Terrestrial Fauna Sensitivity Study for the proposed Taaibos and Soutrivier Wind Energy Facilities

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First Draft Report

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Aliénor is a professional registered Ecologist with SACNASP (Registration Number: 116197) and holds an MSc degree (Zoology) from Rhodes University. Aliénor has been involved in fauna and avifauna surveys for renewable energy projects since 2015. Her main work focus is the use of camera traps to monitor wildlife populations, including designing and implementing species-specific camera trapping surveys for rare and cryptic species. She has extensive field experience across southern Africa and particularly within the Northern Cape. Aliénor has contributed to both the faunal and avifaunal aspects of the Taaibos and Soutrivier sites and has spent a cumulative total of 76 days over the last two years on both these sites. Aliénor is contributing to the Fauna Species of Conservation Concern aspects of these projects including the assessment and surveys for the Riverine Rabbit. She is involved in survey design, field work, data management, analyses, and reporting.

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INTRODUCTION

The potential environmental impacts of Wind Energy Projects to terrestrial fauna has been poorly studied in comparison to the well documented impacts on volant animals (i.e., birds and bats) (Arnett *et al.* 2007; Helldin *et al.* 2012). More recently however, ecologists have become concerned about the possible impacts on terrestrial wildlife and sensitive habitats. Renewable energy in South Africa is relatively novel in comparison to the US and European countries where development began in the 1970s and 1980s respectively and as far as we know no studies on the impacts of Wind Energy Facilities (WEFs) on terrestrial wildlife in South Africa have been conducted. We can, however, draw inferences from broader literature, including other human disturbances, to make scientifically based recommendations and predict potential impacts on animals so that meaningful mitigation measures can be implemented.

This report evaluates the possible impact of wind facilities on wildlife with specific focus on the possible implications for terrestrial faunal Species of Conservation Concern (SCC) which have been identified as potentially or likely to be present on the site. The DFFE National Environmental Screening Tool Animal Species Theme identified two sensitive terrestrial species, based on known records and modelled distribution; the Riverine Rabbit (*Bunolagus monticularis*; Critically Endangered) and the Karoo Dwarf Tortoise/Karoo Padloper (*Chersobius boulengeri*; Endangered). The Riverine Rabbit, which has the greatest potential concern due to its listed status and endemism to the region with restricted distribution range, is being evaluated in a separate study and has been confirmed present on the Taaibos site during an initial targeted camera trap survey. The Karoo Padloper is likely present as it is widespread in the area. The Southern Mountain Reedbuck (*Redunca fulvorufula fulvorufula;* Endangered), which although not identified by the screening tool within the site boundary, was confirmed present during field surveying East of the Taaibos site and a possible sighting in the north-eastern region of the Soutrivier site thus may potentially be present on both the Taaibos and Soutrivier sites. The Black footed Cat (*Felis nigripes;* Vulnerable) is also known to occur to the west of the Taaibos site and was detected on a camera trap during the initial Riverine Rabbit survey. The African Striped Weasel (*Poecilogale albinucha*; Least Concern), a data deficient species (National Red List status, 2014), was also detected on camera traps at two locations on the Taaibos site. Further assessment of species occurrence also identified the Leopard (*Panthera pardus;* Vulnerable), Grey Rhebok (*Pelea capreolus*; Near Threatened), and the Littledale's Whistling Rat (*Parotomys littledalei;* Least Concern) as likely to occur in the general area from historical records using specific QDS from the MammalMap records.

This report provides additional taxa-specific information and assessments for the red-listed species identified as present or likely present within the Taaibos and Soutrivier sites as well as within the broader area. Specific recommendations based on their biological needs and the potential impact from the WEFs have been given. Further investigation and a general fauna monitoring program are recommended, and higher risk or sensitive areas used for breeding found in subsequent site assessments may necessitate avoidance with no go zone buffers.

SPECIES OF CONSERVATION CONCERN (SCC)

Riverine Rabbit (*Bunolagus monticularis*) – Critically Endangered

The Riverine Rabbit was confirmed present on the Taaibos site during the targeted camera trap survey (Figure 1) and although no Riverine Rabbits were recorded during the Soutrivier initial camera trap survey, previous sightings have been recorded in the general area in the riverine habitats of the larger drainage systems (Figure 2). The species is unlikely to be found within higher lying areas where turbines would likely be located but disturbance, primarily from turbine noise, is still a concern and precautionary buffers have been placed to ensure any subpopulations are not negatively impacted by the development. More in depth assessment is discussed in a separate report for this species.

Figure 1. Riverine Rabbit were detected on a follow up camera trapping at the Taaibos site following good rains after a prolonged drought.

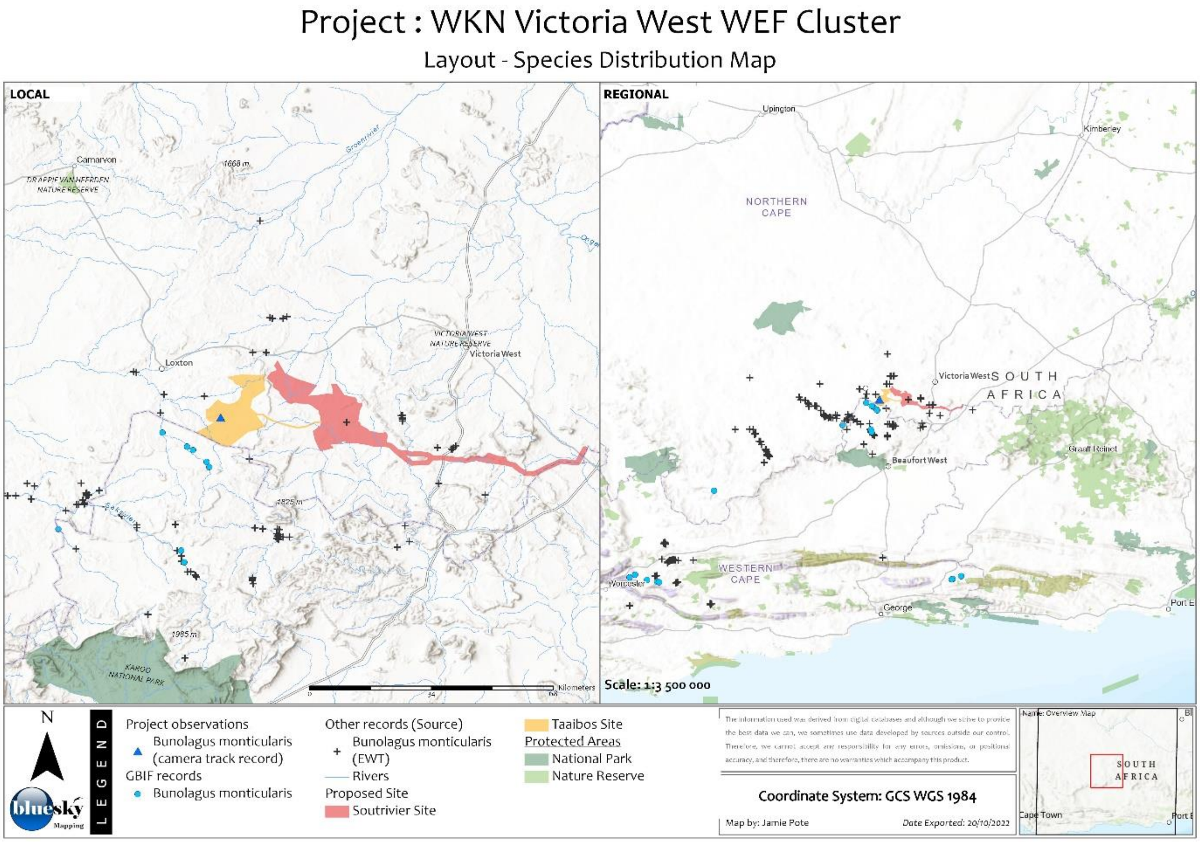

Figure 2: Distribution map of the Riverine Rabbit observations shown in both local and regional extent. The blue triangle represents camera trap record at the Taaibos site. Map compiled by J. Pote.

Karoo Dwarf Tortoise/Karoo Padloper (*Chersobius boulengeri*) - Endangered

The Karoo Dwarf Tortoise, also known as the Karoo Padloper, is categorized as Endangered A4ace and listed in CITES Appendix II, it is also listed as a protected species by the Provincial Nature Conservation Ordinances and biodiversity laws at regional level. It is endemic to South Africa occurring from Bruintjieshoogte in the Eastern Cape to Touwsrivier in the Western Cape. Their range in the Northern Cape extends north of Williston in the northwest and beyond Vosburg in the northeast. This species is a habitat specialist and is associated with rocky outcrops and dolerite ridges as well as sandstone areas. It is usually found on hill slopes where it shelters under rocks in vegetated areas or in rock crevices. It occurs both in the Succulent and Nama Karoo biomes and more specifically in dwarf shrubland that has succulent and grassy vegetation types.

