Annex G

Bat Specialist Report

BAT ASSESSMENT FOR PROPOSED WIND FARM DEVELOPMENT

ROGGEVELD

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Ref No: 1510
Date: December 2010
(finalised September 2011)

Roggeveld Wind Farm: Bat Assessment Report

FINAL DRAFT

December 2010, finalised September 2011

Reference Number: 1510
Compiled By: Kate MacEwan

Natural Scientific Services

NSS

EXECUTIVE SUMMARY

G7 Renewable Energy (hereafter referred to as G7) proposes to develop a wind energy facility at a site in the Roggeveld area, situated in the Western and Northern Cape Provinces. The site is located parallel to the R 354 road in a montainous area, approximately 20km north of Matjiesfontein.

The specifications of the wind energy facility are as follows:

- There will be a maximum of 250 3MW turbines (maximum total 750MW);
- The turbines are mounted on cylindrical steel towers, with a maximum hub height 100 m.
- The maximum turbine rotor diameter would be 117 m;
- Each turbine will have a concrete foundation measuring 5x5 m above ground and an estimated 20x20x3 m below ground;
- A hard gravel standing area of approximately 2500 m^2 for construction and maintenance purposes, as well as a transformer will accompany each turbine;
- Access roads to and around the site will be a maximum of 12m wide.
- There will be one main substation near the centre of the site with up to 6 smaller 132kV substations closer to the turbines collecting capacity from groups of turbines. The smaller substations would be connected to the main one via 132kV overhead lines
- An office and storage building will also be constructed on site.

Natural Scientific Services (NSS) were appointed as the bat specialists required to provide input into the environmental impact assessment (EIA) process for the proposed wind energy facility in Roggeveld. In addition to the detailed desktop review conducted, the field assessment took place over one night and one day on 5 and 6 September 2010. During the day, the study area was scanned for suitable bat roosting and foraging habitat. At night, bat detectors were set up at various points within the study area (where possible), in order to record actual bat activity. Of the 10 bat species with known distribution in the area, only one was confirmed through bat detection. The size of the study and the short sampling period were one of the most significant limitations to the number of bat species recorded.

Potential roost types that are applicable to the study area include:

- Rock crevices.
- Hollows from eroded cliff faces and overhangs.
- Roofs of houses and buildings.
- Culverts under roads.
- Aardvark burrows.
- Clumps of trees in the drainage gullies

Areas of Bat Conservation Importance are highlighted in the report, with the highest level of importance being the valley areas and the adjacent mountain footslopes. In locations where turbines are suspected to cause a high risk of of bat fatalities, these are depicted in the sensitivity map. Impacts are looked at in terms of project specific impacts and cumulative impacts due to numerous wind energy facilities being proposed for the country. The impacts with the highest significance are those that increase the risk of bat fatalities, e.g. placement of turbines in areas of high conservation significance or within migration routes. The ultimate cause of bat deaths is due to collision with moving blades or through barotrauma. Project specific impacts can be avoided or reduced through commitment to the mitigation recommendations in this report. In NSS's opinion, the most important mitigation measures are long-term pre-construction passive monitoring, correct placement of the turbines and curtailment. In addition, research is required in the South African context to better understand and deal with unforeseen impacts that may arise.

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1 INTRODUCTION

G7 Renewable Energies (Pty) (G7) proposes to develop a wind energy facility at the Roggeveld site, extending into both the Western and Northern Cape Provinces. The site is located parallel to the R 354 road in a mountainous area approximately 20km north of Matjiesfontein (***Figure 1-1***).

The facility is proposed to generate up to 750 MW of electricity, collectively from 250 proposed wind turbines. The turbines are mounted on cylindrical steel towers 80 metres high and 4 metres in diameter at the base, the concrete foundation is to be 5 metres x 5 metres. A hard gravel standing area of approximately 2500 m^2 for construction and maintenance purposes, as well as a transformer will accompany each turbine. In addition, the turbines will be connected via medium voltage cables buried underground which is linked to a new proposed substation on site, feeding the electricity into the existing overhead National Power Grid Network transmission lines. Six meter wide access roads are proposed to be from the R 354 road to the site. Some existing farm roads will be upgraded and new gravel roads may be constructed to accommodate construction and maintenance vehicles. An office and storage building will also be constructed on site.

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- An office and storage building will also be constructed on site.

1.1 *AIMS OF THIS STUDY*

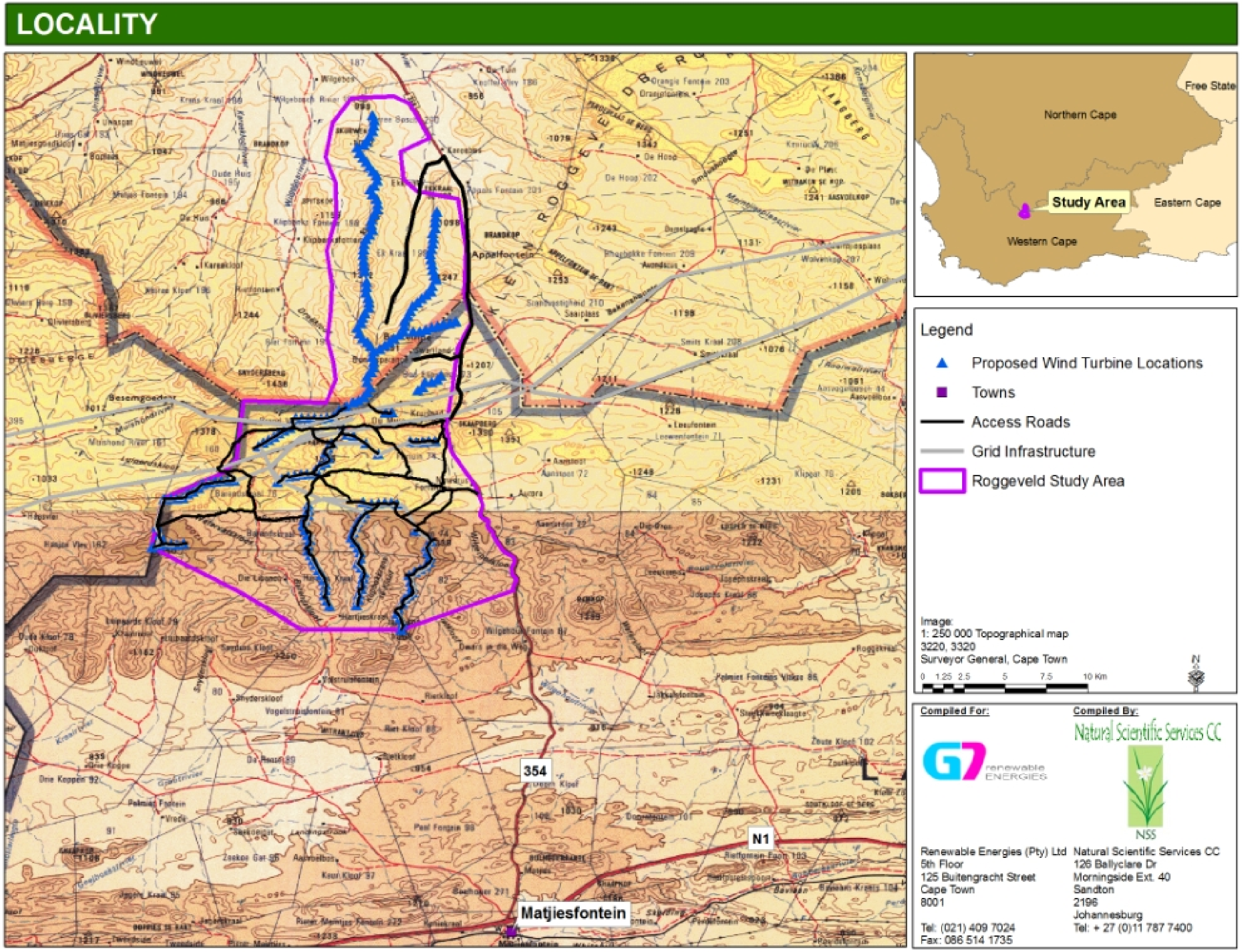
The aim of this study is to:

- Identify and map the bat communities and sensitive areas from a bat conservation perspective for the current Study Area.
- Describe the bat species in and around he site, and note the presence or likelihood of locally and regionally endemic, rare, or near threatened bat species.

- Describe the existing bat environment at the appropriate scale (preferably in a local and regional context).
- Determine and assess the potential bat impacts associated with the proposed development.
- Recommend mitigation measures or management actions to reduce impacts and enhance benefits.
- Provide an overview of key relevant legislation and indicate the implications of these for the development.

However, because the current assessment was conducted months prior to the publication of the the South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments (Sowler & Stoffberg, 2011) and there were sampling limitations, long term monitoring is required prior to final layout design and construction. This current report would only suffice as a Scoping Level report, under the new guidelines

Figure 1-1 *Study Area*



Source: ERM

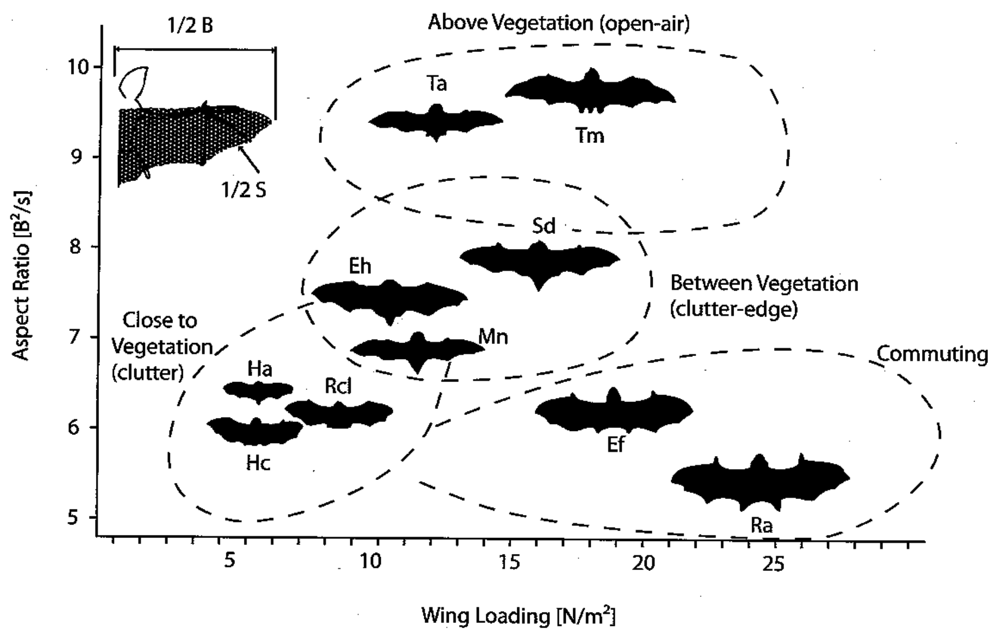
1.2 *Bats & Their Flight Ecology*

Bats are mammals from the order Chiroptera, and are the second largest group of mammals after the rodents. Depending on the species, insectivorous bats have adapted varying flying strategies during nocturnal foraging. An article by Schnitzler and Kalko (2001) has articulately described bat flight and echolocation behaviour in relation to habitat and foraging conditions, as follows in the next couple of paragraphs.

Perceptually, bats are constrained by their sensory capacities (e.g., echolocation, vision, olfaction, passive listening) to detect, classify, and locate prey in the vicinity of clutter-producing background targets. Mechanically, bats are constrained by their motor capacities, such as flight abilities (Norberg and Rayner 1987). For instance, bats that forage near clutter need special maneuverability (e.g., adaptations in wing morphology) to intercept insects while also avoiding collisions. As such, varying species of bats capture prey in different modes: prey in flight (aerial mode) or mostly stationary prey from surfaces such as leaves or ground (gleaning mode) or water (trawling mode). Neuweller (2000) illustrates the adaptations of wing shape and the resulting flight style to different foraging habitats well in ***Figure 1-2***.

