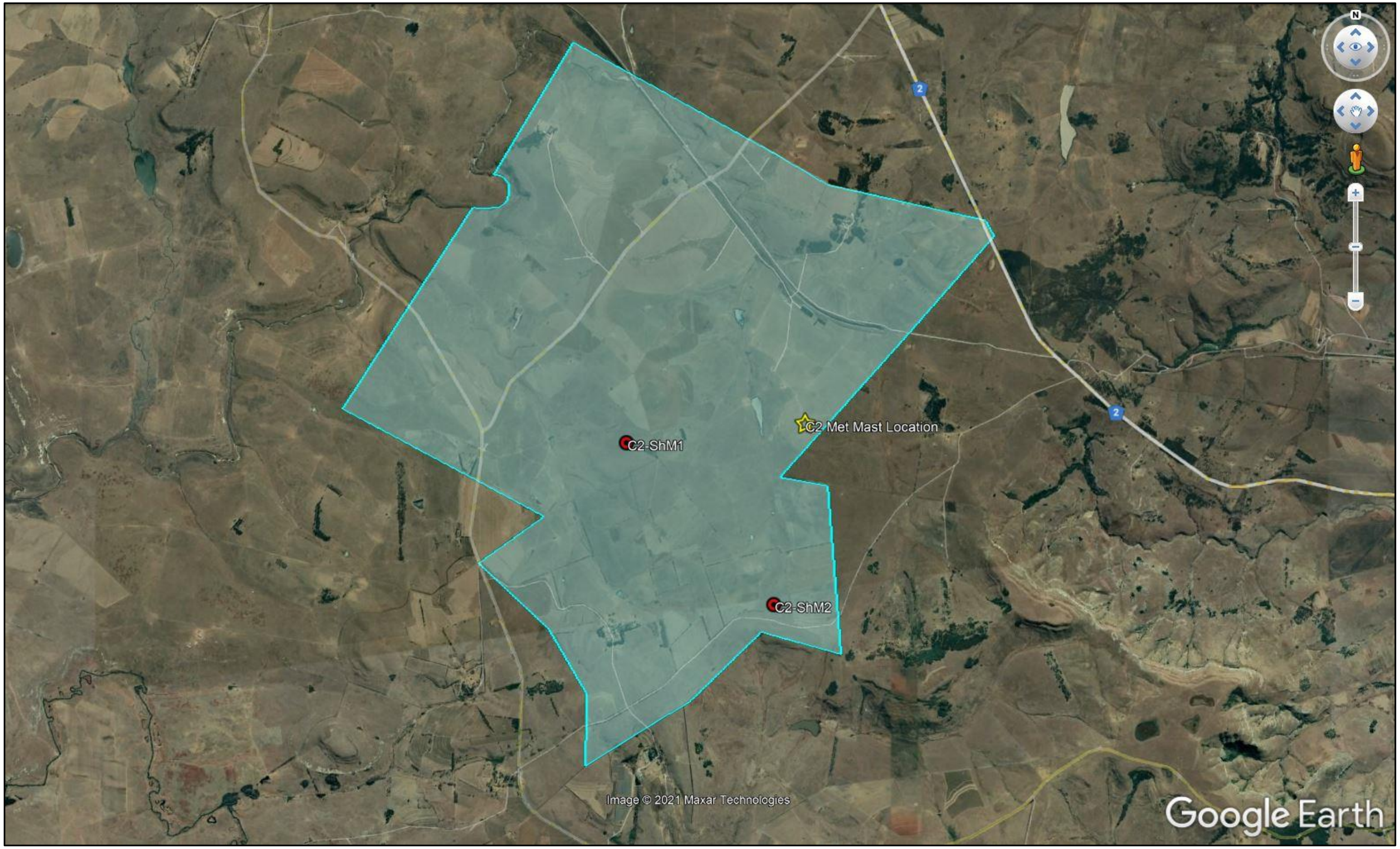

Figure 3.1. Positions of the passive bat detection systems on site. The two Short Mast systems, C2-ShM1 and C2-ShM2, are shown (red circles), as well as the location of the Meteorological Mast (Met 1) system (yellow star).

3.3 Bat Sensitivity Mapping

Google Earth satellite imagery and verifications during site visits were used to spatially demarcate areas of the site with high and medium sensitivities relating to bat species ecology and habitat preferences. The map considers man-made structures and habitat alterations (such as dams), as well as natural terrain features that are likely to offer roosting and foraging opportunities for bat species found in the broader site area. With regards to hydrology features, distinction has been made between permanent and seasonal water sources. Clumps of trees (as opposed to scattered or single trees) offer significantly better roosting and foraging habitat on this site; they have received priority during sensitivity mapping.

3.4 Assumptions and Limitations

As with any environmental study, there are certain assumptions and limitations that exist around the current knowledge we possess regarding bats and their behaviour, movements and distribution. Some important points are discussed briefly below:

- Distribution maps of South African bat species still require further refinement, thus the bat species proposed to occur on the site (and not detected in the area yet) should be considered precautionary. If a species has a distribution marginal to the site, it was assumed to occur in the area.

- The migratory paths of bats are largely unknown, thus some uncertainty in this regard will remain until the end of operational monitoring of at least 2 years.

- The sensitivity map is based partially on satellite imagery and from detailed site visits, although given the large extent of the site, there is always the possibility that what has been mapped may differ slightly to what is on the ground.

- Results from the passive bat detection data will provide insight into possible mitigation measures by highlighting peak activity periods and species assemblages active on site.

4 RESULTS AND DISCUSSION

4.1 Land Use, Vegetation, Climate and Topography

The proposed Camden II WEF falls within the Grassland Biome, and the Mesic Highveld Grassland Bioregion. The vegetation units found on site include **Eastern Highveld Grassland** and **Wakkerstroom Montane Grassland** (Figure 4.1, Mucina & Rutherford 2012). The general geology for these vegetation units on site includes dolerite and arenite formations, which are not prone to cave formation suitable for roosting bats. Land use type is predominantly agricultural in nature and consists of grazing for livestock and ploughed soil for mixed crops.

