Chiropteran Specialist Report for the Proposed Soventix Solar Power Plant, Hanover, Northern Cape.

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1. Introduction

Habitat destruction and global climate change are impacting the earth on a large scale and monitoring such without studying the response of specific taxa to these changes is insufficient to understand the reaching effects of these factors on complex biological communities (Jones *et al.* 2009).

Environmental issues, such as habitat alteration, relating to the installation and operation of solar power plants have not been extensively addressed in literature and there remains a large gap in our knowledge concerning the aspects and impacts on a fine scale as well as the cumulative effects over a regional and global scale. In an attempt to identify and quantify the impacts of solar farms Turney and Fthenakis (2011) identified and evaluated 32 impacts falling into several categories namely; human health and wellbeing, land use intensity, geohydrological resources, climate change and plant and animal life.

Out of the 32 identified impacts, 22 were proposed to be beneficial, 4 neutral and 6 require further research. In relation to traditional power generation, the impacts of solar are much lower as solar power plants occupy the same or less land and have significantly lower CO_2 emissions unless the solar power plant is located in a forested region (Turney and Fthenakis, 2011).

Three main areas of concern that have a direct impact on wildlife and their associated habitats are the construction phase, operational phase and solar power plant fencing. Firstly, during the construction phase there can be a significant alteration to the vegetation and natural habitat as the ground is often scraped bare in preparation for the installation of the solar panels. The construction area is often kept free of vegetation by using herbicides or frequent mowing to prevent vegetation from growing tall. The immediate and direct impact on vegetation will result in a change in food availability (for prey and in turn predators), decrease in hiding spots and an alteration in predation strategies. Secondly, during the operational phase, depending on the management strategy, the solar power farm is either kept free of vegetation by the use of herbicides or mowed frequently to prevent vegetation from shading the solar resulting in similar impacts as listed above. The PV panels also cast shadows causing a change in the microclimate beneath the panels resulting in a change in vegetation composition. Lastly, fencing around solar power plants limit the movement of wildlife and also has a resulting impact on the change in habitat of the land particularly if it excludes herbivores that would have previously grazed and browsed the vegetation (Turney and Fthenakis, 2011).

Environmental impacts of solar power plants will differ based on the location of solar power plants as different biomes will incur different impacts which will affect natural services provided by specific biomes. It has been suggested that solar power plants located in desert or arid regions where the insolation is intense and were biodiversity is very low will have the lowest environmental impact (Turney and Fthenakis, 2011).

Specific taxa within these biomes that show a measurable response to climate change and habitat destruction are extremely important as bioindicators, particularly in an environment prior to the land being transformed (Jones *et al.* 2009). With specific reference to bats, the effects of solar power plants are largely unknown and understudied. Being the second highest species-rich mammalian order in the world (Stone *et al.* 2015), bats form a large component of global biodiversity. Bats are good bio-indicators of ecosystem health and or degradation as they are taxonomically stable, one can monitor trends in their populations, measure short and long-term effects on their populations, and they are distributed on a global scale making the effects of habitat change comparable (Jones *et al.* 2009, Jones *et al.* 2003).

A case study conducted by Montag *et al.* 2016 showed that the environmental management practices of operational solar plants played a major role in the biodiversity within the solar power plant facility. The solar power plant plots that were seeded with species-rich wild flower mixes and agricultural grass mixes and managed with a focus on wildlife management had greater diversity and abundance than the control plots, particularly concerning bird and insect species (Montag *et al.* 2016). However, there was no difference in bat biodiversity but there appeared to be a difference in bat activity which was higher over the control plots than the solar power plants. The reasoning for this may be related to bats being confused by artificially smooth surfaces as these surfaces do not reflect the echolocation calls of bats back to the individual, thus, the bat perceives the smooth surface as a hole and may even collide with the surface (Montag *et al.* 2016). Bats may learn to navigate these “holes” in the landscape, but they may also avoid them. Certain bat species may be more susceptible to avoiding such structures depending on their foraging guild. This in turn will affect bat species composition and the ecosystem services provided by these species.

Bats are threatened on a global scale by anthropogenic activities and climate change (Smith *et al.* 2016, Ancillotto *et al.* 2016). Anthropogenic activities result in the progressive fragmentation and or replacement of natural habitats and influence the community structure, individual fitness, population dynamics and behaviour of animals (Ancillotto *et al.* 2015). As critical components in ecosystem functioning, the cumulative effects on bat populations in relation to climate change, agricultural intensification, disease, fatalities induced by wind turbines, and the loss of habitat due to urbanisation and other anthropogenic activities, needs to be studied, identified and monitored as the future of South Africa bats is unclear.

In South Africa, the environmental effects of the development of solar power plants on vegetation and wildlife, particularly bats, is largely unknown. It is important to understand the science and impacts on wildlife and their habitat in order to develop effective management plans for wildlife, the conservation of biodiversity and preserving ecosystem functioning and health.

The purpose of this study conducted on the proposed Soventix solar power plant is to identify bats species that occur on the site, bat activity over the site, to determine potential impacts on those species and recommend mitigation strategies as part of the Environmental Impact Assessment (EIA).

2. Soventix Solar Farm Site, Vegetation, Climate & Topography

There are three proposed locations for the Soventix Solar Farm indicated in red on the map below (**Image 1**). Three potential locations are proposed for the Soventix Solar Farm Site, namely:

1. Portion 1 of Farm Riet Fountain 39C & Portion 1 of Farm Kafferspoort 56C,
2. Portion 1 of Farm Riet Fountain 39C, Portion 1 of Kwanselaars Hoek 40C & Portion 4 of Taaibosch Fontein 41C.
3. The remainder of the farm Riet Fountain 39 C, the remainder of Kwanselaars Hoek 40C & the remainder of Farm Goedehoop 26C.

All three locations are in the De Bad area (-30.861796°, 24.302868°) situated near the town of Hanover, Northern Cape in the Pixely ka Seme District Municipality.