Foraging bats must detect, classify, and localize an insect and discriminate between echoes of prey and echoes of unwanted targets such as twigs, foliage, or the ground, referred to as clutter echoes, or simply “clutter.” Schnitzler and Kalko (2001) have categorized microchiropteran bats into guild structures according to habitat type, foraging mode, and diet. In the South African context and relevant to the current study, regarding mortality predictions for wind farm developments, the long-term monitoring project will be focusing on aerial foraging insectivorous bats that fly in cluttered and uncluttered space, with particular focus on bats hunting or migrating in open, uncluttered space, high above the ground. These types of bats are the ones most likely to be impacted on by wind turbine developments.

Figure 1-2 Adaptations of wing shape and foraging habitats (adapted from Neuweller, 2000)



Legend:
Ta = *Tadarida aegyptiaca*
Tm = *Taphozous mauritianus*
Eh = *Eptesicus hottentotus*
Sd = *Scotophilus dinganii*
Mn = *Miniopterus natalensis*
Ha = *Hypsugo anchietae*
Rcl = *Rhinolophus clivosus*
Hc = *Hipposideros caffra*
Ef = *Epomops franqueti*
Ra = *Rousettus aegyptiaca*

1.3 *BAT FLYING HEIGHTS*

There is not enough detailed information available on bat flying heights internationally and certainly not in South Africa to make predictions on mortalities at a desktop level. What we do know, is some facts on bat foraging ecology (as discussed in Section 1.3 above) and the results of specific studies conducted in the USA, Canada and Europe. Some examples of such research includes:

- Jensen & Miller (1999) recorded *Eptesicus serotinus* foraging at average heights of 6.8m and 10.7m respectively at two different sites in Europe.
- Some groups of bats have been reported to migrate at altitudes greatly exceeding 100 meters (Altringham 1996). Allen (1939) reported that bats observed migrating during daylight hours over Washington D.C. flew at heights between 46 and 140 meters above the ground.
- Van De Sijpe (2008) reported that trawling pond bats (*Myotis dasycneme*) fly at a median height of 43 cm and Daubenton's bats (*M. daubentonii*) at a median height of 24 cm.

- Williams, *et al*. 1973 recorded the Free Tailed Bat, *Tadarida Brasielinsis*, flying in groups at heights of over 3000m above ground level.
- EchoTrack in Ontario, Canada in their pre-construction bat assessments for various Wind Farm sites found the following:
  - Harwich Wind Project - An average of 67% of the total flights of bats and birds through the proposed development area was outside the sweep area of the blades, leaving an average of 33% of airborne animals potentially exposed to a collision. This exposure is expected to be further reduced by an increase in flight height and avoidance after the installation of turbines. (EchoTrack, 2009).
  - Arner Green Wind Project - An average of 81% of the total flights of bats and birds through the proposed development area was outside the sweep area of the blades, leaving an average of 19% of airborne animals potentially exposed to a collision. This exposure is expected to be further reduced by an increase in flight height and avoidance after the installation of turbines (EchoTrack, 2009).

As Mitchell-Jones & Mitchell-Jones (Date unknown) summarise from literature, there is very little actual assessment information available regarding bat flight heights, but there are some concerns:

- Commuting bats may fly higher than when foraging.
- Bats that are flying high may not be echolocating.
- Heights when given in literature were mostly observed - rarely measured
- As an average:
  - Most small bats flying in cluttered habitats flew within 0-10m
  - Anecdotal records for large bats ranged from 10-120m

1.4 WIND ENERGY & BATS

Wind energy is emerging as a noticeable component of energy markets in a number of regions, with the USA, Spain and China being the biggest players (SAWEA, 2010). Southern Africa is now following this trend. However, it has been estimated that between 33000 and 111000 bats may be killed annually by wind turbines in the Mid-Atlantic Highlands USA by 2020 (Boyles *et al*. 2011). The cumulative impacts of such mortality on affected species of bats could have long-term population effects (Kunz *et al*. 2007).

Given that echolocating bats detect moving objects better than stationary ones, their relatively high fatality rate is perplexing, and numerous explanations have been proposed. Kunz et al. (2007) identified eleven hypotheses regarding how, when, where and why bats are being killed at wind energy facilities. These are further discussed in Strickland (2011). The hypotheses include:

- Linear Corridor Hypothesis;
- Roost Attraction Hypothesis;
- Landscape Attraction Hypothesis;
- Low Wind Velocity Hypothesis;
- Insect Attraction Hypothesis;
- Visual Attraction Hypothesis;

- Acoustic Attraction Hypothesis;
- Echolocation Failure Hypothesis;
- Electromagnetic-Field Distortion Hypothesis;
- Decompression Hypothesis; and
- Thermal Inversion Hypothesis.

Whatever the reason for the bats coming into close contact with the turbines, the most likely cause of death is barotrauma. Barotrauma involves tissue damage to air- containing structures caused by rapid or excessive pressure change; pulmonary barotrauma is lung damage due to expansion of air in the lungs that is not accommodated by exhalation. A study done by Baerwald, *et al*. (2008a) showed that 90% of bat fatalities involved internal haemorrhaging consistent with barotrauma.

Although the exact pressure reduction required to cause the type of internal injuries observed in bats is unknown, pressure differences as small as 4.4 kPa are lethal to Norway rats (Dreyfuss, *et al*., 1985). The greatest pressure differential at wind turbines occurs in the blade tip vortices, which are shed downwind from the tips of the moving blades (Bertin and Smith, 1997); the pressure drop in the vortex increases with tip speed, which in modern turbines turning at top speed varies from 55 to 80 m/s (198 – 288 km/h). This results in pressure drops in the range of 5–10 kPa, levels sufficient to cause serious damage to various mammals (Dreyfuss, *et al*., 1985).

Whilst most biologists would support the development of clean, renewable energy sources, such as Wind Energy Facilities in southern Africa, the impacts that wind turbines may have on southern African bats is largely unknown, due to a lack of research in the country and poor level of knowledge of bat abundance, location of roost sites and foraging and migratory behaviour.

Therefore, in order to integrate this cleaner energy alternative to South Africa, much research is needed – particularly pre-construction research.

1.5 CONSERVATION SIGNIFICANCE OF BATS IN SOUTHERN AFRICA

There are approximately 117 species of bats in the Southern African sub-region, of which 5 species have a global Red List status of Vulnerable and 12 are classified as Near Threatened (Monadjem, *et al*. 2010).

In South Africa, as in other parts of the world, bats provide essential ecosystem services. Insectivorous bats provide essential pest control services to farmers and they eat significant quantities of disease vetor carrying insects such as mosquitos. Frugivorous bats provide seed dispersal (thus aiding forest regeneration) and pollination services. The potential loss of these ecosystem services should be considered when assessing the environmental impact of wind farms. The possible loss of bat colonies could therefore, potentially result in increased costs in pesticides and reduced agricultural productivity.

Many bat species roost in large aggregations and concentrate in small areas. Therefore, any major disturbance to that area can adversely impact many individuals of a population at the same time (Hester and Grenier, 2005).

The reproduction rates of bats are much lower than those of most other small mammals, because usually only one or two pups are born per female annually. According to O'Shea *et al*. (2003), bats may live for up to 30 years. Under natural circumstances, a population's numbers can build up over a long period of time, due to their longevity and the relatively low predation on bats, when compared to other small mammals. Therefore, the rate of recovery of bat populations is slow after major die-offs.

1.6 *CLIMATIC INFLUENCES ON BAT ACTIVITY*

International research supports the prediction that bat foraging activity will be reduced in adverse weather conditions such as cold temperatures, high winds and rainfall. Ahlen, *et al*. (2007) reported that while some species could tolerate higher wind speeds, most bats of all species preferred winds up to about 5 m/s. Arnett (June, 2005) also mentions that bats are known to suppress their activity during periods of rain, low temperatures and strong winds, especially if these factors are combined.

Weather patterns may influence bat fatalities. Some studies have addressed the relationships between bat fatalities and weather patterns and found that most bats were killed on nights with low wind speed (<6 m/sec) and that fatalities increased immediately before and after passage of storm fronts. Weather patterns therefore may be a predictor of bat activity and fatalities, and mitigation efforts that focus on these high-risk periods may reduce bat fatalities substantially (Arnett *et al*. 2008).

Rydell, *et al*. 2010 found that peak mortality varied considerably in frequency and timing among years, but the events usually (90%) occurred on nights with low wind speeds in late July to early October and to a lesser extent (10%) also in April-June.

Wind cut-in speeds and bat mortality is further discussed in Section 6.6.2 – Mitigation Measures.

1.7 *PROJECT TEAM*

The NSS team has extensive experience (over 40 years combined experience) in the project management and fieldwork for numerous biodiversity / ecological studies, inclu ding specialist terrestrial fauna and flora, bats, aquatic biota and wetland assessments. Furthermore, NSS has experience in surface water quality assessments, Environmental Impact Assessments (EIAs), Environmental Management Programme Reports (EMPRs), Strategic Management Plans (SMPs) and Environmental Management Plans (EMPs) for the Conservation, Mining, Waste, Commercial and Industrial sectors.

The main project team for this study was:

- **Kate MacEwan**
  Kate, a founding member of NSS, is registered Professional Natural Scientist (Zoological and Environmental Sciences) and has 12 years of biodiversity experience. She has a BSc Honours in Zoology from the University of the Witwatersrand (Wits) and is currently completing an MSc with Wits in Bat Conservation Biology. Further relevant experience Kate has includes:
    - She is Fall Arrest certified to climb heights over 3m.
    - She has served on the Gauteng & Northern Regions Bat Interest Group (GNorBIG) executive committee for over nine (9) years. Her duties have included bat scientific research and educational talks to the public.
    - She is currently completing a Masters of Science degree with Wits University in Bat Conservation Biology.
    - She has hand-reared over 25 individual bats over her career.
    - She has over 12 years experience as a practicing zoologist in the conservation and consulting industries. Relevant functions have included
        - Numerous faunal impact assessments for EIAs, EMPs, etc.
        - Specialist Bat Assessments for various projects, e.g.
            - Bat impact assessment for the development of an automobile production factory near Bon Accord, Pretoria,
            - Bat assessment for the development of a Management and Action Plan for a cave on a Driefontein Gold Mine,
            - Bat impact assessments for the development of 5 different Wind Farms in the Northern and Western Cape – under ERM.
            - Bat impact assessments for the development of a Wind Farm in Namaqualand, Western Cape – under DJ Environmental Consultants
            - Bat impact assessment for the mining through of old mine adits containing bats at Pilanesburg Platinum Mine, North West Province.
            - Current long-term pre-construction monitoring at two Wind Farm sites near Klawer, Veldrift, Mossel Bay and Matjiesfontein, Western Cape.
- **Werner Marais**
  Werner is a registered Professional Natural Scientist (Zoological Sciences) and has 2 years of biodiversity experience. He successfully completed his Masters Degree in 2009 in Bat Conservation Biology and is currently conducting a PhD degree with the University of Johannesburg on the Ecology and Conservation of Cave Dwelling Bats in Gauteng, South Africa. Further relevant experience Werner has includes:

- Served on the Gauteng and Northern Regions Bat Interest Group (GNorBIG) executive committee for over two (3) years. He fulfilled a research portfolio, provided executive input and presented public presentations and a group workshop.
- Faunal impact assessments for EIAs, EMPs, etc.
- Specialist bat assessment for a cave on a West Rand gold mine; bat habitat and cave assessment for a proposed development adjacent the Cradle of Humankind World Heritage Site; specialist bat cave assessment for a development near Magaliesburg; cave ecology assessment for a proposed bridge adjacent to Groenkloof Nature Reserve in Pretoria; bat cave assessment for a pipeline near Laudium in Pretoria.

