8.3 DESCRIPTION OF RECEIVING ENVIRONMENT

8.3.1 Landscape Baseline

Landscape baseline	A description of the existing elements, features, characteristics, character, quality and extent of the landscape (GLVIA, 2002).

8.3.1.1 Topography

A map of the topography of the region into which the wind farm will be introduced is presented in Figure 8.2. A number of topographic profiles (indicated on the map) with the wind farm in the centre is shown in Figure 8.3. The topography of the area is dominated by the Gamtoos River valley (Figures 8.3 a and b), Cape Fold Belt mountain ranges and the coastal plain (Figure 8.3 a). The mountains lie mostly north and west of the site (Figure 8.3 a and b), while the sheer drop to the Gamtoos River floodplain forms the northern boundary of the wind farm. The wind farm is situated on an elevated plateau above the coastal plain (Figure 8.3 a and d).

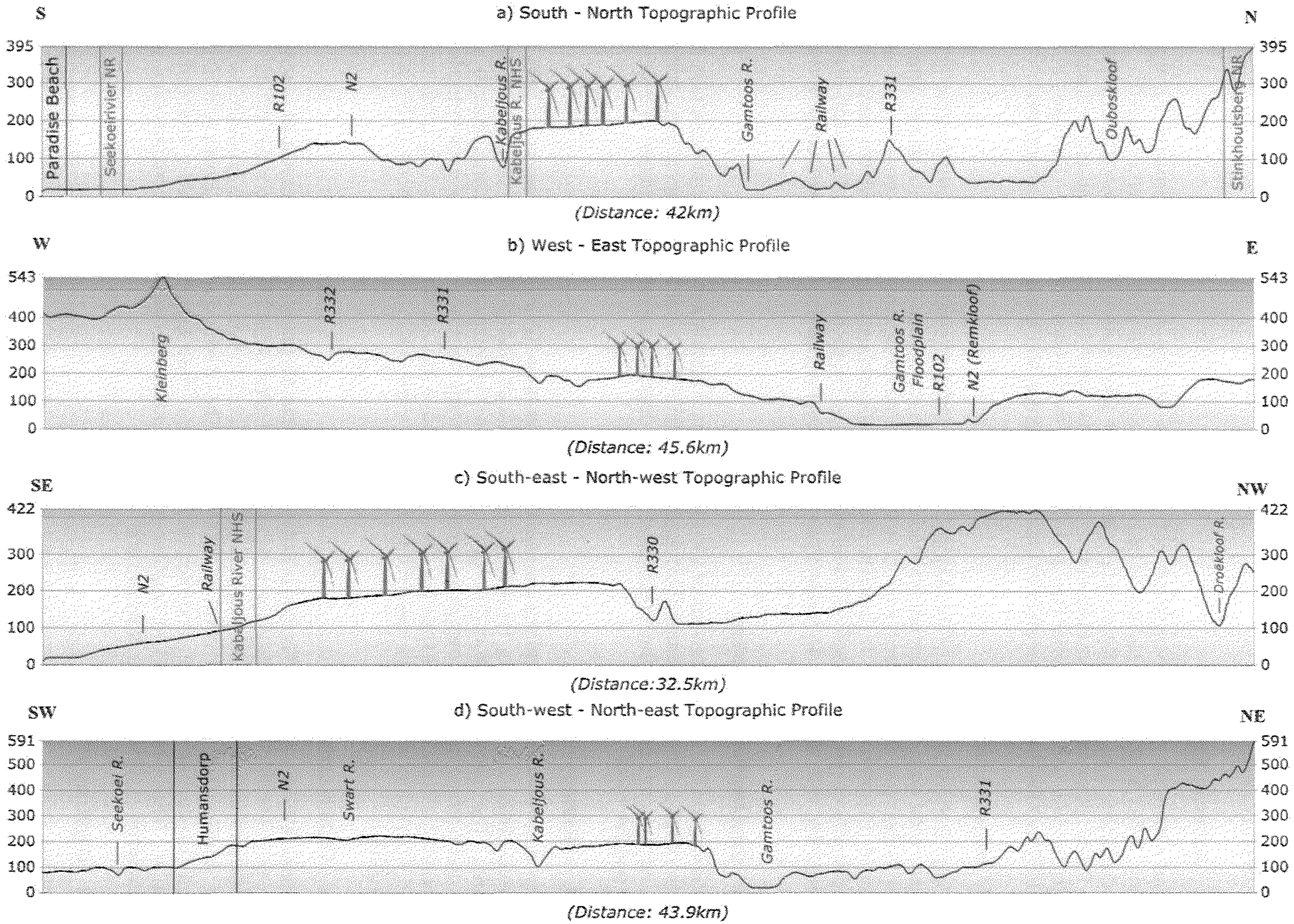


Figure 8.3: **Topographic profiles across the region. Vertical scale exaggerated and different for each profile. Wind turbines (red) in scale in terms of height, not size and provides only an indication of the position of the wind farm in the landscape. See topographic map (Figure 8.) for profile line positions.**

8.3.1.2 Geology

8.3.1.2.1 Alluvium/Sand

The broad Gamtoos floodplain is filled with alluvium eroded from the enormous Gamtoos River catchment. It has deep, arable soil and is heavily cultivated in the study area using irrigation.
Headland-bypass dune fields are common features of the Eastern Cape (Illenberger & Burkinshaw 2008). These dune fields form in corridors across low relief headlands in strong prevailing winds. Examples can be seen near Oyster Bay and Cape St Francis (see Figure 8.4). The fields at Thysbaai and Oyster Bay have become cut off from their sand sources and are becoming vegetated.

8.3.1.2.2 Nanaga Formation

The Nanaga Formation is part of the Algoa Group of rocks and represents palaeo-dune fields. The aelonianite (wind deposited sediment) formed during the early Pleistocene (*ca.* 2 million years ago), a period characterised by a succession of ice ages (transgressions and regressions of sea level) (McCarthy & Rubidge 2006). It consists mostly of calcareous sandstone which weathers to form surficial calcrete or red, clayey soil (Roberts *et al.* 2006). These palaeo dunes form high beach ridges and rolling hills, with crests up to 100m above the valleys between dunes (Illenberger & Burkinshaw 2008).

8.3.1.2.3 Grahamstown Formation

The Grahamstown Formation consists of silcrete which is a combination of sand and pebbles cemented in a matrix of hard siliceous material (Partridge *et al.* 2006). It formed through deep weathering of rocks during a warm humid period in the Cretaceous. These deposits are erosion resistant and will generally produce positive relief.

8.3.1.2.4 Uitenhage Group

The Enon and Kirkwood Formations represent the Uitenhage Group in this region. Rocks from this group were deposited in basins formed along the southern margin of Africa during the break-up of Gondwana. The Enon Formation (the lower most layer) consists mainly of conglomerate with large pebbles and cobbles and were deposited under high energy conditions, generally attributed to initiation of the extensional tectonics prevalent at the time. Above this lie sandstones and mudstones of the Kirkwood Formation which were deposited further from the basin scarps (Shone 2006; McCarthy & Rubidge 2006).

8.3.1.2.5 Cape Supergroup

The Peninsula Formation and Nardouw Subgroup (Table Mountain Group) consist of a sequence of relatively pure sandstone (arenite) layers deposited in shallow seas and fluvial braided plains. Later the sedimentary rocks were altered by compressional tectonic forces and heat to produce hard, erosion resistant metamorphic rocks known as quartzites. The Ceres Subgroup (Bokkeveld Group) was deposited in a deeper marine environment and consists of finer grained material in layers of mudstone and arenite. These rocks tend to weather quicker relative to the harder quartzites and often form valleys between quartzite ridges or mountains.

8.3.1.2.6 Gamtoos Inlier

Rocks of the Gamtoos Group are exposed along the northern flank of the Algoa Basin (Uitenhage Group). These layers were deposited in pre-Cambrian times and imprints of a number of tectonic events obscure accurate interpretation of their origins (Gresse *et al.* 2006).

8.3.1.2.7 Geological History

A number of tectonic events produced the complex topography of the study area. After deposition of the Cape Supergroup rocks, a subduction zone formed along the southern margin of Gondwana. The sediments (Cape Supergroup) on the seafloor were compressed and buckled, and a mountain range similar to that of the Andes was formed (Cape Fold Belt). The break-up of Gondwana occurred during the late Jurassic and Cretaceous Periods along the southern African boundary. Most sedimentation during this time occurred either off-shore (in the Atlantic and Indian Oceans), or in small inland basins formed by extensional tectonics. The Algoa Basin is an example of one of these basins, and it was filled with sediments of the Uitenhage Group. As Gondwana continued to break up the sea flooded into these basins and the southern African continental shelf was developed. Differential erosion of the softer Bokkeveld Group rocks created longitudinal valleys between the mountain ridges formed by harder quartzites of the Table Mountain Group. Various uplift events subsequent to the establishment of the continental shelf caused changes in sea level which produced marine and fluvial terraces along the coast. In particular, two major continental uplift events in the last 20 million years caused major terracing and drainage rejuvenation. Marine terraces were deeply incised during regression of sea level as stream erosion was renewed.

8.3.1.3 Land Cover

Dryland cultivation and stock farming dominate the land use of the region (Figure 8.5). The Gamtoos floodplain is mostly under irrigated cultivation. The natural vegetation for most of the region is fynbos, with thicket and bushland in incised river valleys and north of the Gamtoos River. Some forest plantations also occur in the mountainous terrain north of the wind farm site. Most vegetation has been transformed to some extent by stock farming practises.

8.3.1.4 Built Environment

Settlements in the interior, such as Humansdorp and Hankey, developed as service centres for the surrounding agricultural industry, while those along the coast are holiday resorts with seasonal variation in population (Figure 8.6). Jeffrey's Bay is a large and growing coastal resort with a considerable permanent population. Coastal resorts in this region have expanded rapidly in the last decade, particularly Jeffrey's Bay.

The Gamtoos River valley is densely populated with smaller land parcels and more farmsteads than the surrounding agricultural land. Density of buildings per area also increases east of the Gamtoos towards Port Elizabeth. Several major roads dissect the region, with the N2 a major route between Cape Town and Port Elizabeth. It represents both the easternmost extent of the Garden Route as well as a major freight route between the two cities. The wind farm locality is surrounded by major settlements and in close proximity to the N2 and R330 routes, as well as a railway line. A power line passes just south of the wind farm area. There are no heavy industrial complexes in the area.

8.3.2 Landscape Character

Landscape character	The distinct and recognisable pattern of elements that occurs consistently in a particular type of landscape, and how this is perceived by people. It reflects particular combinations of geology, landform, soils, vegetation, land use and human settlement. It creates the particular sense of place of different areas of the landscape (GLVIA, 2002).

Considering the landscape elements discussed above it is possible to identify a number of landscape character types that potentially may be affected by the proposed wind farm (Figure 8.7):

8.3.2.1 Coastal Plain Pristine

Areas on the coastal plain from which few man-made features are visible from and the vegetation is still more-or-less intact. These are mostly confined to west of Cape St Francis, with a patch between Paradise Beach and St Francis Bay, as well as along the coast from Gamtoos River Mouth east towards Sea View. The vegetation consists of thicket and fynbos.

8.3.2.2 Sparse Coastal Plain Agriculture

Agricultural land where homesteads are far apart and few man-made features are visible in the landscape. The topography is relatively flat (palaeo-marine terraces). The wind farm area is located on this landscape character type.

8.3.2.3 Dense Coastal Plain Agriculture

Agricultural land with a higher density of homesteads per area. This is predominantly land used for dairy farming. The topography is still flat and relief relatively low. Man-made structures are common in this region.

8.3.2.4 Floodplain Irrigated and Dryland Agriculture

The Gamtoos River floodplain is under intense irrigated cultivation. The floodplains of other major rivers such as the Elands River are also cultivated, although not necessarily using irrigation.

8.3.2.5 High Density Agriculture

Small holdings and other small farms along the N2 between the Gamtoos River and Port Elizabeth.

8.3.2.6 High Hill Agriculture

Agricultural land on the highlands. The relief is generally more pronounced here with deeply incised drainage lines. Man-made features are less conspicuous. Stock farming is the main land use of this landscape character type.

8.3.2.7 Highland Forestry

Forestry plantations in the mountainous land to the north and west of the wind farm site. The trees grown in these plantations are exotic (alien) species.

8.3.2.8 Low Mountain Pristine

This landscape character type is often located in protected areas in mountainous terrain north of the Gamtoos River (e.g. Baviaanskloof). Visibility of man-made structures is relatively low.

8.3.2.9 Coastal Resorts

Small towns that developed along the coast as a result of seasonal influx of holiday makers. Many of these resorts have expanded rapidly in recent years.

8.3.2.10 Inland Urban

Towns such as Humansdorp and Hankey which developed as service centres for the surrounding agricultural industry and holiday resorts on the coast.

8.3.3 Landscape Character Sensitivity

Landscape character sensitivity	This provides an indication of the ability of a landscape to absorb change from the proposed development without changing character. A pristine landscape prized for its natural beauty, or a landscape of high cultural value will have high sensitivity to changes brought about by new developments.

Highly visible wind turbines potentially will alter the landscape character types discussed in the previous section. Most likely are the types Low Mountain Pristine and Coastal Plain Pristine. These are by definition types where man-made structures are relatively uncommon and the natural land cover is preserved. Where wind turbines are visible from within these landscape types their character is likely to be changed. These two landscape character types are therefore seen as **highly** sensitive to changes caused by the proposed development.

The other landscape character types will have a capacity to absorb changes which will depend on a number of factors. Agricultural landscape types will have **low** sensitivity since the wind farm will not impinge on agricultural practices. Similarly, Inland Urban types will have a low sensitivity to changes due to the many man-made structures already in the landscape.

The Coastal Resort landscape type will have a **low** sensitivity to the changes caused by a wind farm within the landscape since the landscape type is already changing character as most of the Kouga coastal settlements like Jeffrey's Bay and St Francis are expanding rapidly.

8.3.4 Visual Absorption Capacity

Visual absorption capacity (VAC)	The capacity for the landscape to conceal the proposed development. The VAC of a landscape depends on its topography and on the type of vegetation that naturally occurs in the landscape. The size and type of the development also plays a role.

The VAC for this project is **low** due to the size of the project and the height of its components, as well as the fact that the turbines will be located on land that is relatively elevated. Vegetation such as high exotic trees and thicket will provide some screening directly next to roads and buildings.

8.4 IDENTIFICATION OF ISSUES AND IMPACTS

The following issues were raised regarding the potential visual impact of the wind farm on Interested and Affected Parties:

- How will this project impact on the view that we currently have from our farm towards the sea and the mountains?
- We would like to raise our concern regarding the proposed establishment of a wind energy facility between the Gamtoos and Kabeljauws Rivers. Our home on the Kabeljauws River faces North in the direction of the project and we fear that our beautiful view will be disturbed. Will you please add our concern onto the project register. If you visit our website www.kabeljauws.co.za you can see the view we are referring too.

These issues will be discussed in section 8.6.1.5.

8.5 PERMIT REQUIREMENTS

There are no permit requirements related to potential visual impact, but the Civil Aviation regulations stipulate the following in terms of turbine colours (Minister of Transport 1997):

> "Wind turbines shall be painted bright white to provide maximum daytime conspicuousness. The colours grey, blue and darker shades of white should be avoided altogether. If such colours have been used, the wind turbines shall be supplemented with daytime lighting, as required."

8.6 ASSESSMENT AND MITIGATION OF IMPACTS

The assessment and mitigation of impacts is conducted according to the following steps:

- Identification of visual impact criteria (key theoretical concepts);
- Conducting a visibility analysis; and
- Assessment of impacts of the project on the landscape and on receptors (viewers) taking into consideration factors such as sensitive viewers and viewpoints, visual exposure and visual intrusion.

8.6.1 Visual Impact Concepts and assessment Criteria

8.6.1.1 Visual assessment criteria used in assessing magnitude and significance

The potential visual impact of the proposed wind farm is assessed using a number of criteria which provide the means to measure the magnitude and determine the significance of the potential impact (Oberholzer 2005). The **visibility** (Section 8.6.1.2) of the project is an indication of where in the region the development will potentially be visible from. The rating is based on viewshed size only and is an indication of how much of a region will potentially be affected visually by the development. A high visibility rating does not necessarily signify a high visual impact, although it can if the region is densely populated with sensitive visual receptors. **Viewer (or visual receptor) sensitivity** (Section 8.6.1.3) is a measure of how sensitive potential viewers of the development are to changes in their views. Visual receptors are identified by looking at the development viewshed, and include scenic viewpoints, residents, motorists and recreational users of facilities within the viewshed. A large number of highly sensitive visual receptors can be a predictor of a high **intensity/magnitude** visual impact although their distance from the development (measured as **visual exposure** – Section 8.6.1.4) and the current composition of their views (measured as **visual intrusion** – Section 8.6.1.5) will have an influence on the significance of the impact.

8.6.1.2 Visibility

Visibility of Project	The geographic area from which the project will be visible, or view catchment area. (The actual zone of visual influence of the project may be smaller because of screening by existing trees and buildings). This also relates to the number of receptors affected (Oberholzer 2005). • *High visibility* - visible from a large area (e.g. several square kilometres). • *Moderate visibility* – visible from an intermediate area (e.g. several hectares). • *Low visibility* – visible from a small area around the project site.

In this report there is also another sense in which 'visibility' is used. Cumulative viewsheds indicate not only where a feature is visible from (the meaning of visibility as used in the definition above), but also how much of the feature will be visible from that point or area.

As expected the visibility is **high** in terms of viewshed area due to the turbine heights and their location on relatively elevated land within the coastal plain. The map in Figure 8. shows the spatial extent of areas with potential views on the wind farm.

8.6.1.3 Sensitive Viewers and Viewpoints

Viewer sensitivity	The assessment of the receptivity of viewer groups to the visible landscape elements and visual character and their perception of visual quality and value. The sensitivity of viewer groups depends on their activity and awareness within the affected landscape, their preferences, preconceptions and their opinions.

A rating system provided by the Landscape Institute of the United Kingdom was used to determine viewer sensitivity:

	Definition (GLVIA 2002)
Exceptional	Views from major tourist or recreational attractions or viewpoints promoted for or related to appreciation of the landscape, or from important landscape features.
High	Users of all outdoor recreational facilities including public and local roads or tourist routes whose attention may be focussed on the landscape; Communities where the development results in changes in the landscape setting or valued views enjoyed by the community; Residents with views affected by the development.
Moderate	People engaged in outdoor sport or recreation (other than appreciation of the landscape).
Low	People at their place of work or focussed on other work or activity; Views from urbanised areas, commercial buildings or industrial zones; People travelling through or passing the affected landscape on transport routes
Negligible (uncommon)	Views from heavily industrialised or blighted areas.

The following sensitive viewers or viewpoints were identified:

- Residents of surrounding settlements;
- Residents on farms hosting and surrounding the wind turbines;
- Visitors and viewpoints in surrounding protected areas; and
- Motorists (including tourists) using the N2 and other main roads in the region.

8.6.1.3.1 Residents of surrounding settlements

Current views of residents of Hankey, Milton, Weston and Jeffrey's Bay potentially will be affected by the wind farm. Residents are highly sensitive to changes in their views because they have an interest in the surrounding landscape.

8.6.1.3.2 Residents of surrounding farms

Residents' views and any scenic viewpoints on their farms will be affected according to their visual exposure to the wind farm and the quality of their existing views.

8.6.1.3.3 Protected areas

As can be seen on the map (Figure 8.) there are a number of protected areas which may be affected by the wind farm in terms of altered views. There are no areas officially designated as protected for their scenic views within the study area.

8.6.1.3.4 Motorists

Motorists using the N2, R102, R330 and R332 are likely to have at least occasional views of the wind farm. The R102 and N2 pass within 5km of the wind farm and some wind turbines will be prominent in views.

Motorists are seen as low sensitivity visual receptors since they are unlikely to spend much time studying the landscape. However, tourists travelling the Garden Route will have interest in the landscape.

8.6.1.4 Visual Exposure

Visual exposure	Visual exposure refers to the relative Visibility of a project or feature in the landscape (Oberholzer, 2005). Exposure and visual impact tend to diminish exponentially with distance. The exposure is classified as follows: • *High exposure* – dominant or clearly noticeable; • *Moderate exposure* – recognisable to the viewer; • *Low exposure* – not particularly noticeable to the viewer

The European Wind Energy Association (EWEA) also suggests zones of theoretical visibility (ZTV) as follows (EWEA 2009):

- Zone I – Visually dominant: turbines are perceived as large scale and movement of blades is obvious. The immediate landscape is altered. Distance up to 2km.
- Zone II – Visually intrusive: the turbines are important elements on the landscape and are clearly perceived. Blades movement is clearly visible and can attract the eye. Turbines not necessarily dominant points in the view. Distance between 1 and 4.5 km in good visibility conditions.
- Zone III – Noticeable: the turbines are clearly visible but not intrusive. The wind farm is noticeable as an element in the landscape. Movement of blades is visible in good visibility conditions but the turbines appear small in the overall view. Distance between 2 and 8 km depending on weather conditions.
- Zone IV – Element within distant landscape: the apparent size of the turbines is very small. Turbines are like any other element in the landscape. Movement of blades is generally indiscernible. Distance of over 7 km.

The zones overlap due to the fact that they attempt to incorporate atmospheric or weather conditions. The maps in this section do not show these zones but distance buffers are included to enable readers to apply the EWEA nomenclature.

Visual exposure was calculated using visibility (i.e. how much of the wind farm will be visible) and distance from the nearest wind turbine (Figure 8.9). The combination is calculated statistically using the method described at: http://mapthis-za.blogspot.com/2010/05/visual-exposure-alternative-approach.html. This method is preferred as it is objective and repeatable, and takes the size of the wind farm into consideration. A wind farm which has many turbines exposed against the horizon for a long distance will potentially have a visual exposure for viewpoints far away comparable with that of viewpoints in close proximity but from where only a few turbines are visible.

8.6.1.4.1 Residents of surrounding settlements

Settlements where views of residents may be affected are listed in TTable . The visual exposure indicated is an average for the settlement. Individual residents may have higher exposure, especially for those settlements closer to the wind farm such as Hankey, Jeffrey's Bay and Weston. The screening effect of neighbouring buildings and high vegetation was not taken into account and it is likely that only residents living on the edge of these settlements will be affected.

Table 8.1: Average visual exposure ratings for settlements potentially affected by the WEF.

SETTLEMENT	MIN DIST (KM)	VISUAL EXPOSURE
HANKEY	7.64	Low
MILTON	9.73	Low
SETTLEMENT 01	8.10	Low
JEFFREY'S BAY	6.61	Low
LOERIE	10.53	Low
WESTON	6.06	Low
GAMTOOS RIVER MOUTH	11.18	Low
HUMANSDORP	12.77	Low
ASTON BAY	13.03	Low
KRUISFONTEIN 01	14.56	Low
PARADISE BEACH	14.90	Low
WOLWEHOEK	16.08	Low
PATENSIE	16.73	Low
NOORSHOEK	18.81	Low
KROMME RIVER HOLIDAY RESORT	21.10	Low
KROMME RIVER MOUTH	21.31	Low
ST FRANCIS BAY	21.92	Low
TOWNSHIP 01	25.31	Low

8.6.1.4.2 Protected Areas and Scenic Viewpoints

Protected areas are from the STEP database and the types of protected areas as defined by the STEP project are listed in Table 8.2. The protected areas listed in Table 8.3 will on average (visual exposure per area) have low visual exposure to the proposed wind farm. It is therefore possible that some viewpoints within protected areas will experience high visual exposure to the wind farm. However, most Type 1 protected areas are more than 5 km from the wind farm site.

Table 8.2: Protected area types as defined by STEP (from Lombard *et al.* 2003)

STEP PROTECTED AREA TYPE	TYPE DESCRIPTION
Type 1	A protected area owned and run by the State, Province or a local authority. Conservation legislation is strong.
Type 2	Public or private land managed for conservation and other land uses. Conservation legislation is weak or non-existent.
Type 3	Areas potentially available for conservation, owing to the existence of a structure for communication between conservation planners and landowners.

Table 8.3: Average visual exposure of protected areas that may be affected by the wind farm development.

PROTECTED AREA	STEP TYPE	MIN DIST (KM)	VISUAL EXPOSURE
Kabeljous River NHS	2	0.33	Low
Kabeljousriver NR	1	4.81	Low
State Land 11	2	4.98	Low
State Land 10	2	5.99	Medium
State Land 09	2	7.43	Low
Noorsekloof LNR	1	8.01	Low
Yellowwoods LNR	1	9.04	Low
State Land 07	2	10.94	Low
Loerie Dam LNR	1	11.10	Low
Loerie Dam NR	2	11.39	Low
Gamtoos River Mouth LNR	1	12.66	Low
Lombardini GF	3	12.83	Low
State Land 08	2	13.66	Low
Hankey FR	2	13.75	Low
Seekoeirivier NR	1	14.08	Low
Cape St Francis PC 3	3	15.04	Low
Longmore FR	2	15.76	Low
Stinkhoutsberg NR	1	17.23	Low
State Land 05	2	18.45	Low
State Land 06	2	19.97	Low
Kromme Island Estate PNR	2	20.01	Low
State Land 04	2	20.39	Low
Forest Reserve	2	20.83	Low
Loerie NR	1	21.01	Low
Kromme River Mouth PNR	2	21.06	Low
Eastcot PNR	2	21.39	Low
Cape St Francis PC 1	3	21.54	Low
Cape St Francis PC 5	3	21.95	Low
Van Stadensberg NHS	2	23.91	Low
Cape St Francis PC 2	3	25.36	Low
Thyspunt NHS	2	26.77	Low
Baviaanskloof CA	1	28.78	Low

8.6.1.4.3 Motorists

Sections of the N2, R102 and R330 pass through areas with a medium to **high** visual exposure rating. These sections are between 2.5km and 5km from the wind farm and motorists will occasionally have views of many turbines.

8.6.1.4.4 Residents on surrounding farms

It is clear from the visual exposure map for buildings (Figure 8.10 and Appendix 8.1) that there are several buildings which will potentially be **highly** exposed to the project. The analysis does not take into account vegetation such as high trees and thicket surrounding buildings, or the screening effect of neighbouring buildings. If a building, situated landward of the wind farm for example, has a view of the coast and it has a high visual exposure rating then it is likely that the view will contain many turbines.

8.6.1.5 Visual Intrusion

Visual intrusion	Visual intrusion indicates the level of compatibility or congruence of the project with the particular qualities of the area – its *sense of place*. This is related to the idea of context and maintaining the integrity of the landscape (Oberholzer 2005). It can be ranked as follows: *High* – results in a noticeable change or is discordant with the surroundings; *Moderate* – partially fits into the surroundings, but is clearly noticeable; *Low* – minimal change or blends in well with the surroundings.

Sense of place is defined by (Oberholzer 2005) as: '*The unique quality or character of a place..[It] relates to uniqueness, distinctiveness or strong identity.*' It describes the distinct quality of an area that makes it memorable to the observer.

The visual exposure map includes the localities of sites visited during the photographic survey (Figure 8.9).

8.6.1.5.1 Residents of surrounding settlements

There are no settlements closer than 5km from a wind turbine. Visual exposure to the wind farm is low for all settlements, although there will be areas within some settlements which will have a higher exposure rating. This means that those areas potentially will provide views of a large part of the wind farm. This is especially the case with Hankey where some areas could have views of many turbines against the skyline (Figure 8.17b). However, towns normally contain many structures and buildings which produce complex views with highly contrasting elements and colours and from this distance it is likely that the turbines will form only a small aspect of most views.

Jeffrey's Bay, and particularly the Kabeljous-on-Sea suburb on the southern bank of the Kabeljous River estuary, will have areas where views will be affected by the proposed wind farm. Views to the north often contain the Van Stadens mountains as a backdrop. These views are valued by residents and tourist visitors (e.g. Lagune View guest house) for their scenic qualities. The wind farm lies north-west of Kabeljous-on-Sea and it is unlikely that wind turbines will intrude on scenic views to the north. Figure 8.15, Figure 8.16 and Figure 8.17a provide an indication of the intrusive effect on views from Jeffrey's Bay. The views are from the edges of town and most other views will include buildings and other man-made structures. Visual intrusion is expected to be **moderate** rather than high since scenic views to the north across the Kabeljous River estuary are not likely to be affected by the wind farm.

8.6.1.5.2 Residents on surrounding farms

There are farmsteads and viewpoints on farms which currently have very few man-made structures in view, and potentially have scenic views of distant mountains and the ocean which could be affected by the wind farm. In particular, sensitive viewers and viewpoints west and south of the wind farm, with high visual exposure values (Figure 8.9 and Figure 8.10) will have some of their current views **highly** altered by the wind farm. Figure 8.11 and Figure 8.14 show the potential effect of the wind farm on examples of views in these areas.

Views from north of the Gamtoos River floodplain (Figure 8.10) shows that farmsteads on the floodplain are also likely to be affected, but in this case there are more man-made structures in views and views are generally more complex (Figure 8.12). Sensitive viewers here will experience **low** to **moderate** levels of visual intrusion on their views, depending on visual exposure to the wind farm.

Residents living east of the wind farm will often have the N2 and/or R102 in their views, as well as more structures associated with large settlements, such as power lines, towers, quarries and a railway line.

8.6.1.5.3 Protected Areas

Visual intrusion on viewpoints and visitors in protected areas will be similar to that of residents on farms surrounding the wind farm. Visitors to the Kabeljous River Natural Heritage Site will be in close proximity to the wind farm, but due to the topography of the area only parts of a few turbines will be visible from here. These views will be highly altered by the turbines due to their proximity. The Kabeljous River Nature Reserve north of Jeffrey's Bay is more than 5km from the wind farm and exposure values for the reserve are low. Other man-made elements will also be in many views from here, such as cell phone towers, major roads and power lines. State Land 10 (land owned by the State) is a narrow strip of land along the beach north of the Kabeljous River NR. It is 6km from the wind farm and although the visual exposure rating is medium for this protected area it is likely that the wind farm will have a medium to low effect on views from here due to other structures which will also be common in these views. The other protected areas are too far away to have views from within them significantly altered by the wind farm. A **low** visual intrusion on views from protected areas is expected.

8.6.1.5.4 Motorists

Visual intrusion for motorists driving along sections of the R330 will be **high** as there are very few other similar structures in view and the visual exposure ratings on these sections are high. There are also sections along the N2 and R102 for which visual exposure is high, but here motorists will have many other man-made structures and elements in view (Figure 8.13). Visual intrusion will only be high for a short section close to the wind farm.

8.6.1.6 Shadow Flicker

There are no buildings within 500m of a wind turbine and it is unlikely that shadow flicker will be an issue for residents near the wind farm.

