Perdekraal East Wind Energy Facility-Bat Impact Assessment Amendment Report

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Declaration of Independence

Inkululeko Wildlife Services (Pty) Ltd (IWS) is an independent consultancy. IWS has no legal or financial connection with the developer or the environmental assessment practitioner (EAP), except for fulfilling the tasks required for this assessment. Remuneration to IWS by the developer or the EAP for conducting this assessment is not linked to the authorisation of the project by the competent authority. In addition, IWS has no interest or connection to any secondary or future development associated with the approval of this project. Kate MacEwan was the lead bat specialist on this project. She is registered with the South African Council for Natural Scientific Professions (SACNASP).

Signed:

Kate MacEwan

for Inkululeko Wildlife Services (Pty) Ltd

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1. Project Introduction

1.1 Project History

Mainstream Renewable Power South Africa (Pty) Ltd (Mainstream) intends on developing the Perdekraal East Wind Energy Facility (WEF). The Perdekraal East WEF has received environmental authorisation, however, due to changes in the infrastructure design, capacity and layout, they are required to conduct an amendment application to the Environmental Impact Assessment (EIA).

In 2012/2013, IWS (previously the bat division of Natural Scientific Services (NSS)) conducted 12 months of bat pre-construction monitoring and a bat impact assessment report for Perdekraal East and West combined (NSS 2014). The original monitoring and assessment was done according to a hub height of 120 m and rotor diameter of 120 m. Perdekraal East and West are now separate projects, owned by two separate companies – Mainstream are the owners of the Perdekraal East WEF only.

Mainstream are now applying to increase the turbine blade length at the Perdekraal East WEF, so that all turbine options have a maximum hub height of 120 m and rotor diameter of 140 m (70 m blade length). Furthermore, during the 2012/2013 monitoring (NSS 2014), a meteorological mast was only installed half way into the monitoring, so monitoring data at height was missing in the following months – February, March, April, May and June.

Therefore, due to the change in turbine specifications, Mainstream appointed IWS to conduct monitoring in those missing 5 months and to revise the bat impact assessment. This current report must be read in conjunction with NSS (2014). Background environmental information and methodologies and results from the 2012/2013 NSS study will not be repeated here. Only where new methods were applied are they discussed.

1.2 Study Objectives

The objective of this assessment is to fill the gap in knowledge on bat activity in the rotor swept zone in the Perdekraal East area in the months of February, March, April, May and June and to revise the impact assessment.

2. Bat Assessment Team

Inkululeko Wildlife Services (Pty) Ltd. (IWS), the former bat division of Natural Scientific Services CC (NSS) was the bat specialist consultancy for the Perdekraal East Bat Impact Assessment and Amendment Assessment. The IWS team through both their time with NSS and IWS have conducted over 25 long-term pre-construction bat monitoring studies and 7 current long-term operational bat monitoring studies for wind energy development in South Africa.

Kate MacEwan was a founding member of NSS and is now the Managing Director and senior zoologist of IWS. She is a SACNASP registered zoologist and environmental scientist and holds a BSc (Honours) in Zoology from Wits University. She has over 17 years of zoological and practical bat conservation experience. Kate is currently the chairperson for the South African Bat Assessment Advisory Panel (SABAAP), a co-author of the 4th edition South African Good Practise Guidelines for Surveying Bats in Wind Farm Developments – Pre-construction (Sowler, S., Stoffberg, S., MacEwan, K., Aronson, J., Ramalho, R., Forssman, K., Lötter, C. 2016) and a co-author on the 1st edition South African Good Practice Guidelines for Operational Monitoring for Bats at Wind Energy Facilities (Aronson, J., Richardson, E., MacEwan, K., Jacobs, D., Marais, W., Aiken, S., Taylor, P., Sowler, S. and Hein, C., 2014). In addition, she is Rope Access Level 1 certified and Fall Arrest and Rescue accredited.

Trevor Morgan, as the Senior Technician, Field Manager and Data Analyser, is vital to the team and has worked with Kate for over 5 years. He has served as an active member on the Executive Committee of the GNorBIG for several years. He is very knowledgeable on South African bats and has extensive experience with bat detectors, their related software, mist-netting and harp-trapping. By trade, Trevor is an electrician and an inventor, and has constructed his own harp trap and heterodyne bat detector. Trevor's considerable field-based involvement in all long-term bat monitoring studies performed by NSS and IWS has been invaluable. In addition, he is Fall Arrest and Rescue accredited.

Joshua Weiss is a full time Junior Zoologist with IWS since July 2015. He has a BSc in Geography and Environmental Sciences and an Honours in Ecology & Conservation. He has keen interests and experience in biodiversity (particularly avifauna), conservation planning and spatial analysis. In previous work positions, he has done data analysis, compiling carbon footprint reports, researching and had some involvement in the EIA process. Since joining IWS, he has been responsible for mapping and GIS analysis for all projects, data handling and since gaining his fall arrest certification, has been involved in the field. He is also a qualified Level 1 field guide and member of BirdLife SA and WESSA.

3. Methodology

3.1 Passive Monitoring

On the 9th and 10th of February 2016, IWS installed a Bat Monitoring Station on the new 80 m Meteorological Mast (Met Mast) (PK6) within the Perdekraal East WEF boundary area, with microphones at 10 m and 80 m respectively. It must be noted that this new mast is not the original one (PK3b – now called PK7) where at height monitoring was performed by NSS in 2012/2013, however, it is only 2.56 km from PK7 and is within the same Tanqua Karoo vegetation type and same land use area. The reason for using PK6 and not PK7, is that PK7 is not within the boundaries of Perdekraal East WEF owned by Mainstream. The mast at PK6 was not up during the 2012/2013 monitoring was therefore not available for erecting bat equipment at that time.

Further to the current monitoring at PK6, IWS was appointed by the owners of Perdekraal West WEF to conduct additional monitoring on PK7 and at a new station called PK8 (close to the old PK4) from the 29th March 2016. Data collected from all three stations until June 2016 will be used in this report, as well as information from NSS (2014). The localities of the 55 turbine layout for Perdekraal East only and the three bat stations are shown in **Figure 1**.

The successful recording periods at each station from February to June 2016 are shown in **Figure 2**.

Figure 1 Proposed WEF Infrastructure and Bat Monitoring Stations

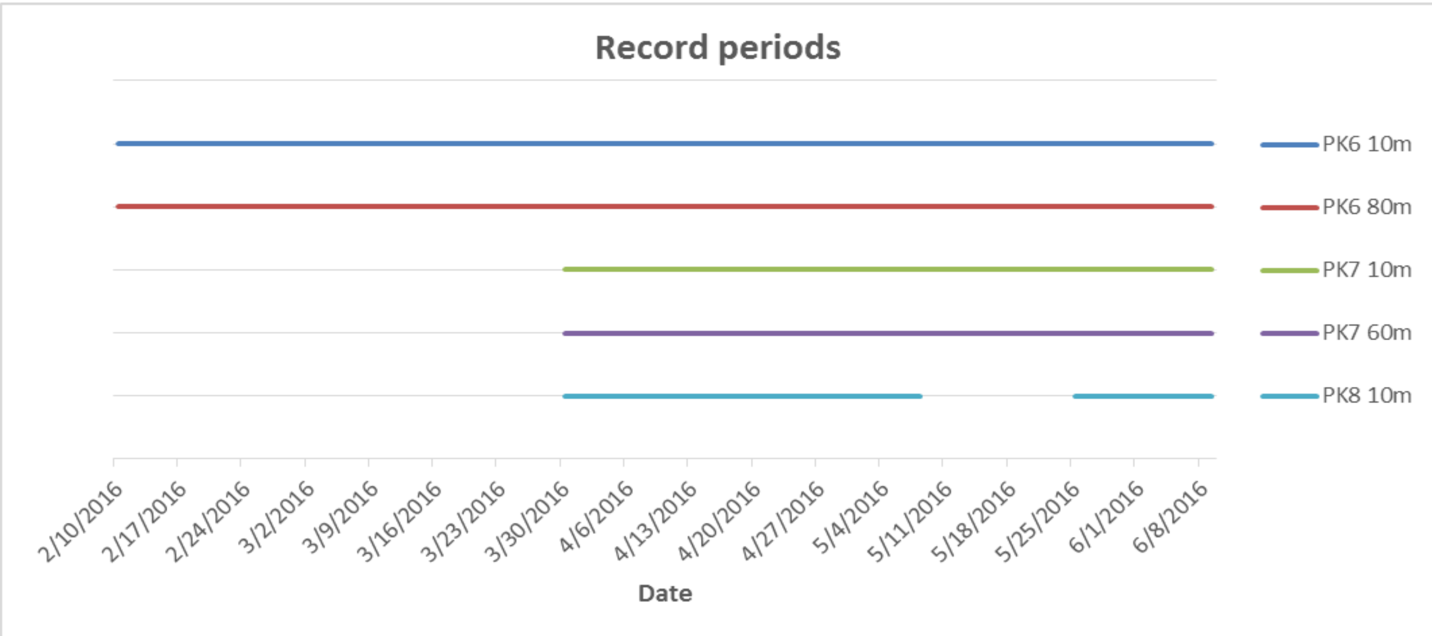


Figure 2 Successful Recording Periods

3.2 Impact Assessment

The overall impact assessment for construction and operation for the proposed Perdekraal East WEF was amended. Potential impacts were evaluated in terms of bat roosting, foraging and migration, as follows:

- Roosting impacts:
  - roosting habitat destruction or disturbance.
  - attraction of bats to towers for roosting and due to curiosity and therefore fatalities due to collision or barotrauma.
- Foraging impacts:
  - displacement from foraging habitat due to wind turbine operation.
  - bat fatalities due to collision or barotrauma during foraging activity.
- Migration impacts:
  - bat fatalities due to collision or barotrauma during long distance seasonal migrations.