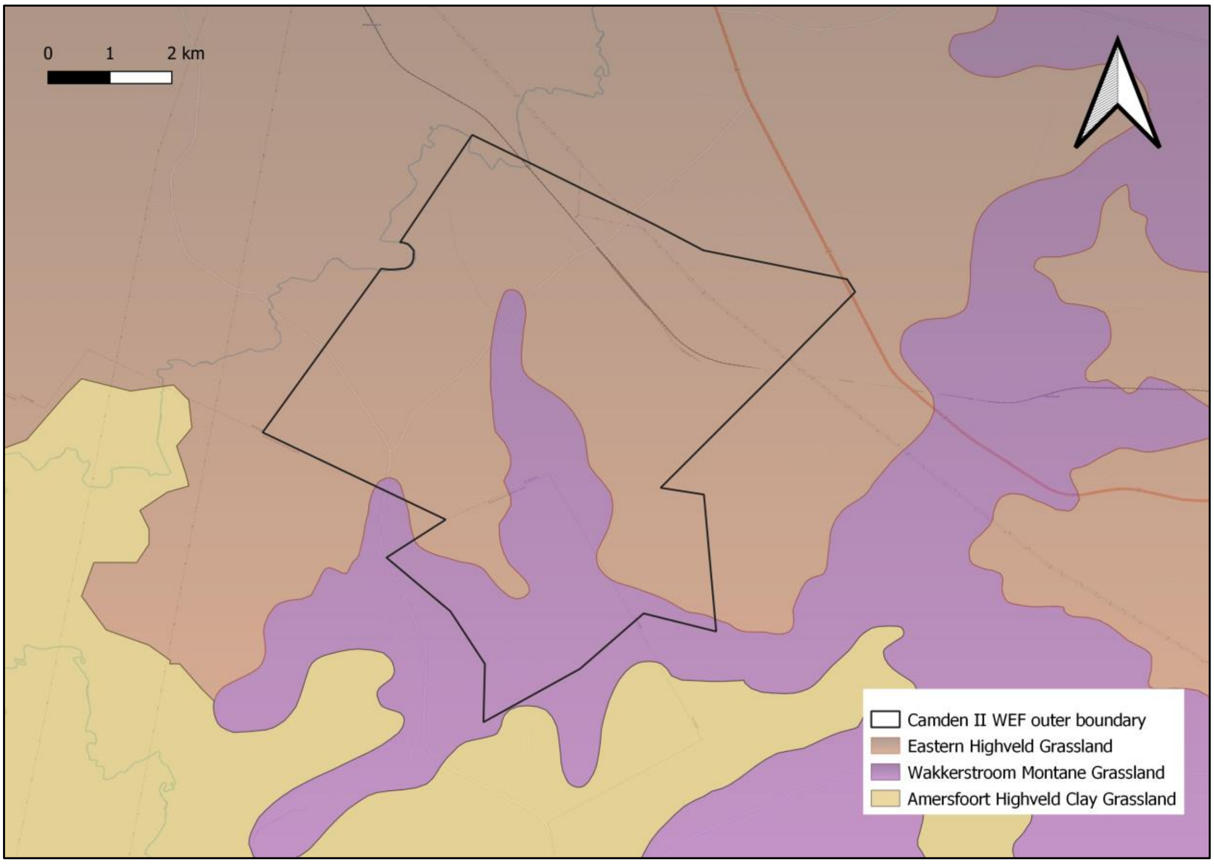

Figure 4.1. Vegetation units present on the proposed Camden II WEF (Mucina & Rutherford 2012).

4.1.1 Eastern Highveld Grassland

The Eastern Highveld Grassland vegetation constitutes most of the Camden II WEF land cover except the extreme south and central portions of the site. It consists of slight to moderate undulating plains of short dense grassland cover. Important taxa include *Aristida*, *Digitaria*, *Eragrostis*, *Themeda* and *Tristachya*. Some rocky outcrops may occur, with associated sour grasses and certain woody species. There is a strongly seasonal rainfall pattern; precipitation ranges from 650 – 900mm per annum, predominantly in the summer. Very limited areas of this vegetation unit are currently conserved in statutory reserves and overall, the unit is endangered (Mucina & Rutherford 2006).

4.1.2 Wakkerstroom Montane Grassland

This vegetation unit comprises low mountains and undulating plains and is found mostly in the south of the Camden II WEF and in a band running through the center of the site. On plateaus and flatter areas, short *Themeda triandra* montane grassland predominates. *Leucosidea* thickets typify short forest patches on steep, often east-facing slopes and drainage zones. Other important herbs include *Senecio scitus* and *Helichrysum nudifolium*. Black wattle (*Acacia mearnsii*) is an aggressive invader of riparian areas here. Summer rainfall is experienced, ranging from 800 – 1250 mm per year, with a mean annual temperature of 14°C. Wakkerstroom Montane Grassland is a frost-tolerant vegetation unit and is considered to be least threatened.

4.2 Currently Confirmed, Previously Recorded and Literature-based Species Probability of Occurrence

Table 4.1 below indicates the species of bat which have been confirmed to occur on site, those unconfirmed species which may potentially occur on site, as well as those occurring in the broader area of the site based on literature review. For each species, the risk of impact by wind energy infrastructure was assigned by MacEwan *et al*. (2020) based on their distributions, altitudes at which they fly, and foraging ecology.

Table 4.1. Species currently confirmed on site, previously recorded in the area, or potentially occurring. Roosting and foraging habitats in the study area, conservation status and risk of impact are also briefly described per species (Monadjem *et al.* 2020).

Species	Common name	Occurrence in area*	Conservation status (SANBI & EWT, 2016)	Possible roosting habitat on site	Possible foraging habitat utilised on site	Risk of impact (MacEwan *et al.* 2020 for wind)
Tadarida aegyptiaca	Egyptian free-tailed bat	Confirmed on site	Least Concern (2016 Regional Listing)	Hollows in trees, and behind the bark of dead trees. The species has also taken to roosting in roofs of buildings.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types of habitats.	High
Mops midas	Midas free-tailed bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Hollows in trees, and behind the bark of dead trees. The species has also taken to roosting in roofs of buildings.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types of habitats.	High
Mops (Chaerephon) pumilus	Little free-tailed bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Hollows in trees, and behind the bark of dead trees. The species has also taken to roosting in roofs of buildings.	It forages over a wide range of habitats; its preferences of foraging habitat seem independent of vegetation. It seems to forage in all types of habitats.	High
Laephotis (Neoromicia) capensis	Cape serotine	Confirmed on site	Least Concern (2016 Regional Listing)	Roosts in the roofs of houses and buildings, and also under the bark of trees.	It appears to tolerate a wide range of environmental conditions from arid semi-desert areas to montane grasslands, forests, and savannahs. Predominantly a medium height clutter edge forager on site.	High
Laephotis zuluensis	Zulu serotine	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts under the bark of trees, and possibly roofs of buildings.	Predominantly a medium height clutter edge forager on site.	Medium – High
Laephotis nanus	Banana bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts under the bark of trees, and in the folded leaves of banana trees in the larger area.	Predominantly a medium height clutter edge forager on site.	Medium – High