2 METHODOLOGY

2.1 FIELDWORK

The bat assessment took place in one day and night on 5 September 2010 and a two days and two nights on the 11th and 12th December 2010. During the daytime, the study area was scanned for suitable bat roosting and foraging habitat. At night, mist nets (***Figure 2-1***) and bat detectors (***Figure 2-2***) were set up at various points within the Study Area in order to record actual bat activity. The localities of the bat detectors and mist nets are depicted in *Error! Reference source not found.*.

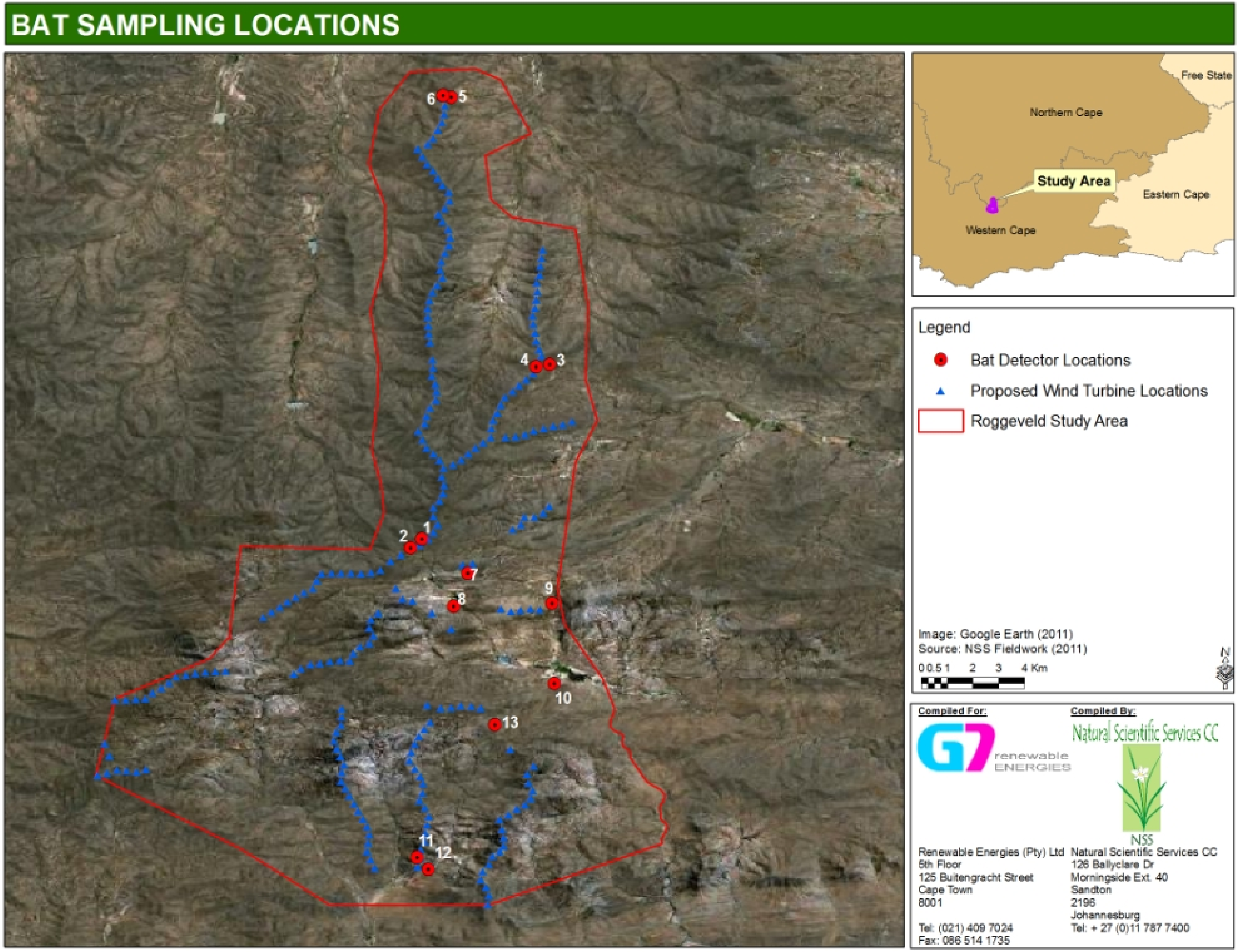
Figure 2-1 Bat Detector at Roggeveld

Figure 2-2 Mist net at Roggeveld

2.2 REPORT COMPILATION

The results from the above desktop review and fieldwork was recorded in the current report that has been formatted according to ERM's report template requirements.

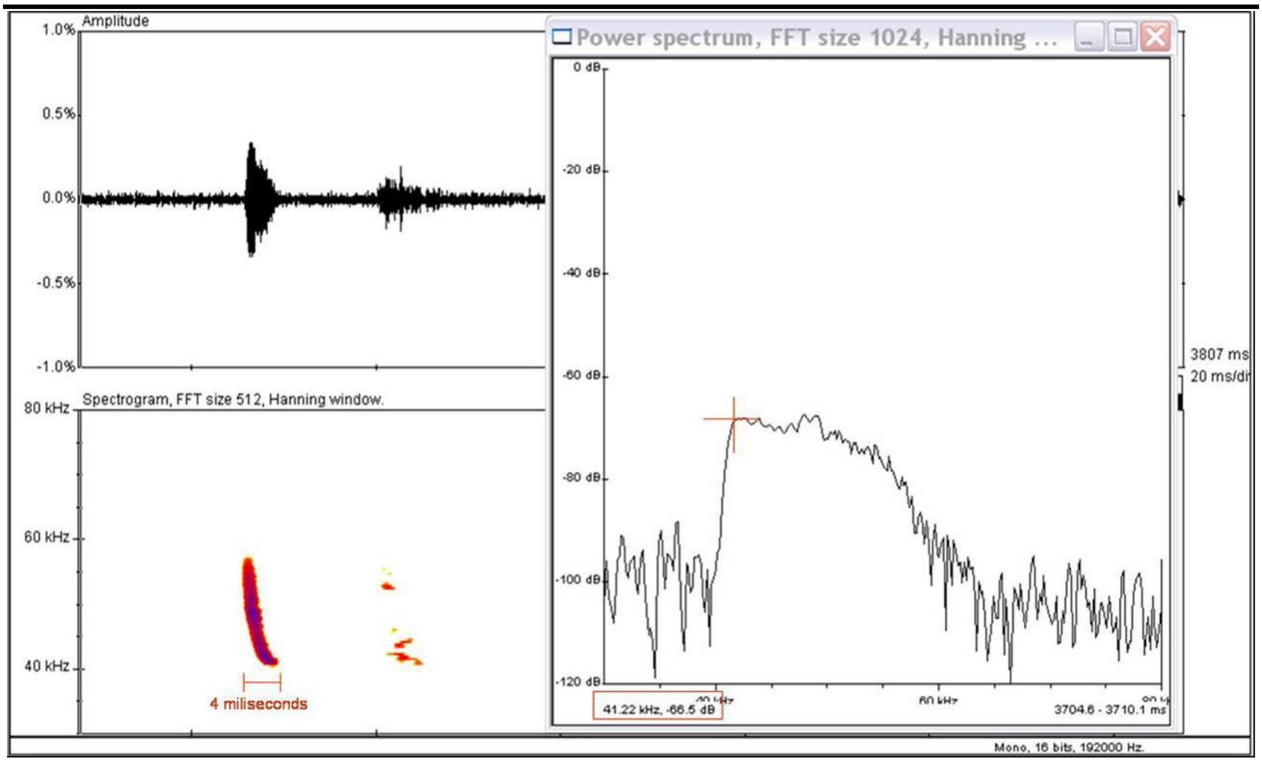
Figure 2-3 Localities of the Bat Detector (BD) in Relation to the Proposed Turbine Localities



2.3 BAT DETECTION

A bat call consists of a series of ultrasonic sound pulses, with each species calling at a different sound frequency (***Figure 2-4***). Pulses within a bat call can also vary in their sound frequency and characteristics, although this variation is within a certain range associated with a certain bat species. Certain call parameters are used to identify a bat species from its echolocation call. These include pulse length, pulse bandwidth, pulse interval and pulse dominant frequency, of which dominant frequency are the most commonly used. When a bat is approaching a prey insect, it will increase the rate of its echolocation pulses dramatically, and each pulse becomes shorter until it is difficult to distinguish the pulses with standard instrumentation. This method of increasing its echolocation resolution while homing in on its prey is referred to as a feeding buzz.

Figure 2-4 Example Spectrogram of a Cape serotine bat (Neoromicia capensis) Call



Source: NSS, 2011

2.4 LIMITATIONS OF THE STUDY

The current assessment was conducted months prior to the publication of the the South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments (Sowler & Stoffberg, 2011). Due to limited budget and time, the protocol was not sufficient to meet those requirements – longer term monitoring will be required prior to the development of this site.

Ecological sampling for Environmental Assessments is usually constrained by resources such as available surveying time and duration, financing and support, which are all interrelated. Constraints often drive the choice of a sample over a complete census. A complete census is only feasible if:

- The target population is small;
- Measurement is not destructive;
- The study area is small and well delineated; and
- Unlimited resources are available.

It must be emphasized that, the absence of a certain species on site does not conclude that the species is not present or does not utilise the site or areas near by. Reasons for not finding certain species may be due to:

- Bad weather conditons
- The inconspicuous nature of the species;
- Low level of species presence; or
- Limited sample size due to extent of the area and financial constraints

Certain specific parameters did limit the level of detail to which the bat activity could be assessed:

- The size of the study area is very large. In order to fully assess and conduct a complete inventory of the bats in the vicinity, several weeks over different seasons would be required. Longer term monitoring according to Sowler & Stoffberg (2011) will be required prior to the final layout design and construction.

  Furthermore, echolocation operates over ranges of metres so any monitoring based on echolocation, samples only a few metres of space, depending on the type and intensity of the call. One must therefore, be cautious when extrapolating data from echolocation surveys over large areas. The accuracy of the species assignation is also very dependent on the quality of the calls one uses and any assignation should be confirmed with capture data.

- Seasonal migrations. Although spring and summer field assessments are the best times to determine regular bat activity, some species of bats are thought to conduct seasonal migrations. Very little is known about these migration routes, therefore, only longer term passive monitoring will be expected to better assess the possibility of migration clashes.

- Speculation: Very limited research has been conducted on the movement patterns of bats within South Africa, therefore, the current study has been based on a thorough literature review (of mainly international journals), a short period of field work and based on NSS's professional opinion.

- Placement of bat detectors at ground level (which was unavoidable at certain bat detector sites) is not ideal because they do not accurately reflect bat activity at the height of the towers and blades ie at 30 m or more (Cryan and Barclay 2009).

- Finally, there is ample evidence that the impact of wind turbines on bats is species specific and other aspects of the life histories of bats, besides roosting and migration, could make them susceptible to wind turbines. There is thus a desperate need for research in this regard.

3 LEGISLATION PERTAINING TO BATS

3.1 INTERNATIONAL

There are various Conventions, Unions and Treaties in place for the protection of biodiversity – to name just a few:

- Convention on Biological Diversity
- The Bonn Convention (on conservation of migratory species of wild animals)
- CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora)
- Agenda 21 and Rio Declaration
- The IUCN (World Conservation Union)
    - The Union's mission is to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable.
    - The IUCN have assigned various conservation categories to faunal species, from those requiring little conservation effort to those in desperate need of conservation:
        - Least Concern (LC)
        - Near Threatened (NT)
        - Vulnerable (VU)
        - Endangered (EN)
        - Critically Endangered (CR)
    - Being at an international level, these categories often don't meet the national conservation needs of certain species, therefore national lists are implemented.