A standard Impact Assessment Methodology was used, which involved ranking different impact parameters as per **Table 1**, and calculating a Significance value for the impact as (Extent + Duration + Intensity) x Probability. This calculated value was then used to classify the Significance of the impact as Low, Medium or High as per **Table 2**. In addition to this, cumulative impacts were assessed using the criteria outlined in **Table 3**.

Table 1 Impact Ranking Matrix

PARAMETER	RANKING				
	0	1	2	3	4
EXTENT	None	Localised	Study Area	Regional / National	International
DURATION	None	Short- term	Medium-term	Long-term	Permanent
INTENSITY	None	Low	Medium	High	Very High
PROBABILITY	None	Improbable	Probable	Highly Probable	Definite

Table 2 Classification of Significance

NATURE OF IMPACT	SIGNIFICANCE		
	Low	Medium	High
Negative	Impact will not have an influence on the decision or require to be significantly accommodated in the project design	Impact could have an influence on the environment which will require modification of the project design and/ or alternative mitigation	Impact could have a 'no-go' implication for the project unless mitigation and/ or re-design is practically achievable.
	1 - 16	17 - 32	33 - 48

Table 3 Cumulative Impacts

CUMULATIVE IMPACTS	
Additive	*"where it adds to the impact which is caused by other similar impacts"*
Countervailing Interactive	impacts that combine to form a new kind of impact: "*the net adverse cumulative impact is less than the sum of the individual impacts"*
Synergistic Interactive	impacts that combine to form a new kind of impact: "*the net adverse cumulative impact is greater than the sum of the individual impacts"*

4. Results

4.1 Confirmed Bat Species on Site and Species Composition

The NSS (2014) assessment confirmed three bat species from three Species Groups on site, which included the Egyptian Free-tailed Bat (*Tadarida aegyptiaca*) in Species Group A, the Cape Serotine Bat (*Neoromicia capensis*) in Species Group B, and the Natal Long-fingered Bat (*Miniopterus natalensis*) in Species Group C. The current IWS (2016) assessment has confirmed all three previous species, as well as one additional one – the Long-tailed Serotine Bat (*Eptesicus hottentotus*) in Species Group B. *E. hottentotus* is clutter edge forager at Medium risk of turbine related fatality.

The composition of the various species at the different microphones for this period are shown in **Figure 3**. At all stations, except for PK7, *T. aegyptiaca* is dominant. At PK7, there is an equal composition of the three main species – *T. aegyptiaca, N. capensis* and *M. natalensis*. The species composition in the rotor swept zone is >95% *T. aegyptiaca*, as is to be expected. *T. aegyptiaca* was also the dominant species in the NSS (2014) assessment.

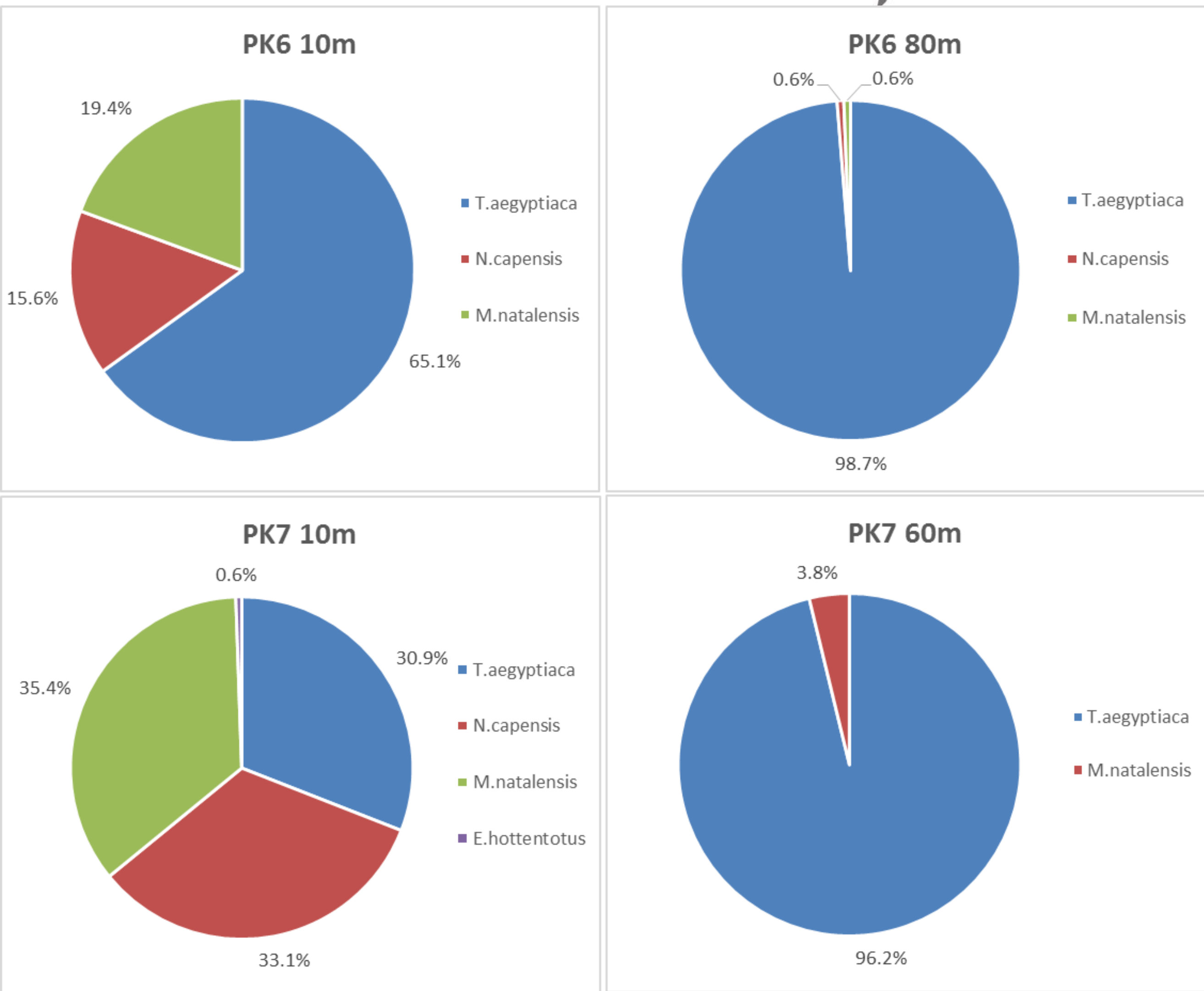


Figure 3 **Potential Bat Roosting Habitats**

4.2 Average Bat Activity

Average bat activity per hour per microphone at the various monitoring stations for NSS (2014) is shown in **Figure 4** and for IWS (2016) is shown in **Figure 5**. By comparing the average activity levels from 2012/2013 to the 2016, the following can be noted:

- In 2016, there was 58.7% more activity at 10 m, compared with 60-80 m.
- The average bat activity at PK6 60 m was the lowest.
- Looking at PK7, the majority of monitoring in 2012/2013 was in spring and early summer and the average is therefore higher (approximately double) than for 2016, as monitoring in 2016 was most just autumn and early winter.
- The same can be said for PK8 if compared to PK4, average bat activity was higher in the spring and early summer combination compared with autumn and early winter combination.
- Furthermore, the results from both 2012/2013 and 2016 confirm that the highest bat activity occurs in the more mountainous region outside of Perdekraal East WEF to the south. These mountainous areas are buffered in the sensitivity map (**Figure 12**), with a

small portion of the medium sensitivity buffer entering the Perdekraal East WEF property in the south west corner of the site.

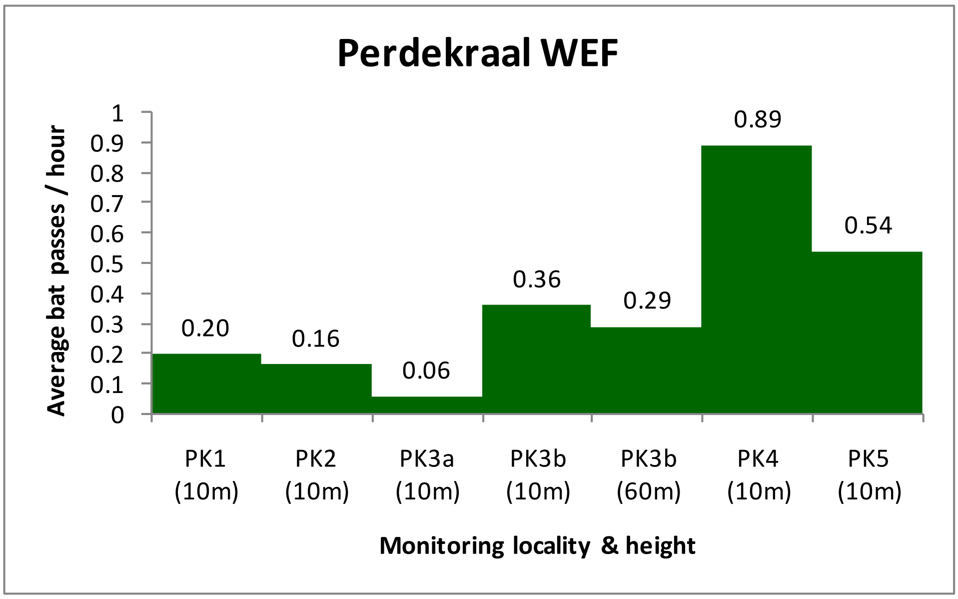


Figure 4 Average Bat Activity per Hour per Microphone (NSS 2014)