Pipistrellus hesperidus	Dusky pipistrelle	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts under the bark of trees, and possibly roofs of buildings.	Prefers vegetation edges and clutter with open water sources.	Medium – High
Miniopterus natalensis	Natal long-fingered bat	Confirmed on site	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area, may also take residence in suitable hollows such as culverts under roads.	Clutter-edge forager. May forage in more open terrain during suitable weather.	High
Miniopterus fraterculus	Lesser long-fingered bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Clutter-edge forager. May forage in more open terrain during suitable weather.	High
Eptesicus hottentotus	Long-tailed serotine	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	It is a crevice dweller roosting in rock crevices in the larger area, as well as other crevices in buildings.	It generally seems to prefer woodland habitats, and forages on the clutter edge. But may still forage over open terrain occasionally.	Medium – High
Myotis tricolor	Temmink's myotis	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area, may also take residence in suitable hollows such as culverts under roads.	Clutter-edge forager. May forage in more open terrain during suitable weather.	Medium – High
Rhinolophus blasii	Blasius's horseshoe bat	Confirmed in 100km radius	Near Threatened (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Low
Rhinolophus clivosus	Geoffroy's horseshoe bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Low
Rhinolophus swinnyi	Swinny's horseshoe bat	Confirmed in 100km radius	Vulnerable (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Low
Rhinolophus simulator	Bushveld horseshoe bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Low
Scotophilus dinganii	Yellow-bellied house bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roofs of buildings and other suitable hollows.	Clutter-edge forager. May forage in more open terrain during suitable weather.	High
Cloeotis percivali	Percival's short-eared trident bat	Confirmed in 100km radius	Endangered (2016 Regional Listing)	Caves and mine tunnels present in the larger area.	Vegetation clutter forager, clumps of trees on site.	Low

Epomophorus wahlbergi	Wahlberg's epauletted fruit bat	Confirmed in 100km radius	Least Concern (2016 Regional Listing)	Roosts in dense foliage of large, leafy trees in the larger area, and may travel several kilometres each night to reach fruiting trees.	Feeds on fruit, nectar, pollen and flowers. If and where available on or near site.	High
Eidolon helvum	African straw-coloured fruit bat	Possible as migrant	Least Concern (2016 Regional Listing) (Globally Near threatened)	Non-breeding migrant with sparse scattered records.	Feeds on fruit, nectar, pollen and flowers, if and where available on site.	High

*Occurrence of species records based on ACR 2020 and Monadjem *et al*. 2020

4.3 Ecology of bat species that may be impacted the most by the Camden II WEF

There are several bat species in the vicinity of the site that occur commonly in the area. Some of these species are of special importance based on their likelihood of being impacted by the proposed WEF, due to high abundances and certain behavioural traits. They have also been dominating records of fatalities at wind energy facilities in South Africa. The relevant species are discussed below.

4.3.1 Tadarida aegyptiaca

The Egyptian free-tailed bat, *Tadarida aegyptiaca*, is a Least Concern species (SANBI Red List 2016) as it has a wide distribution and high abundance throughout South Africa, and is part of the free-tailed bat family (Molossidae). It occurs from the Western Cape of South Africa, north through to Namibia and southern Angola; and through Zimbabwe to central and northern Mozambique (Monadjem *et al*. 2020). This species is protected by national legislation in South Africa (ACR 2020).

Egyptian free-tailed bats roost communally in small (dozens) to medium-sized (hundreds) groups in caves, rock crevices, under exfoliating rocks, in hollow trees and behind the bark of dead trees. It has also adapted to roosting in buildings, in the roofs of houses in particular (Monadjem *et al*. 2020). Thus, man-made structures and large trees on the site would be important roosts for this species.

Tadarida aegyptiaca forages over a wide range of habitats, flying above the vegetation canopy. It appears that the vegetation has little influence on foraging behaviour as the species forages over desert, semi-arid scrub, savannah, grassland and agricultural lands. Its presence is strongly associated with permanent water bodies due to concentrated densities of insect prey (Monadjem *et al*. 2020).

After a gestation of four months, a single pup is born, usually in November or December, when females give birth once a year. In males, spermatogenesis occurs from February to July and mating occurs in August. Maternity colonies are apparently established by females in November.

The Egyptian free-tailed bat is considered to have a high risk of fatality on wind energy facilities due to turbine collisions (MacEwan *et al.* 2020). Due to the high abundance and widespread distribution of this species, high mortality rates due to wind turbines would be a cause for concern as these species have more significant ecological roles than the rarer bat species, and are currently displaying moderate to high numbers of mortalities at nearby operating wind farms.

4.3.2 Laephotis capensis

Laephotis capensis is commonly called the Cape serotine (formerly *Neoromicia capensis*) and has a conservation status of Least Concern (SANBI Red List 2016) as it is found in high numbers and is widespread over much of Sub-Saharan Africa. High mortality rates of this species due to wind turbines would be a cause for concern as precisely because of its abundance. As such, it has a more significant role to play within local ecosystems than the rarer bat species.

The Cape serotine roosts individually or in small groups of two to three bats in a variety of shelters, such as under the bark of trees, at the base of aloe leaves, and under the roofs of houses. They will use most man-made structures as day roosts which can be found throughout the site and surrounding areas (Monadjem *et al*. 2020). They do not undertake migrations and thus are considered residents of the site.

Mating takes place from the end of March until the beginning of April. Spermatozoa are stored in the uterine horns of the female from April until August, when ovulation and fertilisation occur. They give birth to twins during late October and November, but single pups, triplets and quadruplets have also been recorded (van der Merwe 1994 and Lynch 1989).

They are tolerant of a wide range of environmental conditions as they survive and prosper across arid and semi-arid areas to montane grasslands, forests, and savannas; indicating that they may occupy several habitat types across the site, and are amenable towards habitat changes. They are however clutter-edge foragers, meaning they prefer to hunt on the edge of vegetation clutter, but can occasionally forage in open spaces. They are thought to have a medium to high likelihood of fatality due to wind turbines (MacEwan *et al.* 2020) and are currently displaying moderate to high numbers of mortalities at operational wind farms in South Africa.

