4 ASSESSMENT OF POTENTIAL IMPACTS AND POSSIBLE MITIGATION MEASURES

This Chapter forms the focus of the EIAR. It contains a detailed assessment of the operational (or long-term) impacts as well as the construction phase impacts on the biophysical and socio-economic environments using the methodology described in **Annexure D**. A summary table of the assessment of all the potential impacts is also provided.

4.1 INTRODUCTION

This Chapter describes the potential impacts on the biophysical and socio-economic environments, which may occur due to the proposed activities described in **Chapter 3**. These include potential impacts, which may arise during the operation of the proposed development (i.e. long-term impacts) as well as the potential construction related impacts (i.e. short to medium term). The assessment of potential impacts will help to inform and confirm the selection of the preferred alternatives to be submitted to DEA for consideration. In turn, DEA's decision on the environmental acceptability of the proposed project and the setting of conditions of authorisation (should the project be authorised) will be informed by this chapter, amongst other information, contained in this EIAR.

The potential impacts identified during the Scoping Phase of this project, and updated where necessary, are as follows:

- Operational phase impacts on the biophysical environment:
  - Impact on ecology
  - Impact on avifauna;
  - Impact on bats;
  - Impact on climate change; and
  - Impact on freshwater.
- Operational phase impacts on the social environment:
  - Impact on heritage resources;
  - Visual impacts;
  - Impact on energy production;
  - Impact on local economy (employment) and social conditions;
  - Impact on agricultural land; and
  - Impact of noise.
- Construction phase impacts on the biophysical and social environments:
  - Disturbance of flora, avifauna, bats and fauna;
  - Sedimentation and erosion of water ways;
  - Impact on heritage resources;
  - Impact on palaeontology;
  - Visual impacts;

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- o Impact on local economy (employment) and social conditions;
- o Impact on transport;
- o Noise pollution;
- o Storage of hazardous substances on site; and
- o Dust impact.

Each of these impacts is assessed in detail in a section below. The baseline and potential impacts that could result from the proposed developments are described and assessed. Mitigation measures are recommended. Finally, comment is provided on the potential cumulative impacts[18] which could result should these developments, and others like it in the area, be approved.

The methodology used to assess the potential impacts is detailed in **Annexure D**. The (+) or (-) after the significance of an impact indicates whether the impact is positive or negative, respectively.

Only the latest layout, namely the February 2012 layout (see **Figure 3-8** and **Figure 3-9**), is assessed below. It should however be noted that specialists assessed the original layout but also provided comment on the February 2012 layout and this is included along with the full specialist studies.

4.2 Operational phase impacts on biophysical environment

4.2.1 Impact on Ecology

Currently the sites are in a mostly natural condition. Many parts of South Africa contain high levels of biodiversity at species and ecosystem level. At any single site there may be large numbers of species or high ecological complexity. The proposed wind energy facilities would potentially impact on the ecology of the study area including the biodiversity, sensitive habitats and ecosystem function. As such Dr David Hoare was appointed to undertake a desktop Ecological Impact Assessment. A site visit was conducted by Dr Hoare on 23 and 24 November 2011 in order to inform the assessment. The study considered climate, topography, soil, fauna and flora together with the functioning of ecosystems in biodiversity areas and applicable processes along corridors, rivers, wetlands and important topographical features. The Ecological Impact Assessment in included in **Annexure E**. The summary below includes findings and recommendations of the specialist.

[18] EIA's are typically carried out on specific developments, whereas cumulative impacts result from broader biophysical, social and economic considerations, which typically cannot be addressed at the project level.

a) Description of the environment

The mean annual rainfall is approximately 200 mm per year. Rainfall occurs from November to March, but peaks in mid- to late summer (February / March). All areas with less than 400 mm rainfall are considered to be arid and therefore the study area can be considered to be arid.

The study site is located on the high-lying plateau to the north-east of De Aar. The topography of the site varies from steep to flat and is relatively rugged in places. The plateau escarpment faces De Aar and is steep to very steep.

There are three land types in the study area, namely the Fb, Ae and Ib land types (Land Type Survey Staff, 1987). The A-group of land types refer to yellow and red soils without water tables belonging to one or more of the following soil forms: Inanda, Kranskop, Magwa, Hutton, Griffin, Clovelly . A classification of land (climate, terrain form, soil) primarily for rainfed agriculture. The F-group of land types refer to landscapes that are not predominantly rock and nor predominantly alluvial or aeolian and in which the dominant soil-forming processes have been rock weathering, clay illuviation[19], giving rise typically to lithocutanic[20] horizons (MacVicar *et al*. 1974). The I-group of land types refer to soil patterns difficult to accommodate elsewhere, at least 60% of which comprises pedologically youthful, deep (more than 1 000 mm to underlying rock) unconsolidated deposits (MacVicar *et al*. 1974).

The study area falls within the Nama-Karoo Biome (Mucina and Rutherford, 2006). There are two main vegetation types occurring within the study site, namely Northern Upper Karoo and Besemkaree Koppies Shrubland. Both vegetation types are classified nationally as Least Threatened. The Northern Upper Karoo vegetation type occurs across an extensive area (covers an area of almost 42 000 km^2). Besemkaree Koppies Shrubland is less extensive in extent (covers an area of approximately 3 600 km^2). There are no threatened, near threatened or rare plant species that occur on site.

The only tree species protected under the National Forest Act that has a geographical distribution within the proposed study area is *Boscia albitrunca* (Shepherd's Tree/ Witgatboom /! Xhi). However, this species is unlikely to occur on site.

There are two plant species that are protected according to National Environmental Management: Biodiversity Act (Act No. 10 of 2004) that are known to occur in the general geographical area that includes the sites. The species that have a geographic distribution that includes the study area are *Hoodia gordonii* (Hoodia) and *Harpagophytum procumbens* (Devil's Claw). No individuals of these species were found during the field survey and it is considered unlikely that they occur on site.

The shrub, *Prosopis glandulosa* (Mesquite), is potentially the most problematic invasive alien in the Northern Cape and is widely distributed in the Northern Upper Karoo vegetation type.

[19] The process by which a material (illuvium), which includes colloids and mineral salts, is washed down from one layer of soil to a lower layer.
[20] Soils which have weathered rock beneath the A-horizon (the uppermost layer).

However, it was found at a relatively low frequency on site and in immediately adjacent areas.

A landcover map of the study area (Fairbanks *et al*. 2000) indicates that the entire site consists of natural vegetation, classified as “shrubland and low fynbos”. The site is currently used as grazing for domestic livestock and cattle, sheep and/or goats were found in various parts of the study area.

There are no red-listed mammal species (excluding bats) that could occur in available habitats in the study area. However, there are two small mammal species that could potentially occur on site that are protected under the National Environmental Management: Biodiversity Act. These are the Black-footed Cat and the Cape Fox. The Black-footed Cat occurs throughout the dryer parts of the country, although at low densities. Individuals travel between 10-20 km at night hunting and frequently move dens. The Cape Fox has a wider distribution than the Black-footed Cat and is only absent from the eastern seaboard and most of Mpumalanga and Limpopo Provinces. Their presence was not confirmed on the sites although it is possible they may occur there. The Giant Bullfrog is the only amphibian species with a distribution that includes the study area and which could occur on site but based on a field evaluation of the site and surrounding areas, is not likely to be found on site.

The National Parks Area Expansion Strategy (NPAES) has identified a portion of the escarpment of the eastern plateau which is proposed for inclusion in a protected area (reserve). Part of the areas identified falls within the site of the proposed north and south wind energy facilities (see **figure 4-1**). However, it should be noted that no engagement with regards to the identification of the land portions nor with regards to land acquisitions has taken place with the relevant landowners. Representatives from the South African National Parks, South African National Botanical Institute and DEA Chief Directorate: Transfrontier Conservation and Protected Areas have been notified and provided with the opportunity to comment on the proposed projects

b) Impact assessment

The potential impacts most likely to be experienced at the proposed site include:

- Loss or fragmentation of indigenous natural vegetation:
  - Negative change in conservation status of habitat;
  - Increased vulnerability of remaining portions to future disturbance;
  - General loss of habitat for sensitive species;
  - Loss in variation within sensitive habitats due to loss of portions of it;
  - General reduction in biodiversity;
  - Increased fragmentation (depending on location of impact);
  - Disturbance to processes maintaining biodiversity and ecosystem goods and services; and
  - Loss of ecosystem goods and services

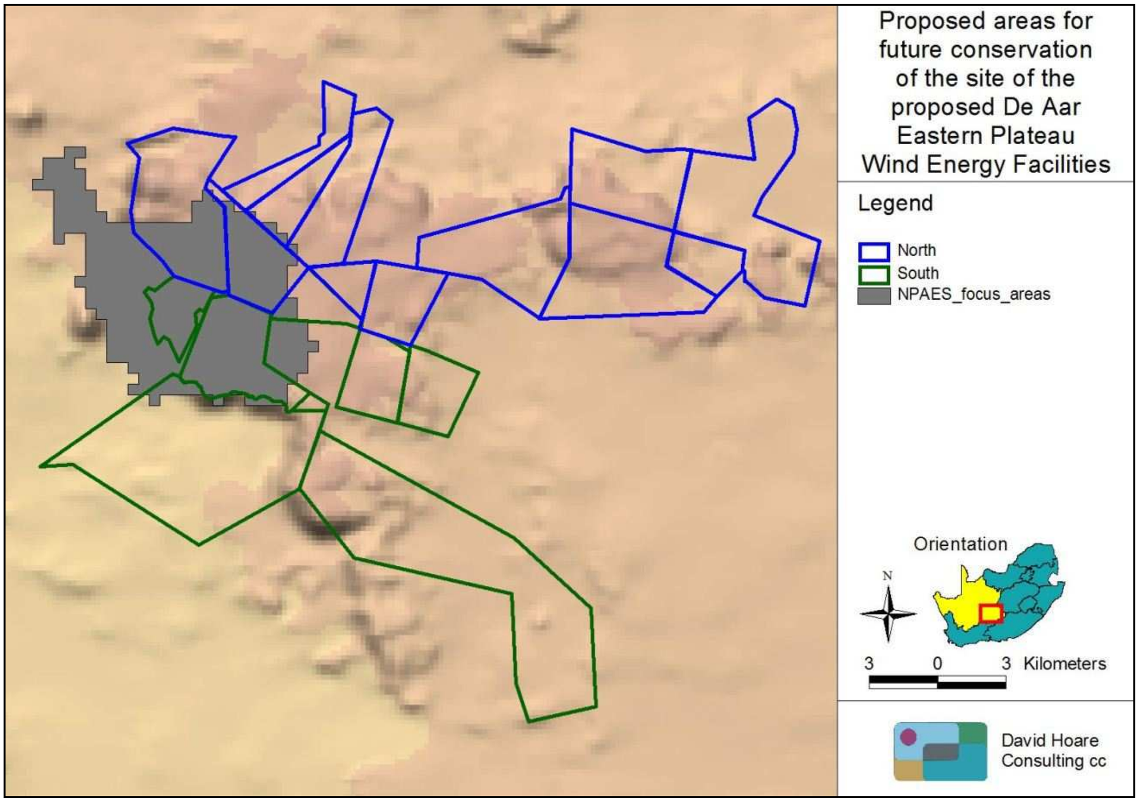

Figure 4-1: Areas included in the National Parks Area Expansion Strategy. (D. Hoare Consulting 2012).

- Loss of individuals of threatened and protected plants and tree species
  - Fragmentation of populations of affected species;
  - Reduction in area of occupancy of affected species; and
  - Loss of genetic variation within affected species.

- Establishment and spread of declared weeds and alien invader plants
  - Loss of indigenous vegetation;
  - Change in vegetation structure leading to change in various habitat characteristics;
  - Change in plant species composition;
  - Change in soil chemical properties;
  - Loss of sensitive habitats;
  - Loss or disturbance to individuals of rare, endangered, endemic and/or protected species;
  - Fragmentation of sensitive habitats;
  - Change in flammability of vegetation, depending on alien species;
  - Hydrological impacts due to increased transpiration and runoff; and
  - Impairment of wetland function.

Both vegetation types found on site are classified nationally as Least Threatened. There are no threatened, near threatened or rare plant species that occur on site. The three protected plant species that occur in the general area are unlikely to occur on site.

The majority of potential impacts are considered to be site specific or local, of low to medium magnitude and long term and therefore of **low to medium (-)** significance, without mitigation. With mitigation measures implemented, the impacts would be of **very low to medium (-)** significance. Note that the greatest impact on ecology (**medium (-)**) is as a result of fragmentation by access roads and it is not possible to mitigate this impact. However, the impact is considered to be acceptable based on the low sensitivity of the vegetation and its widespread distribution.

c) Mitigation measures

The following mitigation measures are recommended:

- An on-going monitoring programme should be implemented to detect and quantify any invasive plant species that may become established and to provide management measures for removing invasive species.

d) Cumulative impacts

Due to the fact that two wind energy facilities are proposed adjacent to one another cumulative impacts from both facilities were addressed. The impact on natural vegetation is due primarily to internal access roads. For this infrastructure component the impact was evaluated as being of medium magnitude at a site specific scale and of long-term duration. If the two proposed facilities are taken together then the scale would be elevated to “local”, but the remaining measures would stay the same. It is therefore concluded that cumulative impacts would not result in impacts having a significance that is greater than for each of the individual proposed wind energy facilities.

4.2.2 Impact on avifauna (birds)

Based on atlas data from the first South African Bird Atlas (SABAP1) and second (SABAP2) bird atlas projects, up to 221 species can be recorded within a 25 km radius of the development zone. Of the 221 species, 12 are red-list species, 60 are endemics or near endemics and four are red-listed endemics (Ludwig’s Bustard, Blue Crane, Blue Korhaan and Black Harrier). Potential avifaunal impacts could arise from disturbance caused by vehicular and people traffic during construction, displacement caused from habitat loss, risk of collision with wind turbine blades and power lines and behavioural displacement (alteration of flight paths). As such Mr Doug Harebottle was appointed to undertake an avifaunal specialist study. A field survey was undertaken from 17 - 20 December 2011 to inform the Avifauna Impact Assessment. The Avifauna Impact Assessment is included in **Annexure F**.

a) Description of the environment

The study area falls within the Nama-Karoo biome and forms part of the 12 000 km^2 Platberg-Karoo Conservancy Important Bird Area. There are no known regionally or nationally critical populations of impact susceptible species within or close to the sites, although there are four red-listed endemic species that occur on site. The natural vegetation present within the study area and impact zone comprises three main vegetation types: Besemkaree Koppies Shrubland, Eastern Upper Karoo and Northern Upper Karoo (Mucina and Rutherford, 2006). Ridges and rocky cliff faces on the plateau are likely to be important sources of lift for soaring species, notably raptors and possibly cranes. These will also support other cliff-nesting and foraging species. Additional avifaunal habitats that are important within the study area would include slopes which are well vegetated with small-medium sized bushes, and the lowland areas which are generally covered by low shrubby vegetation and short grass. The areas around farm dwellings are to some degree degraded mainly due to stock grazing. There are scattered farm dams in the study area with a few larger dams and ephemeral wetlands to the south and east of the plateau. The desktop survey produced a list of 125 species, 17 species were recorded for the top of the plateau including one red-list species (Verreaux's Eagle)(Least Concern) and eight regional endemics (listed below). A total of 16 species were recorded on the plateau and 29 species on the ridge slopes.

The birds of greatest potential relevance and importance in terms of the possible impacts of the wind farms are likely to be (a) resident and breeding raptors, notably Martial Eagle[21] *Polemaetus bellicosus*, Verreaux's Eagle *Aquila verreauxii,* Cape Eagle-Owl *Bubo capensis* and possibly Jackal Buzzard *Buteo rufofuscus*; (b) large terrestrial birds and raptors nesting, foraging on, or moving over, the lowland/plateau interface, including Booted Eagle *Aquila pennatus*, Southern Pale-chanting Goshawk *Melierax canorus*, Black-chested Snake-Eagle *Circaetus pectoralis*, Ludwig's Bustard *Neotis ludwigii*, Blue Crane *Anthropoides paradiseus* and possibly Black Harrier *Circus maurus* (c) endemic passerines that utilise the ridge lines, including Fairy Flycatcher *Stenostira scita* and most likely African Rock Pipit *Anthus crenatus* and (d) flocks of waterbirds moving between the wetlands (farm dams and pans) in and around the development sites, notably Greater Flamingo *Phoenicopterus ruber* and various duck species.

Although no active raptor nests were found during the site survey, a Verreaux's Eagle nest and a disused Martial Eagle nest were noted on a site visit by Aurecon in October 2011.

During the site survey, a preliminary assessment was carried out to determine which species used flight paths across the plateau top, considering ridges and high points especially. A variety of raptors, particularly Southern Pale-chanting Goshawk and Jackal Buzzard, frequent the sites. The Southern Pale-chanting Goshawk is especially significant as it was observed on top of the plateau, while the Jackal Buzzard and Black-chested Snake-eagle tended to prefer the ridgelines and/or cliff lines; however this does not preclude them from

[21] A disused Martial Eagle nest was pointed out by a landowner. Martial Eagles typically return to the same nest every year, so it is likely that the nest will be used at some point in the future.

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using the plateau either as a foraging area or route between the northern and southern portions of the plateau. Other species such as Barn Swallow, Common Swift, Black Swift, White-rumped Swift, Little Swift, and South African Cliff-Swallow were observed flying on top of the plateau at three different locations within the sites. These are all aerial foragers which occur in relatively large flocks (often together) and which could possibly place them at a higher level of collision risk.

b) Impact assessment

The potential impacts on the avifauna of the study area includes displacement and disturbance of large terrestrial birds, resident or breeding species, mortality caused by collision with the wind turbine blades or power lines, habitat loss, electrocution on new power infrastructure as well as behavioural displacement (alteration of flight paths).

Overall the most important species include (i) resident and breeding raptors, especially Martial Eagle (at least one pair in the south site), Verreaux's Eagle (at least one pair in the south site), Southern Pale-chanting Goshawk (use of powerlines on plateau on the north site and numerous breeding pairs on periphery of the entire combined site) and Cape Eagle Owl (at least one breeding pair on periphery of the south site),(ii) large terrestrial bird species, especially Ludwig's Bustard and Blue Crane (which breeds in the surrounding lowlands) (iii) populations of localised/range-restricted or biome-restricted species particularly African Rock Pipit, Sickle-winged Chat and Black-headed and (iv) congregations of wetland species at and around the various dams in the north and south sites.

Collisions with turbines and power lines

The number of collisions of birds with turbines and power lines ranges from low to high across countries and the world. Although collision rates may appear relatively low in many cases, cumulative effects over time, especially when considered for large, long lived, slow reproducing and/or threatened species (many of which are collision-prone), may be of considerable significance.

Many factors influence the number of birds killed at wind energy facilities. These can be classified into three broad groupings: (i) avian variables, (ii) location variables, and (iii) facility-related variables. It is logical to assume that the more birds there are flying through a site, the higher the chances of a collision occurring. The types of birds present in the area are also very important as some species are more vulnerable to collision with turbines and power lines than others. Species-specific variation in behaviour, from general levels of activity to particular foraging or commuting strategies, also affect susceptibility to collision. There may also be seasonal and temporal differences in behaviour, for example breeding males displaying may be particularly at risk.

Landscape features can potentially channel birds towards a certain area, and in the case of raptors, influence their flight and foraging behaviour. Birds fly lower during strong headwinds due to poor visibility so when the turbines are functioning at their maximum speed, birds are likely to be flying at their lowest height, increasing collision risk.

Larger wind energy facilities, with more turbines, are more likely to result in significant numbers of bird casualties, because they are a greater group risk. Turbine size may also be proportional to collision risk, with taller turbines associated with higher mortality rates in some instances. Illumination of turbines and other infrastructure at night is often associated with increased collision risk, either because birds moving long distances at night do so by celestial navigation, and may confuse lights for stars or because lights attract insects, which in turn attract night birds. However, the turbines under consideration would not be lit at night, except with regulation aviation safety lighting (small, flashing red lights).

Some literature suggests that spacing between turbines can change the number of collisions (i.e. wider spacing results in less collisions), but other literature suggests that all attempts by birds to fly between turbines, rather than over or around them, should be discouraged to minimise collision risk.