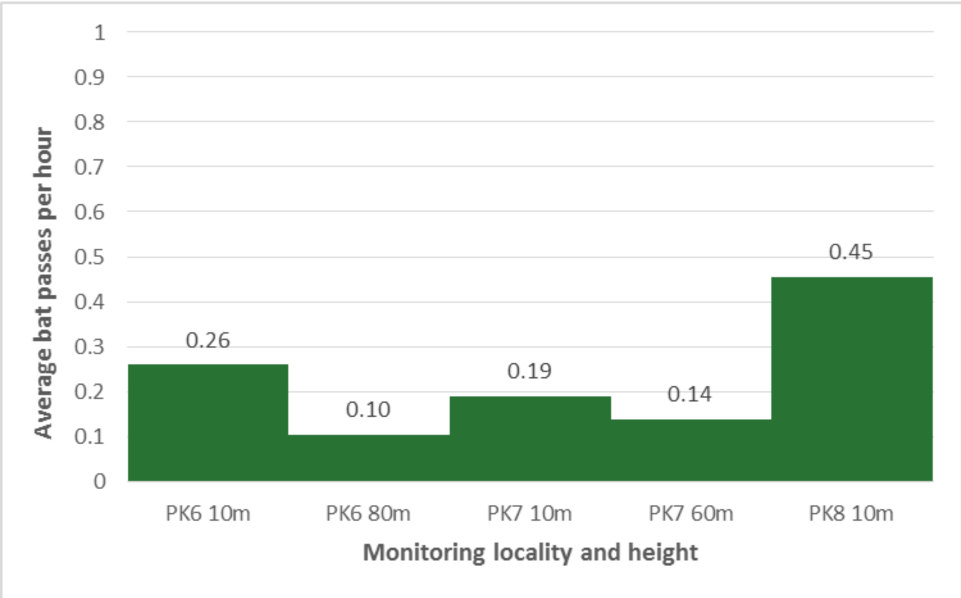
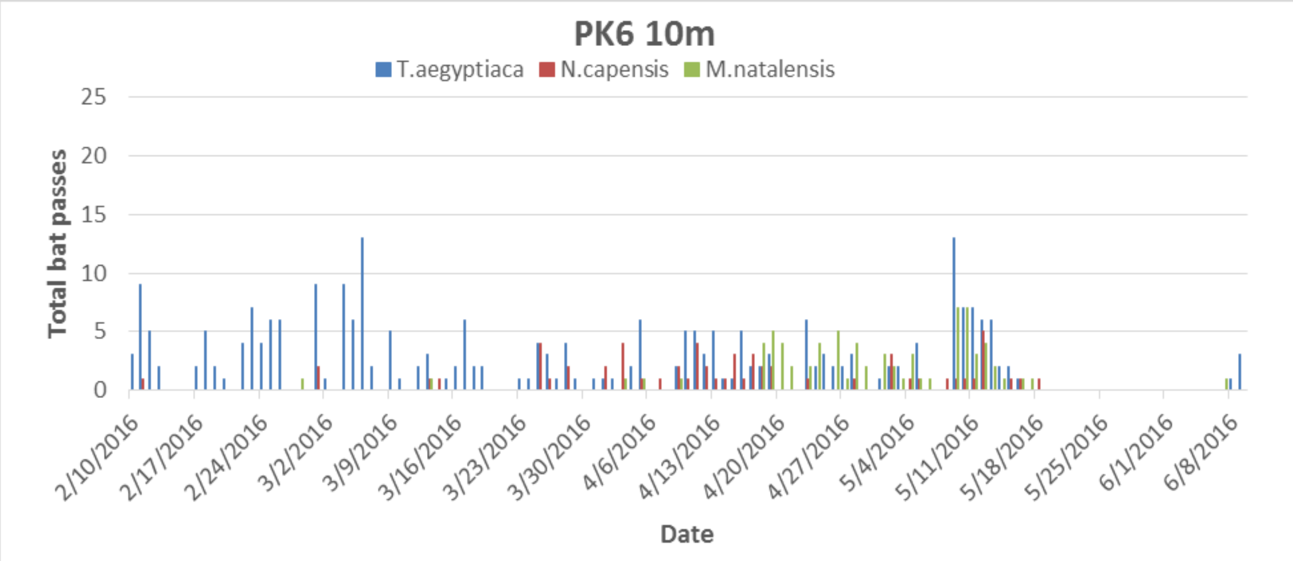


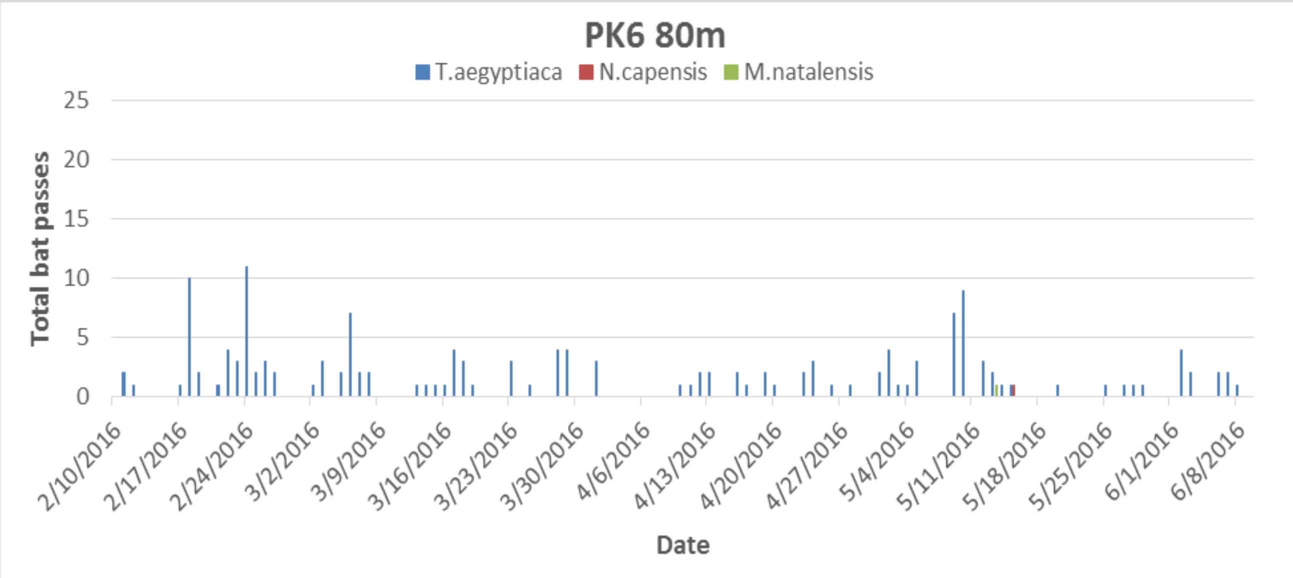
Figure 5 Average Bat Activity per Hour per Microphone (IWS 2016)

4.3 Monthly and Daily Bat Activity

The total bat calls recorded per species at each of the four microphones for IWS (2016) are shown in **Figure 6**. In order to get an understanding for what might be happening in a full year, it is important to read this report in conjunction with NSS (2014). The following information can be derived from the various graphs:

The most significant peaks in activity for species at the highest risk, particularly for the microphones in the important rotor swept zone, appear to be through summer (December, January and February) and autumn (March, April and May) and to a lesser degree spring for *T. aegyptiaca*. In the rotor swept zone, there is very little *N. capensis* and *M. natalensis* activity, with smaller peaks than for *T. aegyptiaca* for these species in both spring and autumn.