4.3.3 Miniopterus natalensis

Miniopterus natalensis, commonly referred to as the Natal long-fingered bat, occurs widely across the country but mostly within the southern and eastern regions, and is listed as Least Concern (Monadjem *et al*. 2020). This bat is a cave-dependent species and identification of suitable roosting sites may be more important in determining its presence in an area than the presence of surrounding vegetation. It occurs in large numbers when roosting in caves with approximately 260 000 bats observed making seasonal use of the De Hoop Guano Cave in the Western Cape, South Africa. Culverts and mines have also been observed as roosting sites for either single bats or small colonies. Separate roosting sites are used for winter hibernation activities and summer maternity behaviour, with the winter hibernacula generally occurring at higher altitudes in more temperate areas and the summer hibernacula occurring at lower altitudes in warmer areas of the country (Monadjem *et al*. 2020).

Mating and fertilisation usually occur during March and April and is followed by a period of delayed implantation until July/August. Birth of a single pup usually occurs between October and December as the females congregate at maternity roosts (Monadjem *et al.* 2020 & van de Merwe 1979).

The Natal long-fingered bat undertakes short migratory journeys between hibernaculum and maternity roosts. Due to this migratory behaviour, they are considered to be at high risk of fatality from wind turbines if a wind farm is placed within a migratory path (MacEwan *et al.* 2020). The mass movement of bats during migratory periods could result in mass casualties if wind turbines are positioned over a mass migratory route and such turbines are not effectively mitigated. Very little is known about the migratory behaviour and paths of *M. natalensis* in South Africa with migration distances exceeding 150 kilometres. If the site is located within a migratory path, the bat detection systems should detect higher numbers and activity of the Natal long-fingered bat in spring and autumn; this will be examined over the course of the 12-month monitoring survey.

A study by Vincent *et al.* (2011) on the activity and foraging habitats of Miniopteridae found that the individual home ranges of lactating females were significantly larger than that of pregnant females. It was also found that the bats predominately made use of urban areas (54%) followed by open areas (19.8%), woodlands (15.5%) orchards and parks (9.1%) and water bodies (1.5%) when selecting habitats. Foraging areas were also investigated with the majority again occurring in urban areas (46%), however a lot of foraging also occurred in woodland areas (22%), crop and vineyard areas (8%), pastures, meadows and scrubland (4%) and water bodies (4%).

MacEwan *et al.* (2020) advise that *M. natalensis* faces a medium to high risk of fatality due to wind turbines. This evaluation was based on broad ecological features and excluded migratory information. The species is currently displaying low to moderate numbers of mortalities at operational wind farms in South Africa.

4.3.4 Relation between Bat Activity and Weather Conditions

Several sources of literature describe how numerous bat species are influenced by weather conditions (O'Farrell *et al.* 1967, Rachwald 1992, Arnett *et al*. 2010). Weather may influence bats in terms of lowering activity, changing the time of emergence and flight duration. It is also important to note that environmental factors are never isolated and therefore a combination of these factors can have synergistic or otherwise contradictory influences on bat activity. For example, a combination of high temperatures and low wind speeds will be more favourable to bat activity than low temperatures and low wind speed, whereas low temperature and high wind speed will be the least favourable for bats. Below are short descriptions of how wind speed, temperature and barometric pressure influences bat activity.

If it is found during operation that the wind farm is causing unsustainable numbers of bat fatalities, an analysis can be performed to determine the wind speed and temperature range within which 80% of bat passes were detected. The results of such an analysis may be used, if necessary, to inform mitigation measures for turbines based on conserving 80% of detected bat passes. This is keeping in mind the synergistic or otherwise contradictory effects that the combination of wind speeds and temperatures can have on bat activity.

4.3.4.1 Wind speed

Some bat species show reduced activity in windy conditions. Strong winds have been found to suppress flight activity in bats by making flight difficult (O'Farrell *et al.* 1967). Several studies at proposed and operating wind facilities in the United States have documented discernibly lower bat activity during 'high' wind speeds (Arnett *et al*. 2010).

Wind speed and direction also affect availability of insect prey, as insects on the wing often accumulate on the lee side of wind breaks such as tree lines (Peng *et al.* 1992). At edges exposed to wind, flight activity of insects, and therefore bats, may be suppressed while at edges to the lee side of wind, bat activity may be greater.

4.3.4.2 Temperature

Flight activity of bats generally increases with temperature. Flights are of shorter duration on cooler nights and extended on warmer nights. Rachwald (1992) noted that distinct peaks of activity disappeared in warm weather such that activity was mostly continuous through the night. During nights of low temperatures bats intensified foraging shortly after sunset (Corbet and Harris 1991).

Peng (1991) found that many families of aerial dipteran insects (flies) preferred warm conditions for flight. A preference among insects for warm conditions has been reported by many authors suggesting that temperature is an important regulator of bat activity, through its effects on insect prey availability.

4.4 Conservation and protected areas, known sensitivities and caves/roosts within 100km of the site

There is only a single conservation area within 100km of Camden II WEF, namely the Ramsar-recognised Seekoeivlei Nature Reserve of approximately 4 300 ha on the outer extent of the 100km boundary (see Figure 4.2). This has no bearing on the current site and will not be discussed further.