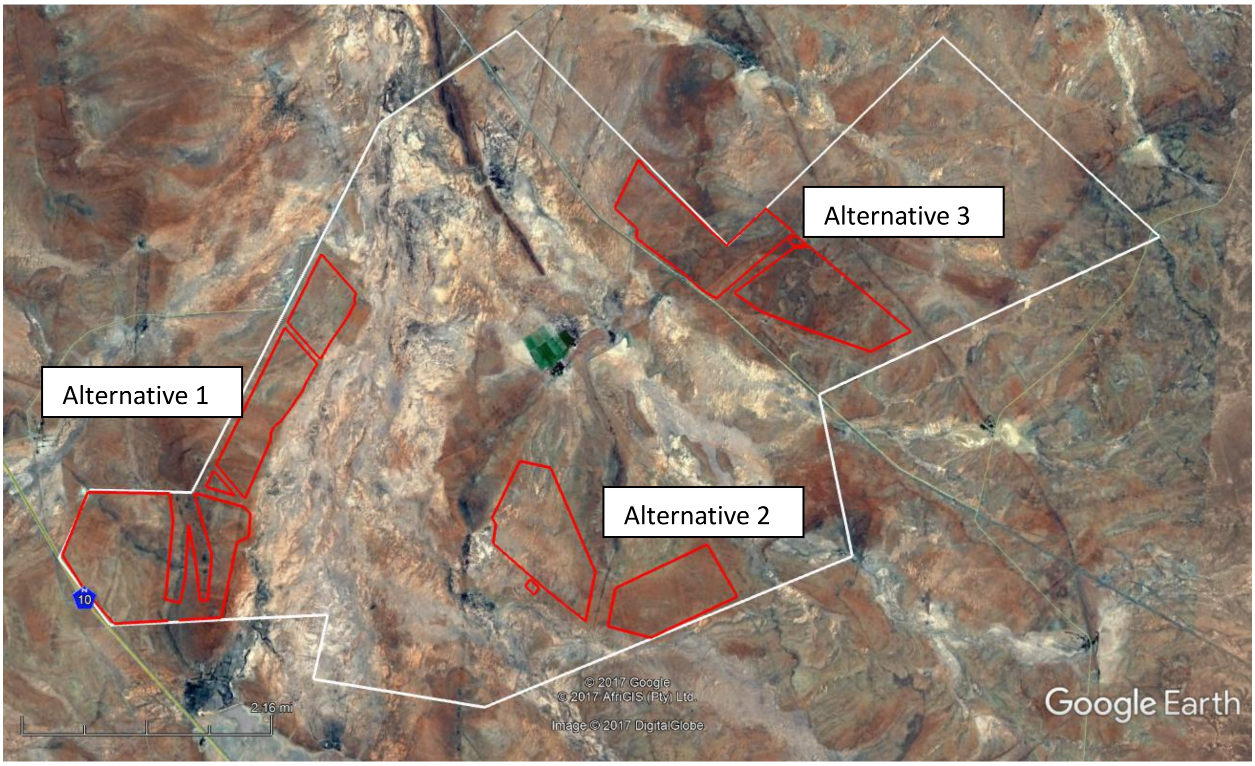

Image 1. The extent of the three alternative areas of the proposed Soventix Solar Farm (red) and the boundary of the affected property (white).

The Nama-Karoo, within which lies the Eastern Upper Karoo, does not contain any centre of endemism and is not particularly florally diverse, and as with other arid and semi-arid areas, it is dominated by Poaceae, Asteraceae and Fabaceae (Mucina and Rutherford, 2006). The dry/arid, open and exposed landscape of the Eastern Upper Karoo is dominated by dwarf microphyllous shrubs and *Eragrostis* and *Aristida* grass species. There are numerous important and several endemic floral taxa that occur in the Eastern Upper Karoo for example *Lycium oxycarpum, Eriocephalus ericoides, Pentzia globose, Helichrysum dregeanum, Aristida diffusa* and *Eragrostis lehmanniana*. The conservation status of the Eastern Upper Karoo is "Least Threatened" with moderate to high soil erosion and the presence of the common and widespread alien plant *Medicago laciniata* (Mucina and Rutherford, 2006).

The peak rainfall season is autumn and summer ranging from 180-430mm across the west to east gradient (Mucina and Rutherford, 2006). The minimum winter temperature is approximately -7°C with regular occurrences of frost and the mean maximum summer temperature is 36°C (Mucina and Rutherford, 2006).

The Eastern Upper Karoo landscape generally consists of vast flats and gentle sloping plains (**Image 2**) with rocky areas, hills and koppies (**Image 3**) scattered in the landscape (Mucina and Rutherford, 2006).

Image 2. The generally flat open dry arid landscape of the Eastern Upper Karoo with rocky outcrops in the distance.

Image 3. Scattered koppies protruding from the otherwise flat landscape providing shelter and habitats for numerous vertebrate and invertebrate species.

3. Sample Methods and Data Analysis

3.1 Desktop Study

The desktop study was conducted to identify areas of potential importance to bats such as foraging areas and roosting sites, the species probability of occurrence, and potential impacts expected during the construction and operational phases of the solar power plant (**Table 1**).

3.2 Data Collection and Analysis

It was imperative that the data collection was conducted during the late spring or summer season when bats are most active in South Africa due to warmer temperatures, increase in precipitation and the associated increase in insect activity. If data collection was conducted outside of the late spring to summer period, there is a high risk that bat activity and species assemblages would be underestimated and adequate aspects, impacts and mitigation measures would not be able to be determined with confidence. In addition, due to the short time period that the survey was conducted over, the time period may limit the number of species detected as the area was still rather dry as the seasonal rains had not yet fallen that would have influenced insect activity. In addition, apart from the man made water points, there were no natural open water bodies that may have yielded better insight into the significance of larger open water bodies to bats in the area.

In addition, the short time frame did not allow for active trapping of bats to verify species recorded by the bioacoustic recorder and to capture species that are not generally recorded during transects based on the structure of their call such as the Common Slit-faced bat, *Nycteris thebaica*.

Roost Sites

The potential roosting sites identified during the desktop (**Image 4**) study were investigated on foot on 28 October 2016 for signs of bat occupancy (the presence of urine stains on rocks, the characteristic smell of guano particularly that of free-tailed bats, and audible squeaking that bats tend to emit when disturbed in their roost during the day).

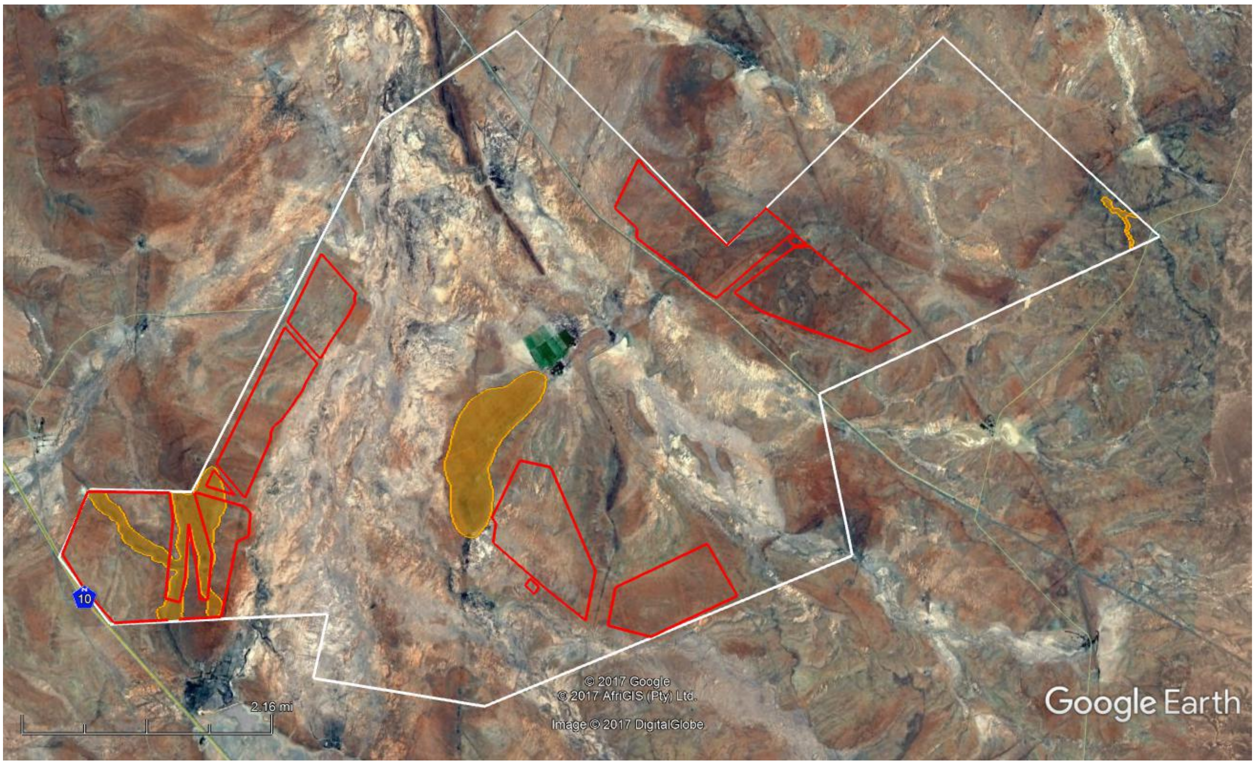

Image 4. Locations of potential roosting sites highlighted in orange in relation to the proposed solar arrays (red).