Populations of the Karoo Dwarf Tortoise have severely declined over the past few decades. This is attributed to habitat destruction and degradation which are the species' main threats. It is estimated that nearly 50% of their range is either moderately or severely degraded. The effects of climate change and over grazing pressure by livestock is changing the vegetation structure in such a way that dwarf shrubs and geophytes are being replaced by grasses. This impacts the tortoises by reducing both cover and food availability. Predation by crows has also been found to be on the rise and has been identified as a major threat to tortoise species in general (Fincham *et al.* 2015).

A population of Karoo Dwarf Tortoise was known near Victoria West along the R63 road and multiple incidental sightings were recorded in that general area between 2005-2020 (V. Loers, pers. comm, 2022) (Figure 3). However, despite intensive searches during a recent population assessment at that locality, Dwarf tortoise specialists were unable find a population (V. Loers, pers. comm, 2022) and there is presently only one known Karoo Dwarf Tortoise population, located further north near Williston (Loehr & Keswick 2022). The Karoo Dwarf Tortoise is inconspicuous, secretive, and sparsely distributed which makes it difficult to detect and may lead to uncertainties to their status when doing on-site assessments (Hofmeyr *et al.* 2018).

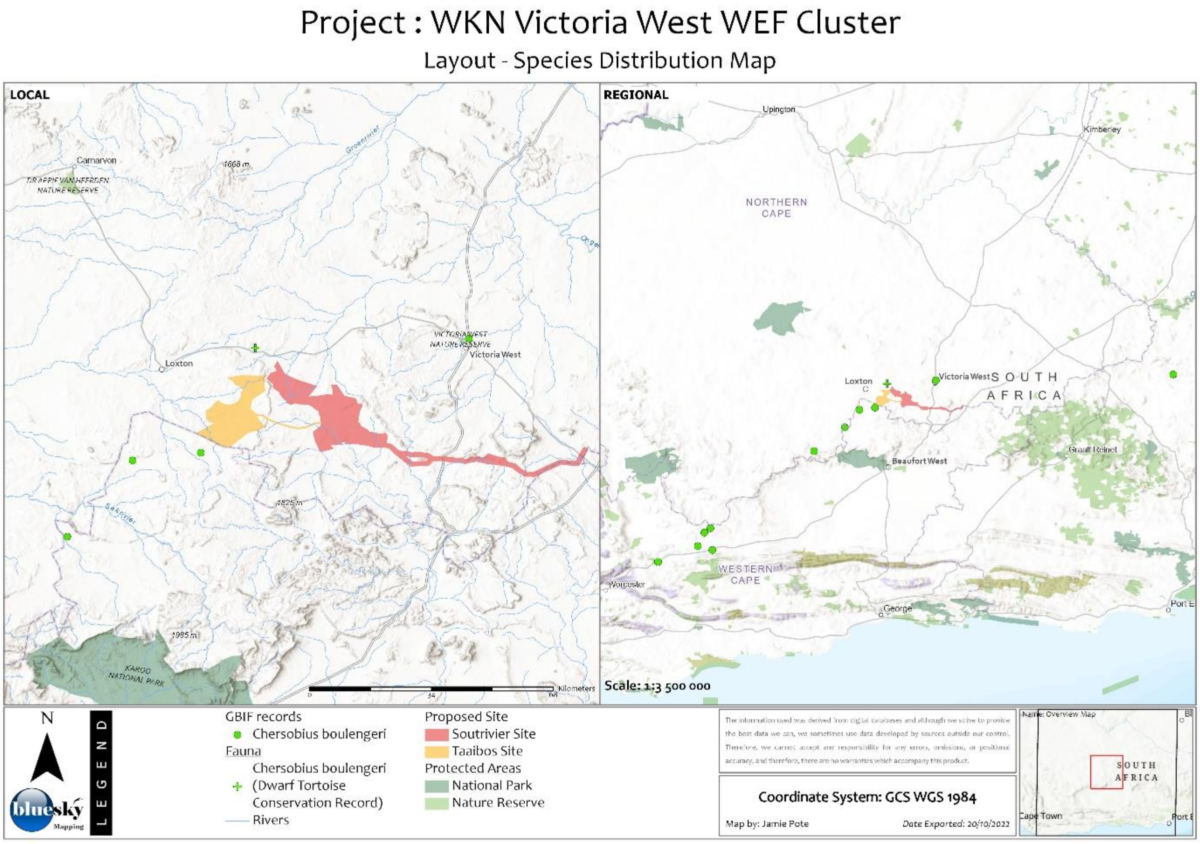

Figure 3: Records of Karoo Dwarf Tortoise are shown for the local and regional extent. The green cross represents historical record of a previously found population north of the site, however despite extensive searches, no individuals have been found at that locality in a recent assessment. Map compiled by J. Pote.

The potential impact of wind energy facilities (WEF) on the Karoo Dwarf Tortoise is mostly unknown but we can draw inferences from the broader scientific literature and studies that have been conducted on other desert tortoises that occur at operational WEFs. The Agassiz's desert tortoise (*Gopherus agassizii*, Critically Endangered) is a long-lived semi-fossorial (burrowing) species that is native to the Mojave and Sonoran Deserts in the southwest of North America. This desert tortoise was studied to better understand potential impacts of WEFs post construction (operational phase) (Agha *et al*. 2015). Contrary to the authors predictions, their activity centres and survival rates did not vary significantly and no significant decline in annual survival rates were found (Agha *et al*. 2015). Rather their results indicated that long-term tortoise survivorship was in fact significantly higher on the WEF than in the nearby wilderness area (Agha *et al*. 2015). The habitat modifications on the WEF lead to increased resource availability from artificial rain catchments on turbine pads and edge enhancement of vegetation along roads and these may in fact enhance survivorship. Burrow locations of the Agassiz's desert tortoise were also found to be located closer to dirt roads and turbines than expected (Agha *et al*. 2015). The tortoises were also observed to have larger activity areas within the WEF which was attributed to the use of access roads which enable easier mobility within the modified landscape

(Agha *et al*. 2015). Tortoise sightings along dirt roads have been observed for other tortoise species, and where traffic volume is low, populations have been found to be in higher densities around dirt roads, however where traffic is high they are more susceptible to collisions and as a result occur in lower abundances (Nafus *et al.* 2013).

The ecology of the Karoo Dwarf Tortoise is not yet fully understood, but it is highly sedentary with relatively small home ranges of 1 hectare and short daily displacement distances of around 30m (unbubl. Data, V. Loers). Dispersal may occur but these events would be considered rare. Road collision risk is therefore unlikely, but, as with other desert tortoises, road edge effect may attract this species if it is within proximity of suitable habitats and mitigation may be required if a roadkill is recorded.

Suitable habitat (rocky slopes that are not too degraded from over grazing) at both WEF sites and along the expected powerline routes may contain Karoo Dwarf Tortoises and as such a precautionary approach is applied and suitable habitats have been mapped as very high sensitivity and no-go zones. Importantly, the development may create increased predation pressures on the Karoo Dwarf Tortoise due to possible artificial increase in Pied Crow (*Corvus albus*) abundance from powerline infrastructures by providing both perching and nesting sites. Pied Crow predation may have substantial long-term negative impacts on tortoises as nest building will occur throughout the operational phase. This impact has been assessed in more details in the OHP reports where mitigation strategies have been recommended.

Due to the high threat status of the species and intense search effort required to find the species, once final layout is provided, including laydown areas and road lay out, we recommend that a herpetofauna specialist further investigates the suitability of these sites with targeted search efforts at specific designated sites that may be affected by the development footprint. Findings from this assessment may further refine 'No Go areas' that must be avoided by the development footprint.

Search and rescue will also be required during the construction phase of the project. The Karoo Dwarf Tortoise is particularly difficult to find even when targeted searches are conducted, they are active for short periods of time and when conditions are unfavourable, they may aestivate (lay dormant) for extended periods. Searches have previously been done with scent detection dog teams with some positive results (V. Hudson, Cape Nature, pers. comm. 2022).

The most likely threat and mitigation measure is to ensure the development does not encourage the proliferation of corvids in the general area. This includes perching and nesting sites (powerline pylon design, nest deterrents, and frequent removal of nests that are built nevertheless), food availability (avoid open dump sites and additional road mortality), and water availability (where possible make water inaccessible to corvids). Access roads, both for the WEF and powerline must avoid passing through rocky terrain and degrading the habitat further. Where the powerline traverses' rocky outcrops, access roads can be redirected around these sensitive habitats. The species would also benefit from a net positive biodiversity offset program. This could be achieved, for example, by reducing overgrazing in sensitive habitats, the removal of existing corvid nesting sites such as broken windmills and old powerline/telephone poles and providing of funding for a Karoo Tortoise Conservation program in the region. Should a tortoise or tortoise derivative such as shell remains be found, further searches need to be conducted and impact mitigation may be required where a subpopulation is found, including no go zone and monitoring.