3.2 NATIONAL

Unlike in the UK and the USA, bats are not directly protected in South Africa. However, there are various Acts and Regulations relevant to the protection fauna, including bats:

- National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA)
- NEMA: Biodiversity Act, 2004 (Act 10 of 2004)
- NEMA: Biodiversity Act, 2004: Threatened and Protected Species (TOPS) Regulations
    - A person may not carry out a restricted activity involving a specimen of TOPS without a permit.
    - However, the NEMA TOPS Regulations fail to recognise most bat species of conservation concern; therefore, this list needs to be updated. Only one species of bat, the Large-eared Free-tailed Bat (*Otomops martiensseni*), is listed as vulnerable on the TOPS list.
- NEMA: Protected Areas Act, 2003 (Act 57 of 2003)
- National Policies, Guidelines and Inventories:
    - National Spatial Biodiversity Assessment (NSBA)

- South Africa's National Biodiversity Strategy and Action Plan (NBSAP)
  - Conservation planning tools, eg C-PLAN for Gauteng and Mpumalanga
  - Red Data Species Listings according to IUCN categories at a National level, eg Birds; Mammals (Friedman and Daly, 2004); Frogs; Butterflies, etc.
  - Provincial Biodiversity Guidelines, eg Gauteng

3.3 PROVINCIAL

- Provincial Biodiversity Guidelines, eg Gauteng
- Permits for capturing and releasing of bats, transporting bats, conducting scientific research on bats are required by the Provincial Authorities. NSS has current permits with both Cape Nature and Northern Cape Nature Conservation.
- Nature and Environmental Conservation Ordinance no. 19 of 1974.
- Northern Cape Department of Tourism, Environment and Conservation – Schedule 5: All bats, except fruit bats of the Family PTEROPODIDAE.
- Western Cape Nature Conservation Board: Protected under the Biodiversity Act (see above).

3.4 BUFFER ZONES

Although well intended for conservation purposes, the issue of placing a standardised buffer on conservation important habitats, plant localities or animal roosts is a controversial one. The controversy is sparked by the following challenges:

- Often these buffer distances are based on very little scientific research, but rather on educated guesses.
- If a buffer is placed on a particular habitat, the success of that buffer working is dependent on the requirement of all species and ecosystems utilizing that habitat. Different species and ecosystems usually have different needs.
- If enough pressure exists for a particular development, buffers will be relaxed to accommodate that development.
- For non-linear conservation important areas, a radial buffer is presumed, however, often habitats will be far more suitable on one side of the area than the other. Therefore, a radial buffer may not be appropriate – it may be more appropriate to select specific patches of suitable habitat around the sensitive ecological entity that will ensure its survival.
- Not all South African provinces have developed any policy or guidelines addressing buffers. There are no South African guidelines for the consideration of bats in relation to wind farm developments. Therefore, one can extrapolate from other provinces and other country's guidelines, for instance:
  - Gauteng Department of Agriculture and Rural Development (GDARD, 2009) recommends a 500m on natural caves systems and

200m on Class 1 ridge systems, 200m buffer on conservation important vegetation areas, 50 meters on riparian edge; all of these are important bat habitats.

- Guidelines such as the Eurobats Guidance and the Natural England Technical Note (Mitchell-Jones and Carlin 2009) give some indication of buffer zones which may be applicable, in the absence of limits in South Africa:
    - The Eurobats Guidance (Rodrigues *et al*. 2008) proposes a minimum distance of 200m to forest edges where forest clearing and tree felling is necessary to establish a wind farm.
    - The Natural England Interim Guidance suggests a 50m buffer from wind turbine blade tip to the nearest feature (tree top or house).

In conclusion on buffers and bats, appropriate buffers need to be selected for bat conservation important habitat (whether it is for foraging or roosting) that will meet the requirements of the particular species occurring there. Foraging distances are not very well documented; however, at least one South African study has shown that bats can cover between 1 – 3 km during foraging (Jacobs and Barclay 2009).

4 BRIEF DESCRIPTION OF THE AFFECTED ENVIRONMENT

4.1 REGIONAL VEGETATION AND TERRAIN

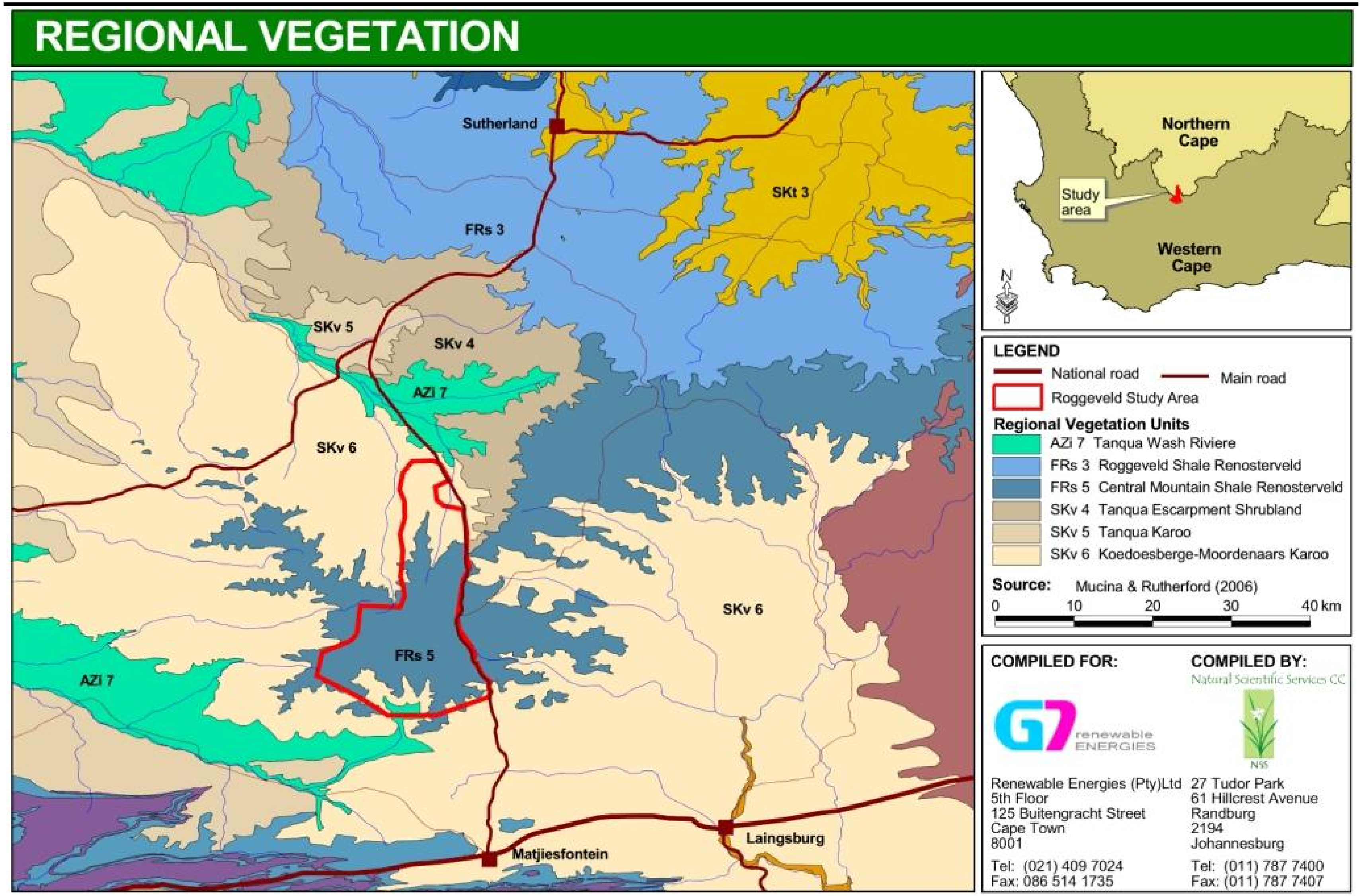
According to Mucina and Rutherford (2006) the northern part of the site falls within the Koedoesberge-Moordenaars Karoo vegetation unit and the southern larger half is classified as Central Mountain Shale Renosterveld vegetation unit (***Figure 4-1***).

The Koedoesberge-Moordenaars Karoo vegetation unit is found mostly in the Western Cape, with a smaller portion extending into the Northern Cape, and is part of the greater Succulent Karoo Biome (Mucina and Rutherford, 2006). The northern part of the site is hilly and undulating terrain covered in short shrubs, with small scattered succulents (***Figure 4-2***). The southern half of the site is higher lying and more mountainous than the northern half, and is dominated by low and scattered shrubs from taxa associated with the greater Fynbos Biome (***Figure 4-3***). This part of the site was notably more windy and colder, with an almost constant wind force and direction from the north.

4.2 CLIMATE

The climate of the Koedoesberge-Moordenaars Karoo has two slight rainfall optima, one in March and another more probable rainy season from May to August, with a MAP (Mean Annual Precipitation) of approximately 200 mm and MAT (Mean Annual Temperature of 16˚C. The Central Mountain Shale Renosterveld has an arid to semi-arid climate with a MAP of 180 - 410 mm spread relatively evenly throughout the year, although a slight high occurs in autumn and winter. Mean daily maximum and minimum temperatures for January and July respectively are 29.9˚C and 0.9˚C (Mucina and Rutherford, 2006).

Figure 4-1 Regional Vegetation within and Surrounding the Study Area



Source: Mucina and Rutherford (2006)

Figure 4-2 Northern Part of the Study Site Showing Lower Lying Terrain.

Source: NSS

Figure 4-3 Southern Higher Lying and More Mountainous Terrain of the Site.

Source: NSS

5 RESULTS AND DISCUSSION

5.1 LIKELIHOOD OF OCCURRENCE

Based on distribution (Friedman and Daly, 2004 and Monadjem *et al*, 2010), the bats presented in ***Table 5-1*** have the potential to occur in the Study Area, but vary in their LoO, due to different habitat requirements.

Please note that only bats that have had previous confirmed records within the relevant QDSs that study area falls within receive a High LoO.

Table 5-1 Potential Bat Species for the Study Area

Family	Species	Common Name	PoO
MOLOSSIDAE	*Tadarida aegyptiaca*	Egyptian free-tailed bat	2
VESPERTILIONIDAE	*Neoromicia capensis*	Cape serotine bat	2
VESPERTILIONIDAE	*Eptesicus hottentotus*	Long-tailed serotine	2
VESPERTILIONIDAE	*Cistugo lesueuri*	Lesueur's wing-gland bat	2
NYCTERIDAE	*Nycteris thebaica*	Egyptian slit-faced bat	2
RHINOLOPHIDAE	*Rhinolophus clivosus*	Geoffroy's horseshoe bat	3
RHINOLOPHIDAE	*Rhinolophus capensis*	Cape horseshoe bat	3
MINIOPTERIDAE	*Miniopterus natalensis*	Natal long-fingered	3
VESPERTILIONIDAE	*Myotis tricolor*	Temminck's myotis	3
VESPERTILIONIDAE	*Cistugo seabrae*	Angolan wing-gland bat	3
		1	Highly Likely
		2	Possible
		3	Unlikely

5.2 BAT DETECTION

Bat echolocation data analysis confirmed the presence of two species (*Tadarida aegyptiaca* and *Neoromicia capensis*) and the possibility of two additional species (call data to be verified by longer term monitoring and mist netting) (refer to **Table 5-2**). Bat activity was highest in the low lying areas in particular adjacent to human dwellings.

Table 5-2 Activity Recorded by the Bat Detectors

Roggeveld - Estimated actual bat numbers				
Species	*Tadarida aegyptiaca*	*Neoromicia capensis*	Unknown species	Unknown species
Domimant call frequency	20-25kHz	37-43kHz	30-35kHz	25-27kHz
Call Duration	9-20ms	3-8ms	9-12ms	8.6-11.4ms
Bat Detector				
1				
2		1		
3				
4		2		
5				
6				
7				
8	1	1		
9				
10	10	4	2	3
11	3			
12	10	1		3
13	3			

The Egyptian free-tail bat (*Tadarida aegyptiaca*) is a widespread crevice dwelling species, commonly associated with granite hills and the numerous rock cracks provided in such terrain. It is an aerial open-air forager, hence tends to fly high.