Collision prone birds are generally either (i) large species and/or species with high ratios of body weight to wing surface area (wing loading), which confers low manoeuvrability (cranes, bustards, vultures, gamebirds, waterfowl, falcons), (ii) species which fly at high speeds (gamebirds, pigeons and sandgrouse, swifts, falcons), (iii) species which are distracted in flight - predators or species with aerial displays (many raptors, aerial insectivores, some open country passerines[22]), (iv) species which habitually fly in low light conditions, and (v) species with narrow fields of forward binocular vision. Exposure is greatest in (i) very aerial species, (ii) species inclined to make regular and/or long distance movements (migrants, any species with widely separated resource areas - food, water, roost and nest sites), (iii) species that regularly fly in flocks (increasing the chances of incurring multiple fatalities in a single collision incident).

Soaring species may be particularly prone to colliding with turbines where the turbines are placed along ridges to exploit the same updrafts favoured by such birds for cross-country flying. Large soaring birds such as many raptors and storks depend heavily on external sources of energy for sustainable flight. In terrestrial situations, this generally requires that they locate and exploit pockets or waves of rising air, either in the form of bubbles of vertically rising, differentially heated air (thermal soaring) or in the form of wind forced up over rises in the landscape, creating waves of rising turbulence (slope soaring).

Habitat loss – destruction, disturbance and displacement

Birds in the proposed study area are likely to be disturbed, especially shy and/or ground-nesting species. Some studies have shown that specific bird species avoid wind energy facilities due to noise or movement of the turbines or avoidance of the collision impact zone Power line service roads or servitudes would need to be cleared of excess vegetation at regular intervals in order to allow access to the line for maintenance, and to prevent vegetation from intruding into the legally prescribed clearance gaps between the ground and the conductors. These activities have an impact on birds breeding, foraging and roosting in or in close proximity to the servitude, and retaining cleared servitudes can alter the bird

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[22] Perching birds and songbirds.

community structure at the site. Due to the low level of the shrub at the site it is unlikely that much maintenance would be required below any overhead power lines.

Electrocution on power infrastructure

Avian electrocutions occur when a bird perches or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components. Electrocution risk is strongly influenced by the voltage and design of the hardware installed (generally occurring on lower voltage infrastructure where air gaps are relatively small), and mainly affects larger, perching species, such as vultures, eagles and storks, easily capable of spanning the spaces between energised components.

Figures 4-2 and 4-3 show the locations of a few of the species of concern, and flight paths noted, on the sites.

Based on the above, the potential impacts most likely to be experienced at the proposed site include:

- Disturbance and displacement of resident or breeding Karoo species (notably Eastern Clapper Lark and Rufous-eared Warbler) from foraging/breeding areas by operation of the facility;
- Disturbance and displacement of large terrestrial birds (notably Northern Black Korhaan and possibly Ludwig's Bustard) from nesting or foraging areas by operation of the facility and/or mortality of these species in collisions with new power lines.
- Disturbance and displacement of resident/migrant raptor species (notably Lesser Kestrel) from foraging/breeding areas by operation of the facility, and/or mortality of these species in collisions with new power lines, or electrocution when perched on powerlines

The extent of the potential impacts on avifauna would be regional if Martial Eagles, Verreaux's Eagles, Jackal Buzzards or Booted Eagles are killed or displaced, or local should only other priority species be affected, such as Ludwig's Bustard and Blue Crane. The duration would be long-term as the ecology of the area would remain affected for as long as the proposed facilities are operational. Some priority species may be displaced for the duration of the project. Based on the above, the potential impact on birds is considered to be of medium-high magnitude for both the north and south sites, local extent and long term and therefore of **medium - high (-)** significance, without mitigation for the north site and south site, respectively.

The significance of this impact, with mitigation, is considered to be **medium (-)**, for both sites.

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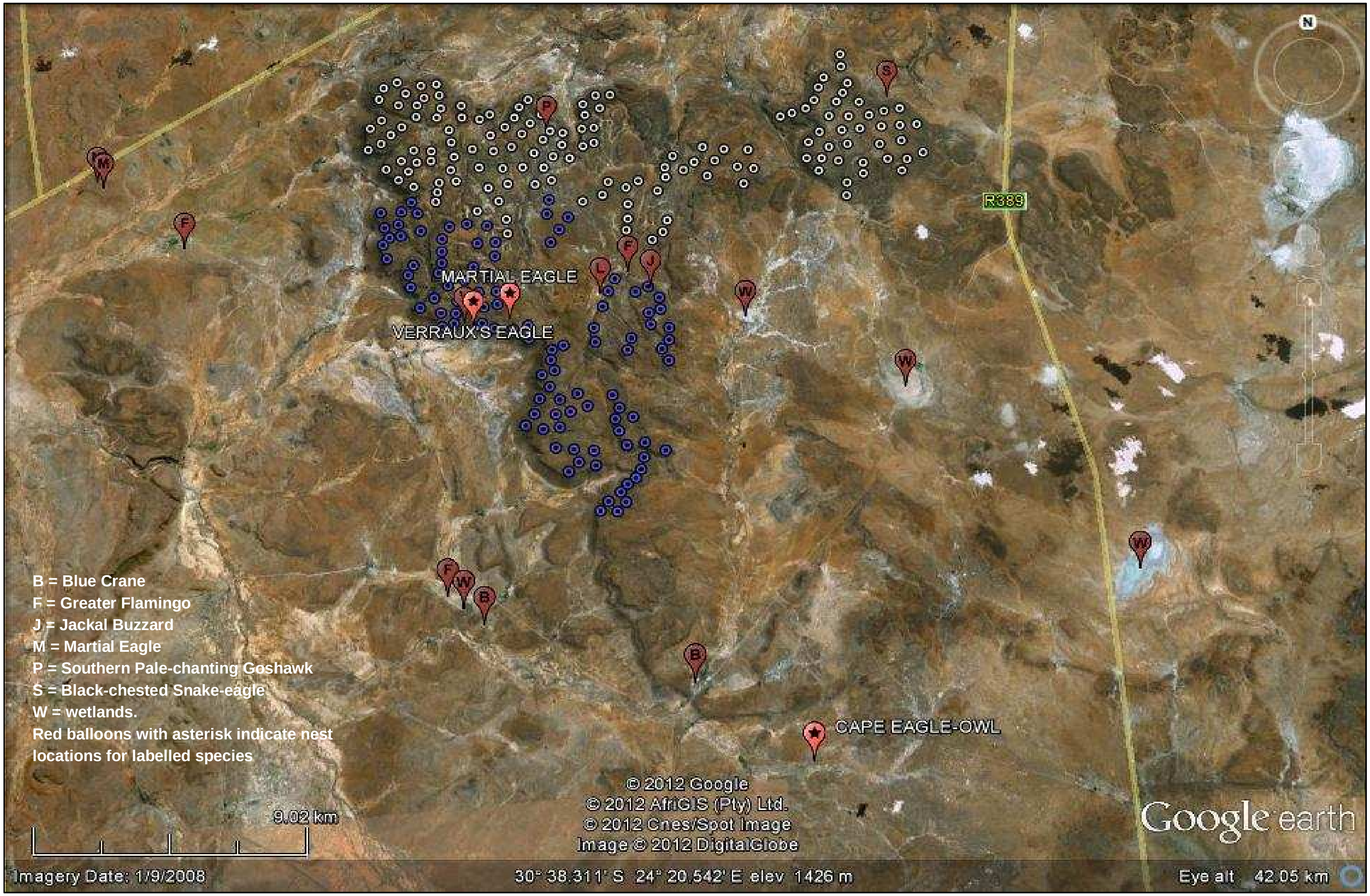

Figure 4-2: Locations of important bird species at the proposed eastern plateau north and south wind energy facilities sites (Source: D. Harebottle 2012)

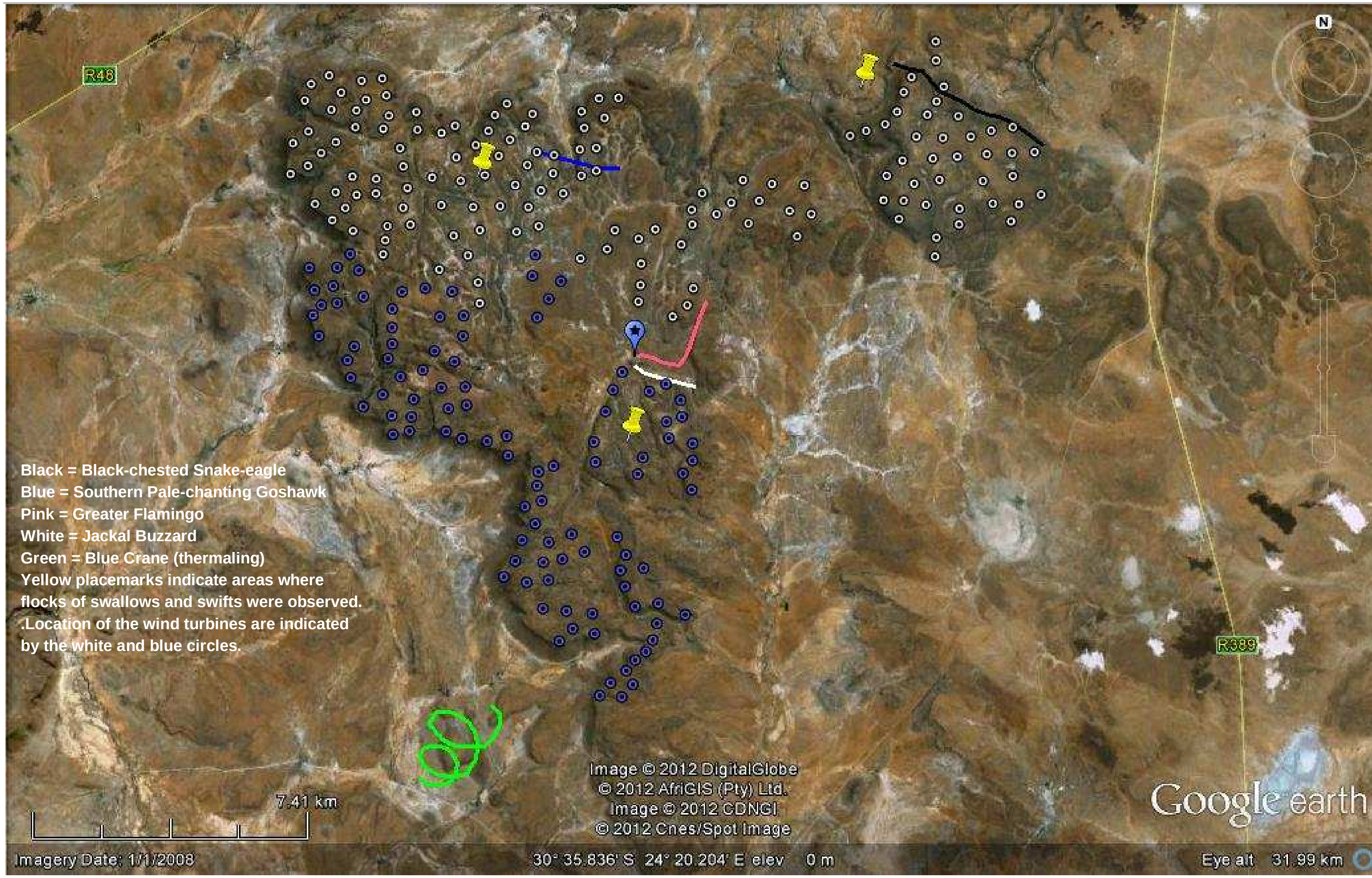

Figure 4-3: Observed flight paths of five priority bird species at the proposed eastern plateau north and south wind energy facilities sites as observed during a field survey from 17-20 December 2011 (Source: D. Harebottle 2012).

c) Mitigation measures

The following mitigation measures are recommended:

- Carefully monitor the local avifauna pre- and post-construction and implement appropriate additional mitigation as and when significant changes are recorded in the number, distribution or breeding behaviour of any of the priority species listed in the Avifaunal Impact Assessment, or when collision or electrocution mortalities are recorded for any of the priority species listed in the assessment; and
- Minimize the disturbance associated with maintenance activities by scheduling maintenance activities to avoid and/or reduce disturbance in sensitive areas at sensitive times (identified during the monitoring programme);
- Restricting the construction footprint to a bare minimum;
- Demarcation of 'no-go' areas identified during the pre-construction monitoring phase to minimise disturbance impacts associated with the construction of the facility;
- Reducing and maintaining noise disturbance to a minimum particularly with regards to blasting on the ridge-top associated with excavations for foundations. Blasting should not take place during the breeding seasons of the resident avifaunal community and in particular for priority species (June-September). Blasting should be kept to a minimum and, where possible, synchronized with neighbouring blasts;

d) Cumulative impacts

The nearest wind energy development to the eastern plateau development is the approved (but not constructed) 100 MW Mulilo wind energy facility located about 100 km north of De Aar on the Maanhaarberg mountain range. There are at least six proposed solar energy facilities planned for the De Aar surrounds (Aurecon, 2011). These projects, when viewed in isolation, may pose a limited threat to the avifauna of the area. However, in combination with a number of renewable energy facilities in the region, significant barriers to birds either in the form of displacement from foraging areas or reducing energy-efficient travel between resource areas may result. Cumulative impacts from the approved Maanhaarberg wind energy facility may be negligible based on distance from the Eastern Plateau site but migrant raptors, swallows and swifts and long-distance flyers such as ducks, might be at risk from collisions should their flight paths traverse the locations of the wind energy facilities. It is not possible to assess these cumulative impacts in a project specific EIA, not least because not all the proposed projects may be approved or constructed. As such it would be necessary for DEA, or a similar body, to undertake a strategic assessment in this regard.

4.2.3 Impact on bats

Urban development and agricultural practices have contributed to a decline in bat numbers globally, as well as in South Africa. Bats can consume large numbers of insects nightly and are therefore the only major predators of nocturnal flying insects in South Africa and contribute greatly in the control of their numbers. Their prey also includes agricultural insect pests, such as moths and vectors for diseases. Wind energy facilities are known to impact on bats and as such the proposed project could have an impact on any bats found on site. A study of bats was undertaken by Mr Werner Marais of Animalia Zoological & Ecological Consultation cc. The study area was visited from the 12 - 16 December 2011. Bat activity was observed at dusk and at night. Bat echolocation calls were recorded on a continuous basis, during night and day time, while traversing the study area with a vehicle. The bat study is included in **Annexure F**. The findings and recommendations of the bat study are summarised below.

a) Description of the environment

The bat detector device is capable of recording ultrasonic bat calls not always audible to the human ear for computer analysis afterwards. Although advanced technology, it is not necessarily possible to identify bat species by their echolocation calls. Bat activity was detected primarily at the rocky outcrop parts of the sites, while open and windier areas did not have significant bat activity. A number of species were identified and their occurrence confirmed in the study area, including Geoffroy's horseshoe bat (*Rhinolophus clivosus*), Egyptian free-tailed bat (*Tadarida aegyptiaca*), Natal long-fingered bat (*Miniopterus natalensis*) and the Long-tailed and Cape serotine (*Eptesicus hottentotus* and *Neoromicia capensis*).

Geoffroy's horseshoe bat roosts gregariously in caves, but may also utilise any other cavities. The Egyptian free-tailed bat is a very common bat and can typically be found roosting in crevices and buildings. Both species have a conservation status of "Least Concern". The Natal long-fingered bat is a Near Threatened species, which roost gregariously in caves, but there are no known caves close to the study site. The Long-tailed serotine, considered to be least concern is a crevice dweller and prefers rock crevices in rocky outcrops or buildings. Another very common species, the Cape serotine, is a red-listed species considered to be Least Concern, and can also be found in crevices and the roofs of buildings. Temmink's myotis (*Myotis tricolor*), also considered to be Least Concern, may possibly be confirmed to be present in the study area. The cliffs and rocky outcrops on site offer a multitude of crevice roosting space for bats and are therefore regarded as areas of high bat sensitivity. Water bodies, small seasonal streams and drainage gulleys on site offer valuable foraging terrain for bats in the area and are also considered to be sensitive.

b) Impact assessment

Many bat species roost in large aggregations and concentrate in small areas. Furthermore, the reproductive rates of bats are also much lower than those of most other small mammals- usually only 1-2 pups per female annually. Therefore any major disturbance to a small area within which a bat population resides would impact on the whole population and the recovery of the population would be very slow.

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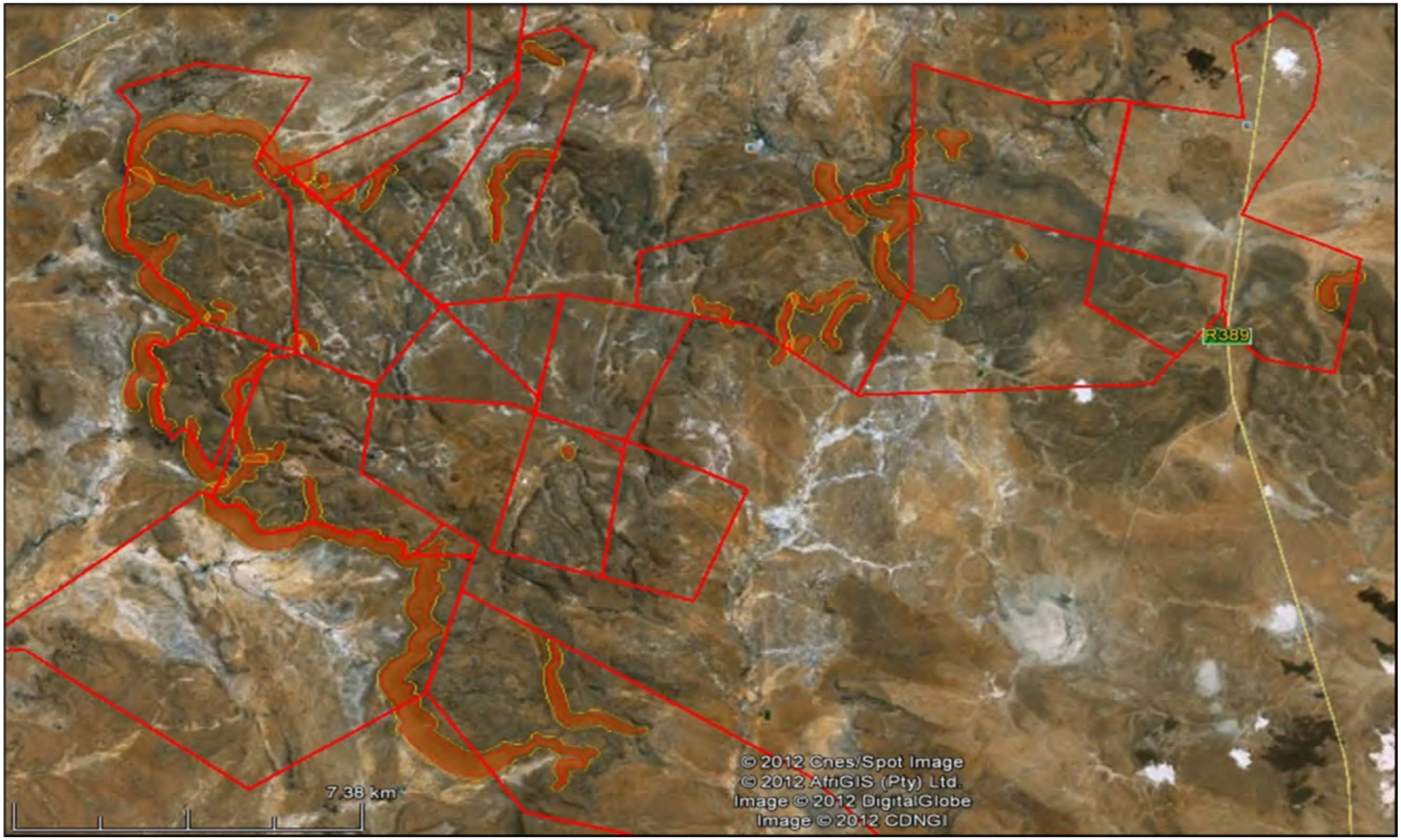

Site boundary **High sensitivity** **100m buffer zone**

Figure 4-4: Bat sensitivity map, indicating the cliffs and rocky outcrops with a high sensitivity and therefore a 100 m buffer. (Source: Animalia 2012)

Since bats have highly sophisticated navigation by echolocation, it is not understood why they are hit by rotating turbine blades. A number of theories exist, one theorizing that under natural circumstances bats' echolocation is designed to track down and pursue smaller insect prey or avoid stationary objects, not focus on unnatural objects moving sideways across the flight path. Another is that bats may be attracted to the large turbine structure as roosting space or that swarms of insects get trapped in low air pockets around turbines and subsequently attracts bats. Whatever the reasons, it has been found internationally that wind turbines can have a negative impact on bats either through physical injury or through barotrauma, the leading cause of bat mortality. This is a condition where the lungs of a bat collapse in the low air pressure around the moving blades, causing severe and fatal internal haemorrhage.