Southern Mountain Reedbuck (*Redunca fulvorufula fulvorufula*) - Endangered

The Southern Mountain Reedbuck (*Redunca fulvorufula fulvorufula*) was sighted approximately 8km to the west of the Taaibos site and a brief sighting of a small herd was observed on the Soutrivier site in the dolerite koppies in the eastern side of the site (Figure 4). Although the sighting on Soutrivier was brief and identification could not be confirmed, the locality of the sighting being on rocky and grassy hillside suggests it most likely to be Mountain Reedbuck. The species is also confirmed present in the general area and found within the nearby Karoo National Park. The Southern Mountain Reedbuck is categorised as Endangered by the International Union for Conservation of Nature (IUCN) Red List status (Taylor *et al.* 2016a) and it is therefore important that the species be considered as it is likely to also occur in other areas of the sites where other suitable habitats may support Mountain Reedbuck and may be impacted by the developments.

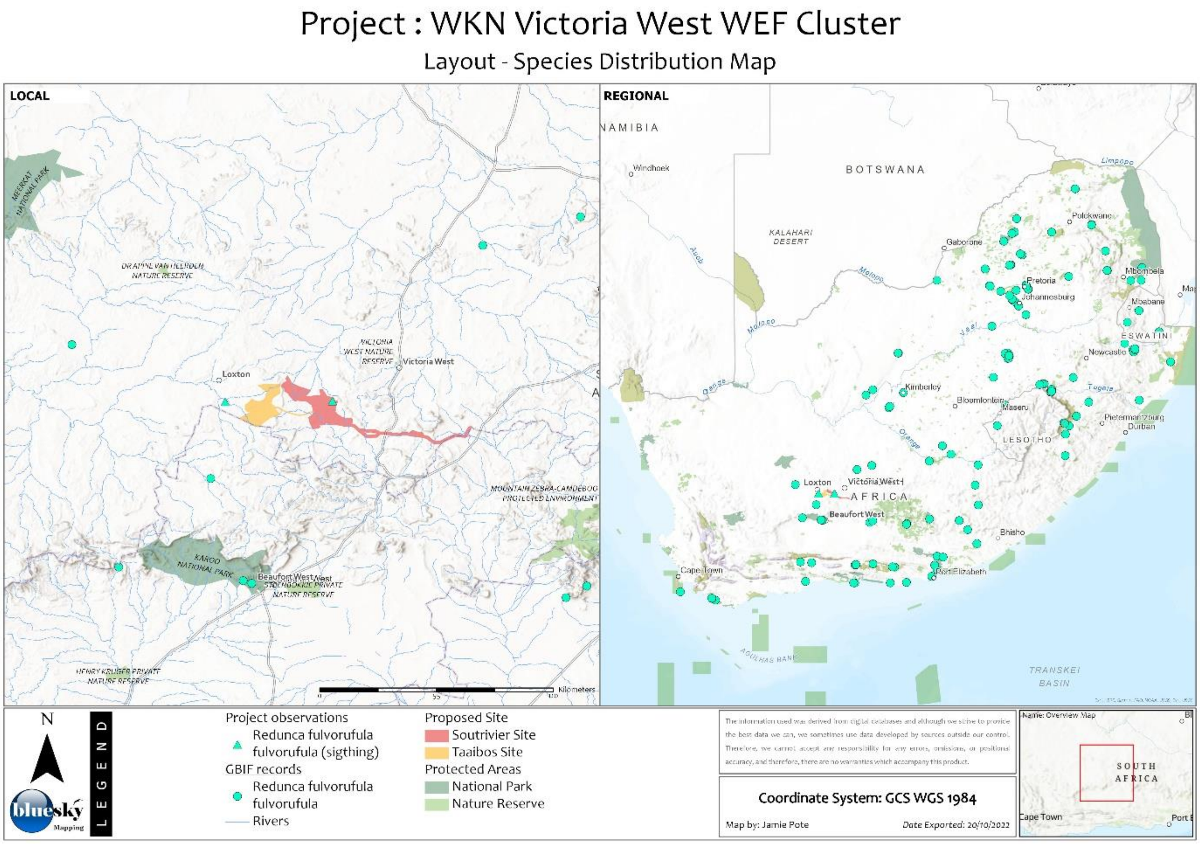

Figure 4: Records of Southern Mountain Reedbuck are displayed for both local and National extent. Sightings during field visits are shown using the turquoise triangle icon. Map compiled by J. Pote.

The Southern Mountain Reedbuck (SMR) is one of three recognized subspecies of Mountain Reedbuck and the only subspecies to occur in the Southern African subregion (Skinner & Chimimba 2005). The SMR were historically widespread in South Africa but owing to their specialized habitat requirements their distribution was patchy (Skinner & Chimimba 2005). SMR are typically found on grassy and rocky hillsides, taking cover in bushes, and avoiding open areas. It is a water dependent species and generally found on slopes of mountains venturing onto flats to feed and drink (Skinner & Chimimba 2005).

Populations of SMR still occur throughout much of their former range both on private and formally protected areas, however the latest assessment of the subspecies has found a dramatic decline in numbers across the region in the past decade prompting a status re-evaluation which led to the current classification as Endangered (Taylor *et al.* 2016a). It is unlikely that a local population would be significantly impacted by the development as their preferred habitat has been recommended to be avoided as 'no go areas' which includes dolerite koppies where they will likely seek refuge during daytime. Nonetheless there is likely to be some disturbance particularly during the construction phase from general increase in human activities and noise. During operation, the impact would be reduced but noise and visual effect from the turbines may impact the species that may choose to avoid the site. Due to the species status and uncertainties of the occurrence of a possible population further assessment and monitoring is recommended.

SMR are relatively shy and avoid open areas, thus the use of camera traps at targeted sites is recommended for monitoring. We recommend that the monitoring of SMR is done in conjunction with a broader biodiversity survey which would provide information not only on SMR occurrence, but also a general species inventory and occupancy estimates for species status comparison before, during and after construction of the WEFs. The camera trap survey thus requires a Before-after-impact (BAI) design with a comprehensive area-wide spatial arrangement of camera traps. Species that are rare and cryptic require a targeted camera trap approach to increase likelihood detection rates, this is done by placing camera traps in the SMR preferred habitat including mountain ridges, hill slopes and nearby permanent waterpoints. This approach increases detection rates and provides a more meaningful dataset including locality of herds, potential routes used to access water and forage as well as higher likelihood of a sufficient dataset for occupancy and activity pattern analyses.

Black-footed cat (*Felis nigripes*) – Vulnerable

The Black-footed Cat (*Felis nigripes*), a Vulnerable species C2a(i), is endemic to the Karoo and Kalahari regions (Wilson *et al.* 2016). It occurs at low densities in open arid and semi-arid habitats where it favours habitats with low vegetation cover and is a specialist of short grass areas with high prey abundance, where it hunts primarily small rodents and ground roosting birds (Wilson *et al.* 2016). It uses abandoned termite mounts or dens dug by other animals such as Aardvark (*Orycteropus afer*) for resting and breeding (Skinner & Chimimba 2005). The Black-footed Cat was confirmed present (Figure 5) on the Taaibos site during the initial Riverine Rabbit camera trapping survey, and it was also known to occur to the west of the Taaibos site from previous records (Figure 6). We have also been in consultation with the Black Footed Cat Working Group (BFCWG), and we are awaiting possible additional records in the area (A. Sliwa, BFCWG, Pers. Comm. 2022)

Figure 5: Black-footed cat capture on camera trap at the Taaibos site during the Riverine Rabbit survey.