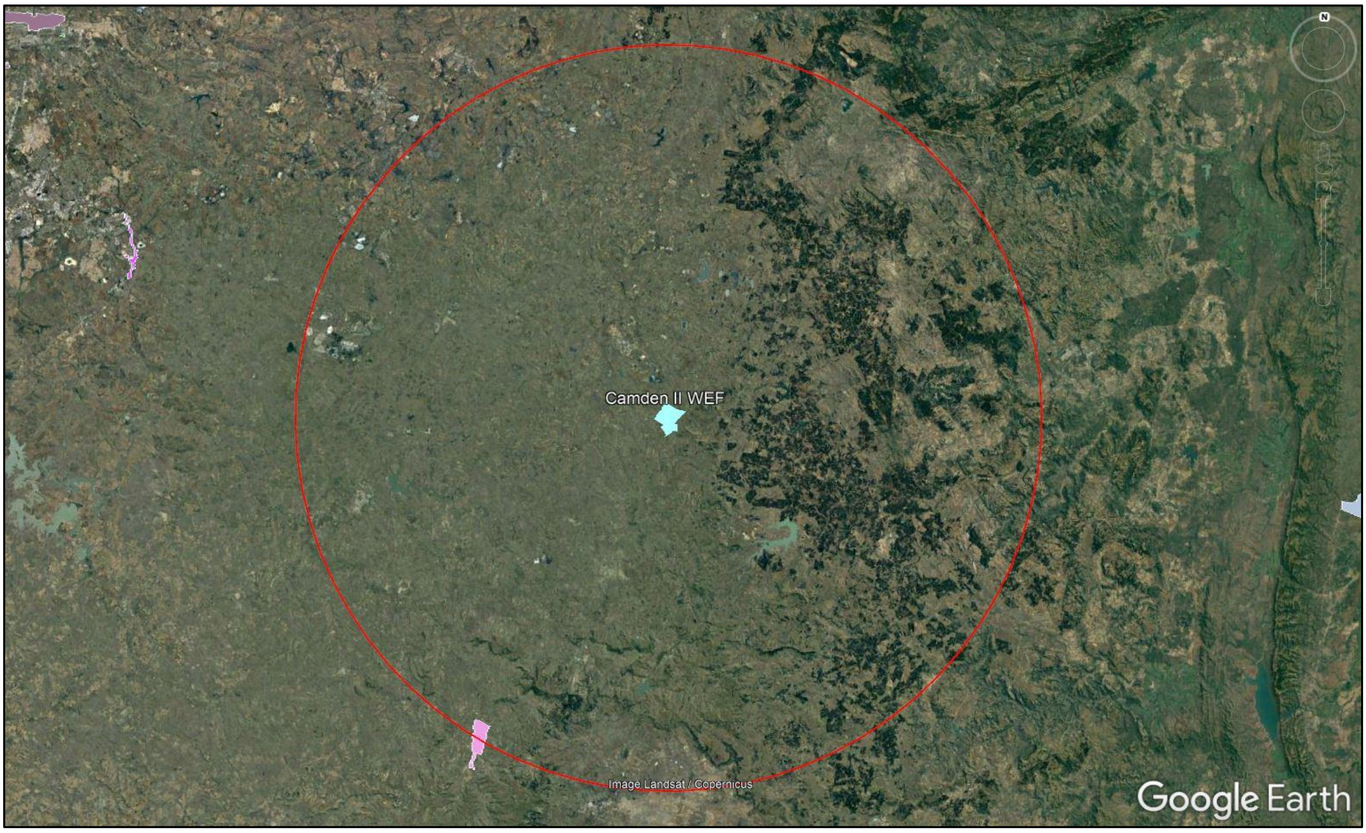

Figure 4.2. Protected areas within a radius of approximately 100km (red line) around the Camden II WEF site (DEA, 2021)

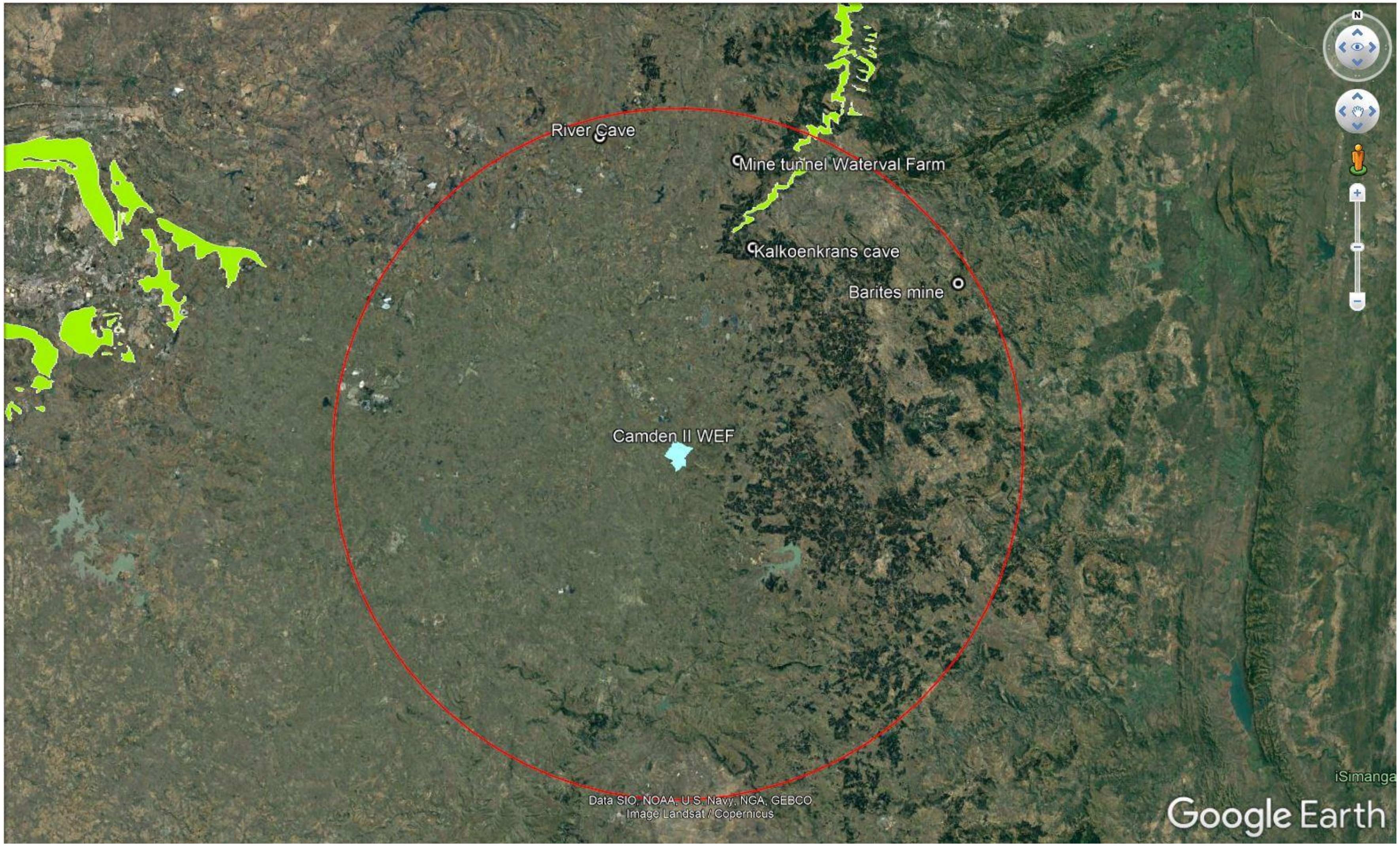

Figure 4.3. Approximate 100km radius (red circle) surrounding Camden II WEF (blue shape). Dolomite geology represented in lime green (SEA data), and four known bat roosts depicted with white circles.