These potential impacts are particularly relevant to migrating bats. The migration paths of South African bats in the Northern Cape Province are not well studied and are virtually unknown. Cave dwelling species undertake annual migrations between caves. However, no caves are known to be in close proximity to the study area, and it is not located within any known direct line of path between major caves. As such the threat to migrating bats is considered to be low.

Considering the number of species bats confirmed on site, as well as the potential impacts described above, the potential impact of the proposed project on bats during operational phase is considered to be of a high magnitude, regional extent and long term, and thus of a **medium (-)** significance without mitigation, at both sites. With the implementation of mitigation measures, the significance would reduce too **low to medium (-)** at both sites.

c) Mitigation measures

The following mitigation measures are recommended:

- No turbines may be placed in the area indicated as having a High Bat Sensitivity (**Figure 4-4**). A 100 meter buffer should apply to cliffs and rocky outcrops and water bodies designated as areas of high sensitivity;
- Where required by long-term bat monitoring, curtail selected turbines to a preliminary cut-in speed of 5 - 5.5 m/s, or as recommended by the monitoring, as a mitigation measure to lessen bat mortalities. Curtailment is where the turbine cut-in speed is raised to a higher wind speed based on the principle that bats will be less active in strong winds due to the fact that their insect food cannot fly in strong wind speeds, and the small insectivorous bat species need to use more energy to fly in strong winds. Curtailment should be informed by long term bat monitoring which will indicate at which turbines, seasons, time of night and in which weather curtailment is required.
- Consider implementing an ultrasonic deterrent device so as to repel bats from wind turbines if any turbines are placed in moderate sensitivity areas. Should this measure prove effective it may be implemented in place of curtailment, should this be agreed to by a bat specialist, based on long term monitoring; and

- Undertake affordable long term monitoring of bats and the potential impacts of turbines on them to effectively fine tune mitigation. This should include 12 month long term monitoring (preferably prior to construction) where bat detectors are deployed on the site and passively recording bat activity every night. Additionally the site should be visited by a bat specialist quarterly to assess and compare the bat activity on a seasonal basis. The wind speed data gathered by meteorological masts can then be correlated with bat activity to determine the most feasible cut-in speed and fine tune other mitigation measures. Monitoring should also take place for 12 months during operation to evaluate the effectiveness of mitigation measures such as curtailment or ultrasonic deterrent devices; and
- Research from long term monitoring should be shared with academic institutions to aid in research of the potential impacts of wind energy facilities on bats.

d) Cumulative impacts

Bat populations are slow to recover to equilibrium numbers once major mortalities take place due to low reproductive rates. If any mortalities due to blade collisions are allowed to continue without mitigation for a long period of time across the two proposed wind energy facilities as well as the third wind energy facility proposed in the Maanhaarberg mountain range 100 km north of De Aar, the mortality rate is highly likely to exceed the reproductive rates of local bat populations, causing a cumulative impact of high (-) significance.

Migrating bats have been recorded to migrate several hundred kilometres in South Africa, such that the cumulative impact of several wind farms along migration routes operating without mitigation would be catastrophic to the population sizes of these migrating bats. It would be beneficial to collaborate with academic institutions to research any bat migration routes in relation to location of the sites and determine the season of the year migration take place.

4.2.4 Impact on climate change

The establishment of a wind energy facility would reduce South Africa's future reliance on energy from coal-fired power stations which could in turn reduce the future volume of greenhouse gases emitted to the atmosphere, reducing the greenhouse effect on a regional, national and international scale.

a) Description of the environment

Gases which contribute to the greenhouse effect are known to include carbon dioxide (CO_2), methane (CH_4), water vapour, nitrous oxide, chloroflurocarbons (CFCs), halons and peroxyacylnitrate (PAN). All of these gases are transparent to shortwave radiation reaching the earth's surface, but trap long-wave radiation leaving the earth's surface, acting like a greenhouse. This action leads to a warming of the earth's lower atmosphere, with changes in the global and regional climates, rising sea levels and extended desertification. This is turn is expected to have severe ecological consequences and a suite of implications for humans. Total greenhouse gas emissions reported to be emitted within South Africa for the 2008 year was approximately 435 million metric tons of CO_2 equivalent (UN Statistical division, 2011).

b) Impact assessment

Greenhouse gases released from a new coal-fired power station are primarily CO_2 with minor amounts of nitrous oxide (N_2O). The Medupi Power Station (4 788 MW), currently under construction near Lephalale in Limpopo, is expected to produce 29.9 million metric tons of CO_2 per annum. The emissions from Medupi Power Station would increase South Africa's CO_2 equivalent emissions (2008) by some 7 %. This is a significant increase in greenhouse gas emissions, given the aims of the Kyoto Protocol, which are to reduce overall emission levels of the six major greenhouse gases to 5 % below the 1990 levels, between 2008 and 2012 in developed countries. While South Africa, as a developing country, is not obliged to make such reductions, the increase in greenhouse gas emissions must be viewed in light of global trends to reduce these emissions significantly.

No greenhouse gases are produced by wind energy facilities during operation, as wind drives the turbines that generate the electricity. Although wind energy facilities would not completely replace coal-fired power stations within South Africa, since these would still be required to provide base-load, they would reduce South Africa's reliance on them. This would assist in reducing future volumes of greenhouse gas emissions.

A life-cycle analysis looks at the entire chain of activities needed for electricity production and distribution, such as fuel extraction and transport, processing and transformation, construction and installation of the plant and equipment, waste disposal, as well as the eventual decommissioning. Every energy technology (wind, hydro, coal, gas, etc) has its own very distinct fuel cycle. A comparative life-cycle analysis for the current energy technologies used in Europe was conducted by AUMA (2000). The study focused mainly on emissions from the various energy technologies. Although the results of the analysis are not necessarily entirely accurate in the South African context, they offer a good proxy for a comparative assessment of coal-fired and wind energy facilities in South Africa. The results of the analysis are illustrated graphically in **Figure 4-5** below.

It is evident from **Figure 4-5** above that small to almost negligible environmental impacts are associated with renewables, particularly wind, relative to fossil fuels such as coal, over the entire life-cycle.

While the proposed wind energy facility would not provide an equivalent amount of energy as a typical new coal-fired power station (140 MW compared to 4 788 MW), when considered with regards to climate change and given the spirit of the Kyoto Protocol, the impact is deemed to be of regional extent, very low magnitude and long term and therefore of ***low (+)*** significance, without mitigation.

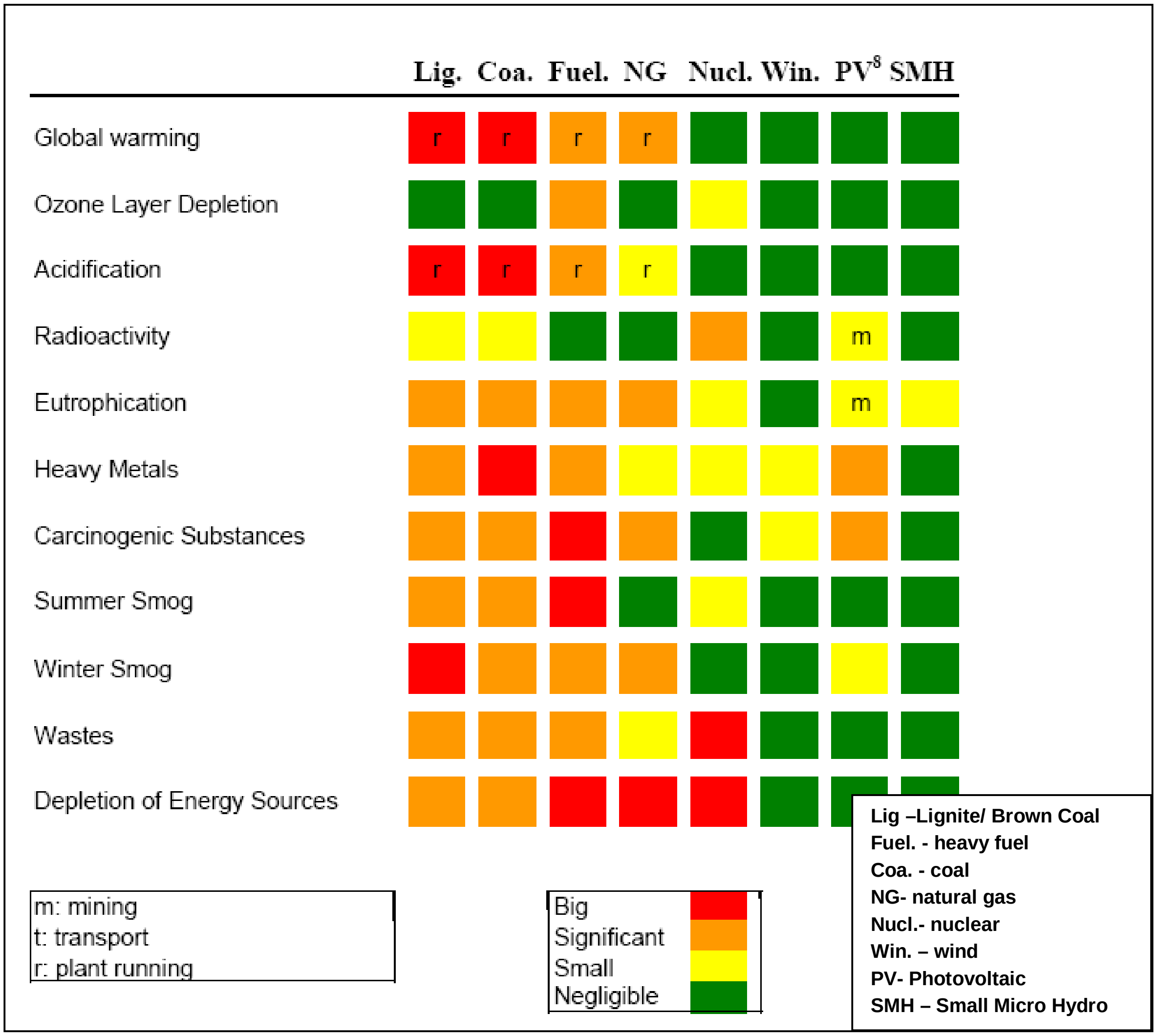

Figure 4-5: Matrix of environmental impacts by categories (AUMA, 2000)

c) Mitigation measures

No mitigation measures are recommended.

d) Cumulative impacts

As shown in **Figure 4-5**, five other renewable energy projects are proposed for the area, with a combined capacity of 900-950 MW. Furthermore, many more wind energy facilities are proposed throughout South Africa. Given the number of wind energy facilities proposed across the country, the potential reduction in future greenhouse gas emissions is considered to be of regional extent, low magnitude and long term, and therefore of *medium (+)* significance.

Chapter 4

4.2.5 Impact on freshwater

A number of wetland and seeps, as well as numerous drainage lines, are found in the vicinity of the sites. The potential exists for the proposed wind energy facilities to impact on the natural vegetation adjacent to and within the freshwater features, modify water quality, cause erosion and/or invasive plant growth. As such a freshwater study was undertaken Mrs Antonia Belcher. A desktop review was undertaken as well as a more detailed assessment of the freshwater features at the sites. Furthermore, aquatic ecosystem health assessments were carried out. A site visit was conducted on 24 and 25 January 2012. in order to inform the Freshwater Impact Assessment. During this study, the characterisation, mapping and integrity assessments of the freshwater features were undertaken. The Freshwater Impact Assessment is included in **Annexure J.** The findings and recommendations of the study are summarised below.

a) Description of the environment

The main aquatic features within the study area are the Brak and Hondeblaf Rivers which are seasonal tributaries within the Orange River System. The Brak River (see Figure 4.5) flows in a north westerly direction along the southern boundary of the study area with a number of its tributaries crossing the site as they flow in a southerly direction. Most of the smaller tributaries within the study area are ephemeral with no clear associated vegetation and slightly clayey soils.

Small, shallow in stream dams have been constructed within many of the drainage channels on site. Associated with these dams are small wetland areas with a significant series of pans within the study area located at Slingershoek, (**Figure 4.6**).

Geology and soil
The geology of the study area can be described as being underlain by flat-lying sedimentary rocks of the Karoo Supergroup, which have been intruded by innumerable sills and dykes of dolerite. The overlying soils of the plateau are primarily red soils of a restricted soil depth, excessive drainage, high erodibility and low fertility. The higher lying areas of the plateau are shallow rock. These areas are water recharge areas. Both the Brak and Hondeblaf Rivers have predominantly sandy/silty substrate with outcrops of bedrock. The rivers drain shrubland vegetation in an area with a very low rainfall. As a result, the water flowing in these rivers is saline, turbid and seasonal.

Vegetation
Portions of the proposed sites are in a disturbed condition, mostly as a result of livestock grazing. There is however little presence of invasive alien plants. Along the Brak and Hondeblaf Rivers much of the associated vegetation occurs instream (dominated by the common reed *Phragmites australis* with some sedge).

Figure 4-6: Water features in the study area (Source: A. Belcher 2012).

There is very little discernible riparian vegetation. The instream habitat of the Brak River is still largely natural to moderately modified while the riparian habitat is more impacted (moderately to largely modified) as a result of surrounding farming activities. Both the riparian and instream habitat integrity of the Hondeblaf River are considered to be in a moderately modified state. The ephemeral streams (tributaries of these two rivers) have no visible aquatic vegetation and are largely natural to moderately modified, with the modification of the habitat occurring as a result of the surrounding farming activities (livestock grazing).

Freshwater Biodiversity and Conservation
The Brak River system is deemed to have a moderate[23] to low[24] Ecological Importance and Sensitivity, while the Hondeblaf River provides refuge for juvenile Vaal-Orange Largemouth Yellowfish in the lower reaches of the river and as such has a high[25] Ecological Importance and Sensitivity. According to the Freshwater Ecosystem Protected Areas (FEPA) map for the study area, a portion of the Brak River system has been identified as having conservation importance. FEPAs are strategic spatial priorities for conserving freshwater ecosystems and associated biodiversity. The series of pans, located at Slingershoek, have also been identified as a FEPA wetland.

The wetlands on site are considered to be depression wetlands or pans with small contributions of surface water runoff and possibly a minor contribution of groundwater. The pans are still in a largely natural condition with the only impacts being from upstream rural and agricultural activities (flow and water modification as well as the impact of livestock grazing). The key services, which should be maintained, provided by the pans relate to flow regulation/flood attenuation and sediment trapping (see **Figure 4-7**).

b) Impact assessment

The potential impacts on the freshwater systems on the sites include increased runoff, erosion (in particular on surfaces with a steeper gradient) and sedimentation of downslope areas due to hard surfaces created during development.

None of the locations proposed for the wind turbines would be within an identified drainage line/stream or wetland/pan as they are placed on higher areas. Some of the proposed wind turbines are however near to pans. Overhead transmission lines would cross drainage lines

[23] Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are not usually very sensitive to flow modifications and often have substantial capacity for use.
[24] Quaternaries/delineations that are not unique on any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have substantial capacity for use.
[25] Quaternaries/delineations that are considered to be unique on a national scale based on their biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases may have substantial capacity for use.

in a number of places. The proposed access routes (some of which are existing roads only requiring widening and upgrade) would also cross a number of the identified freshwater features and go past a number of pans.

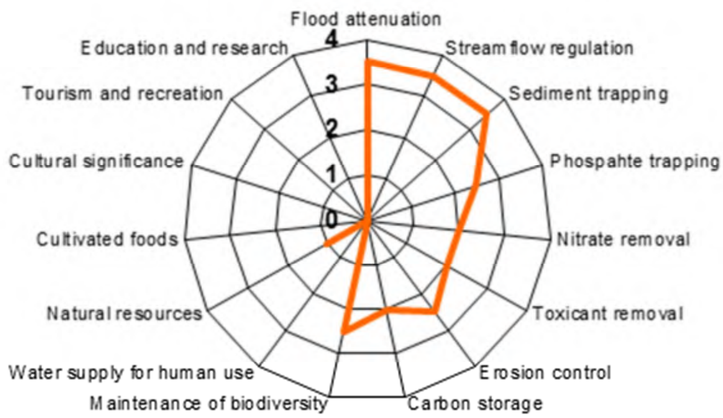

Figure 4-7: Ecosystem services provided by the wetland/pan areas

Based on the above, the potential impact on freshwater is considered to be of local extent, low magnitude and long term, and therefore of **low (-)** significance, without mitigation for both projects. With the implementation of mitigation measures the significance would reduce to **very low (-)** significance for both sites.

c) Mitigation measures

The following mitigation measures are recommended:

- Operational activities should as far as possible be limited to the delineated site for the proposed development and the identified access routes. Invasive alien plant growth should be monitored on an ongoing basis to ensure that these disturbed areas do not become infested with invasive alien plants.
- Storm water run-off infrastructure must be maintained to mitigate both the flow and water quality impacts of any storm water leaving the wind energy facilities site. Should any erosion features develop, they should be stabilised as soon as possible.
- Where transmission lines need to be constructed over/through the drainage channel, disturbance of the channel should be limited. All crossings over drainage channels or stream beds after the construction phase should be rehabilitated such that the flow within the drainage channel is not impeded.

d) Cumulative impacts

Erosion and sedimentation from the project activities, together with invasive alien plant growth and the possible modification of surface water runoff and water quality may lead to additional impacts on the freshwater habitats within the study area. These impacts can however be monitored and easily mitigated.

4.3 OPERATIONAL PHASE IMPACTS ON SOCIO-ECONOMIC ENVIRONMENT

4.3.1 Impact on heritage resources

Heritage resources include archaeological material (e.g. rock paintings, stone tools), palaeontological material (e.g. fossilised materials) and cultural heritage material (e.g. old graveyards, fences or ruins of buildings). Since some potential heritage material is buried, it is often only found during the construction phase of a project.

Due to the relatively undisturbed nature of the site, and the findings from an inception site visit, it was likely that archaeological or cultural material would be found on site. A large scale development such as the proposed project could have a negative impact on the archaeological and cultural heritage resources (including visual, landscape and sense of place impacts) by damaging or destroying such material or by requiring the material to be removed and stored *in situ*. As such a Heritage Impact Assessment (HIA) was conducted by Lita Webley and Jayson Orton of the Archaeology Contracts Office (ACO) to assess the impacts of the proposed project. Information for the study was sourced from published and unpublished archaeological reports, and a site visit was undertaken in November 2011.

a) Description of the environment

"Archaeology" pertains to the remains resulting from human activity in disuse and older than 100 years such as artefacts, human and hominid remains, artificial features and structures. "History" refers more to the activities of 19^{th} century seasonal Trekboers, their shepherds and farmers from the colonial era.

During the site visit extensive pre-colonial and colonial scatters of material were found, which include Middle and Late Stone Age (MSA and LSA) archaeological material, historic period ruins and stone kraal complexes and scatters of historic material. The historic building environment comprises a number of late 19^{th} century and early 20^{th} century farm houses and sheds.

Pre-colonial archaeology

No Early Stone Age (ESA) material was identified on either the north or south sites. MSA material was found scattered throughout the North and South sites and represents the dominant Stone Age archaeological material found. Artefacts include cores, flakes, and blades and snapped blades of which some show signs of damage from utilisation.

Archaeological site boundaries were not clearly defined as material was generally widely spread over the project area, referred to as "ancient litter" of material in archaeological terms. No MSA sites with fossil bone or other organic material were identified. A few dense scatters were identified on the South site, most significantly a “factory” site (where tools are made) on Knapdaar where both MSA and LSA material were found on site (see **Figure 4-8** and **Figure 4-9**). Later Stone Age (LSA) findings were relatively uncommon on the plateau top and only a few discreet sites were recorded.