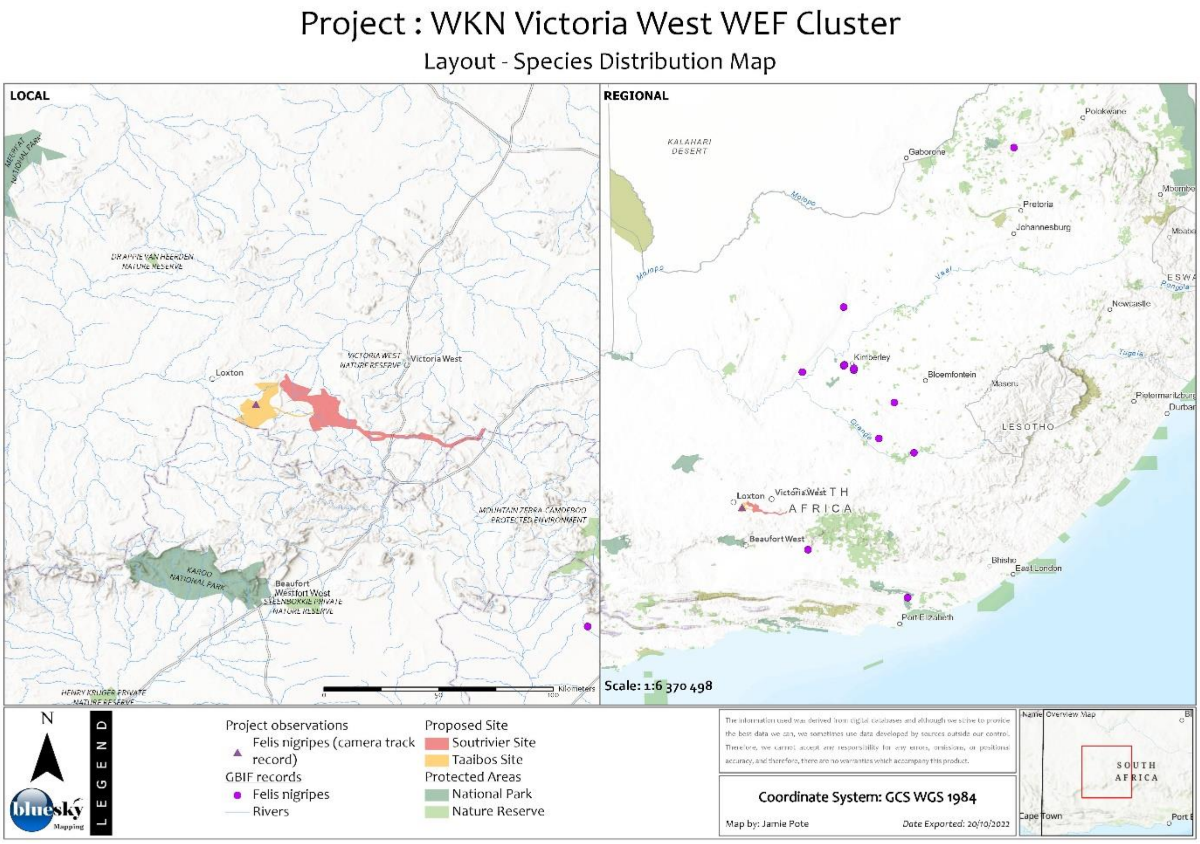

Figure 6: Observation records of Black-footed Cat at Taaibos site (purple triangle) and within the greater region. Map supplied by J. Pote.

It is therefore likely that a free-ranging subpopulation exists within the site and may potentially be affected by the development. However, the species occurs widely with large national and provincial distribution ranges in semi-arid habitats, but with relatively restricted and patchy distributions, and the central Karoo region is suspected to be a stronghold for the species with highest known densities. The species is threatened by habitat degradation, poisoning and predation from over abundant mesopredators (Black backed jackals and Caracals) as well as domestic dogs (Wilson *et al.* 2016). Loss of prey base and key resources such as den sites due to human disturbance or habitat degradation from overgrazing is also listed as one of their most serious threats (Wilson *et al.* 2016). Location records suggest that their distribution is primarily outside protected areas and is highly fragmented thus it is important that these subpopulations are adequately conserved where they occur on farmlands.

The development is unlikely to have a significant impact on this species but disturbance around any identified burrows/dens should be kept to a minimum. We recommend that further investigation is conducted in suitable denning sites and that the biodiversity camera trap survey includes targeted camera trap sites for this species. This naturally rare and secretive species is particularly difficult to survey, and camera trapping alone may be inadequate so additional methodologies to increase detection rates, such as the use of a scent detection dog team, may be required. The Black-footed Cat is considered an iconic flagship species of southern Africa, particularly in the Karoo region, and thus requires some form of protection and monitoring which would provide much needed information on this data deficient species (Wilson *et al.* 2016).

Black-footed Cat are strictly crepuscular and nocturnal whilst during the day they make use of available dens dug by other species (Skinner & Chimimba 2005). Thus, daytime activities of an operational WEF are unlikely to have a significant impact provided that their den sites are not in proximity to human related activities including turbines, roads, and substations. The species would also benefit from the establishment of large conservancy areas and dispersal corridors with suitable conditions for the species to ensure that subpopulations remain connected and viable.

Leopard (*Panthera pardus*) - Vulnerable

The leopard is unlikely to be present on site on account of human disturbance and likely persecution. However, it is possible that leopard may still occur in the large mountain ranges both East of Taaibos and East of the Soutrivier sites. These mountains are rugged and mostly inaccessible and thus may provide refuge for the species. As these mountain ranges would be avoided by the development, the likelihood of possible impact on the leopard is unlikely. Additionally, this species is widespread both regionally and nationally and is adaptable to a human dominated landscape, nonetheless fragmented subpopulations may be threatened primarily from ongoing intense persecution due to real or perceived livestock depredation.

Grey Rhebok (*Pelea capreolus*) – Near Threatened

The Grey Rhebok is listed as Near Threatened A2bd but continued declines across its range may require a reassessment and higher threatened listing (Taylor *et al.* 2016b). The species occurs in rocky grassland habitats both on private and protected land including in the nearby Karoo National Park. Their distribution is patchy but widespread with subpopulations fragmented by natural and anthropogenic land uses. The primary threat to the species is likely increased poaching rates from both bushmeat snaring and illegal sport hunting with dogs (Taylor *et al.* 2016b). Overabundance of mesopredators is also identified as a possible threat which is as a result of poor carnivore management (Taylor *et al.* 2016b). Habitat degradation and climate change may also play a role in their decreasing numbers (Taylor *et al.* 2016b). The Grey Rhebok has not been observed to date on the site, but it is present in the general area particularly in higher-lying areas, thus further assessment may detect the species as some areas of the site are broadly suitable. Likely impacts of the development would primarily be from disturbance from both noise and visual effect, where they may be displaced particularly during the construction phase. Similarly, to the Mountain Reedbuck, it would be expected that habituation would occur over time.

Brown Hyena (*Hyaena brunnea*) – Near Threatened

The Brown Hyena was not identified during the assessment process but is known to occur in the broader area in the Karoo National Park and it is possible that sporadic visitors pass through the site. Should the specie's presence be detected by the camera trap biodiversity survey or during future site visits, the general mitigation measures for the faunal species of conservation concern will also be applicable as part of monitoring and adaptive management process. This would include restricted activity around any identified den sites if such are identified at a future time.

African Striped Weasel (*Poecilogape albinucha*) – Least Concern

The African Striped Weasel (ASW) was confirmed present at the Taaibos site during the initial Riverine Rabbit camera trap survey (Figure 7).

Figure 7: Camera trap capture of African striped weasel at two locations in three independent events on the Taaibos site.

This species was last assessed for the IUCN Red List of Threatened Species in 2015, where it is listed as Least Concern for the Global Red List status, however, the Regional Red List status (2016) lists the species as Near Threatened C1 and on the Data Watch-list. The reason for this categorisation is given because, despite a lack of data available about this species, there has been a notified decline in reporting rates from most areas of the country which suggests a declining population. In the Northern Cape the status of the species is unclear as there are only two historical records with a few incidental records in more recent years (Figure 8).

Little is known about habitat requirement, but it has been recorded in a wide variety of habitats and bioregions, suggesting a wide distribution range but occurring at naturally low population densities. The greatest threat identified for the ASW is habitat loss while loss of prey base (from poor land management and overgrazing) is also likely to significantly affect this species as it is a specialist predator and relies on adequate prey base of small mammals for survival. In dry arid regions the species appears to be associated with mole-rats and may have a sympatric distribution range with this species. The ASW is included in this assessment as although currently globally designated a Least Concern Status, it is a Data watchlist species with regional Near Threatened status, and thus the species would benefit from monitoring to better understand its ecology and preferred habitat. Furthermore, ASW may be negatively impacted on by sound effects as they rely on auditory cues for communication and alarm calls (Skinner & Chimimba 2005).