Figure 4.3 shows the dolomitic geology of the greater area, with an approximate 100km site boundary radius shown in red. At its nearest, this extends to approximately 70km north-east of the WEF. Dolomite is known to be prone to good cave formation, and many bat colonies are supported in such caves in the country, particularly in the province of Gauteng. Museum records of bats collected from two caves and two mines within approximately 100km of the site exist. Specimens of *Miniopterus. natalensis* and *Rhinolophus clivosus* were collected from River Cave (100km north of site); *R. simulator*, *Myotus tricolor* and *Cloeotis percivali* from a mine tunnel on Waterval Farm (91km north), *R. simulator*, *R. blasii*, *R. clivosus* and *Miniopterus fraterculus* from Kranskalkoen Cave (67km north east) and *Miniopterus. natalensis* from Barites mine (100km northeast). The habitat preferences and sensitivity of these species have been discussed in Table 4.1.

The Strategic Environmental Assessment (SEA) assigns 50km buffers to large bat roosts for wind energy, therefore any of the existing or possible cave/roost locations may be assigned this buffer if they are found to be supporting large enough bat colonies. All of the cave locations identified are further than 50km from the proposed site. The cave/roost buffers assigned by the SEA may be subject to change based on field-verified observations and roost buffers recommended by the South African Good Practice Guidelines for Surveying Bats (pre-construction) at Wind Energy Facility Developments (MacEwan *et al*. 2020).

The Department of Environmental Affairs (DEA) Screening Tool (accessed 03/12/2021) was consulted for the "Bat" and "Wind" themes, to determine the environmental sensitivity ranking assigned to the site area and surrounds. There are no nearby wind or solar developments with an approved Environmental Authorisation or applications under consideration within 30km of the proposed area. For wind energy generation, the tool denotes areas of the site as "high sensitivity" with regards to being within 500m of a river and within 500m of a wetland; a "medium sensitivity" is also denoted with regards to the presence of croplands (see Figure 4.4).

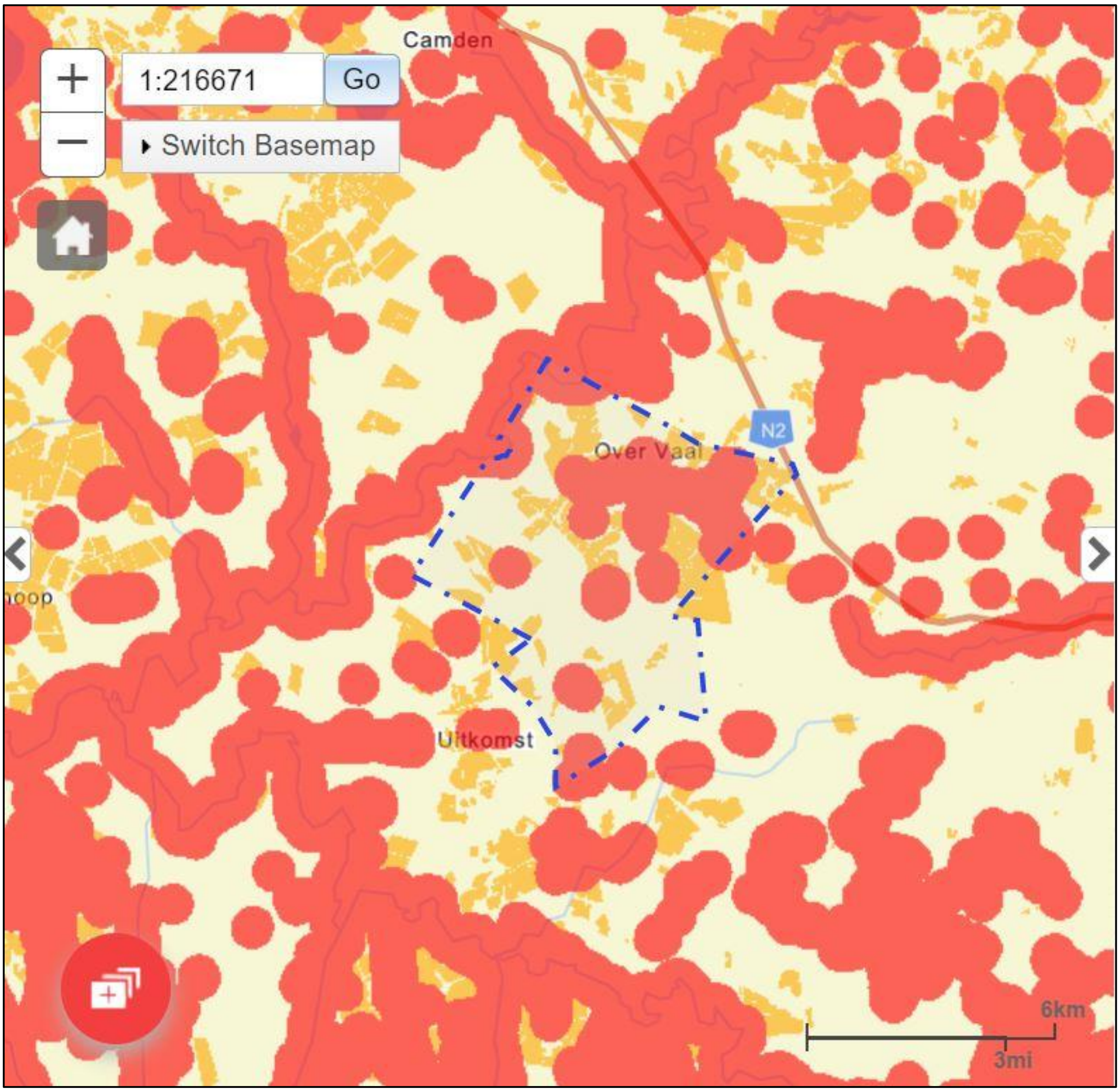

Figure 4.4. DEA Screening Tool for the “Bat” and “Wind” theme. The Camden II WEF boundary is shown in a blue outline, with red and orange areas depicting high and moderate sensitivities in the area, respectively (DEA Screening Tool 03/12/2021)

4.5 Sensitivity Map

Google Earth satellite imagery and verifications during site visits were used to spatially demarcate areas of the site with high and medium sensitivities relating to bat species ecology and habitat preferences, where high sensitivities and their buffers are no-go zones for turbines and turbine blade overhang (Tables 4.2 and 4.3). In other words, no turbine blades may intrude into high sensitivity buffers. Medium sensitivities indicate areas of probable increased risk due to seasonal fluctuations in bat activity, but turbines are allowed to be constructed in medium sensitivity areas. Figure 4.5 depicts the sensitive areas of the site, based on features identified to be important for foraging and roosting of the species that are most likely to occur on site.