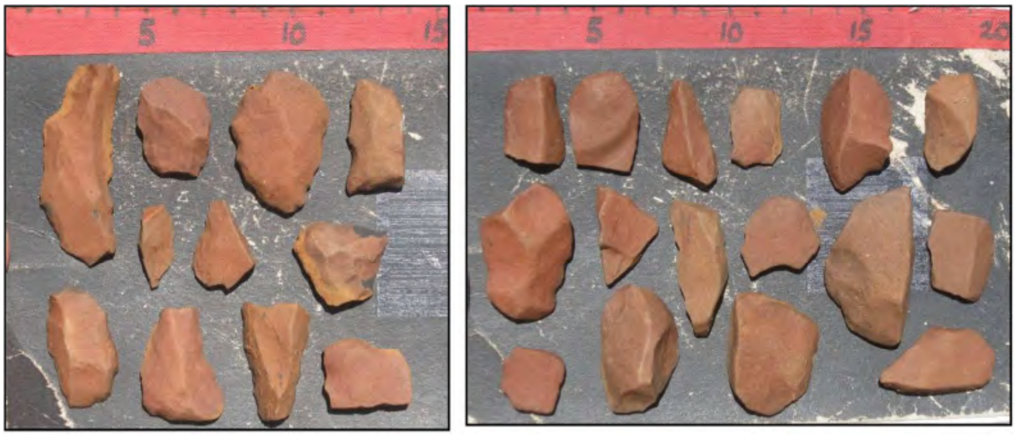

Figure 4-8: Typical weathered and patinated MSA stone artefacts found widely distributed in the area

Engravings

On the North site engravings on dolerite boulders were recorded on the farm Zwagershoek and consist of an engraving of an ostrich and unknown animal. Engravings in the form of 19th century historic graffiti by Boer soldiers were recorded on the South site on the farm Slingershoek, located on a little koppie behind the main farmhouse.

Historical Archaeology

A large number of stone kraal complexes were documented during the survey and were found on both the North and South sites on farms Enkeldebult, Pienaarskloof, Matjiesfontein, Meyersfontein, Vendussie Kuil and Knapdaar. The majority of kraals were rectangular or square suggesting they date back to the historical period, possibly seasonal outposts of the 19th century Trekboers and/or their shepherds.

A few circular or oblong kraals were recorded at Enkeldebult (North site) and Knapdaar (South site) and they may date to the pre-colonial period, although little substantive evidence (in the form of associated artefacts) were found (see **Figure 4-9** and Figure 4-10).

Cemeteries and Graves

A number of graves were recorded on the farm Zwagershoek, on the North site. The landowners were questioned about possible graves in the study area, but apart from Zwagershoek, none were reported and recorded

General Built Environment

On both sites old farm houses and buildings, potentially of greater than 60 years of age were found, which would then have protection under NHRA. Some of these buildings older than

60 years had medium heritage significance (see **Figure 4-9**). The majority of permanent farm dwellings are located below the plateau.

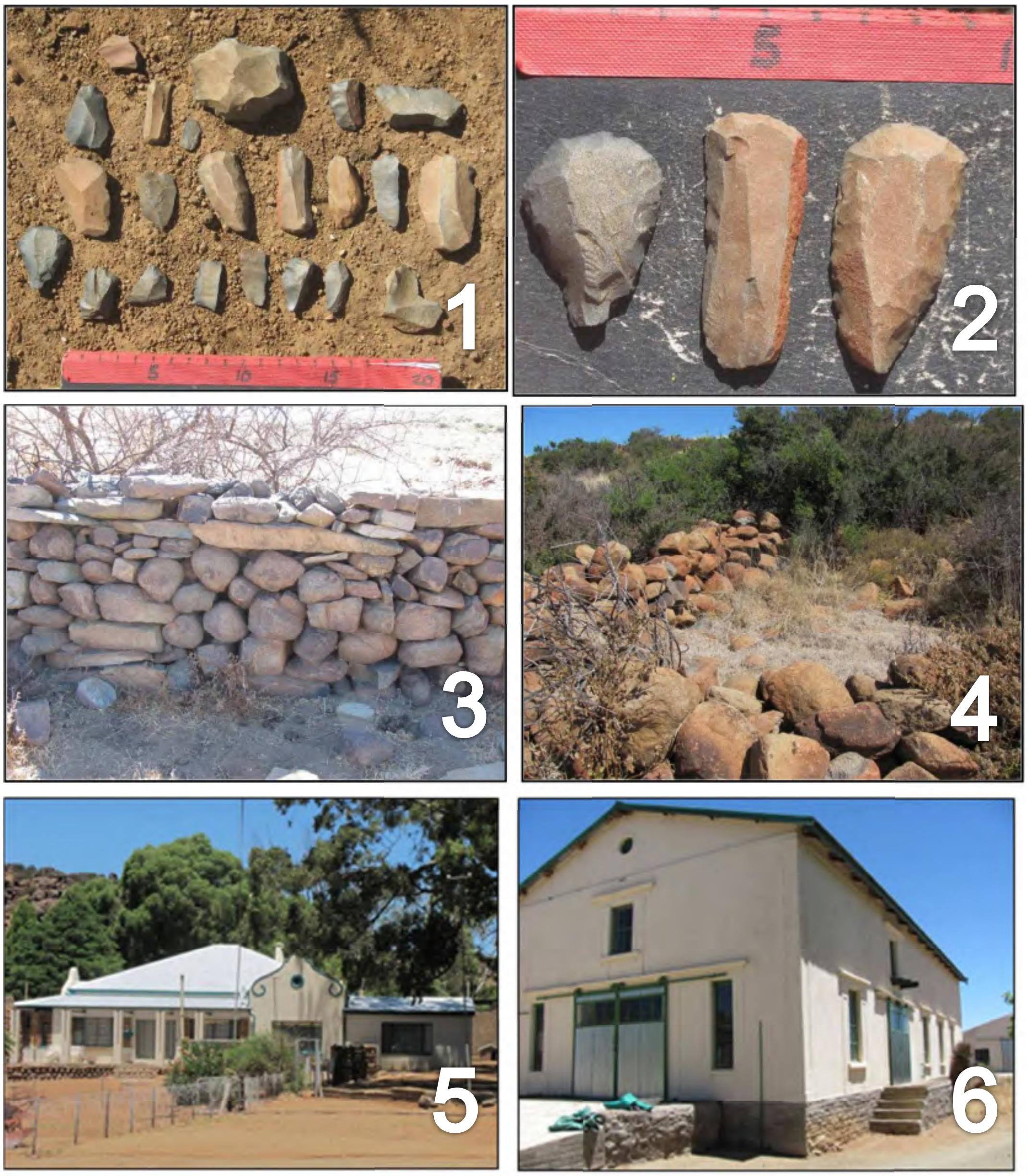

Figure 4-9:LSA artefacts from the site on Enkeldebult (1&2). Section of stone walling from Knapdaar and on Matjiesfontein (3&4). Cape Dutch homestead of Kranskop on Vendussie Kuil and a 1942 barn on Knapdaar (5&6).

Cultural landscape

The cultural landscape is typical Karoo landscape with vast open plains covered in low scrub and grasses, low ridges and small hills. Although maybe not desirable as a tourist destination, the landscape does have archaeological and historic significance because of the activities of prehistoric people and colonial Trekboers in the area. The potential impact on the cultural landscape is assessed within visual impacts in Section 4.3.2. Construction phase impacts on archaeology are assessed under Section 4.4.5

Figure 4-10: A stone feature on Enkeldebult.

4.3.2 Visual impacts

The overall landscape is defined as Karoo plain, with extensive grasslands, scrublands, and isolated uplands, with tree groups mostly associated with farmsteads, and long open views over the plains. The proposed location of the projects is on a plateau which rises about 200 – 250 m above the plain. Wind turbines and their associated infrastructure make a strong visual statement, because of their semi-industrial character and the potential to be visible from many kilometres away. As such, Mrs Karen Hansen, a private consultant, was appointed to undertake a Visual Impact Assessment (VIA) to determine potential visual impacts of the proposed projects. The receiving site was assessed, and also surrounding areas from where the site appeared to be likely to be visible on 17 and 18 November 2011. The VIA, and comments on the updated site layout, is contained in **Annexure I**. The VIA included a desktop survey of various maps and aerial photography. Terrain analysis software, Global Mapper, was also used to start the visual envelope definition process. Based on professional experience, as well as the experience of other specialists in visual impact a study area with a radius of 25 km was considered in the VIA. The findings and recommendations of the study are provided below.

a) Description of the environment

The character of the landscape is defined as open, flat, remote and sparsely populated lands, typical of the rural open plains of the Karoo. Emerging from the sedimentary rocks of the plain, are conical and ridge shaped hills and a larger flatter plateau that is comprised of intrusions of dolerite rock, and form the vertical relief. The hills are about 100 m above the plain, and the plateau about 200-250 m above the plain. Existing vertical elements in the landscape are the lines of transmission pylons leading to and from existing substations, and telegraph poles. These bring some industrial character into this rural area.

A landscape may be valued for many reasons, which may include landscape quality, scenic quality, tranquillity, wilderness value, or consensus about its importance either nationally or locally, and other conservation interests and cultural associations. The site landscape appears to have some value for its wilderness value; however the site does not have a strong or identifiable sense of place.

The 25 km viewsheds for the proposed projects include Phillipstown, the R48 De Aar-Philipstown Road, R48 Philipstown-Petrusville road, R389 Philipstown-Hanover road, Burgerville road between hydra and R389, R388 from the R48 to Hopetown, the local, gravel and farm roads within this area, and rail lines north to Kimberley and south east to Middelburg and a number of farmsteads and places of work. The viewshed envelope is therefore defined partly by views from existing settlements, transport corridors and by topography, and within extensive but under-populated areas.

b) Impact assessment

Turbines on the north site would be positioned mainly on the highest ground at a distances of between 450 m and 1 000 m apart and with elevations ranging from 1 480 m to 1 680 m above sea level (asl). Turbines on the south site would be situated at elevations from 1 440 m to 1 630 m above sea level (asl).

The degree to which the proposed project would be visible is determined by the height of the turbines and rotors. Visibility is moderated by the distance over which this would be seen, the weather and season conditions and some back-grounding effect from the environment. Factors affecting visibility are the open quality of the site and the surrounding land uses and land cover.

Visual exposure refers to the visibility of the site in terms of the capacity of the surrounding landscape to offer screening. This is determined by the topography, tree cover, built form, etc. In the case of both the proposed sites the visual exposure is high i.e. there is little screening offered by the landscape.

The Zones of Visual Influence or Theoretical Visibility (i.e. affected area) for the proposed project is considered to be high as the proposed projects would strongly influence the view and act as a visual focus over significantly large areas (see **Figure 4.11** and **4.12** for the zones of visual influence of a few turbines on the north and south site, for turbine alternative 2).

Parts of the northern edge of Philipstown would lie within the zone of visual influence of the North site, with the nearest turbine just over 9 km away. Shielding would be provided by buildings and trees in the town.

A number of inhabited farmsteads are located on the sites or adjacent to the boundaries of the sites. For some there are significant elevation differences and a few of the farmsteads are located within 3 km of the nearest turbine (see **Figure 4.15**). The magnitude of the impact is considered to be high for a total number of eight of these farmsteads. Almost all the farmsteads have surrounding tree planting for shelter and this would offer some screening.

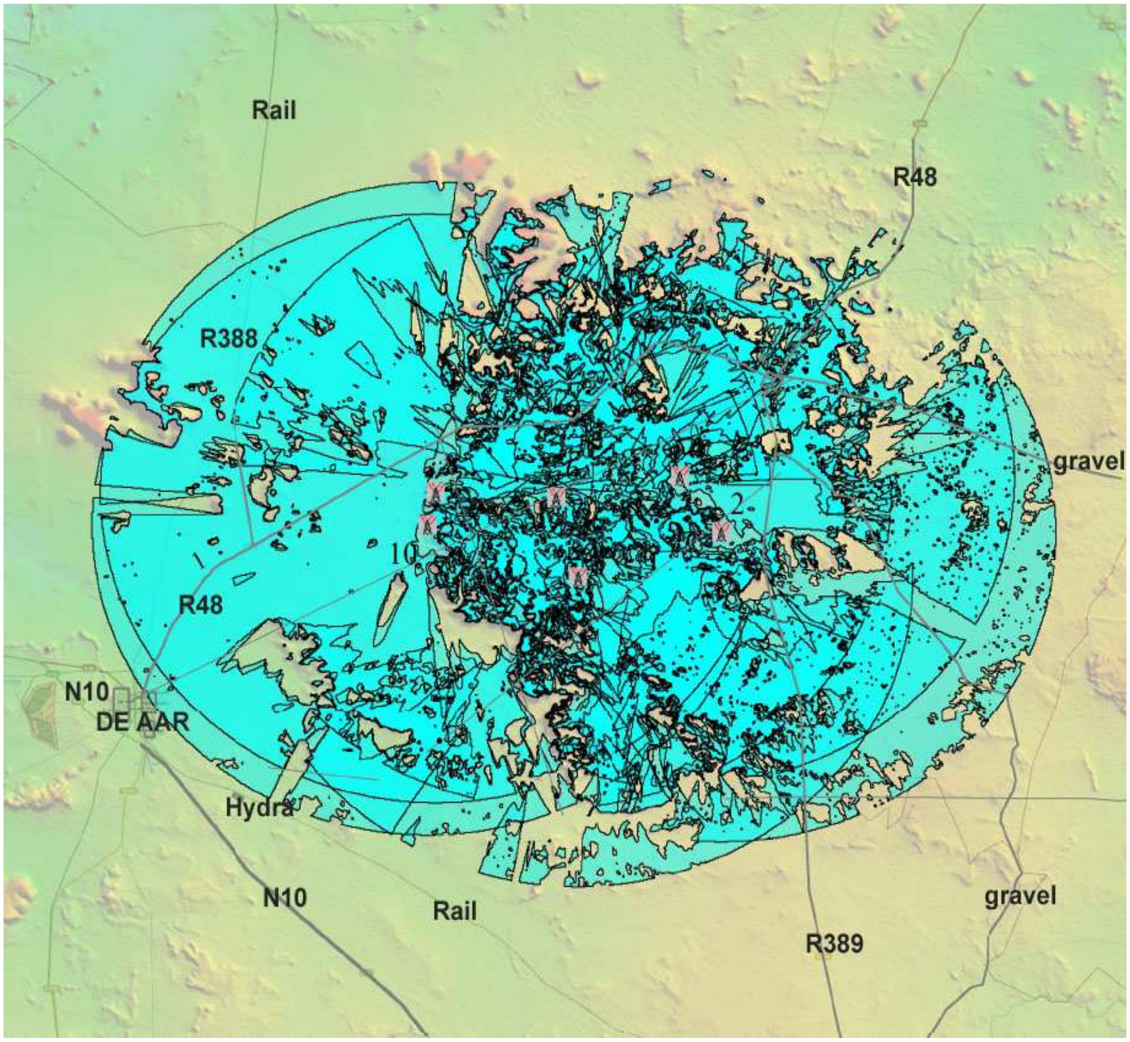

Figure 4-11: Visual envelope of turbines N23, N28, N29, N115, N141, N56 for the proposed North site for turbine alternative 2 (100 m mast, 60 m rotors). (Source: K. Hansen 2012)

The R48 De Aar-Philipstown Road carries a moderate amount of local farm and regional commercial traffic. The nearest turbines would be those on the west side of the north project and range from 3 – 6 km in distance, while the nearest turbine within the south site would be 8 km away.

The R48 Philipstown-Petrusville road also experiences moderate traffic volumes, however the visual impact is reduced by its distance to the closest turbine on the eastern side of the north site (9 km away).

The R389 Philipstown-Hanover Road is moderately used by local and regional traffic and the nearest turbines would be those on the east side of the north project and would be about 3.5 to 4 km away. For drivers travelling north of Philipstown the turbines would be visible for approximately 32 km. The closest turbine on the South site would be 12 km away and visible for approximately 14 – 17 km.

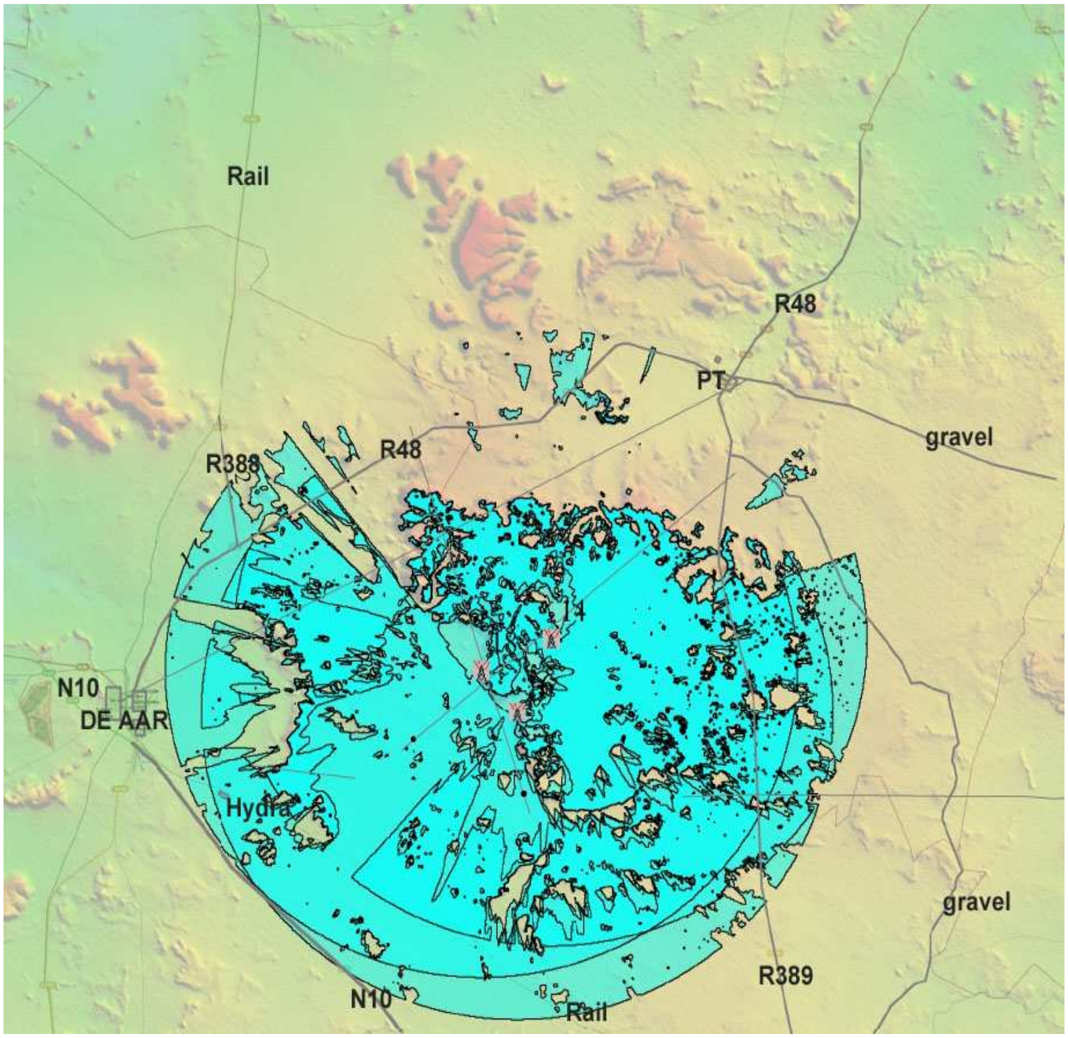

Figure 4-12: Visual envelope of turbines S83, S67, S33 on the east side of the proposed South site for turbine alternative 2 (100m mast, 60m rotors). (Source: K. Hansen 2012)

The Burgerville Road between Hydra and the R389 is a gravel road and serves a few local farms. The nearest turbines would be on the South site, about 5 km away. One of the substations may be located 2 km from the road. Road users would obtain glimpsed views of the western and eastern side of the north project, and short glimpses of the western side of the south project would be visible from the west section of the road closest to Hydra. Road users travelling in each direction and looking both ahead and to the side, would view the east side of the South site for most of the length of the road (31 km).

The R388 from the R48 to Hopetown is a well maintained gravel road which follows the rail line and carries local and commercial traffic and serves local farms in the area. Although both proposed projects would be visible to users of this road, the nearest turbines would be those of the North site, 12 km away.

A number of other local, gravel and farm roads runs within the project area and their landscape setting and the zone of visual influence would be low due to the few receptors in the area.

The zones of visual influence on the rail lines running north to Kimberley and south east to Middelburg would be low due to the shielding effect created by the distance. The Kimberley rail line mainly carries passengers and both the north and south projects are equally close at about 18 km. The rail line to Middelburg carries freight and would not be impacted on by the North site. The rail is approximately 20 km from the nearest turbine groups in the South site and would be visible.