Acoustic Monitoring

Three nights of driven transects were conducted on the nights from 26-28 October 2016 to determine the presence/absence and temporal distribution of chiropteran species which may occur in the area. A SM3BAT Bioacoustics Recorder and SMM-U1 ultrasonic microphone (Wildlife Acoustics, Inc) was mounted onto the research vehicle and the largest possible area of all three portions of the proposed solar farm were covered using existing farm roads. Transects began shortly after sunset and was terminated once all three portions of the proposed solar farm were covered. To prevent a bias towards chiropteran abundance (during the evening emergence) on a given portion of the farm each transect was started on a different portion of the farm.

All calls recorded by the SM3BAT Bioacoustics Recorder were converted into zero-crossing (ZC) and sound (WAV) files for identification purposes. BatSound (Pettersson Elektronik AB) and AnalookW (Chris Corben) were used to identify individual bat echolocation calls. Species were identified based on peak frequency, call duration and bandwidth.

During transects, echolocation calls spaced a minute apart were considered as individual bats to lessen the possibility of replication of calls by the same individual. Each species was mapped onto the transect tracks using Myotisoft Transect (Digital Bat Services) and Google Maps to indicate areas where bats may be most active across the site in relation to potential roosting sites, available surface water and or insect abundance associated with available surface water or land use activities.

To determine time periods of main activity (foraging, commuting and/or social), transect times were divided into time categories of 30min.

4 Results

4.1 Desktop Study

A list of species that may occur on the proposed Soventix Solar Power Farm was composed with all species considered "Least Concern" on the IUCN Red data list (IUCN 2016-3) and 2016 Red List of Mammals of Southern Africa, Lesotho and Swaziland.

Table 1. Probability of occurrence of bats species over the proposed Soventix Solar Farm.

Scientific Name	Common Name	Habitat Preference	Foraging Guild	Roost Type	Probability of Occurrence (Low/Medium/High)
Tadarida aegyptiaca	Egyptian Free-tail Bat	Widespread and abundant, found in all habitat types	Open air forager	Rock crevices, caves, exfoliating rock, behind tree bark, ceilings, thatch roofs	High
Neoromicia capensis	Cape Serotine	Widespread and abundant	Clutter-edge forager	Roofs of houses, under tree bark, at the base of aloe leaves	High
Eptesicus hottentotus	Long-tailed Serotine	Widespread but sparse	Clutter-edge forager	Caves and rocky outcrops	Medium
Miniopterus natalensis	Natal Long-fingered Bat	Widespread. More common in the south and east than the arid west	Clutter-edge forager	Caves	Low

Rhinolophus clivosus	Geoffroy's Horseshoe Bat	Variety of habitats including riparian forest, woodland and arid savanna	Clutter forager	Caves, mine adits, culverts, cavities in piles of boulders	Low
Rhinolophus darlingi	Darling's Horseshoe Bat	Variety of habitats including arid savanna	Clutter forager	Caves, mine adits, culverts, cavities in piles of boulders	Low
Rhinolophus denti	Dent's Horseshoe Bat	Arid habitats-Restricted to areas with rocky outcrops and caves	Clutter forager	Caves, crevices in rocky outcrops, semi-dark caverns	Medium
Nycteris thebaica	Egyptian Slit-faced Bat	Variety of habitats, avoids open grassland	Clutter forager	Road culverts, caves, aardvark burrows, hollow trees	Medium

4.2 Roost Sites

Potential roosting sites were searched for on foot in the rocky outcrops on the southwest portion of the farm closest to the N10 (30.88475°S; 24.25497°E) (**Image 5**), along the ridge (30.83403S; 24.38355E) situated on the northeast farm portion and lastly on the mountain (30.88089S; 24.29344E) situated near the centre of the farm.

No current roosts were located, but this does not imply that roosts are not present on the affected property and the rocky areas particularly on the southwest and northeast portions of the farm should be preserved and buffered with a zone of at least 100m from the parameter of the solar array.

Image 5. An example of one of the numerous koppies situated on the southwest portion that may provide suitable roosting sites for bats.

Image 6. The ridge running along the northeast boundary that may provide suitable roosting sites for bats, particularly crevice dwelling species.

Image 7. A rocky outcrop on the mountain near the farm house. The image is deceptive in the size of the outcrop and this specific grouping of boulders has a low potential as a suitable roosting site for bats.

4.3 Acoustic Monitoring

Over the three nights of transects, only two species of bats were recorded namely the Egyptian Free-tailed bat, *Tadarida aegyptiaca* and the Cape Serotine, *Neoromicia capensis. T. aegyptiaca* accounted for 95.6% of the calls recorded and *N. capensis* accounted for the remaining 4.4% (**Figure 2**). Both species are widespread and abundant and are classified as "Least Concern" on the IUCN Red Data List (IUCN 2016) and the Red List of Mammals of Southern Africa, Lesotho and Swaziland.

Table 2. Species identified according to echolocation calls, conservation status, distribution, habitat preference, foraging ecology, roost type and profile.

Species Name and Conservation Status	**Distribution & Habitat Preference**	**Foraging Ecology**	**Roost Type**	**Profile**
Family VESPERTILIONIDAE				
Cape Serotine – *Neoromicia capensis* **Least Concern***	Widespread throughout southern and central Africa. Tolerant of a wide range of habitat types: arid semi-desert, forest, montane grasslands and savanna.	Clutter-edge forager.	Roofs of houses, under bark of trees, at bases of aloes and thatch roofs.	
Family MOLOSSIDAE				
Egyptian Free-tailed bat – *Tadarida aegyptiaca* **Least Concern***	Widespread and abundant throughout southern Africa but restricted distribution in western Botswana and western Namibia. Absent from most of Mozambique and Malawi. Vegetation type appears to have little influence on distribution. Occurs in most habitat types but avoids forests.	Open air forager.	Rock crevices, caves, hollow trees, under bark and under exfoliating rocks. Have been recorded roosting in large colonies in roofs of anthropogenic structures.	

*IUCN Red Data List 2016-3

4.4 Bat activity over the proposed Soventix Solar Farm, Hanover.

Transects conducted on 26-28 October 2016 (**Image 8**), provided some insight with regards to bat activity across the site. Three main areas of activity were identified based on the total number of bat calls recorded in the specific areas (**Image 8**). The irrigated lucerne fields, farm house and the low-lying area to the west of the farm house (Area 1), the low-lying area and associated riparian vegetation (Area 2) and rocky outcrops on the southwestern portion of the farm (Area 3) had the highest bat activity recorded over the site.

The high bat activity over Area 1 may be related to the available surface water, prey availability (high insect activity over the irrigated lucerne fields and around security light at the farm house) and available roosting sites provided by the anthropogenic structures (farm house and barns).