The Cape serotine bat (*Neoromicia capensis*) may be the most widespread bat in South Africa, and they roost singly or in groups of two or three individuals under the bark of trees, base of aloe leaves and in the roofs of houses. They have a tolerance for a wide variety of habitats from arid semi-desert areas to montane grasslands up to 1600m (Skinner and Chimimba, 2005; Monadjem, *et al*, 2010). This species is attracted to the insects that gather around lights, and their diet varies significantly on a seasonal basis. Under natural circumstances they forage above tree tops some 10-15m above ground.

5.3 HABITAT RESULTS

On a large scale, the study area can be divided into two terrain units. The northern part of the site is hilly and undulating terrain covered in short shrubs, with small scattered succulents. The southern half of the site is higher lying and more mountainous than the northern half, and is dominated by low and scattered shrubs from taxa associated with the greater Fynbos Biome. This part of the site was notably more windy and colder, with an almost constant wind force and direction from the north

Potential roost types that are applicable to the study area include:
- Rock crevices.

- Hollows from eroded cliff faces and overhangs.
- Roofs of houses and buildings.
- Culverts under roads.
- Aardvark burrows.
- Clumps of trees in the drainage gullies.

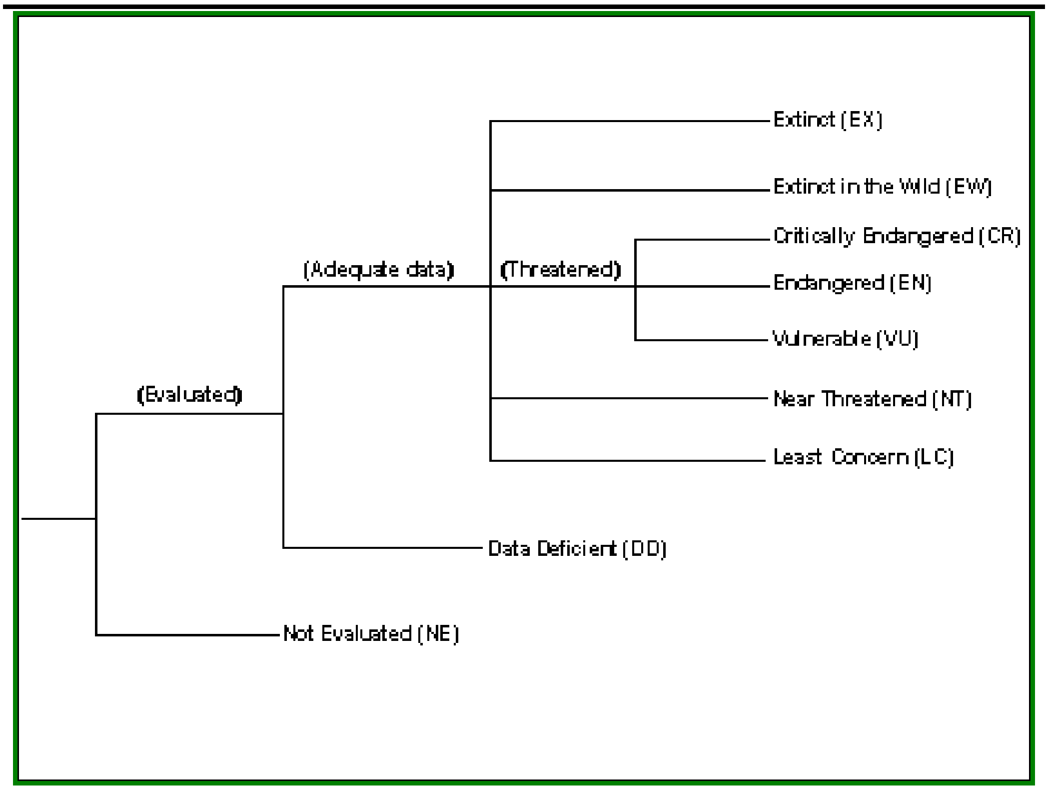
5.4 SPECIES OF CONSERVATION IMPORTANCE

The best-known criteria for categorizing the level of threats facing species, is the IUCN's Red List Categories and Criteria (IUCN, 2001). The IUCN Red List Categories and Criteria have several specific aims:

- to provide a system that can be applied consistently by different people;
- to improve objectivity by providing users with clear guidance on how to evaluate different factors which affect the risk of extinction;
- to provide a system which will facilitate comparisons across widely different taxa;
- to give people using threatened species lists a better understanding of how individual species were classified.

The IUCN categories are depicted below in **Figure 5-1**.

Figure 5-1 IUCN categories (IUCN, 2001)



Source: IUCN (2010)

Whilst the global conservation status of a species is important, often the international assessment underestimates the plight of a particular species at a national level, hence, the importance of a national red data listings. The latest red data listing for mammals (Friedmann and Daly, 2004) has been used to classify the conservation status of bats in the current assessment.

A detailed summary of potential bat species for the Roggeveld site, their LoO, conservation status and required roost types are described below in Table 5-3.

Family	Scientific Name	Common Name	PoO	Conservation Status	Required Roost Type
Nycteridae	*Nycteris thebaica*	Egyptian slit faced bat	2	Least concern	Culverts, rock overhangs/hollows, aardvark burrows
Rhinolophidae	*Rhinolophus capensis*	Cape horseshoe	3	Near threatened	Culverts, rock overhangs/hollows
	Rhinolophus clivosus	Geoffroy's horseshoe bat	3	Near threatened *	Culverts, rock overhangs/hollows
Molossidae	*Tadarida aegyptiaca*	Egyptian free-tailed bat	Confirmed	Least concern	Rock crevices, building roofs
Miniopteridae	*Miniopterus natalensis*	Natal long-fingered	3	Near Threatened	Caves, possibly large rock overhangs
Vespertilionidae	*Neoromicia capensis*	Cape Serotine	Confirmed	Least concern	Rock crevices, building roofs
	Eptesicus hottentotus	Long-tailed Serotine	2	Least concern	Rock crevices, building roofs
	Myotis tricolor	Temminck's myotis	2	Least concern	Caves, possibly large rock overhangs
	Cistugo lesueuri	Lesueur's wing-gland bat	2	Vulnerable	Rock crevices at high altitude
	Cistugo seabrae	Angolan wing gland	3	Near threatened	Unknown, possibly hollows from granite boulders

Cistugo lesueuri (Lesueur's wing-gland bat), a Vulnerable (VU) species has the Moderate potential to occur on site. Four bat species with a Low LoO have a Near Threatened (NT) conservation status: *Rhinolophus capen sis* (Cape horseshoe bat), *Cistugo seabrae* (Angolan wing-gland bat), *Rhinolophus clivosus* (Geoffroy's horseshoe bat) and *Miniopterus natalensis* (Natal long-fingered).

Due to their potential occurrence on site, the presence of these species actually being on site or migrating through the site needs to be assessed during more detailed long-term monitoring.

Table 5-3 Potential Species That May Occur or Confirmed in the Study Area.

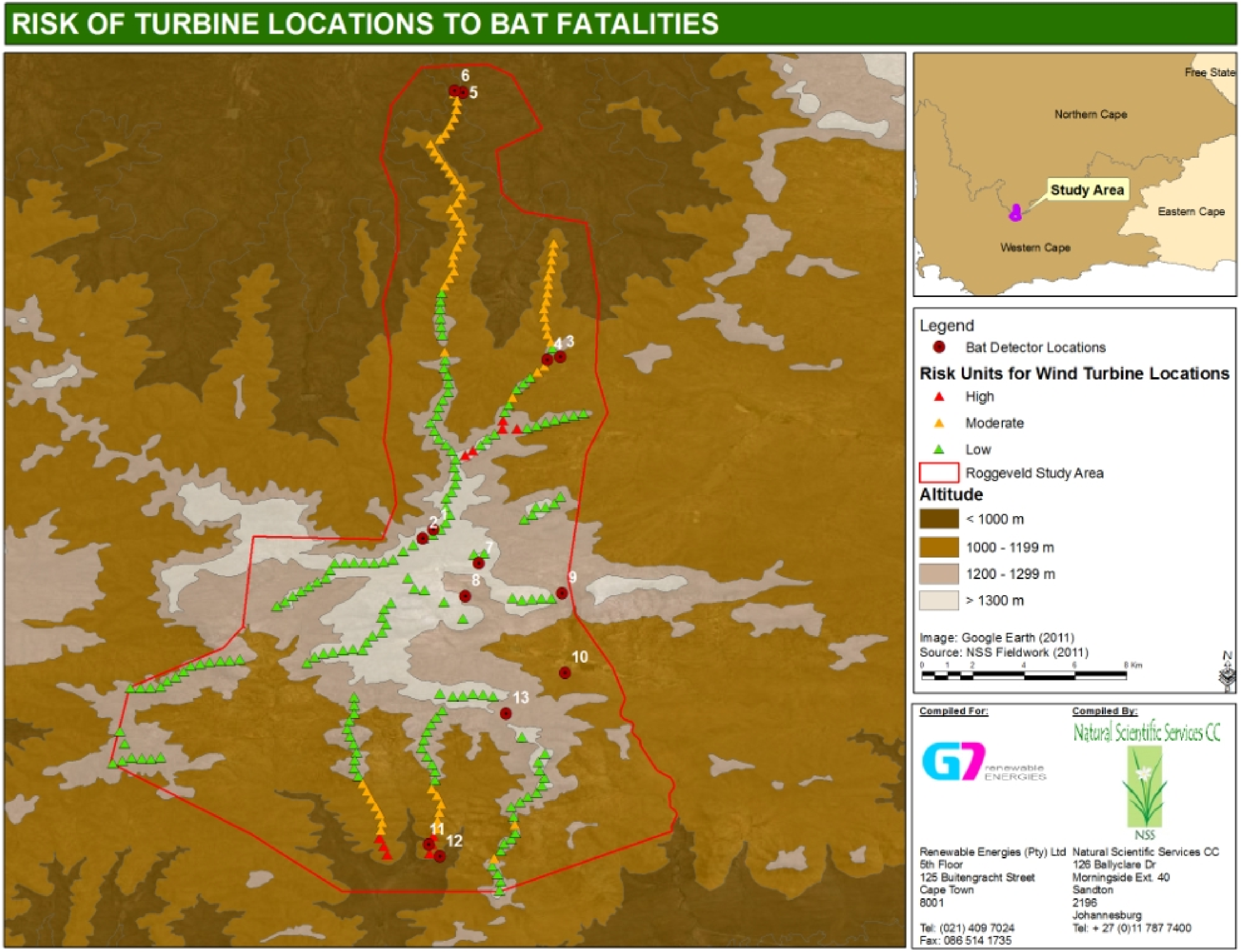
Family	Scientific Name	Common Name	PoO	Conservation Status	Required Roost Type
Nycteridae	*Nycteris thebaica*	Egyptian slit faced bat	2	Least concern	Culverts, rock overhangs/hollows, aardvark burrows
Rhinolophidae	*Rhinolophus capensis*	Cape horseshoe	3	Near threatened	Culverts, rock overhangs/hollows
	Rhinolophus clivosus	Geoffroy's horseshoe bat	3	Near threatened *	Culverts, rock overhangs/hollows
Molossidae	*Tadarida aegyptiaca*	Egyptian free-tailed bat	Confirmed	Least concern	Rock crevices, building roofs
Miniopteridae	*Miniopterus natalensis*	Natal long-fingered	3	Near Threatened	Caves, possibly large rock overhangs
Vespertilionidae	*Neoromicia capensis*	Cape Serotine	Confirmed	Least concern	Rock crevices, building roofs
	Eptesicus hottentotus	Long-tailed Serotine	2	Least concern	Rock crevices, building roofs
	Myotis tricolor	Temminck's myotis	2	Least concern	Caves, possibly large rock overhangs
	Cistugo lesueuri	Lesueur's wing-gland bat	2	Vulnerable	Rock crevices at high altitude
	Cistugo seabrae	Angolan wing gland	3	Near threatened	Unknown, possibly hollows from granite boulders

5.5 AREAS OF BAT CONSERVATION IMPORTANCE

The lower lying areas are considered to have a high probability of being utilized as bat foraging habitat on a nightly basis. It is expected that bats will roost in the mountain foot slope areas, and move down into the wetter valley areas where insect numbers will be elevated and wind speed less. Therefore, the turbines located in the lower lying areas are considered moderate risk turbines. It is recommended that long term monitoring and mitigations be prioritized for these turbines. The high risk turbines indicated are potentially in key locations where bats may be concentrated while moving between the main valley areas following insect abundances, and are therefore recommended to be moved to any of the medium risk areas. It is very important to note, that this map is based on the best scientific knowledge and judgement of NSS, and that sampling time was very limited. Also, there exists a vast gap in South African research on the relationship between bats and wind turbines.