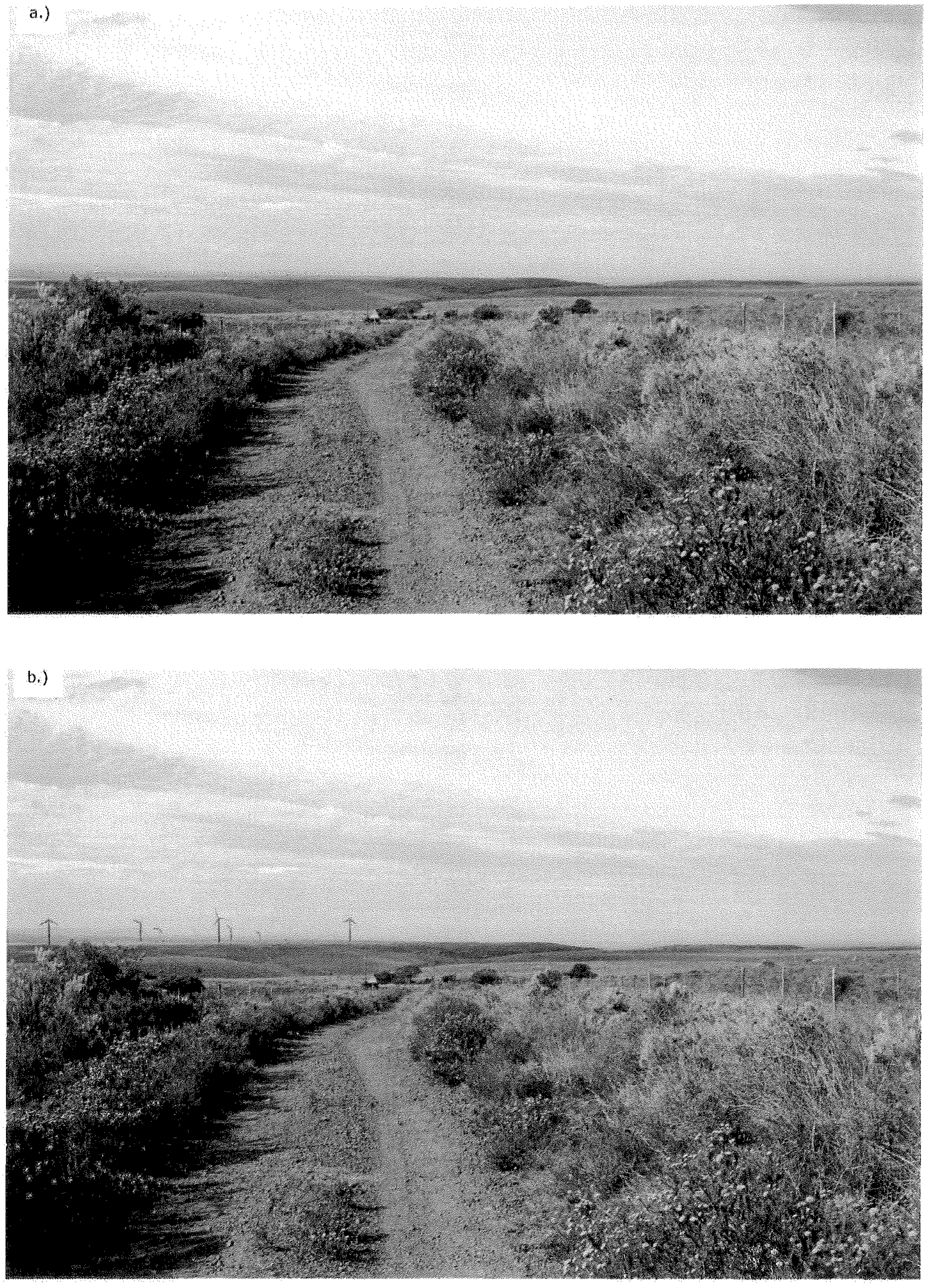


Figure 8.14: **View east from photo site K032 (4km from nearest turbine). a) Photo b) Photomontage.**

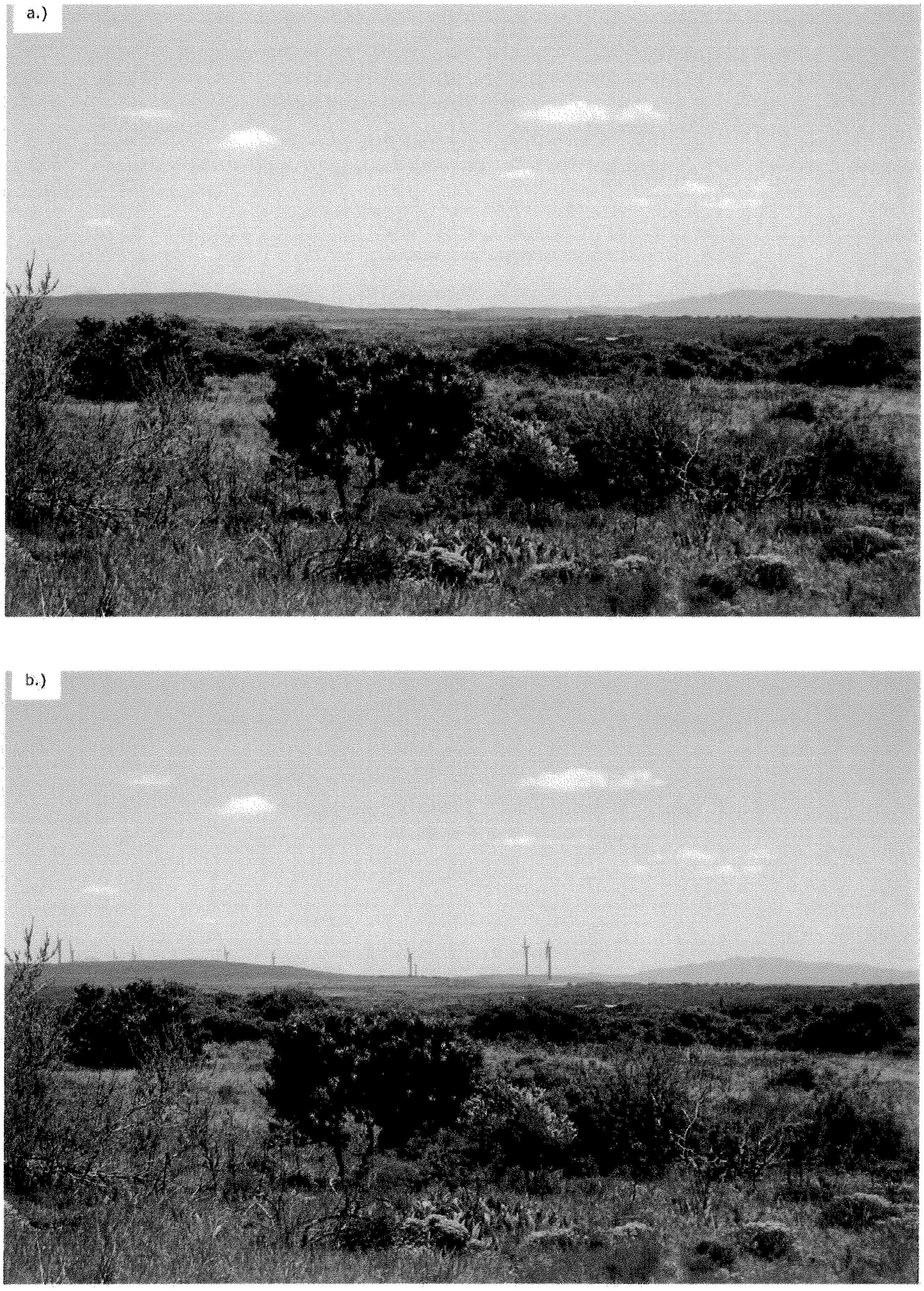


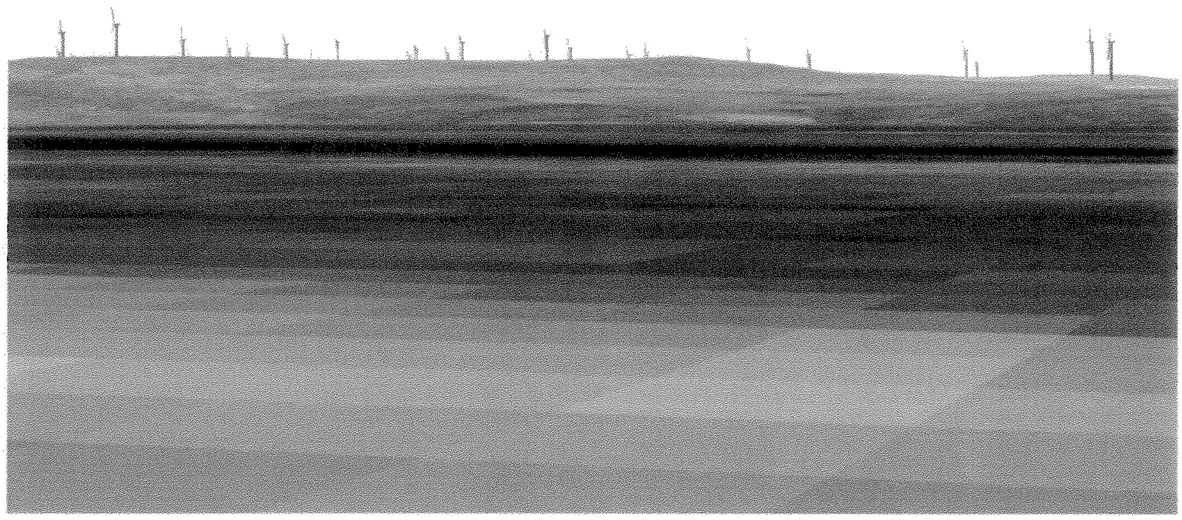
Figure 8.15: View from Kabeljous-on-Sea village north of Jeffrey's Bay (Photo site LBVP01 - 6.7km from nearest turbine). a) Photo b) Photomontage.

a.)

b.)

Figure 8.16: **View (a) and photomontage (b) from Jeffrey's Bay (photo site K010 – 7.5km from nearest wind turbine).**

a.)



b.)

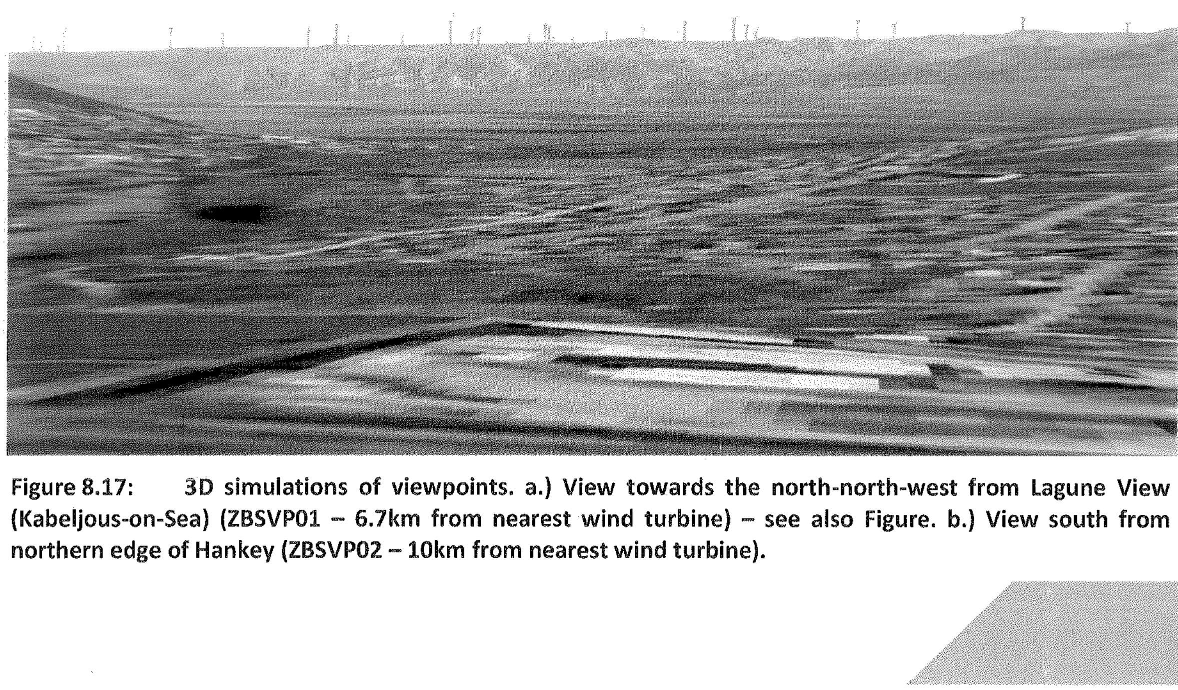


Figure 8.17: 3D simulations of viewpoints. a.) View towards the north-north-west from Lagune View (Kabeljous-on-Sea) (ZBSVP01 – 6.7km from nearest wind turbine) – see also Figure. b.) View south from northern edge of Hankey (ZBSVP02 – 10km from nearest wind turbine).

Table 8.4: Summary of visual impact criteria

Criteria	*Impact*
Viewer Sensitivity	Residents of settlements – Highly sensitive to changes in their views. Residents on surrounding farms – Highly sensitive to changes in their views. Scenic viewpoints and protected areas – Highly sensitive to the introduction of human-induced changes to views. Motorists – Low sensitivity due to short exposure time and the fact that their focus on landscape is reduced. Tourists will have more attention on the landscape and are seen as highly sensitive viewers.
Visibility of Development	**High** due to the tall structures and their position in the topography.
Visual Exposure	Residents of surrounding settlements – **Low** due to their distance from the wind farm. Views from some areas in Hankey and Jeffrey's Bay may be more exposed to the development. Residents on surrounding farms – **high** visual exposure for a number of sensitive viewers due to their proximity to the wind farm site. Protected areas – **Low** visual exposure for protected areas due to their distance from the development site. However, some areas in the Kabeljous River natural heritage site are very close to wind turbine positions. Motorists – **high** for sections of the N2, R102 and R330.
Visual Intrusion	Residents of surrounding settlements – **Low** for most surrounding settlements due to low visual exposure and complexity of views. **Medium** for Kabeljous-on-Sea since there are scenic views which may be affected by the wind farm. Residents on surrounding farms – **high** visual intrusion is expected for residents west of the wind farm site with high or moderate visual exposure since there are few man-made structures in existing views, and there are scenic views of the mountains and ocean which may be affected by the wind farm. Protected areas – **Low** visual intrusion due to low visual exposure. Kabeljous River natural heritage site may experience high visual intrusion in a few places due to its proximity to the wind farm. Motorists – High for sections of the R330.

8.6.2 Significance of Visual Impact On The Landscape

Landscape impacts	Change in the elements, characteristics, character and qualities of the landscape as the result of development (GLVIA, 2002). These effects can be positive or negative, and result from removal of existing landscape elements, addition of new elements, or the alteration of existing elements.

8.6.2.1 Impact 1: Impact of introducing highly visible wind turbines into a mixed agricultural and coastal resort landscape

Cause and Comment

Most of the landscape character types of this region have a low sensitivity to changes brought about by the introduction of a wind farm. Agricultural landscapes will remain agricultural landscapes since they will still function in the same way as before (especially for stock farming). In other countries it is normal to see wind turbines in agricultural landscapes. The coastal resort towns of the Kouga region are changing character as many of them expand and merge, developing from small sea-side villages into coastal resort towns with large commercial centres and light to medium industry. There are highly sensitive landscape character types in the region which may be altered by tall wind turbines.

Mitigation Measures

There are no mitigation measures that will change the significance of the landscape impact other than avoiding the site entirely. A reduction in wind turbine numbers is unlikely to have an appreciable effect since even a few wind turbines will still be highly visible. It is also likely that a wind farm will become a tourist attraction and the impact is therefore not necessarily negative. A visitor centre with information on the wind farm as well as tours to wind turbines may enhance its positive aspects. Local residents will most likely (based on similar developments in other countries) become used to the wind turbines within months.

Significance Statement

The operational lifetime of the wind farm is between 20 and 40 years after which it is relatively easy to disassemble the structures and remove the highly visible components (i.e. turbines). It is possible to extend the lifetime of the wind farm by upgrading or replacing turbines. In light of the indeterminate nature of the wind farm lifetime this author is assuming a *long term* duration of the impact rather than permanent since it is a simple procedure to remove these highly visible components from the landscape when compared with other developments of a similar scale such as nuclear plants or power stations. The extent is *regional* due to the visibility and size of the project. The intensity of the impact is expected to be *low* since the landscape character sensitivity of the agricultural and coastal resort character types are low, and the highly sensitive pristine landscape types are far enough away for the effect on these to be low. The probability of the impact occurring is *high* due to the size of the wind farm and its components, and their high visibility. The significance of the landscape impact according to the rating methodology is therefore expected to be **medium** due to the long duration and regional extent of the impact. Confidence in this assessment is *medium* to *high* since knowledge, information and experience in the Kouga region is extensive, but all research on wind farms and their effect on landscapes refer to countries other than South Africa. There are enough similarities to be able to make inference, but until wind farms are more common in South African landscapes there will always be some uncertainty in their impact on existing landscapes.

Table 8.5: Significance of impact on an agricultural landscape caused by introduction of a wind farm.

Direct Impacts							
Mitigation	Spatial Extent	Intensity	Duration	Probability	Significance & Status		Confidence
					Without Mitigation	With Mitigation	
Visual Impact: Impact on agricultural/coastal resort landscape character types							
No mitigation due to the size and visibility of wind turbines.	Regional (at least visible to 20km on a clear day)	Low – landscape character types have a low sensitivity to the development type	Long term/permanent – can be completely dismantled after 20 years.	High – the height and visibility of the turbines means that it is highly likely that some impact will occur.	Medium due to long term and regional extent of the impact.	Medium	Medium to high – research commonly refer to other countries such as Europe and the USA.

8.6.3 Significance of visual impact on viewers

Visual impacts	Changes to the visual character of available views resulting from the development that include: obstruction of existing views; removal of screening elements thereby exposing viewers to unsightly views; the introduction of new elements into the viewshed experienced by visual receptors and intrusion of foreign elements into the viewshed of landscape features thereby detracting from the visual amenity of the area

8.6.3.1 Impact 2: Visual intrusion on views of sensitive visual receptors of constructing a wind farm

Cause and Comment

The height of the features being built and the siting on the relatively flat coastal plain landscape is likely to expose construction activities against the skyline (Figure 8.18). Large, abnormal freight vehicles and equipment will be visible. Traffic may be disrupted while large turbine components are moved along public roads. Activity at night is also probable since transport of large turbine components may occur after work hours to minimise disruption of traffic on main roads.

Figure 8.18: Construction of the existing Coega wind turbine (2km away).

Mitigation Measures

The most obvious causes of impacts resulting from construction activities cannot be mitigated since the turbines are so tall and they are to be installed on the top of ridges close to settlements and busy roads. The duration of the impact is short, though, and there are a number of mitigation measures that will curtail the intensity to some extent:

- Dust suppression is important as dust will raise the visibility of the development.
- New road construction should be minimised and existing roads should be used where possible.
- The contractor should maintain good housekeeping on site to avoid litter and minimise waste.
- Clearance of indigenous vegetation should be minimised and rehabilitation of cleared areas should start as soon as possible.
- Erosion risks should be assessed and minimised as erosion scarring can create areas of strong visual contrast with the surrounding vegetation, which can often be seen from long distances since they will be exposed against the hillslopes.
- Laydown areas and stockyards should be located in low visibility areas (e.g. valleys between ridges) and existing vegetation should be used to screen them from views where possible.
- Night lighting of the construction sites should be minimised within requirements of safety and efficiency. See section on lighting for more specific measures.
- Fires and fire hazards need to be managed appropriately.
- If practical, notify locals when turbines are being assembled, and invite them to a viewing of the construction process.

Significance Statement

The duration of the impact is *short term* (while construction lasts). The extent is *regional* due to the nature of the development (height of towers and siting on ridges and higher ground) and construction activities will be visible over long distances. The intensity of the visual impact will be *high* since many highly sensitive visual receptors will be affected by the impact. The probability of the impact occurring is *definite* since construction of the turbines will be outlined against the skyline (or the sea) for many of the viewers, and is likely to be viewed with some curiosity. The mitigation measures are there to contain the severity of the impact. The significance of the impact is **high** due to the regional extent and high intensity of the impact. Construction will last approximately 12 to 15 months, of which several weeks are spent erecting the turbines (under favourable weather conditions) – potentially the most visible activity as it will most probably be exposed against the skyline. It is also worth noting that the visual impact of at least some of the construction phase is likely to be positive, especially during assembly of the turbine towers. The construction engineering feat of lifting and attaching components weighing more than 50 tons a piece in a highly visible area is bound to be spectacular (see for example Degraw 2009 or filmsfromyes2wind 2010).

Table 8.6: Significance of wind farm construction activities on sensitive viewers

Direct Impacts							
Mitigation	Spatial Extent	Intensity	Duration	Probability	Significance & Status		Confidence
					Without Mitigation	With Mitigation	
Visual Impact: Impact on sensitive visual receptors due to the construction of a wind farm.							
Limited mitigation to contain the severity of the impact.	Regional (at least visible to 20km on a clear day)	High – construction will be outlined against the sky from most viewpoints.	Short term – it should take less than a year to construct the highly visible component of the wind farm.	Definite – the high visibility of construction activity on wind turbines ensures that there will be a visual impact.	High due to the high intensity of the impact and the number of sensitive viewers who will be affected. The impact is not necessarily negative though and some viewers will find the construction activity fascinating.	High	Medium to high – research commonly refer to other countries such as Europe and the USA.

8.6.3.2 Impact 3: Intrusion of large highly visible wind turbines on the existing views of sensitive visual receptors

Cause and Comment

The region has a mixture of agricultural landscape (including settlements which developed as agricultural service centres) and coastal holiday resort towns with a large seasonal influx of holiday makers and tourists. Some settlements such as Humansdorp and Jeffrey's Bay are expanding at a high rate and commercial and industrial developments are becoming part of the visual landscape. Most of the region inland from these settlements is still used for agriculture (mainly stock farming on the higher ground, with irrigated and dry land crops in some of the river floodplains) although game farming is replacing stock farming in some areas. Large man-made structures are still scarce and are mostly limited to major roads, power lines and a few quarries. Other structures common to views in the region are communication towers, chicken broiler housing and farmsteads/buildings.

There are scenic views with distant mountains or the ocean as a backdrop, and a wind farm will potentially be intrusive on these, especially if these views include few other structures. Areas west of the wind farm site have sense of remoteness which will be affected if wind turbines are introduced into the region.

Mitigation Measures

There are no mitigation measures that can reduce the impact significantly unless the site is avoided but there are a number of measures that can enhance the positive aspects of the impact. It has been shown that uncluttered sites are preferred for wind farms (Gipe 1995; Stanton 1996; Vissering 2005). In view of this the following mitigation measures and suggestions may enhance the positive visual aspects of the development:

- Ensure that there are no wind turbines closer than 500 m to a residence.
- Maintenance of the turbines is important. A spinning rotor is perceived as being useful. If a rotor is stationary when the wind is blowing it is seen as not fulfilling its purpose and a negative impression is created (Gipe 1995).
- Signs near wind turbines should be avoided unless they serve to inform the public about wind turbines and their function. Advertising billboards should be avoided.
- According to the Aviation Act, 1962, Thirteenth Amendment of the Civil Aviation Regulations, 1997: "Wind turbines shall be painted bright white to provide maximum daytime conspicuousness. The colours grey, blue and darker shades of white should be avoided altogether. If such colours have been used, the wind turbines shall be supplemented with daytime lighting, as required."
- Lighting should be designed to minimise light pollution without compromising safety. Investigate using motion sensitive lights for security lighting. Turbines are to be lit according to Civil Aviation regulations (see impact 4, section 8.6.3.3).
- An information centre (provided that it is located in a low visibility area) and trails along the wind farm can enhance the project by educating the public about the need and benefits of wind power. 'Engaging school groups can also assist the wind farm proponent, as energy education is paramount in developing good public relations over the long term. Instilling the concept of sustainability, and creating awareness of the need for wind farm developments, is an important process that can engage the entire community' (Johnston 2001). This has also been borne out by a more recent study on the effect of wind farms on tourism in which respondents said they would visit wind farms as long as there was an information centre (Frantál & Kunc 2010).

Significance Statement

The operational lifetime of the wind farm is between 20 and 40 years after which it is relatively easy to disassemble the structures and remove the highly visible components (i.e. turbines). It is possible to extend the lifetime of the wind farm by upgrading or replacing turbines. In light of the indeterminate nature of the wind farm lifetime this author is assuming a *long term* duration of the impact rather than permanent since it is a simple procedure to remove these highly visible components from the landscape when compared with other developments of a similar scale such as nuclear plants or power stations. A wind farm is not a permanent structure and it can be dismantled completely (refer to Section 6.2.1)." The extent of the impact is *regional* since the turbines will be visible from more than 20km away on clear days. Due to the high visual intrusion that is expected on the views of some of the highly sensitive visual receptors in the region, the intensity of the impact is expected to be *high*. The status in this case will depend on the viewer's opinion on the aesthetic and symbolic appeal of wind turbines and is also likely to change from negative to positive if acceptance of the development follows international experience. It is *definite* that the impact will occur due to the high visibility of the turbines and the high visual exposure that some highly sensitive viewers in the surrounding region will experience. The overall significance of the visual impact on sensitive viewers is **high**.

Table 8.7: Significance of the visual impact of the proposed wind farm on sensitive viewers

Direct Impacts							
Mitigation	Spatial Extent	Intensity	Duration	Probability	Significance & Status: Without Mitigation	Significance & Status: With Mitigation	Confidence
Visual Impact: Intrusion of a wind farm on the views of sensitive visual receptors.							
Limited mitigation.	Regional (at least visible to 20km on a clear day)	High – the views of a number of highly sensitive viewers surrounding the wind farm will be severely affected due to high visual exposure and intrusion.	Long term/permament – the lifetime of the wind farm is expected to be at least 20 years after which the turbines can be dismantled and removed.	Definite – there are no other similar structures in the region.	High due to the high intensity of the impact and the number of sensitive viewers who will be affected. The impact is not necessarily negative and will vary from viewer to viewer.	High	Medium to high – research commonly refer to other countries such as Europe and the USA.

8.6.3.3 Impact 4: Impact of night lights of a wind farm on existing nightscape

Cause and Comment

Wind farms are required by law to be lit at night as they represent hazards to aircraft due to the height of the turbines. Marking of turbines depends on wind farm layout and not all turbines need to be lit. Marking consists of a red flashing light of medium intensity (2000 candela). The marking requirements from the South African Civil Aviation Authority(SACAA) will be adhered to.

According to this author's interpretation of the Civil Aviation Regulations the wind farm layout will entail lighting of at least 28 turbines. These lights are not bright and are unlikely to contribute to sky-glow or light pollution in the region, but they will be highly visible due to their height. Views towards the sea across the wind farm will be affected, but the background sky-glow caused by coastal villages and chokka boats, and existing tower lights is likely to reduce the impact. Views from east to west are likely to be more affected although there are many lights in the foreground including lights from traffic on the N2.

Mitigation Measures

The aviation standards have to be followed and no mitigation measures are applicable in terms of marking the turbines. Lighting of ancillary buildings and structures should be designed to minimise light pollution without compromising safety. Motion sensitive lighting can be used for security purposes.

Significance Statement

Extent is difficult to determine and since these are medium intensity lights the extent of the impact is expected to be *local* even though they may be visible over a longer distance. Duration is *long term or permanent.* The intensity of the impact is expected to be *moderate* (for a few farm residents living close to the turbines) to *low*. Likelihood is *probable* for residents living close to the wind farm and having views of turbines, and *unlikely* for other viewers due to existing lights and sky-glow. The significance of the impact is **low** to **moderate** due to the long term of the development.

Table 8.8: Significance of the impact of night lighting of the wind farm on sensitive viewers

Direct Impacts							
Mitigation	Spatial Extent	Intensity	Duration	Probability	Significance & Status: Without Mitigation	Significance & Status: With Mitigation	Confidence
Visual Impact: Impact of night lighting of wind farm on sensitive viewers							
Mitigation options are limited by aviation standards	**Local** since it's unlikely that the lights will be noticed from further than 5km away.	**Low** to **moderate** depending on the viewer's distance away from the wind farm.	**Long term/permanent** – lifetime of the wind farm.	**Probable** due to the visibility of the turbines.	**Medium** due to the long duration of the impact.	**Medium**	**Medium** to high – research commonly refer to other countries such as Europe and the USA.

8.7 CONCLUSIONS AND RECOMMENDATIONS

The wind farm will be built on a highly visible plateau above the N2, and it will potentially be visible over a large region. Viewers who will be most affected by the wind farm are those living on farms surrounding the development site, especially for viewpoints west and south of the site where existing views contain relatively few man-made structures and a sense of remoteness prevails. However, there are not many sensitive viewers in these areas who will be highly exposed to the wind farm. Views from Jeffrey's Bay are unlikely to be highly impacted since scenic views are normally directed at the mountains in the north or the ocean. Protected areas in the region are generally too far from the site to be highly impacted.

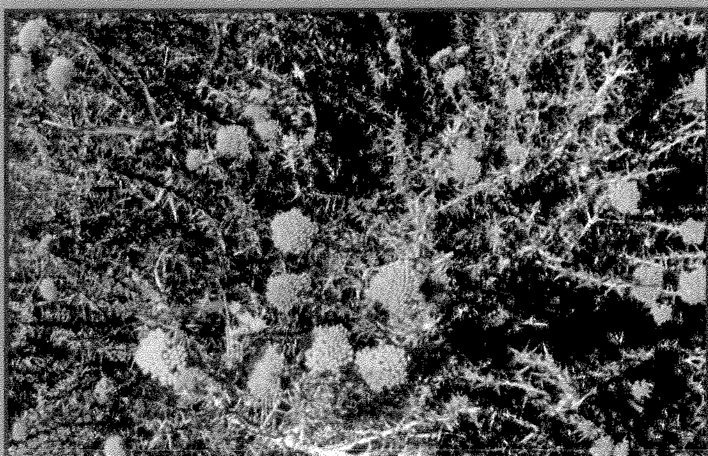
Appendix 8.1: Sensitive viewers who will experience high visual exposure to the wind farm

BUILDING	MIN DIST (m)	VISUAL EXPOSURE	LONGITUDE	LATITUDE
MISGUND (341/4)	2796.75	High	24.8692	-33.9646
ROOI HOEK (342/R)	2909.60	High	24.8781	-33.9736
NEW PAPIESFONTEIN (320/5)	3221.10	High	24.9521	-33.9629
NEW PAPIESFONTEIN (320/4)	3278.41	High	24.9555	-33.9593
MISGUND (341/6)	3309.57	High	24.8622	-33.9645
PAPIES FONTEIN (319/8)	3509.69	High	24.9459	-33.9717
ZUUR BRON (191/R)	3690.38	High	24.8276	-33.9003
ZUUR BRON (191/R)	3715.34	High	24.8274	-33.9001
BOSCH BOK HOEK (182/3)	4033.51	High	24.9015	-33.8743
ROODE FONTEIN (181/R)	4418.56	High	24.9319	-33.8827
BOSCH BOK HOEK (182/R)	4419.39	High	24.9091	-33.8730
BUFFELS HOEK (180/23)	4425.30	High	24.9504	-33.8927
KABELJAUWS RIVIER (339/6)	4436.24	High	24.8872	-33.9916
BOSCH BOK HOEK (182/3)	4439.90	High	24.9051	-33.8714
KABELJAUWS RIVIER (339/4)	4467.24	High	24.8859	-33.9917
BOSCH BOK HOEK (182/R)	4513.20	High	24.9102	-33.8726
WELTEVREDEN (306/1)	4789.88	High	24.8127	-33.9273
WELTEVREDEN (306/1)	4797.08	High	24.8125	-33.9271
WELTEVREDEN (306/1)	4822.88	High	24.8122	-33.9272
WELTEVREDEN (306/1)	4841.85	High	24.8121	-33.9274
BUFFELS HOEK (180/23)	4925.61	High	24.9357	-33.8790
WELTEVREDEN (306/1)	5085.52	High	24.8086	-33.9245
WELTEVREDEN (306/1)	5117.60	High	24.8083	-33.9244
WELTEVREDEN (306/1)	5311.66	High	24.8062	-33.9247
WELTEVREDEN (306/1)	5381.66	High	24.8054	-33.9246
WELTEVREDEN (306/1)	5416.00	High	24.8051	-33.9250
KABELJAUWS RIVIER (339/2)	5485.84	High	24.8893	-34.0015
KABELJAUWS RIVIER (339/2)	5528.75	High	24.8907	-34.0020
KABELJAUWS RIVIER (339/2)	5532.38	High	24.8896	-34.0020
KABELJAUWS RIVIER (339/2)	5545.86	High	24.8905	-34.0022
KABELJAUWS RIVIER (339/2)	5549.25	High	24.8901	-34.0022
WELTEVREDEN (305/3)	5906.64	High	24.8156	-33.9523
WELTEVREDEN (305/3)	5927.01	High	24.8149	-33.9518
WELTEVREDEN (305/3)	5931.53	High	24.8150	-33.9520
MISGUND (341/3)	6361.48	High	24.8463	-33.9915
MISGUND (341/3)	6365.03	High	24.8464	-33.9917
MISGUND (341/3)	6385.40	High	24.8464	-33.9919
LOERIE RIVIER VLAKTE (314/31)	6752.12	High	24.9812	-33.8934
MELKHOUTBOSCH (345/4)	6796.24	High	24.8362	-33.9879

MELKHOUTBOSCH (345/4)	6804.18	High	24.8364	-33.9881
MELKHOUTBOSCH (345/4)	6805.29	High	24.8362	-33.9880
MELKHOUTBOSCH (345/4)	6845.65	High	24.8360	-33.9883
MELKHOUTBOSCH (345/4)	6846.22	High	24.8362	-33.9885
MELKHOUTBOSCH (345/4)	6858.46	High	24.8359	-33.9885
LOERIE RIVIER VLAKTE (314/8)	6993.88	High	24.9874	-33.9004
LOERIE RIVER (436/62)	7084.19	High	24.9841	-33.8917
ZWARTEBOSCH (347/5)	7096.79	High	24.8087	-33.9629
BUFFELS HOEK (180/38)	7104.26	High	24.9613	-33.8686
ZWARTEBOSCH (347/5)	7141.82	High	24.8085	-33.9633
ZWARTEBOSCH (347/5)	7181.13	High	24.8079	-33.9632
ZWARTEBOSCH (347/5)	7185.53	High	24.8076	-33.9630
BUFFELS HOEK (180/38)	7206.62	High	24.9629	-33.8685
ZWARTEBOSCH (347/5)	7211.73	High	24.8076	-33.9634
BUFFELS HOEK (180/38)	7215.90	High	24.9627	-33.8683
ZWARTEBOSCH (347/5)	7226.26	High	24.8074	-33.9634
BUFFELS HOEK (180/38)	7235.75	High	24.9629	-33.8681
ZWARTEBOSCH (347/5)	8023.72	High	24.7986	-33.9655
PARCEL ID 200	8780.56	High	24.9689	-33.8546
PARCEL ID 200	8993.93	High	24.9698	-33.8528
PARCEL ID 200	9023.84	High	24.9701	-33.8527

Environmental Impact Assessment for the proposed Ubuntu Wind Energy Project near Jeffrey's Bay, Eastern Cape: Draft Environmental Impact Assessment Report

Chapter 9: Noise Impacts



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CHAPTER 9. IMPACT OF NOISE

This Chapter presents the Noise Specialist Study conducted by Safetrain CC (trading as Safetech) under the leadership of Mr Brett Williams, as input to the EIA being conducted by CSIR for the proposed WKN-Windcurrent Ubuntu Wind Energy Project.

9.1 INTRODUCTION & METHODOLOGY

This section presents the approach to the noise assessment. Wind Current Ubuntu is intending to construct a wind energy electricity generation project at Jeffery's Bay, Eastern Cape. The project will consist of three possible turbine types. This study only addresses the noise impact. The study was requested by the CSIR as part of the overall Environmental Impact Assessment for the project.

9.1.1 Methodology

The methodology used in the study consisted of three approaches to determine the noise impact from the proposed project and associated infrastructure:

- A desktop study to model the likely noise emissions from the site;
- Field measurements of the existing ambient noise at different locations in the vicinity of the project; and
- The identification of potential noise sensitive areas.

The desktop study was done using the available literature on noise impacts from wind turbines as well as numerical calculations of the possible noise emissions. A Danish modelling program, EMD WindPro Software Version 2.7 was used and has been developed specifically for wind turbine noise. This program is used extensively worldwide and has been developed and validated in Denmark. The method described in SANS 10357:2004 version 2.1 (The calculation of sound propagation by the Concawe method) was used a reference for further calculations where required.

WindPro uses the methods described in ISO 9613-2 (Acoustics – Attenuation of sound during propagation outdoors. Part 2 – General method of calculation). This method is very similar to SANS 10357:2004 and is used worldwide for modelling noise from various sources including wind turbine generators (Wind turbines). Where a tonal character is identified in the noise emitted from the turbines, a 5 dB(A) penalty is included in the modelling result.