High bat activity over Area 2 may be due to insect activity related to the riparian vegetation growing in the low-lying area. The bat activity over Area 3 may be related to roost availability and the presence of prey items associated with the vegetated rocky koppies that may boast a variety of insects based on available shelter and food resources.

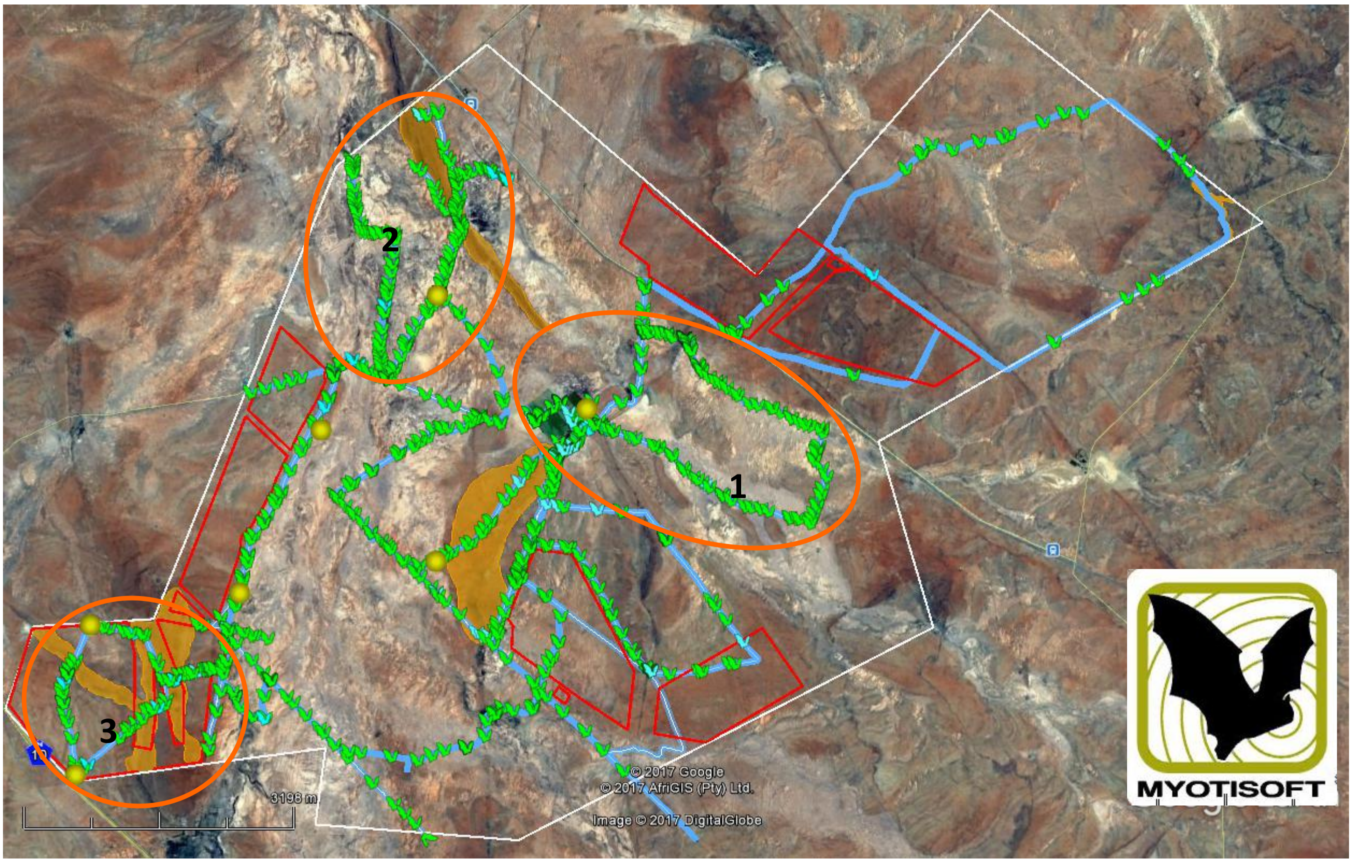

Image 8. Overall bat activity and main areas of bat activity over the proposed solar farm in relation to the landscape and land use.

Overall, bat activity over the proposed solar farm site was high with a total of 3413 calls recorded over the three transect nights (Figure 1). The high bat activity may have been in response the high insect activity observed during the transects that may have emerged in response to the rains that had recently been received.

Bat activity during the night appears to be bimodal with two peaks in activity from 20:00-22:30 and 22:31-01:00, thereafter activity decreased (Figure 2).

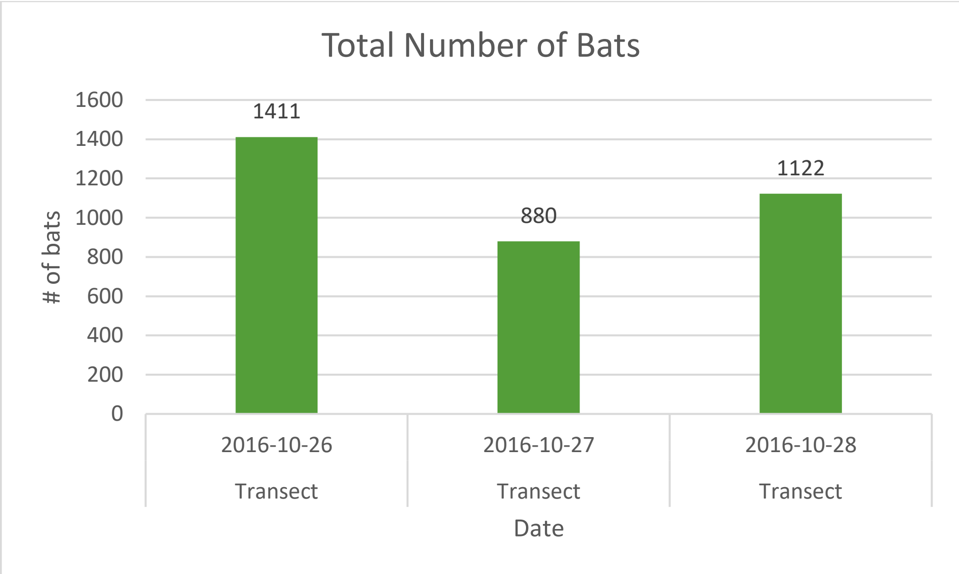

Figure 1. Total bat activity recorded during the transect surveys from 26-28 October 2016.