Figure 4-13: View from the R48, 6.5 km north of the Hopetown Road, (R388), and looking at the North project turbines about 6 km away.

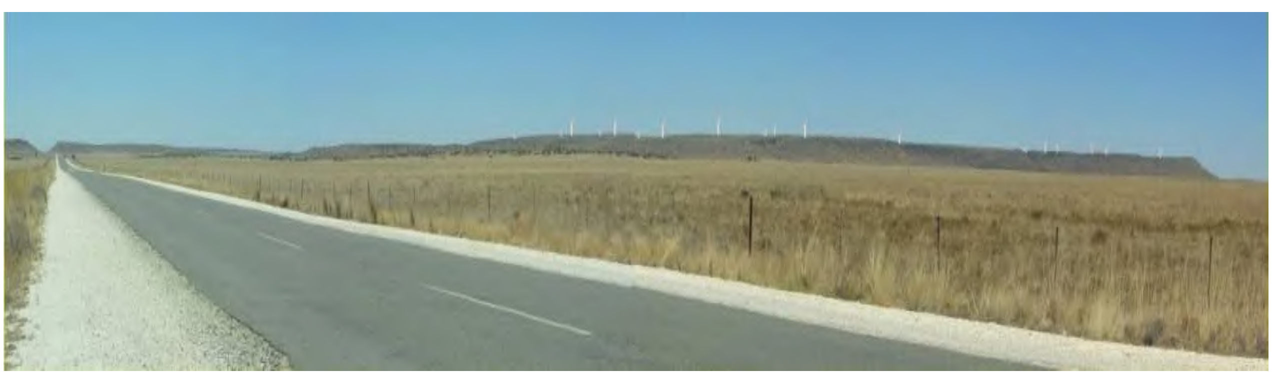

Figure 4-14: View from the R389 looking south and about 6 km south of Philipstown, looking at the North Project turbines which are about 4 km away and appear to be the same height as the hill

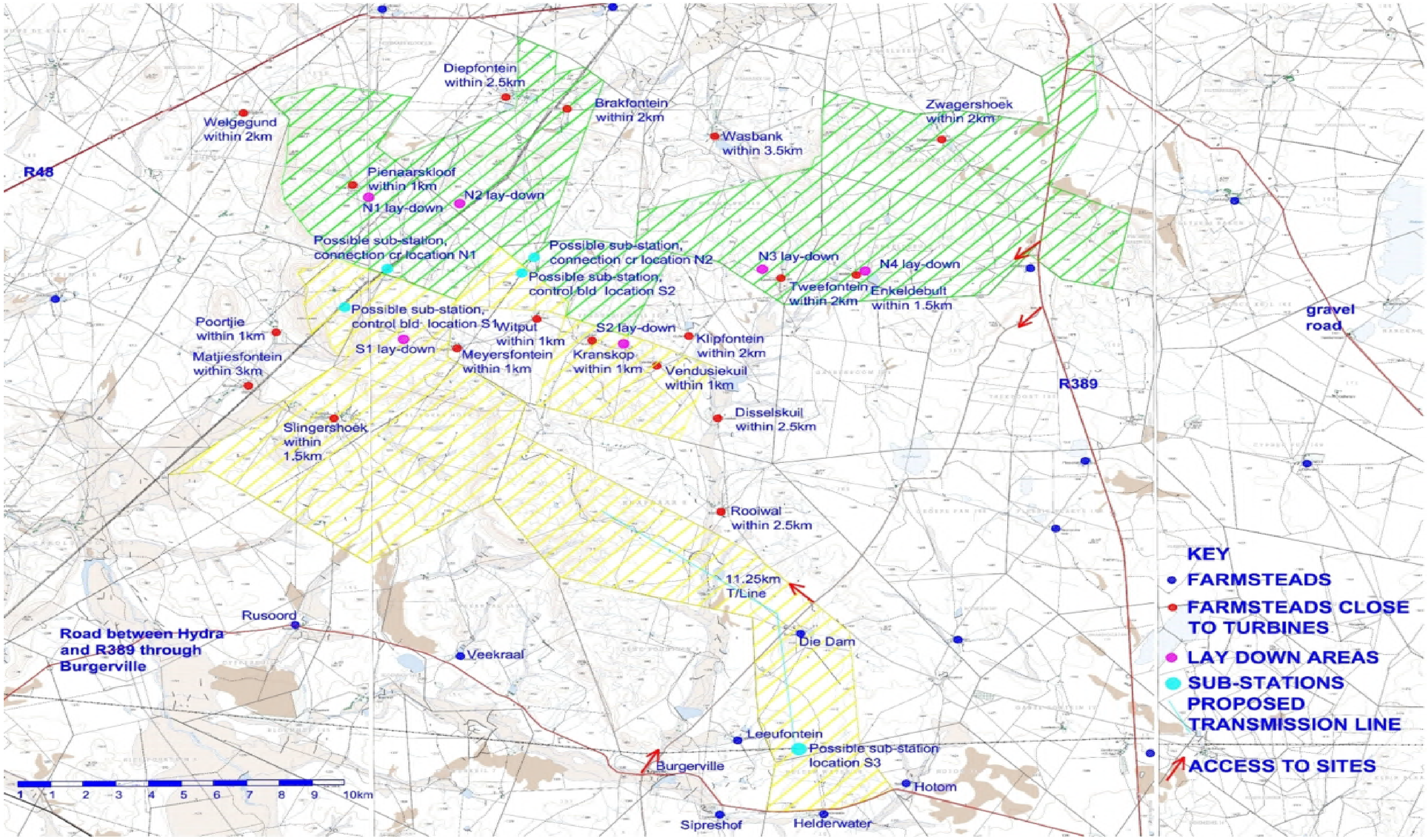

Figure 4-15 :Farmsteads on or near the sites. Farmsteads which would be within 3 km of a turbine location and deemed to be visually impacted upon by the proposed developments are shown in red. (Source: K. Hansen 2012)

Figure 4-16: View from 6 km west of the road junction at Burgerville on the gravel road between Hydra and the R389; the development would be 5 km away. This section of road presents a clear view of the South Project turbines but further to the west, the view is more broken up.

The visual influence is determined by the distance from which turbines would be visible, as well as the length of road and travelling time over which the turbines would be visible. The general zone of visual influence is assessed as moderate to low (see **Figure 4.17**).

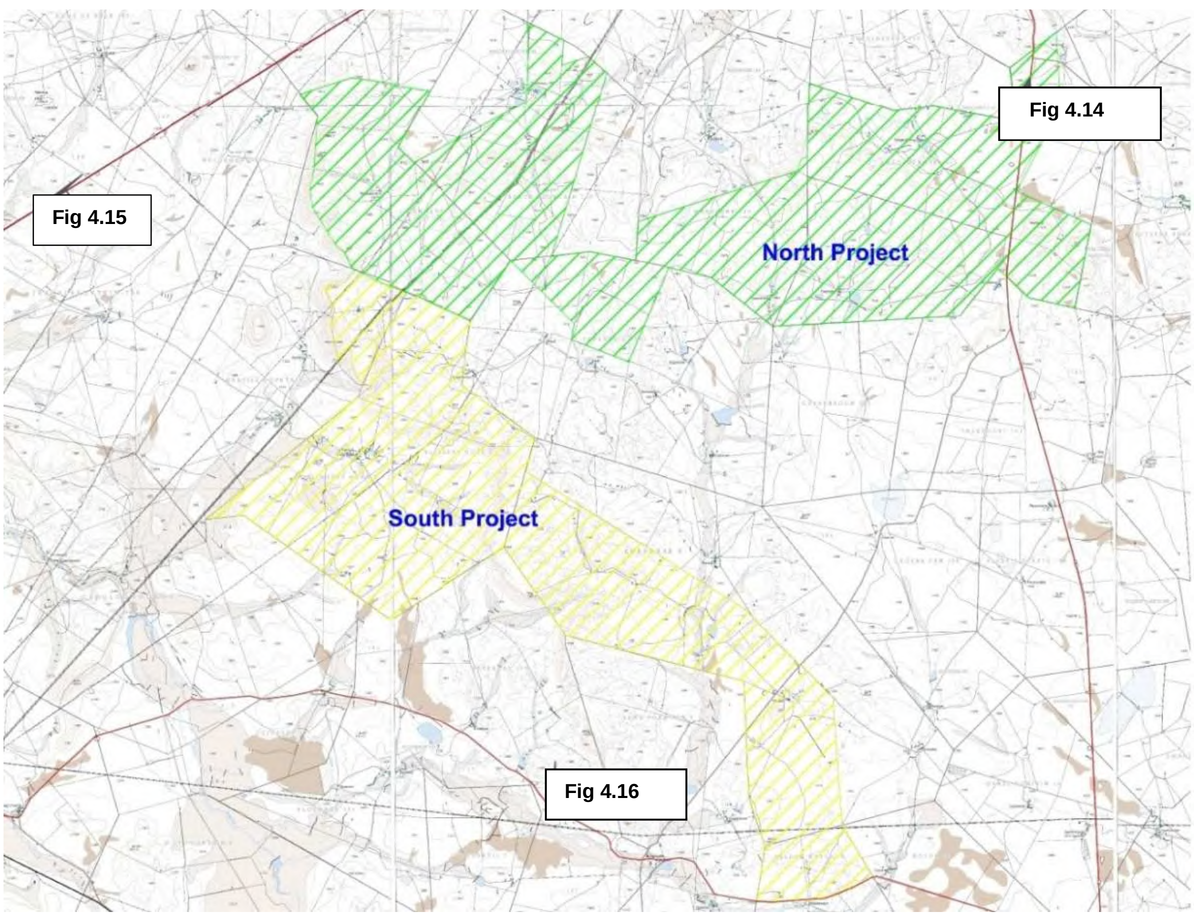

Figure 4-17: Locations of the illustrated view points. (Source: K. Hansen 2012)

The land has a rural character and the project structures would look somewhat out of place in an open upland landscape (see **Figure 4.14, 4.15 and 4.16**). There are few vertical elements in the local landscape, apart from electricity pylons. The proposed projects would change the use of rural, exposed and windswept hill lands to a semi-industrial use. The visual absorption capacity, the ability of the surrounding area to visually absorb the project, is considered to be medium. Based on these considerations, the overall potential visual impact is considered to be of high magnitude, regional extent and long term and therefore of **high (-)** significance, without or with mitigation for both sites. This potential impact remains the same for both technology alternatives as the 55 m height difference is not considered to be significant when the scale of the proposed projects are considered. Where it is at its most significant however is in proximity to farm dwellings where mast height and rotor length would be seen closely.

The potential visual impact is assessed in optimum weather conditions, when there is good visibility i.e. non – rain days from sunrise to sunset. The extent of the impact would be reduced in poor light, induced by time of day, (dusk and dawn) haze or dust in the air, and rain.

c) Mitigation measures

The following mitigation measures are recommended:

- Power lines should run underground where possible.
- The ratio between the height of the turbines and relative height of their sites should be about two thirds : one third (example 100m turbine on the summit of a 200m hill should be more acceptable).
- Paint nacelles and towers in matte white or off-white. Where it does not conflict with other specialist recommendations (e.g. avifauna) rotors should be painted in the same colour as the remainder of the turbine structure.
- Do not display brand names on turbines. Stripes of contrasting colour on the blades are similarly discouraged, where they are not as a result of mitigation of other specialist concerns, as they interfere with visual clarity.
- Fit aircraft warning lights with shields so that they are only visible to aircraft, not to receptors on the ground.
- Provide information on the proposed project to local people through a small education centre or office.
- Maintain turbines in operational condition.

d) Cumulative impacts

A number of other renewable energy projects are proposed for the area. Should these be approved it would mean additional infrastructure (such as roads and powerlines) as well as solar panels and turbines. The local landscape character would be made more industrial. In the context of the De Aar-Phillipstown area, with its long views, exposed sites, roads with little traffic and small to medium sized towns, the cumulative impact is considered to be of medium (-) significance.

4.3.3 Impact on energy production

South Africa has experienced a shortfall in electricity supply in the past few years and continues to experience constrained electricity supply. The proposed projects could impact on the ability of Eskom to provide electricity.

a) Description of the environment

Historical trends in electricity demand in South Africa have shown a consistent increase in demand. There are some years where the demand levels off or decreases but over the long term there is still an increase. Such a decrease in demand was seen in 2009 in line with the global recession, demand growth has since resumed. As a result, the reserve margin still remains low and Eskom is still short of capacity, a situation that is expected to continue until new base load capacity can be brought online from 2012 onwards. The reserve margin will again be constrained after 2018 should no new base load power stations be constructed. The proposed wind energy facilities would be able to provide power to assist in meeting the energy demand within South Africa.

In Eskom's Medium Term Adequacy Report (Week 44 of 2011) it is anticipated that the reserve margin would vary between 6.8 % (2013) and 12.7 % (2011) of Eskom's capacity and it would be necessary to import 1 500 MW of electricity annually up til 2014[26].

As noted in **Section 2.5** South Africa aims to procure 3 725 MW capacity of renewable energy by 2016 (the first round of procurement). The proposed projects could each provide 155-360 MW, or 4.0-5.4 %, of this figure.

b) Impact assessment

Given the need for increased production capacity in South Africa, as well as the targeted renewable energy figure, the potential impact of the proposed projects on energy production is considered to be of low magnitude, regional and long term and therefore of ***low (+)*** significance, without or with mitigation measures.

No difference in significance would result from the proposed alternatives.

c) Mitigation measures

No mitigation measures are recommended.

[26] http://www.eskom.co.za/c/article/803/adequacy-report-week-44/ (accessed 15/11/11)

d) Cumulative impacts

As noted previously a number of other renewable energy projects are proposed for the area, with a combined capacity of over 1 000 MW. The potential cumulative impact of these proposed projects on South Africa's energy production would remain of *low (+)* significance.

4.3.4 Impact on local economy (employment) and social conditions

The establishment of the proposed wind energy facilities would provide a number of direct, indirect and induced jobs. Direct jobs are created during manufacturing, construction and installation, operation and maintenance. The proposed projects would also result in a large amount of expenditure in South Africa, both to procure services (e.g. transportation services) and materials (e.g. road building materials).

a) Description of the environment

De Aar is located within the Emthanjeni Local Municipality (LM) of the Pixley ka Seme District of the Northern Cape. The Emthanjeni LM had a total population of 38 612 in 2010 and an average annual population growth rate of -0.7 % (1996-2008) (Urban-Econ, 2010 in DJ Environmental Consultants, 2010). Although the unemployment rate is only 26 %, the economically inactive population amounts to 46.9 %. The skills levels in the municipality is generally low (32 % of labour force are unskilled workers) as is annual household income (79.8 % of households earn low-income annual salaries). The four main languages spoken in the Northern Cape is Afrikaans, English, IsiXhosa and Tswana.

According to a Socio-economic Impact Assessment (Urban-Econ, 2010 in DJEC, 2010), the local area has a diverse economy, while the main sectors contributing to the Gross Geographic Product (GGP) in 2008 included the financial and business services sector(21.6 %), the general government sector (21.1 %) and the trade sector (15.5 %). The general government sector employs more than 24 % of the share of total labour, while the agricultural sector employs 21.5 % of the labour and a total of 19 % of the labour is employed in the trade sector.

De Aar has the largest abattoir in the southern hemisphere and supplies all the major centres throughout the country with the famous "Karoo" lamb and mutton. Sheep farms around De Aar are also major suppliers of wool (Emthanjeni Local Municipality, 2009).

De Aar is a declared industrial growth point and is trying to position itself as an attractive location for industry in the Northern Cape[27]. Industrial sites are reasonably priced and De Aar is centrally located with excellent rail and road links. De Aar is the second most important railway junction in the country as its central to Gauteng, Cape Town, Port Elizabeth and Namibia (Macroplan, 2007).

[27] http://www.deaar.co.za/, accessed 29/10/11

Philipstown is located within the Renosterberg Local Municipality (LM) of the Pixley ka Seme District of the Northern Cape. Phillipstown falls primarily in a farming region comprising of mostly wool industries and hunting lodges.

The site is located in a rural area and as such the population density is very low, with neighbouring farms located great distances from each other. The De Aar area has large areas of land which are very dry and the farmers struggle to earn a living from the land. Employment opportunities in the immediate area predominately stem from farming.

b) Impact assessment

The establishment of the proposed wind energy facilities would provide a number of direct, indirect and induced jobs. Direct jobs are created during manufacturing, construction and installation, operation and maintenance.

The proposed projects would have workforce comprising at least 50 % local labour. Approximately 420 and 320 jobs during the pre-construction and construction phases for the proposed northern and southern facilities, respectively and 35 and 30 jobs during the operational phase for the proposed northern and southern facilities, respectively, would be created. Indirect and induced jobs would also result from the proposed projects. It is important to note that the number of jobs does not equate to the number of people employed. This is expressed in job years. A job year is equivalent to one year of work e.g. a person who works from age 20 to 65 has worked 45 job years.

Increased employment opportunities (direct and indirect) would allow for an improvement in social conditions for those who obtain employment. The proposed projects would also result in an increase in the revenue of the Local Municipality through increased rates and taxes. This in turn could result in an increase in municipal spending on social programmes. Increased spending (procurement of goods and services) in South Africa would indirectly result in more employment opportunities.

Based on the number of employment opportunities during the operational phase the potential impact on the local economy (employment) and social conditions is considered to be medium magnitude, regional and long term and therefore of ***medium (+)*** significance, with or without mitigation.

No difference in significance would result from the proposed alternatives.

c) Mitigation measures

The following mitigation measures are recommended:

- Obtain a list of locally available labour and skills. Give preference to local communities for employment opportunities.
- Give preference to local communities for employment opportunities.

- Provide appropriate training, which would enable individuals to apply their skills to other construction and development projects in the region once construction is complete.
- Base recruitment on sound labour practices and with gender equality in mind.

d) Cumulative impacts

As noted previously, many other renewable energy projects are proposed for the area. The potential cumulative impact of these proposed projects on employment and socio-economic conditions in the local area would remain of *medium (+)* significance.

4.3.5 Impact on agricultural land

The site is used for agricultural purposes, consisting mostly of sheep grazing. The foundations of the wind turbines would cover an area of approximately 15 m x 15 m, which could be recovered with top soil to allow vegetation growth around the 6 m diameter steel tower. Furthermore, hardstandings of 20 x 40m are required to erect turbines, access roads and powerlines all add to the footprint of the proposed projects. The footprint of the proposed development would reduce the area available for agriculture. As such Mr Kurt Barichievy of SiVEST (Pty) Ltd was appointed to undertake a desktop Agricultural Impact Assessment. A desktop review was undertaken and due to the size of the projects two separate site visits were undertaken by Mr Barichievy on 21 – 25 November 2011 and 10 – 14 December 2011 in order to inform the Agricultural Impact Assessment. The study considered climate, soils, terrain, land capability, geology, current agricultural practices and agricultural potential. The Agricultural Impact Assessment is included in **Annexure L.** The findings and recommendations of the study are summarised below.

a) Description of the environment

In terms of this study, agricultural potential is described as an area's suitability and capacity to sustainably accommodate an agricultural land use. A study of local agricultural practices was also carried out.

Climate

The study area has a semi-arid to arid continental climate with a summer rainfall regime i.e. most of the rainfall is confined to summer and early autumn. Mean Annual Precipitation (MAP) is approximately 300 mm per year. An MAP of 300 mm is deemed low as 500 mm is considered to be the minimum amount of rain required for sustainable dry land farming. Without some form of supplementary irrigation natural rainfall for the study area is insufficient to produce sustainable harvests. This is reflected in the lack of dry land crop production within the study area.

De Aar typically experiences hot days and cold nights with the highest maximum temperature of approximately 40^{o}C and the lowest minimum temperature of approximately - 8^{o}C. Evaporation is estimated to be in the region of 2 000 mm per annum and the area is subjected to very severe moisture availability restrictions Agricultural Geo-Referenced Information System (AGIS, 2012). In summary the climate for the study area is severely restrictive to arable agriculture which is primarily due to the lack of rainfall and severe moisture availability restrictions.

Geology

The study area is underlain by a variety of parent materials including dolerite, mudstone, shale and tillite. Dolerite, a basic igneous rock dominates the central regions of both the North and South sites. These areas coincide with the top of the plateau which comprises most of the sites. Shale and mudstone geologic materials are found on the plains which surround the plateau. Shale, a clastic sedimentary rock, is formed by the settling and accumulation of clay rich minerals and other sediments. Due to the settling process this parent material usually takes the form of parallel rock layers which lithify[28] over time.