The numerical results were then used to produce "noise maps" that visually indicate the extent of the noise emissions from the site. The noise emissions were modelled for various wind speeds from 4m/s to 12m/s. The direction of the wind is not taken into consideration as the wind could blow from any direction at the speeds that were modelled. The modelling is thus for worst case scenarios and takes the topography around the turbine and noise sensitive area (NSA) into account. The site elevation data was sourced from NASA and imported into WindPro. A comparison was done using the digital elevation data and the contour heights from a 1:50 000 topographical map. The comparison showed that the digital data and the map corresponded well. Furthermore, the digital data provided a better resolution.

Field Study

A number of measurements were taken by placing the noise meter on a tripod and ensuring that it was at least 1.2 m from floor level and 3.5 m from any large flat reflecting surface.

All measurement periods exceeded at least 10 minutes, except where indicated. The noise meter was calibrated before and after the survey. At no time was the difference more than one decibel (If the difference is more than 1 decibel the meter is not calibrated properly and the measurement is discarded). The weighting used was on the A scale and the meter placed on impulse correction, which is the preferred method as per Section 5 of SANS 10103:2008. No tonal correction was added to the data. Measurements were taken during the day and night-time. The meter was fitted with a windscreen, which is supplied by the manufacturer. The screen is designed so as to reduce wind noise around the microphone and not bias the measurements.

The test environment contained the following noise sources:

- Vehicular traffic that included trucks and cars;
- Birds and insects;
- Farm animals;
- Wind noise; and
- Noise from the Chicken houses fans.

The instrumentation that was used to conduct the study is as follows:

- Rion Precision Sound Level Meter (NL32) with 1/3 Octave Band Analyzer Serial No. 00151075;
- Microphone (UC-53A) Serial No. 307806; and
- Preamplifier (NH-21) Serial No. 13814.

All equipment was calibrated in October 2010 (see Appendix 9.2)

9.1.2 Terms of Reference

The Terms of Reference provided by CSIR for this noise study included the following:

Objectives of the noise study:

- Describe the affected environment covered by the scope of the noise specialist study, drawing on existing information, professional experience and limited field work;
- Contribute to the scoping process by identifying issues and concerns that need to be addressed in the specialist study, based on the experience of the specialist;
- Identify relevant protocols, legal and permit requirements (if any); and
- Assess the potential impacts of the project, and provide management actions to avoid/reduce negative impacts or enhance benefits, as well as associated monitoring requirements.

The scope of work of the noise study includes the following:

- Conduct a desktop study of available information that can support and inform the specialist noise study;
- Identify issues and potential impacts, as well as possible cumulative impacts related to the noise aspects of the project;

- Measure the existing ambient noise at the proposed site, during both the day and night time;
- Identify the components of the project that could generate significant noise levels;
- Identify the sensitive noise receptors in the vicinity of the proposed project;
- Conduct a noise study of the predicted (future) noise impacts during construction and operation of the proposed wind farm;
- Assess the potential impacts associated with the proposed project for the construction, operation and decommissioning phases; and
- Identify management and mitigation actions to enhance positive impacts and avoid/reduce negative impacts respectively.

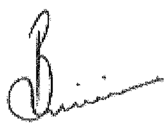
The required EIA end-product from the noise assessment is to provide a comprehensive and detailed Noise Impact Assessment (NIA) that presents and evaluates the noise impact of the wind turbines under different operating conditions. The specialists will be required to assess impacts for the preferred layout and an alternative layout.

9.1.3 Declaration of independence

The declaration of independence by the noise specialist is provided in Box 9.1 below:

BOX 9.1: DECLARATION OF INDEPENDENCE FOR NOISE IMPACT ASSESSMENT

I Brett Williams declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Wind Current Ubuntu Wind Energy Project, application or appeal in respect of which I was appointed, other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.



BRETT WILLIAMS

9.2 DESCRIPTION OF THE NOISE IMPACTS

The sources of sounds emitted from operating wind turbines can be divided into two categories, firstly mechanical sounds, from the interaction of turbine components, and secondly aerodynamic sounds, produced by the flow of air over the blades.

9.2.1 Mechanical Sounds

Mechanical sounds originate from the relative motion of mechanical components and the dynamic response among them. Sources of such sounds include:

- Gearbox

- Generator
- Yaw Drives
- Cooling Fans
- Auxiliary Equipment (e.g., hydraulics)

Since the emitted sound is associated with the rotation of mechanical and electrical equipment, it tends to be tonal (of a common frequency), although it may have a broadband component. For example, pure tones can be emitted at the rotational frequencies of shafts and generators, and the meshing frequencies of the gears.

In addition, the hub, rotor, and tower may act as loudspeakers, transmitting the mechanical sound and radiating it. The transmission path of the sound can be air-borne or structure-borne. Air-borne means that the sound is directly propagated from the component surface or interior into the air. Structure-borne sound is transmitted along other structural components before it is radiated into the air.

Figure 9.1 shows the type of transmission path and the sound power levels for the individual components for a 2 MW wind turbine.

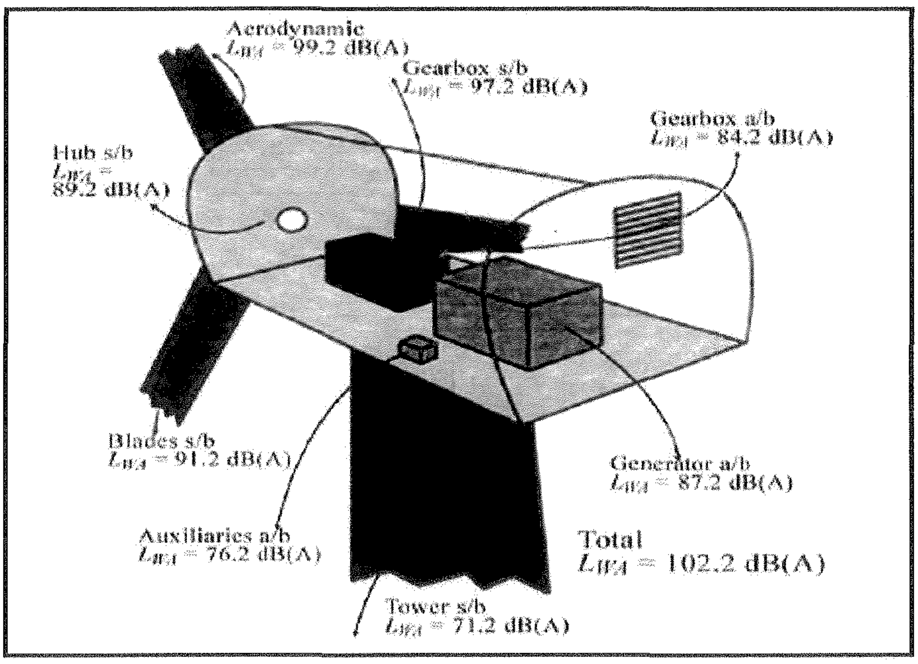


Figure 9.1: **Typical Sound Power Levels of a 2 MW Turbine**

9.2.2 Aerodynamic Sound

Aerodynamic broadband sound is typically the largest component of wind turbine acoustic emissions. It originates from the flow of air around the blades. A large number of complex flow phenomena occur, each of which might generate some sound (see Figure 9.2). Aerodynamic sound generally increases with rotor speed. The various aerodynamic sound generation mechanisms that have to be considered are divided into three groups:

- *Low Frequency Sound:* Sound in the low frequency part of the sound spectrum is generated when the rotating blade encounters localized flow deficiencies due to the flow around a tower, wind speed changes, or wakes shed from other blades;
- *Inflow Turbulence Sound:* Depends on the amount of atmospheric turbulence. The atmospheric turbulence results in local force or local pressure fluctuations around the blade; and
- *Airfoil Self Noise:* This group includes the sound generated by the air flow right along the surface of the airfoil. This type of sound is typically of a broadband nature, but tonal components may occur due to blunt trailing edges, or flow over slits and holes.

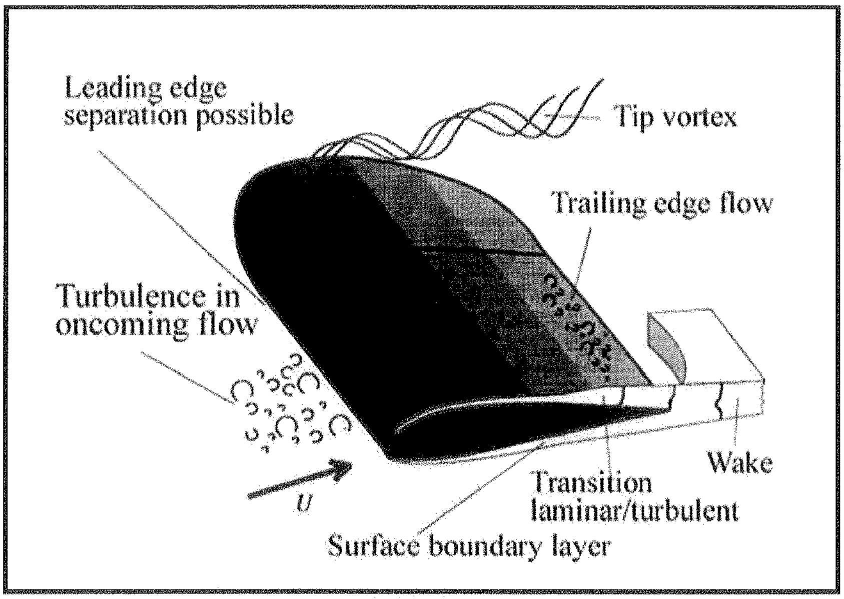


Figure 9.2: Sources of Aerodynamic Noise

Modern airfoil design takes all of the above factors into account and is generally much quieter that the first generation of bade design.

9.2.3 Ambient Sound & Wind Speed

The ability to hear a wind turbine in a given installation depends on the ambient sound level. When the background sounds and wind turbine sounds are of the same magnitude, the wind turbine sound gets lost in the background. Both the wind turbine sound power level and the ambient sound pressure level will be functions of wind speed. Thus whether a wind turbine exceeds the background sound level will depend on how each of these varies with wind speed.

The most likely sources of wind-generated sounds are interactions between wind and vegetation. A number of factors affect the sound generated by wind flowing over vegetation. For example, the total magnitude of wind-generated sound depends more on the size of the windward surface of the vegetation than the foliage density or volume.

The sound level and frequency content of wind generated sound also depends on the type of vegetation. For example, sounds from deciduous trees tend to be slightly lower and more broadband than that from conifers, which generate more sounds at specific frequencies. The equivalent A-weighted broadband sound pressure generated by wind in foliage has been shown to be approximately proportional to the base 10 logarithm of wind speed.

Sound levels from large modern wind turbines during constant speed operation tend to increase more slowly with increasing wind speed than ambient wind generated sound. As a result, wind turbine noise is more commonly a concern at lower wind speeds and it is often difficult to measure sound from modern wind turbines above wind speeds of 8 m/s because the background wind-generated sound masks the wind turbine sound above 8 m/s.

It should be remembered that average sound pressure measurements might not indicate when a sound is detectable by a listener. Just as a dog's barking can be heard through other sounds, sounds with particular frequencies or an identifiable pattern may be heard through background sounds that is otherwise loud enough to mask those sounds. Sound emissions from wind turbines will also vary as the turbulence in the wind through the rotor changes. Turbulence in the ground level winds will also affect a listener's ability to hear other sounds. Because fluctuations in ground level wind speeds will not exactly correlate with those at the height of the turbine, a listener might find moments when the wind turbine could be heard over the ambient sound.

9.2.4 Low Frequency Noise and Infrasound

Infrasound was a characteristic of some wind turbine models that has been attributed to early designs in which turbine blades were downwind of the main tower. The effect was generated as the blades cut through the turbulence generated around the downwind side of the tower. Modern designs generally have the blades upwind of the tower. Wind conditions around the blades and improved blade design minimise the generation of the effect.

Low frequency pressure vibrations are typically categorized as low frequency sound when they can be heard near the bottom of human perception (10-200 Hz), and infrasound when they are below the common limit of human perception. Sound below 20 Hz is generally considered to be infrasound, even though there may be some human perception in that range. Because the ranges of low frequency sound and infrasound overlap it is important to understand how the terms are applied in a given context.

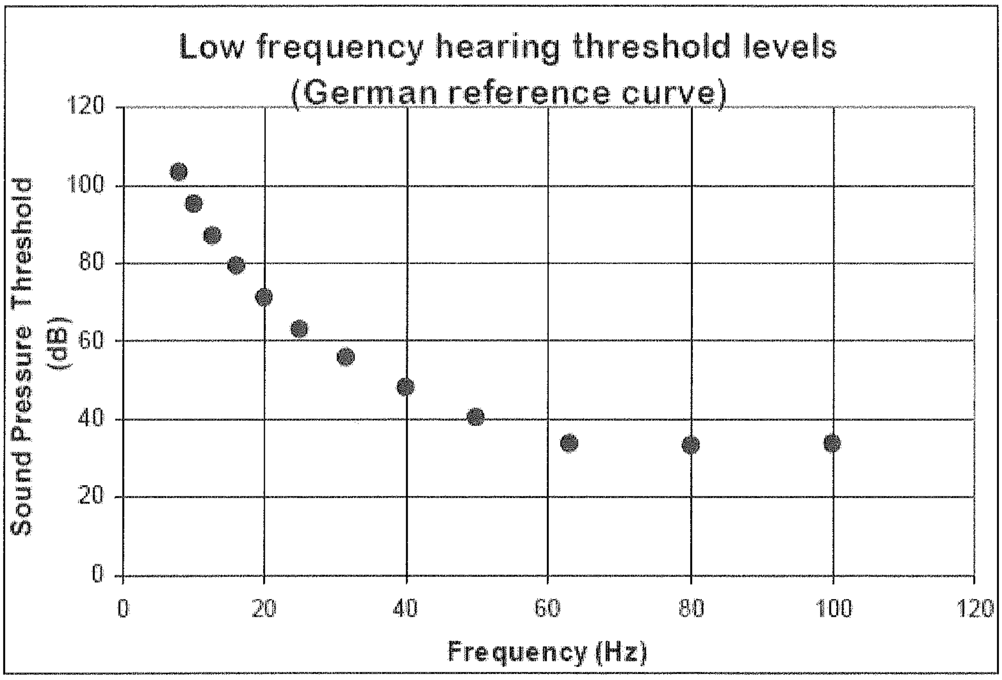


Figure 9.3: Low frequency Hearing Threshold Levels

Infrasound is always present in the environment and stems from many sources including ambient air turbulence, ventilation units, waves on the seashore, distant explosions, traffic, aircraft, and other machinery. Infrasound propagates farther (i.e. with lower levels of dissipation) than higher frequencies. To place infrasound in perspective, when a child is swinging high on a swing, the pressure change on its ears, from top to bottom of the swing, is nearly 120 dB at a frequency of around 1 Hz.

Some characteristics of the human perception of infrasound and low frequency sound are:

- Low frequency sound and infrasound (2-100 Hz) are perceived as a mixture of auditory and tactile sensations;
- Lower frequencies must be of a higher magnitude (dB) to be perceived, e.g. the threshold of hearing at 10 Hz is around 100 dB (see Figure 9.4 above);.
- Tonality cannot be perceived below around 18 Hz; and
- Infrasound may not appear to be coming from a specific location, because of its long wavelengths.

The primary human response to perceived infrasound is annoyance, with resulting secondary effects. Annoyance levels typically depend on other characteristics of the infrasound, including intensity, variations with time, such as impulses, loudest sound, periodicity, etc. Infrasound has three annoyance mechanisms:

- A feeling of static pressure;
- Periodic masking effects in medium and higher frequencies;
- Rattling of doors, windows, etc. from strong low frequency components.

Human effects vary by the intensity of the perceived infrasound, which can be grouped into these approximate ranges:

- 90 dB and below: No evidence of adverse effects'
- 115 dB: Fatigue, apathy, abdominal symptoms, hypertension in some humans;
- 120 dB: Approximate threshold of pain at 10 Hz; and
- 120 – 130 dB and above: Exposure for 24 hours causes physiological damage.

There is no reliable evidence that infrasound below the perception threshold produces physiological or psychological effects.

The typical range of sound power level for wind turbine generators is in the range of 100 to 105dBA – a much lower sound power level (10dB or more) than the majority of construction machinery such as bulldozers. In order for infrasound to be audible even to a person with the most sensitive hearing at a distance of, say, 300m would require a sound power level of at least 140dB at 10Hz and even higher emission levels than this at lower frequencies and at greater distances. There is no information available to indicate that wind turbine generators emit infrasound anywhere near this intensity[(2)].

Several studies have confirmed that there are no physiological effects from low frequency or infrasound from wind turbines (Bell Acoustic Consulting, 2004; DEFRA, 2003; DTI, 2006; ISO 9613-2; SANS 10103:2008 Version 6; Swedish Environmental Protection Agency, 2003 and University of Groningen, 2003).

9.3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The proposed Ubuntu wind energy project is to be constructed on farmland in an area adjacent to the N2 near Jeffrey's Bay located in the Eastern Cape Province of South Africa. The project is planned to host up to 50 turbines. Various options are modelled in this report. The topography surrounding the site is characterised by undulating hills.

9.3.1 Site Location

The location and position of the various wind turbines are contained in the Table 9.1 and Figures 9.4 and 9.5 below.

Table 9.1: Wind Turbine Location Co-ordinates

	Vestas V90		Vestas V112	
WTG Name	X	Y	X	Y
WEA01	307 981.1044	6 242 449.8391	307 938.9502	6 242 531.4075
WEA02	308 080.8166	6 241 829.2690	308 079.1198	6 241 828.4598
WEA03	307 495.0948	6 244 557.7529	307 240.0000	6 244 683.9997
WEA04	307 370.8725	6 243 920.3476	307 323.6601	6 244 004.9575
WEA05	306 391.9497	6 242 073.9916	306 575.0000	6 243 837.9997
WEA06	306 183.1011	6 241 621.3102	306 044.0000	6 243 419.9997
WEA07	305 800.0000	6 241 231.0000	305 897.2196	6 242 754.9884
WEA08	306 999.9015	6 244 315.4135	306 353.3684	6 242 232.7870
WEA09	306 542.4556	6 242 999.3911	305 949.0000	6 241 662.9997
WEA10	306 193.6987	6 242 483.5648	305 601.4494	6 241 054.8451
WEA11	305 515.6978	6 241 752.1822	306 572.0000	6 244 775.9997
WEA12	305 198.3235	6 241 313.4211	306 041.0000	6 244 331.9997
WEA13	306 697.0000	6 244 783.0000	305 393.5238	6 243 595.9074
WEA14	306 545.0000	6 244 085.0000	305 189.6522	6 242 944.5800
WEA15	306 232.2860	6 243 462.3262	305 151.0000	6 242 273.9997
WEA16	305 967.4028	6 242 982.8257	305 139.0718	6 241 563.5391
WEA17	305 628.2354	6 242 558.5007	305 772.1883	6 244 972.6204
WEA18	305 188.6810	6 242 237.7599	305 255.5208	6 244 253.5845
WEA19	304 884.0317	6 241 764.4781	304 733.0000	6 243 435.9997
WEA20	306 134.0000	6 244 864.0000	305 197.6628	6 245 394.9803
WEA21	306 041.0000	6 244 318.0000	304 864.3631	6 244 810.9442
WEA22	305 828.9474	6 243 821.3777	304 495.0340	6 244 081.9997
WEA23	305 494.7057	6 243 256.6391	303 997.6516	6 243 484.9137
WEA24	305 130.9955	6 242 775.8074	304 716.5329	6 245 865.0531
WEA25	305 524.9905	6 244 276.1299	304 217.7385	6 245 284.1391
WEA26	305 622.0000	6 245 084.0000	303 992.0000	6 244 570.9997
WEA27	304 852.1961	6 243 262.8230	303 972.5235	6 245 904.1010
WEA28	305 234.1139	6 243 730.4498	303 491.4114	6 245 416.7417
WEA29	304 694.1775	6 243 798.3980	303 337.6936	6 244 750.6912
WEA30	305 190.4770	6 245 424.0753	303 023.3457	6 244 152.3858
WEA31	304 983.7157	6 244 927.9887	303 354.0000	6 246 149.9997
WEA32	304 707.7771	6 244 377.0725	302 827.0000	6 245 623.9997
WEA33	304 130.0000	6 243 968.0000	302 353.2313	6 245 025.1441
WEA34	303 981.1134	6 243 448.9309	-	-
WEA35	304 784.0000	6 245 816.0000	-	-
WEA36	304 538.0000	6 245 291.0000	-	-
WEA37	304 175.7907	6 244 515.4986	-	-
WEA38	303 683.2229	6 244 280.2406	-	-

	Vestas V90		Vestas V112	
WTG Name	X	Y	X	Y
WEA39	303 236.5010	6 243 801.0602	-	-
WEA40	304 220.7199	6 245 814.8370	-	-
WEA41	304 007.7686	6 245 133.4796	-	-
WEA42	303 599.2441	6 244 757.6284	-	-
WEA43	303 156.6053	6 244 328.1289	-	-
WEA44	303 649.0000	6 245 655.0000	-	-
WEA45	303 226.0000	6 245 266.0000	-	-
WEA46	303 357.0000	6 246 151.0000	-	-
WEA47	302 955.0000	6 245 761.0000	-	-
WEA48	302 557.0000	6 245 368.0000	-	-
WEA49	302 345.9603	6 244 884.2621	-	-
WEA50	302 433.4716	6 244 444.1159	-	-

	Nordex N100		Alternative (Vestas V112)	
WTG Name	X	Y	X	Y
WEA01	307 962.0000	6 242 456.0000	309 308.8803	6 242 547.6027
WEA02	308 079.0000	6 241 828.0000	308 637.2682	6 242 409.9470
WEA03	307 502.0000	6 244 332.0000	308 751.4760	6 241 728.1156
WEA04	306 903.7374	6 243 986.8508	308 561.7655	6 241 052.7479
WEA05	306 982.0000	6 244 789.0000		
WEA06	306 280.0000	6 243 969.0000		
WEA07	306 092.9451	6 243 264.5964		
WEA08	305 929.6099	6 242 658.8928		
WEA09	306 295.1745	6 241 895.0818		
WEA10	305 784.5866	6 241 481.1164		
WEA11	305 206.5567	6 241 287.2637		
WEA12	305 669.2886	6 240 883.4709		
WEA13	306 366.0000	6 244 781.0000		
WEA14	305 840.0000	6 244 433.0000		
WEA15	305 648.3059	6 243 859.9187		
WEA16	305 481.8937	6 243 270.7172		
WEA17	305 151.7507	6 242 735.4551		
WEA18	305 389.4651	6 242 137.3040		
WEA19	304 847.1313	6 241 854.4181		
WEA20	304 603.9672	6 241 305.9008		
WEA21	305 656.0000	6 245 031.0000		
WEA22	305 091.7739	6 244 479.0094		
WEA23	305 043.7455	6 243 872.5598		
WEA24	304 812.8269	6 243 314.5966		

WEA25	305 176.0000	6 245 427.0000
WEA26	304 741.0000	6 244 977.0000
WEA27	304 485.7086	6 244 434.0209
WEA28	304 469.7160	6 243 820.9537
WEA29	303 983.4187	6 243 450.6598
WEA30	304 717.0000	6 245 865.0000
WEA31	304 198.7163	6 245 308.2102
WEA32	303 969.0000	6 244 739.0000
WEA33	303 725.9071	6 244 181.7724
WEA34	303 973.0000	6 245 904.0000
WEA35	303 491.0000	6 245 417.0000
WEA36	303 357.7480	6 244 669.1508
WEA37	303 023.0000	6 244 152.0000
WEA38	303 354.0000	6 246 150.0000
WEA39	302 827.0000	6 245 624.0000
WEA40	302 353.0000	6 245 025.0000

The positions of the turbines are shown in Figures 9.4 to 9.7 below.

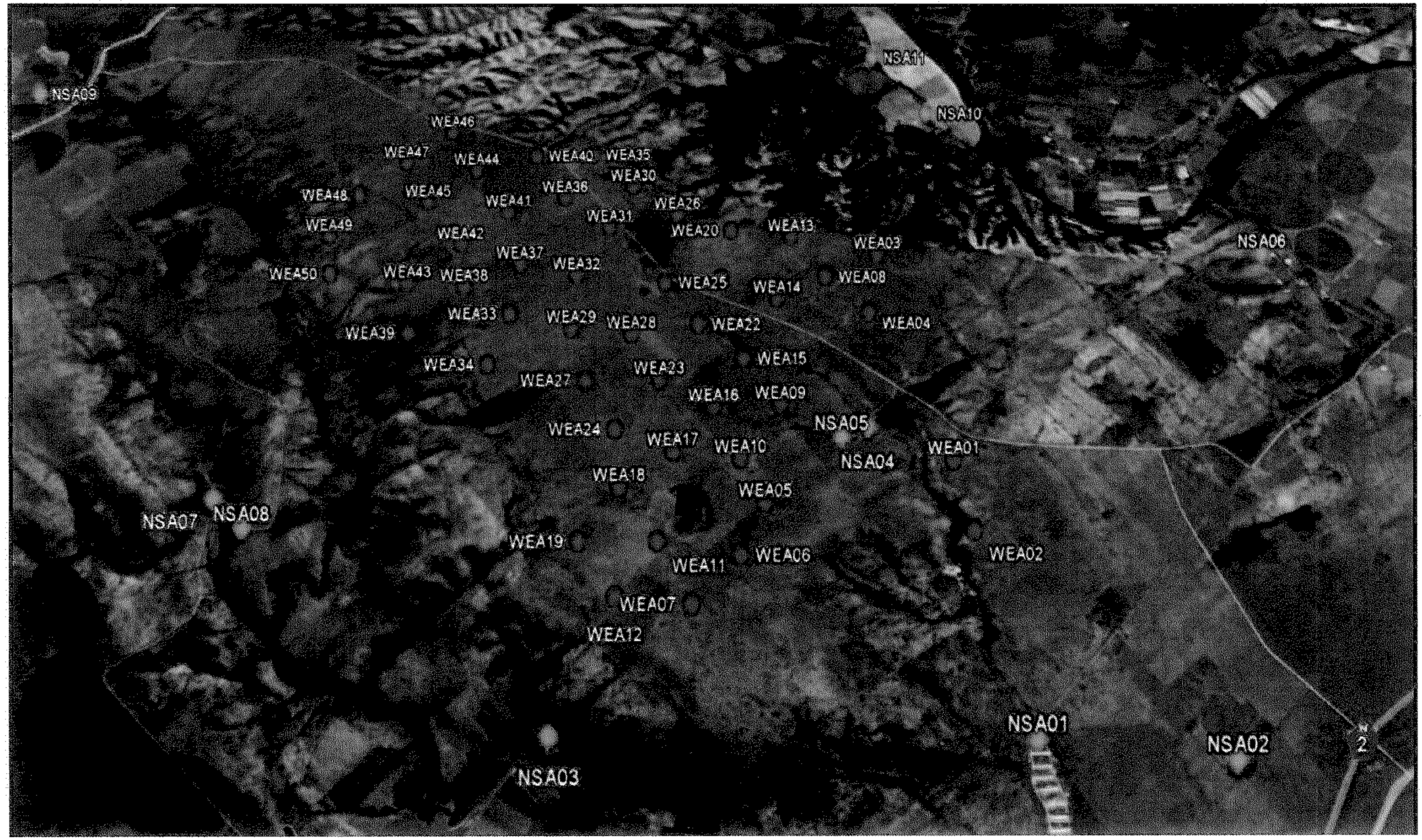


Figure 9.4: Wind turbine locations (Vestas V90)

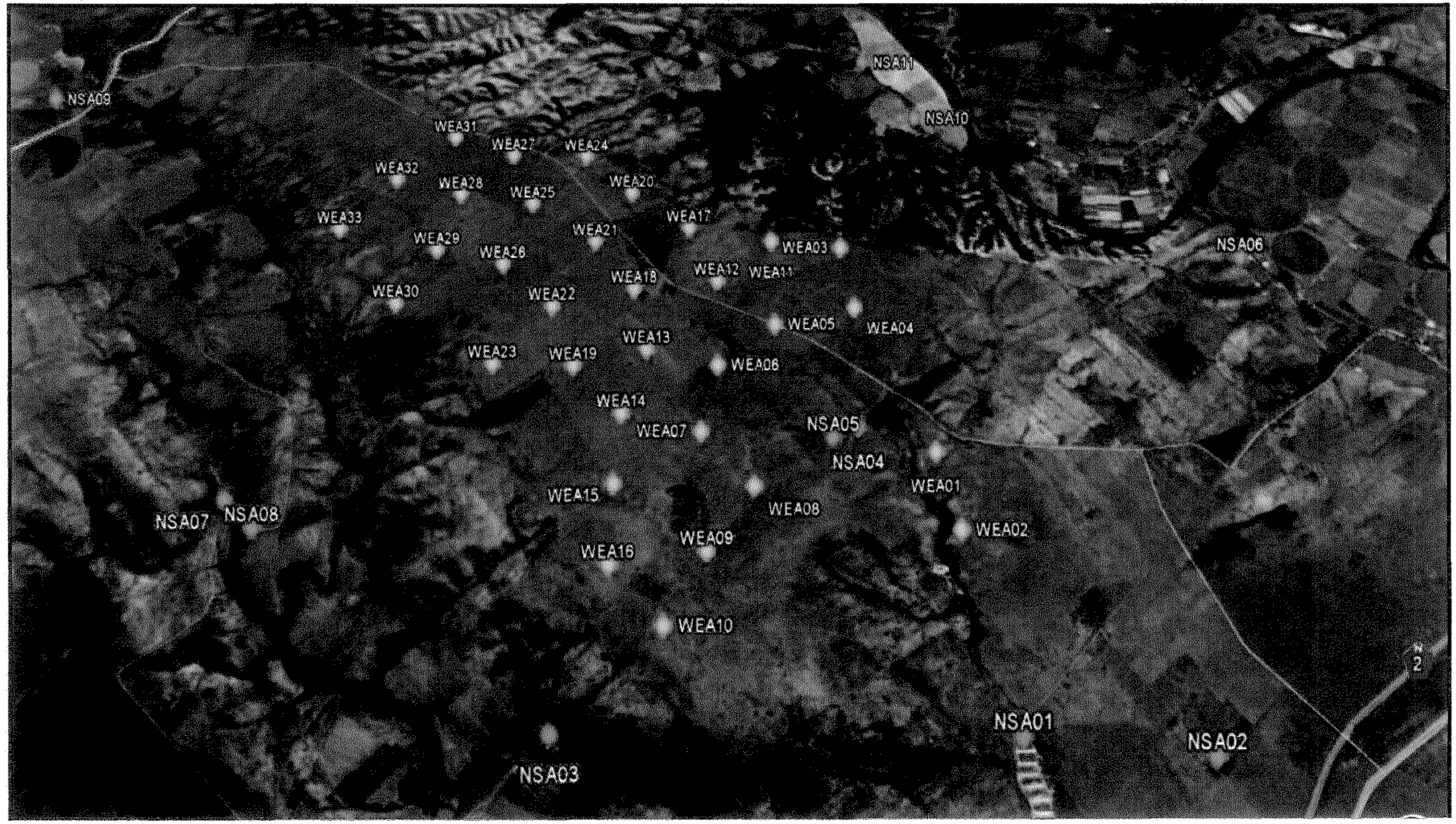


Figure 9.5: Wind turbine locations (Vestas V112)

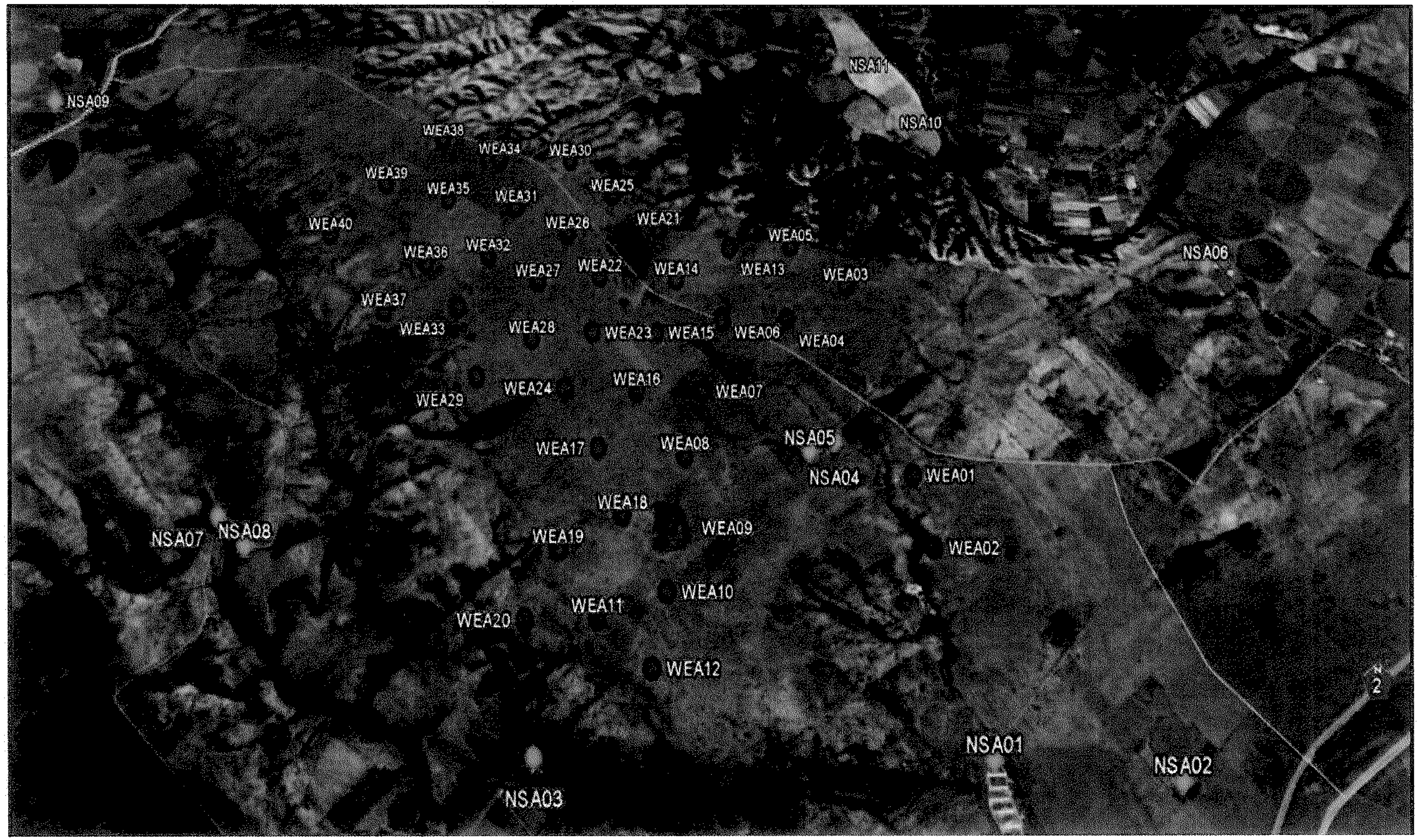


Figure 9.6: Wind turbine locations (Nordex N100)

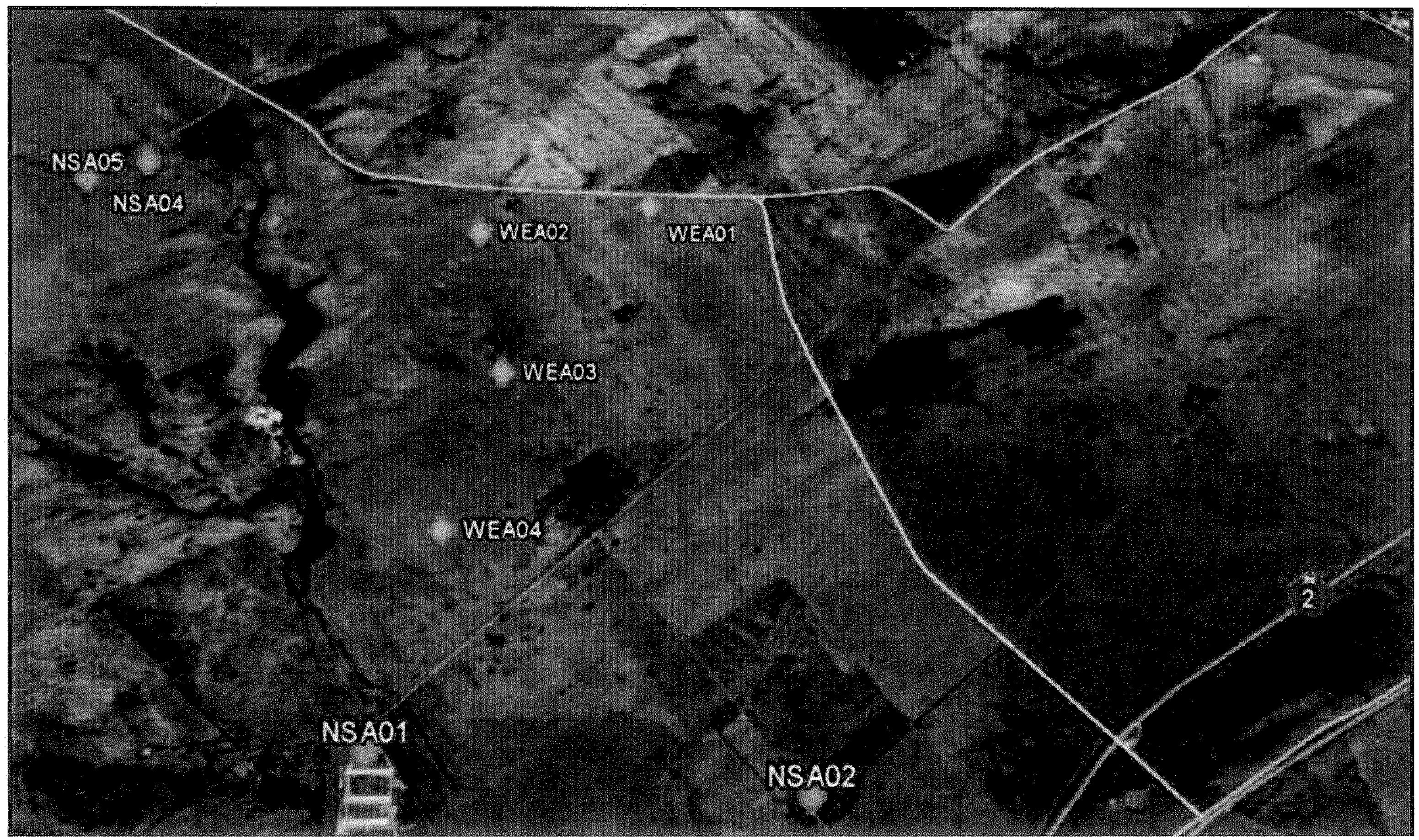


Figure 9.7: Wind turbine locations (Alternative)

The potential sensitive receptors are discussed below. The main noise sensitive receptors that could be affected by noise pollution are the terrestrial fauna, the avifauna and humans. receptors.