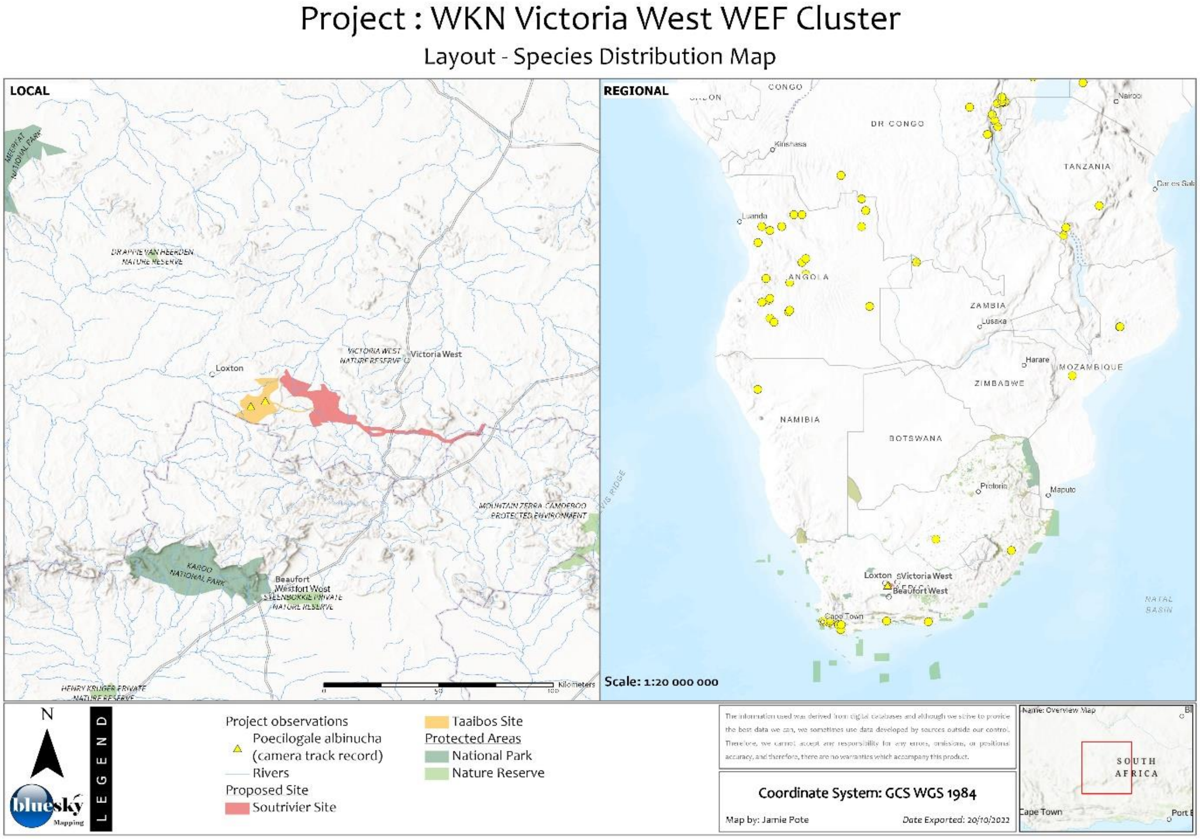

Figure 8: The African Striped Weasel was detected at two camera trap stations (Yellow triangle) at the Taaibos site during the Riverine Rabbit camera trap survey. Records of this species are rare, and these detections provide important distribution data. Map supplied by J. Pote.

Littledale's Whistling Rat (*Parotomys littledalei*) – Least Concern

The Littledale's Whistling Rat is listed as Least Concern by the Global Red List (2016) because of its wide distribution. However, the Regional Red List Status for the species is Near Threatened B2b(iii,iv)+c(iii) (2016) and the species is both on the Data and Threat Watch-lists as it is suspected to be especially vulnerable to drought conditions which affect key forage resources. Drought conditions are increasing in frequency and duration with climate change. Habitat degradation from overgrazing is also threatening the species that relies on plant cover for survival. The species is similar to Brants's Whistling Rat (*Parotomys brantsii*) and is pending phylogenetic analyses. Both species have historical distribution records at the site, but present presence of a subpopulation on the site is unlikely following the prolonged drought period and further habitat degradation exacerbated by overgrazing. However, long distance dispersal and re-colonisation is a possibility where shrub areas are connected as population irruptions are known to occur following favourable environmental conditions (Schradin *et al.* 2016). Their distribution is patchy owing to the need of deep sandy soils and plant cover where they form complex warren systems under bushes. The development is unlikely to have a direct impact on this species but would benefit from conservation of buffered zones with lowered stocking rates to conserve key resource areas. Additionally, they may provide an important prey base for other threatened predator species of the area. Sound emissions from the turbines may also impact this species that relies on auditory cues for communication and predator avoidance.

Refer to separate bat assessment for specific assessment and recommendations.

POTENTIAL IMPACTS OF WIND ENERGY PROJECTS

All infrastructural components of WEFs (turbines, powerlines, roads, turbine pads, electrical substations, and housing for control facilities) and the increased human activity in the area can have a negative impact on a variety of vertebrate species (Helldin *et al.* 2012). Although wind farms have a relatively small footprint in terms of habitat loss (5-10% of entire site) they have one of the largest footprints in terms of the disturbance and avoidance area per GW rating compared to other forms of renewable energy generation (Arnett *et al.* 2007; Agha *et al.* 2015)

Specific risks associated with terrestrial biodiversity will primarily relate to ecological fragmentation and potential alteration of water flows that could have localized and downstream ecological impacts to catchments. More specifically the potential effects of WEFs on terrestrial mammals may include habitat deterioration and fragmentation, which may create barriers to geneflow, noise effect, road mortality, visual effect, vibration and shadow flicker effects, electromagnetic field generation, macro- and micro-climate change as well as increased fire risk. Of particular concern is the possible cumulative and cascading impacts on the ecosystem across trophic levels (Lopucki *et al.* 2017; Thaker *et al.* 2018).

WEFs may however, also have opposite effects, where a positive reaction (e.g., higher abundance) is observed in some species (Agha *et al.* 2015; Lopucki *et al.* 2017; Thaker *et al.* 2018). This may be due to lower presence of birds of prey due to collision risk and general avoidance of foraging near turbines. Consequently, there may be a reduced predation risk close to turbines and this habitat may be favoured by some species (Agha *et al.* 2015, Lopucki *et al.* 2017; Thaker *et al.* 2018). Some species may benefit from increased road edge effect, where the roads and turbine pads become artificial rain catchments and subsequently increase roadside plant productivity thus enhancing resource availability within the site (Agha *et al.* 2015). Habitat perturbation during construction activities can also attract species onto WEFs. This has been observed in the US with prairie dogs (*Cynomys* species), cottontail rabbits (*Sylvilagus* species) and prairie hares (*Lepus townsendii*) (Hötker *et al.* 2006). Change in current land use such as from livestock farming or reduced stocking rates due to the alternative income source from renewable energy may also provide a positive impact on the ecosystem.

The effect of WEFs will vary with each project depending on the type and number of turbines used, location, and phase of the project (construction, operation maintenance, or decommissioning) (Lopucki *et al.* 2017). Importantly, present-day wind developments are using very different turbines than older facilities and may have associated changes such as reduced sound emission, thus caution should be exercised when reviewing previous findings of some of the impacts assessed.

The effect of WEFs on terrestrial mammals is primarily from increased human activity particularly during the construction phase (Skarin *et al.* 2015). Most studies have found that there is avoidance of the area during the construction phase by larger fauna (Helldin *et al.* 2012). Studies on the effect of wind farms during the operational phase have had various results with either no or low-level impact with observed habituation to significant effect with observed displacement (Helldin *et al.* 2012). The variation appears to be species-specific and may vary with environmental factors including habitat and climate (Lopucki *et al.* 2017; Skarin *et al.* 2018). Species response will also depend on foraging methods and presence of predators. The effect of WEFs may also impact physiology, behaviour and even morphology of certain species and, although no displacement is observed, this does not necessarily mean that there is no effect of disturbance which may be in the form of increased levels of stress (Thaker *et al.* 2018). Stress triggers the fight-or-flight response, increasing alertness and draining energy reserves, this will affect overall health and body condition will deteriorate (Helldin *et al.* 2012). Animals that are in poor condition may choose to forage in more productive habitats but with higher risks (Helldin *et al.* 2012).

The ecological plasticity of the species and its capability of adjustment or habituation to various anthropogenic disturbances will also play an important role (Helldin *et al.* 2012; Broucek 2014). The habituation period may vary with species where some may require more time to adapt to novel turbines in their environment than others (Helldin *et al.* 2012). For example, historical persecution on certain species may play an important role on the habituation period for carnivore species that are persecuted due to real or perceived livestock depredation. These species may feel threatened by human activities and choose to avoid the general area.

The effect of the wind farm on one species may have indirect cascading effects (knock on effect) on other species within the same communities due to ecological relations to one another (Rabin *et al.* 2006; Thaker *et al.* 2018). This means that an effect on one species may in turn affect many others within the same ecosystem. Cascading effects may be complex and unpredictable as it may be the result of different types of interactions including competition, predation, parasitism, or symbiosis (Helldin *et al.* 2012). Consequently, it is important to look at the faunal community as a whole and understand current population status to assess possible impacts and adopt an adaptive management approach.

Visual Impact

Visual stimuli may affect wildlife, particularly prey animals that react to visually detected movement and therefore may be affected by the movement of turbine blades. Available literature gives one example; the roe deer (*Rangifer tarandus*) shifted their home range where wind turbines were visible and chose habitats where turbines were obscured by topography (Skarin *et al.* 2018). Visual stimuli may cause annoyance or stress and the effect of visual disturbance may be far reaching where the site is open and unobscured (Skarin *et al.* 2018). SCC such as the Riverine Rabbit, Mountain Reedbuck and Grey Rhebok are most likely to be impacted by possible visual stimuli but personal observation at existing windfarms suggest that they are likely to habituate over time, however this can only be confirmed through monitoring.

Noise impact

Quantifying the effect of noise on wildlife is challenging as not only does it depend on the frequency, intensity, duration, and pattern of the sound, but also on the biology of the species including hearing range, vocal behaviours, and physiological state of the animal at the time of exposure (Shannon *et al.* 2016; Broucek 2014). Additionally, the effect of noise also depends on the individual's previous exposure to the noise (noise exposure history) and the predictability of the noise to which an animal is exposed to (Broucek 2014). Noise can induce multiple biological responses, including disrupting vocal communication and auditory impairment which may cause a change in vocalisation or a shift in habitat selection (Helldin *et al.* 2012). Noise is rarely isolated from other human related disturbances such as habitat change and visual disturbance which makes it difficult to interpret or predict biological responses so that appropriate mitigation measures are implemented (Shannon *et al.* 2016). Species that rely on hearing for courtship, mating, prey location, predator detection and homing may be particularly negatively impacted by increased noise in their environment (Broucek 2014). All SCC identified on this site, may be impacted in one way or another by noise effect and to better understand this impact it is recommended that monitoring is conducted whilst the buffers that have been provided may provide some distance from turbine to reduce this unknown effect.