Like shale, mudstone is also clastic sedimentary rock which is formed from the lithification of deposited mud and clay. Mudstone consists of a very fine grain size of less than 0.005 mm but unlike shale it is mostly devoid of bedding. Pockets of tillite, consisting of consolidated masses of unweathered blocks and unsorted glacial till, also dot the study area.

Slope

The plateau terrain influences climate and soil characteristics and thus plays a dominant role in determining whether land is suitable for agriculture. The steep cliffs which form an arrow head shape towards the north western corner of the study area are the most prominent topographical feature. These cliffs divide the flat lower plains with the more undulating plateau. Away from these cliffs the study area is generally flat with an average gradient of less than 10 %.

Land use

The proposed site consists of a mix of natural veld and unimproved shrubland which is used as general grazing land for sheep, goats and cattle. Grazing land is interspersed with incised river channels which flow intermittently and seasonal pans occur through the landscape. According to the spatial databases there are no cultivated fields or irrigated lands.

Soils

The Environmental Potential Atlas for South Africa (ENPAT) for the Northern Cape Province shows the majority of the study area is dominated by shallow Red Apedal (structureless) soils with a high base status. The southern portion of the site is underlain by Glenrosa and Mispah soil forms. These forms are associated with shallow soils, where parent rock is found close to the land surface. The entire study area is classified as having an effective soil depth (depth to which roots can penetrate the soil) of less than 0.45 m deep, which is a limiting factor in terms of sustainable crop production.

Agricultural potential

Climate is the overriding and major limiting factor for agricultural potential at both sites. The combination of low rainfall and an extreme moisture deficit means that sustainable arable

[28] The process whereby loose mineral fragments and/or particles of sand are solidified into rock.

agriculture cannot take place without some form of irrigation. The sites do not contain nor are they bounded by a reliable surface water irrigation resource and the use of borehole water for this purpose does not seem agriculturally and economically feasible.

The majority of the sites contain soils which are not suitable for arable agriculture but remain suitable to grazing and forestry (only where climate permits). A restrictive climate rating, due to low rainfall and moisture/heat stress dramatically reduces the agricultural potential of the projects area. The ENPAT Database provides a summary of the study area's agricultural potential based on its soil characteristics. It should be noted this spatial dataset does not take the prevailing climate into account.

Taking all the site characteristics (climate, geology, land use, slope and soils) into account, the actual agricultural potential for the majority of the study area is classified as being extremely low for crop production and moderate to moderately low for grazing. The poor agricultural potential rating is primarily due to climatic characteristics and soil depth limitations. The site is not classified as high potential nor is it a unique dry land agricultural resource.

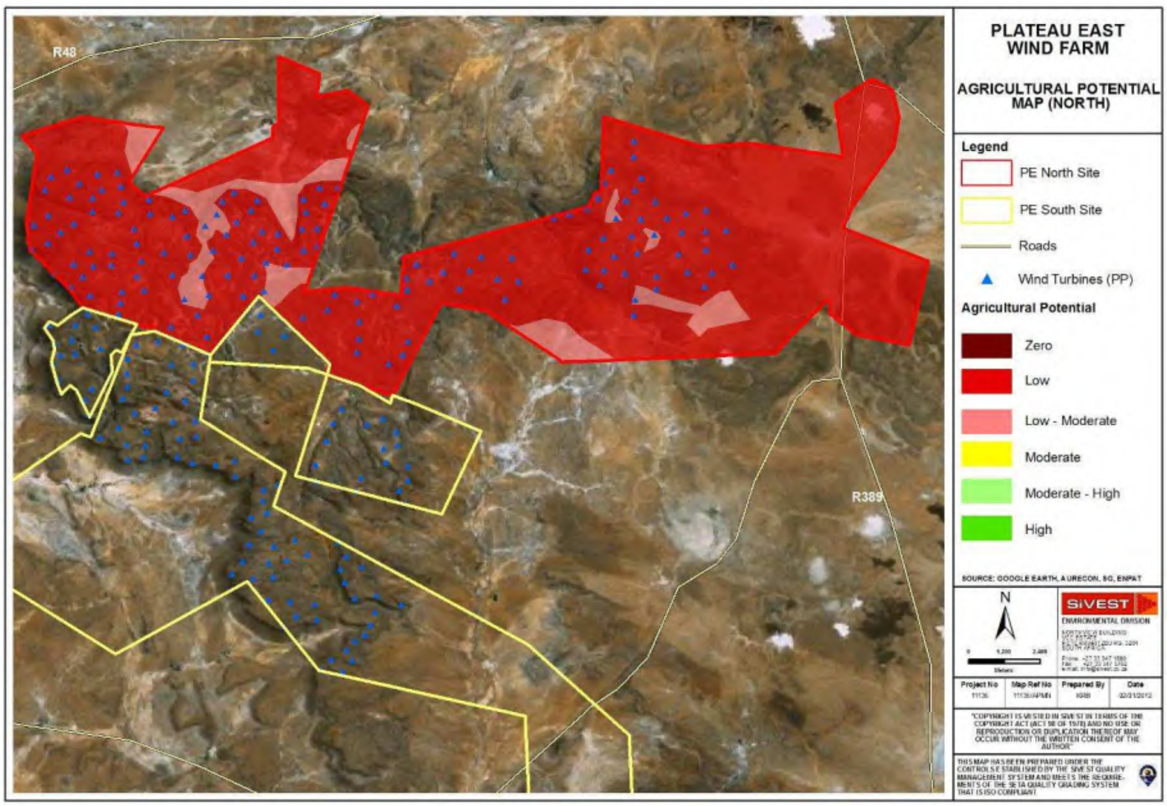

Figure 4-18: Agricultural potential map for the north site. (Source: SIVEST 2012)

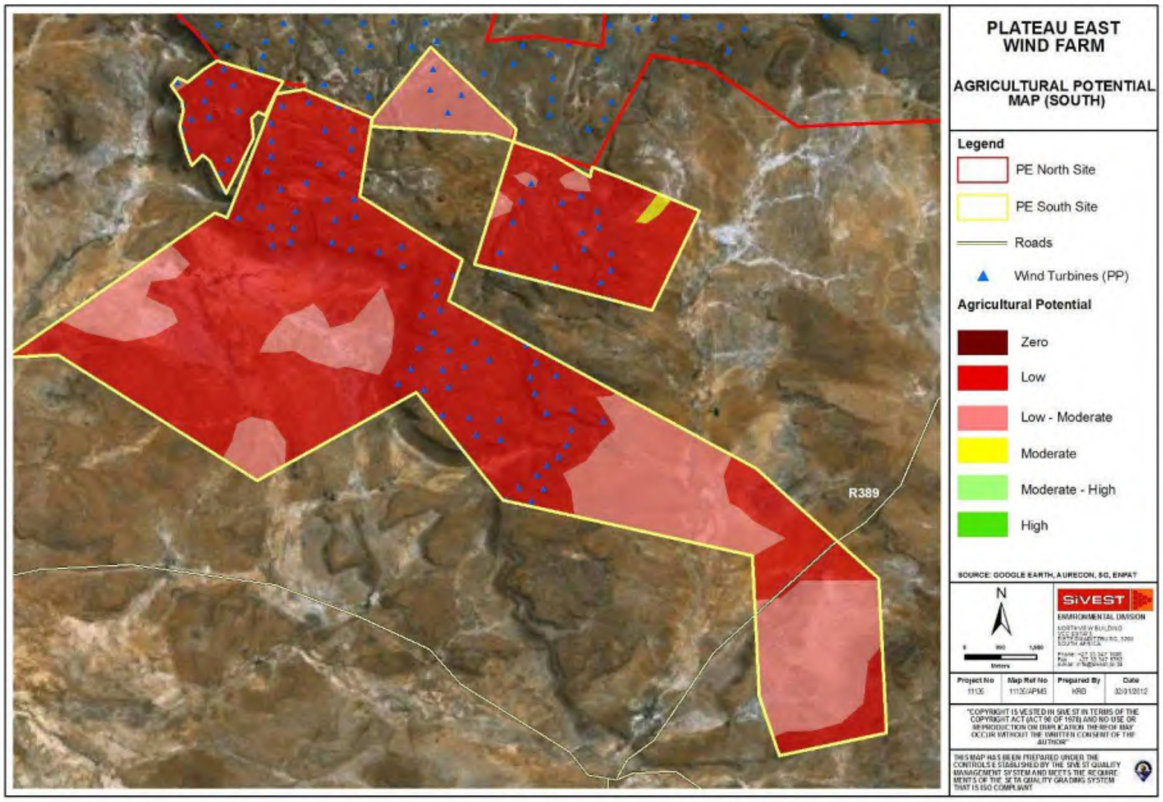

Figure 4-19: Agricultural potential map for the south site. (Source: SIVEST 2012)

b) Impact assessment

The proposed developments' primary impact on agricultural activities would involve the construction of the wind turbines and associated infrastructure. The construction of these turbines would only influence a small area of the total farm portion. The total loss of grazing land would be less than 1 %. Normal grazing (the dominant agricultural activity) would be permitted around the turbines. Both the North and South sites are dominated by grazing land and this activity is considered non-sensitive when assessed within the context of the proposed projects. There are no centre pivots, irrigation schemes or active agricultural fields which would be influenced by the proposed projects.

Furthermore, due to minimum wind speed requirements and to optimise power generation, the various wind turbines have been positioned on top of the plateau and kopjes. The onsite soil survey indicated that these areas are dominated by rocky and shallow soils with an inherently low agricultural potential. Thus the direct impact of the wind turbines on soil resources would be of local extent, very low magnitude and long term and therefore of **very low (-)** significance, without mitigation for both sites.

c) Mitigation measures

No mitigation measures are recommended.

d) Cumulative impacts

The potential cumulative impact of the two proposed projects is considered to be very low (-) due to minor loss of agricultural land.

4.3.6 Impact of noise

Currently the study area has a rural character in terms of the background sound levels. The potential exists for noise from the proposed wind turbines to affect surrounding landowners and the ambient noise environment. As such Mr Morné de Jager of M^2 Environmental Connections was appointed to undertake a specialist study and a site visit was undertaken on the 29 and 30 December 2011 to inform the Noise Impact Assessment (NIA). The study considered the current ambient sound character and undertook noise propagation modelling for both the construction and operational phases. Potentially sensitive receptors were initially identified using Google Earth®, supported by the site visit to confirm the status of the identified dwellings. The area studied in terms of the noise impact of the proposed projects is approximately 600 km^2 and includes an area up to a radius of 2 000 m beyond the proposed wind turbines. The Noise Impact Assessment is included in **Annexure K**. The findings and recommendations of this study are summarised below.

a) Description of the environment

The proposed projects would be developed in a rural area that is mountainous. The R399 crosses the North site in the east, although this road is more than 6 km from the top of the plateau. This provincial road carries significant traffic during the day yet is relatively quiet during the night. There are a number of gravel roads traversing the proposed sites, mainly used by the farmers in the area. Currently traffic on these roads is insufficient to significantly impact on the ambient sound levels in the area.

b) Impact assessment

The word "noise" is generally used to convey a negative response or attitude to the sound received by a listener. There are four common characteristics of sound, any or all of which determine listener response and the subsequent definition of the sound as "noise". These characteristics are: intensity, loudness, annoyance and offensiveness.

Noise emitted by wind turbines can be associated with two types of noise sources. These are aerodynamic sources due to the passage of air over the wind turbine blades and mechanical sources that are associated with components within the turbine, such as the gearbox and generator. Mechanical noise from wind turbines is generally perceived as audible tones that are associated with components of the power train within the turbine. In addition there are other lesser noise sources, such as the substations themselves, traffic (maintenance) as well as transmission line noise emitted from the proposed projects.

The exact make and model of wind turbine to be used is not yet known. It was decided that the Vestas V90 2.0MW VCS wind turbine would be used to illustrate, identify and model potential noise impacts. The final turbine selection would be dependent on wind data (different turbines are better suited to different wind conditions) as well as financial considerations.

It should be noted that wind-induced noises are usually seen as unwanted noises, and samples reflecting significant background interference due to wind-induced noises are normally discarded. However, for the purpose of this study, it was opted to include all measurements taken because the typical operating noise of the proposed facilities would only be emitted during times when wind-induced noise levels are relevant.

The day time period (working day) was not considered in the NIA as noise generated during the day by the proposed projects would generally be masked by other noises from a variety of sources surrounding potentially noise-sensitive developments.

Projected noise levels in the area due to the operation of the proposed facilities are illustrated in **Figure 4-20** illustrating the cumulative impact from the proposed facilities with all the wind turbines operating.

The operation of the proposed wind energy facilities would alter the existing ambient sound levels. The changes in ambient sound levels are important as noise-sensitive receptors would become aware of the increased noise levels and may result in noise complaints. Excluding Potential Sensitive Receptor (PSR) 1, the homestead on Vendussiekuil (see **Figure 4.20)**, the operation of the proposed projects would not have any noise impact on any other identified potential noise-sensitive development

The proposed facilities would be situated in an area dominated by agricultural use with the only significant towns in the area being relatively far away. The potential exists for noise from the proposed wind turbines to affect surrounding landowners and one landowner in particular, PSR1, was identified who would most likely be impacted by the noise. However, the layout was revised to allow for a minimum 1 000 m buffer around this receptor.

Based on the above considerations, the significance of the noise impact is considered to be of low intensity, local extent and long term and therefore of **low (-)** significance for the proposed South project, without mitigation. The significance after mitigation is considered to be **very low (-) – no impact**.

a) Mitigation measures

No mitigation is recommended for the proposed North site. A number of alternative mitigation measures are provided below, any one of which could be implemented to reduce the potential noise impact for the proposed South site, should the receptor (PSR1) lodge a reasonable noise complaint:

- Use a quieter wind turbine, possibly with an increased setback from the sensitive receptor, in order to reduce sound levels at the sensitive receptor.

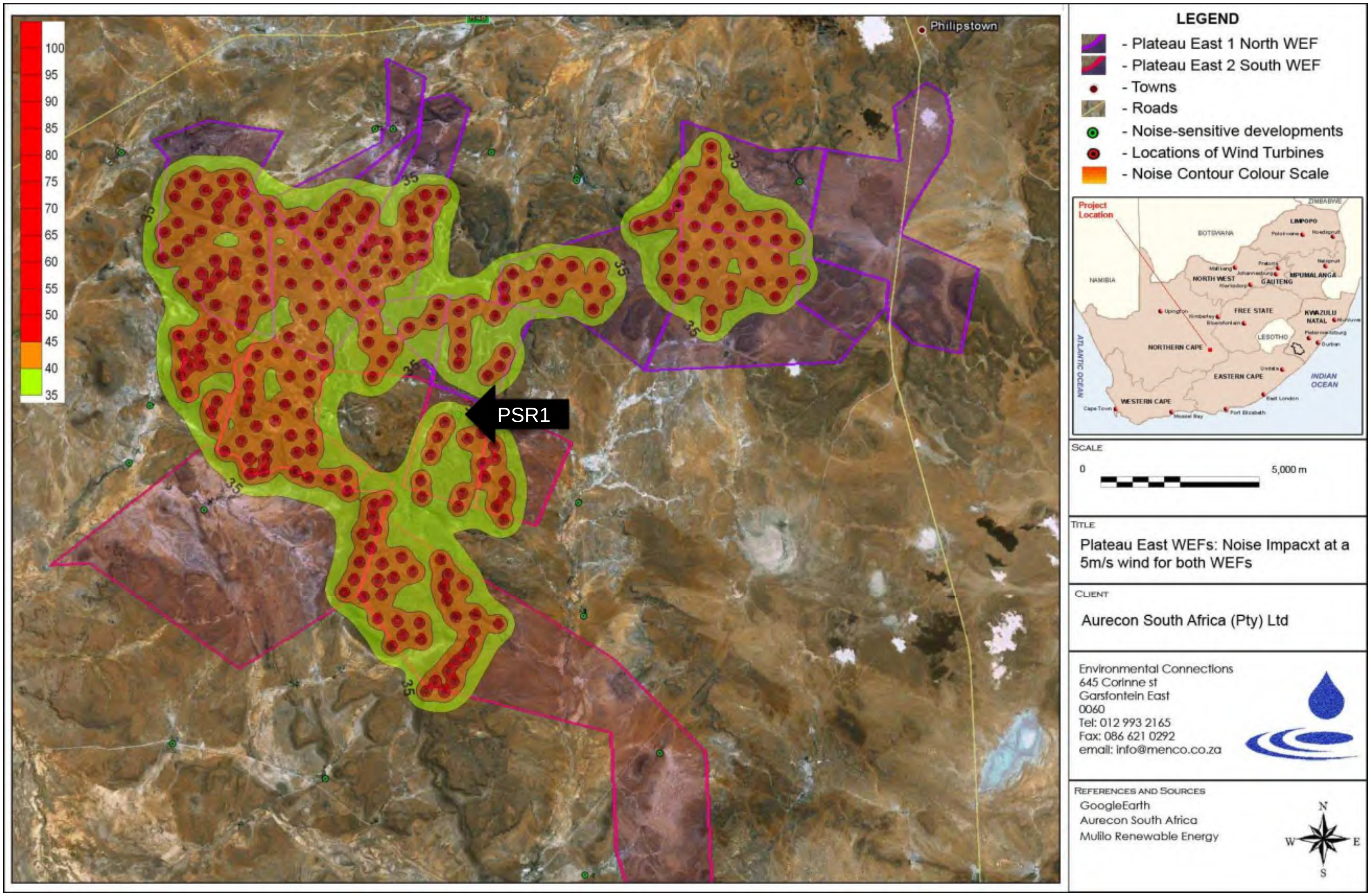

Figure 4-20: Projected noise levels (ISO model) showing contours of constant sound levels for a 5 m/s wind with both proposed projects operating (based on original layouts). (Source: MENCO 2012)

- Operating all, or selected wind turbines in a different mode. Most manufacturers allow the turbines to be operated in a different mode. This allows the wind turbine generator to operate more silently, albeit with a slight reduction of electrical power generation capability;
- Problematic wind turbines could also be disabled, or the rotational speeds significantly decreased during periods when a quieter environment is desired (and reasonable complaints registered).
- Should the receptor be amenable, relocate the receptor to a location agreed to with the receptor, outside of the projects footprint.

b) Cumulative impacts

The impacts of the two proposed projects considered cumulatively are no higher than each of the individual impacts, namely low (-) significance. As no other wind energy facilities are proposed in the vicinity it is not anticipated that any further cumulative noise impacts would result.

4.4 CONSTRUCTION PHASE IMPACTS ON THE BIOPHYSICAL AND SOCIAL ENVIRONMENTS

The construction phase is likely to result in a number of negative impacts on the biophysical and the social environment. The following potential impacts have been identified as relevant to the construction of the proposed projects:

- Disturbance of flora, avifauna, bats and fauna;
- Sedimentation and erosion of water ways;
- Impact on heritage resources including palaeontology;
- Visual impacts;
- Impact on local economy (employment) and social conditions;
- Impact on transport;
- Noise pollution;
- Storage of hazardous substances on site; and
- Dust impact.

The significance of construction phase impacts is likely to be limited by their relatively short duration, since the construction phase should last approximately 18 months. Many of the construction phase impacts could be mitigated through the implementation of an appropriate EMP. A life-cycle EMP is contained in **Annexure M** of this report, which specifies the mitigation measures that could be implemented to mitigate construction phase impacts, amongst others.

4.4.1 Impact on ecology

The primary potential ecological impacts from the proposed projects would arise from (a) impacts on indigenous natural vegetation and (b) establishment and spread of declared weeds and alien invader plants and animals.

As noted in Section 4.2.1, there are no threatened, near threatened, declining or rare plant species that occur in the area. There are three protected plant species that have a geographical distribution that includes the sites, but they were not found on site and, based on a field evaluation of the site, they are unlikely to occur there.

The Black-footed Cat and Cape Fox, both protected species that could be found on site, are both highly mobile animals and would move out of the path of any construction activities. If either of these species occur in the area, they are likely to return to site after construction of the facilities.

There is the potential for invasive alien plants, such as Mesquite, to spread or invade the area following disturbance on site.

The greatest impact during construction is as a result of roads, which would cover an area of approximately 28 ha (approximately 70 km x 4 m) for the north site and approximately 20 ha (approximately 50 km x4 m) for the south site.