9.3.2 Noise Sensitive Areas

Human Sensitive Receptors

The site is situated in a farming community. Several homesteads are located on the properties where the turbines will be erected as well as on neighbouring farms. The sensitive noise receptors have been recorded in Table 9.2 below.

Table 9.2: Noise Sensitive Areas (NSA)

Label	Location Description	X	Y
NSA 1	Chicken Houses	308361	6240217
NSA 2	Homestead	309810	6240044
NSA 3	Homestead	304743	6240331
NSA 4	Homestead	307279	6242780
NSA 5	Homestead	307050	6242688
NSA 6	Homestead	311145	6244610
NSA 7	Homestead	301841	6242270
NSA 8	Homestead	302128	6242012
NSA 9	Homestead	299056	6246784
NSA 10	Homestead	308155	6246537
NSA 11	Homestead	307662	6247375

Natural Environment Receptors

The vegetation around the site is characterised by grassy fynbos with thicket in areas of richer soil. The fauna includes bats, birds, commercial livestock and a variety of buck.

9.3.3 Ambient Noise at Proposed Site

The ambient noise was measured at two locations as described in the methodology and results thereof are contained in Table 9.3 below. The author is confident that this represents the ambient noise at the project site.

Table 9.3: Ambient Noise Results during the day – 12th April 2011

Location	Start Time	Duration (minutes)	Wind (m/s) *(At Microphone)	Temperature (° Celsius) *(At Microphone)	$L_{Req,T}$ dB(A)	Comments
Point 1 (NSA 1)	13:10	10	1.8	21.8	61.4	• Noise from chicken house fans • Vehicles in distance on N2
Point 2 (NSA 4)	14:10	10	1.8	21.1	52.3	• Dog barking • One bakkie

*Author measurements of wind speed and temperature at microphone height (1.2m).

Table 9.4: Ambient Noise Results during the night – 19th April 2011

Location	Start Time	Duration (minutes)	Wind (m/s) *(At Microphone)	Temperature (° Celsius) *(At Microphone)	$L_{Req,T}$ dB(A)	Comments
Point 1 (NSA 1)	22:15	10	2.2	15.3	51.6	• Noise from chicken house fans • Vehicles in distance on N2
Point 2 (NSA 4)	22:55	10	2.1	15.7	45.2	

*Author measurements of wind speed and temperature at microphone height(1.2m).

The general ambient noise at each location varies substantially as the ambient sound is influenced by human activities, vehicles, wind noise and animal sounds.

9.4 IDENTIFICATION OF ISSUES AND IMPACTS

The key issues regarding the noise impact are as follow:

- What is the current noise ambient noise in the vicinity of the proposed project?
- What is the likely noise impact during construction and operation of the site and associated infrastructure?
- Where are local sensitive human receptors located and how is the noise going to affect them?
- Could low frequency sound and infra sound be a problem?

9.5 APPLICABLE LEGISLATION AND STANDARDS

South Africa has noise legislation or standards that could be applied to the project. The draft scoping report has identified that the applicable environmental legislation places a general onus on the developer to ensure that the environment is not affected negatively by the development.

The following legislation and standards have been used to aid the study and guide the decision making process with regards noise pollution:

- South Africa - GNR.154 of January 1992: Noise control regulations in terms of section 25 of the Environment Conservation Act (ECA), 1989 (Act No. 73 of 1989).
- South Africa - GNR.155 of 10 January 1992: Application of noise control regulations made under section 25 of the Environment Conservation Act, 1989 (Act No. 73 of 1989).
- South Africa - SANS 10103:2008 Version 6 - The measurement and rating of environmental noise with respect to annoyance and to speech communication.
- South Africa - SANS 10210:2004 Edition 2.2 – Calculating and predicting road traffic noise.
- South Africa - SANS 10357:2004 Version 2.1 - The calculation of sound propagation by the Concawe method.
- International Finance Corporation – 2007 General EHS Guidelines: Environmental Noise.

SANS 10103:2008 provides typical rating levels for noise in various types of districts, as described in Table 9.5 below. The project is being proposed for a rural district, therefore this is the typical rating level chosen as per the SANS standard.

Table 9.5: Typical rating levels for noise in various types of districts

Type of District	Equivalent Continuous Rating Level, LReq.T for Noise					
	Outdoors (dB(A))			Indoors, with open windows (dB(A))		
	Day-night	Daytime	Night-time	Day-night	Daytime	Night-time
Rural Districts	**45**	**45**	**35**	**35**	**35**	**25**
Suburban districts with little road traffic	50	50	40	40	40	30
Urban districts	55	55	45	45	45	35
Urban districts with one or more of the following: Workshops; business premises and main roads	60	60	50	50	50	40
Central business districts	65	65	55	55	55	45
Industrial districts	70	70	60	60	60	50

SANS 10103:2008 defines Daytime as 06:00 to 22:00 hours and night time as 22:00 to 06:00 hours. The rating levels in the table above indicate that in rural districts the ambient noise should not exceed 35 dB(A) at night and 45 dB(A) during the day or a combination of 45 dB(A) for day/night. These levels can thus be seen as the maximum levels for any noise pollution sources.

Furthermore the South African noise control regulations describe a disturbing noise as **any** noise that exceeds the ambient noise by more than 7 dB. This difference is usually measured at the complainants location should a noise complaint arise. Therefore, if a new noise source is introduced into the environment, irrespective of the current noise levels, and the new source is louder than the existing ambient environmental noise by more than 7 dB, the complainant will have a legitimate complaint.

SANS 10103: 2004 also provides a guideline for expected community responses to excess environmental noise above the ambient noise. These are reflected in table below.

Table 9.6: Categories of environmental community / group response (SANS 10103:2008)

EXCESS Lr dB (A)	ESTIMATED COMMUNITY/GROUP RESPONSE	
	CATEGORY	DESCRIPTION
0 - 10	Little	Sporadic complaints
5 - 15	Medium	Widespread complaints
10 - 20	Strong	Threats of community / group action
> 15	Very Strong	Vigorous community / group action

International Standards

There are various international criteria levels for ambient sound from wind turbines. These are listed below:

- New Zealand – 40 dB(A)
- Denmark – 40 dB(A)
- United Kingdom (L_{A90}) 35 – 40 dB(A)

Australia has set the following limits that wind turbine noise should not exceed:

- 35 dB(A) at relevant receivers in localities which are primarily intended for rural living, or
- 40 dB(A) at relevant receivers in localities in other zones, or
- the background noise (L_{A90}) by more than 5 dB(A)

Germany has set the following standards

- Purely residential areas with no commercial developments 50 dBA (Day) and 35 dBA (Night)
- Areas with hospitals, health resorts, etc. 45 dBA (Day) 35 dBA (Night)

The rationale behind the criteria levels is that the design limit should be 5 dB below the natural ambient limit. This corresponds well with the South African guideline limit of 45 dB for rural districts.

9.6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

9.6.1 Predicted noise levels for the Construction Phase

9.6.1.1 Construction Equipment

The construction noise at the various sites will have a local impact. Safetech has conducted noise tests at various sites in South Africa and have recorded the noise emissions of various pieces of construction equipment. The results are presented in Table 9.7 below.

Table 9.7: Typical Construction Noise

Type of Equipment	$L_{Req,T}$ dB(A)
CAT 320D Excavator measured at approximately 50 m.	67.9
Mobile crane measured at approximately 70 m	69.6
Drilling rig measured at approximately 70 m	72.6

The impact of the construction noise that can be expected at the proposed site can be extrapolated from the Tables above. As an example, if a number of pieces of equipment are used simultaneously, the noise levels can be added logarithmically and then calculated at various distances from the site to determine the distance at which the ambient level will be reached (refer to *Tables 9.8 - 9.10*).

Table 9.8: Combining Different Construction Noise Sources – High Impacts (Worst Case)

Description	Typical Sound Power Level (dB)
Overhead and mobile cranes	109
Front end loaders	100
Excavators	108
Bull Dozer	111
Piling machine (mobile)	115
Total*	**117**

*The total is a logarithmic total and not a sum of the values (at approximately 3m).

Table 9.9:Combining Different Construction Noise Sources – Low Impacts (at approximately 3m).

Description	Typical Sound Power Level (dB)
Front end loaders	100
Excavators	108
Truck	95
Total	**111**

The information in Tables 9.8 and 9.9 above can then be used to calculate the attenuation by distance. Noise will also be attenuated by topography and atmospheric conditions such as temperature, humidity, wind speed and direction etc. but this is ignored for this purpose. Therefore, the distance calculated below would be representative of maximum distances to reach ambient noise levels.

An illustration of attenuation by distance from a noise of 117 dB measured from the source is presented in Table 9.10 below

Table 9.10: Attenuation by distance for the construction phase (worst case)

Distance from noise source (metres)	Sound Pressure Level dB(A)
10	89
20	83
40	77
80	71
160	65
320	59
640	53
1280	47

What can be inferred from Table 9.10 above is that if the ambient noise level is at 45 dB(A), the construction noise will be similar to the ambient level at approximately 1280 m from the noise source, if the noise characteristics are similar. Beyond this distance, the noise level will be below the ambient noise and will therefore have little impact. The above only applies to the construction noise and light wind conditions. In all likelihood, the construction noise will have little impact on the surrounding community as it will most likely occur during the day when the ambient noise is louder and there are unstable atmospheric conditions.

9.6.2 Low frequency noise concerns

The effects of low frequency noise include sleep disturbance, nausea, vertigo etc. These effects are unlikely to impact upon residents due to the distance between the plant and the nearest communities. Sources of low frequency noise also include wind, train movements and vehicular traffic.

9.6.3 Predicted noise levels for the Wind Turbines Generators

The tables and figures below indicate the isopleths for the noise generated by the turbines at wind speeds from 4 m/s to 12 m/s. The area shaded red in the tables indicates where the recommended limit is exceeded. It must be remembered that as the wind speed increases, so too does the background noise. Therefore the predicted noise levels below 8m/s are of more concern those above 8m/s.

The results below are modelled as follows:

Table 9.11: Table of Results of the Noise Impacts at the Noise Sensitive Areas (NSAs)

NSA 1						
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90	Vestas V112	Nordex N100	Alternative plus V112	Noise Demand Fulfilled?
4	45	20.2	22.0	25.0	27.8	Yes
6	45	28.3	29.0	30.4	34.8	Yes
8	45	29.8	31.0	31.6	36.8	Yes
10	45	29.8	31.0	31.6	36.8	Yes
12	45	29.8	31.0	31.6	36.8	Yes

NSA 2						
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90	Vestas V112	Nordex N100	Alternative plus V112	Noise Demand Fulfilled?
4	45	16.1	17.9	21.0	22.5	Yes
6	45	24.2	24.9	26.1	29.5	Yes
8	45	25.7	26.9	27.4	31.5	Yes
10	45	25.7	26.9	27.4	31.5	Yes
12	45	25.7	26.9	27.4	31.5	Yes

NSA 3						
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90	Vestas V112	Nordex N100	Alternative plus V112	Noise Demand Fulfilled?
4	45	24.2	25.6	30.9	25.7	Yes
6	45	32.3	32.6	36.5	32.7	Yes
8	45	33.8	34.6	37.6	34.7	Yes
10	45	33.8	34.6	37.6	34.7	Yes
12	45	33.8	34.6	37.6	34.7	Yes

NSA 4						
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90	Vestas V112	Nordex N100	Alternative plus V112	Noise Demand Fulfilled?
4	45	30.6	32.2	34.2	32.7	Yes
6	45	38.7	39.2	39.8	39.6	Yes
8	45	40.2	41.2	40.9	41.6	Yes
10	45	40.2	41.2	40.9	41.6	Yes
12	45	40.2	41.2	40.9	41.6	Yes

NSA 5						
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90	Vestas V112	Nordex N100	Alternative plus V112	Noise Demand Fulfilled?
4	45	31.7	32.1	34.1	32.4	Yes
6	45	39.8	39.1	39.7	39.4	Yes
8	45	41.3	41.1	40.8	41.4	Yes
10	45	41.3	41.1	40.8	41.4	Yes
12	45	41.3	41.1	40.8	41.4	Yes

NSA 6						
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90	Vestas V112	Nordex N100	Alternative plus V112	Noise Demand Fulfilled?
4	45	14.6	16.0	19.1	18.0	Yes
6	45	22.7	23.0	24.0	25.0	Yes
8	45	24.2	25.0	25.4	27.0	Yes
10	45	24.2	25.0	25.4	27.0	Yes
12	45	24.2	25.0	25.4	27.0	Yes

NSA 7						
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90	Vestas V112	Nordex N100	Alternative plus V112	Noise Demand Fulfilled?
4	45	21.0	21.8	25.3	21.9	Yes
6	45	29.1	28.8	30.6	28.8	Yes
8	45	30.6	30.8	31.8	30.8	Yes
10	45	30.6	30.8	31.8	30.8	Yes
12	45	30.6	30.8	31.8	30.8	Yes

NSA 8						
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90	Vestas V112	Nordex N100	Alternative plus V112	Noise Demand Fulfilled?
4	45	21.1	22.0	25.6	22.1	Yes
6	45	29.2	29.0	30.9	29.1	No
8	45	30.7	31.0	32.1	31.1	No
10	45	30.7	31.0	32.1	31.1	No
12	45	30.7	31.0	32.1	31.1	No

NSA 9						
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90	Vestas V112	Nordex N100	Alternative plus V112	Noise Demand Fulfilled?
4	45	14.0	15.3	18.3	15.4	Yes
6	45	22.1	22.3	23.3	22.3	Yes
8	45	23.6	24.3	24.6	24.3	Yes
10	45	23.6	24.3	24.6	24.3	Yes
12	45	23.6	24.3	24.6	24.3	Yes

NSA 10						
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90	Vestas V112	Nordex N100	Alternative plus V112	Noise Demand Fulfilled?
4	45	20.3	21.8	24.8	22.1	Yes
6	45	28.3	28.8	30.1	29.1	Yes
8	45	29.8	30.8	31.4	31.1	Yes
10	45	29.8	30.8	31.4	31.1	Yes
12	45	29.8	30.8	31.4	31.1	Yes

NSA 11						
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90	Vestas V112	Nordex N100	Alternative plus V112	Noise Demand Fulfilled?
4	45	18.9	20.5	23.6	20.7	Yes
6	45	27.0	27.5	28.8	27.7	Yes
8	45	28.5	29.5	30.1	29.7	Yes
10	45	28.5	29.5	30.1	29.7	Yes
12	45	28.5	29.5	30.1	29.7	Yes

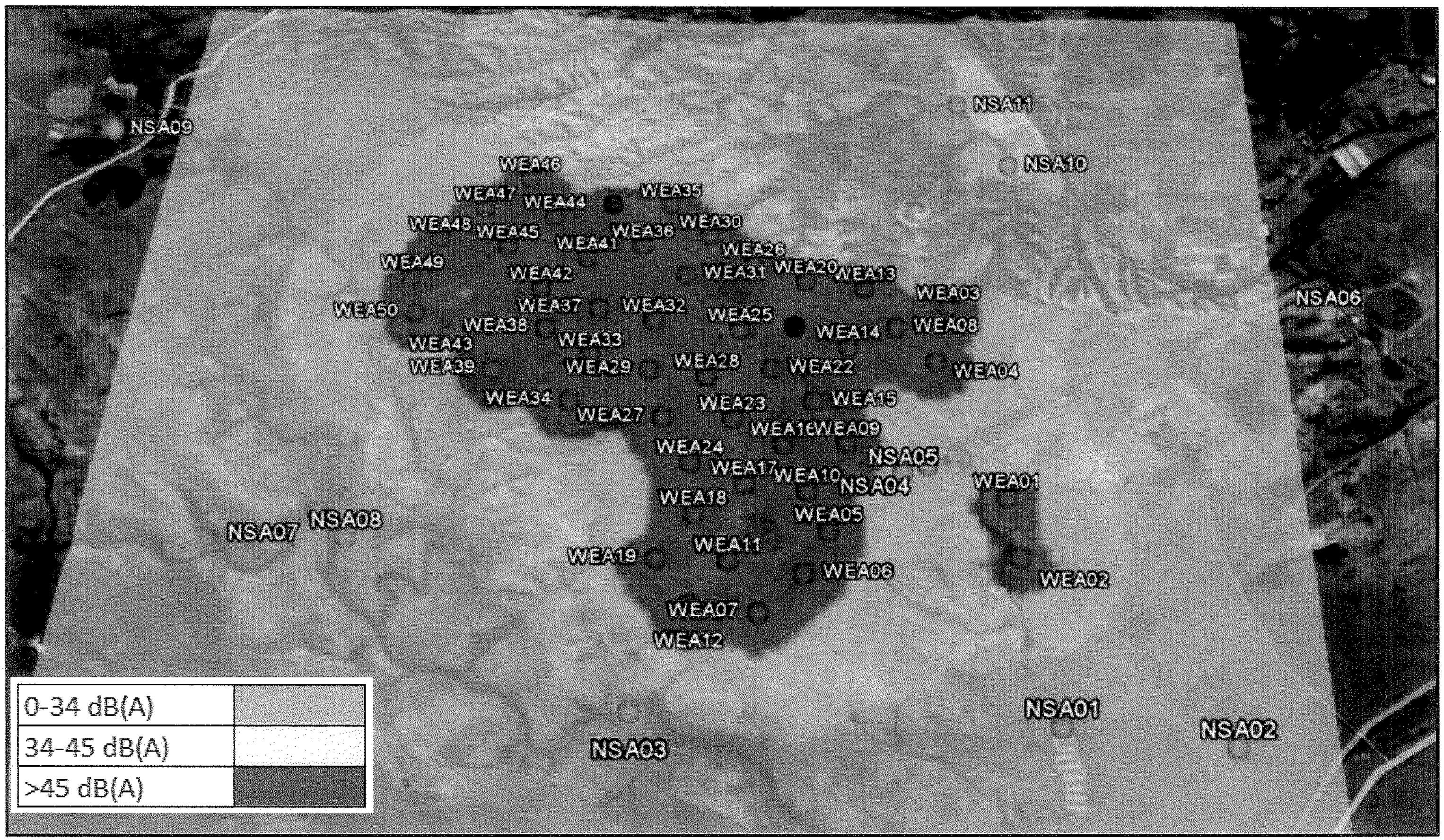


Figure 9.8: Raster Image of Noise Isopleths & Noise Sensitive Areas (Vestas V90 at 8m/s)

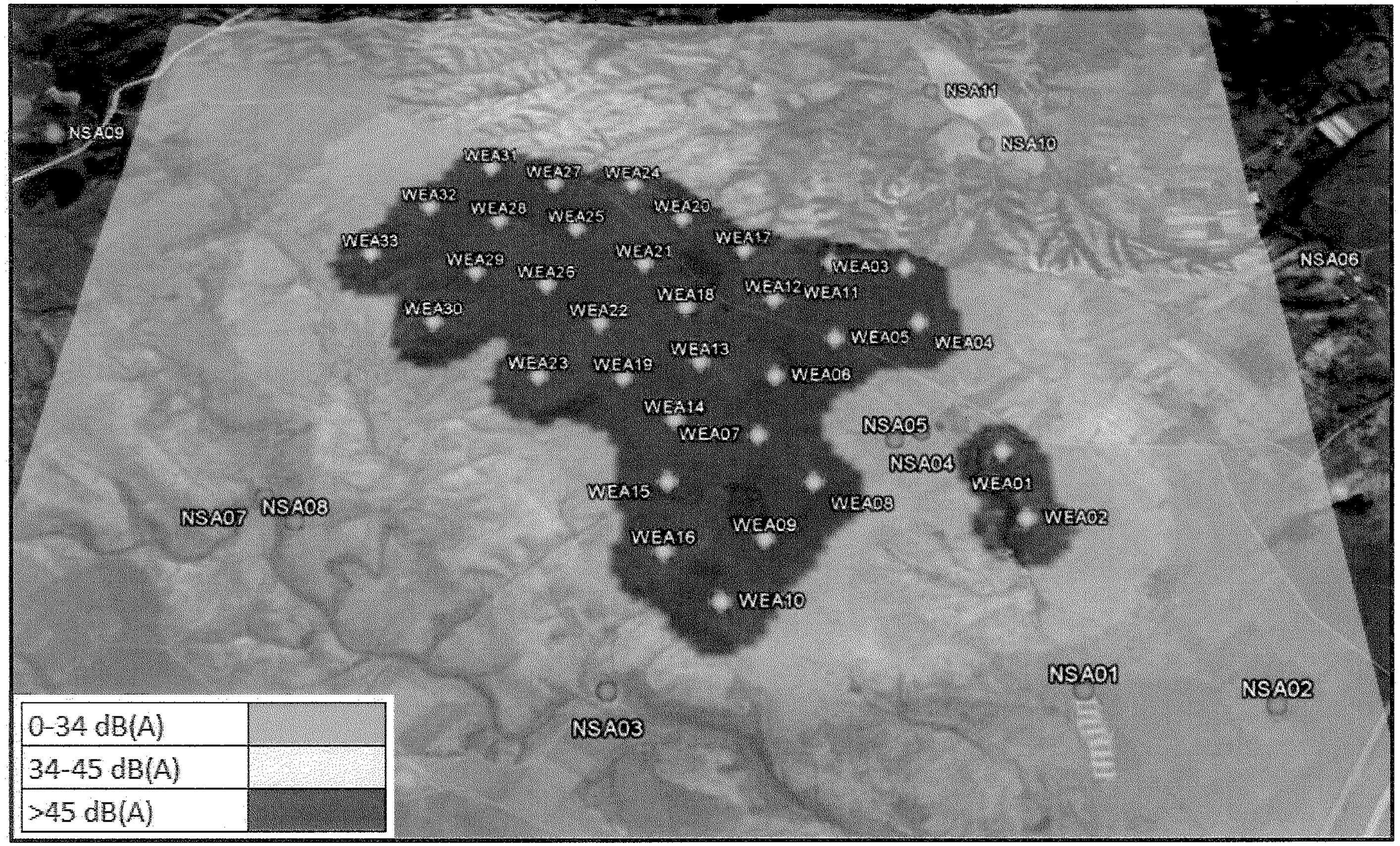


Figure 9.9: Raster Image of Noise Isopleths & Noise Sensitive Areas (Vestas V112 at 8m/s)

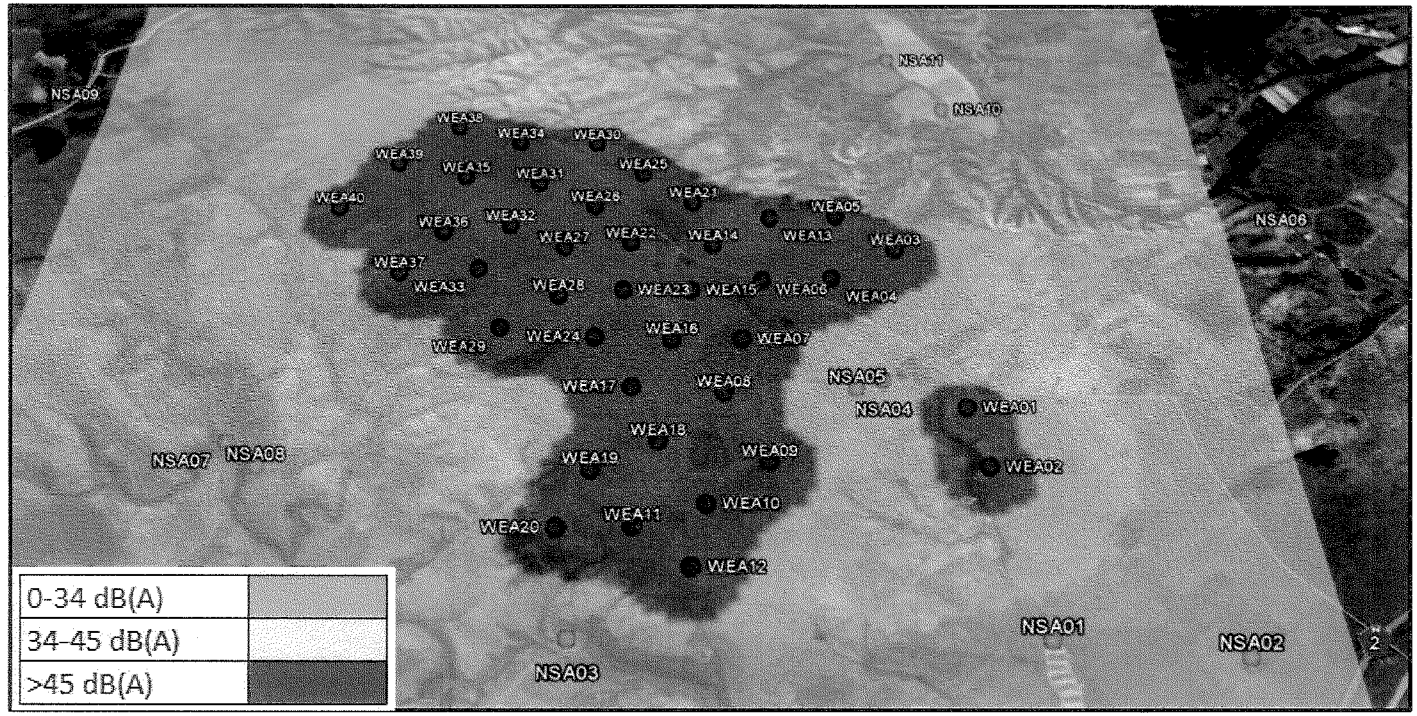


Figure 9.10: Raster Image of Noise Isopleths & Noise Sensitive Areas (Nordex N100 at 8m/s)

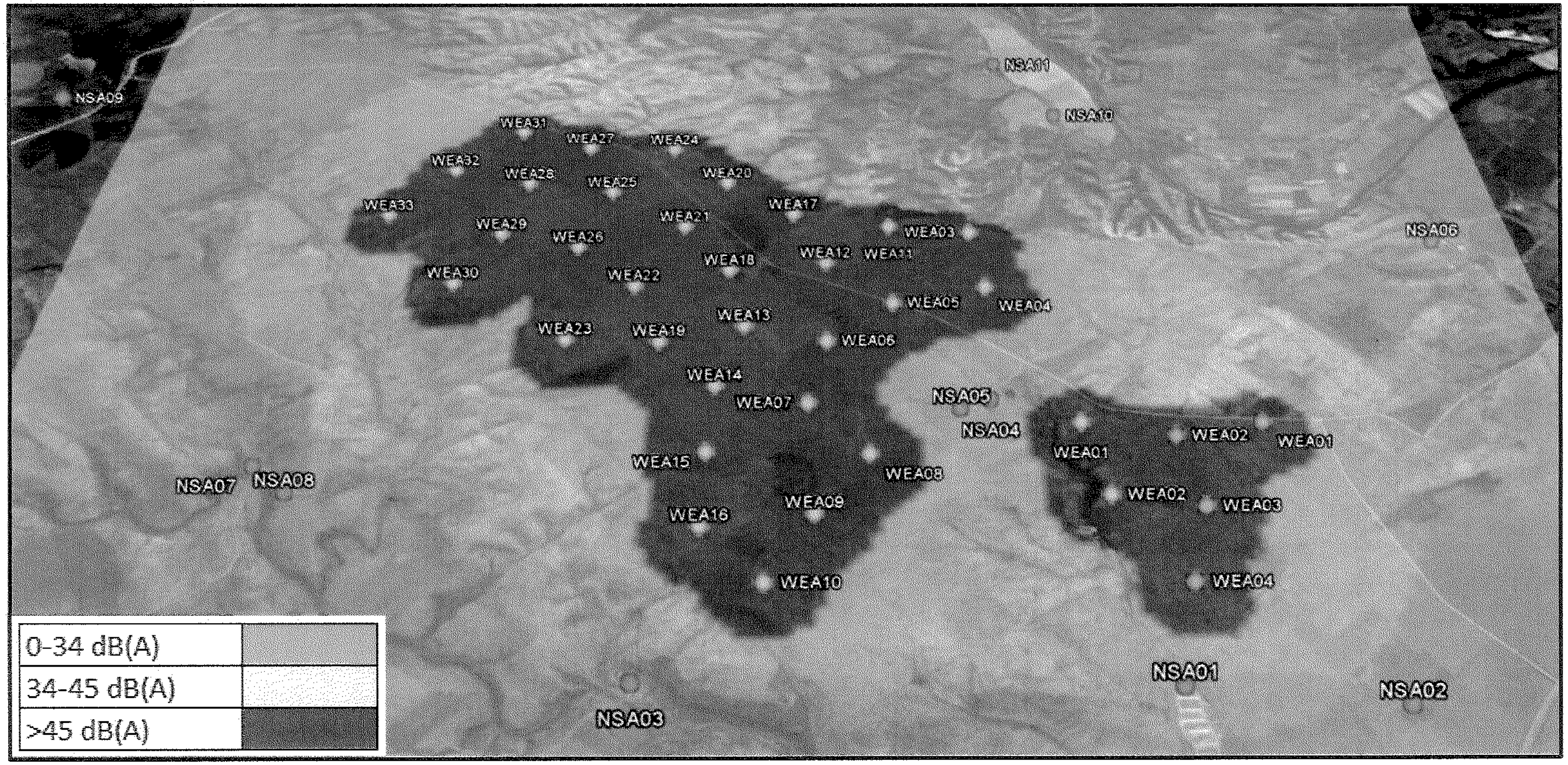


Figure 9.11: Raster Image of Noise Isopleths & Noise Sensitive Areas (Alternative WTG's at 8m/s)

9.6.4 Assessment of Noise Impacts

The impact of the noise pollution that can be expected from the site during the construction and operational phases is presented below. A summary of the noise impact assessment using the standard assessment criteria is provided in Tables 9.12 – 9.14.