Noise can cause sensory degradation or impact the ability to detect acoustic cues from conspecifics, predators, prey, or the environment (Barber *et al.* 2010; Shannon *et al.* 2016). This masking effect can change predator-prey interactions and may have substantial changes in foraging and anti-predator behaviour, directly affecting reproductive success and indirectly affecting community structure and population dynamics through changes in habitat use, courtship, mating, and parental care (Rabin *et al.* 2006; Broucek 2014; Shannon *et al.* 2016). The effect of masking also decreases the distance over which acoustic signals can be heard, this may compromise the ability to communicate or detect alarm calls to warn of approaching predators (Barber *et al.* 2010). Additionally, many species are known to listen to other species' vocalisation, including alarm calls, and to make habitat decisions (Barber *et al.* 2010). Masking can also affect an animal's ability to use sound for spatial orientation and can inhibit the perception of important ecological sounds which may trigger certain responses, for example the sound of approaching fire is used by African reed frogs to flee (Dai *et al.* 2015). The acoustical environment is not just the collection of private conversations between the signaller and receiver but an interconnected landscape of information networks. Hence, the masking imposed by anthropogenic noise could have volatile and unpredictable consequences.

Noise can be perceived as a threat and sudden, higher intensity noise appears to be particularly stress producing in mammals, provoking distress responses similar to those associated with predation risk including startlement, freezing and fleeing from the sound source (Broucek 2014; Shannon *et al.* 2016). Chronic background or repetitive noise is in comparison less stress inducing, and stress responses also reduce with prolonged exposure or if sound is at regular intervals (Broucek 2014). Chronic noise is, however, more likely to reduce auditory cues important for communication, orientation and predator/prey detection which is particularly important if the source of noise overlaps with the species' hearing capabilities or masks sounds of interest (Shannon *et al.* 2016). Importantly hearing, and the resultant potential stress response, continues to function when sleeping or hibernating.

There has been very little research on the impact of noise on wildlife species and there are no guidelines about noise levels that can be used. Sound level of -20 dBA is just audible to most acoustic reliant species (such as bats, owls, foxes) and wildlife species that are known to be sensitive to noise although species' response to noise disturbance will differ due to differences in audibility range and sensitivities at different frequencies (Mockrin & Gravenmeir 2012; Broucek 2014). In the US, Forest Service guidelines have a noise threshold of a maximum of 10 dB above ambient noise level where development is in or near habitat of wildlife known to be sensitive to noise during reproduction, roosting, or hibernation, or where habitat abandonment may be an issue (Mockrin & Gravenmeir 2012).

It is difficult to provide definitive levels at which point noise starts to impact on animal species and most studies have been carried out in laboratory experiments with very high noise levels. Additionally, it is difficult to clearly define the impact of noise on an animal as it may be associated with other environmental and anthropogenic factors. Species with sensitive hearing may choose to avoid noisy areas and relocate. This is particularly important for habitat specialist species such as Riverine rabbits, as they may not have the possibility to relocate and thus a conservative buffer has been used to avoid turbines being placed too close to their preferred habitat.

Wind turbine noise varies with design and size and noise reduction is continuously improving with new turbine manufacture. Sound consists of both high- and low-frequencies with low-frequencies carrying over longer distances. Particularly noisy turbines have recorded a maximum sound output of 110 dB, which would typically require the turbine to be at least 1km from human residence to attain levels below about 42 dB. However, other turbines have recorded noise levels of less than 60dB (100-110 dB at rotor axis). But noise levels at a distance varies with number of turbines in operation. 1 turbine at 500m is about 25-25 dB whereas 10 turbines at that distance will generate sound in range of 35-40 dB (Dai *et al.* 2015). Turbines emit both tonal (frequencies 20-100Hz) and broadband noise (above 100Hz and as high as ~6-8kHz) (Dai et al 2015), however the most prominent frequency range is 63-4000Hz (Helldin *et al.* 2021). Aerodynamic noise has the highest strength of sound in the range of low frequencies (Lopucki et al 2018). Accordingly, it is very likely that auditory reliant species, including the Riverine rabbit, Mountain reedbuck, Black-footed cat, Grey Rhebok and Littledale's

Whistling Rat may have hearing frequency ranges which overlap with the frequency range of wind turbine noise (See figure 9 below for a visual example of frequency overlap in a range of animals). Low frequency noise, (below 100Hz) although inaudible for some rodents, may still induce stress at high levels.

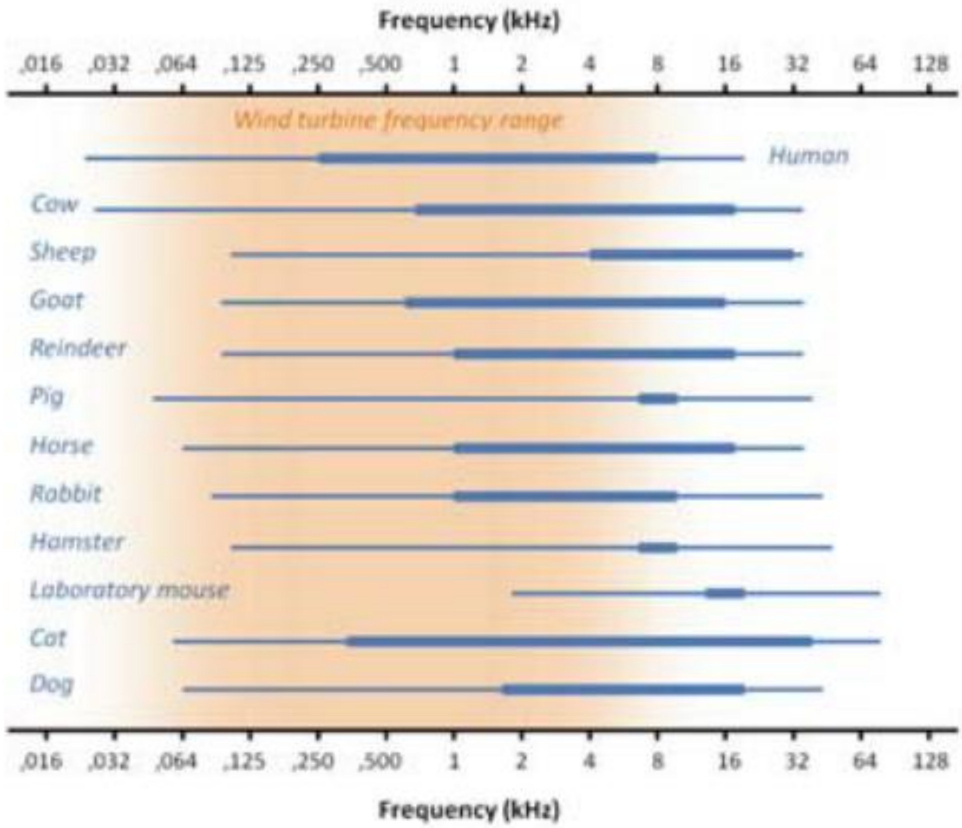

Figure 9: Frequency ranges of hearing in a number of domestic animals. The broad lines indicate the most sensitive areas which are audible at <10dBA. The dominant frequency range of turbine noise is shown in the orange colour. Figure is taken from Helldin *et al.* (2012).

Turbines emit sound from both the hub as well as from the swish of the blades. When it is windless the blades will be stationary and limited sound will be emitted, ambient noise readings have been found to be very similar both in terms of decibel level and frequency characteristics (Rabin *et al.* 2006). During strong wind the turbines will emit more sound as blades are turning but then the ambient noise levels from the wind through the vegetation will usually be louder than the turbines. It is the in-between wind strength which may be more of a concern as the turbine's noise may be louder than ambient sounds.

Habitat loss and fragmentation

Farmlands are already fragmented from current land use including the presence of roads and fences. Roads cause loss of habitat and can create barriers to animal movement, fragmenting the landscape (Helldin *et al.* 2012). Roads are known to have negative impacts on wildlife through direct mortality, vegetation alterations, and disturbance from noise, lights, and traffic motion (Mockrin & Gravenmier 2012). However, traffic on an operational windfarm is expected to be low (a few vehicles a day) compared to the traffic levels where disturbance effects have been studied (Helldin *et al.* 2012). Nonetheless, it is expected that there will be an increase in traffic volume on regional roads outside the WEFs and this is particularly concerning where a number of wind farm developments have been proposed in an area as the cumulative effect may be the significant increase in traffic levels in an area that otherwise had almost no daily traffic (pers. Observations). Wildlife is threatened by the impact of roads due to risk of collision as well as the fragmentation of habitat. Landscape level planning is crucial to reduce the impact of cumulative wind farms. Critical habitats such as riverine areas and dolerite koppies must be avoided, and the design of the WEF can be in such a way as to create the least number of roads by using those already in existence where possible.