This map is depicted in ***Figure 5-2***.

Figure 5-2   Areas of Bat Conservation Importance



Source: 1:50 000 topographical maps and NSS

5.6 DISCUSSION

Most of the research around bats and the impacts that wind energy facilities / wind farms can have on these animals has occurred within countries such as North America and Canada, where wind has been used as an alternative energy source for many years already (Kunz, *et al*. 2007(a); Kunz, *et al*. 2007(b); Arnett, *et al.*, 2008).

In terms of the results for the current study, there was not a high diversity of bats, however, the highest bat activity was associated with human dwellings and valley areas. Impacts are likely during all phases of the project – construction, operation and decommissioning to varying degrees, with potential bat fatalities due to collision or bartrauma caused by the moving turbine blades being the most significant. Loss of roosting and foraging habitat due to infrastructure development needs to also be considered.

Project specific impacts and recommended mitigation measures are discussed in *Section 6- Impact Identification and Assessment on page 24 below*; using the Impact Assessment Methodology criteria provided by ERM (see ***Appendix A***).

6 IMPACT IDENTIFICATION AND ASSESSMENT

6.1 PROJECT IMPACTS

The potential for impacts on bats by the proposed wind energy facility is evaluated in terms of impacts related to bats three main behavioural activities:

- Roosting impacts:
  - roosting habitat destruction or disturbance
  - attraction of bats to towers for roosting and therefore fatalities due to collision or barotrauma.
- Foraging impacts:
  - disturbance of foraging habitats; and
  - bat fatalities due to collision or barotrauma during foraging activity.
- Migration impacts:
  - Fatalities due to collision or barotrauma during long distance seasonal migrations

Potential impacts likely to arise during the construction and the operational phases of the development are summarised in ***Table 6.1***, below.

Table 6.1 Impact characteristics: Impacts on Bats

	Construction	Operation
Project aspect/ activity	(i) Disturbance associated with noise and movement. (ii) Loss of foraging and roosting habitat.	(i) Disturbance and/or displacement from foraging or roosting areas by movement and/or noise of rotating turbine blades. (ii) Mortality due to collisions with turbine blades (iii) Mortality from barotrauma.
Impact type	Direct	Direct
Receptors affected	(i) Bats on site, key species being crevice and roof dwelling species.	(ii) Bats on site, key species being crevice dwelling species (iii) Migratory bat species, key species being *Miniopterus natalensis* (Natal long-fingered bat), *Myotis tricolor* (Temminck's hairy bat) and *Rousettus aegyptiacus* (Egyptian rousette).

Two of the ten potential bat species likely to occur on site were acoustically recorded during three nights in total in September and December 2010.

There are three known migratory bat species in South Africa - (*Miniopterus natalensis* (Natal long-fingered bat), *Myotis tricolour* (Temminck's myotis) and *Rousettus aegyptiacus* (Egyptian rousette). These bats regularly undertake migratory flights between bushveld caves and highveld caves. There is a possibility that migratory species pass through the wider Roggeveld area during migration between roosts, although locations of roosting caves and migration routes in South Africa are poorly known and not well documented. Further, information on bat diversity, abundance, roost sites and migratory patterns at and near the study site is not available and requires monitoring to obtain a better understanding. Therefore, the impacts presented below are difficult to evaluate with any degree of confidence at this stage, and has had to be inferred from observations of available habitat and limited sampling effort. A conservative approach should be adopted until longer term pre-construction monitoring is complete.

6.2 HABITAT LOSS – DESTRUCTION, DISTURBANCE AND DISPLACEMENT DUE TO WIND TURBINES AND ASSOCIATED IINFRASTRUCTURE

6.2.1 Impact Description and Assessment

Construction Phase Impacts

The construction phase of the development inevitably incurs some temporary damage or permanent destruction of habitat which has both direct and indirect impacts on bats. The clearance of natural vegetation and rocks during the construction phase may alter the foraging or roosting habitat available to bat species, resulting in displacement of bats. The Roggeveld Wind Energy Facility is going to be a large facility with up to 250 turbines, 12m wide roads, up to 7 sub-stations, overhead power lines and office and storage infrastructure. Each turbine will involve disturbing a minimum are of 20x20m. The cumulative disturbance of all the infrastructure required results in several hectares of surface disturbance.

Increased noise and dust generated from machinery and other construction activities may impact bat roosting or foraging behaviour. The construction phase is expected to take up to 24 months, hence not considered to be short-term.

During construction of infrastructure, disturbance to bat foraging and roosting habitat is expected.

Box 6.1 **_Construction Impact: Habitat Loss – Destruction, Disturbance and Displacement_**

Nature: Damage to and loss of vegetation and rock during site clearance in the construction phase would result in a negative impact on bats through loss of roosting and foraging habitat.

Impact Magnitude – Medium

- **Extent**: The extent of the impact is limited to **on-site**.
- **Duration**: The duration would be **medium-term** (disturbances due to noise and dust) to **long-term** (as bat habitat will be affected until the project stops operating (i.e. over 25 years)).
- **Intensity:** Access road construction and turbine installation will result in a **medium** intensity impact. During construction of other infrastructure, disturbance of foraging areas, destruction of rocks and roosting areas is likely to be of **medium** intensity.

Likelihood – There is a **definite** likelihood that small areas of foraging and roosting habitat will be lost.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MODERATE (-VE)

Degree of Confidence: The degree of confidence is **medium** since the current study did produce some results but there is a need for research on bat populations in the study area and bat migratory patterns in the central Cape region of South Africa.

Operational and Decommissioning Phase Impacts

The operation of the Wind Farm may result in the long term disturbance to and/or displacement of bats from foraging or roosting areas across the Roggeveld site due to blade movement and noise emitted from rotating turbine blades. There is a potential that Natal long-fingered bat , Temminck's myotis and Egyptian rousette migratory routes pass through the wider study area and the presence of the turbines could result in disturbance of their typical migratory patterns. Noise and vibration generated from maintenance activities and decommissioning in the vicinity of rocky outcrops may result in temporary disturbance of bat roosts as works are undertaken, as the proposed turbines are sited in close proximity to the presumed bat roosts.

Box 6.2 Operational Impact: Habitat Loss: Destruction, Disturbance and Displacement

Nature: Noise and vibration generated by the turbines during operation would cause displacement and disturbance of bats on and near the site and result in a **negative direct** impact on bat habitat if roost sites are present.

Impact Magnitude – Medium

- **Extent**: The extent of the impact is limited to **on-site**.
- **Duration**: The duration would be **long-term** as bat habitat will be affected until the project stops operating (i.e. over 25 years).
- **Intensity:** Any factor that causes bats to desert their roosts (i.e noise and vibration) is likely to be of **medium** intensity. Disturbance of foraging areas is likely to be of **medium** intensity given the extent likely to be disturbed.

Likelihood – It is **likely** that small areas of habitat will be lost.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MODERATE (-VE)

Degree of Confidence: The degree of confidence is **medium** since the current study did produce some results but there is a need for research on bat populations in the study area and bat migratory patterns in the central Cape region of South Africa.

6.2.2 Mitigation of Habitat Loss- Destruction, Disturbance and Displacement

Design Phase

The objective of mitigation is to minimize the impacts on bats and their habitat and to maximize rehabilitation of disturbed areas. Pre-construction passive monitoring is required to further establish the current baseline and inform appropriate mitigation measures. Specific measures that can be implemented at the design phase include:

- Keep road development to a minimum where possible, upgrade existing roads rather than developing new road infrastructure.
- All project infrastructure, i.e. turbines, substations and mast should be located away from any areas considered to be of bat conservation importance. The following areas/ receptors should be avoided:
    - Turbines assessed as being moderate to high risk turbines in terms of bat fatalities should be avoided.
    - To minimise risk to bat populations, it is important to maintain a minimum of a 50 m buffer around any bat roosting habitat (tree lines, significant rock outcrops, houses etc.). Should any caves be discovered, a minimum of a 3km buffer is recommended based on the foraging distance findings by Jacobs and Barclay (2009). .

Construction and Operational Phase

- Blasting activities to be kept to the absolute minimum.
- Caution should be taken to ensure construction footprints are kept to an absolute minimum, including storage of materials, stockpiling etc.
- Construction activities should avoided as far as possible during early to mid summer (November to February) when it is peak bat breeding season and young bats may not be able to leave the roost.

6.2.3 Residual Impacts

The implementation of the construction and operational phase mitigation measures listed above would contribute towards ensuring that the post mitigation impact significance decreases to **minor** during both the construction and operation phases. The pre- and post-mitigation impacts are compared in ***Table 6.2***.

Table 6.2 Pre- and Post- Mitigation Significance: Habitat loss - Destruction, Disturbance and Displacement

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	MODERATE (-VE)	MINOR (-VE)
Operation	MODERATE (-VE)	MINOR (-VE)

6.3 COLLISIONS WITH TURBINES

6.3.1 Impact Description and Assessment

Operational Phase Impact

The growing concern over the potential impacts of wind farms on bat species in recent years is particularly in relation to the risk of collision with rotors or turbine towers, and barotrauma caused by rapid air-pressure reduction near moving turbine-blades (Cryan and Barcley, 2009). These impacts occur during the operational phase. The impacts associated with barotrauma are discussed below in *Section 6.4.2*.

Various hypotheses have been proposed for why bats may actually be attracted to wind turbines. A widely accepted explanation is that insects may concentrate around wind turbines, attracted by the heat radiation emitted or the colour of the paint on the turbines (Long, 2010) and in turn, bats may be attracted to these concentrations of insects (Ahlén *et al.* 2007). Given this theory, insectivorous species such as those belonging to the Molossidae Vespertilionidae, Rhinolophidae, Miniopteridae and Nycteridae families are more likely to be impacted from the turbines.

The proposed wind turbines, once operational, may impact on bat populations in the area by contributing to bat mortality through direct collisions with the turbine blades. The highest collision rates involving bats have been found in wind farms near forests but bat collisions have also been reported from turbines in open areas and even at offshore wind farms (Ecosystems Ltd, 2010). In North America, it is mostly tree-roosting migratory bats that are affected, with fatality numbers influenced by the height of towers (taller towers resulting in more fatalities), the level of bat activity at the site and the proximity of turbines to active bat hibernacula.