9.6.4.1 Assessment and mitigation for Construction Phase

1) There will be an impact on the immediate surrounding environment from the construction activities, especially if pile driving is to be done. This, however, will only occur if the underlying geological structure requires piling.
2) The area surrounding the construction site will be affected for a short periods of time in all directions by construction noise impacts, should several pieces of construction equipment be used simultaneously.
3) The number of construction vehicles that will be used in the project will add to the existing ambient levels and will most likely cause a disturbing noise, albeit for a short period of time.

In conclusion, there will be a short term increase in noise in the vicinity of the site during the construction phase as the ambient noise level will be exceeded. The impact during the construction phase will be difficult to mitigate. The significance of the construction noise impact is predicted to be ***low*** (without mitigation).

The following **mitigation measures** are recommended for construction activities:

- All construction operations should only occur during daylight hours, if possible.
- No construction piling should occur at night. Piling should only occur during the hottest part of the day to take advantage of unstable atmospheric conditions.
- Construction staff should be given "noise sensitivity" training in order to mitigate the noise impacts caused during construction.

9.6.4.2 Assessment and mitigation for Operational Phase

The ambient noise increases as the wind speed increases. Under very stable atmospheric conditions, a temperature inversion or a light wind, the turbines will in all likelihood not be operational as the cut-in speed is 4 m/s. As the wind speed increases above the cut-in speed the ambient noise will also increase. If the atmospheric conditions are such that the wind is very light (<4 m/s) at ground level but exceeds the cut-in speed at hub height i.e. the turbines will begin to operate, it is feasible that little ambient noise masking will occur. As the wind speed increases, the ambient noise also increases and masks the wind turbine noise. The critical wind speeds are thus between 4-6 m/s when there is little possibility of masking. Above 8m/s the wind noise starts masking the wind turbine noise. The noise modelling indicates that, in general, noise from the turbines will be below the SANS10103 limits for rural areas at a distance of approximately 500 m from the turbines.

The results indicate the following:

Table 9.12: Summary of Noise Impacts (Vestas V90)

Wind Speed	NSA 1	NSA 2	NSA 3	NSA 4	NSA 5	NSA 6	NSA 7	NSA 8	NSA 9	NSA 10	NSA 11
4m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

NSA = Noise Sensitive Area
✓ = Within Recommended Noise Limits
X = Exceeds 45 dB (A) Rural Recommended Limit

Table 9.13: Summary of Noise Impacts (Vestas V112)

Wind Speed	NSA 1	NSA 2	NSA 3	NSA 4	NSA 5	NSA 6	NSA 7	NSA 8	NSA 9	NSA 10	NSA 11
4m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

NSA = Noise Sensitive Area
✓ = Within Recommended Noise Limits
X = Exceeds 45 dB (A) Rural Recommended Limit

Table 9.14: Summary of Noise Impacts (Nordex N100)

Wind Speed	NSA 1	NSA 2	NSA 3	NSA 4	NSA 5	NSA 6	NSA 7	NSA 8	NSA 9	NSA 10	NSA 11
4m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

NSA = Noise Sensitive Area
✓ = Within Recommended Noise Limits
X = Exceeds 45 dB (A) Rural Recommended Limit

Table 9.15: Summary of Noise Impacts (Alternative layout plus All Vestas V112 Turbines)

Wind Speed	NSA 1	NSA 2	NSA 3	NSA 4	NSA 5	NSA 6	NSA 7	NSA 8	NSA 9	NSA 10	NSA 11
4m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

NSA = Noise Sensitive Area
✓ = Within Recommended Noise Limits
X = Exceeds 45 dB (A) Rural Recommended Limit

The results indicate the following:

- The Vestas V90 did not exceed the 45 dB(A) guideline at any of the identified noise sensitive sources.
- The Vestas V112 did not exceed the 45 dB(A) guideline at any of the identified noise sensitive sources.
- The Nordex N100 did not exceed the 45 dB(A) guideline at any of the identified noise sensitive sources.
- The Vestas V112 and the additional 4 turbines known as the alternative layout did not exceed the 45 dB(A) guideline at any of the identified noise sensitive sources.

All the turbine positions met the required 500m setback distance.

9.6.5 Recommendations

The results of the study indicate that the following conclusions can be drawn:

- There will be a short term increase in noise in the vicinity of the site during construction as the ambient level will be exceeded. The impact during construction will be difficult to mitigate.
- The impact of low frequency noise and infra sound will be negligible and there is no evidence to suggest that adverse health effects will occur as the sound power levels generated in the low frequency range are not high enough to cause physiological effects.

The following is recommended:

9.6.5.1 Construction Activities

- All construction operations should only occur during daylight hours if possible.
- No construction piling should occur at night. Piling should only occur during the hottest part of the day to take advantage of unstable atmospheric conditions.
- Ensuring that construction staff is given "noise sensitivity" training.

9.6.5.2 Operational Activities

Ambient noise monitoring is recommended at all noise sensitive areas once the turbines are erected. This is to determine whether or not the noise rating limits are being exceeded.

9.7 IMPACT ASSESSMENT RATING TABLE

Table 9.16: Table of impact assessment rating

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Construction Phase									
1.1 Impact of the construction noise on the Noise Sensitive Areas (NSAs)	Negative	**Local**, given impact is limited to one NSA at a time.	**Short**, only for the duration of the construction (approx 22 months)	**Low** no change in the environment is expected	**Improbable**, based on calculations	**Low**	Staff to receive noise sensitivity training; Monitoring of noise; Limit high noise activities to daytime operations when possible, noting that operational requirements might not allow this due to various factors e.g. Crane use optimization, weather conditions etc.	**Low**	**High**, since based on actual measurements
Operational Phase									
1.1 Impact of the operational noise on the Noise Sensitive Areas (NSAs) using the Vestas V90, Vestas V112, Nordex N100 and the alternative lyout.	Negative	**Local**, given impact is limited to a one NSA at a time.	**Long Term**	**Low** – no change in the environment is not expected	**Probable**, based on calculations	**Low**	Ensure that noise monitoring is conducted during the commissioning phase to determine the actual noise impact during operation.	**Low**	**High**, since based on modelling and ambient measurements

9.8 MONITORING ACTIONS

Table 9.17: Table of monitoring actions (Construction)

Impact	Mitigation/Management action	Monitoring		
		Methodology	Frequency	Responsibility
Reduce construction noise	Conduct noise sensitivity training for all construction staff	Training	Before construction commences	Contractor
Monitor construction noise	Ambient noise monitoring to be conducted at the 11 NSAs as well as any other areas the specialist bird study will identify.	As per the requirements of SANS 10103	Four times during the construction phase	Specialist noise consultant

Table 9.18: Table of monitoring actions (Operation)

Impact	Mitigation/Management action	Monitoring		
		Methodology	Frequency	Responsibility
Reduce operational noise	Ambient noise monitoring to be conducted at the 11 NSAs when operations commence to verify the noise emissions meet the noise rating limit.	As per the requirements of SANS 10103	During project commissioning	Specialist noise consultant
Reduce operational noise	Confirm the noise impact by conducting monitoring.	As per the requirements of SANS 10103	Monitoring to be done at three NSA's per year over a 3 year period to confirm that the actual noise complies with the predicted noise levels in the EIA. The monitoring to be done in the first year in the month that shows the most wind production from the historical data available. The monitoring to be done in the second year in the month that shows the least wind production from the historical data available. The monitoring to be done in the third year in the month that shows the "average" wind production from the historical data available.	Specialist noise consultant

a) Ambient noise monitoring to be conducted at the 11 NSAs when operations commence to verify the noise emissions meet the noise rating limit.

9.9 CONCLUSIONS

Provided that the mitigation measures presented in the noise specialist study are implemented effectively, the noise from the turbines at the identified noise sensitive areas is predicted to be less than the 45 dB(A) limit for rural areas presented in SANS 10103:2008. The overall noise impact with recommended mitigation is expected to be negative and of **Low** significance.

Appendix 9.1: AIA Approval Certificate

DEPARTMENT OF LABOUR

Certificate

This is to certify that

SAFETRAIN CC
TRADING AS T\A SAFETECH

has been approved as an

APPROVED INSPECTION AUTHORITY

in terms of the Occupational Health and Safety Act, 1993, for the monitoring of

Physical Stress Factors and Chemical Stress Factors (including Lead and Asbestos, Ergonomic hazards and Ventilation Installation) and Biological Factors

2009-08-27

DATE

CI 049 OH

CERTIFICATE NUMBER

CHIEF INSPECTOR

Appendix 9.2:
Calibration Certificate

sanas
Calibration Laboratory
148 1302

M AND N ACOUSTIC SERVICES CC
VAT NO: [illegible]
[illegible]
0045
Co. Reg. [illegible]
Tel: 012 689 2[illegible]
Fax: 086 211 4690
E-mail: calservice@[illegible]

CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	2010-1352
ORGANISATION	SAFETRAIN T/A SAFETECH
ORGANISAION ADDRESS	P.O. BOX 27607, GREENACRES, PORT ELIZABETH, 6057
CALIBRATION OF	INTEGRATING SOUND LEVEL METER, ½" MICROPHONE and ⅓-OCTAVE/OCTAVE FILTER CARD
CALIBRATED BY	M.W. DE BEER
MANUFACTURER	RION
MODEL NUMBERS	NL-32, UC-53 and NX-22RT
SERIAL NUMBERS	00151075, 12930 and 00150957 V2.2
DATE OF CALIBRATION	19 OCTOBER 2010
RECOMMENDED DUE DATE	OCTOBER 2011
PAGE NUMBER	PAGE 1 OF 4

This certificate is issued in accordance with the conditions of approval granted by the South African National Accreditation System (SANAS). This Certificate may not be reproduced without the written approval of SANAS and M and N Acoustic Services.

Calibrations performed by this laboratory are in terms of standards, the accuracies of which are traceable to national measuring standards as maintained by NMISA

The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the amount of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.

The South African National Accreditation System (SANAS) is member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). This arrangement allows for mutual recognition of technical test and calibration data by member accreditation bodies worldwide. For more information on the arrangement please consult www.ilac.org

M.W. DE BEER (SANAS TECHNICAL SIGNATORY)

20 October 2010
DATE OF ISSUE

Only Member : Marianka Naudé

Appendix 9.3: Typical Sound Power and Sound Pressure Levels

Acoustic Power	Degree		Pressure Level	Source
32 GW	Deafening		225 dB	12" Cannon @ 12ft in front and below
25 to 40 MW			195 dB	Saturn Rocket
100 Kw			170 dB	Turbojet engine with afterburner
10 Kw			160 dB	Turbojet engine, 7000lb thrust
1 kW			150 dB	4 Propeller Airliner
100 W			140 dB	Artillery Fire
10 W	Threshold of pain		130 dB	Pneumatic Rock Drill
				130 dB causes immediate ear damage
3 W			125 dB	Small aircraft engine
1.0 W			120 dB	Thunder
100 Mw			110 dB	Close to train
10 mW	Very Loud		100 dB	Home lawn mower
1 mW			90 dB	Symphony or a Band
				85 dB regularly can cause ear damage
100 uW	Loud		80 dB	Police whistle
10 uW			70 dB	Average radio
1 uW	Moderate		60 dB	Normal conversational voice
100 nW			50 dB	Quiet stream
10 nW	Faint		40 dB	Quiet conversation
1 nW			30 dB	Very soft whisper
100 pW	Very faint		20 dB	Ticking of a watch
10 pW	Threshold of hearing		10 dB	
1 pW			0 dB	Absolute silence

Sound Perception

Change in Sound Level	Perception
3 dB	Barely perceptible
5 dB	Clearly perceptible
10 dB	Twice as loud

Environmental Impact Assessment for the proposed Ubuntu Wind Energy Project near Jeffrey's Bay, Eastern Cape:
Draft Environmental Impact Assessment Report

Chapter 10: Economic Impacts

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CHAPTER 10. IMPACT ON ECONOMICS

10.1 INTRODUCTION

10.1.1 Terms of Reference

This economic specialist study forms part of the assessment phase of the EIA process. Its brief is to:

- Describe the existing economic characteristics/context of the local area and broader region.
- Identify and assess potential economic impacts at local as well as wider scales as relevant. These are expected to include the following:
    - Broad level review of the need and financial viability/risks associated with the project.
    - Degree of fit with local, regional and national economic development visions and plans including renewable energy planning
    - Impacts on overall economic development potential in the area including impacts on commercial enterprises nearby the site (incl. agriculture, small businesses, tourism establishments and others).
    - Impacts associated with project expenditure on direct and indirect employment and household incomes. These impacts should be investigated through an examination of how the project and the spending injection associated with it may affect on the local, regional and national economy.
    - Impacts associated with environmental impacts that have economic implications. This should focus on positive impacts associated with renewable energy use as well as potential negative impacts on neighbouring land owners should they be relevant.
- Propose and implement additional ToR, if required, based on professional expertise, experience and compliance with the relevant specialist study guidelines and best practice.

10.1.2 Approach and information sources

The approach adopted in this study involved the following steps in line with accepted EIA practice:

1. Investigate the existing economic context within which the project would be established.
2. Identify economic impacts.
3. Evaluate economic impacts including those of a cumulative nature.
4. Recommend mitigation measures.

The approach to this study was taken from the Department of Environmental Affairs and Development Planning (Western Cape) guidelines on economic specialist input to EIA processes which are broadly based on a cost-benefit approach to assessment (van Zyl *et al.*, 2005). They include guidance on the appropriate level of detail required for the assessment in order that it is adequate for informing decision-making without going into excessive or superfluous detail (i.e. superfluous detail in this report as well as superfluous detail when the briefs of other specialist studies forming part of the EIA are taken into account). While these guidelines were developed as part of a Western Cape government initiative, they are equally applicable to other parts of South Africa and were endorsed at a national level by the then Department of Environment Affairs and Tourism. Impact significance ratings were generated using CSIR guidelines for impact rating (see Chapter 4 of this report for an outline of the assessment criteria). All ratings reflect a consideration of direct and cumulative impacts.

Information was gathered from the following sources in order to investigate the existing economic situation that potentially would be affected by the project:

- Information generated during consultations with the public and authorities;
- Census 2001 and Community Survey 2007 data from the Statistics South Africa database; and
- Local economic development and planning documents.

Details on the approaches used to assess impacts are contained in the individual sections dealing with the impacts.

10.1.3 Assumptions and limitations

- All technical, financial (i.e. market surveys, business plans and costs) and other information provided by the proponent and other official sources is assumed to be correct.
- The quantification of economic impacts in order to inform the assessment of the significance of impacts was not possible, nor considered necessary, for all impacts. Where possible, quantification focused on impacts considered to be most important in the overall assessment. Assessments of impact significance made without quantification (and based on a consideration of the likely magnitudes of impacts and/or expert judgements) are, however, considered adequate unless otherwise specified.
- The assessment only considers the impacts of the proposed project and the "no-go" option and does not make comparisons with other wind energy projects.
- The assessment borrows heavily from information gathered as part of the compilation of the economic specialist study forming part of the EIA of the Mainstream Jeffrey's Bay Wind Project (This is done only where relevant and in order to avoid unnecessary duplication of effort).
- The findings of the assessment reflect the best professional assessment of the author drawing on relevant and available information within the constraints of time and resources thought appropriate and made available for the assessment. See Appendix 10.1 for the disclaimer associated with this report.

10.1.4 Expertise and declaration of independence

The report was compiled by Dr. Hugo van Zyl who holds a Ph.D. in economics from the University of Cape Town. He has thirteen years experience focusing on the analysis of projects and policies with significant environmental and development implications and has been involved in project appraisals of infrastructure projects, industrial and mining developments, mixed use developments, conservation projects and eco-tourism initiatives throughout Southern Africa. He has led, participated in, and co-ordinated research in economic impact assessment, environmental resource economics and project appraisal and has contributed specialist input to over 50 environmental assessments (EIAs and SEAs). Dr. van Zyl is also the lead author of the Western Cape Department of Environmental Affairs and Development Planning guidelines on economic specialist input into EIAs (van Zyl *et al.*, 2005).

Dr. Hugo van Zyl is independent and has no vested or financial interests in the proposed development being either approved or rejected.

10.2 DESCRIPTION OF THE AFFECTED ECONOMIC ENVIRONMENT

The significance of impacts is often highly dependent on the economic environment or context within which they occur. For example, job creation in a small local community with a stagnating economy and high unemployment will be far more significant than it would be in a larger community with a healthy economy. In order to offer such baseline information to the impact assessment this section describes the economic environment. The main information sources used were Census 2001 data, Community Survey 2007 data, Integrated Development Plans and Demarcation Board data.

The site is between Jeffrey's Bay and Hankey and forms part of the Kouga Municipality, which, in turn, forms part of the Cacadu District Municipality in the Eastern Cape.

According to the Kouga IDP,

> *"The Regional settlement pattern in the study area is characterised by various nodes and urban areas that have different functions within the region. Humansdorp, with the highest population concentration in the region, has an established infrastructure and acts as a regional service centre, supplying the surrounding agricultural communities and the coastal towns with commodities and services. Commercial and industrial activities of the region are centred in Humansdorp. The coastal towns of Jeffrey's Bay (which is developing tremendously), St Francis Bay, Cape St Francis and Oyster Bay are important and well-established tourist destinations. The urban areas of Hankey and Patensie, situated in the Gamtoos River Valley, provide important services to the surrounding high-density agriculture industry. These two towns are characterised by agricultural related industries"* (Kouga Municipality, 2007).

10.2.1 Current land uses

The proposed Ubuntu Wind Energy Project is planned to be situated on a coastal plateau, approximately 120 m to 200 m above sea level, inland of the N2 national road. The facility will extend over two farms, Zuurbron and Vlakteplaas. Zuurbron extends from approximately 6 to 15 km from the coast; and Vlakteplaas extends from approximately 4 to 6 km from the coast, with the southern border of the latter farm being on the N2.

At present the proposed site is zoned for Agriculture and is mainly used for extensive cattle grazing. No other viable agricultural activities have been identified for the site aside from broiler chickens and potentially game farming. Given the rocky ground and shallow soils, the land is not particularly suitable for crop farming.

To the east of the site the Gamtoos River floodplain is under intensive irrigated cultivation. In the Hankey and Patensie area citrus cultivation is particularly prominent using irrigation water sourced from the nearby Kouga Dam. Settlements such as Hankey and Humansdorp have developed as service centres for the agricultural industry.

In terms of proximity to residential areas, the eastern-most point of the study area is approximately 5-6 km south from the closest inhabited residential area of Kabeljous River Mouth which is at the north eastern tip of Jeffrey's Bay (Chapter 1, Figure 1.1). These areas and other towns along the coast have a strong tourism component with strong seasonal variations in ***population. Jeffrey's Bay is the largest of the coastal towns and aside from tourism is diversifying*** into light and medium industry. Other towns with a strong tourism and retirement focus include Aston Bay, Paradise Beach and St Francis Bay to the south of Jeffrey's Bay.

There are various power line, road and railway networks covering the area as one would expect given its status as a regional hub. A 132 kV power line crosses the site in an east-west direction north of the N2 highway, with the Melkhoutbosch substation located on this power line north of the N2-R330 interchange. The electricity generated at the Ubuntu Wind Energy Project will feed into the 132 kV line and into the Melkhoutbosch substation (CSIR, 2011).

The N2 is a main freight and tourist route between Port Elizabeth and Cape Town. Other main roads are the R102 between Jeffrey's Bay and Humansdorp and the R330 between Hankey and St Francis Bay. A number of relatively large structures are visible in the wind farm area, such as communication towers and chicken broiler housing. Various quarries are also present in the area. In addition, there are viewpoints in protected areas which potentially will be affected by the wind farm including the Kabeljous River Nature Reserve and the Kabeljous River Natural Heritage Site. Tourism facilities are also present nearby the site particularly north of the N2 between the site and Jeffrey's Bay.

10.2.2 Demographics

The 2007 Community Survey estimated that the total population in Kouga has grown slightly since 2001 to 73 274 and decreased slightly in the Cacadu District to 363 485 (StatsSA, 2008). Estimates in the Kouga IDP argue for a substantially higher population estimate of up to 86 000 people fuelled by a population growth rate of 2.4% per annum between 2000 to 2010 (Kouga Municipality, 2007).

The revised Kouga IDP (KLM, 2010) points out that Jeffrey's Bay is now reputed to be one of the fastest growing towns in South Africa and the current trend suggests a high growth rate at 2.5% per annum for Jeffreys Bay and 2% for Humansdorp. It predicts that the population of the municipality will reach 90,000 within four years (see Table 10.1). Population growth predictions for smaller towns such as Hankey and Patensie are generally 1% or lower with only Cape St Francis and St Francis Bay exceeding this estimate with 1.5% annual growth.

Table 10.1: Population numbers in the wider study area (2010 and onwards)

SETTLEMENT	GROWTH RATE	NO. OF HOUSEHOLDS	CURRENT POPULATION	EFFECTIVE POPULATION GROWTH RATE				
				YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
CAPE ST. FRANCIS & ST. FRANCIS BAY	1.5%	3,031	2,800	2,842	2,885	2,928	2,972	3,016
HANKEY	1%	3,039	11,721	11,838	11,957	12,076	12,191	12,319
HUMANSDORP	2%	5,617	23,991	24,471	24 960	25,459	25,968	26,488
JEFFREYS BAY	2.5%	11,356	40,203	41,208	42,238	43,294	44,377	45,486
LOERIE	0.5%	573	2,428	2,440	2,452	2,465	2,477	2,489
OYSTER BAY	1.0%	533	1,016	1,026	1,036	1,047	1,057	1,068
PATENSIE	1.0%	928	3,845	3,883	3,922	3,962	4,001	4,041
THORNHILL	0.5%	660	2,250	2,257	2,264	2,270	2,277	2,284

Source: KLM (2010)

10.2.3 Employment

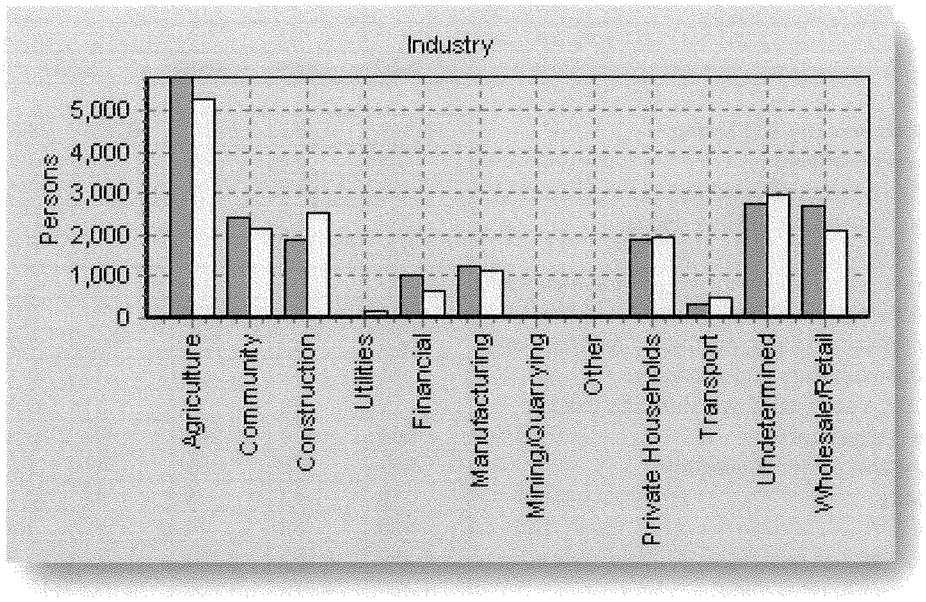
As with the rest of the country, unemployment is a major challenge in the area. The 2007 Community Survey indicates that unemployment in the Kouga Municipality has stayed at 27% for 2007 little changed from the 2001 estimate (StatsSA, 2008). For the individual towns in the municipal area, Table 10.2 shows that unemployment was highest in the smaller towns of Patensie (39.7%), Hankey (32.5%), Thornhill (32.5%) and Loerie (32.5%). Jeffrey's Bay and Humansdorp fared better at roughly 20% unemployment.

Table 10.2: Unemployment in the towns within the Kouga Municipality (2006)

SETTLEMENT TYPE	ELIGIBLE WORK FORCE (19 - 65 YRS)	PERMANENT RESIDENTS WITHOUT JOBS	%	SEASONAL FARM WORKERS	TEMPORARY DOMESTIC WORKERS	PERMANENT FARM WORKERS	PERMANENT INDUSTRY WORKERS	PROFESSIONAL WORKERS
CAPE ST. FRANCIS & ST. FRANCIS BAY	1523	305	20	N/A	Unknown	N/A	N/A	Unknown
HANKEY	6388	2078	325	430	860	2364	430	227
HUMANSDORP	13051	2662	20.4	82	862	2513	6315	615
JEFFREYS BAY	21870	4462	20.4	0	459	0	15230	1720
LOERIE	1320	429	32.5	Unknown	Unknown	Unknown	Unknown	Unknown
OYSTER BAY	553	114	20.6	N/A	43	N/A	352	44
PATENSIE	2092	830	39.7	221	83	258	1070	92
THORNHILL	1224	398	32.5	Unknown	Unknown	Unknown	Unknown	Unknown

Source: KLM (2010)

Figure 10.1 shows that the number of jobs in the Kouga Municipality increased by the greatest degree in the construction sector between 1996 and 2001 reflecting rapid development of the area. The agriculture, forestry and fisheries sector shed the greatest number of jobs during the same period in keeping with trends such as increased mechanisation. Notwithstanding this, for the Cacadu District Municipality and the Kouga Municipality, the dominant sector in terms of employment provision in 2001 was agriculture, forestry and fishing providing 36% and 33% of all employment opportunities in these areas respectively. Other important sectors in the Kouga Municipality include wholesale and retail trade (15% of employment in 2001) and community/social/personal services (14% of employment in 2001). By comparison with the wider Kouga Municipality, Humansdorp and Jeffrey's Bay have particularly high proportions of workers in the wholesale and retail trade, services as well as construction sectors reflecting their status as service centres with high growth. In Patensie, Hankey, Thornhill, Loerie and KwaNomzamo, by contrast, far higher levels of employment are associated with the agriculture, forestry and fishing reflecting a high concentration of lower skilled jobs among its residents.



Source: Demarcation Board using Census 2001 & 1996

Figure 10.1: Jobs per sector for the Kouga Municipality (1996 – dark bars, 2001 – lighter bars)

Data from the ECSECC (Eastern Cape Socio-Economic Consultative Council) database provides a more recent detailed breakdown of employment per industry within the Kouga Municipality (see Table 10.3). It shows that the key proportional increases in employment relative to 2001 have come in business and personal services (6% of employment in 2001 up to 12% of employment in 2010) and the key proportional decreases have occurred in agriculture, forestry and fishing (33% of employment in 2001 down to 28% of employment in 2010).

Table 10.3: Employment per industry in the Kouga Municipality (2007 -2010)

	2007	2008	2009	2010	
Agriculture, forestry and fishing	11 479	9 463	7 457	9 856	28.3%
Mining and quarrying	23	28	32	27	0.1%
Food, beverages and tobacco	617	641	662	692	2.0%
Textiles, clothing and leather goods	197	183	173	210	0.6%
Wood, paper, publishing and printing	226	230	207	249	0.7%
Petroleum products, chemicals, rubber and plastic	145	155	154	160	0.5%
Other non-metal mineral products	303	292	239	294	0.8%
Metals, metal products, machinery and equipment	368	382	387	405	1.2%
Electrical machinery and apparatus	44	47	46	47	0.1%
Radio, TV, instruments, watches and clocks	20	20	21	21	0.1%
Transport equipment	269	284	271	307	0.9%
Furniture and other manufacturing	508	475	463	547	1.6%
Electricity	39	43	39	42	0.1%
Water	106	88	74	91	0.3%
Construction	4 359	3 587	2 961	4 121	11.9%
Wholesale and retail trade	4 421	4 079	3 700	4 682	13.5%
Catering and accommodation services	704	617	563	570	1.6%
Transport and storage	320	340	330	312	0.9%
Communication	62	61	60	50	0.1%
Finance and insurance	300	333	345	341	1.0%
Business services	3 368	3 880	3 954	3 854	11.1%
Community, social and personal services	4 396	4 468	4 423	4 909	14.1%
General government	2 699	2 791	2 867	2 984	8.6%
Total	**34 972**	**32 488**	**29 426**	**34 770**	**100.0%**

Source: Data from ECSECC database

10.2.4 Income levels and poverty measures

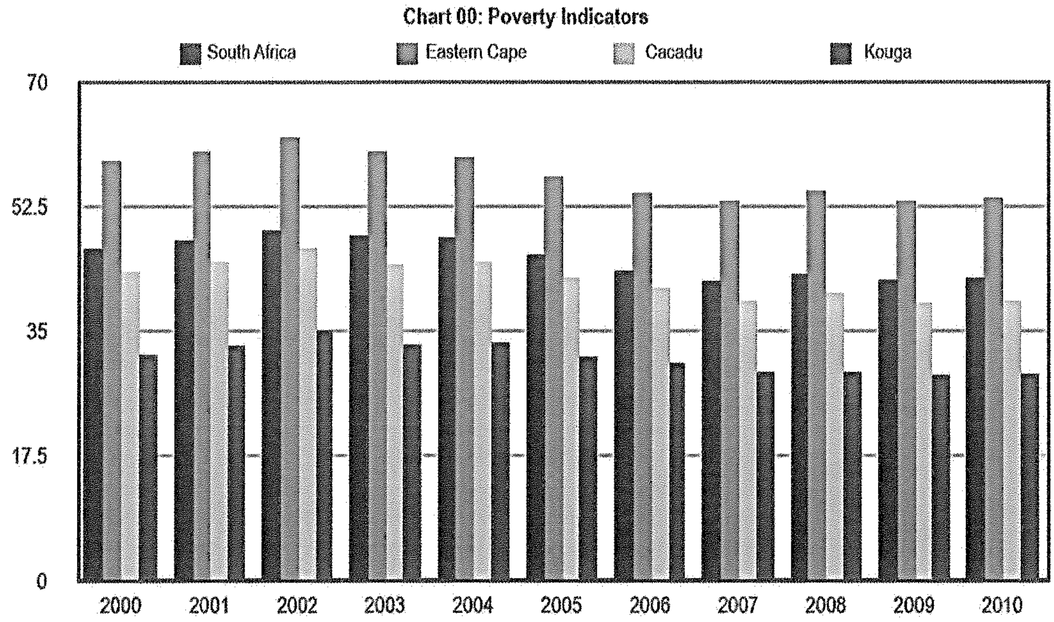
Household income levels in the study area are presented in Table 10.4. Approximately 44% of households in the Cacadu District Municipality and 33% in the Kouga Municipality had incomes below R 9,600 per year in 2001. KwaNomzamo had a similar income pattern to the District (46% of households with incomes below R9,600 per year) while Jeffrey's Bay and Humansdorp fared substantially better than the District and slightly better than the wider Kouga Municipality.

Table 10.4: Household incomes in the wider study area (2001)

	Cacadu District	Kouga Municipality	Humansdorp	Jeffreys Bay	KwaNomzamo
No income	14%	11%	9%	10%	17%
R1 - R4 800	7%	5%	3%	3%	8%
R4 801 - R9 600	23%	17%	13%	13%	21%
R9 601 - R19 200	23%	24%	20%	17%	29%
R19 201 - R38 400	15%	19%	26%	17%	18%
R38 401 - R76 800	8%	12%	15%	18%	5%
R76 801 - R153 600	5%	8%	9%	14%	1%
R153 601 - R307 200	2%	3%	4%	6%	0%
R307 201 - R614 400	1%	1%	1%	1%	0%
R614 401 - R1 228 800	0%	0%	0%	1%	0%
R1 228 801 - R2 457 600	0%	0%	0%	0%	0%
R2 457 601 and more	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%

Source: StatsSA, 2002

The 2007 Kouga IDP notes that the proportion of households living in poverty has increased by 6.4% in the past 10 years from 26.6% to 32.9%. The rate of increase in the Eastern Cape Province and Cacadu District ranges between 9% and 10% over the same period. Encouragingly the Human Development Index (HDI) for the Kouga area has improved in the past 10 years from 0.57 in 1996 to 0.62 in 2005 and remains better than the provincial and District HDI (KLM, 2007). The 2010 IDP review also notes the lower rates of poverty in the Kouga Municipality than nationally, provincially or on a district level (see Figure 10.2). It further illustrates that since 2003 there has been a steady decline in poverty in the Kouga Municipality (KLM, 2010).



Source: KLM (2010)

Figure 10.2: Poverty levels in the Kouga Municipality over time

10.2.5 Economic growth and development

Economic development faces many challenges in the Kouga Municipality although its performance relative to other areas in the Cacadu District Municipality and Eastern Cape is encouraging. The Kouga IDP points out that municipal productivity is higher than the averages for the Cacadu District and Eastern Cape Province principally due to high growth in value creation relative to employment and labour remuneration. Growth in Gross Domestic Product (GDP) and employment, from 1996 to 2004, and skills available to the local economy, are both higher than the Provincial average. The Kouga Municipality also has among the highest Formal Economy Performance scores in the province, with positive factors including the positive trade balance, a fairly diversified economy, low financial grant dependence, and strong GDP and employment growth performance. The Municipality fares well on Economic Absorption Capacity, considering high total disposable income, employment multiplier and informal sector capacity to generate economic opportunities relative to formal employment. The local economy claims a comparative advantage, for both employment and GDP contribution, in agriculture (centred on agriculture and hunting at 9.87% of GVA and 27.99% of employment) and construction (6.18% of GVA and 10.42% of employment). Kouga also claims GVA advantages in utilities (electricity supply and water), trade (centred on retail trade) and community services (dominated by public administration) (KLM, 2007).