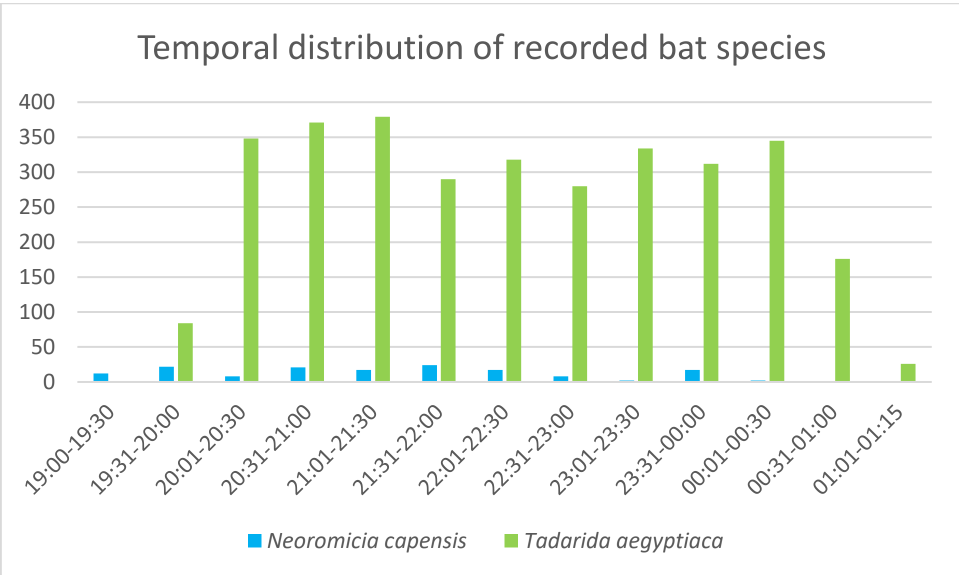

Figure 2. Overall temporal distribution of bat activity across the proposed solar farm.

5. Potential Impacts and Mitigation Measures

The conservation of the Nama-Karoo is largely dependent on the land use and conservation practices of privately owned land as the vast majority of vertebrate and invertebrate species are nomadic and move with the fluctuating availability of resources associated with the unpredictable nature of rainfall events. In order to conserve the Nama-Karoo, it is vital that landowners and developers understand that is valuable to conserve and maintain the diverse indigenous vegetation.

The significance of the impacts of the planning & design phase, the construction phase and the decommissioning phase were determined by rating the impacts for each phase according to the following criteria:

- The **aspect** relates to the characteristic of a given activity that interacts with the environment that can cause an environmental impact. The impact can be either beneficial or adverse and can have a direct and decisive impact on the environment. The aspect can contribute partially or indirectly to a larger environmental change.
- The **extent** of the impact is rated;
  - High (4) if it extends beyond the boundaries of the site (Provincial, National, or International);
  - Moderate (3) if the impact is local (within the farm boundaries) to Regional (affects the neighbours);
  - Low (2) if the impact is contained within the boundary of the site or;
  - No impact (1) if no area is affected.
- The **intensity or magnitude** of the impact is rated;
  - High (4) if the functioning of the environmental processes will cease, if there is a complete change in species occurrence and species assemblages, or the disturbance of pristine areas;
  - Moderate (3) if the altered environmental processes will continue, if there are moderate changes in species occurrence and species assemblages or if areas of potential conservation and resource use by the species are disturbed

    - Low (2) if the natural processes are affected but not modified, if there are minor changes in species occurrence and species assemblages and if already degraded areas are disturbed;
    - No impact (1) if natural processes are not affected.
- The **duration** of the impact is rated;
    - High (4) if the impact is long term and permanent (>2years);
    - Moderate (3) if the impact is medium term and the lifespan of the impact is temporary and restricted to the operational phase (>1<2 years);
    - Low (2) if the impact is immediate and once-off with the lifespan of the impact restricted to the construction phase or to a season (<1 year).
- The **mitigation potential** will be rated;
    - High (4) if the potential to mitigate the impact and achieve the objectives is high;
    - Moderate (3) if the potential to mitigate the impact and achieve the objectives is moderate;
    - Low (2) if there is potential to mitigate the impact and a risk remains of the objectives not being met;
    - If there is no mechanism for mitigation and achieving the objects, the impact will be rated 1.
- The **acceptability** of the impact will be rated;
    - High (4) if the impact is unacceptable and the project or design must be abandoned;
    - Moderate (3) if the impact is manageable with expensive regulatory controls and the project proponent’s commitments;
    - Low (2) if there is some risk to the environment but can be easily prevented using simple controls or mitigation measures;
    - No impact (1) if the impacts are acceptable with no risk to the environment.

- The **probability of the impact occurring** will be reported as;
  - Definite (D – 4) if the impact has a high probability of occurring (>95%) if there is substantial supportive data or even if preventative measures are put in place;
  - Probable (P – 3) if there is a risk of the impact occurring (5-95%);
  - Improbable (I – 2) if the impact is unlikely to occur (<5%);
  - No impact (N – 1) if the impact will not occur (0%).
- The **status** if the impact occurs is categorised as;
  - Negative if there is a net loss of the resource, thus an adverse effect;
  - Neutral, if there is no net loss or gain;
  - Positive if there is a net gain of the resource if the impact occurs, thus a beneficial effect of the impact.
- The **potential to mitigate** is determined by the sum of the extent, magnitude and duration of the impact multiplied by the potential to mitigate as is classified as;
  - High if the significance value is between 30-40, thus there is a high potential to mitigate and achieve the project objectives;
  - Moderate if the significance value is between 20-29, thus there is a moderate potential to mitigate and achieve the project objectives;
  - Low if the significance value is between 0-19, thus indicating that there is a potential to mitigate, however, there is a risk that the project objectives are not met.

The potential impacts and recommended mitigation measures are discussed below in Table 3.

Table 3: Potential Impacts during the Planning & Design Phase, Construction & Operational Phases and Decommissioning.

Phase	Aspect		Mitigation Action	Extent	Magnitude	Duration	Mitigation Potential	Significance	Acceptability	Probability of Impact Occurring	Status	Mitigation potential (to meet objectives)
Compliance												
Planning & Design	Decrease in species composition, activity and abundance.	Alternative 1	Without	3	3	4	4	40	4	P-3	Negative	H
			With	2	1	3	3	18	2	I-2	Positive	
		Alternative 2	Without	3	3	4	4	40	4	P-3	Negative	H
			With	2	1	3	3	18	2	I-2	Positive	
		Alternative 3	Without	2	2	4	4	32	4	P-3	Negative	H
			With	2	1	1	3	12	2	I-2	Positive	

It is important when considering the planning, layout and design of the solar arrays, to take into consideration the areas of significance for bat roosting, commuting, foraging and socialising as highlighted in the current report.

Taking into consideration not only the impacts of the proposed Soventix Solar Farm but the potential cumulative impacts of anthropogenic activities in the area and South Africa as a whole, it is important that the project developers are cautious and sensitive to species occurring within a given development footprint and the potential cumulative impacts on fauna and flora. The Linde Solar Farm (Simacel 155 Pty Ltd), Du Plessis Solar PV4, Mulilo Solar PV De Aar, South African Mainstream Renewable Power De Aar PV (De Aar Solar Power Pty Ltd) and Solar Capital De Aar (Solar Capital Pty Ltd) that lie 36km, 37km, 39km, 37km and 35km respectively from the proposed Soventix Solar Farm. The impacts of bats over these solar farms have not been assessed and addressed, which is worrisome. There is a high potential for loss of species diversity, decrease in ecosystem functionality & service provision, and the cessation of processes within the landscape that can be permanent, lead to further land degradation and ultimately a collapse in the livelihood of not only the species that currently occur there, but may significantly impact negatively on the livelihood of the human inhabitants in the area.