Based on the above, the potential impact on ecology is considered to be of local extent, medium magnitude and long term and therefore of **medium (-)** significance, without mitigation, for both sites. With mitigation this potential impact would remain **medium (-)** significance for both sites. However, the impact is considered to be acceptable based on the low sensitivity of the vegetation and its widespread distribution. No difference in significance would result from the proposed alternatives.

The following mitigation measures are recommended:

- Unnecessary impacts on surrounding natural vegetation must be avoided. The construction impacts must be contained to the footprint of the turbines and laydown area.
- Where disturbance is unavoidable, disturbed areas should be rehabilitated as quickly as possible, using site-appropriate indigenous species.
- Any invasive alien plants within the control zone of the applicant must be immediately controlled to avoid establishment of a soil seed bank. Control measures must follow established norms and legal limitations in terms of the method to be used and the chemical substances used.
- Existing access roads must be used, where possible, as the location for new roads; Steep slopes must be avoided when routing roads, where possible.
- Service roads for the projects' powerlines must be properly maintained to avoid erosion impacts.

4.4.2 Disturbance of avifauna

The primary potential avifaunal impacts would arise from (a) disturbance caused by vehicular and people traffic during construction, (b) displacement caused from habitat loss, disturbance during the construction phase and from maintenance activities. The construction phase would result in temporary damage or permanent destruction of habitat large than this area. This could have a lasting impact in cases where the site coincides with critical areas for restricted range, endemic and/or threatened species. Furthermore, construction activities could disturb breeding, foraging or migrating birds. Bird species of particular concern, which may be affected, include the Southern Pale-chanting Goshawk, Black-chested Snake-eagle, Greater Flamingo Verreaux's Eagle, Martial Eagle, Greater Flamingo, Ludwig's Bustard and Blue Crane.

The construction of the proposed projects are envisaged to have a potential impact on avifauna of medium magnitude, site specific extent and short to long term and therefore a **medium (-)** significance, without mitigation, for both sites. With implementation of mitigation measures this impact would reduce to **low - medium (-)** significance for both sites. No difference in significance would result from the proposed alternatives.

The following mitigation measures are recommended:

- Restricting the construction footprint to a bare minimum.
- Demarcation of 'no-go' areas identified during the pre-construction monitoring phase to minimise disturbance impacts associated with the construction of the facility.
- Reducing and maintaining noise disturbance to a minimum particularly with regards to blasting on the ridge-top associated with excavations for foundations. Blasting should not take place during the breeding seasons of the resident avifaunal community and in particular for priority species (June-September). Blasting should be kept to a minimum and, where possible, synchronized with neighbouring blasts.

4.4.3 Disturbance of bats

During the construction phase of the projects, turbine and infrastructure construction activities may result in loss of foraging and roosting habitat. The extent of the impact is site specific and the magnitude regarded as ranging from low to very low, resulting in a significance rating of **low - very low (-)** without mitigation and **very low (-)** with mitigation measures applied for both sites.

The following mitigation measures are recommended:

- Construction of any wind turbines in the areas designated as having a High Bat Sensitivity should be avoided.

4.4.4 Sedimentation and erosion impacts

The study area falls within the arid region of South Africa. Average annual rainfall is low (196 mm). The main aquatic features within the study area are the Brak and Hondeblaf Rivers, seasonal tributaries within the Orange River System and a number of pans.

The sediment loads of any drainage depressions or pans may increase due to the excavations on the site, the laying of linear infrastructure such as roads or power lines across drainage lines and other construction related activities.

The potential impact of sedimentation and erosion from the construction of the proposed projects are considered to be of medium to high magnitude, site specific and short term and therefore of **low (-)** significance, without mitigation for both sites. The potential of this impact would reduce to **very low (-)** significance, after mitigation, for both sites

The following mitigation measures are recommended:

- Construction activities should as far as possible be limited to the identified sites for the proposed wind energy facilities and the identified access routes. A buffer of 30 m should be maintained adjacent to the identified freshwater features, and 75 m for the pans at Slingershoek.
- Any of the cleared areas that are not hardened surfaces are rehabilitated after construction is completed by revegetating the areas disturbed by the construction activities with suitable indigenous plants. Invasive alien plants that currently exist within the immediate area of the construction activities should also be removed and the sites.
- To reduce the risk of erosion, the locality of the turbines should preferably not be on any steep slopes. Run-off over the exposed areas should be mitigated to reduce the rate and volume of run-off and prevent erosion occurring on the site and within the freshwater features and drainage lines.
- Contaminated runoff from the construction site(s) should be prevented from entering the rivers/streams. All materials on the construction sites should be properly stored and contained. Disposal of waste from the sites should also be properly managed. Construction workers should be given ablution facilities at the construction sites that are located at least 100maway from the river system and regularly serviced. These measures should be addressed, implemented and monitored in terms of the EMP for the construction phase.
- Minimise duration and extent of construction activities in the river – construction should also preferably take place in the low flow season.
- Clearing of debris, sediment and hard rubble associated with the construction activities should be undertaken post construction to ensure that flow within the drainage channels are not impeded or diverted.
- Rehabilitate disturbed stream bed and banks and revegetation with suitable indigenous vegetation.
- The existing road infrastructure should be utilized as far as possible to minimize the overall disturbance created by the proposed projects. For new access roads to the turbines, these should rather be along the ridges of the hills than in the drainage/stream beds.
- Where access routes need to be constructed through ephemeral streams, disturbance of the channel should be limited.
- Wetland and pan areas should be avoided and any road adjacent to a wetland feature should also remain outside of the 30m buffer zone as far as possible.
- All crossings over drainage channels or stream beds should be such that the flow within the drainage channel is not impeded.
- Road infrastructure and cable alignments should coincide as much as possible to minimize the impact.
- Any disturbed areas should be rehabilitated and monitored to ensure that these areas do not become subject to erosion or invasive alien plant growth.

4.4.5 Impact on heritage resources

Given the common occurrence of heritage resources on site, as indicated in Section 4.3.1, it is likely that heritage resources would be encountered during construction.

a) Impact Assessment

The proposed wind energy facilities have potential to produce a wide range of impacts that would affect the heritage qualities of an area. During the construction phase of the project, activities such as bulldozing of access roads to turbine sites and excavation of tower foundations and cable trenches may result in the following impacts on the landscape and heritage environment:

- Displacement of pre-colonial and colonial archaeology material at turbine footings, access roads and trenches
- Accidental damage and/or vandalism to the build environment, such as farmsteads, sheds and workers' cottages
- Destruction of cemeteries and graves which are not clearly marked
- Negative visual impact of construction of turbines, substations and overhead transmission lines on the cultural landscape of the Great Karoo.

The volume and widespread distribution of MSA material of relatively low heritage significance over the entire plateau results in an overall impact of relatively small magnitude, except for a single "factory" site on the farm Knapdaar (South site) which may be negatively affected. LSA is of greater significance because the material is relatively sparse on the plateau and may provide valuable information on LSA settlements in the area. Historic kraal complexes represent an unrecorded part of the 19^{th} century farming settlement patterns in this part of the Karoo and their destruction will result in a loss of heritage.

Some of the access roads run in close proximity to farmhouses, historic farm sheds, ruins and engraving sites and so the heritage sites may be vulnerable to destruction and vandalism unless these roads are re-routed or measures taken to conserve the heritage sites. Engravings in the form of 19^{th} century historic graffiti by Boer soldiers were recorded on the South site on the farm Slingershoek, located on a little koppie behind the main farmhouse, but these would not be impacted by the proposed projects as they are on the lowlands.

Although no visible farm cemeteries or graves were identified within the footprint of the development, the excavation of turbine footings and cable trenches and the construction of access roads may result in the destruction of cemeteries and graves which are not clearly marked. A number of graves were recorded on the farm Zwagershoek, on the North site, but these would not be impacted on by the proposed project as they are located on the lowlands.

The wind energy facilities are planned to be constructed a plateau which rises about 100 m above the plains and visible from a number of local roads. The potential visual impacts of the proposed projects are assessed in **Section 4.3.2**. The cultural landscape around De Aar is representative of the great Karoo and the potential visual intrusion caused by the facility would not result in the loss of a significant portion of the Karoo cultural landscape.

Based on the above considerations the potential impact on the archaeological and historical resources found on both the North and South sites is considered to be of local to national extent, medium magnitude and permanent nature and therefore of **medium to high (-)** significance, without mitigation for all alternatives. With the implementation of mitigation measures the potential impact is likely to be local and of **low (-)** significance, for both sites, as little to no impact is foreseen. No difference in significance would result from the proposed alternatives.

b) MITIGATION MEASURES

The following mitigation measures are recommended:

- Areas known to have sensitive archaeological sites should be avoided. An archaeologist should be involved in the placement of the turbines and associated infrastructure in these sensitive areas.
- If mitigation by avoiding sensitive archaeological sites is not feasible, sampling and recording of the archaeological site before its destruction must be undertaken.
- In the case of unexpected exposure of below-ground archaeological material during excavations, SAHRA must be consulted immediately to ensure timeous implementation of appropriate mitigation measures.
- At least one LSA site on the North site and one MSA "factory" site and two LSA sites on the South site will require targeted sampling and excavation to allow for more accurate characterization of the archaeological finding.
- Old buildings should be fenced off during construction to avoid vandalism of the buildings, kraal complexes must be avoided and access roads re-routed to avoid damage to the buildings.
- A 500 m buffer should be implemented around farmsteads, buildings, sheds, kraals etc.
- In the event of accidental uncovering of graves, work must stop immediately and the SAHRA Burials Unit should be notified. An archaeologist should be involved to assist with the investigation and procedures to address the situation.

c) Cumulative Impacts

Generally the cumulative impact of the two proposed wind energy facilities on the plateau may result in significant loss of archaeological knowledge if no mitigation occurs. Considering the number of renewable energy applications in the area it is likely that there will be further cumulative impacts. However, should each of these sites be adequately mitigated it is likely that cumulative impacts would be of low (-) significance.

4.4.6 Impact on palaeontology

The project sites are situated in an area of the Northern Cape and Karoo known for the presence of potentially fossiliferous Palaeozoic rocks of the Karoo Supergroup, consisting of Ecca and Beaufort Groups. Due to this underlying geology of the area, there is a possibility of finding palaeontological material during excavations on site. A large scale development such as the proposed project could have a negative impact on the palaeontological resources by damaging or destroying such material or by requiring the material to be removed and stored *in situ*.

Palaeontology Impact Assessment (PIA) was therefore undertaken by Dr John Almond. The assessment was based on a desktop review and field-based assessment of the paleontological aspects in the project area and included a site visit on 8 to 12 January 2012. The PIA is included in **Annexure H**. The findings and recommendations of the study is summarised below.

a) Description of the environment

The geology of the project areas near De Aar is mainly the Karoo Supergroup. The region is of special geological and palaeontological interest in that the stratigraphic boundary, between the Ecca Group (largely composed of freshwater inland sea rocks) and the overlying continental sediments of the Beaufort Group, runs between the escarpment edge and De Aar.

The geological map of the region east of De Aar indicates the following rock units within the project area (see **Figure 4.21**):

- Tierberg Formation (Ecca Group);
- Adelaide Subgroup (Lower Beaufort Group);
- Intrusive dykes and sills of the Karoo Dolerite Suite;
- Neogene to Quaternary calcretes;
- Quaternary to Recent superficial deposits (alluvium, colluvium, etc); and
- Kimberlite pipe.

The plateau is fairly rugged, typical dolerite terrain with the escarpment slopes almost entirely mantled in doleritic colluvium, with very little bedrock exposure of Karoo Supergroup country rocks beneath the sill. The terrain surrounding the plateau is less rugged, being underlain by softer-weathering mudrocks and sandstones of the Karoo Supergroup, and extensively mantled with alluvium and soils.

The Ecca and Beaufort Group sediments of the Karoo Supergroup generally have a moderate to high palaeontological sensitivity respectively, while the superficial sediments and dolerite intrusions are of low to zero sensitivity. Rare kimberlite pipes of Createaceous age are unfossiferous and are not associated with preserved crater lake deposits or diamonds.

The upper Ecca Group bedrocks in the De Aar area contain well-preserved, locally abundant fossil wood as well as low diversity trace fossil assemblages typical of the Middle Permian Waterford Formation. The trace fossils include various invertebrate burrows as well as possible tracks and partial body impressions of large crocodile-like amphibians.

Although natural and artificial exposures of Lower Beaufort Group bedrocks (Adelaide Subgroup) are exceedingly sparse in the De Aar region, several of the localities investigated yielded fragmentary to semi-articulated vertebrate remains. The localities of the finds are located on the low ground of the study area and are indicated in **Figure 4.22** and **4.23**.

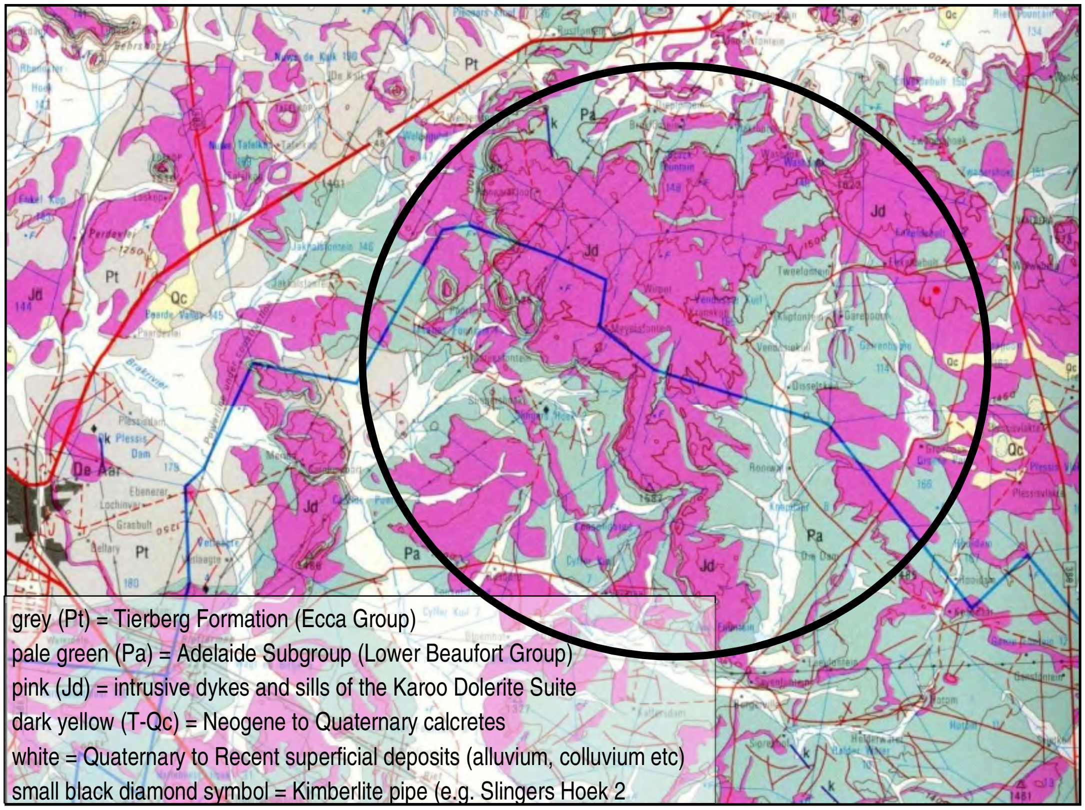

Figure 4-21: Geological map of the region east of De Aar, Northern Cape, showing in very broad outline the location of the proposed projects on the eastern plateau c. 20km east of De Aar (Abstracted from 1: 250 000 geology sheet 3024 Colesberg, Council for Geoscience, Pretoria) (Source: Natura Viva 2012).

The fragments are among the first ever recorded in this part of the Karoo. They include skull and postcranial remains of small therapsids (probably the small dicynodont *Diictodon*) as well as a partial specimen of the rare tortoise-like parareptile *Eunotosaurus*. Other fossil groups recorded from these rocks in the study area include transported plant material (horsetail ferns), **(Figure 4.25)** and well-preserved silicified wood **(Figure 4.24).** These fossil remains probably belong to the *Pristerognathus* Assemblage Zone of late Middle Permian age that is associated to the west with the Poortjie Member of the Teekloof Formation. Fossils are sparsely distributed but *not* very rare within the Lower Beaufort Group near De Aar; the main constraint is lack of bedrock exposure.

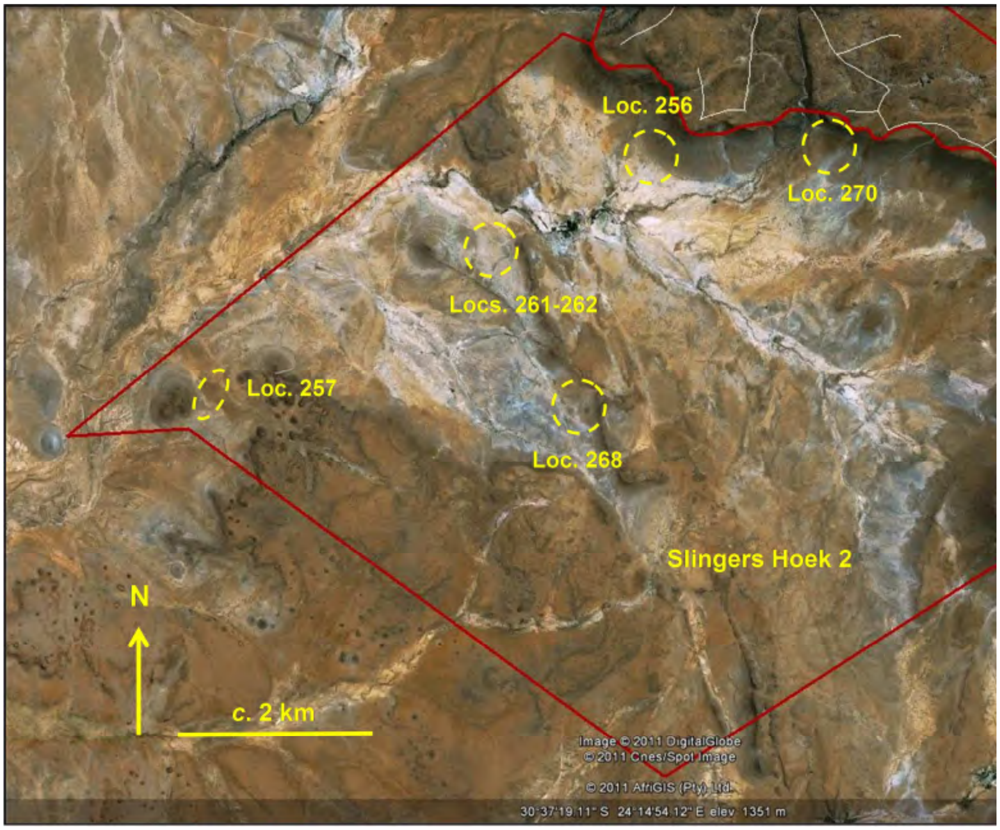

Figure 4-22 Locality of Late Palaeozoic vertebrate, plant and trace fossils found on the southern site. (Source: Natura Viva 2012)

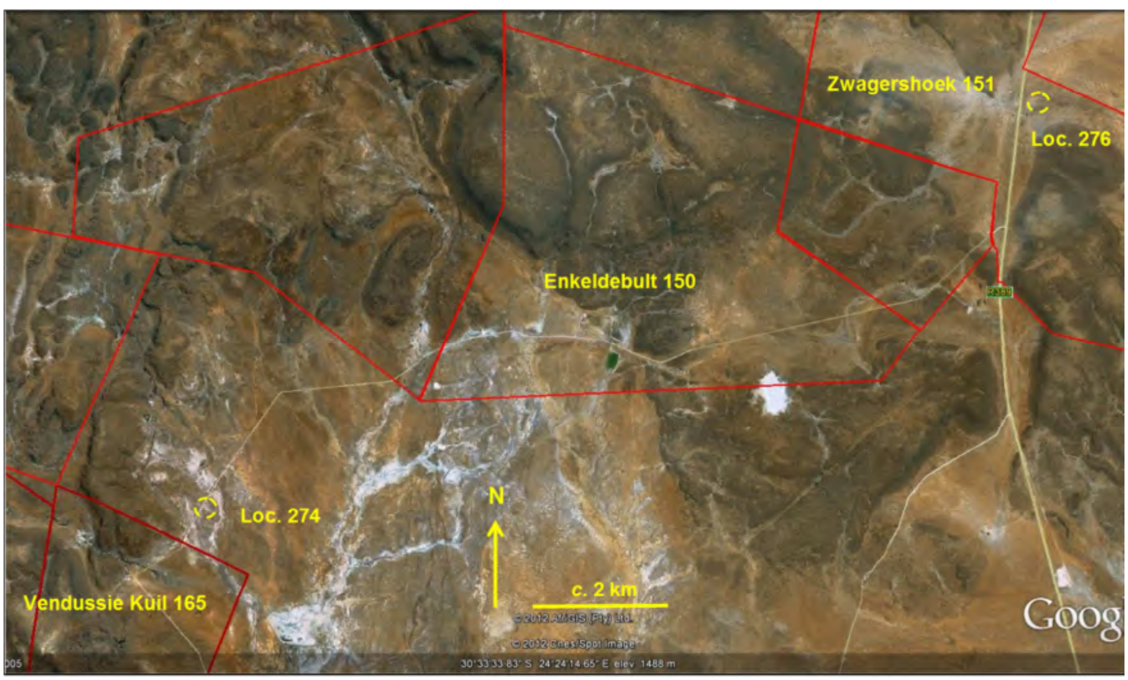

Figure 4-23 Northern site showing the position of two Beaufort Group vertebrate fossil localities within the Lower Beaufort Group. (Source: Natura Viva 2012)

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Figure 4-24: Locally abundant fragments of silicified wood that have been reworked from upper Ecca beds into surface sheetwash gravels near the base of the escarpment on Slingers Hoek 2 (Loc. 256) (Source: Natura Viva 2012).