With regard to tourism, the Kouga Municipality is home to a string of popular coastal tourist destinations from Jeffrey's Bay to Cape St Francis, and offers a wide range of activities and products including historical and heritage sites, the Kouga Cultural Centre, surfing, fishing, hiking, biking and sandboarding, birding and game viewing, and various other outdoor and adventure activities (Kouga Municipality, 2007). Tourism in the region is predominantly linked to the natural environment and has shown strong growth.

10.3 IDENTIFICATION OF ISSUES

Aside from fit with planning and financial viability (and associated risks), the following impacts were identified as relevant for assessment based on the guidelines for economic specialist input (van Zyl *et al*., 2005), information from consultations with the public and nature of the project and receiving environment:

1. Impacts on land owners within the site boundaries;
2. Impact on surrounding land uses;
3. Impacts on tourism; and
4. Impacts on commercial activity associated with expenditure linked to the construction and operation of the development.

These impacts were rated using accepted EIA conventions for determining their significance. Significance ratings were not appropriate or necessary for planning fit and financial viability. A discussion regarding cumulative impacts is also provided.

The key environmental impacts that could result in economic costs (externalities) are assessed in the sections dealing with impacts on tourism, impacts on land owners on the site, and impacts on surrounding land owners.

The economic implications of the loss of conservation-worthy habitat are not expected to be significant. Further consideration of the strategic conservation importance of the site and impacts on its ecology has been covered in the ecological specialist study (Pote and Marshall, 2011). This study found that impacts on ecological functioning and value would be low with mitigation. This mitigation would need to include avoiding ecologically sensitive areas, limiting the footprint of the wind turbines and other facilities, relocating plants where necessary, etc. The specialist studies dealing with impacts on birds and bats also found that successful mitigation should be possible and that monitoring in the early stages of the project would help to clear up any uncertainties with regard to impacts and assist with mitigation (see Chapters 6 and 7 of this report respectively).

10.4 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

This section provides an assessment of the impacts identified above and suggests management actions to avoid or reduce negative impacts; or to enhance positive benefits.

10.4.1 Need and Fit with policy and planning

The Ubuntu Wind Energy Project's key strategic objectives can be summarised as providing additional generation capacity and grid stability in the Kouga area whilst meeting national renewable energy and climate change targets. This section assesses the likely impact of the project on achieving these objectives along with a wider consideration of the project's fit or compatibility with economic development planning objectives.

10.4.1.1 Energy policy imperatives and the environment

Historically, South Africa has relied heavily on non-renewable fossils fuels (primarily coal) for energy generation purposes. This reliance remains a key feature of the current energy mix with just over 90% of the electricity generation need met by non-renewables. Given the abundance of coal reserves relative to most other countries, it is not particularly surprising that the energy mix favours coal and it is to be expected that coal will remain dominant. However, relatively recent imperatives with regard to global warming, other environmental impacts associated with 'dirty' fuels and energy security have elevated renewable energy solutions to a far more prominent position both within energy policy and in the economic development arena in general. This has happened at a rapid pace particularly in response to the threats associated with global warming. Most governments in the global community now recognise that the roll-out of renewable energy at an unprecedented scale will be needed among a number of other actions to curb global warming. Targets for the promotion of renewable energy now exist in more than 58 countries, of which 13 are developing countries. In addition, the renewable energy industry is now a major economic player, with the industry employing over 2.5 million people worldwide. Renewable energy companies have grown significantly in size in recent years, with the market capitalisation of publicly traded renewables companies doubling from $50 billion to $100 billion in just two years from 2005 to 2007 (NERSA, 2009).

There may still be disagreement on the equitable sharing of responsibilities for curbing global warming among nations. However, proposals tabled at the 2009 UN Climate Change conference in Copenhagen by a group consisting of the United States, China, Brazil, South Africa and India indicate that key developing nations including South Africa recognise that they will not be able to avoid significant responsibilities. When one looks at the developing nations as a wider group, South Africa stands out as a country that is going to have to introduce particularly significant measures as it is characterised by high levels of Greenhouse Gas (GHG) emissions relatively to other countries at similar stages of development. Du Plooy (2009) points out the following in this regard:

- South Africa's carbon dioxide ($CO^{2)}$ production doubled between 1980 and 2004 and is higher than that of Brazil, which has more than four times the population, and only slightly lower than the UK.
- South Africa's economy is 5-10 times less carbon efficient (or its carbon intensity is 5-10 times higher) than the US, UK or Japan. Regarding total emissions, South Africa is not nearly as significant a contributor to climate change as China. However, South Africa is a far greater contributor to the world's CO^2 emissions than to the world's GDP and on this score just about exactly equalled China in 2003 at 2.8 tonnes of CO^2 for every $1000 of GDP generated, compared with the US at 0.55.
- South African emissions per capita are still half that of the US and slightly lower than Russia's, but three times higher than China's and nine times higher than India's.

South African energy policy has started to change from one that did very little to encourage renewable energy to one that actively encourages it. The Government's 2003 White Paper on Renewable Energy has set a target of 4% of electricity demand (equivalent to 10,000 Giga-watt hours (GWh)) from renewable energy sources in 2013 (DME, 2003).[1] This target has been further refined to differentiate between various renewables. On 3 August 2011, the Department of Energy (DoE) released the qualification and proposal documentation for South Africa's first renewable energy independent power producer (IPP) tender process, and announced that it has

[1] To put this into context, Europe as a whole has a renewable energy target of 20% by 2020.

allocated a total of 3 725 MW capacity across various renewables technologies, with 1 850 MW set aside for onshore wind, 200 MW for concentrated solar thermal, a further 1 450 MW for solar photovoltaic solutions, 12.5 MW for both biomass and biogas, 25 MW for landfill gas capacity, 75 MW for small hydro, and a further 100 MW for small-scale IPP projects of less than 5 MW. This allocation to wind energy is an increase on the 1 025 MW set out for the first procurement round in the Integrated Resource Plan (IRP) 2010-2030 (Source: Engineering News, 4 & 5 August 2011).

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Within the renewable energy sector in South Africa, wind energy shows substantial promise despite there being very few commercial wind turbines in the country at present. By comparison, for example, Germany currently has 22,000 wind turbines installed that produce the equivalent power of half of all South Africa's fossil fuel and nuclear power stations (van der Merwe, 2009).

According to Marquad *et al.* (2008) who researched the cost of achieving a 2020 target of 15% renewable electricity generation for South Africa, "Wind power is one of the most mature new renewable technologies, is currently in widespread use throughout the world, and is still growing very rapidly, particularly in developing countries such as China and India: Within a very short time, the Chinese wind programme has accelerated to a point where almost 3,500MW of new wind power is being installed each year (with estimates of 50,000MW installed by 2015), and 40 local companies are involved in manufacturing 56% of the equipment (Global Wind Energy Council 2007). An additional 20,000MW was installed globally in 2007, almost one fifth of totally global installed capacity of close to 100,000MW. There is also a trend towards larger-scale installations – currently, wind farms of over 1,000MW are being planned in a number of locations."

In summary, the policy case for the urgent roll-out of renewable energy in South Africa has been made at a national government level using compelling arguments that are in line with international policy trends. Targets that include wind energy have been set (which may be revised upwards) and significant financial and other incentives have been offered to renewable energy developers in order to encourage projects and move decisively towards full-cost pricing of energy (i.e. prices which reflect global warming and other environmental impacts).

10.4.1.2 Energy security

As is noted in the Scoping Report for this project (CSIR, 2010), "The Eastern Cape does not generate bulk power and is thus reliant on electricity imports from other provinces (e.g. Mpumalanga). The existing transmission capacity to the province is fully utilised, which restricts the province from realising its industrial and rural development potential. Due to the length of the Eskom power lines from the power stations to the Kouga area and the inherent characteristics of the Kouga network, the area experiences power quality and voltage instability. The project could thus assist in stabilising energy supply to the Eastern Cape and in particular the Kouga Municipality" (CSIR, 2011).

Aside from impacts on the achievement of national goals and policy imperatives outlined in the preceding section, the project therefore has the potential to contribute to:

- Greater energy supply stability in the area
- Higher levels of energy security in the area

This will benefit local residential electricity consumers as well as farmers and businesses in the area. In simplified terms the project could produce enough electricity to power approximately

175,000[2] typical Eastern Cape households in a year when at full generation capacity (CSIR, 2011).

10.4.1.3 Fit with local development and spatial planning

Economic development imperatives inform spatial planning imperatives. A critical aspect of economic desirability is thus whether the proposed development complements economic planning as reflected in spatial development planning. Note that the importance of the role played by local municipalities throughout South Africa in fostering sustainable economic development has increased since 1994 and will continue to increase in the future in keeping with a clear shift towards more 'developmental' local government. Tools such as Integrated Development Plans (IDPs) and their accompanying Spatial Development Frameworks (SDFs) are likely to play a prominent role in facilitating this shift. SDFs in particular are central to economic development planning and are drawn up in order to guide overall development in a direction that local and provincial authorities see as desirable. Indeed, the basic purpose of an SDF is to specify the spatial implications of IDPs designed to optimise economic opportunities.[3] Specifically, a SDF has the following objectives and characteristics (Dennis Moss Partnership, 2003):

- It expresses government policy and the views and aspirations of all I&APs.
- Government departments and other authorities and institutions involved in future development and land use planning in the municipality will be bound by the SDF proposals.
- It provides certainty to the affected communities regarding future socio-economic and spatial development in the area.
- It provides a basis for co-ordinated decision-making and policy formulation related to future land use.
- It creates opportunities for preparing development and action plans to which financial budgets can be linked.

The proposed development thus ideally needs to 'fit' with what is envisaged in SDFs, structure plans and other planning documents in order for it to clearly 'fit' with the optimal distributions of economic activity as envisaged in these plans. Or, if it doesn't obviously fit with existing planning, there need to be clear and compelling reasons why a deviation from planning should be considered.

The following provincial and regional planning documents were found to be of relevance and are reviewed in more detail in the study:

- Eastern Cape Provincial Spatial Development Framework (2005);
- Western Cape Provincial Urban Edge Guidelines (2005);
- Kouga Municipality IDP and SDF (2007 & 2011).

Considered as a whole these documents recognise the importance of integrated and diversified economic development that makes optimal use of each area's comparative advantages. The

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[2] Where a typical Eastern Cape household uses 1,500 KWh per annum. In South Africa, usage ranges from less than a 1,000 KWh per year to over 8,000 KWh per year.

[3] Note that studies such as the growth potential of towns in the Western Cape study (van der Merwe *et al.*, 2005) also inform IDPs and economic planning.

concept of a wind farm is thus broadly supported and the levels of support for wind projects in the area and other parts of South Africa indicates that interest in their potential to add to economic development is recognised.

With regard to specific spatial planning that applies to the site, the Kouga SDF is most relevant. A review of the SDF reveals that the site is situated significantly outside the reasonably anticipated short, medium and long term Urban Edge of the nearest urban areas of Jeffrey's Bay implying no potential conflict in this regard. Furthermore, it is on the northern side of the N2 which is likely to remain a significant barrier to further expansion of Jeffrey's Bay in the direction of the wind project site in the longer term.

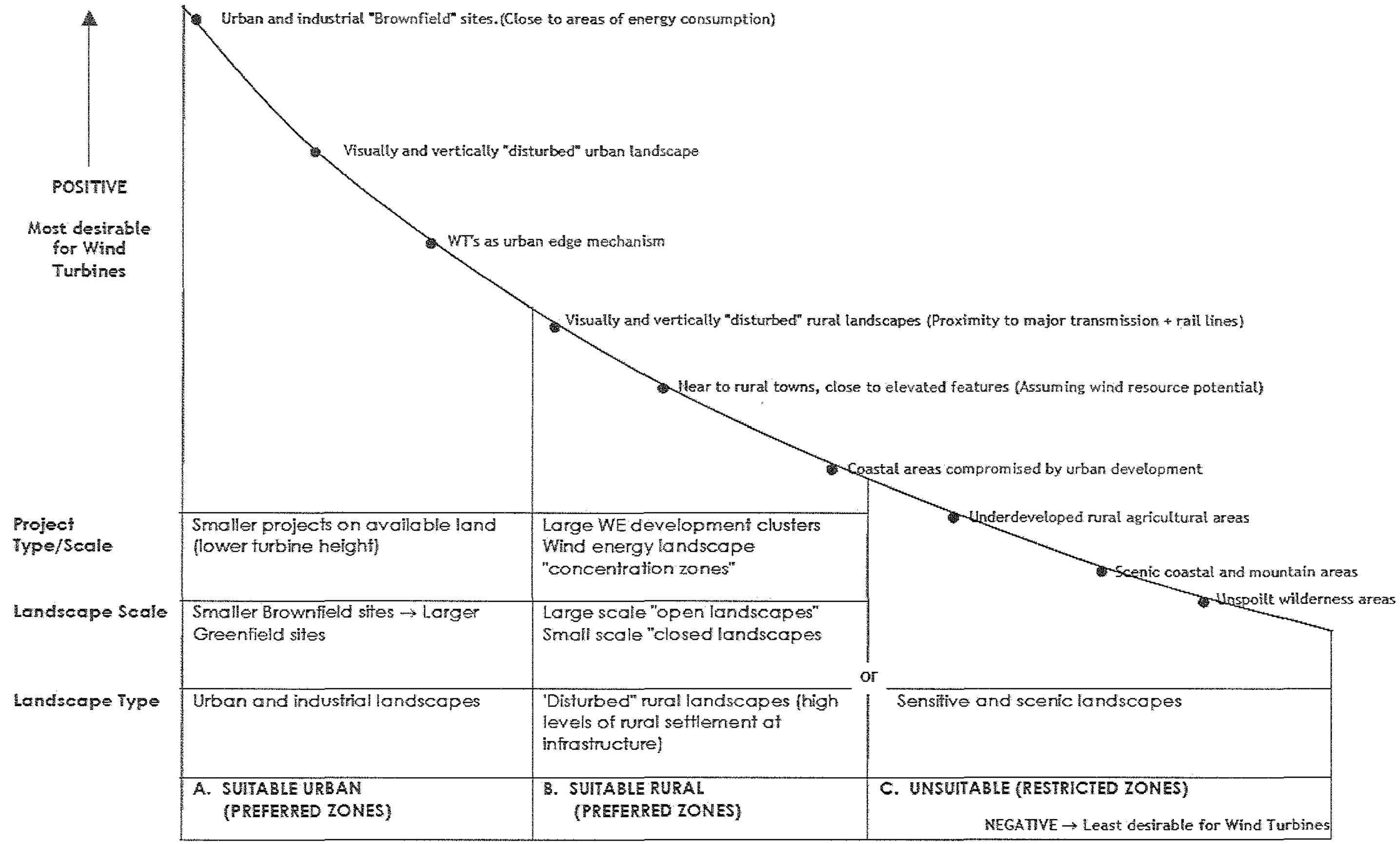
10.4.1.4 Wind energy development guidance

The 2006 DEA&DP Strategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape resulted in the publication of broad guidelines for the siting of wind farms in order minimize their potential to impact negatively on other land uses and sources of economic value (see CNdV, 2006). A key focus of the guidelines is on minimizing visual impacts on key receptors. The guidelines combine relevant elements of two assessment methodologies (i.e. criteria based assessment and landscape based assessment) in order to produce a consolidated 'Revised Regional Methodology' which provides the primary guidance regarding siting. Figure 10.3 provides a summary of how the landscape criteria in this methodology are to be used to conclude whether a site is likely to be suitable for wind energy developments or not. When applying this methodology to the proposed Ubuntu site, the following factors indicate that it should probably be most accurately classified as 'suitable rural':

- The close proximity of coastal areas with relatively high levels of development.[4]
- Its location relatively close to Jeffrey's Bay and Humansdorp and therefore energy consumers.
- The presence of infrastructure and other elements in the area such as major roads, powerlines, a broiler chicken housing and quarries.

It should, however, be borne in mind that site specific assessments are needed in order to establish suitability particularly from a visual perspective. These are provided in the visual specialist study (see visual study in Chapter 8 of this report).

[4] The visual specialist study notes that "The wind farm will be located within a mixed landscape containing agricultural and coastal resort elements. Agricultural landscapes have a low sensitivity to changes brought by wind farms, and the coastal resort landscapes in Kouga are rapidly changing as towns expand and merge." (see visual study in Chapter 8 of this report).



Source: CNdV Africa (2006)

Figure 10.3 Framework for Location of Wind Energy Projects Based on Landscape Character

A Strategic Environmental Framework (SEF) for the Optimal Placement of Wind Farms in the Coastal Provinces of South Africa (Environomics, 2011) has also recently been produced for the National Department of Environmental Affairs (DEA). This document is intended as a national decision-making level framework to guide national decision-makers and especially the DEA. It recognises and draws on provincial or regional guidelines such as that referred to above and supports the use of relatively strict criteria in the wind farm approval process in order to avoid unnecessary risks including those related to tourism. One of its key points is that there are a large number of applications for wind farms which gives decision makers the 'luxury' of being in a position to pick only the ones with the greatest promise and minimal risks. This dynamic concerning decisions between wind farms and it implications are discussed further in Section 5.2.

10.4.2 Financial viability and risks

Long term positive economic impacts can only flow from a project that is financially sustainable (i.e. financially viable in the long term with enough income to cover costs). As with all other wind power and other renewables projects, the proposed project would not be financially viable without the gradual phasing out of implicit subsidies for non-renewables and coal in particular. This phasing out also needs to be combined with the phasing in of subsidies for renewable in order to 'level the playing field' as outlined in Section 10.4.1.1. In combination, the tax on non-renewables, the accelerated depreciation allowance and REFIT or other financial support outlined previously have catalysed high levels of interest in establishing renewable energy projects such as the Ubuntu Wind Project. These measures should essentially ensure the financial viability of appropriate renewables projects in order to encourage these types of projects. The Ubuntu Wind Project is thus highly likely to prove financially viable assuming it is able to secure a long term contract based on a reasonable tariff - this has been confirmed with the proponent (D. Wolfromm, WKN-Windcurrent SA, pers com).

As mentioned previously, in a competitive bidding process, the relevant authorities will only be offering a limited number of private wind power producers long term power purchase contracts. It is therefore likely that the project will have to compete with other private wind projects for long term contracts. This competition may prove intense. Groenewald (2010) speculates that "All the wind power projects under way (in application phase) at present might ultimately deliver 5000 MW of power to Eskom's grid. This means that some start-up wind projects might not get in on the deal." At this stage it is not possible to determine whether the Ubuntu Wind Energy Project will be one of the projects chosen to qualify for a long term contract - the adjudication process will determine this. There are, however, a number of factors in the project's favour that include:

- Strong international and local partnerships;
- Extensive experience and reputation of WKN AG and Windcurrent SA;
- Advanced stage of viability assessment and environmental application process; and
- Potential to stabilise the local grid.

It needs to be recognised that profitable wind farms are only currently possible with a government subsidy and that a number of wind farm projects are competing for this subsidy. The use of public funds in the form of the subsidy calls for high levels of care in the allocation of funds. Fortunately, the existence of a number of alternative wind farm developers and sites looking to access the subsidy means that the state can be selective in allocating the subsidy to those projects (and project alternatives) that show the most promise and lowest levels of risks of negative impacts. Indications are that a particularly large number of alternative wind energy projects will be available for the state to choose from. Private developers recently submitted expressions of interest to The Department of Energy for the development of various renewable energy projects with a combined capacity of 20,000 MW, the bulk of which would be wind power generation (Salgado, 2010). This exceeds the 3725 MW earmarked for the allocation of the first round of the REFIT by a highly significant margin (Source: Engineering News, 4 & 5 August 2011). Alternatives are therefore not likely to be in short supply even if one assumes that a large proportion of expressions of interest related to projects that have yet to reach the EIA stage and that many may not even get this far.

While risks cannot be ignored, financial viability risks are considered minor assuming a long term contract can be agreed on with the relevant authorities that secures payment for the electricity generated. The project will, however, have to compete with other wind energy projects in order to secure a contract.

The balance between financial benefits and costs are thus likely to be positive for the applicant and land owners partners. These financial returns that motivate developments such as the Ubuntu Wind Energy Project are necessary as the promise of profit is what fuels much of our economy. It does, however, need to be recognized that achieving profits for some can come at an unacceptable cost to wider society. The remainder of this report focuses on the economic impacts (including costs and benefits) that would accrue to wider society in order to provide information on the overall economic desirability of the project.

10.4.3 Impacts on land owners within the site boundaries

The installation of wind turbines and associated infrastructure has the potential to impact both positively and negatively on the land owners whose land parcels will be included in the project. Positive impacts would flow primarily from sharing in the profits of the projects while negative impacts could be associated with the loss of land, disruption of activities and the introduction of nuisance factors (primarily noise and visual impacts).

10.4.3.1 Positive impacts

As in the case of wind farms in other parts of the world, the project would entail payments to the private land owners on whose land turbines and related infrastructure would be placed. These would take the form of either fixed rental payment per turbine or variable payments based on a share of profits. Each land owner would be required to decide between these options and whether the final payment offer is acceptable. As no-one would be forced to accept an offer, each land owner would be able to weigh up the financial gains from the project against any negatives. This should result in net financial gains to land owners and minimise the chances of land owners ending up financially worse off because of the project.

10.4.3.2 Negative impacts

At present the proposed site is zoned for Agriculture, and is mainly used for extensive cattle grazing, with a relatively low carrying capacity of roughly 1 Large Stock Unit (LSU) / 3.5 hectares and higher with feed augmentations. Given the rocky ground and shallow soils, the land is not suitable for crop farming (CSIR, 2010). Table 10.5 below summarises the key farming activities on each farm making up the study site.

Table 10.5: Activities on the farms making up the site

Landowner	Farm name and size of land included in wind farm proposal	Activities
Jaques Steenkamp	Zuurbron – 3,550 ha in total, of which 2,050 ha where turbines are planned	– Farming with roughly 600 beef cattle on permanent grasses. – Staff of 12 workers on all land including those parcels with no turbines planned (i.e. 3,550 ha). – Soil potential generally low. Carrying capacity is roughly 1 LSU / 3.5 ha.
Frank Lotter	Vlakteplaas – 800 ha	– Farming with roughly 400 beef cattle on permanent grasses. – Staff of 3 workers on farm. – Soil potential generally low. Potential being augmented with chicken litter from neighbouring farm which allows for higher carrying capacity of roughly 1 LSU / 2 ha.

Potential impacts on these activities could stem from loss of land, changed access, noise and other nuisance factors.

With regard to loss of agricultural land, the following estimates can be made for each component of the project:

- Mast footprints – roughly 400 m^2 (20m X 20m) for each turbine and 1.6 ha for 40 turbines
- Hard standing area – roughly 2000 m^2 (50m x 40m) for each turbine and 8 ha for 40 turbines
- Operations and maintenance building – 5,000 m^2
- Gravel roads – roughly 10 to 15 km (5 m width) of new roads covering a total of 5 to 7.5 ha

The likely total land needed for 40 turbines would be between 14.6 ha and 17.1 ha. Based on the natural carrying capacity of the area, the loss of this land would result in reduced capacity of 4 to 5 cattle in total. This would represent a minimal loss in production. It should also be considered a worst case scenario as both land owners have indicated that they have spare capacity to move cattle and should in a position to expand production elsewhere on their land using income from the wind project (J. Steenkamp & F. Lotter, *pers com.*)

With respect to potential negative impacts from noise, the noise specialist study has found that if adequate mitigation measures are implemented negative impacts associated with noise would be acceptably low for inhabited buildings (Williams, 2011).

With respect to visual impacts, there can be no doubt that the visual landscape on the farms will change significantly. It is not, however, anticipated that these changes will lead to unmanageable conflicts of agricultural activities on the farms making up the site. Also it should be borne in mind that the farmers will be compensated for the presence of the turbines on their land and have indicated their willingness to accommodate the turbines on this basis.

Note that the construction phase of roughly one year would be associated with disruptions. However, these are expected to be minimal and manageable in consultation with land owners. Once established, all farming activities would essentially be able to continue largely as before resulting in minimal, if any, impacts on these activities.

10.4.3.3 The balance between positive and negative impacts

Given the above, it is highly likely that the net impacts on all land owners would be positive and probably significantly so. All the land owners consulted confirmed that they were positive about the project and see it as a welcome source of additional income with relatively minimal risks and potential negative impacts provided there is adequate mitigation. Given the added income stream that would be associated with the wind farm, it is also likely that the value of properties on the site would increase. This would conform with experience in other countries.

Impacts have consequently been given a medium significance positive rating with mitigation (see summary impact rating table at the end of Section 5).

Mitigation measures

- Recommendations of noise, visual, ecological, bird and bat specialist studies to be implemented.
- Adequate setbacks from buildings, structures and residences in particular to be strictly enforced.

10.4.4 Impacts on surrounding land owners

Aside from onsite impacts, the installation of wind turbines and associated infrastructure has the potential to affect surrounding land owners. Negative impacts could be associated primarily with noise and visual impacts.

The site is surrounded mainly by other farms. No negative impacts are anticipated on the agricultural activities on these farms for the same reasons that no significant impacts are anticipated on agricultural activities on the site. All agricultural production and activities will be able to continue as at present.

The turbines would also be adequately set back from the closest residences and exceed the minimum requirements in this regard. The nearest turbine to any neighbouring residence would be approximately 1 km away from the residence on Kransplaas along the Kabeljous River. The nearest turbine to the residence on Farm 865 would also be adequately set back roughly 1.5 km from the residence.

With respect to noise, the noise specialist study found no instances where turbines would result in unacceptable impacts on neighbouring farms (Williams, 2011). In addition, WKN-Windcurrent SA intends applying international standards with respect to turbine placement distances from farm boundaries.

As a consequence of the prediction of minimal, if any, significant negative impacts, it is unlikely that there would be negative impacts on the agricultural value of properties surrounding the site.

Impacts consequently have been given a low negative to neutral rating with mitigation during operations although impacts may be slightly negative during construction given the potential for disruptions (see summary impact rating table at the end of Section 5).

Mitigation measures

- Recommendations of noise, visual, ecological, bird and bat specialist studies to be implemented.
- Adequate setbacks from site borders and residences in particular to be strictly enforced.

10.4.5 Impacts on tourism potential and development

As was outlined in the economic context section, tourism plays an important role in the economy of the local area and region and has the potential to play an increasingly prominent role as a driver of economic development. It is thus important to consider the potential impacts of the proposed development on this sector. Tourism impacts are often driven by changes in the sense of place in an area. The proposed development thus has the potential to impact on tourism as its nature dictates that it is likely to change the character of the area. Potential positive impacts could also arise should the development provide an added attraction in the area that could draw tourists.

In order to assess tourism impacts, information on current tourism use and potential future use focusing on the area surrounding the site was gathered. In order to verify and augment tourism issues raised during scoping, discussions were also held with tourism authorities and tourism stakeholders in order to get their views on potential impacts and inform assessment. Pertinent information from other specialist studies was examined, discussions were held with the specialists where necessary and an assessment of impacts made. In this regard the visual specialist study was most relevant.

Current tourism 'use' of the site is not direct in nature as there are no tourism facilities on the site. However, the site is indirectly part of the tourism package of the area as it can be seen from a number of vantage points, from routes used by tourists (i.e. the N2, R330 and R102) and from tourism establishments such as those offering accommodation.

10.4.5.1 Negative impacts

The potential for wind farms to have negative impacts on tourism is something that has received more research attention in Europe and the United States given the far greater number of wind farms in these countries. A recent review of research on the economic impact of wind farms on tourism covering 40 studies in the UK and Ireland and other reports from Denmark, Norway, the US, Australia, Sweden and Germany provides a comprehensive source of information on this issue (GCU, 2008). In summary it found that:

- "There is often strong hostility to developments at the planning stage on the grounds of the scenic impact and the perceived knock on effect on tourism. However developments in the most sensitive locations do not appear to have been given approval so that where negative impacts on tourism might have been a real outcome there is, in practice, little evidence of a negative effect.
- There is a loss of value to a significant number of individuals but there are also some who believe that wind turbines enhance the scene.

- An established wind farm can be a tourist attraction in the same way as a hydro-electric power station. This of course is only true whilst a visit remains a novel occurrence.
- In Denmark, a majority of tourists regard wind turbines as a positive feature of the landscape.
- Over time hostility to wind farms lessens and they become an accepted even valued part of the scenery. Those closest seem to like them most.
- Overall there is no evidence to suggest a serious negative economic impact of wind farms on tourists."

These findings indicate that clear instances of negative impacts on tourism are relatively rare. This does not imply that negative impacts cannot occur, but does point to the need to have high levels of certainty before concluding that a wind farm will have a significant negative impact on tourism. The available evidence in the GCU review suggests that instances where wind farms are most likely to result in negative impacts are those where they are situated in areas with a clear wilderness quality with little or no signs of 'civilisation' in the form of infrastructure such as power lines, major roads, etc. In addition concerns regarding tourism have been a key motivator of guidelines on wind farm location such as those produced for the Western Cape Department of Environmental Affairs and Tourism (CNdV, 2006) and, more recently, for the national Department of Environmental Affairs (Environomics, 2010). Concerns around tourism should not therefore be downplayed and risks should be kept to a minimum.

The visual specialist study has found that the proposed wind farm will be located within a mixed landscape containing agricultural and coastal resort elements. Agricultural landscapes have a low sensitivity to changes brought by wind farms, and the coastal resort landscapes in Kouga are rapidly changing as towns expand and merge (see visual study in Chapter 8 of this report).
The significance of the impact on the landscape character of the region has thus been assessed as moderate by the visual specialist. Potential for negative impacts have been noted as the facility would be visible over a large region. Viewers who will be most affected by the wind farm are those living on farms surrounding the development site. However, it is also noted that "there are not many sensitive viewers in these areas who will be highly exposed to the wind farm. Views from Jeffrey's Bay are unlikely to be highly impacted since scenic views are normally directed at the mountains in the north or the ocean. Protected areas in the region are generally too far from the site to be highly impacted (see visual study in Chapter 8 of this report)." The Kabeljous River Natural Heritage Site would be adjacent to the site. However, due to the topography of the area only parts of a few turbines will be visible from here and do not seem to be a cause for particular concern based on the visual assessment.

With respect to routes that tourists use in the area, the visual specialist study has found that the facility would be highly visible when viewed from routes used by tourists. However, it would have a relatively significant set-back distance from the N2 (roughly 3 km), the R330 (roughly 3.2 km) and the R102 (3.3 km). This would mitigate the visual impacts particularly when viewed from the N2 and R102. Also it should be noted that this area is already in a partially disturbed state. The views along the R330 are generally of a more undisturbed and rural nature with fewer signs of human habitation and infrastructure. Impacts on these views were a key concern for the tourism authorities in the area.

Key tourism establishments near the site are located along the gravel road to the south of the site that branches off the R102, crosses under the N2 and runs in a north-easterly direction roughly parallel to the Kabeljous River. They include Cob Creek restaurant and vineyards roughly 1.8 km from the N2 and Fijnbosch Game Lodge and Spa (offering accommodation for 20 in three chalets and one main lodge) situated roughly 4.5 km from the N2. The nearest turbines to Cob Creek would be 3 km distant to the north which is probably adequate to ensure low risks to Cob Creek given the tourism product it has to offer. The nearest turbines to the Fijnbosch Game

Lodge would be 2.5 km to the north and, at worst, would be partially visible from the lodge given the presence of a ridge near the lodge which shields views to the north. Risks to the lodge are also considered low given these factors.

For tourism establishments in Jeffrey's Bay the wind farm would be relatively distant. The nearest turbine would be roughly 6.3 km from the nearest houses in the Kabeljous-on-Sea part of Jeffrey's Bay. Impacts on existing tourism establishments or the tourism potential of Kabeljous-on-Sea would thus most likely be minimal due to this distance and the character of the area between Kabeljous-on-Sea and the wind farm. The visual specialist study notes that views to the north from Kabeljous-on-Sea often have the Van Staden's Mountains as a backdrop and are valued by residents and tourist visitors for their scenic qualities. However, it found that it is unlikely that wind turbines will intrude on scenic views to the north (see visual study in Chapter 8 of this report). Similarly the Kabeljous River Nature Reserve north of Kabeljous-on-Sea is roughly 5 km from the nearest turbines in the wind farm and visual exposure values for the reserve are low.

Notwithstanding the potential for relatively moderate impacts on the overall landscape level, high visual impacts on individuals have been predicted by the visual specialist study as one would expect given the size and nature of the project. However, the visual specialist study also notes that, with regard to potentially sensitive areas, it is not clear whether the wind farm will have a positive or negative impact as opinions on the aesthetic appeal of wind farms vary widely (see visual study in Chapter 8 of this report). It is also not clear that individual negative impacts (should they arise) will result in collective impacts that are significant enough to create significant risks for tourism.

Discussions with the tourism associations, and municipal officials responsible for tourism, revealed that they have relatively high levels of concern with regard to the project and other wind farms in the area.[5] Their key concern is essentially that this project and others are of such a scale that they would change the overall character of the area thereby risking a detraction from its tourism appeal. Potential cumulative impacts are therefore their key concern (see Section 10.4.7 for a further discussion of cumulative impacts). Although it is recognised by the tourism authorities that the Kouga area is built up in many places, it largely has managed to maintain a relatively natural sense of place which is a key tourism draw-card. There is a general recognition for the need for renewable energy among tourism stakeholders. However, achieving this with no or minimal risks to tourism is seen as preferable if possible.