Phase	Aspect		Mitigation Action	Extent	Magnitude	Duration	Mitigation Potential	Significance	Acceptability	Probability of Impact Occurring	Status	Mitigation potential (to meet objectives)
Compliance												
Construction & Operational Phase	Disturbance to or destruction of roosting sites.	Alternative 1	Without	3	3	3	2	18	3	P-3	Negative	L
			With	2	2	3	2	14	2	P-3	Neutral	
		Alternative 2	Without	2	3	2	4	28	1	N-1	Negative	M
			With	1	3	2	4	24	1	N-1	Neutral	
		Alternative 3	Without	1	1	1	4	12	3	I-2	Negative	L
			With	1	1	1	4	12	2	I-2	Neutral	
	Disturbance/alteration of important areas of bat activity associated with vegetation clearing.	Alternative 1	Without	3	3	3	2	18	3	P-3	Negative	L
			With	2	2	3	2	14	2	P-3	Neutral	
		Alternative 2	Without	3	3	3	2	18	3	N-1	Neutral	L
			With	2	2	3	2	14	2	N-1	Neutral	
		Alternative 3	Without	2	3	2	4	28	3	I-2	Negative	M
			With	1	2	2	4	20	2	I-2	Neutral	
	Light pollution may alter species composition, foraging patterns, reproductive success and predation rate.	Alternative 1	Without	3	3	3	4	36	2	P-3	Negative	H
			With	2	2	3	3	21	2	P-3	Neutral	
		Alternative 2	Without	3	3	3	4	36	2	P-3	Positive	H
			With	2	2	3	3	21	2	P-3	Neutral	
		Alternative 3	Without	3	3	3	4	36	2	P-3	Positive	H
			With	2	2	3	4	28	2	P-3	Neutral	
	Construction of PV altering commuting routes within the landscape.	Alternative 1	Without	2	3	3	3	24	3	P-3	Negative	M
			With	2	2	3	2	14	2	I-2	Neutral	
		Alternative 2	Without	2	3	3	3	24	2	P-3	Negative	M
			With	2	2	3	3	21	1	P-3	Neutral	
		Alternative 3	Without	3	2	3	4	32	2	I-2	Neutral	H
			With	2	2	3	3	21	2	I-2	Neutral	

	Bat foraging patterns affected by habitat changes beneath the solar panels.	Alternative 1	Without	3	3	3	3	27	3	P-3	Negative	M
			With	2	3	3	3	24	2	P-3	Neutral	
		Alternative 2	Without	3	3	3	3	27	3	P-3	Negative	M
			With	2	2	3	3	21	2	P-3	Neutral	
		Alternative 3	Without	3	2	3	3	24	3	P-3	Negative	M
			With	2	2	3	3	21	2	I-2	Neutral	
	Changes in bat community, abundance and activity of bat species due to habitat degradation.	Alternative 1	Without	3	3	3	3	27	3	P-3	Negative	M
			With	2	2	3	2	14	2	P-3	Neutral	
		Alternative 2	Without	3	3	3	3	27	3	P-3	Negative	M
			With	2	2	3	2	14	2	P-3	Neutral	
		Alternative 3	Without	2	2	3	3	21	2	I-2	Neutral	M
			With	2	2	3	3	21	2	I-2	Neutral	
	Overall Cumulative Impact of Construction & Operational Phase.	Alternative 1	Without	3	3	3	2	18	3	P-3	Negative	L
			With	2	2	3	2	14	2	P-3	Neutral	
		Alternative 2	Without	3	3	3	3	27	3	P-3	Negative	M
			With	2	2	3	3	21	2	P-3	Neutral	
		Alternative 3	Without	2	2	3	3	21	2	P-3	Neutral	M
			With	2	2	3	3	21	2	I-2	Neutral	

a. Disturbance to roosting sites during construction activities,

- Bats are known to use a variety of roost types from rock cavities, exfoliating rock, tree foliage, under tree bark, tree cavities, aardvark burrows, natural and man-made caves and numerous man-made structures (Jones *et al* 2009, Monadjem *et al.* 2010, Voight *et al.* 2016) however, during the active search for roosts in the natural terrain, no roosting sites were located. There is a colony of bats roosting in the main farm house, but this colony will not be impacted by any solar power plant related construction activities.

It is recommended that if the solar power farm is to be installed near the numerous rocky outcrops in the southwest portion of the farm (**Image 3**), it would be preferable for a 100m buffer zone to be extended around the area to limit any potential impact on roosting sites in the rocky outcrops.

b. **The removal of vegetation and degradation of habitat resulting in the disturbance of important areas of bat activity,**

- Changes in landscape and habitat conversion can affect bat populations and assemblages on a local and regional scale (Jones *et al*. 2009, Jones *et al*. 2003, Jung and Kalko 2011).
- Large scale removal of natural vegetation for the installation and operation of solar power plants can cause a change in prey availability and thus a change in bat activity in the landscape.
- Open water in arid and semi-arid environments (such as in the Nama-Karoo) may be an important resource influencing survival, resource use, distribution and activity of insectivorous bats (Korine *et al.* 2016).
- It is important that areas with low lying depressions where water pools during the autumn and summer rainfall season are not altered as they may be important areas not only for bats to drink and forage but also for socialising.

It is recommended that;

- As much of the natural established vegetation is conserved.
- Use pre-existing farm roads during construction. Discourage construction vehicles from driving through the natural vegetation and drainage lines were construction activities are not taking place.
- Seed disturbed areas after construction with seeds of the naturally occurring plant species to encourage invertebrate species richness.
- If possible, refrain from using herbicides to control the height of vegetation, rather use domestic stock (preferably sheep as goats tend to be unselective of the vegetation they consume and tend to be more destructive than sheep) to graze and browse the vegetation, however, this will need to be carefully

monitored as grazing during and shortly after a drought can cause palatable plant species to die off, heavy grazing pressure in summer will favour the growth of karoid shrubs, and high grazing pressure during winter will favour the growth of perennial grasses (Mucina and Rutherford, 2006) both of which can affect insect abundance which in turn may affect bats.

- Ensure that the vegetation in the solar plant farm footprint is not overgrazed as this will significantly alter plant canopies can lead to the reduction in leaf litter from the plants which is important for seed retention (Jones and Esler, 2004) and will expose the soil to erosion by both wind and water. With the loss of precious topsoil, the restoration of these areas will be difficult.

c. Light pollution during construction and operational phase.

- Light pollution impacts both negatively and positively on bats and can alter species composition, foraging patterns, reproductive success and predation rate (Stone *et al.* 2015). Research has shown that there are open-area foraging bat populations that may benefit from feeding on insects attracted to artificial light sources (Jones *et al.* 2009, Voigt *et al.* 2016). Conversely, if artificial lighting is located close to roosting sites, the foraging emergence times of the bats can be delayed.

It is recommended that security lights/spot lights are erected only near infrastructure/where absolutely necessary and are only switched on just after the night time bat emergence (seasonally dependent).

d. Habitat changes beneath the solar panels.

- The change in the microclimate beneath the solar panels and between the solar panels may provide different ecological conditions which may encourage or provide suitable conditions for botanical diversity (Montag *et al.* 2016). Invertebrate diversity will be influenced by botanical diversity as plants provide forage, habitat and structure for reproduction (Montag *et al.* 2016), and thus in turn may positively influence and possibly increase bat foraging activity.

Phase	Aspect		Mitigation Action	Extent	Magnitude	Duration	Mitigation Potential	Significance	Acceptability	Probability of Impact Occurring	Status	Mitigation potential (to meet objectives)
Compliance												
Decommissioning	Loss in species diversity, abundance and a decrease in activity if rehabilitation objectives are not met.	Alternative 1	Without	3	3	4	4	40	4	P-3	Negative	H
			With	2	1	3	4	24	2	I-2	Positive	
		Alternative 2	Without	3	3	4	4	40	4	P-3	Negative	H
			With	2	1	3	4	24	2	I-2	Positive	
		Alternative 3	Without	2	2	4	4	32	4	P-3	Negative	H
			With	2	1	1	4	16	2	I-2	Positive	

It is recommended that during the rehabilitation phase, a seed mix containing a variety of the local floral species is used and that the management practices are focused on biodiversity conservation.