Roads and roadsides may attract some species that will exploit verges and some species use roads to facilitate movement. An increase in wildlife abundance around roads further increases collision risks and requires careful planning and monitoring to reduce this possible impact. Public roads typically have livestock fences on either side of the roads and wildlife, such as Steenbok are often found inside this corridor, when vehicles approach, these antelopes are frightened and run alongside fences looking for escape holes, this may result in injury or death. Vehicles need to reduce speed and when necessary, stop to reduce this risk. Night time driving should be avoided as much as possible but, if necessary, speed needs to be reduced significantly to avoid collisions. Lagomorph species (hares and rabbits) often freeze in headlights and require headlights to be momentarily turned off to allow the animal to move off the road. Reduced speeds also need to be implemented during reduced visibility such as misty conditions that have been observed on the site.

Electromagnetism

According to Helldin *et al.* (2012) exposure to electromagnetic fields (EMF) from turbines and associated transmissions are negligible and unlikely to cause risk to wildlife. McCallum *et al.* (2014) investigated the output of electromagnetic levels at WEFs. Measurements taken during three operational states of 1.8 MW wind turbines found magnetic field levels at the base of turbines under both 'high wind' (generating power) and 'low wind' (drawing power from the grid but not generating power) conditions to be low (mean = 0.9 mG) and rapidly decreases with distance, becoming undistinguishable from background levels (0.2 – 0.3 mG) within 2m of the base. Measurements beneath overhead high voltage 27.5 kV and 500 kV powerlines had magnetic field levels up to 16.5 and 46 mG respectively, with levels diminishing rapidly with distance to background levels within 10-25m for 27.5 kV lines and 115m for 500 kV lines. Magnetic fields measured 1m above buried collector lines were also within background levels (<0.3 mG). Magnetic field levels at substations ranged from 0.2 - 4.1 mG when turbines were operating at 'high wind' conditions and ranged from 0.3 – 1.9 mG when turbines were 'shut off'. Mitigation from magnetic fields from electromagnetism of powerlines is recommended by burying electrical transmission infrastructure as much as possible.

Cumulative effects and Landscape level impact

Particularly concerning is the cumulative effect of wind power developments in relation to other existing anthropogenic impacts as well as other proposed WEFs. The combination of past, present and planned developments or land use may impact terrestrial fauna with unexpectedly large effects (Helldin *et al.* 2012). This is particularly important where a population of species is already impacted and threatened from other human activities or where a population is displaced from disturbed areas, where the result is loss of available habitat (Helldin *et al.* 2012). Cumulative effects can also result where the construction phase occurs at several locations simultaneously or if a new project begins construction immediately following the completion of another. Thus, it is important to evaluate the consequences of each development before the next is begun. Cumulative effects can cause a small, localised effect (which may have a limited effect on its own) to have a significant impact on population level as there may be thresholds where the cumulative effects increase disproportionally (Helldin *et al.* 2012). The combination of road networks and increased traffic on public roads will further fragment the landscape and may increase collision mortality. It is important that the effect of multiple WEFs and other existing impacts are assessed in combination to understand their effect at landscape level.

CONCLUSION AND RECOMMENDATIONS

There is a lack of information concerning the impact of WEFs on terrestrial fauna which makes it difficult to draw conclusions and make clear recommendations, but a key recommendation is the need of monitoring programs to strengthen our knowledge base and every project provides an opportunity for this. As a precautionary principle, the aim is to minimize negative effects even where the effects are not fully known.

The primary identified potential risks of adverse impacts of WEFs to terrestrial SCC and their habitat include habitat fragmentation, direct mortality from road collisions, noise impact, and possible complex and unpredictable cascading impact on the ecosystem and biodiversity as well as population-level impacts from the cumulative impacts of other wind energy facilities in the region. The very nature of an ecosystem is the result of interlinked interactions of all the organisms and their physical environment, and the state of the ecosystem depends on the balance of all these components.

Mitigation is proposed through no go areas and buffers as well as the implementation of monitoring programs including a general biodiversity baseline survey. This can be done by utilizing several methodologies, ideally combined to increase detection rates of rare and secretive species. Camera trapping is ideal for a range of mammal species and a camera trap biodiversity survey can be done in conjunction with targeted species-specific surveys. Conservation scent detection dogs are also encouraged where species are difficult to locate such as for the Karoo Dwarf Tortoise and to assist in finding possible den sites of Black-footed cats, as well as to improve camera trap detection rates.

A roadkill monitoring survey is also recommended. The survey should be done on both smaller internal roads as well as outside the WEF on larger public roads. The roadkill monitoring needs to be carried out where road access is through identified sensitive habitats and include traffic counts.

Monitoring programs must be initiated at pre-construction phase and continued during construction and post-construction. Preconstruction monitoring must be conducted for a minimum of 2 years to capture inter-annual and inter-seasonal variability and to meet monitoring objectives, to inform whether the development has resulted in changes in presence, abundance or activity level of SCC and whether efforts to mitigate predicted adverse impacts are effective or need revising and refining. We recommend a before-after-impact study (BAI). Findings from the pre-construction monitoring should be used in an adaptive management framework to assist with the design of the WEF and design of future studies. We recommend that monitoring of the species community also targets wildlife corridors and that adequate wildlife passes are established where artificial barriers are found; this includes both physical barriers such as roads and fences as well as disturbance barriers which may be in the form of noise or other disruptive human activities. Wildlife corridors are vital for the connectivity of the landscape (Skarin *et al.* 2015).

Additionally, findings from bird monitoring may provide useful information on changes in populations of birds of prey, such as changes in population abundances, distributions, and nesting sites. These findings may help in understanding predator-prey dynamics, for instance in the US the bald eagle, a common predator to desert tortoises, have been found to avoid WEFs altogether due to high collision risks (Agha *et al*. 2015), thus the reduced predation rate may also enhance environments for certain faunal species within WEFs.

Guidelines for assessment and monitoring of SCC and particularly the Riverine Rabbit is urgently needed, we advise that a workshop is conducted inviting all fauna specialists and ecologists to participate. Guidelines are required to establish standards for conducting site-specific, scientifically sound, and consistent pre- and post-construction evaluation using comparable methods as much as is feasible.

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APPENDIX I: RECOMMENDED MITIGATION MEASURES

Impact 1: Habitat Loss, degradation, and fragmentation

The development may fragment an already highly fragmented landscape which may create barriers to geneflow where subpopulations are disconnected and isolated. Roads and fences can affect the quality and quantity of available habitat, most notably through fragmentation, creating barriers to animal movement. Erosion from construction may degrade the habitat and direct loss of habitat will occur due to necessity of access roads.

Mitigation Measures:

- Minimising the project footprint by utilising existing roads and disturbed areas as much as practicable;
- Locate developments away from identified sensitive habitats, this includes no go zones and buffer zones for turbine pads, electrical substations and housing facilities as well as construction laydown areas.
- Implementing adequate dust control and erosion control.
- Careful planning of road layout to minimise the length of roads traversing through riverine habitats and rocky ridges that have been identified as Very high or high sensitivity which may create barriers and fragment habitats.
- Establish wildlife passes, where artificial barriers are found; this particularly refers to physical barriers such as roads and fences.
- Develop and implement a site-specific spill management plan

Impact 2: Disturbance

Disturbance will be primarily in the form of visual and noise effects as well as general human activities. Visual stimuli from movements of the turbine blades may cause a disturbance which may be far reaching due to the site being open and unobscured. Noise effect from construction and associated human activities during this phase is highly probable. This impact will reduce once the WEF is operational however there will be continued noise pollution from turbines from both the hub and the swish of the blades.

Mitigation Measures:

- Implementing adequate noise reduction measures, including the use of insulation to reduce noise output from turbine hubs.
- Temporal (curtailment) restrictions. Temporal restriction strategies can focus on altering turbine operation during times or weather conditions when wildlife is most active or where a negative impact has been found during the monitoring program.
- Targeted operational timing by working with wind facility managers to target specific turbines under certain weather conditions where a negative impact has been identified. This may require changing the minimum windspeed at which turbines begin to turn and generate energy (cut-in speed) so that they idle during gentle wind and in so doing reduce noise during periods of low ambient noise.
- Minimise development lighting in order to minimise light pollution, disturbance to animals at night;
- Minimize noise disturbance during constructions where construction takes place within 1000m of Very high and high sensitivity habitats. Restricting noise to daytime (9am – 4pm) periods when most fauna are less active.

Impact 3: Mortality from road collision

There is an increased collision risk from increased traffic levels at the site and in the general area. This impact is likely to be of highest concern during construction but is also expected during the operational phase. Roads and roadsides may attract SCC such as Riverine Rabbits and Karoo Dwarf Tortoises due to verge edge enhancement of vegetation and roads may be used to facilitate movement, thus further increasing collision risks. Access roads that traverse riverine habitats require careful planning and monitoring to reduce risk of rabbit mortality.