Drawing on the visual assessment and international experience, it is seems most reasonable to conclude that the development would make a significant change to the current sense of place of the site and would not be without tourism risks. However, these would be mitigated by the site's location and the lack of particularly sensitive tourism receptors nearby. They are thus expected to be of a low to medium level noting the low to medium level of confidence that one can attach to this kind of assessment (i.e. tourism impacts of a largely unknown type of development in South Africa)

[5] Discussions were held with Mrs J Prinsloo (Kouga and Humansdorp Tourism chairperson), Ms K Nelani (Kouga Municipality LED and Tourism Department) and Mr Andy Thuysman (Jeffrey's Bay Tourism chairperson and Supertubes Surfing Foundation representative on environmental matters)

10.4.5.2 Positive impacts

Potential positive impacts on tourism would stem from the potential attraction that a wind farm would introduce. Wind farms are certainly a rarity in South Africa and can create a visual spectacle that may appeal to tourists. This is not to say that tourists would visit the area specifically to see the wind farm (although this is a possibility). Rather, it seems likely that the wind farm could add somewhat to the overall tourist experience in the area particularly while it remains novel. Note that the facility is only likely to appeal to certain tourists and positive impacts are likely to be of a short term nature and of a low significance.

Aside from potential benefits through visiting and/or viewing the facility, it also has the potential to contribute to the tourism package on offer in the area through its potential to enhance the 'sustainable tourism' or 'eco-friendly' brand of the area. Numerous examples can be found of individual tourism establishments and wider tourism areas that have used initiatives such as renewable energy installations, recycling programmes, rehabilitation programmes, etc. to their advantage. These initiatives are commonly used to enhance general reputation and credibility. In some cases they are part of a focused strategy that actively markets high levels of eco-friendliness or sustainability.

10.4.5.3 The balance between positive and negative impacts

Arriving at an assessment of the overall risk to tourism needs to be recognised as an exercise with high levels of uncertainty given the total lack of experience with wind farms in South Africa and widely diverging views regarding their aesthetic appeal in different contexts. Nevertheless, considered as a whole, the key potential drivers of negative tourism impacts (primarily visual impacts) do not seem to be significant enough to provide any clear basis to conclude that the project would entail more than a low to medium level of risk for tourism with mitigation (see summary impact rating table at the end of Section 5). In the short term, whilst novel, it is possible that this risk would be somewhat off-set by the positive attraction provided by the project.

Some disturbance and nuisance would be experienced during construction. This would include the potential for increased dust and noise as well as increased social risks associated with a large workforce. Impacts should, however, be minimal provided the construction phase is well managed and the mitigation measures suggested by the other specialist studies forming part of the EIA are implemented. Impacts during construction are thus expected to be low with mitigation.

The "no-go" would have no impact relative to the status quo with regard to tourism.

It should be borne in mind that the balance between positives and negatives as well as the significance of tourism impacts are difficult to predict as they are primarily reliant on the perceptions of tourists some of whom may find that the project detracts from their experience and others who may not. Confidence in assessment is thus low to medium.

<u>Mitigation measures</u>

- Impacts on tourism are dependent on how the site is developed and managed to minimise negative biophysical impacts. The measures recommended in other specialist reports to these impacts (primarily the minimisation of visual, noise and ecological impacts) would thus also minimise tourism impacts.

10.4.6 Impacts linked to expenditure on the construction and operation of the development

The construction and operational phase of the project would both result in a positive spending injection into the area that would lead to increased economic activity best measured in terms of impacts on employment and associated incomes in the local area and region.

All new expenditure will lead to linked direct, indirect and induced impacts on employment, incomes and production. Taking employment as an example, impacts would be direct where people are employed directly on the project in question (e.g. jobs such as construction workers), indirect - where the direct expenditure associated with a project leads to jobs and incomes in other sectors (e.g. purchasing building materials maintains jobs in that sector) and induced where jobs are created due to the expenditure of employees and other consumers that gained from the project. Direct impacts are the most important of these three categories as they are the largest and more likely to affect the local area. Their estimation also involves the lowest level of uncertainty. The quantification of indirect and induced impacts is a far less certain exercise due to uncertainty surrounding accurate multipliers particularly at a local and regional level. This uncertainty makes it inadvisable to quantify indirect employment unless an in-depth analysis is required. Potential direct employment and income impacts are consequently quantified here and likely indirect impacts are considered in a qualitative sense when providing overall impact ratings.

10.4.6.1 Construction phase impacts

Construction expenditure would not displace other investment and would constitute a positive injection of new investment. During the construction phase the civil and other construction, specialised industrial machinery, and building construction sectors would benefit substantially. The development would provide a major injection for contractors and workers in the area that would in all likelihood purchase goods and services in Jeffrey's Bay, Humansdorp, Hankey and the wider region.

Preliminary estimates indicate that a total of approximately R1.6 billion would be spent on the entire construction phase including infrastructure and building construction as well as turbine and other specialised machinery installation (see Table 10.6). The majority of the machinery and equipment such as the turbines will have to be imported as these items are not currently available in South Africa. Notwithstanding the need for relatively high proportions of imports, the construction of the project represents a significant investment spread over roughly one year. It should be borne in mind that the estimates are not to be regarded as highly accurate and are subject to revision. They are relatively coarse estimates only meant to give an approximate indication of potential expenditure.

Table 10.6: Construction phase expenditure (in 2011 Rands)

	Cost in 2011 rands over roughly one year	% of total costs that would go to suppliers in the local municipal area	% of total costs that would go to suppliers in the rest of the Eastern Cape	% of total costs that would go to suppliers in the rest of South Africa	% of total costs for imports
Civils and all buildings	R 500 000 000	29%	65%	16%	0%
Machinery & equipment	R 1 100 000 000	0.5%	0.5%	11%	88%
Total	R 1 600 000 000				

Note: Machinery & equipment such as turbines are presently only available through import. Should this change, the need to import will decrease.

10.4.6.1.1 Employment during construction

In order to estimate direct temporary employment during construction standard construction industry estimates for labour required were used. The levels of employment that would be associated with the two main components of the construction phase over roughly one year are presented in Table 10.7. Roughly 187 jobs of one year's duration would be associated with the entire construction phase with the majority of jobs in the low and medium skill sectors as expected. Again, the estimates are not to be regarded as highly accurate and are meant to give an indication of potential employment impacts.

Table 10.7: Estimated direct temporary employment during construction

	Number of workers				Duration of employment
	Highly skilled	Medium skilled	Low skilled	Total	
Construction component					
-Civils and Building	7	30	80	117	8 -12 Months
-Installation of machinery and equip	10	20	40	70	8 -12 Months
Total	17	50	120	187	

Estimates of how much employment is likely to go to workers from different areas are presented in Table 10.8. It is anticipated that approximately 80 jobs of one year's duration would be allocated to workers from the Kouga Municipality, a further 72 to workers from the Eastern Cape, 9 to workers from the rest of the country and 24 to overseas workers given the need for specialist skills not available in South Africa.

Table 10.8: Estimated direct temporary employment per area during construction

	Construction workers			
	High skill	Medium skill	Low skill	Total
Anticipated % of workers from the Kouga municipal area	0%	20%	60%	
Number from the Kouga municipal area	-	10	72	**82**
Anticipated % of workers from the rest of the Eastern Cape	25%	40%	40%	
Number from the rest of the Eastern Cape	4	20	48	**72**
Anticipated % of workers from the rest of South Africa	25%	10%	0%	
Number from rest of SA	4	5	-	**9**
Anticipated % of workers from overseas	50%	30%	0%	
Number from overseas	9	15	-	**24**
Total	17	50	120	**187**

10.4.6.1.2 Household incomes linked to wages during construction

Direct household income impacts would flow from all wages paid during construction. These were estimated by multiplying the projected number of direct jobs associated with the project above by assumed average monthly salaries for each skill category (i.e. R4,200 for low skilled, R10,000 for medium skilled and R20,000 for highly skilled employees). Again, these estimates are to be treated as indicators. The results of this exercise indicate that incomes flowing to workers from the Kouga Municipality would probably amount to R9.7 million over the course of the project, R11.7 million would accrue to workers from the rest of the Eastern Cape, and R3.2 million to workers from the rest of the country (Table 10.9).

Table 10.9: Direct household income per area during construction (2011 Rands)

	Direct income during construction			
	High skill	**Medium skill**	**Low skill**	**Total**
Workers from the Kouga Municipality	R 0	R 2 400 000	R 7 257 600	R 9 657 600
Worker from the rest of the Eastern Cape	R 2 040 000	R 4 800 000	R 4 838 400	R 11 678 400
Workers from the rest of SA	R 2 040 000	R 1 200 000	R 0	R 3 240 000
Workers from overseas	R 4 080 000	R 3 600 000	R 0	R 7 680 000
Total	**R 4 080 000**	**R 8 400 000**	**R 12 096 000**	**R 24 576 000**

10.4.6.2 Operational phase impacts

Once established, the operation of the facility would result in direct and indirect economic opportunities. These would stem from expenditure on operations including expenditure on employees that would not otherwise have occurred, particularly in the local area. Estimates of operational costs and where operational goods and services would be sourced from are highly preliminary at this stage. It is anticipated that roughly R20.9 million would be spent annually on operations (Table 10.10). As with construction, a high percentage (roughly 70%) of this would initially be imported given the limited availability particularly of highly skilled engineers. It is hoped that after 5 years or so, local skills will have been built up to the required level and maintenance engineering companies will have been established in response to projects like the Ubuntu Wind Energy Project so that the importation of these services will no longer be necessary. Aside from engineering services, all other operational costs would entail purchases of goods and services mostly from the local area and/or region resulting in an ongoing investment injection.

Table 10.10: Preliminary estimate of operational expenditure (2011 Rands)

Operational cost categories	Annual costs once project is fully operational	% of total costs that would go to suppliers in the lcoal municipal area	% of total costs that would go to suppliers in the rest of the Eastern Cape	% of total costs that would go to suppliers in the rest of South Africa	% of total costs for imports
Salaries and wages	R 2 000 000	20%	30%	50%	0%
Municipal services	R 100 000	100%	0%	0%	0%
Outsourced engeneering services	R 15 800 000	0%	20%	0%	80%
Sundry supplies	R 1 000 000	80%	20%	0%	0%
Insurance, community benefits etc	R 2 000 000	70%	10%	20%	0%
Total costs once fully operational	**R 20 900 000**				

10.4.6.2.1 Employment during operations

The expected direct employment during operations is presented in Table 10.11. In keeping with the relatively low maintenance and high technology nature of the facility, it is expected that approximately 10 direct employment opportunities will be created by the project equally spread across skill levels. Although high skill positions will probably have to initially be filled by imported technicians, medium and low skill positions will offer opportunities for locals and those from the region.

Table 10.11: Employment associated with activities on the site during operations

	Number of employees			
	Highly skilled	Medium skilled	Low skilled	Total
Operational jobs once fully operational	2	4	4	10

Aside from these direct employment opportunities, the operational expenditure on the project (detailed above) and the spending of those employed directly would result in positive indirect impacts on the local and regional economy.

10.4.6.2.2 Opportunities associated with growing the national wind energy sector

The potential for the Ubuntu Wind Energy Project and other future wind energy projects to result in greater impacts on local economies and the South African economy as a whole is primarily dependent on economies of scale. Currently, import content is necessarily high. However, if the wind programme grows in size (aided by projects such as the Ubuntu Wind Energy Project) it should provide opportunities for manufacturing and servicing at local scale and the additional benefit that would flow from it. Marquad *et al.* (2008) point out that opportunities for competing with overseas firms on a cost basis in manufacturing are minimal at present, and an extensive wind programme would initially be implemented with imported equipment and using international expertise. However, according to Marquad *et al.* (2008), the introduction of a large-scale programme could provide local economic opportunities for component manufacture, and with an appropriate industrial policy it would be possible to leverage South Africa's relatively cheap steel resources. The distance from other international manufacturers will also confer a competitive advantage, especially for less-specialised large-scale components such as steel towers.

10.4.6.3 Significance of impacts

An assessment of the significance of the combined impacts of project-related expenditure on increased employment and incomes based on the findings above (both without and with mitigation measures) is presented at the end of Section 5. Impacts with mitigation would be of a medium significance during construction given the size of the expenditure injection and the number of potential employment and income generation opportunities involved. Similarly, new impacts during operations would be of a medium significance with mitigation. With time local impacts should become more pronounced as the sourcing of labour, goods and services becomes easier.

The no-go would have no impact relative to these benefits as there would be no expenditure injection.

<u>Mitigation measures</u>

Mitigation in the form of benefit enhancement should focus on three areas:

1. Targets should preferably be set for how much local labour should be used based on the needs of the proponent and the availability of existing skills and people that are willing to undergo training. Opportunities for the training of unskilled and skilled workers from local communities should be maximized.
2. Local sub-contractors should be used where possible and contractors from outside the local area that tender for work should also be required to meet targets for how many locals are given employment.
3. The proponent should continue to explore ways to enhance local community benefits with a focus on broad-based BEE through mechanisms such as community shareholding schemes, trusts, preferential procurement, etc. In accordance with the relevant BEE legislation and guidelines, if the proponent wishes to maximise BEE points a minimum of 4% of after tax profit would need to find its way into community upliftment and enterprise

development initiatives over and above that associated with expenditure injections into the area.

Operationalising the first two measures is challenging and it is difficult to decide on appropriate targets and ensure they are reached. It is thus recommended that the proponent should draft proposals regarding targets with reasons for their choice for inclusion in the EMP. These should include targets for (1) the percentage of the total construction contract value that should go to local contractors and (2) the percentage of total labour requirement that should be met using local labour. Targets should then be negotiated further with the local economic development authorities in the local municipality before any tendering is done.

Note that the national government has signalled its intention to place significant emphasis on the local economic development initiatives which wind project developers propose when deciding which wind projects to support financially. This should ensure that only wind projects which have paid significant attention to this aspect will be given the financial support required to go ahead.

10.4.7 Cumulative impacts

Cumulative impacts are defined as those impacts on the environment, which result from incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (CEQ, 1997).

The impact assessments, including significance ratings, discussed in the foregoing sections of this study have encompassed all impacts including those of a cumulative nature. Specific comment on their cumulative nature has been provided where relevant. This section provides further consolidated discussion of these impacts in order to provide greater clarity. Also it should be borne in mind that the distinction between cumulative and other impacts is often extremely difficult to make. The assessment of cumulative impacts also is more difficult mainly because they often require more onerous assumptions regarding the likely actions of others.

The wind projects in the region currently either in the application stage or with approvals in place are listed in Table 10.12.

Table 10.12: Wind projects planned in the Kouga region

Environmental Practitioner	Last document released, approval status	Applicant	Location	Number of Turbines	Capacity MW
Savannah Environmental (Pty) Ltd	Draft EIA Report	VentuSA Energy Corp (Pty) Ltd	Dieprivier Mond, 17km west of Humansdorp north of the N2	50	100
Savannah Environmental (Pty) Ltd	Background Information Document	African Clean Energy Developments (Pty) Ltd	Near Cookhouse in the Eastern Cape	Up to 50 turbines	Capacity not indicated in BID
Savannah Environmental (Pty) Ltd	Draft EIA Report	VentuSA Energy Corp (Pty) Ltd	Happy Valley, 3 km west of Humansdorp near the N2	20	40
Savannah Environmental (Pty) Ltd	Draft Scoping Report	Exxaro Resources and Watt Energy (Pty) Ltd Tsitsikamma community	The proposed site is situated approximately 30 km west of Humansdorp, south of the N2 National Road in the Tsitsikamma area	Maximum of 50	100MW
CSIR	Environmental Authorisation granted (April 2011)	Mainstream SA	Between Jeffrey's Bay and Humansdorp north of the N2	40 to 85	180
CSIR	Draft Scoping Report	Windcurrent SA	Banna Ba Pifhu, 3.5 km south of Humansdorp	14 - 25	50
Arcus Gibb http://projects.gibb.co.za/Projects	Environmental Authorisation granted (June 2011)	Redcap Invest.	Western Sector to the east of the Tsitsikamma River Central Sector near Oyster Bay Eastern Sector north of St Francis Bay	50 to 150	100 to 300

The key source of potential negative cumulative impacts identified in this assessment is the proposed development's risk to tourism when combined with other planned wind farm projects in the area (see Table 10.12). Those with environmental approvals in place are particularly pertinent and include the Mainstream proposal between Jeffrey's Bay and Humansdorp and the Red Cap proposal in three locations near St Francis Bay, Oyster Bay and adjacent to the Tsitsikamma River (see Appendices 2 and 3 respectively for maps of these proposals). The concern would be that if these projects and others go ahead along with the Ubuntu project, the area would become dominated by wind turbines with consequences for tourism. Should they all go ahead, turbines would certainly become a prominent feature of the local environment and this would not be without risks. The likelihood of this is however very small due to the nature of the competitive tendering process for the long-term Power Purchase Agreements. It is these risks among others that have prompted the drafting of guidelines with regard to wind farm location (CNdV, 2006 and Environomics, 2011). However, it is not clear how significant these risks would be particularly in the absence of a regional study focusing on this question. The lack of such a study in the area should be viewed as a significant information gap. In the absence of such a study, it is probably reasonable to tentatively rate cumulative risks as low to medium particularly when one considers the international literature on the subject (see Section 10.4.5) and the findings of the visual specialist studies for the projects in question which have not identified situations of serious concern.

Positive cumulative impacts are also likely as the project should set a positive precedent for further investment in the area. By committing to investment in a large development, the proponent would be casting a strong 'vote of confidence' in the local economy. This has the potential to influence other investors (including locals) to also act with similar confidence thereby resulting in cumulative impacts on overall investment levels. In a sense the project and other wind projects have the potential to lead to the 'crowding in' of further investment. As has been noted, if the wind energy industry grows in size (aided by projects such as the Ubuntu Wind Energy Project) it should provide opportunities for manufacturing and servicing at scale and the additional, cumulative benefit that would flow from it.

Table 10.13:Summary table of impacts

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Construction Phase over approximately 1 year									
1.1. Impacts on land owners and land uses on the site	**Negative**	**Local**, i.e. on site	**Short**, i.e. 1 year	**Low**, since construction activity would be relatively localised to smaller areas relative to each land parcel	**Highly probable**, since construction will entail significant activity on site	**Low**, since footprints would be minimal, farming can continue and owners would be paid for use of their land	Implement recommendations of noise, visual, ecological, bird and bat specialist studies. Adequate setbacks from buildings, structures and residences to be strictly enforced.	**Low**, since mitigation, e.g. limit footprints, locate turbine appropriately, will further limit negative impacts	**Medium**, since based on new and not well known type of land use
1.2. Impacts on surrounding land users	**Negative**	**Local**, i.e. on surrounding lands	**Short**, i.e. 1 year	**Low**, since construction activity would be relatively localised to smaller areas relative to each land parcel	**Highly probable**, since construction will entail significant activity on site	**Low**, since farming and other activities can continue	Implement recommendations of noise, visual, ecological, bird and bat specialist studies. Adequate setbacks from borders and residences in particular to be enforced.	**Low**, since farming and other activities can continue	**Medium**, since based on new and not well known type of land use
1.3. Impacts associated with project investment / expenditure	**Positive**	**Local, regional and national**	**Short**, i.e. 1 year	**Medium**, since construction expenditure would be a significant injection	**Highly probable**, since construction will entail significant activity on site and investment	**Medium**, given significance of injection relative to economy	Set targets for use of local labour and maximise opportunities for training. Use local sub-contractors where possible Explore ways to enhance local community benefits with a focus on broad-based BEE through mechanisms such as community shareholding schemes and trusts.	**Medium**, given significance of injection relative to economy	**High**, since based on known investment amounts

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Operational Phase over approximately 25 years									
1.1. Impacts on land owners and land uses on the site	**Positive**	**Local**, i.e. on site	**Long**, i.e. 25 years	**Low to Medium**, since farmers would be compensated and risks would be relatively minimal	**Highly probable**, since structures will be permanent and operations would continue for at least 25 years	**Low to Medium**, since footprints would be minimal, farming can continue and owners would be paid for use of their land	Implement recommendations of noise, visual, ecological, bird and bat specialist studies. Adequate setbacks from buildings, structures and residences to be strictly enforced.	**Medium**, since mitigation will further limit negative impacts	**Medium**, since based on new and not well known type of land use
1.2. Impacts on surrounding land users	**Negative to Neutral**	**Local**, i.e. on surrounding lands	**Long**, i.e. 25 years	**Low,** since risks are considered manageable	**Highly probable**, since structures will be permanent and operations would continue for at least 25 years	**Low Negative**, since farming and other activities can continue	Implement recommendations of noise, visual, ecological, bird and bat specialist studies. Adequate setbacks from borders and residences in particular to be enforced.	**Low Negative to Neutral**, since farming and other activities can continue	**Medium**, since based on new and not well known type of land use
1.3. Impacts on tourism	**Negative**	**Regional**	**Long**, i.e. 25 years	**Low to medium,** since risks are considered manageable	**Highly probable**, since structures will be permanent and operations would continue for at least 25 years	**Low to Medium,** considering risks and opportunities	The measures recommended in other specialist reports to minimise biophysical impacts (primarily the minimisation of visual, noise and ecological impacts) would also minimise tourism impacts.	**Low to Medium,** considering risks and opportunities	**Low to Medium,** since tourism behaviour difficult to predict
1.4. Impacts associated with project investment / expenditure	**Positive**	**Local, regional and national**	**Long**, i.e. 25 years	**Medium,** since operational expenditure would be a significant injection	**Highly probable**, since expenditure on operations would continue for at least 25 years	**Medium,** given significance of injection relative to economy	Set targets for use of local labour and maximise opportunities for the training of unskilled and skilled workers. Use local sub-contractors where possible Explore ways to enhance local community benefits with a focus on broad-based BEE through mechanisms such as community shareholding schemes and trusts.	**Medium,** given potential for mitigation to enhance benefits	**High,** since investment, employment are known

10.5 CONCLUSION

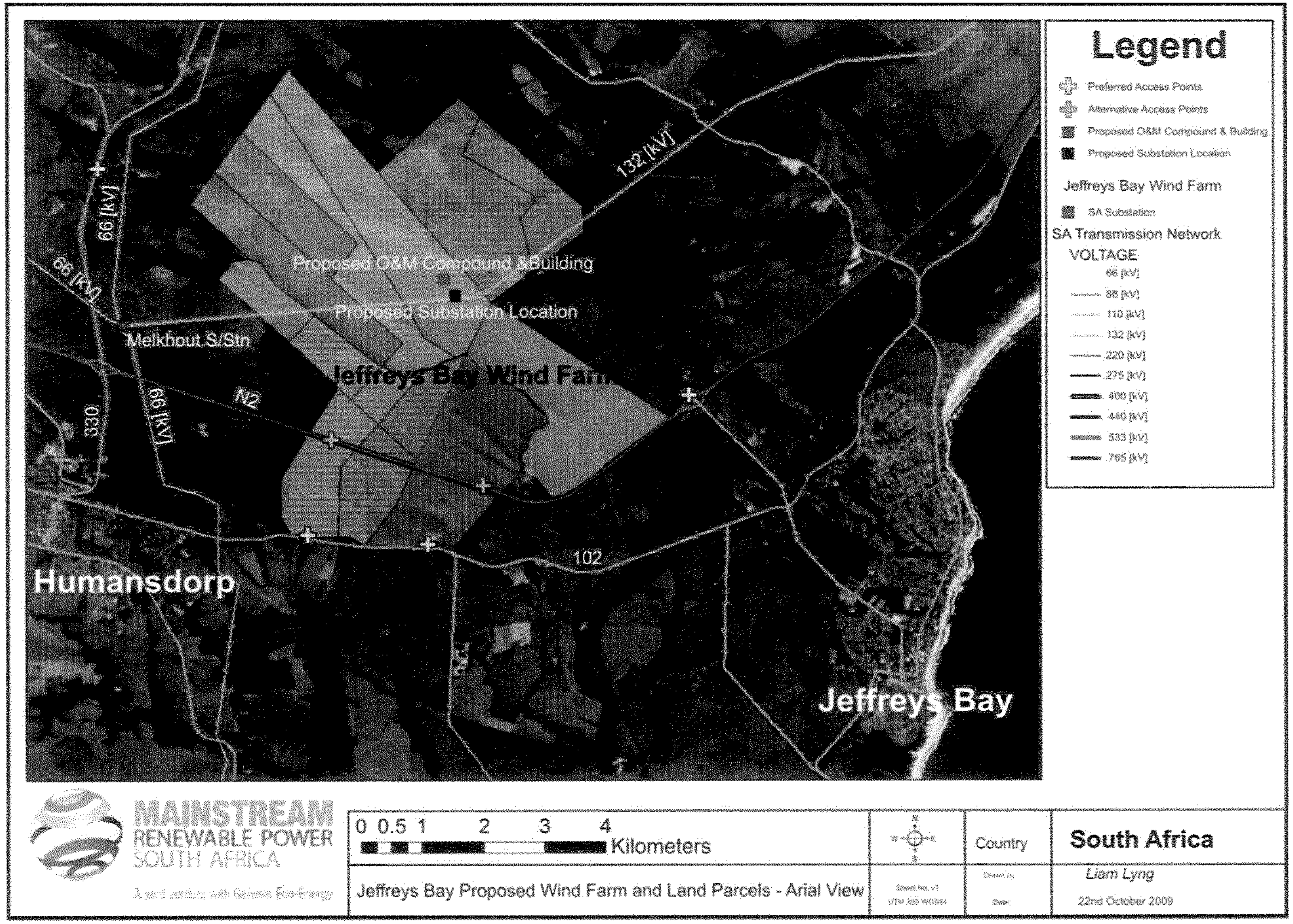
When considering the overall costs and benefits of the project it was found that the latter should be more prominent allowing for the achievement of a net benefit. Benefits would be particularly prominent for the project proponents, land owners on the site and in the achievement of national and regional energy policy goals. The project would also result in significant positive economic spin-offs primarily because of the large expenditure injection associated with it.

With respect to risks and negative impacts, these are difficult to assess accurately but should prove to be acceptable provided adequate mitigation is put in place much of which will revolve around optimal turbine locations. Tourism risks in particular are a source of concern when cumulative impacts are considered.

Appendix 10.1: Disclaimer

The primary role of this study is to inform the decision-making processes being undertaken by the relevant environmental authorities with regards to the proposed project. Due care and diligence has been applied in the production of the study. However, ultimate responsibility for approving, denying or requiring changes to the proposed project application rests with the relevant environmental authorities (and other government bodies where relevant) who also bear responsibility for interrogating and determining how assessment information from this economic specialist study along with other information is to be used to reach their decisions. Independent Economic Researcher and Dr Hugo van Zyl can therefore not be held responsibility or liable for any consequences of the decisions made by the relevant environmental authorities with regard to the proposed project. This includes any financial, reputational or other consequences that such decisions may have for the applicant, the Environmental Assessment Practitioner responsible for conducting the Environmental Impact Assessment process or for the environmental authorities themselves.

Appendix 10.2: Location of proposed Mainstream Wind Energy Project



Source: Mainstream EIA done by CSIR, 2010

Appendix 10.3: Locations of proposed Red Cap Wind Energy Project

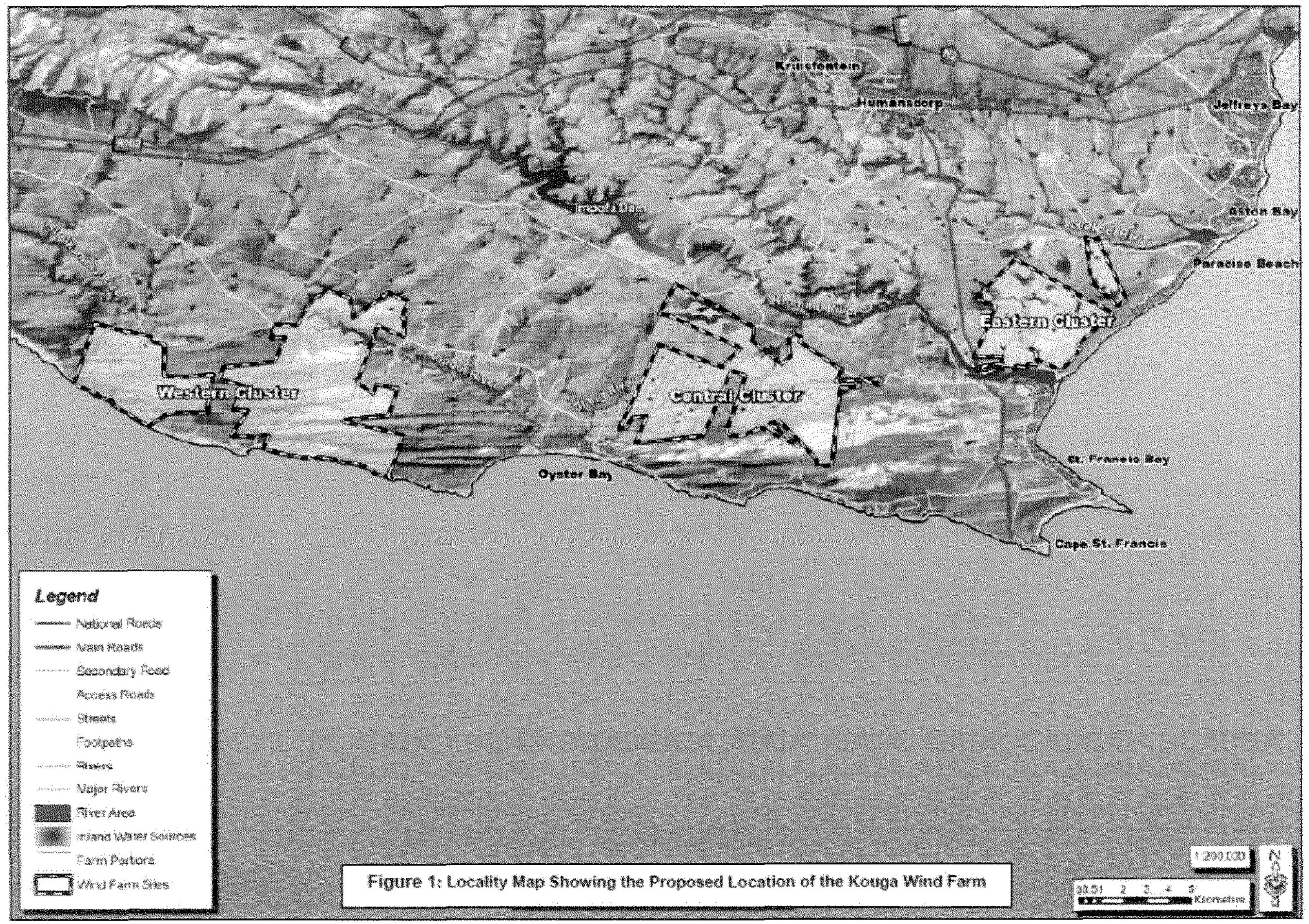


Figure 1: Locality Map Showing the Proposed Location of the Kouga Wind Farm

Source: Red Cap EIA done by Arcus Gibb, 2010

Environmental Impact Assessment for the proposed Ubuntu Wind Energy Project near Jeffrey's Bay, Eastern Cape: Draft Environmental Impact Assessment Report

Chapter 11:

Impact on Archaeology

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CHAPTER 11. IMPACT ON ARCHAEOLOGY

This Chapter presents the Archaeological Impact Assessment conducted by Jonathan Kaplan of the Agency for Cultural Resource Management for the Ubuntu wind energy EIA

Note: This report follows the minimum standard guidelines required by the South African Heritage Resources Agency for compiling Archaeological Heritage Phase 1 Impact Assessment (AHIA) reports.

11.1 INTRODUCTION

11.1.1 Approach to the study

Note: This report is a phase 1 archaeological heritage impact assessment/investigation only and does not include or exempt other required heritage impact assessments (see below).

11.1.2 Terms of Reference

Terms of Reference for the archaeological assessment were to conduct a survey of possible archaeological heritage sites for the proposed Ubuntu Wind Energy Facility to be constructed near Jeffrey's Bay, Kouga Local Municipality, Humansdorp District, Eastern Cape Province. The survey was conducted to establish the possible range and importance of exposed and in situ archaeological heritage features, the potential impact of the development and, to make recommendations to minimize possible damage to these sites.

11.1.3 Method of survey

The proposed Ubuntu Wind Energy site was investigated by two people from vehicle and on foot. It was not feasible to do a complete survey because of the very large size of the property and the dense vegetation cover. A layout map for the proposed locations of 33 turbines was available at the start of the survey (see Figure 2.1 in Chapter 2). This enabled the well-developed network of farm tracks throughout the area to be followed in a vehicle and to survey on foot transects leading from the farm tracks. In this way most of the area and proposed locations were investigated. GPS readings were taken and all important features were digitally recorded. Consultation was conducted with the local Gamtkwa KhoiSan community regarding the archaeological heritage of the area.

11.1.4 Assumptions, constraints and limitations

The archaeological study is based on background information supplied by the CSIR regarding the proposed development, and all that information is assumed to be correct.

There were no constraints or limitations associated with the field work.

11.1.5 Information sources

Museum/University databases and collections
The Albany Museum in Grahamstown houses collections and information from the wider region.

Community consultation
Consultation with the Gamtkwa KhoiSan First Nation was conducted as required by the National Heritage Resources Act No. 25 of 1999, Section 38(3e).

11.1.6 Declaration of Independence

BOX 10.1: DECLARATION OF INDEPENDENCE FOR NOISE IMPACT ASSESSMENT

I **Johan Binneman** declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Ubuntu Wind Energy Project, application or appeal in respect of which I was appointed, other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Johan Binneman

11.2 DESCRIPTION OF AFFECTED ENVIRONMENT

The adjacent coastline between Gamtoos River and Jeffrey's Bay once housed large numbers of archaeological sites including the remains of indigenous people (Rudner 1968). Unfortunately, in a few decades virtually all of these important archaeological features have been destroyed by the development of the coastal towns and many were covered with dune sand and vegetation (Binneman 1985, 2001, 2005).

Little is known of the very early prehistory of the region. The oldest evidence of the early inhabitants are large stone tools, called hand axes and cleavers, which can be found in the river gravels which capped the hill slopes in the region (Laidler 1947). These large stone tools are from a time period called the Earlier Stone Age and may date between 1.5 million and 250 000 years old. These large stone tools are often found associated with the gravels in the area, and were later replaced by smaller stone tools called the Middle Stone Age (MSA) flake and blades industries. Evidence of MSA sites occur throughout the region and date between 120 000 and 30 000 years old. Fossil bone in rare cases may be associated with MSA occurrences along the coast.