Table 4.2. Description of parameters used in the development of the sensitivity map.

Last revision	November 2021
High sensitivities and 200m buffers	Valley bottom wetlands
	Pans and depressions
	Dams
	Drainage lines capable of supporting riparian vegetation which in turn increases localised insect abundance
	Other water bodies and other sensitivities such as manmade structures, buildings, houses, barns, sheds, stands of tall trees.
Moderate sensitivities and 150m buffers	Seasonal wetlands
	Seasonal drainage lines

Table 4.3. The significance of sensitivity map categories for each infrastructure component for the Camden II WEF.

Sensitivity	Turbines	Roads and cables	Internal overhead transmission lines	Buildings (including substation, battery storage facility and construction camp/yards)
High Sensitivity	These areas are 'no-go' zones and turbines may not be placed in these areas. Turbine blades (blade overhang) **may not** intrude into these areas.	Preferably keep to a minimum within these areas where practically feasible.	Allowed inside these areas.	Avoid these areas.
High Sensitivity buffer	These areas are 'no-go' zones and turbines may not be placed in these areas. Turbine blades (blade overhang) **may not** intrude into these areas.	Allowed inside these areas.	Allowed inside these areas.	Preferably keep to a minimum within these areas where practically feasible.
Moderate Sensitivity	Turbines within these areas may require priority (not excluding all other turbines) during post-construction studies, and in some instances, there is a higher likelihood that mitigation measures may need to be applied to them.	Allowed inside these areas.	Allowed inside these areas.	Allowed inside these areas.
Moderate Sensitivity buffer	Turbines within these areas may require priority (not excluding all other turbines) during post-construction studies, and in some instances, there is a higher likelihood that mitigation measures may need to be applied to them.	Allowed inside these areas.	Allowed inside these areas.	Allowed inside these areas.

Figure 4.5. Bat sensitivity map of the site. Site area indicated in a light blue boundary. Sensitivity polygons are provided in .kml format with this report. Shaded red = high sensitivity; Red line = 200m high sensitivity buffer; Shaded orange = medium sensitivity; Orange line = 150m medium sensitivity buffer.

4.6 Cumulative impact consideration within a 30km radius: Proposed Camden I Renewable Energy Complex

Enertrag South Africa (Pty) Ltd has proposed the development of an additional Renewable Energy Complex (REC) adjacent to the Camden II WEF, namely the Camden I REC, with a capacity of up to 210MW (up to 47 turbines). The footprint of these two developments will likely be cumulative, with the ecological impact of all facilities operating in combination likely to exceed the sum of individual parts. The cumulative impacts of Camden I REC on Camden II WEF are discussed in Section 5.1 (Table 5.2).

5 IMPACT IDENTIFICATION

Tables 5.1 & 5.2 below indicate the identified impacts associated with the proposed Camden II Wind Energy Facility (WEF) during the construction and operational phases. No significant impacts are identified for the decommissioning phase.

5.1 Wind Energy Facility

Table 5.1. Identified **potential impacts** of the proposed Camden II WEF project as well as possible mitigation measures.

Potential impact	Possible mitigation
Construction phase	
Loss of foraging habitat by clearing of vegetation.	Adhere to the sensitivity map criteria. Rehabilitate cleared vegetation where possible at areas such as laydown yards.
Roost destruction during earthworks.	Adhere to the sensitivity map criteria.
Operational phase	
Bat mortalities during foraging.	Turbine layout adjustments to adhere to the sensitivity map, and where needed, reducing blade movement at selected turbines during high-risk bat activity times/weather conditions. Acoustic deterrents are developed well enough to be trialled.
Bat mortalities during migration.	Reducing blade movement at selected turbines if a migration route is discovered. Acoustic deterrents are developed well enough to be trialled.
Increased bat mortalities due to light attraction and habitat creation.	Only use lights with low sensitivity motion sensors that switch off automatically when no persons are nearby, to prevent the creation of regular insect gathering pools. This will be at turbine bases (if applicable, and other infrastructure

	buildings). For buildings, avoid tin roofs and roof structures that offer entrance holes into the roof cavity.

Table 5.2. Identified **potential cumulative impacts** of the proposed Camden I & II WEF projects, as well as possible mitigation measures.

Potential impact	Possible mitigation
Construction phase	
Loss of foraging habitat by clearing of vegetation.	Each WEF adhere to its respective sensitivity map criteria. Rehabilitate cleared vegetation where possible at areas such as laydown yards.
Roost destruction during earthworks.	Each WEF adhere to its respective sensitivity map criteria.
Operational phase	
Bat mortalities during foraging.	Each WEF adhere to its respective sensitivity map criteria. Turbine layout adjustments to adhere to the sensitivity maps, and where needed reducing blade movement at selected turbines and high-risk bat activity times/weather conditions. Acoustic deterrents are developed well enough to be trialled. Each WEF should measure its bat mortality impact during operation and ensure that the WEF impacts remain within sustainable levels.
Bat mortalities during migration.	Reducing blade movement at selected turbines if a migration route is discovered. Acoustic deterrents are developed well enough to be trialled. Each WEF should measure its bat mortality impact during operation and ensure that the WEF impacts remain within sustainable levels.
Increased bat mortalities due to light attraction and habitat creation.	Each WEF to only use lights with low sensitivity motion sensors that switch off automatically when no persons are nearby, to prevent the creation of regular insect gathering pools. This will be at turbine bases (if applicable and other infrastructure buildings). For buildings, avoid tin roofs and roof structures that offer entrance holes into the roof cavity.

6 POSSIBLE MITIGATION MEASURES

The correct placement of wind farms, their individual turbines and the application of sufficient sensitivity maps for these technologies can significantly lessen the impacts on bat fauna in an area, and should be considered as the preferred and initial layer of mitigation.