Figure 4-25: Striated-walled horizontal burrows of Palaeophycus striatus, a typical Carnarvon facies trace fossil, from thin-bedded Ecca sandstones on Slingers Hoek 2 (Loc. 257) (Scale in cm). (Source: Natura Viva 2012).

Figure 4-26: Single track-like impression from the Jakhalsfontein wave-rippled palaeosurface apparently showing five digit impressions (Scale marked in cm). (Source: Natura Viva 2012)

b) Impact assessment

The development footprints are mainly situated in areas underlain by unfossiliferious dolerite or doleritic colluvium (scree, gravels, etc) and is therefore unproblematic in fossil heritage terms. The exception is the flatter-lying areas in the northeast of the North site (on the farm Zwagershoek) where rare fossil vertebrate remains have been recorded from Beaufort Group sediments.

The potentially fossiliferous Karoo Supergroup rocks (Ecca and Beaufort Groups) within the development footprints of the wind turbines, transmission lines, access roads and other infrastructure are generally buried beneath a mantle of fossil-poor superficial sediments such as soils, alluvium, gravels and calcretes. These superficial deposits are probably of Pleistocene to Recent origin and are of low palaeontological sensitivity in the study area as a whole. The Karoo Supergroup rocks are often extensively disrupted by near-surface secondary calcrete formation. Furthermore baking by dolerite intrusion has often further compromised their original fossil heritage.

Potentially fossiliferous bedrocks occur extensively in the western (Slingers Hoek 2) **(Figure 4-22)** and south-eastern (Knapdaar 8/Die Dam) portions of the South site, but these would not be affected by the development footprint. Numerous impressions of large tetrapod tracks were found in the sandstone surface exposed in a stream bed near the homestead on Jakhalsfontein **(Figure 4-26)** outside the project area.

When pits are dug for the turbine foundations fossils could be found and it is possible that these may be damaged. However, the palaeontological sensitivity of all the rock units ranges from zero to low. Therefore it is unlikely that there would be any impacts on fossil heritage. However, if there is any potential impact it would be of low magnitude, local and long term and therefore of **low (-)** significance, for both projects.

c) Mitigation measures

No mitigation is considered to be necessary.

4.4.7 Visual impact

During the construction period activities on site would involve excavations, construction of concrete foundations, installation of above ground infrastructure and erection of new transmission lines along the new access routes linking the turbines. Traffic movements would increase and construction camps would be visible, although it is expected that these would be most visible within a 3 km radius.

The potential construction phase visual impact is considered to be of medium intensity, local and site specific in extent with the duration of the impact limited to the construction period and therefore of **medium (-)** significance, without mitigation. With the implementation of mitigation measures this would reduce to **medium - low (-)** significance. No difference in impact significance would result from the proposed alternatives.

The following mitigation measures are recommended:

- Minimise the construction period, where possible;
- Retain 100-150 mm of topsoil, where there is sufficiently deep topsoil, from any disturbed areas to rehabilitate disturbed areas after construction;
- Use cut material where possible in construction or on site (e.g. in grading gravel roads) or remove cut material from site;
- Where site offices are required, limit these to single storey and use temporary screen fencing to screen offices from the wider landscape; and
- Ensure prompt revegetation of disturbed areas.
- Access roads should be kept tidy and storage of materials and builders' rubble should be screened from public view;
- The use of contaminants, such as diesel, curing compounds, shutter oil and cement, should be controlled on site, litter should be regarded a serious offence and no fires should be allowed on site. All site employees should receive training in awareness of these issues;
- The alignment of access roads should be carefully considered to minimize visible scarring from cut and fill, and gravel should be used as surface material. Roads alignments should lie with the contour as far as possible;
- Consider temporary hard-standings for cranes in place of permanent hard-standings;

- As much as possible, place any new structures where they are least visible to the greatest number of people;

4.4.8 Impact on local economy (employment) and social conditions

The proposed wind energy facilities would employ a medium local content i.e. up to 50% of the procurement would be within South Africa.
Local labour would be employed during construction. Up to 740 construction, installation and manufacturing direct jobs could be created for both facilities. The construction period would last for some 18 Months.

The projects would generate approximately 420 and 320 jobs for the proposed northern and southern facilities, which includes construction, installation and manufacturing direct jobs. Increased employment opportunities would allow for an improvement in social conditions for those who obtain employment. As the majority of labour would be accommodated within De Aar or Phillipstown, an increase in spending would result in these areas thereby stimulating the local economies. The projects would also result in an increase in the revenue of the LM's through increased rates and taxes. This in turn could result in an increase in municipal spending on social programmes.

Based on the number of employment opportunities, as well as the local expenditure, during the construction phase the potential impact on the local economy (employment) and social conditions is considered to be medium magnitude, regional and short term (for the construction period) and therefore of ***medium (+)*** significance, with or without mitigation for both proposed projects.

The following mitigation measures are recommended:

- Obtain a list of locally available labour and skills. Give preference to local communities for employment opportunities;
- Base recruitment on sound labour practices and with gender equality in mind; and
- Provide appropriate training, which would enable individuals to apply their skills to other construction and development projects in the region once construction is complete.

4.4.9 Impact on transport

Construction vehicles are likely to make use of the existing roads, including the R389 and R48, to transport equipment and material to the construction site. For each wind turbine approximately 72 - 83 construction vehicles would be required to bring in construction materials and components (based on the N100 (2.5 MW) turbine transport requirements in Nordex Energy GmbH (Nordex), 2009). The proposed projects consist of 145 turbines in the north hence approximately 10 440– 12 035 construction vehicles would be required, and 105 turbines in the south would equate approximately to 7 560 – 8 715 construction vehicles. This equates to 19 to 22 construction vehicles per day for the north site and 14 to 16 for the south site, assuming an even spread over the 18 months construction period.

Transporting components to site is likely to necessitate the upgrading of sections of road to ensure clearances and bends are negotiable by trucks (see Section 3.2 for more details).

Due to the large size of many of the facility's components (e.g. tower and blades) and the need for them to be transported via "abnormal loads" from either Port Elizabeth or Cape Town harbour, construction related transport could impact negatively on the traffic flow in the vicinity and on the integrity of the affected roads. This may exacerbate the risk of vehicular accidents. The necessary clearances from the respective Roads Authorities would need to be in place prior to the transporting of these loads.

Cumulatively, it is estimated by The GreenCape Initiative (2011) that some 13 abnormal loads would be on roads daily in the Western Cape until 2015. Most of these loads would use on the N1 or the N7 and many would extend to the Northern Cape.

The potential impact of the projects on transport is considered to be of medium magnitude, regional extent and short term and therefore of **medium (-)** significance, with or without mitigation for both proposed projects. The cumulative potential impact of wind energy projects on transport is considered to be of high magnitude, regional extent and short term and therefore of **high (-)** significance, with or without mitigation. No difference in impact significance would result from the proposed alternatives.

The following mitigation measures are recommended:

- Ensure that road junctions have good sightlines;
- Implement traffic control measures where necessary;
- Transport components overnight as far as possible; and
- Engage with the roads authorities prior to construction to ensure the necessary road upgrades, permits, traffic escorts etc are scheduled.

4.4.10 Noise pollution

Projected noise levels for the construction of the proposed wind energy facilities were modelled using the methods as proposed by SANS 10357:2004. The resulting noise projections indicated that the construction activities, as modelled for the worst case scenario, would comply with the Noise Control Regulations (GN R154) as well as the acceptable day rating levels as per the SANS 10103:2008 guidelines.Therefore this potential impact is considered to be of low magnitude, local extent and short term and therefore of **very low (-)** significance, with and without mitigation.

The following mitigation measures are recommended:

- Route construction traffic as far as practically possible from potentially sensitive receptors;
- Ensure a good working relationship between the developer and all potentially sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close to them. Information that should be provided to the potential sensitive receptor(s) include:

  - o Proposed working times;
  - o how long the activity is anticipated to take place;
  - o what is being done, or why the activity is taking place;
  - o contact details of a responsible person where any complaints can be lodged should there be an issue of concern.
- When working within 500 m of a potential sensitive receptor, limit the number of simultaneous activities (e.g. construction of access roads, trenches, etc) to the minimum as far as possible;
- When working near to potentially sensitive receptors, coordinate the working time with periods when the receptors are not at home where possible. An example would be to work within the 08:00 to 14:00 time-slot to minimize the significance of the impact because:
  - o Potential receptors are most likely at school or at work, minimizing the probability of an impact happening;
- Consider using the smallest/quietest equipment for the particular purpose. For modelling purposes the noise emission characteristics of large earth-moving equipment (typically of mining operations) were used, that would most likely over-estimate the noise levels. The use of smaller equipment therefore would have a significantly lower noise impact;
- Ensuring that equipment is well-maintained and fitted with the correct and appropriate noise abatement measures.

4.4.11 Storage of hazardous substances on site

As at any construction site, various hazardous substances are likely to be used and stored on site. These substances may include amongst other things, diesel, curing compounds, shutter oil and cement. Utilisation of such substances in close proximity to the aquatic environment such as pans is of greater concern than when used in a terrestrial environment.

This potential impact is considered to be of high magnitude, local extent and short to medium term and therefore of **low to medium (-)** significance, with and without mitigation for both sites. With the implementation of mitigation the likelihood of this impact occurring would reduce. No difference in impact significance would result from the proposed alternatives.

The following mitigation measures are recommended:

- Implement measures as provided in the EMP, which *inter alia* specify the storage details of hazardous compounds and the emergency procedures to follow in the event of a spillage; and
- Comply with the various pieces of legislation controlling the use of hazardous substances at a construction site.

4.4.12 Dust impacts

Construction vehicles are likely to make use of the existing farm roads to transport equipment and material to the construction site. Earthworks would also be undertaken. These activities would exacerbate dust especially in the dry winter months.

This potential impact is considered to be of medium magnitude, local extent and short term and therefore of **low (-)** significance, without mitigation and **very low (-)** significance with mitigation for both sites.

The following mitigation measures are recommended:

- Implement measures as provided in the EMP, which includes procedures for dealing with dust pollution events including watering of roads, etc.

4.5 SUMMARY OF POTENTIAL IMPACTS

A summary of all the potential impacts from the proposed projects assessed above is included in **Table 4-1** and **Table 4-2** . While some difference in magnitude of the potential impacts would result from the proposed alternatives this difference was not considered to be significant for any of the potential impacts. As such, the tables below applies to all proposed alternatives.

Table 4-1: Summary of potential impacts of the proposed project (south)

Potential impact	No mit/Mit[29]	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Conf.[30]	Reversibility
OPERATIONAL PHASE								
Impact on Ecology: Preferred layout	No mit	Local	Low- Medium	Long term	**Low – Medium (-)**	Definite	Sure	Irreversible
	Mit	Local	Low	Long term	**Very Low- Medium (-)**	Probable	Sure	Irreversible
No-go alternative	No mit	Local	Low	Long term	**Low (-)**	Definite	Sure	Irreversible
	Mit	Local	Low	Long term	**Low (-)**	Probable	Sure	Irreversible
Impact on birds	No mit	Local	High	Long term	**Medium - High (-)**	Probable	Sure	Irreversible
	Mit	Local	Low- Medium	Long term	**Medium (-)**	Probable	Sure	Irreversible
Impact on bats	No mit	Local	High	Long term	**Medium (-)**	Probable	Low	Irreversible
	Mit	Local	Low	Long term	**Low - Medium (-)**	Probable	Sure	Reversible
Impact on freshwater	No mit	Local	Low	Long term	**Low (-)**	Probable	Low	Reversible
	Mit	Local	Low	Long term	**Very Low (-)**	Probable	Low	Reversible
Impact on climate change	No mit	Regional	Very Low	Long Term	***Low (+)***	Probable	Sure	Reversible
	Mit	Regional	Very Low	Long Term	***Low (+)***	Probable	Sure	Reversible
Visual aesthetics	No mit	Regional	High	Long term	**High (-)**	Definite	Sure	Reversible
	Mit	Regional	High	Long term	**High (-)**	Definite	Sure	Reversible
Impact on energy production	No mit	Regional	Low	Long term	***Low (+)***	Probable	Sure	Reversible
	Mit	Regional	Low	Long term	***Low (+)***	Probable	Sure	Reversible
Impact on local economy (employment) and social conditions	No mit	Regional	Medium	Long term	***Medium (+)***	Probable	Sure	Reversible
	Mit	Regional	Medium	Long term	***Medium (+)***	Probable	Sure	Reversible
Impact on agricultural land	No mit	Local	Low	Long term	**Low (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Long term	**Low (-)**	Probable	Sure	Reversible
Impact of noise	No mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible
CONSTRUCTION PHASE								
Impacts on flora, avifauna, fauna and bats	No mit	Local	Low-Medium	Medium term	**Low-Medium (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Medium term	**Low (-)**	Probable	Sure	Reversible
Sedimentation and erosion	No mit	Local	Medium	Short term	**Low (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible

[29] Note that this refers to No mitigation and Mitigation.
[30] Conf.=Confidence in the assessment of the potential impact.

Potential impact	No mit/Mit[29]	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Conf.[30]	Reversibility
Impact on heritage resources:	No mit	Local	Medium - High	Long term	**Medium- High (-)**	Definite	Low	Irreversible
Archaeology	Mit	Local	Low	Long term	**Low (-)**	Probable	Sure	Irreversible
Cultural heritage	No mit	-	-	-	**-**	-	-	-
Palaeontology	No mit	Local	Low	Long term	**Low (-)**	Unlikely	Low	Reversible
	Mit	Regional	Low	Long term	**Low (-)**	Unlikely	Sure	Reversible
Visual aesthetics	No mit	Local	Medium - High	Short term	**Medium (-)**	Probable	Sure	Reversible
	Mit	Local	Medium	Short term	**Low (-)**	Probable	Sure	Reversible
Impact on local economy	No mit	Regional	Medium	Short term	***Medium (+)***	Probable	Sure	Reversible
(employment) and social conditions	Mit	Regional	Medium	Short term	***Medium (+)***	Probable	Sure	Reversible
Impact on transport	No mit	Regional	Medium	Short term	**Low (-)**	Probable	Sure	Reversible
	Mit	Regional	Medium	Short term	**Low (-)**	Probable	Sure	Reversible
Noise pollution	No mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible
Storage of hazardous substances	No mit	Local	High	Short term	**Low (-)**	Probable	Sure	Irreversible
on site	Mit	Local	High	Short term	**Low (-)**	Unlikely	Sure	Irreversible
Impact of dust	No mit	Local	Medium	Short term	**Low (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible

Table 4-2: Summary of potential impacts of the proposed project (north)

Potential impact	No mit/Mit[31]	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Conf.[32]	Reversibility
OPERATIONAL PHASE								
Impact on Ecology:	No mit	Local	Low- Medium	Long term	**Low – Medium (-)**	Definite	Sure	Irreversible
Preferred layout	Mit	Local	Low	Long term	**Very Low- Medium (-)**	Probable	Sure	Irreversible
No-go alternative	No mit	Local	Low	Long term	**Low (-)**	Definite	Sure	Irreversible
	Mit	Local	Low	Long term	**Low (-)**	Probable	Sure	Irreversible
Impact on birds	No mit	Local	High	Long term	**Medium - High (-)**	Probable	Sure	Irreversible
	Mit	Local	Low- Medium	Long term	**Medium (-)**	Probable	Sure	Irreversible
Impact on bats	No mit	Local	High	Long term	**Medium (-)**	Probable	Low	Irreversible
	Mit	Local	Low	Long term	**Low - Medium (-)**	Probable	Sure	Reversible

[31] Note that this refers to No mitigation and Mitigation.
[32] Conf.=Confidence in the assessment of the potential impact.

Potential impact	No mit/Mit[31]	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Conf.[32]	Reversibility
Impact on freshwater	No mit	Local	Low	Long term	**Low (-)**	Probable	Low	Reversible
	Mit	Local	Low	Long term	**Very Low (-)**	Probable	Low	Reversible
Impact on climate change	No mit	Regional	Very Low	Long Term	**Low (+)**	Probable	Sure	Reversible
	Mit	Regional	Very Low	Long Term	**Low (+)**	Probable	Sure	Reversible
Visual aesthetics	No mit	Regional	High	Long term	**High (-)**	Definite	Sure	Reversible
	Mit	Regional	High	Long term	**High (-)**	Definite	Sure	Reversible
Impact on energy production	No mit	Regional	Low	Long term	***Low (+)***	Probable	Sure	Reversible
	Mit	Regional	Low	Long term	***Low (+)***	Probable	Sure	Reversible
Impact on local economy (employment) and social conditions	No mit	Regional	Medium	Long term	***Medium (+)***	Probable	Sure	Reversible
	Mit	Regional	Medium	Long term	***Medium (+)***	Probable	Sure	Reversible
Impact on agricultural land	No mit	Local	Low	Long term	**Low (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Long term	**Low (-)**	Probable	Sure	Reversible
Impact of noise	No mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible
CONSTRUCTION PHASE								
Impacts on flora, avifauna, fauna and bats	No mit	Local	Low-Medium	Medium term	**Low-Medium (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Medium term	**Low (-)**	Probable	Sure	Reversible
Sedimentation and erosion	No mit	Local	Medium	Short term	**Low (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible
Impact on heritage resources: Archaeology	No mit	Local	Medium - High	Long term	**Medium- High (-)**	Definite	Low	Irreversible
	Mit	Local	Low	Long term	**Low (-)**	Probable	Sure	Irreversible
Cultural heritage	No mit	-	-	-	**-**	-	-	-
Palaeontology	No mit	Local	Low	Long term	**Low (-)**	Unlikely	Low	Reversible
	Mit	Regional	Low	Long term	**Low (-)**	Unlikely	Sure	Reversible
Visual aesthetics	No mit	Local	Medium - High	Short term	**Medium (-)**	Probable	Sure	Reversible
	Mit	Local	Medium	Short term	**Low (-)**	Probable	Sure	Reversible
Impact on local economy (employment) and social conditions	No mit	Regional	Medium	Short term	***Medium (+)***	Probable	Sure	Reversible
	Mit	Regional	Medium	Short term	***Medium (+)***	Probable	Sure	Reversible
Impact on transport	No mit	Regional	Medium	Short term	**Low (-)**	Probable	Sure	Reversible
	Mit	Regional	Medium	Short term	**Low (-)**	Probable	Sure	Reversible
Noise pollution	No mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible
Storage of hazardous substances	No mit	Local	High	Short term	**Low (-)**	Probable	Sure	Irreversible

Potential impact	No mit/Mit[31]	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Conf.[32]	Reversibility
on site	Mit	Local	High	Short term	**Low (-)**	Unlikely	Sure	Irreversible
Impact of dust	No mit	Local	Medium	Short term	**Low (-)**	Probable	Sure	Reversible
	Mit	Local	Low	Short term	**Very Low (-)**	Probable	Sure	Reversible