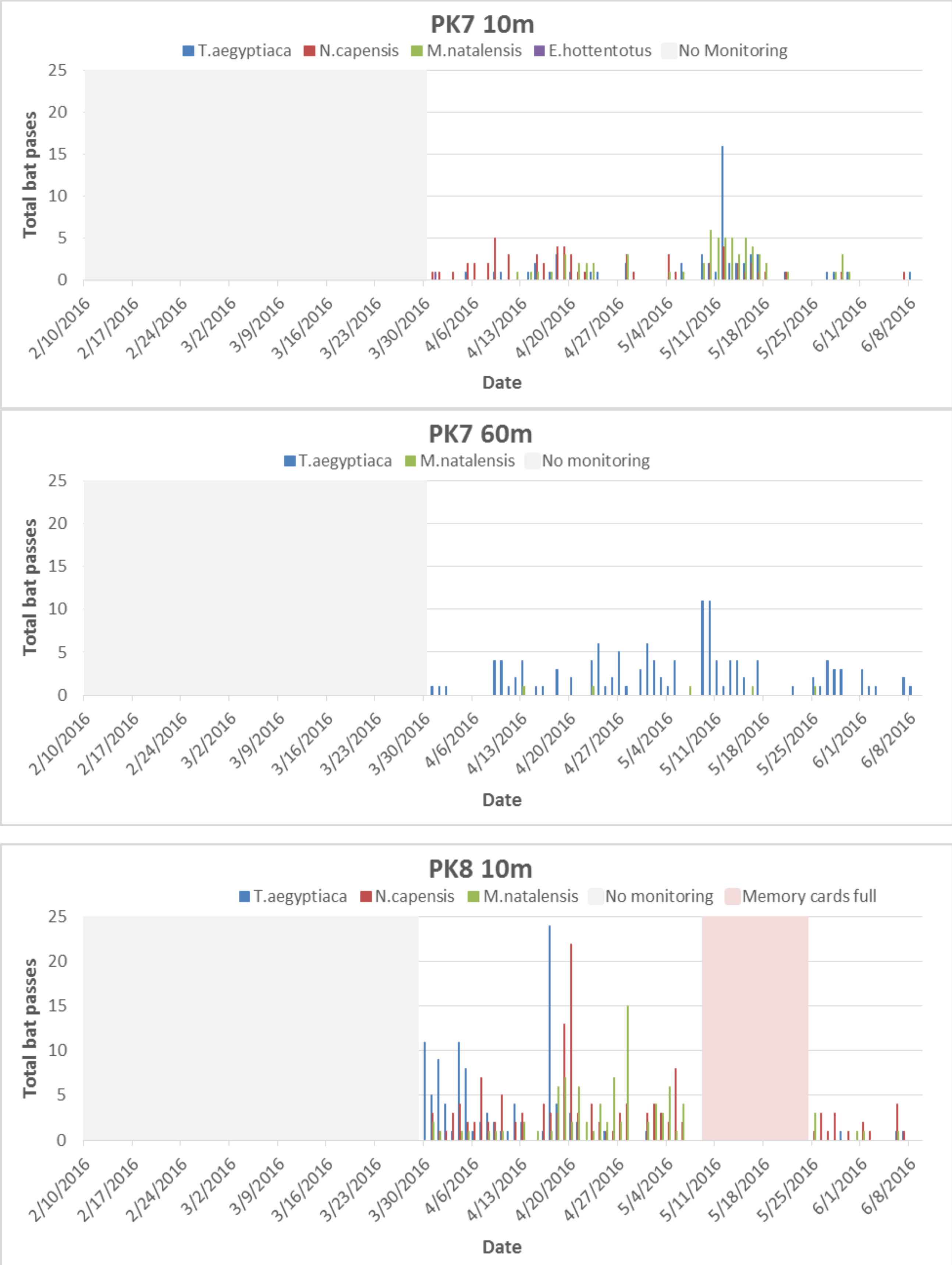


Figure 6 **Total Bat Passes per Species per Date per Station (IWS 2016)**

4.4 Bat Activity vs. Time of Night

Looking particularly at activity versus time for summer and autumn in **Figure 7**, in summer, activity seems to be concentrated in the middle of the night, whereas in autumn there is a slightly higher peak immediately after sunset, tapering out throughout the night. NSS (2014) did not separate the seasons when looking at bat activity vs. time of night, hence the below graphs are more accurate.

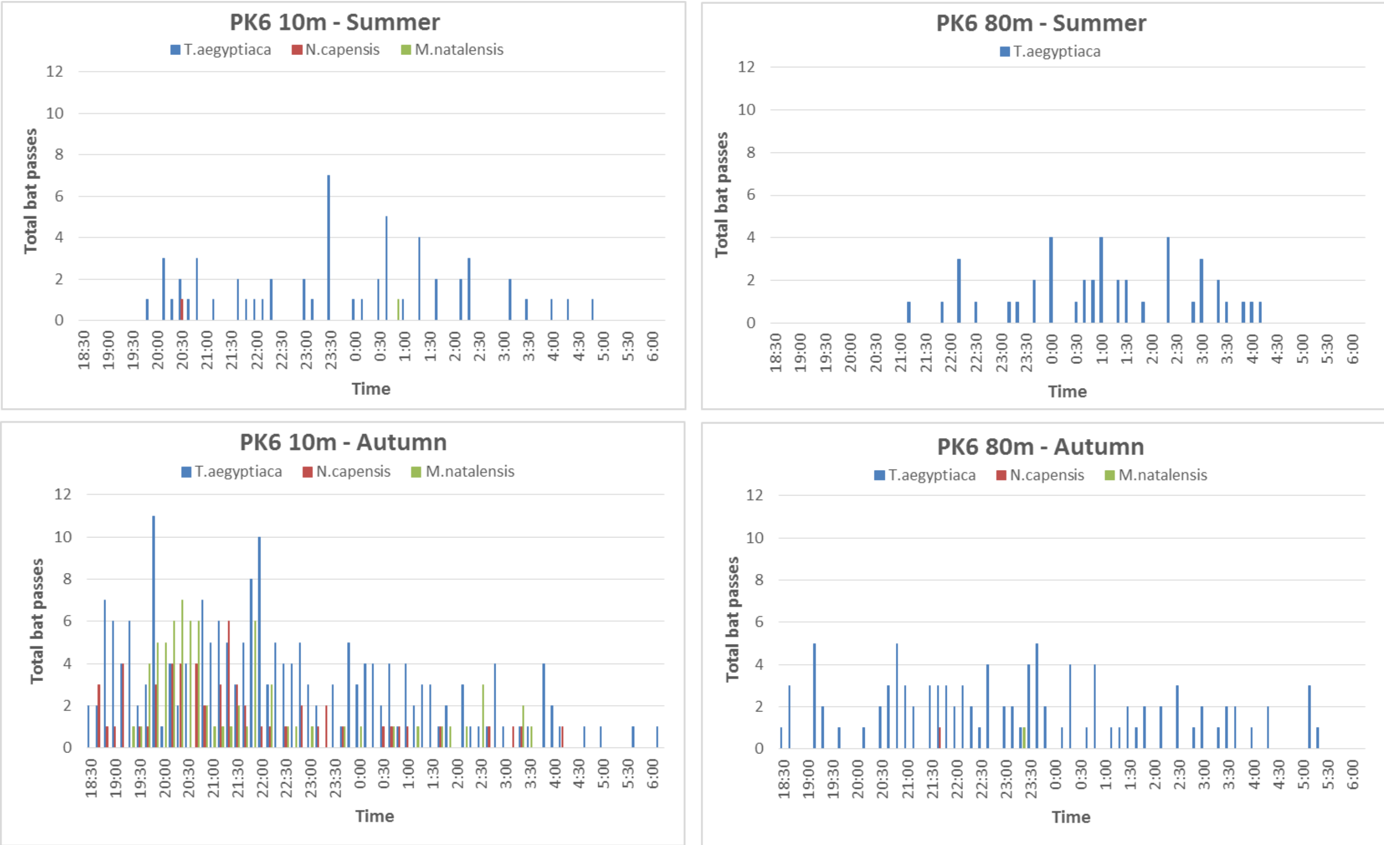


Figure 7 **Bat Activity vs. Time of Night (IWS 2016)**

4.5 Bat Activity vs. Weather Variables

4.5.1 Wind Speed

Bat activity vs. wind speed within the rotor swept zone (80 m) is displayed in **Figure 8.** Approximately 80% of bat activity occurs below wind speeds of 7-7.5 m/s and approximately 50% of activity occurs below wind speeds of 4.5-5 m/s. This is consistent with the mean number of bat passes at 60 m occurring under wind speeds of 4.7 m/s in NSS (2014).

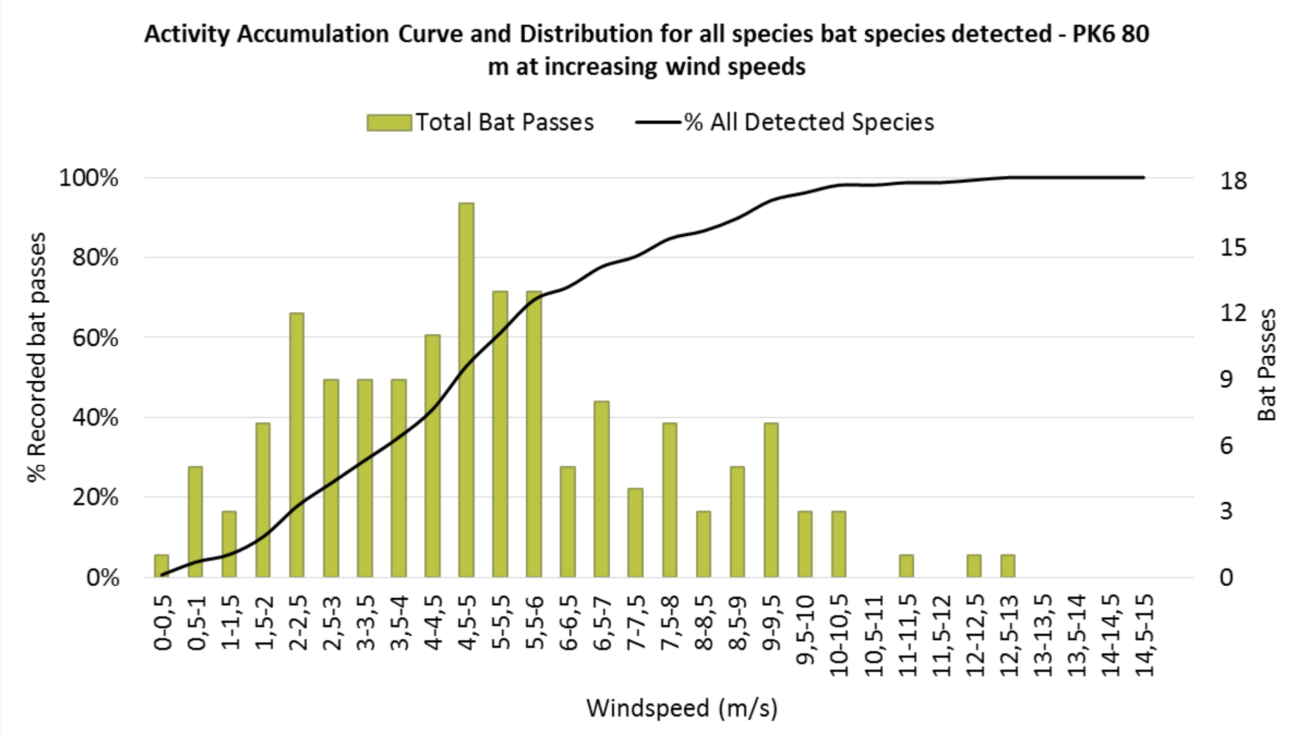


Figure 8 Bat Activity vs. Wind Speed

4.5.2 Temperature

Bat activity vs. temperature is displayed in **Figure 9**. Approximately 80% of all bat passes occur in temperatures of between 14°C and 23.5°C. The mean number of bat passes occurs between 19-20°C, consistent with the NSS (2014) report that states that the mean number of bat passes occurs between 18.8-20.5°C. Only 10% of bat passes occur below temperatures of 14°C.