In South Africa, it is suspected that the bats most susceptible to collisions with wind turbines are likely to be the open foragers, such as those belonging to the families Molosidae and Vespertilionidae and the migratory cave-dwelling species, for example, Natal long-fingered Bat (*Miniopterus natalensis),* Temminck's myotis (*Myotis tricolour*) and Egyptian rousette *(Rousettus aegyptiacus*). Although undetected on site during the brief field survey, the presence of these species in the vicinity of the site is a possibility. Higher collision rates with non-migratory species are expected during periods of greater bat activity such as mating.

Box 6.3 Operational Impact: Collisions of bats with wind turbines

Nature: Rotation of the turbine blades during operation could result in mortality of bats through collision, with a **negative direct** impact on the bats at the Wind Farm site.

Impact Magnitude – High

- **Extent:** The extent of the impact is **on-site**, but would likely affect bats occurring outside the development footprint.
- **Duration:** The duration would be **long-term** as the ecology of the area would be affected for the life of the wind farm.
- **Intensity:** High numbers of bats may be killed in collision incidents with a resulting intensity of **high**.

Likelihood – Based on available literature**, it** is **likely** that bats will collide with turbines.

IMPACT SIGNIFICANCE (PRE-MITIGATION) –MAJOR (-VE)

Degree of Confidence: The degree of confidence is **low** since there is a need for research on bat populations in the study area and bat migratory patterns in the central Cape region of South Africa.

6.3.2 *Mitigation for Collision Risks*

Collision mitigation measures are aimed at reducing the risks of bats colliding with turbines by erecting wind turbines in places of little or no bat activity. Possible mitigation measures for the Roggeveld Wind Farm include:

- Locating turbines away from High Bat Risk areas.
- Implementing pre- and post-construction monitoring (see *Section 6.6*) to provide additional detailed baseline data to help define clearer mitigation measures, and to monitor the impacts on bats once the facility is operational.
- Increasing the cut-in speed of the rotors or curtailment is one of the only mitigation measures successful in significantly reducing bat mprtalities. Curtailment is where a turbine is kept stationary at a very low wind speed and then allowed to rotate once the wind exceeds a specific speed. The theory behind curtailment is that there is a negative correlation between bat activity and wind speed, causing bat activity to decrease as the wind speed increases. Refer to Section 6.7 for more detail on curtailment.
- Installing ultrasonic deterrent devices on selected functional turbines to minimise risk of collision, and monitoring the results. Refer to Section 6.7 for more detail on audio deterrents.

6.3.3 *Residual Impacts*

If the mitigation measures recommended in Section 6.3.2 are adhered to, this results in the reduction a **moderate** impact significance during the operational phase. The pre- and post-mitigation impacts are compared in ***Table 6.3***.

Table 6.3 Pre- and Post- Mitigation Significance: Collision Risk

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	N/A	N/A
Operation	MAJOR (-VE)	MODERATE (-VE)

6.4 BAROTRAUMA

6.4.1 *Impact Description and Assessment*

Operational Phase Impact

Barotrauma involves tissue damage to air-containing structures caused by rapid or excessive pressure change. Bats can suffer from pulmonary barotraumas, which is lung damage caused by expansion of air in the lungs that is not accommodated by exhalation, and this may result in mortality (Baerwald *et al*, 2008). As air moves over a turning turbine blade, an area of low pressure is created and bats flying or foraging in the vicinity of this sudden change in pressure can suffer barotrauma (Baerwald *et al*, 2009). As with the collision risks discussed above, barotrauma may impact migratory bats, bats moving through the area, or resident bats foraging in the vicinity of the wind turbine towers. Any species of bat foraging or migrating over the Roggeveld ridges may come into close proximity of the turbines may suffer barotrauma. Migratory species susceptible to barotrauma include Natal long-fingered bat, Temminck's myotis and Egyptian rousette.

Box 6.4 Operational Impact: Barotrauma

Nature: Pressure differences caused by turning of turbine blades can cause death of bats through barotrauma, resulting in a **negative direct** impact on the bats found within the Roggeveld site

Impact Magnitude – High

- **Extent:** The extent of the impact is **on site**, but may affect bats beyond the development footprint.
- **Duration:** The duration would be **long-term** as the bat populations of the area would be affected for the life of the wind farm.
- **Intensity:** Barotrauma may result in an unknown number of bat fatalities and is assigned an intensity of **high**.

Likelihood – There is a **likely** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) –MAJOR (-VE)

Degree of Confidence: The degree of confidence is **low** since little is known about bat populations, migratory patterns and mating behaviour of bats in the study area.

6.4.2 *Mitigation for Barotrauma*

The mitigation measures described for mitigating impacts of collision (*Section 6.3.2* above) are also aimed at reducing the risk of bats suffering from barotraumas, and are therefore relevant here.

6.4.3 *Residual Impacts*

If the mitigation measures recommended in Section 6.3.2 are adhered to, this results in the reduction a **moderate** impact significance during the operational phase. The pre- and post-mitigation impacts are compared in ***Table 6.3***.

Table 6.4 Pre- and Post- Mitigation Significance: Collision Risk

Phase	Significance (Pre-mitigation)	Residual Impact Significance

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	N/A	N/A
Operation	MAJOR (-VE)	MODERATE (-VE)

6.5 CUMULATIVE IMPACTS

SAWEA is the leading trade and professional body representing the wind industry in South Africa. As the voice of South Africa's wind industry, SAWEA's primary purpose is to promote the sustainable use of wind energy in South Africa, acting as a central point of contact for information for its members, and as a group promoting wind energy to government, industry, the media and the public.

Although this map is due to be updated, they had compiled a map (SAWEA, 2010) of all the applications received for wind energy farms in the country to that date (***Figure 6-1***). As can be seen, there were already over 50 proposed facilities. This is significant and definitely changes the picture in terms of impacts on bats, increasing the risks for fatalities exponentially. It also increases the risks for clashes with bat migration routes.

Figure 6-1 Proposed Wind Facilities Map for South Africa

Source: SAWEA (2010)

6.6 *ADDITIONAL MITIGATION MEASURES*

In addition to the mitigation measures discussed in Section 6.3 and 6.4 above, some mitigation recommendations are expanded on below and new ideas are explored.

6.6.1 *Turbine Locations and Dimensions*

Site layout and turbine design can assist in reducing the impacts on bats.

The Site Reconnaissance visit and Pre-construction Monitoring will identify if there are species or areas of Conservation Importance and recommend appropriate mitigation measures. An obvious measure would be to avoid areas of sensitivity (eg bat roost sites) and apply appropriate buffer zones to these areas.

The characteristics of wind energy facilities (e.g., rotor swept area, height, support structure, lighting, number of turbines, etc.) influence bird and bat fatalities (Strickland *et al.*, 2011).

A key question is whether more smaller or fewer bigger turbines cause less impacts on bats. NSS's desktop review has revealed that there is evidence to suggest that larger turbines cause higher mortalities in bats, however, site specific location of turbines in terms of sensitive habitats cannot be overlooked. The following literature refers:

- In terms of turbine design, Rydell *et al* (2010) discusses how increased rotor diameter increases bat fatalities. The mortality increased with turbine tower height and rotor diameter but was independent of the distance from the ground to the lowest rotor point.
- According to NWCC (2010), early turbines were mounted on towers 18-25 metres in height and had rotors 15-18 meters in diameter that turned 60–80 revolutions per minute (rpm). Today's land-based wind turbines are mounted on towers 60-80 meters in height with rotors 45-80 meters in diameter, resulting in blade tips that can reach over 425 feet above ground level. Rotor swept areas now exceed 1 acre and are expected to reach nearly 1.5 acres within the next several years. Even though the speed of rotor revolution has significantly decreased to 11–28 rpm, blade tip speeds have remained about the same; under normal operating conditions, blade tip speeds range from 138–182 mph. Wider and longer blades produce greater vortices and turbulence in their wake as they rotate, posing a potential problem for bats in terms of barotrauma.

The long term pre-construction monitoring must advise of the spacing of the turbines in relation to bat activity patterns. However, the current brief study recommends that the Areas of Bat Conservation Importance and associated buffer areas be avoided for turbine placement. There is information available regarding bat activity patterns in relation to habitat features. The evidence in Britain is that most bat activity is in close proximity to habitat features. Activity was shown to decline when measured at fixed intervals up to 50 m away from tree lines.

To minimise risk to bat populations, it is important to maintain a minimum of a 50 m buffer around any bat roosting habitat (trees, rock outcrops, houses etc.). Should any caves be discovered, a minimum of a 3km buffer is recommended based on the foraging distance findings by Jacobs and Barclay (2009).

6.6.2 *Curtailment*

The theory behind this mitigation measure is that there is a negative correlation between bat activity and wind speed, causing bat activity to decrease as the wind speed increases.

Curtailment of operations during high risk periods may substantially reduce bat fatalities. Scientists have hypothesized that bat fatalities could be lowered substantially by reducing the amount of turbine operating hours during low wind periods when bats are most active. This can be done by increasing the minimum wind speed, known as the "cut-in" speed, at which the turbine's blades begin rotating to produce electricity. Arnett *et al.* (2010) employed three treatments at each turbine with four replicates on each night of the experiment: a) fully operational, b) cut-in speed at 5.0 m/s (C5 and c) cut-in speed at 6.5 m/s, demonstrated nightly reductions in bat fatality ranging from 53–87% with marginal annual power loss.

A test done by Baerwald *et al*. (2008b) where they altered the wind speed trigger of 15 turbines from 4 m/s to 5.5 m/s at a site with high bat fatalities in south-western Alberta, Canada, during the peak fatality period, showed a reduction of bat fatalities by 60%. Under normal circumstances the turbine would turn slowly in low wind speeds but only starts generating electricity when the wind speed reaches 4 m/s. During the experiment the Vestas V80 type turbines were kept stationary during low wind speeds and only allowe d to start turning and generate electricity at a cut-in speed of 5.5 m/s. Another strategy used in the same experiment involved altering blade angles to reduce rotor speed, meaning the blades were near motionless in low wind speeds which resulted in a significant 57.5% reduction in bat fatalities.

Long term field experiments and studies done by Arnett *et al*. (2011) in Pennsylvania, USA showed a 44 – 93% reduction in bat fatalities with marginal annual power generation loss (≤ 1% per annum), when increasing cut-in speeds to 5 and 6.5 m/s respectively. Their studies concluded that curtailment can be used as an effective mitigation measure to reduce bat fatalities at wind energy facilities.

It is strongly recommended that the curtailment mitigation measure be considered if pre-construction bat monitoring indicates that it may be warranted. A cut-in speed of 6.5 m/ sec is recommended. However, all mitigation measures will be refined during the EIA Phase.

6.6.3 Ultrasonic and Radar Deterrent Devices

An ultrasonic deterrent device is a device emitting ultrasonic sound in a broad range that is not audible to humans. The concept behind such devices is to repel bats from wind turbines by creating a disorientating or irritating airspace around the turbine. Research in the field of ultrasonic deterrent devices is progressing and yielding some promising results, although controversy about the effectiveness and a lack of large scale experimental evidence exists.

Nevertheless, a study done by Szewczak and Arnett (2008), who compared bat activity using an acoustic deterrent with bat activity without the deterrent, showed that when ultrasound was broadcasted only 2.5-10.4% of the control activity rate was observed. A lab test done by Spanjer (2006) yielded promising results, and a field test of such devices done by Horn *et al*. (2008) indicated that many factors are influencing the effectiveness of the device although it did deter bats significantly from turbines.

Nicholls and Racey (2009) found that bat activity and foraging effort per unit time were significantly reduced during experimental trials when a radar antenna was fixed to produce a unidirectional signal therefore maximising exposure of foraging bats to the radar beam.

It is recommended that further research in this area be conducted in the South African context for potential application at Wind Frams throughout the country. If collaboration with local academic and research institutions is established to monitor and improve such devices during the functional stage of the wind farm, they can potentially lessen the impacts of the wind farm on bat populations significantly.