Annual monitoring during preconstruction and during the operational phase will provide much needed insight into the changes in bat activity, species composition and ecology over the affected property. One year preconstruction and two years post-construction of continuous bat monitoring using passive bioacoustic recording systems in line with the South African Good Practice Guidelines for Surveying Bats at WEF's (Sowler and Stoffberg, 2014) and SAGPG for Operational Monitoring (Aronson *et al.* 2014) should be followed as any changes in bat activity and perceived impacts will be most evident in the first two years of operation. The time frame for post-construction monitoring thereafter can be altered. By following these guidelines, data sets that are comparable with other large-scale renewable energy projects that impact bats, can be collected and collectively used to understand the extent of the impacts of these projects and define effective mitigation strategies.

6. Limitations and Assumptions

Following the bat specialist study and submission of the scoping and compilation and first submission of specialist report, the EAP issued the revised layout for the proposed Soventix Solar Farm based on the inputs from the specialists (**Image 9**).

The limitations of the revised layout of the footprints are few and essentially restricted to Alternative 3 portion 6/27 as the area is located outside of the initial assessment, however it is assumed that since it falls outside of the low-lying areas that the bats appear to favour, bat activity will not necessarily be negatively impacted. The initial impact assessment ratings will remain the same for the revised Alternative 3 footprint as the original Alternative 3 footprint ratings.

The reduction in the size of Alternative 1 where the initial footprint falls into a developmental "no-go" area, sufficiently lowers the impacts of the aspect that potential roosting sites will be disturbed and or destroyed during the construction phase and reduces the impacts from moderate (3) to no impact (1). The original ratings of the criteria that have been assigned for the Alternative 1 footprint under potential impacts and mitigation measures (Section 5) may in all likelihood be rated similarly to Alternative 2 under the revised reduced footprint area.

Based on the initial impact assessment that suggests that Alternative 2 and 3 footprints are preferred development sites for the proposed Soventix Solar Farm, when overlaying the original map of overall bat activity and main areas of bat activity (**Image 8**) with the revised extended proposed Alternative 2 and 3 footprints (**Image 9**), both footprints continue to fall in areas of lower bat activity. In addition, the revised Alternative 2 footprint has increased in distance away from a potential roosting site and extended into an area that had low bat activity recorded, thus gaining favour for development. However, based on the limitations incurred from the short time frame in which the data was collected, the impact assessment ratings will stay the same as the original Alternative 2 footprint.

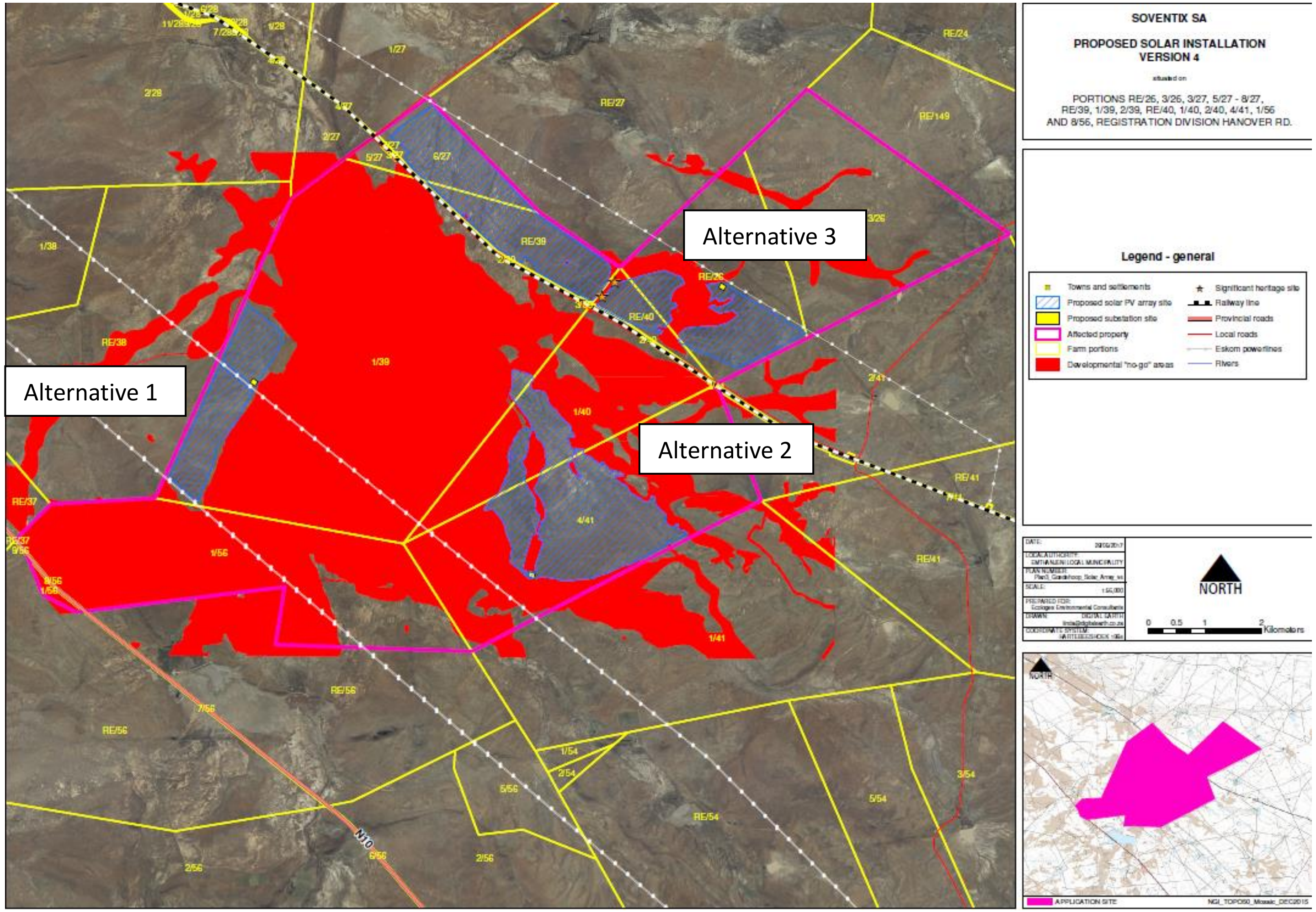

Image 9. Revised alternative footprints for the proposed Soventix Solar Farm based on specialist studies.

7. General Conclusion

Bat activity and trends in population numbers are of particular interest to determine the cumulative long-term effects of solar power plants, it is suggested that a passive recording monitoring system be put in place for one year pre-construction and two years post construction. These systems are to be maintained by a specialist to determine the impacts of solar power plants on bat populations in relation to landscape changes in both the physical changes with the installation of the PV panels, the resulting change in vegetation structure underneath the PV panels and the management strategy of the operational facility.

No specialist species of bats were identified during the field study, nonetheless, with additional deterioration to the landscape and the loss of habitat due to vegetation clearing may cause a shift in the species composition within the bat community to a bias towards more hardy species such as the Egyptian free-tailed bat, *T. aegyptiaca*.