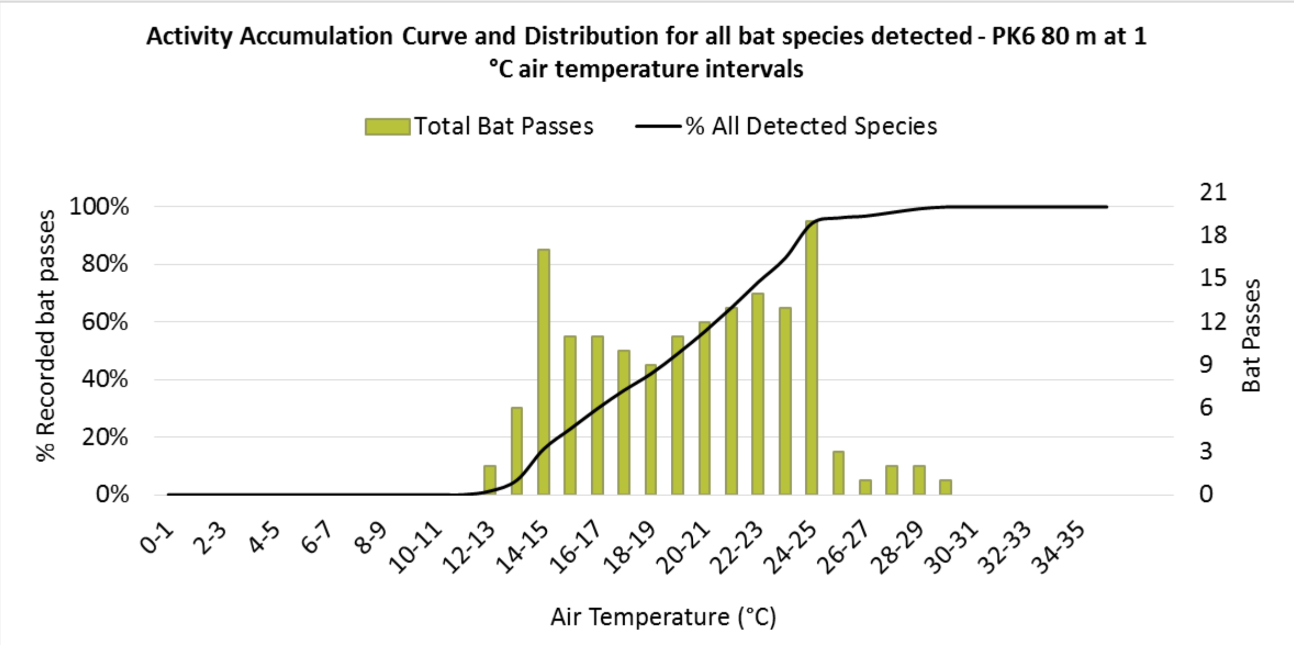


Figure 9 Bat Activity vs. Temperature

4.5.3 Barometric Pressure

Bat activity vs. barometric pressure is displayed in **Figure 10**. All bat activity occurs between 930 and 950 mB.

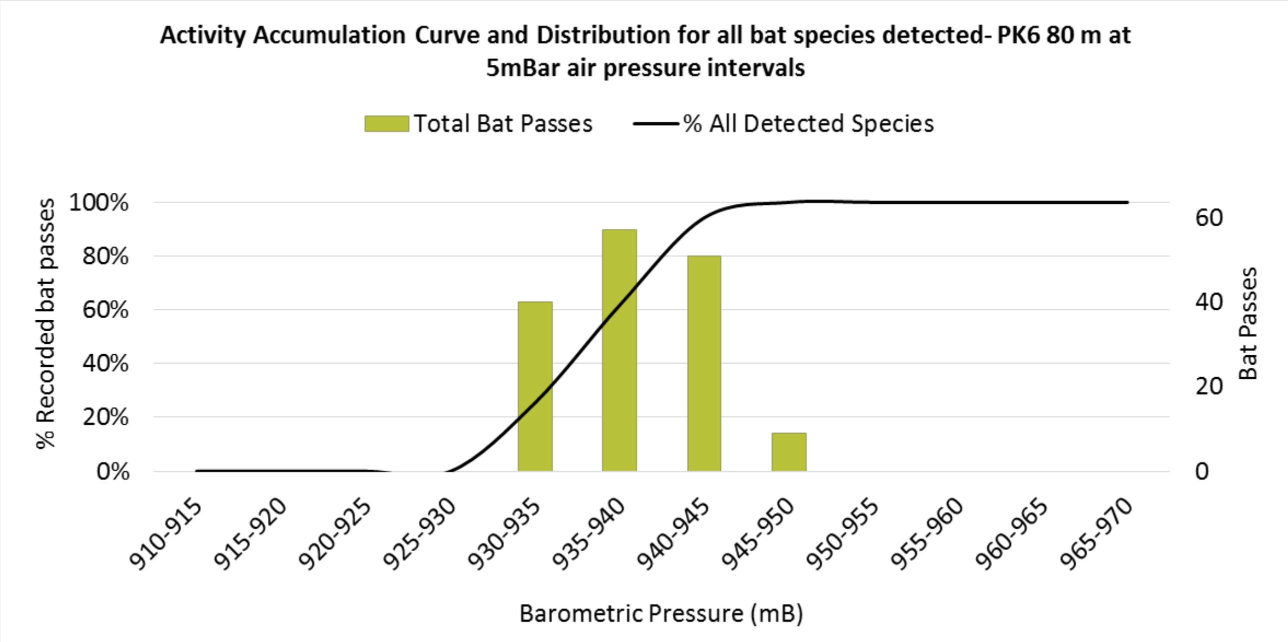


Figure 10 Bat Activity vs. Barometric Pressure

5. Bat Sensitivity

A bat sensitivity map for Perdekraal East and West WEFs was compiled by NSS (2014) (**Figure 11**). This was based on the bat activity levels observed and the bat roosting and foraging habitat potential. The NSS (2014) sensitivity map shows an old turbine layout for both Perdekraal East and West. IWS has used the sensitivity layers from NSS (2014) and overlaid a new turbine layout as provided by Mainstream on the 29th June 2016 (**Figure 12**). Based on what we have learnt at operating WEFs in SA, IWS has changed the Low sensitivity areas to Low-Medium, as it is still very possible and likely that bat fatalities will occur at turbines within these zones but at a lower frequency than Medium to High sensitivity zones.

Despite the revised turbine layout, there are still some turbines that encroach on bat sensitive areas, as per **Table 4**and **Figure 12**.

Table 4 Turbines in or near bat sensitive areas

Turbine Coordinates		Issue
X_DMS	Y_DMS	
20° 4' 57.39" E	33° 3' 26.01" S	3 m inside a High Bat Sensitivity Area
20° 7' 11.27" E	33° 5' 11.24" S	88 m inside a Medium Bat Sensitivity Area
20° 4' 10.90" E	33° 2' 44.07" S	46 m outside of a High Bat Sensitivity Area
20° 5' 39.29" E	33° 3' 39.08" S	44 m outside of a High Bat Sensitivity Area
20° 6' 45.50" E	33° 4' 9.66" S	69 m outside of a High Bat Sensitivity Area
20° 6' 18.73" E	33° 3' 44.01" S	10 m outside of a High Bat Sensitivity Area
20° 5' 37.75" E	33° 3' 15.62" S	6 m outside of a High Bat Sensitivity Area
20° 4' 54.21" E	33° 2' 24.39" S	42 m outside of a High Bat Sensitivity Area