Mitigation Measures:

- Careful planning of roads to minimise the length that traverses through riverine and rocky habitats that have been identified as Very high or high sensitivity.
- Use existing roads as much as possible.
- Roadkill monitoring program on both internal and external public roads targeting sensitive habitats and wildlife corridors. Roadkill Monitoring programs must be initiated at pre-construction phase and continued during construction and post-construction as well as conducted over different seasons.
- Pre-construction Road planning to identify target sites for wildlife crossing structures which should be considered during the EIA process and with pre-construction roadkill monitoring findings. Wildlife crossing structures must be made in consultation with road planner, construction manager and wildlife biologist. This is generally more cost effective than retro fixing existing roads.
- Assess efficiency of roadkill mitigation approaches via a post-implementation roadkill monitoring program.
- Implementation of speed limits on both internal access WEF roads (40km/h) as well as external public roads (60km/h).
- Reduced speed limits of 40km/h where roads (both internal and external) cross High and Very high sensitivity areas identified; including riverine habitat, koppies and ecotones which may harbour sensitive species and generally have higher species diversity and abundance.
- Wildlife warning signage and speed reduction measures where roads cross High and Very high sensitivity areas.
- Education and awareness campaigns on SCC and their habitat must form part of staff induction procedures to help increase awareness, respect and responsibility towards the environment for all staff and contractors.
- Inductions on safe wildlife passing and driving to reduce possible injury and roadkill alongside roads.
- There is higher risk of collision when animals are more active which is typically from late afternoon to early morning. During these times a low-speed limit (40km/h) needs to be implemented. Night-time driving should be avoided as much as possible but, if necessary, speed needs to be reduced significantly to avoid collisions. Lagomorph species (hares and rabbits) often freeze in headlights and require headlights to be momentarily turned off to allow the animal to move off the road.
- Reduced speeds also need to be implemented during reduced visibility such as misty conditions that have been observed on the site.
- Induction must include reporting of any vehicle/wildlife collision or found roadkill to the appointed Roadkill monitoring personnel.
- Search and rescue of slow-moving species, specifically Karoo Dwarf Tortoises, during the construction phase. IUCN guidelines for translocation of sensitive species should be consulted. Tortoises will need to be carefully relocated and provided shelter and water-rich food as well as monitoring of threatened species to ensure of their survival. Should a subpopulation be found further consultations with a herpetologist will be required for appropriated mitigation.

Impact 4: Predation from possible influx of Pied Crow and other birds of prey that use Powerline Pylons for nest sites

Power line infrastructure is often used for nesting sites and may lead to the proliferation of crows in the region (Cunningham *et al.* 2015). In the past three decades Pied Crow numbers have increased significantly in South Africa with their spread facilitated by electrical infrastructure (Cunningham *et al.* 2015; Fincham *et al.* 2015). A strong relationship has been found between the rate of population increase and density of power line infrastructure in shrubland biomes (Cunningham *et al.* 2015). This is particularly due to the expansion of power lines in the largely treeless, semi-arid landscapes of the Karoo. Pied Crows are generalist predators, preying on a wide range of species, with evidence of heavy predation pressures on threatened or restricted-range species such as tortoises. The development may thus create increased predation pressures on the Karoo Dwarf Tortoise and a number of other susceptible vulnerable faunal species of the region.

The possible artificial increase in Pied Crow abundance (also termed native invaders) may have substantial long-term negative impacts on faunal populations as nest building will occur throughout the operational phase. Furthermore, we currently have very little understanding of the ecological consequences and ecosystem-level implications of these native invaders. It is anticipated that this impact will be most severe in regions where no other power line infrastructures exists, providing nesting sites in an otherwise treeless environment.

The design of the pylon may influence the opportunities for nesting sites. Pylons which have a lattice structure with horizontal sections provide numerous nesting sites on various levels. Additionally, anti-climb fences are also providing nesting sites for Pied Crows and other species (Figure 1). It is likely that crows (and other birds) will also nest on insulator carriers which can cause electrical problems if conducive materials such as wires are used in nest construction (Figure 2) or when a nest becomes wet during rain. The existing powerlines that run into the Gamma Substation have four different pylon designs and provide an opportunity to assess which designs are less favourable for nesting sites. The Cross Rope Suspension Towers were found to be less desirable and provide fewer opportunities for nesting sites (Figure 3). We understand, however, that the tower design is constrained by topography, costs and the size of the high voltage transmission lines.

Martial Eagles (*Polemaetus bellicosus*) are also known to nest on pylons that support high voltage transmission lines and despite these birds being threatened, the artificial dispersion and use of pylons for their nests may have a negative impact on the local fauna including the Critically Endangered Riverine Rabbit. Personal observation below Martial Eagle nests have shown that Lagomorph species (rabbits and hares) make up a substantial part of their diets (Figure 4).

Figure 10: Pied Crow nest on Anti-climb fences.

Figure 11: Crow nests constructed entirely out of wire may become a fire hazard.

Figure 12: Pylon design that provide fewer opportunities for nesting sites.

Figure 13: Lagomorph remains under three different Martial Eagle nests found in the Karoo region

Mitigation Measures:

- The use of pylon designs that are less favourable for nesting sites see figure 12.
- The monitoring of powerlines by avifaunal specialists or bird monitors. Nests found on the powerline should be identified to species level. An adaptive management approach can then be implemented, where identified problematic nests can be removed by maintenance personnel and nest deterrents fitted where needed.
- The fitting of nest deterrents/discouragers on horizontal and cross beam sections where self-supporting pylons are used.
- The design of the anti-climb fence must not offer any suitable sites for nests. This can be done by modifying structures so that they are angled downwards to avoid having horizontal platforms. Anti-climb fences must also be set as low as possible on the towers to discourage nesting by Pied Crows.
- Record prey species below Corvid nests (not limited to powerlines) and use findings to implement culling if required. Targeting culling at individuals that prey on tortoises.
- Remove available food and water that have been artificially created.
- No open dumpsite and carcass pits – All waste, organic and inorganic, including oil spills, and any existing agricultural biproduct needs to be environmentally safely disposed of and covered.
- Avoid using livestock feeding sites to attract corvids and locate away from sensitive habitats.
- Remove existing artificial nest sites including old broken windmills and telephone/electric poles. This should be done with the advice from an avifaunal specialist.

Impact 5: Cumulative impact

The cumulative impact is of concern, given the fact that the renewable-energy industry is rapidly expanding in South Africa. The local fauna is already impacted and threatened by past and current land use and the combination of these existing anthropogenic impacts with planned developments may impact the local fauna with unexpectedly large effects. Cumulative effects can also result where the construction phase occurs at several locations simultaneously or if a new project begins construction immediately following the completion of another. Cumulative effects can cause a small, localized effect (which may have a limited effect on its own) to have a significant impact on population level as there may be thresholds where the cumulative effects increase disproportionally.

Mitigation Measures:

- It is important to evaluate the consequences of each development before the next is begun.
- Use a precautionary approach and aim to minimise negative effects even when the effects are not fully known.
- Ensure the construction phase is done in as short a period as possible and avoid breeding season, typically in the spring after good rains.
- Construction needs to be done during daytime, avoiding noise and disturbance when faunal communities are most likely active, particularly where the construction is in proximity to their habitat. Sensitive habitats near construction will need to be clearly marked.
- Relating construction phase of the development with neighbouring developments and farming activity to ensure construction does not begin immediately after the completion of another or simultaneously.
- The developer instigates a proactive mitigation measure by initiating a multi-stakeholder dialogue at a workshop to clarify these concerns and how they might be taken forward and co-funded. The aim of this mitigation is to reduce current impacts that threaten the survival of SCC populations. We recommend a biodiversity wildlife corridor approach whereby protecting sensitive habitats is made a priority. This may include species refuge areas where no form of indiscriminate wildlife killing/snaring is allowed, no or highly reduced livestock grazing, and no pest control including locust spraying is carried out.
- Poaching and the use of hunting dogs at site is prohibited.

Impact 6: Cascading impact across trophic levels

The effect of the wind farm on one species may have indirect cascading effects (knock on effect) on other species within the same community due to ecological relations to one another. This means that an effect on one species may in turn affect many others within the same ecosystem. Cascading effects may be complex and unpredictable as it may be the result of different types of interactions including competition, predation, parasitism, or symbiosis.

Mitigation Measures:

- Initiate a general **Fauna Biodiversity Monitoring program**
    - A Fauna Biodiversity program must be initiated pre-construction to have baseline population status and monitoring must be ongoing post-construction to identify any changes in occupancy in certain species' population which may in turn indirectly impact other fauna populations.
    - We recommend the use of multiple monitoring methods including and not limited to; camera trapping in diverse habitats, targeted camera trapping for SCC; small mammal monitoring with the use of Sherman traps; the use of Conservation Scent Detection Dog teams to assist in detecting SCC.