6.6.4 Long-term Pre- and Post-construction Monitoring

South Africa, through an initiative facilitated by the Endangered Wildlife Trust (EWT) has adopted best practise guidelines similar to existing international ones -

South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments (Sowler & Stoffberg, 2011). These guidelines seek to provide technical guidance for consultants charged with carrying out impact assessments for proposed wind farms, in order to ensure that pre-construction monitoring surveys produce the required level of detail and answers for authorities determining applications for wind farm developments. It outlines basic standards of good practice and highlights specific considerations relating to the pre-construction monitoring of proposed wind farm sites for bats. The guidelines recommend that in order to assess the impacts correctly, the following information is required:

- Assemblage of species using the site;
- Relative frequency of use by different species throughout the year;
- Location and time of activity, which must include turbine locations where known;
- Locations of roosts within and close to the site;
- Details on how the surveys have been designed to determine presence of rarer species;
- Type of use of the site by bats - at and away from turbine locations, for example foraging, commuting, migrating, roosting etc.

6.6.5 Research Collaboration Efforts

By ensuring that bat species and population information gathered on specific sites, is shared amoungst bat researchers, this knowledge base can be collaborated for future risk predictions on new applications.

7 *CONCLUSIONS AND RECOMMENDATIONS*

Although limited research has been conducted in the South African context, most biologists would support the development of clean, renewable energy sources, such as wind energy facilities in South Africa, on the condition that wildlife kills can be prevented or minimized through adequate monitoring and mitigation.

It is suspected that some bat fatalities may occur as a result of the wind turbines for the current project. , however, as long as the site does not transect an important migration route and the HIGH risk turbine localities are avoided, it is anticipated that there will not be large numbers of fatalities.

The lower lying areas are considered to have a high probability of being utilized as bat foraging habitat on a nightly basis. It is expected that bats roost in the mountain foot slope areas and human dwellings and move down into the valley areas to foragewhere insect numbers will be elevated and wind speed less. Therefore, the turbines located in the lower lying areas are considered moderate risk turbines. It is recommended that long term monitoring and mitigation be prioritized for these turbines. The high risk turbines indicated are potentially in key locations where bats may be concentrated while moving between the main valley areas following insect abundances, and are therefore recommended to be moved to any of the medium risk areas. It is very important to note, that this map is based on the best scientific knowledge and judgement of NSS, and that sampling time was very limited. Also, there exists a vast gap in South African research on the relationship between bats and wind turbines.

Project specific impacts can be avoided or reduced through commitment to the mitigation recommendations in this report. In NSS's opinion, the most important mitigation measures are:

- Long-term pre-construction passive monitoring.
- Correct placement of the turbines
- Curtailment

Problems foreseen are due to knowledge gaps and cumulative impacts.

- The movement patterns of bats, with specific reference to migratory bats, are not known. This lack of knowledge leads to impact predictions being weak and important mitigation measures may be lacking.
- South Africa is looking towards a future of cleaner energy production; hence, numerous wind energy facilities are planned. The cumulative impact of all of these facilities could have detrimental impacts on bird and bat populations,

and indirectly affect other biodiversity through micro-climates changes and habitat disturbance, etc.

The onus is not only on the individual energy companies to invest in research to lessen these knowledge gaps, but it is also governments responsibility to have a better understanding, in order to make informed decisions on the approval of the numerous applications received.

8 GLOSSARY OF ACRONYMS, TERMS AND UNITS

BD	Bat Detector
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CR	Critically Endangered
DD	Data Deficient
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMPR	Environmental Management Programme Report
EN	Endangered
ERM	Environmental Resource Management
GDARD	Gauteng Department of Agriculture and Rural Development
IUCN	World Conservation Union
kPa	Kilo Pascals
LC	Least Concern
m/s	Milli seconds
MAR	Mean Annual Runoff
MAT	Mean Annual Temperature
MN	Mist Net
NEMA	National Environmental Management Act
NSS	Natural Scientific Services
NT	Near Threatened
PoO	Probability of Occurrence
QDS	Quarter Degree Squares
SANBI	South African National Biodiversity Institute
SAWEA	South African Wind Energy Association
SMP	Strategic Management Plan
SOW	Scope of Work
TOPS	Threatened and Protected Species
UK	United Kingdom
USA	United States of America
VU	Vulnerable

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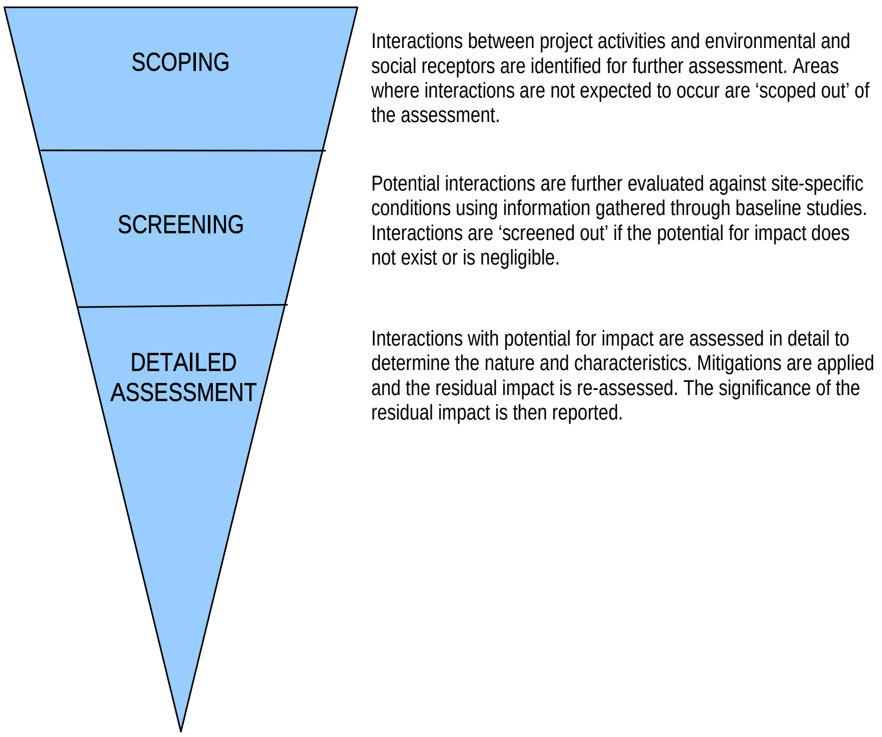
10 APPENDICES

10.1 ERM'S IMAPACT ASSESSMENT METHODOLOGY.

10.1.1 *Impact Assessment Process*

The following diagram (*Figure 10.1*) describes the impact identification and assessment process through scoping, screening and detailed impact assessment. The methodology for detailed impact assessment is outlined in *Section 10.1.2* below.

Figure 10.1 Impact Assessment Process



10.1.2 *Detailed Assessment Methodology*

The purpose of impact assessment and mitigation is to identify and evaluate the significance of potential impacts on identified receptors and resources according to defined assessment criteria; to develop and describe measures that will be taken to avoid or minimise any potential adverse effects and enhance potential benefits; and to report the significance of the residual impacts that remain following mitigation.

Impact Types and Definitions

An impact is any change to a resource or receptor brought about by the presence of a Project component or by the execution of a Project related activity. The evaluation of baseline data provides crucial information for the process of evaluating and describing how the Project could affect the biophysical and socio-economic environment.

Impacts are described as a number of types as summarised in *Table 10-1*. Impacts are also described as *associated*, those that will occur, and *potential,* those that may occur.

Table 10-1 Impact Nature and Type

Nature or Type	Definition
Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (eg between occupation of a site and the pre-existing habitats or between an effluent discharge and receiving water quality).
Indirect	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (eg in-migration for employment placing a demand on resources).
Cumulative	Impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the Project.

Significance

Impacts are described in terms of '*significance*'. Significance is a function of the **magnitude** of the impact and the **likelihood** of the impact occurring. Impact magnitude (sometimes termed *severity*) is a function of the **extent, duration and intensity** of the impact. The criteria used to determine significance are summarised in *Table 10-2.* Once an assessment is made of the magnitude and likelihood, the impact significance is rated through a matrix process as shown in *Table 10-3*. For ease of review, the significance is colour-coded in the text according to *Table 10-4*. *Table 10-5* outlines the various definitions for significance of an impact.

Significance of an impact is qualified through a statement of the **degree of confidence**. Confidence in the prediction is a function of uncertainties, for example, where information is insufficient to assess the impact. Degree of confidence is expressed as low, medium or high.

Table 10-2 Significance Criteria

Magnitude – the degree of change brought about in the environment	
Extent	**On-site** – impacts that are limited to the Site Area only. **Local** – impacts that affect an area in a radius of 20 km around the development area. **Regional** – impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystems. **National** – impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences. **Transboundary/International** – impacts that affect internationally important resources such as areas protected by international conventions.
Duration	**Temporary** – impacts are predicted to be of short duration and intermittent/occasional. **Short-term** – impacts that are predicted to last only for the duration of the construction period. **Long-term** – impacts that will continue for the life of the Project, but ceases when the Project stops operating. **Permanent** – impacts that cause a permanent change in the affected receptor or resource (eg removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.
Intensity (1)	BIOPHYSICAL ENVIRONMENT: *Intensity can be considered in terms of the sensitivity of the biodiversity receptor (ie habitats, species or communities).* **Negligible** – the impact on the environment is not detectable. **Low** – the impact affects the environment in such a way that natural functions and processes are not affected. **Medium** – where the affected environment is altered but natural functions and processes continue, albeit in a modified way. **High** – where natural functions or processes are altered to the extent that it will temporarily or permanently cease.
	SOCIO-ECONOMIC ENVIRONMENT: *Intensity can be considered in terms of the ability of project affected people/communities to adapt to changes brought about by the Project.*

(1) The frequency of the activity causing the impact also has a bearing on the intensity of the impact, ie the more frequent the activity, the higher the intensity.

	Negligible – there is no perceptible change to people's way of life. **Low** - People/communities are able to adapt with relative ease and maintain pre-impact livelihoods. **Medium** - Able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support. **High** - Those affected will not be able to adapt to changes and continue to maintain-pre impact livelihoods.
Likelihood - the likelihood that an impact will occur	
Unlikely	The impact is unlikely to occur.
Likely	The impact is likely to occur under most conditions.
Definite	The impact will occur.

Table 10-3 Significance Rating Matrix

SIGNIFICANCE				
		LIKELIHOOD		
		Unlikely	**Likely**	**Definite**
MAGNITUDE	**Negligible**	Negligible	Negligible	Minor
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Table 10-4 Significance Colour Scale

Negative ratings	Positive ratings
Negligible	Negligible
Minor	Minor
Moderate	Moderate
Major	Major

Table 10-5 Significance Definitions

Significance definitions	
Negligible significance	An impact of negligible significance is where a resource or receptor will not be affected in any way by a particular activity, or the predicted effect is deemed to be imperceptible or is indistinguishable from natural background levels.
Minor significance	An impact of minor significance is one where an effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards, and/or the receptor is of low sensitivity/value.
Moderate significance	An impact of moderate significance is one within accepted limits and standards. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable

	(ALARP). This does not necessarily mean that "moderate" impacts have to be reduced to "minor" impacts, but that medium impacts are being managed effectively and efficiently.
Major significance	An impact of major significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. A goal of the EIA process is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (ie ALARP has been applied). An example might be the visual impact of a development. It is then the function of regulators and stakeholders to weigh such negative factors against the positive factors, such as employment, in coming to a decision on the Project.

10.1.3 Mitigation of Potential and Residual Impacts

For activities with significant impacts, the Project would be required to identify suitable and practical mitigation measures and fully implement them. The implementation of the mitigations is ensured through the EMP.

Once the mitigation is applied, each impact is re-evaluated, assuming that the mitigation measure is effectively applied, and any remaining impact is rated once again using the process outlined above. The result is a significance rating for the residual impact.