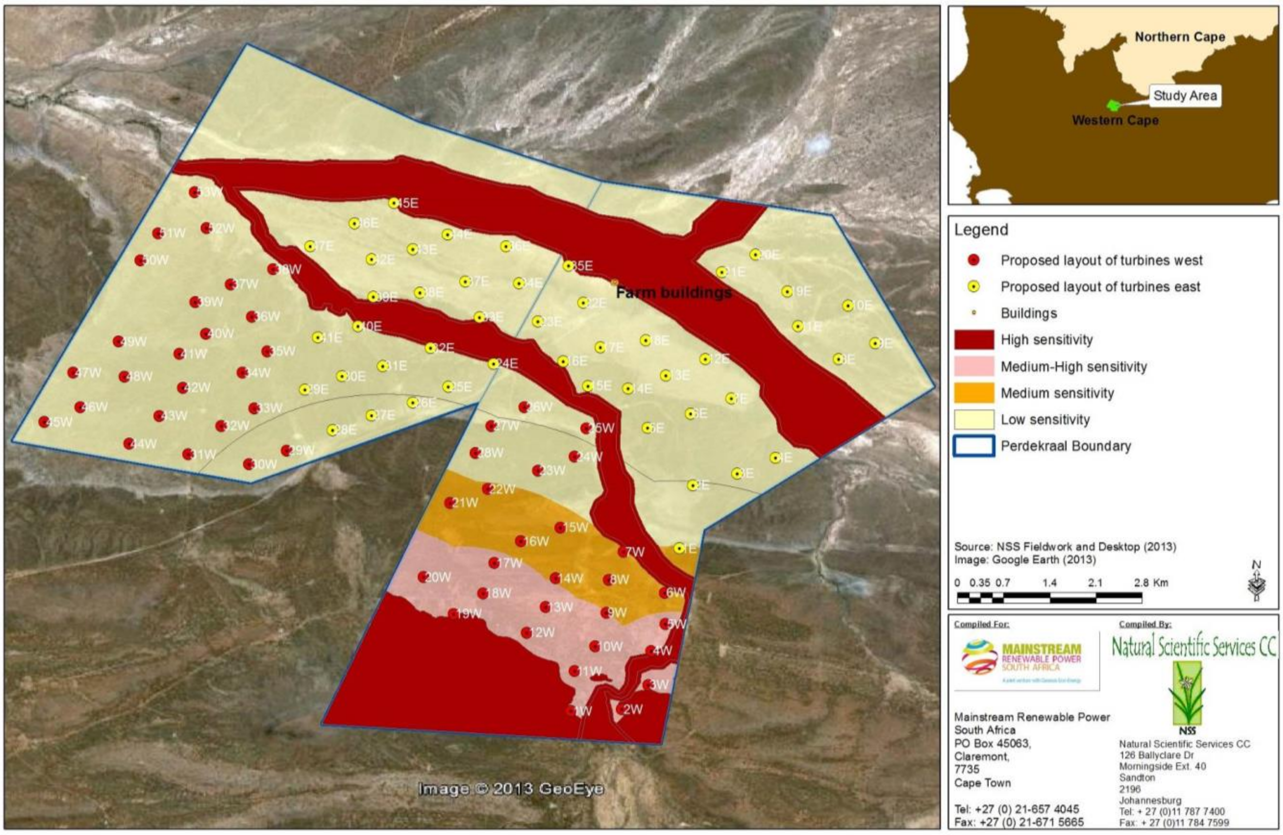


Figure 11 Bat Sensitivity Map for Perdekraal East and West (NSS 2014) (old turbine layout)

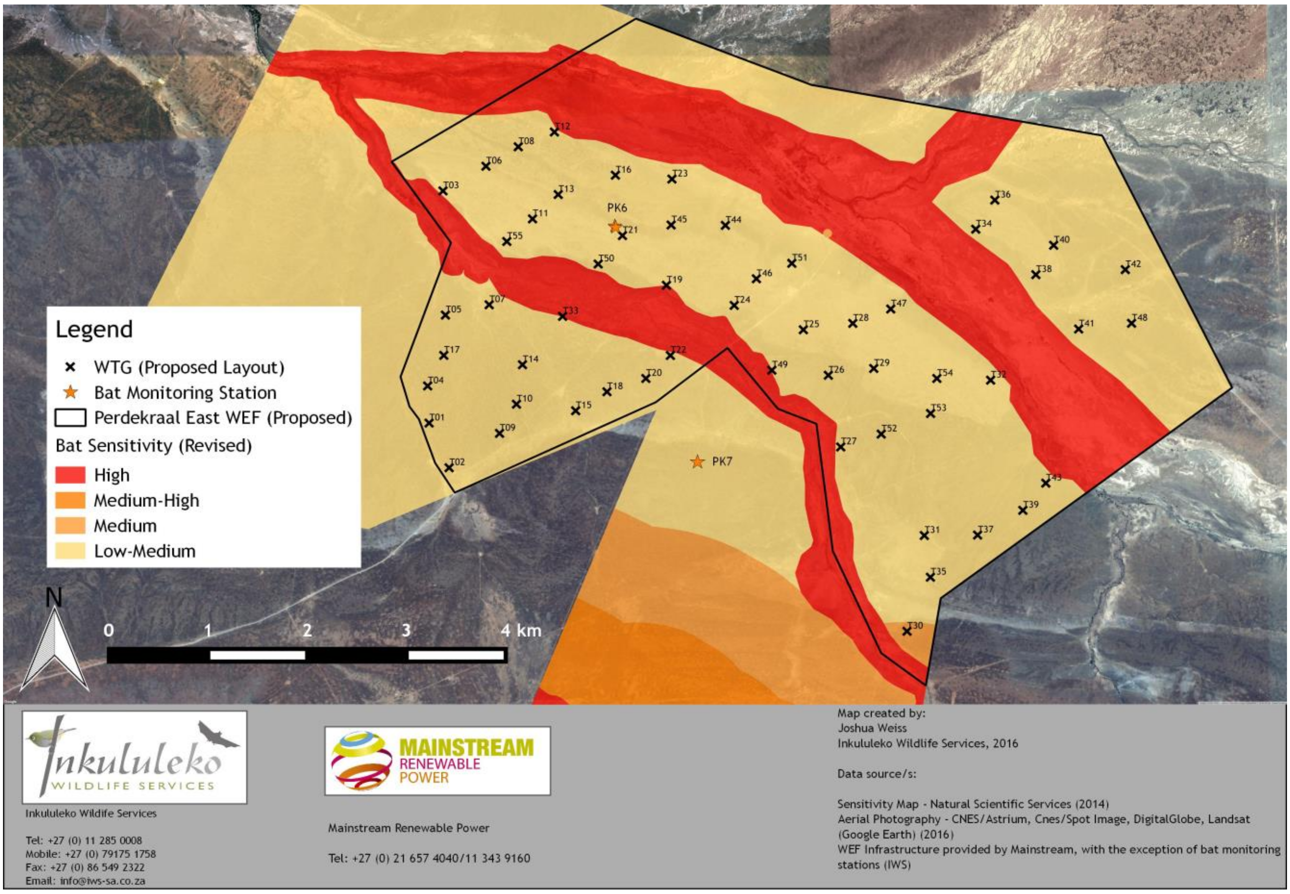


Figure 12 Bat Sensitivity Map for Perdekraal East and West (IWS 2016) (new turbine layout)

6. Bat Impact Assessment and Mitigation

The impact assessment matrix for the proposed Perdekraal East WEF is shown in **Table 5**. The NSS (2014) impact assessment was revised here based on the new turbine specifications and the additional 5 months of monitoring data at height.

6.1 Impact 1: Roost disturbance or destruction due to construction activities

6.1.1 Cause & Significance

On Perdekraal East WEF, the disturbance or destruction of a few small farm buildings on site would affect only a small number of house-dwelling bats. This potential impact, therefore, has a **Low** significance rating, which can be reduced to Low by the following recommended mitigation measures.

6.1.2 Mitigation & Management

- All turbines (**including their full rotor swept zone**) to be kept out of all High bat sensitivity areas.
- Minimize disturbance and destruction of farm buildings on site (where bats were observed roosting in a roof).

6.2 Impact 2: Fragmentation to and displacement from foraging habitat due to wind turbine construction and operation

6.2.1 Cause & Significance

Construction of the proposed Perdekraal East WEF could cause destruction and fragmentation of woody habitat (bushes and trees) along the Groot and Adamskraal streams, which would have an impact on the clutter-edge foraging Species Group B and C bats. This impact, therefore, has a **Medium** significance rating, which can be reduced to Low by the following mitigation measures.

6.2.2 Mitigation & Management

- All turbines (**including their full rotor swept zone**) to be kept out of all High bat sensitivity areas.
- With the exception of compulsory civil aviation lighting, minimize artificial lighting at night, especially high-intensity lighting, steady-burning, or bright lights such as sodium vapour, quartz, halogen, or other bright spotlights. Lights should be hooded downward and directed to minimize horizontal and skyward illumination. All internal turbine nacelle and tower lighting should be extinguished when unoccupied.

6.3 Impact 3: Bat fatalities due to collision or barotrauma during foraging activity

6.3.1 Cause & Significance

Deaths caused by moving turbine blades are a reality in South Africa (IWS is monitoring at 7 operational facilities and all facilities have fatalities ranging from 20 bat fatalities to over 200 bat fatalities per annum, depending on the risk levels).

According to the estimated bat fatality risk levels in Sowler *et al.* (2016) for the different terrestrial ecoregions of SA, Perdekraal East WEF is classified as having a medium to high turbine fatality risk, being in the Succulent Karoo biome/bioregion. Fatal collisions and barotrauma could have a permanent impact and, therefore, this impact has a **High** significance rating. Fortunately, certain measures to mitigate this impact have been proven to work, and could potentially reduce the significance rating of this impact to Low.