It is assumed based on the short time frame of the fieldwork and the time of the fieldwork that took place prior to the area receiving the first good summer rainfalls, that not all bat species that should occur in the area (**Table 1**) were recorded by the bioacoustic recorder, but all species were considered for all three solar farm alternatives when determining the significance of the potential impacts and mitigation strategies.

In addition, there is desperate need for thorough long-term studies (including baseline studies of bat populations and dynamics) of renewable energy project developments in South Africa and their effects on bat communities as there is a large gap in the current scientific literature and understanding of the future conservation of South African bats.

The views expressed in this report are cautious with an emphasis on conserving the natural vegetation, rocky outcrops and ecosystem functionality to enhance the conservation of all bat species that occur in the area and not only the Cape Serotine bat (*N. capensis*) and the Egyptian free-tailed bat (*T. aegyptiaca*) that were recorded during the specialist study.

The rehabilitation and management of the operational solar power plant will be a critical activity as this will have a direct impact on biodiversity and ecosystem functioning.

In my opinion, based on the data collected during the bat baseline survey and available literature, there is little reason from a chiropteran perspective for the development of the proposed Soventix Solar Farm not to be approved for the original Alternative 2 and 3 footprints and the revised Alternative 1, 2 and 3 footprints provided mitigation measures are put in place during all phases of the development and decommissioning of the Soventix Solar Farm.

7.Credentials of the Author

Dawn Cory-Toussaint has had an interest in bats from a young age and has been involved with the Gauteng and Northern Regions Bat Interest Group since 2004 which developed her interest in Chiropterans further. Her post graduate studies were focused on heterothermy in bats producing three publications from her work:

Cory Toussaint, D., McKechnie, A. E., & van der Merwe, M. 2010. Heterothermy in free-ranging male Egyptian free-tailed bats (*Tadarida aegyptiaca*) in a subtropical climate. *Mammalian Biology* **75**: 466–470.

Cory Toussaint, D., & McKechnie A. E. 2012. Interspecific variation in thermoregulation among three sympatric bats inhabiting a hot, semi-arid environment. *Journal of Comparative Physiology B.* **182**: 1129-1140.

Cory Toussaint, D., Brigham, R. M., & McKEchnie, A. E. 2013. Thermoregulation in free-ranging *Nycteris thebaica* (Nycteridae) during winter: No evidence of torpor. *Mammalian Biology* **78**: 365–368.

Dawn Cory Toussaint has been involved in bat surveys for North West Nature Conservation, biodiversity projects and assisting in the study of reproduction in *Tadarida aegyptiaca* (University of Pretoria).

From August 2013-August 2014 she held a position as a Junior Environmental Consultant for Animalia: Zoological and Ecological Consultation CC. as a bat specialist for pre-construction surveys of Wind Energy Farms across the country.

During 2016 she conducted the baseline assessment of the bats species on the proposed Spitsvale opencast mining project, Steelpoort, Limpopo Province and compiled a bat species list for the Booysendal Mine, Limpopo Province.

8. References

Ancillotto, L., Santini, L., Ranc, N., Maiorano, L and Russo, D. 2016. Extraordinary range expansion in a common bat: the potential roles of climate change and urbanisation. *Sci Nat* DOI: 10:1007/s00114-016-1334-7.

Aronson, j. Richardson, E. K., MacEwan, K., Jacobs, D., Marais, W., Aiken, S., Taylor, P., Sowler, S. and Hein, C. 2014. South African good practice guidelines for operational monitoring for bats at wind energy facilities.

IUCN 2016. The IUCN Red List of Threatened Species. Version 2016-3. http://www.iucnredlist.org.

Jones, G., Jacobs, D. S., Kunz, T. H., Willig, M. R. and Racey, P. 2009. Carpe noctem: the importance of bats as bioindicators. Endangered Species Research 8: 93-115.

Jones, K. E., Russ, J. A., Bashta, A., Bilhari, Z., Catto, C., Csosz, I., Gorbachev, A., Gyorfi, P., Hughes, A., Ivashkiv, I., Koryagina, N., Kurali, A., Langton, S., Collen, A., Margiean, G., Pandourski, I., Parsons, S., Prokofev, I., Szodoray-Paradi, A., Szodoray-Paradi, F., Tilova, E., Walters, C. L., Weatherill, A. and Zavarzin, O. 2013. Indicator Bat Program: A System for the Global Acoustic Monitoring of Bats. *Biodiversity Monitoring and Conservation: Bridging the Gap between Global Commitment and Local Action, 1st Edition.* John & Wiley Sons, Ltd. Chapter 10.

Jones, F. E. and Esler, K. J. 2004. Relationship between soil-stored seed banks and degradation in Eastern Nama Karoo rangelands (South Africa). *Biodiversity & Conservation* 13: 2027-2053.

Jung, K. and Kalko, E. K. V. 2011. Adaptability and vulnerability of high flying Neotropical aerial insectivorous bats to urbanisation. *Diversity and Distributions* 1-13.

Korine, C., Adams, R., Russa, D., Fisher-Phelps, M. and Jacobs, D. 2016. Chapter 8 – Bats and water: Anthropogenic alterations threaten global bat populations. *Bats in the Anthropocene: Conservation of Bats in a Changing World,* DOI 10.1007/978-3-319-25220-9_8.

Montag, H., Parker, G. and Clarkson, T. 2016. The effects of solar farms on local biodiversity: A comparative study. Clarkson and Woods and Wychwood Biodiversity.

Monadjem, A., Taylor, P.J., Cotterill, F.P.D. & Schoeman, M.C. (2010).Bats of southern and central Africa – A biogeographic and taxonomic synthesis, Ultra Litho (Pty) Ltd, Johannesburg.

Mucina, L. and Rutherford, M. C. 2006. The Vegetation of South Africa, Lesotho and Swaziland- *Strelitzia 19,* South African National Biodiversity Institute, Pretoria.

South African Red List of Mammals 2016. http://www.ewt.org.za/reddata.

Sowler, S. and Stoffberg, S. 2014. South African good practice guidelines for surveying bats in wind farm developments. *Endangered Wildlife Trust.*

Smith, A., Schoeman, M. C., Keith, M., Erasmus, B. E., Monadjem, A., Moilanen, A. and Di Minin, E. 2016. Synergetic effects of climate and land-use change on representation of African bats in priority conservation areas. *Ecological Indicators* **69**: 276-283.

Stone, E. L., Harris, S. and Jones, G. 2015. Impacts of artificial lighting on bats: a review of challenges. *Mammalian Biology*, DOI 10.1016/j.mambio.2015.02.004.

Turney, D. and Fthenakis, V. 2011. Environmental impacts from the installation and operation of large-scale solar power plants. *Renewable and Sustainable Energy Reviews* 15: 3261-3270.

Voight, C. C., Phelps, K. L., Aguirre, L. F., Schoeman, M. C., Vanitharani, J and Zubaid, A. 2016. Chapter 14 - Bats and buildings: The conservation of sympatric bats. *Bats in the Anthropocene: Conservation of Bats in a Changing World,* DOI 10.1007/978-3-319-25220-9_14.

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Thank you to the farm owner Willem Retief for granting me access to his property in order to conduct the survey.

10. Declaration of Independence

Appendix 1.

11. Compliance to Appendix 6 of GNR 982 (EIA 2014 regulations)

Appendix 2.