With regards to the above-mentioned technologies, an essential mitigation to implement in the design of the facility is to keep artificial lighting to a minimum at infrastructure buildings and on wind turbines, while still adhering to safety and security requirements. For example, this can be achieved by having floodlights down-hooded, installing passive motion sensors onto lights around buildings, and possibly utilising lights with lighting temperatures that attract fewer insects. Light pollution will impact bat feeding habits and species compositions negatively, by artificially discouraging photophobic (light averse) species and favouring species that readily forage around insect-attracting lights.

The required and most effective method of mitigation can be determined from pre-construction acoustic bat activity data, climatic data and the results from the operational bat mortality monitoring. The latter monitoring will determine the need for mitigation and if necessary, the specific turbines to be mitigated. In combination, the data from the pre-construction and operational studies will enable a detailed mitigation schedule to be implemented as needed.

6.1 Curtailment that increases cut-in speed

The activity levels of South African bats generally decrease in weather conditions with increased wind speeds. However, in scenarios where significant numbers of bats are being killed, and these bats fly in wind speeds above the turbine manufacturer’s cut-in speed, the turbine’s computer control system (referred to as the Supervisory Control and Data Acquisitions or SCADA system) can be programmed to a cut-in speed higher than the manufacturer’s set speed. The new cut-in speed will then be referred to as the mitigation cut-in speed, and can be determined from studying the relation of long term (12-month) bat activity patterns with wind speed. In such a case the turbines are curtailed by means of blade feathering, to render the blades motionless in wind speeds below the mitigation cut-in speed.

6.2 Curtailment to prevent freewheeling

Free-wheeling occurs when the blades are rotating in wind speeds below the generator cut-in speed (also called the manufacturer's cut-in speed), thus no electricity is being produced and only some blade momentum is maintained.

Since bat activity tends to be negatively correlated with wind speed, it means that high numbers of bats are likely to be flying and impacted on in low wind speeds where freewheeling will be occurring. If turbine blades are feathered below the generator cut-in speed, to prevent free-wheeling, it can result in a very significant reduction of bat mortalities with minimal energy production loss.

6.3 Acoustic bat deterrents

This technology is being experimented with on wind farms in South Africa, and thus far yielded positive results that may indicate effectiveness of the devices in the correct scenarios. However, current data on the SA trials is still limited to a small sample set, and the technology will not necessarily be effective in all mitigation scenarios and on all species. Therefore, it should be considered and tested on a case specific basis, and the effect on reducing bat mortalities must be adequately monitored to determine the level of effectiveness.

6.4 Minimising light pollution on site

All lights on turbines and at substation and/or Operations and Management (O&M) buildings (excluding aviation lights), should be down-hooded and connected to motion sensors (where safe to do so), to minimise light pollution. Light pollution can attract bats that readily forage on insects attracted to light sources, significantly increasing the likelihood of collisions with turbines.

7 CONCLUSION

This Bat Impact Assessment Scoping Report considered information gathered from site visits between November 2020 and October 2021, literature, and satellite imagery. The bat species most likely to be impacted on by the proposed WEF are *Miniopterus natalensis, Laephotis* (formally *Neoromicia*) *capensis* and *Tadarida aegyptiaca*. These species are of special importance based on their likelihood of being impacted by the proposed WEF, due to high abundances and certain behavioural traits. They have also been dominating records of fatalities at wind energy facilities in South Africa. These more abundant species are of a large value to the local ecosystems as they provide a greater contribution to most ecological services than the rarer species, due to their higher numbers.

The presence of security lights on and around associated infrastructure creates significant light pollution that can impact bat feeding habits and species compositions negatively, by artificially discouraging photophobic (light averse) species and favouring species that readily forage around insect-attracting lights. Additionally, if the buildings and associated infrastructure for these facilities are placed close to wind turbines, the light pollution at these buildings can attract photophilic bat species, thereby significantly increasing their chances of being killed by moving blades of turbines within close proximity.

The Strategic Environmental Assessment (SEA) assigns 50km buffers to large bat roosts for wind energy, therefore any existing or possible cave/roost locations may be assigned this no-go area if they are found to be supporting large enough bat colonies. Figure 4.3 shows the dolomitic geology of the greater area, with an approximate 100km site boundary radius shown in red. At its nearest, the dolomite extends to approximately 70km north-east of the WEF. Dolomite is known to be prone to good cave formation, and many bat colonies are supported in such caves in the country, particularly in the province of Gauteng. Museum records of bats collected from two caves and two mines within approximately 100km of the site exist. Specimens of *Miniopterus. natalensis* and *Rhinolophus clivosus* were collected from River Cave (100km north of site); *R. simulator*, *Myotus tricolor* and *Cloeotis percivali* from a mine tunnel on Waterval Farm (91km north), *R. simulator*, *R. blasii*, *R. clivosus* and *Miniopterus fraterculus* from Kranskalkoen Cave (67km north east) and *Miniopterus natalensis* from Barites mine (100km north east). All of the above locations are further than 50km from the proposed site. The cave/roost buffers assigned by the SEA may be subject to change based on field-verified observations and roost buffers recommended by the South African Good Practice Guidelines for Surveying Bats (pre-construction) at Wind Energy Facility Developments (MacEwan et al. 2020).

A sensitivity map was drawn up indicating potential roosting and foraging areas. The High Bat Sensitivity areas are expected to have elevated levels of bat activity and support greater bat diversity. High Bat Sensitivity areas and their buffers are ‘no–go’ areas due to expected elevated rates of bat fatalities due to wind turbines. Avoidance is the most affective mitigation measure for reducing the impact on bats, and should be implemented as the first layer of mitigation.

No turbine blades may intrude into high sensitivity buffers. Medium sensitivities indicate areas of probable increased risk due to seasonal fluctuations in bat activity, but turbines are allowed to be constructed in medium sensitivity areas. Table 4.3 provides details on the significance of the sensitivity criteria on each infrastructure type.

The pre-construction bat monitoring has now been completed and will inform the EIA phase; passive bat activity data has been gathered, which will provide comparative bat activity and species assemblages across all seasons as well as various habitats, terrain and/or areas of the site. If the proposed WEF is approved, a minimum of 2 years of operational bat mortality monitoring should be conducted from the start of the operation of the facility.

Thus far, from a bat impact perspective, no reasons have been identified for the Camden II Wind Energy Facility development not to proceed to the EIA phase.

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