6.3.2 Mitigation & Management

- Turbines, including the blade length, should be spaced ≥250 m from each other.
- All turbines (**including their full rotor swept zone**) to be kept out of all High bat sensitivity areas. At least eight turbines, based on **Table 4,** will need to move to avoid curtailment.
- For those turbines that remain in medium-high and high sensitivity areas, a turbine cut-in wind speed of 7 m/s at hub-height is recommended for curtailment of these turbines in in the following times of year, times of night and temperature:
  - In December, January and February (summer) from 19h30 to 04h00.
  - In March, April and May (autumn) from 18h30 to 00h00.
  - Only when temperatures are 14°C or higher.
- For those turbines that remain in medium sensitivity areas and with a rotor blade sweep equal to or lower than 50 m, a turbine cut-in wind speed of 4.7 m/s at hub-height is recommended for curtailment of these turbines in in the following times of year and the following times of night:
  - In December, January and February (summer) from 19h30 to 04h00.
  - In March, April and May (autumn) from 18h30 to 00h00.
  - Only when temperatures are 14°C or higher.
- With the exception of compulsory civil aviation lighting, minimize artificial lighting at night, especially high-intensity lighting, steady-burning, or bright lights such as sodium vapour, quartz, halogen, or other bright spotlights at sub-station, offices and turbines. All non-aviation lights should be hooded downward and directed to minimize horizontal and skyward illumination. All non-aviation internal turbine nacelle and tower lighting should be extinguished when unoccupied.
- Post-construction bat monitoring MUST be performed according to the South African Good Practise Guidelines for Operational Monitoring for Bats at Wind Energy Facilities (Aronson *et al.*, 2014) or later version valid at the time of monitoring to inform adaptive mitigation management. IWS recommends that:
  - Should adjusted bat fatalities (adjusted for biases such as searcher efficiency and carcass persistence) equal or exceed 2 bat fatalities/10 ha/annum[1] after Year 1 of monitoring, then operational mitigation be applied at certain turbines in certain seasons and at certain times of night. The selection of turbines, during which season and at what time of night should be determined by a combination of the activity data and the unadjusted fatality data. The type of mitigation and the intensity is then determined by relating activity data to weather variables.
  - After the implementation of mitigation measures recommended by the specialist after the Year 1 monitoring, should adjusted bat fatalities (adjusted for biases such as searcher efficiency and carcass persistence) be below 2 bat fatalities/10 ha/annum after Year 2 of monitoring, then no further action other than the mitigation measures employed for Year 2 to remain ongoing is required.

[1] The number of hectares included in calculating the bat fatalities/10 ha, is determined by drawing a boundary around the developed turbine area that is being monitored. It does not include the entire farm property, only the developed area that have turbines built on it.

   - Should adjusted bat fatalities (adjusted for biases such as searcher efficiency and carcass persistence) equal or exceed 2 bat fatalities/10 ha/annum after Year 2 of monitoring, then adaptive mitigation and management must be implemented based on the recommendations from the bat specialist and an ongoing monitoring programme should be designed.
   - As other mitigation measures, for example ultrasonic deterrents, prove to be effective, these should be explored for use at sites displaying high levels of mortality.
- As other mitigation measures, for example ultrasonic deterrents, prove to be effective, these should be explored for use at sites displaying high levels of mortality.
- During operational monitoring, quarterly progress reports and annual monitoring reports to be submitted to SABAAP and to the SANBI Bird and Bat Database.
- The above recommendations should be written into the authorisation of this amendment application.

6.4 Impact 4: Bat fatalities due to collision or barotrauma during migration

6.4.1 Cause & Significance

In South Africa, migrating bat species, such as *M. natalensis* and the Egyptian Rosetta *Rousettus aegyptiacus* have been fatality victims at wind turbines in the Eastern Cape (MacEwan 2016), however, only a handful of each to date. Due to the low occurrence of *M. natalensis* at Perdekraal East WEF and no evidence of any other migrating species, the significance of this impact is considered to be **Low**. Mitigation measures recommended above in Section 6.3.2 will assist to reduce the risk of fatalities of migrating bats.

6.5 Impact 5: Bat fatalities due to collision or barotrauma due to attraction of bats to towers for roosting

6.5.1 Cause & Significance

Bats have been shown, through thermal imagery studies, to be attracted to wind turbines, either looking for potential roost sites, or out of curiosity, and are often struck by the moving blades (Horn et al. 2008). This has been further confirmed by Rollins et al. (2012). This has not yet been shown in South Africa, so this is assessed as having a **Low** significance.

Unfortunately, no mitigation measure has been found to effectively prevent this. Whilst ultrasonic sound emitters are currently being investigated as a deterrent for bats from wind turbines, this research has not yet produced enough evidence to support this measure. Hence, we cannot yet recommend this. The most well documented measure is curtailment, which is discussed below, and which would be prescribed if post-construction monitoring revealed unacceptably high numbers of bat fatalities.

6.6 Impact 6: Loss or population disturbances to Conservation Important Bat Species from the greater area due to construction and operation activities

6.6.1 Cause & Significance

One of the three species confirmed for the Perdekraal East WEF study area is of Conservation Importance, namely the nationally Near Threatened *M. natalensis*. Given the low activity and probable abundance of this species at Perdekraal, this impact has a **Low** significance rating, which would be maintained by the mitigation measures described under Section 6.3.2.

6.7 Impact 7: Reduction in the size, genetic diversity, resilience and persistence of bat populations

6.7.1 Cause & Significance

Bat population sizes are likely to be reduced by the fatality of bats at WEFs. This is because bats have low reproductive rates, slow generation turn-over and low population resilience against mass die-offs. The additional loss of flying adults to a population, other than natural death rates is likely to have a significance impact. Smaller populations also contain less genetic diversity, and are more susceptible to genetic drift and inbreeding. WEFs may, therefore, reduce the long-term persistence of local and even regional bat populations. Given the medium to high activity levels of bats at Perdekraal East WEF relative to other sites in the Succulent Karoo biome/bioregion in South Africa where IWS/NSS has performed long-term monitoring for proposed WEFs, this potential impact has a **Medium** significance rating, which can be reduced to Low based on the mitigation measures described under Section 6.3.2.

6.8 Cumulative Impacts

When assessing impacts, it is important to also consider what other pressures could be on the bats to cause a greater cumulative impact. If other WEFs are developed in the greater study area, these will have an additive cumulative impact on bats at a regional scale. In addition, the greater the area of wind turbine development, the greater the risk of this clashing with bat migration routes. Based on the DEA (2016) Renewable Energy EIA Application Database, there are several proposed WEFs within 120 km of the Perdekraal East WEF, with Perdekraal West being immediately adjacent (**Figure 13**). Most of the applications within 120 km of Perdekraal East WEF have approved environmental authorisations, meaning that they are likely to proceed. With this in mind, it is very important that the mitigation measures recommended in this report and the NSS (2014) report are implemented and that adaptive mitigation during operational monitoring is taken seriously and is implemented according to the specialist's recommendations.

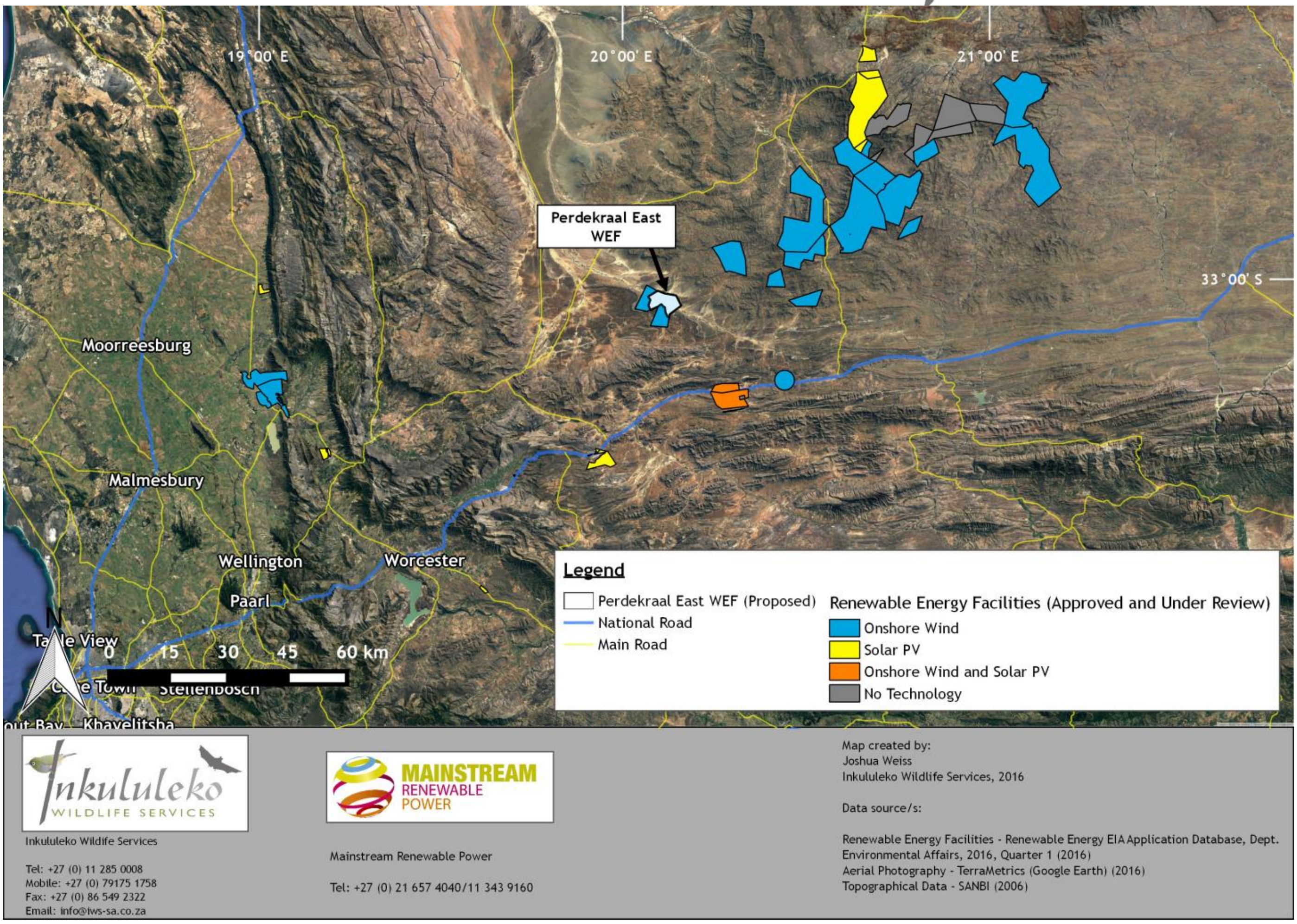


Figure 13 Cumulative Impact Map

Table 5 Amended Impact Assessment Matrix

Impact		Status	Extent		Duration		Intensity		Probability		Significance		Confidence	
			Details	Rating	Details	Rating	Details	Rating	Details	Rating	Details	Total	Details	Rating
Roost disturbance or destruction due to construction activities	Without Mitigation	Negative	Localised	1	Long-term	3	Low	1	Improbable	1	Low	5	High	3
	With Mitigation	Negative	Localised	1	Long-term	3	Low	1	None	0	Negligible	0	High	3
Fragmentation to and displacement from foraging habitat due to wind turbine construction operation	Without Mitigation	Negative	Study Area	2	Permanent	4	Medium	2	Highly Probable	3	Medium	24	High	3
	With Mitigation	Negative	Study Area	2	Permanent	4	Medium	2	Probable	2	Low	16	High	3
Bat Fatalities due to collision or barotrauma during foraging activity	Without Mitigation	Negative	Study Area	2	Permanent	4	High	3	Definite	4	High	36	High	3
	With Mitigation	Negative	Study Area	2	Permanent	4	Medium	2	Probable	2	Low	16	High	3
Bat Fatalities due to collision or barotrauma during migration	Without Mitigation	Negative	Regional	3	Permanent	4	Low	1	Probable	2	Low	16	High	3
	With Mitigation	Negative	Study Area	2	Permanent	4	Medium	2	Improbable	1	Low	8	High	3
Bat fatalities due to collision or barotrauma due to attraction of bats to towers for roosting, out of curiosity	Without Mitigation	Negative	Study Area	2	Permanent	4	Low	1	Probable	2	Low	14	Medium	2
	With Mitigation	Negative	Localised	1	Permanent	4	Low	1	Improbable	1	Low	6	Medium	2
Loss of Conservation Important/Threatened speciesdue to wind turbine construction operation	Without Mitigation	Negative	Study Area	2	Permanent	4	Low	1	Probable	2	Low	14	High	3
	With Mitigation	Negative	Study Area	2	Permanent	4	Low	1	Improbable	1	Low	7	High	3
Reduction in size, genetic diversity, resilience and persistence of bat populations	Without Mitigation	Negative	Regional	3	Long-term	3	High	3	Probable	2	Medium	18	Medium	2
	With Mitigation	Negative	Study Area	2	Long-term	3	Medium	2	Improbable	1	Low	7	Medium	2

7. Conclusions

- Of the 11 potentially occurring bat species at Perdekraal East WEF, IWS has confirmed four of them:
  - Egyptian Free-tailed Bat (*Tadarida aegyptiaca*)
  - Cape Serotine Bat (*Neoromicia capensis*)
  - Natal Long-fingered Bat (*Miniopterus natalensis*)
  - Long-tailed Serotine Bat (*Eptesicus hottentotus*)
- The species composition in the rotor swept zone is >95% *T. aegyptiaca*
- In 2016, there was 58.7% more activity at 10 m, compared with 60-80 m.
- The highest bat activity occurs in the more mountainous region to the south of Perdekraal East WEF.
- The most significant peaks in activity for species at the highest risk, particularly for the microphones in the important rotor swept zone, appear to be through summer (December, January and February) and autumn (March, April and May) and to a lesser degree spring for *T. aegyptiaca*.
- Looking particularly at activity versus time for summer and autumn, in summer, activity seems to be concentrated in the middle of the night, whereas in autumn there is a slightly higher peak immediately after sunset, tapering out throughout the night.
- Approximately 80% of bat activity occurs below wind speeds of 7-7.5 m/s and approximately 50% of activity occurs below wind speeds of 4.5-5 m/s.
- Approximately 80% of all bat passes occur in temperatures of between 14°C and 23.5°C. Only 10% of bat passes occur below temperatures of 14°C.
- All bat activity occurs between 930 and 950 mB.
- Despite the revised turbine layout, there are still some turbines that encroach on bat sensitive areas, as follows:

Turbine Coordinates		Issue
X_DMS	Y_DMS	
20° 4' 57.39" E	33° 3' 26.01" S	3 m inside a High Bat Sensitivity Area
20° 7' 11.27" E	33° 5' 11.24" S	88 m inside a Medium Bat Sensitivity Area
20° 4' 10.90" E	33° 2' 44.07" S	46 m outside of a High Bat Sensitivity Area
20° 5' 39.29" E	33° 3' 39.08" S	44 m outside of a High Bat Sensitivity Area
20° 6' 45.50" E	33° 4' 9.66" S	69 m outside of a High Bat Sensitivity Area
20° 6' 18.73" E	33° 3' 44.01" S	10 m outside of a High Bat Sensitivity Area
20° 5' 37.75" E	33° 3' 15.62" S	6 m outside of a High Bat Sensitivity Area
20° 4' 54.21" E	33° 2' 24.39" S	42 m outside of a High Bat Sensitivity Area

- Potential impacts were identified and assessed. Where impacts were assessed as having a Medium or a High significance, mitigation measures were recommended. The most important measures being:
- Turbines, including the blade length, should be spaced ≥250 m from each other.
- All turbines (**including their full rotor swept zone**) to be kept out of all High bat sensitivity areas. At least eight turbines, will need to move to avoid curtailment.

- For those turbines that remain in medium-high and high sensitivity areas, a turbine cut-in wind speed of 7 m/s at hub-height is recommended for curtailment of these turbines in in the following times of year, times of night and temperature:
  - In December, January and February (summer) from 19h30 to 04h00.
  - In March, April and May (autumn) from 18h30 to 00h00.
  - Only when temperatures are 14°C or higher.
- For those turbines that remain in medium sensitivity areas and with a rotor blade sweep equal to or lower than 50 m, a turbine cut-in wind speed of 4.7 m/s at hub-height is recommended for curtailment of these turbines in in the following times of year and the following times of night:
  - In December, January and February (summer) from 19h30 to 04h00.
  - In March, April and May (autumn) from 18h30 to 00h00.
  - Only when temperatures are 14°C or higher.
- With the exception of compulsory aviation lighting, minimize artificial lighting at night, especially high-intensity lighting, steady-burning, or bright lights such as sodium vapour, quartz, halogen, or other bright spotlights at sub-station, offices and turbines. All non-aviation lights should be hooded downward and directed to minimize horizontal and skyward illumination. All non-aviation internal turbine nacelle and tower lighting should be extinguished when unoccupied.
- Implement comprehensive long-term post-construction/ operational bat monitoring to inform adaptive mitigation management, as per Aronson *et al*. 2014 or later version valid at the time of monitoring. IWS recommends that:
  - Should adjusted bat fatalities (adjusted for biases such as searcher efficiency and carcass persistence) equal or exceed 2 bat fatalities/10 ha/annum[2] after Year 1 of monitoring, then operational mitigation be applied at certain turbines in certain seasons and at certain times of night. The selection of turbines, during which season and at what time of night should be determined by a combination of the activity data and the unadjusted fatality data. The type of mitigation and the intensity is then determined by relating activity data to weather variables.
  - After the implementation of mitigation measures recommended by the specialist after the Year 1 monitoring, should adjusted bat fatalities (adjusted for biases such as searcher efficiency and carcass persistence) be below 2 bat fatalities/10 ha/annum after Year 2 of monitoring, then no further action other than the mitigation measures employed for Year 2 to remain ongoing is required.
  - Should adjusted bat fatalities (adjusted for biases such as searcher efficiency and carcass persistence) equal or exceed 2 bat fatalities/10 ha/annum after Year 2 of monitoring, then adaptive mitigation and management must be implemented based on the recommendations from the bat specialist and an ongoing monitoring programme should be designed.
  - As other mitigation measures, for example ultrasonic deterrents, prove to be effective, these should be explored for use at sites displaying high levels of mortality.

[2] The number of hectares included in calculating the bat fatalities/10 ha, is determined by drawing a boundary around the developed turbine area that is being monitored. It does not include the entire farm property, only the developed area that have turbines built on it.

- During operational monitoring, quarterly progress reports and annual monitoring reports to be submitted to SABAAP and to the SANBI Bird and Bat Database.
- The above recommendations should be written into the authorisation of this amendment application.

8. References

- Aronson, J., Richardson, E., Macewan, K., Jacobs, D., Marais, W., Aiken, S., Taylor, P., Sowler, S. and Hein, C., 2014. 1st edition South African Good Practise Guidelines for Operational Monitoring for Bats at Wind Energy Facilities. 1st Edition. South African Bat Assessment Association.
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- Sowler, S., Stoffberg, S., MacEwan, K., Aronson, J., Ramalho, R., Forssman, K. and Lötter, C. 2016. 4th Edition South African Good Practice Guidelines for Surveying Bats at Wind Energy Facility Developments – Pre-construction. 4th Edition. South African Bat Assessment Association.