The most common archaeological sites found in the area are shell middens (Binneman 1996, 2001, 2005; Rudner 1968). They are relatively large piles of marine shell and are popularly referred to as 'strandloper middens'. In general these shell middens date from the past 6 000 years. They are found mainly opposite rocky coasts, but also occur along sandy beaches if there was a large enough source of white mussels. These concentrations of shell represent the campsites of San hunter-gatherers (dating from as much as 6 000 years ago), Khoi pastoralists and KhoiSan (dating from the past 1 800 years in the region) peoples who lived along the immediate coast and collected marine foods on a daily basis. The Khoi people were the first food producers in South Africa and introduced domesticated animals (sheep, goat and cattle) and ceramic vessels to southern Africa as early as 2 000 years ago. The oldest sheep remains recovered from the middens near the Kabeljous River Mouth were radiocarbon dated to 1 560 years old - the oldest date for the presence of sheep in the Eastern Cape (Binneman 1996, 2001).

Shell middens are usually within 300m of the high water mark, but may be found up to 5 km inland. Mixed with the shell and other marine food waste are other terrestrial food remains, cultural material and often human remains are found buried in the middens. Also associated with middens are large stone floors which were probably used as cooking platforms.

Other archaeological sites may consist of concentrations of stone artefacts and/or bone remains. Some of the stone tools may date back to 100 000 years old, and the fossil bone occurrences along the coast may also date this old (See Appendix 11.1 for a list of possible archaeological sites that maybe found in the area).

11.2.1 Cultural sensitivity of the Kabeljous River estuary and adjacent coastal areas

Archaeological research conducted, and observations made, in the region indicate that places like the Kabeljous River estuary were popular areas for the hunter-gatherers and pastoralists to live because of the wide variety of food resources within easy walking distance, i.e., shellfish along the beach, fish in the estuary and game in the nearby hills.

Research at Kabeljous River Shelter some four kilometres upstream from the estuary mouth (close to the proposed development) indicated that this part of the valley was well utilised by pre-colonial groups from 6 000 years ago (research report available on request) (Binneman 1996, 2007). Two KhoiSan skeletons were also found on the nearby New Papiesfontein farm during the past few years, indicating that such remains may also be buried on the property in question (*Die Burger* 27-09-2005). One of the skeletons was re-buried in 2008 by the Gamtkwa KhoiSan Tribe according to Khoi tradition (*The Herald* 24-03-2008). During 1983 several middens were badly damaged and eventually demolished by a bulldozer when houses were being built near the present day caravan park. These were found to be extremely rich in archaeological material (Binneman 1985, 1996, 2001, 2005). The following results were obtained from the limited research project.

1. Two of the shell middens were occupied by San hunter-gatherers ('Bushmen') and one was radiocarbon dated to 2 570 years old. Although the middens were situated along a sandy beach, the hunter-gatherers preferred to collect brown mussel from the rocky shore almost a kilometre away, rather than the white mussel which could be collected 50 metres away.

2. Two shell middens were of Khoi pastoralist origin. A similar shellfish collecting pattern was followed by the Khoi.

3. The Khoi were the first food producers in South Africa and the sheep remains recovered from the middens were radiocarbon dated to 1 560 years old - the oldest date for the presence of sheep in the Eastern Cape.

4. These middens yielded more fish remains than any other open-air shell midden along the Eastern Cape coast. The remains were mainly from mullet species and taken from the nearby estuary. The method of capture is unknown because it is known from historical records that the indigenous groups did not process nets of any kind.

5. The Kabeljous River Shelters provide a history of hunter-gatherer-fishers of the past 6000 years for the area. Several burials were also found in the shelters. The archaeological deposits are extremely important and sensitive to any disturbances.

11.3 PERMIT AND LEGISLATIVE REQUIREMENTS

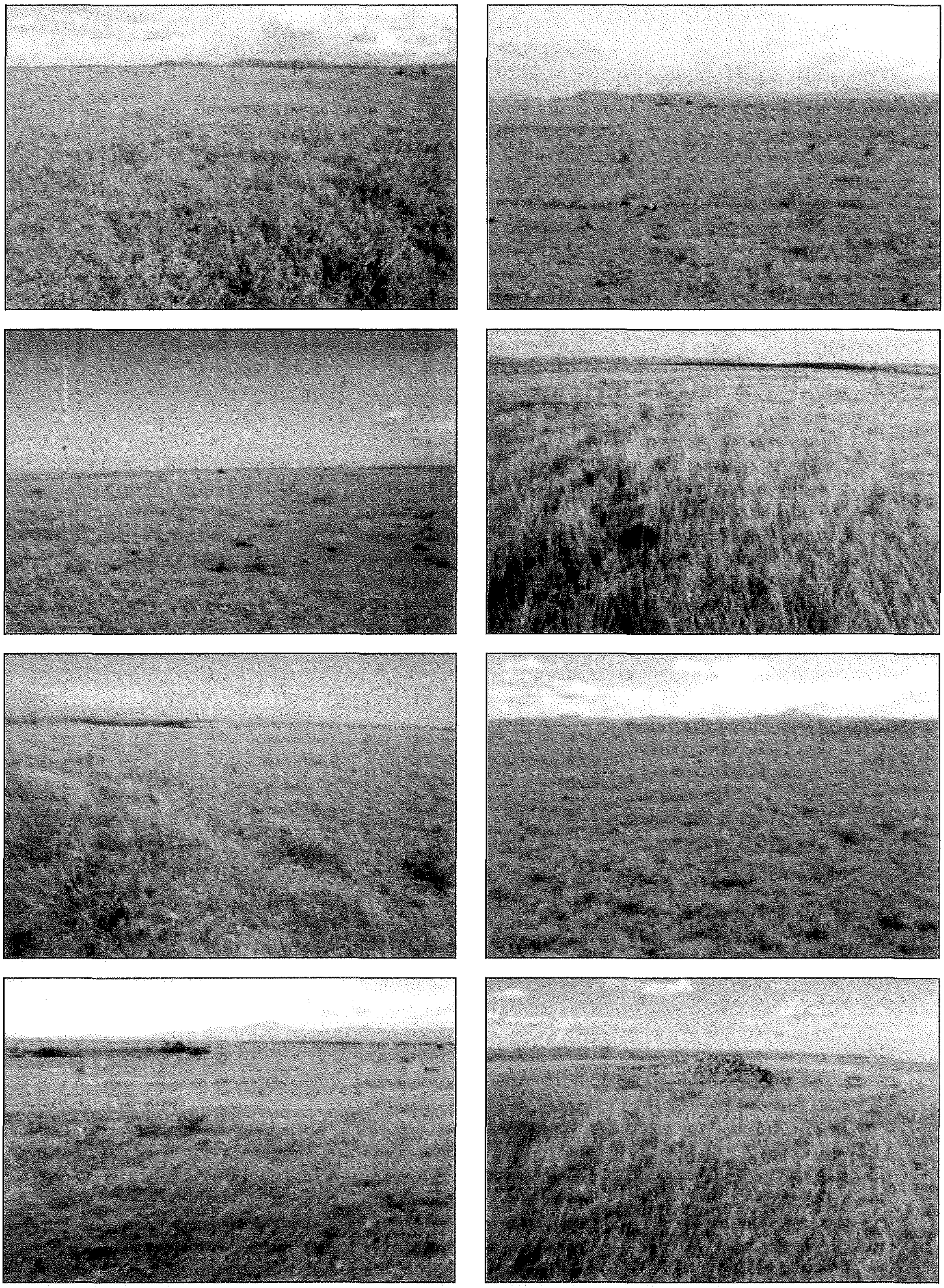
The National Heritage Resources Act (Act No. 25 of 1999, section 35) (see Appendix 11.2) requires a full Heritage Impact Assessment (HIA) in order that all heritage resources, that is, all places or objects of aesthetics, architectural, historic, scientific, social, spiritual linguistic or technological value or significance are protected. Thus any assessment should make provision for the protection of all these heritage components, including archaeology, shipwrecks, battlefields, graves, and structures older than 60 years, living heritage, historical settlements, landscapes, geological sites, palaeontological sites and objects.

11.4 RESULTS OF THE ARCHAEOLOGICAL STUDY

11.4.1 Findings of the Archaeological study

Virtually the entire area for the proposed development has been disturbed by ploughing in the past and is covered by dense low grass which is used for grazing. The dense grass cover made it difficult to find archaeological sites/materials and no visible in situ archaeological sites were found during the investigation (Figures 11.1a-11.1g). Mole heaps and a number of the large stone piles (large stones removed from the ploughed fields) were investigated for evidence of archaeological materials (Figure 11.1h). Only a few weathered quartzite Middle Stone Age stone tools were observed where the pebble/cobble gravels were exposed by ploughing. These stone tools date between 30 000 and 250 000 years old. They were mainly thick, small 'informal' flakes and chunks manufactured from quartzite. All stone tools were in secondary context and not associated with any other remains. Although none was found, one would also expected to find occasional Earlier Stone Age stone tools (1,5 million – 250 000 years old) in the gravels as well.

The nearest important cultural sites to the proposed development are the Kabeljous Rock Shelters (2,5 kilometres south of the closest turbine), a large number of sites along the coastline (7 kilometres south of the closest turbine) and Sara Baartman's grave site at Hankey (8 kilometres north of the closest turbine) (Figure 11.2 and Figure 11.3). The turbines will have little or no visual impact on the Kabeljous Rock Shelters because the shelters face south and are situated in the kabeljous River valley along the eastern embankment. The turbines will be visible from the coastal sites and possibly also from Sara Baartman's grave.



Figures 11.1a-h: Views of the proposed Ubuntu Wind Energy site. One of the stone piles is visible in the bottom right. Note the dense low grass cover throughout the entire site.

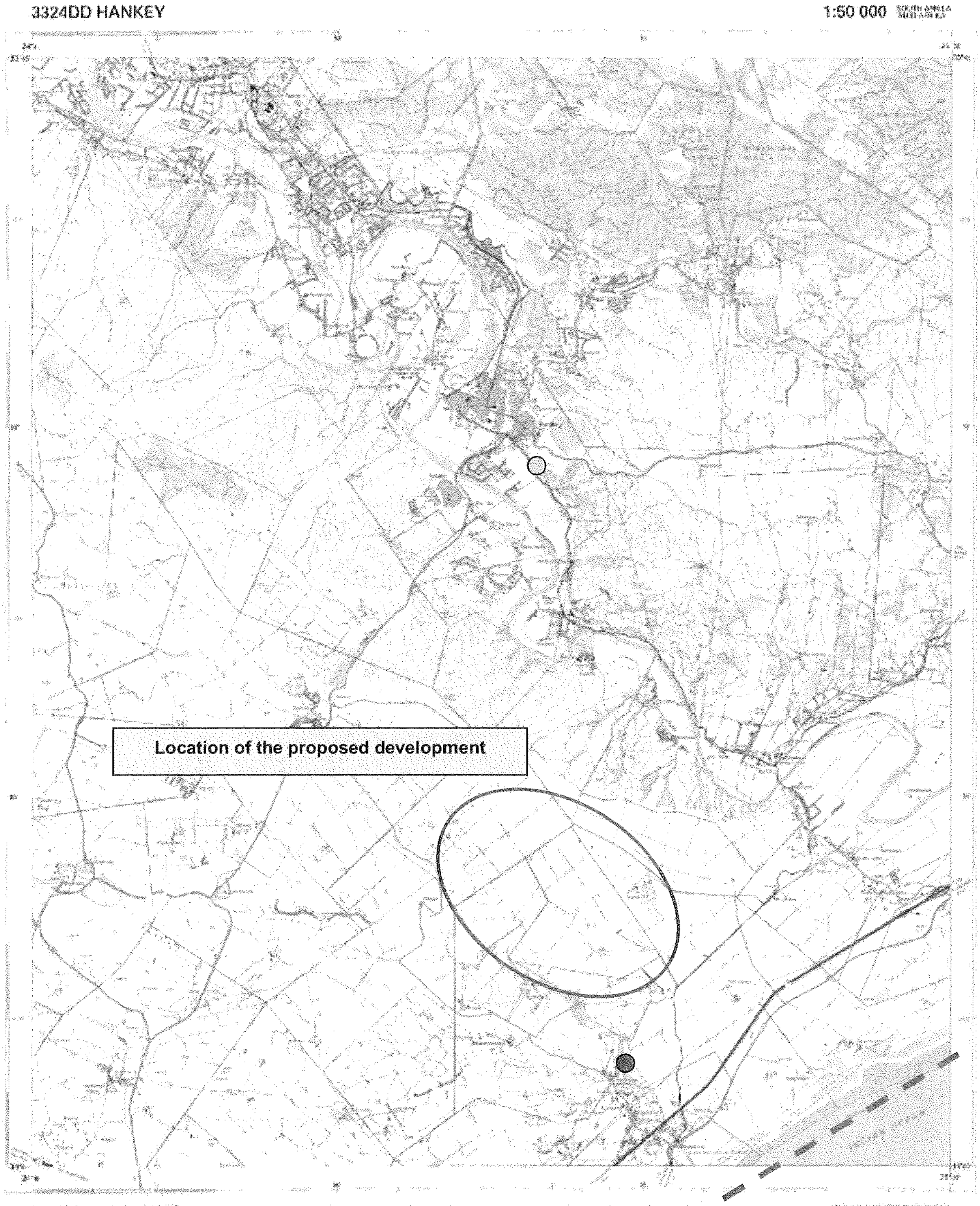


Figure 11.2: 1:50 000 map of the location of the proposed Ubuntu Wind Energy Project. The red oval indicates the approximate size of the development, the red dot marks the Kabeljous River Shelters, the yellow dot Sara Baartman's grave site and the pink broken line the coastal sites.

Figure 11. 3: Aerial photograph indicating the location and turbine positions of the proposed Ubuntu Wind Energy Project. The red dots mark the Kabeljous River Shelters, the yellow dot Sara Baartman's grave site and the pink solid line the coastal sites.

11.5 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

The proposed area for the construction of the Ubuntu Wind Energy Facility, apart from the presence of a few Middle Stone Age stone tools, appears to be of low archaeological sensitivity. It is also highly unlikely that any archaeological heritage remains of any value will be found in situ or of any contextual value. The impact of the development on archaeological sites/materials will be limited. The area is also situated more than five kilometres from the coast which is further than the maximum distance shell middens are expected to be found inland. No such features were observed. However, there is always a possibility that human remains and/or other archaeological and historical material may be uncovered during the development. Should such material be exposed then it must be reported to the nearest museum, archaeologist or to the South African Heritage Resources Agency (see general remarks and conditions in the conclusions section below). There are sensitive cultural sites in the wider area and the development may have a visual impact on these. Visual image reconstructions should take this into account and images should be included/presented as part of the community/public consultation process.

Table 11.1: Impact Assessment summary table

Impact	Status	Extent	Duration	Intensity	Probability	Significance Without mitigation	Mitigation	Significance with mitigation	Confidence
Destruction or disturbance of archaeological sites	Negative	Local	Permanent	Low	Improbable	Low	Notify the Albany Museum or SAHRA	Low	High

11.6 RECOMMENDATIONS

1. In the unlikely event that any concentrations of archaeological material are uncovered during further development of the site, it should be reported to the Albany Museum and/or the South African Heritage Resources Agency immediately so that systematic and professional investigation/excavations can be undertaken. Sufficient time should be allowed to remove/collect such material (See Appendix 11.1 for a list of possible archaeological sites that maybe found in the area).

2. The visual effect of the development on important cultural sites in the wider area, such as Sara Baartman's grave and archaeological sites along the nearby coast must be included in the visual investigation for community/public consultation. The development will have little or no effect on the Kabeljous River Rock Shelters due to their location in the Kabeljous River valley.

3. Construction managers/foremen should be informed before construction starts on the possible types of heritage sites and cultural material they may encounter and the procedures to follow when they find sites. It is suggested that a person be trained to be on site to report to the site manager if sites are found.

11.7 CONCLUSIONS

The area investigated appears to be of **low** archaeological sensitivity and the impact of construction will be **insignificant**. Apart from the nearby coastline which is rich in archaeological sites, there are also two other important cultural sites in the wider vicinity of the development, namely, Kabeljous River Shelter and the grave site of Sara Baartman. There is concern from the Gamtkwa KhoiSan Council that the development may have a visual impact on these sites.

11.7.1 General remarks and conditions

It must be emphasised that the conclusions and recommendations expressed in this archaeological heritage sensitivity investigation are based on the visibility of archaeological sites/features and may not therefore, reflect the true state of affairs. Many sites/features may be covered by soil and vegetation and will only be located once this has been removed. In the event of such finds being uncovered, (such as during any phase of construction work), archaeologists must be informed immediately so that they can investigate the importance of the sites and excavate or collect material before it is destroyed. The onus is on the developer to ensure that this agreement is honoured in accordance with the National Heritage Act No. 25 of 1999.

It must also be clear that Archaeological Specialist Reports (AIA's) will be assessed by the relevant heritage resources authority. The final decision rests with the heritage resources authority, which should grant a permit or a formal letter of permission for the destruction of any cultural sites.

Appendix 11.1: Disclaimer Identification of Archaeological Features and Material from Inland Areas: Guidelines and Procedures for Developers

Human Skeletal material

Human remains, whether the complete remains of an individual buried during the past, or scattered human remains resulting from disturbance of the grave, should be reported. In general the remains are buried in a flexed position on their sides, but are also found buried in a sitting position with a flat stone capping and developers are requested to be on the alert for this.

Stone artefacts

These are difficult for the layman to identify. However, large accumulations of flaked stones which do not appear to have been distributed naturally should be reported. If the stone tools are associated with bone remains, development should be halted immediately and archaeologists notified

Fossil bone

Fossil bones may be found embedded in geological deposits. Any concentrations of bones, whether fossilized or not, should be reported.

Large stone features

Large stone features may be present in various forms and sizes, but are easy to identify. The most common are roughly circular stone walls (mostly collapsed) and may represent stock enclosures, remains of wind breaks or cooking shelters. Others consist of large piles of stones of different sizes and heights and are known as *isisivane*. They are usually near river and mountain crossings. Their purpose and meaning is not fully understood, however, some are thought to represent burial cairns while others may have symbolic value.

Historical artefacts or features

These are easy to identified and include foundations of buildings or other construction features and items from domestic and military activities.

Appendix 11.2: Brief legal requirements

Parts of sections 35(4), 36(3) and 38(1) (8) of the National Heritage Resources Act 25 of 1999 apply:

Archaeology, palaeontology and meteorites

35 (4) No person may, without a permit issued by the responsible heritage resources authority—

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

Burial grounds and graves

36. (3) (a) No person may, without a permit issued by SAHRA or a provincial heritage resources authority—
(a) destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;
(b) destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or
(c) bring onto or use at a burial ground or grave referred to in paragraph (a) or (b)any excavation equipment, or any equipment which assists in the detection or recovery of metals.

Heritage resources management

38. (1) Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorized as –

(a) the construction of a road, wall, powerline, pipeline, canal or other similar form of linear development or barrier exceeding 300m in length;
(b) the construction of a bridge or similar structure exceeding 50m in length;
(c) any development or other activity which will change the character of the site –
(i) exceeding 5000m^2 in extent, or
(ii) involving three or more erven or subdivisions thereof; or
(iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or

(iv) the costs of which will exceed a sum set in terms of regulations by SAHRA, or a provincial resources authority;

(d) the re-zoning of a site exceeding 10 000m^2 in extent; or

(e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must as the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

Environmental Impact Assessment for the proposed Ubuntu Wind Energy Project near Jeffrey's Bay, Eastern Cape: Draft Environmental Impact Assessment Report

Chapter 12:
Impact on Palaeontology

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CHAPTER 12. IMPACT ON PALAEONTOLOGY

12.1 INTRODUCTION

12.1.1 Approach to this Palaeontological Impact Assessment (PIA)

The present report forms part of the EIA for the proposed Ubuntu Wind Energy Project near Jeffrey's Bay, and it will also inform the Environmental Management Plan for this project. The extent of the proposed development (over 5000 m^2) falls within the requirements for a Heritage Impact Assessment (HIA) as required by Section 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999). The various categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act include:

- geological sites of scientific or cultural importance;
- palaeontological sites; and
- palaeontological objects and material, meteorites and rare geological specimens.

A desktop Palaeontological Impact Assessment (PIA) as part of the EIA and EMP for the Ubuntu Wind Energy Project has accordingly been commissioned by Environmental Management Services of the CSIR, Stellenbosch, on behalf of WKN-Windcurrent SA (Pty) Ltd.

Minimum standards for the palaeontological component of heritage impact assessment reports are currently being developed by SAHRA. The latest version of the SAHRA guidelines is dated May 2007.

This PIA report provides an assessment of the observed or inferred palaeontological heritage within the study area in particular, with recommendations for specialist palaeontological mitigation where this is considered necessary. The report is based on: (1) a review of the relevant scientific literature; (2) published geological maps and accompanying sheet explanations; and (3) the author's extensive field experience with the formations concerned and their palaeontological heritage.

The potentially fossiliferous rock units (groups, formations etc) represented within the study area have been determined from geological maps. The currently recorded fossil heritage within each unit is determined from the published scientific literature and the author's field experience. These data are then used to assess the palaeontological sensitivity of each rock unit to development (N.B. A tabulation of palaeontological sensitivity of all formations in the Eastern Cape has already been compiled by Almond *et al.*, 2008).

The likely impact of the proposed development on local fossil heritage is then determined on the basis of (1) the rock units concerned, and (2) the nature of the development itself, most notably the extent of fresh bedrock excavation envisaged. Adverse palaeontological impacts normally occur during the construction rather than operational phase. Mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (e.g. sedimentological data) – is usually most effective during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for a palaeontological collection permit from the relevant heritage management authority (e.g. SAHRA for the Eastern Cape, Heritage Western Cape for the Western Cape). It should be emphasized that, *providing appropriate mitigation* is carried out, the majority of developments involving bedrock excavation can make a positive contribution to our understanding of local palaeontological heritage.

12.1.2 Assumptions made for the PIA desktop study

Note that while fossil localities recorded within the study area itself are obviously highly relevant, most of the fossil heritage is buried beneath the land surface or obscured by surface deposits (soil, alluvium etc) and vegetation cover. The hidden fossil resources, therefore, have to be inferred from palaeontological observations made within the same formations elsewhere in the region, or even further afield (*e.g.* an adjacent province). Here it is assumed that fossil heritage is fairly uniformly distributed throughout the outcrop area of a given formation. Experience shows that this assumption does not always hold. This is because the original depositional setting across a formation that may extend over hundreds of kilometres may vary significantly, with palaeoecological implications (e.g, from a shallow to deeper water environment), while fossils are often patchy in their occurrence. Furthermore, the levels of tectonic deformation (folding, cleavage development etc), as well as the intensity and nature of metamorphism and weathering experienced by a given formation may change markedly across its outcrop area. These factors may seriously compromise the preservation of fossil remains present within the original sedimentary rock.

12.1.3 Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed wind energy project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

John E. Almond

JOHN ALMOND

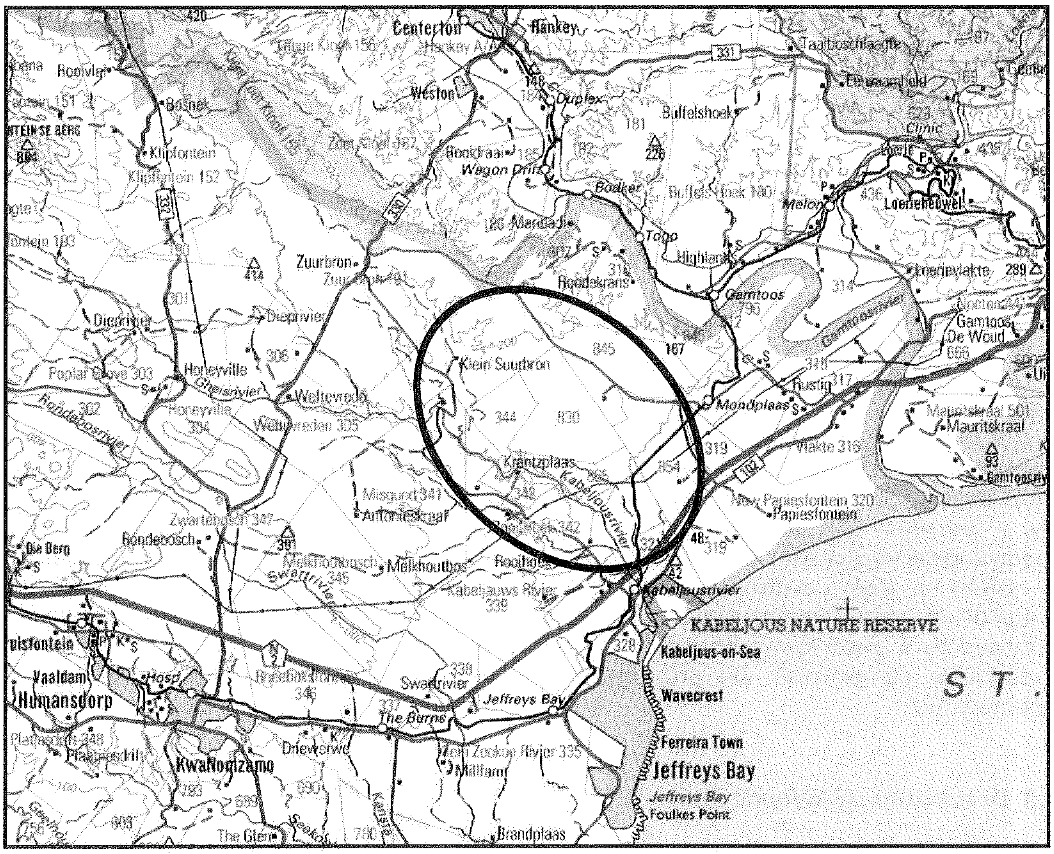
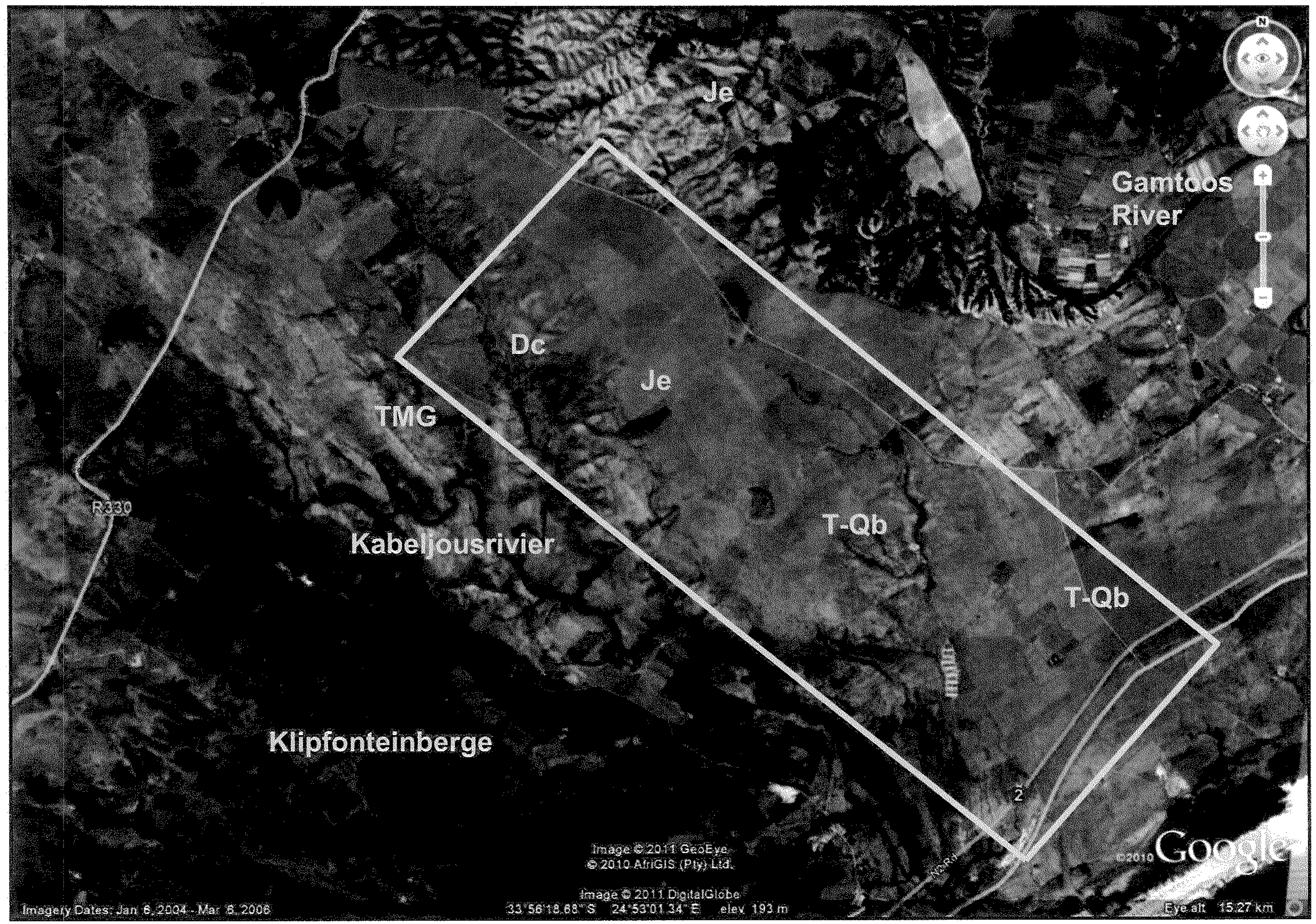


Fig. 12.1. Approximate location and extent (black ellipse) of the proposed Ubuntu Wind Energy Project immediately north of Jeffrey's Bay in the Eastern Cape Province (Extract from 1: 250 000 topographical sheet 3324 Port Elizabeth, Courtesy of the Chief Directorate of Surveys & Mapping, Mowbray).

Fig. 12.2. (following page). Satellite image (Google Earth©) of the region immediately north of Jeffrey's Bay showing the very approximate outline of the area (yellow rectangle) and major roads Compare this image with the geological map in Fig. 3 below where the geological symbols used here are also explained. Note that the greater part of the study area is underlain by a relatively flat, marine-planed platform lying between the Kabeljous and Gamtoos Rivers that is underlain by the Enon Formation (Ke), locally mantled with residual soils of the Bluewater Bay Formation (T-Qb). The highly dissected areas on the plateau margins are also underlain by Enon rocks. To the west occur Lower Bokkeveld Group sediments (Dc) on the floor of the Kabeljousrivier Valley (brown hues) and pale grey quartzitic rocks of the Table Mountain Group (TMG) on the marine-planed slopes of the Klipfonteinberge.


Je
Gamtoos
River
Dc
Je
TMG
R330
Kabeljousrivier
T-Qb
T-Qb
Klipfonteinberge
2
Image © 2011 GeoEye
© 2010 AfriGIS (Pty) Ltd.
Image © 2011 DigitalGlobe
Imagery Dates: Jan 6, 2004 - Mar 8, 2006
33°56'18.88" S 24°53'01.34" E elev 193 m
©2010 Google
Eye alt 15.27 km

12.2 POTENTIAL IMPLICATIONS OF PROJECT FOR FOSSIL HERITAGE

The proposed Ubuntu Wind Energy Project is located in an area that is underlain by potentially fossil-bearing sedimentary rocks of Palaeozoic and younger age (Sections 12.3, 12.4). The construction phase of the development will entail numerous and extensive excavations into the superficial sediment cover as well as the underlying bedrock. These notably include excavations for the 33 to 50 turbine foundations, buried cables and any new gravel access roads. In addition, substantial areas of bedrock will be sealed-in or sterilized by infrastructure such as standing areas for each wind turbine, lay down areas as well as the new gravel road system. All these developments may adversely affect the potential fossil heritage within the study area by destroying, disturbing or permanently sealing-in fossils that are then no longer available for scientific research or other public good. Once constructed, the operational and decommissioning phases of the wind energy project will not involve further adverse impacts on palaeontological heritage.

12.3 GEOLOGICAL BACKGROUND

12.3.1 General introduction to local geology

The proposed Ubuntu development site, located between three and twelve kilometres north of Jeffrey's Bay is situated along the western margin of the Mesozoic Gamtoos Basin, between the courses of the Kabeljous and Gamtoos Rivers (Figures 12.1 to 12.3). The study area is roughly rectangular (*c.* 12 km x 6 km), elongated NW-SE. The R330 lies to the northwest, and the N2 freeway along its southeastern edge. The major part of the site is occupied by a gently sloping coastal plateau that rises gradually from *c.* 50-60 m amsl in the southeast to *c.* 200 m amsl in the northwest. The higher-lying interior portion of this extensive surface is equivalent to the 180-280 m amsl marine-carved George Terrace recognised by Roberts *et al.* (2008) that stretches along the south coast as far east as Port Elizabeth. In the Eastern Cape the George Terrace is directly overlain by coastal (estuarine / shallow marine) sediments of the Miocene-Pliocene Alexandria Formation or alternatively – as in the present study area - conglomeratic weathering products of this last unit which are mapped on the 1: 250 000 geology sheet as the "Bluewater Bay Formation". The George terrace is tentatively related by Roberts *et al.* (2008) to an Early Tertiary, possibly Eocene, marine highstand, although it may alternatively represent a Late Tertiary (Miocene) marine-cut surface that has since been elevated by continental uplift.

The geology of the Ubuntu study area is depicted on the 1: 250 000 scale geological map sheet 3324 Port Elizabeth (Figure 12. 3). In addition to the explanation for this map published by Toerien & Hill (1989), useful background information on local geology and palaeontology is also given in the older sheet explanation for the coastal belt near the Gamtoos Valley by Haughton *et al.* (1937). The extensive coastal plateau forming the core of the study area is underlain by conglomeratic fluvial sediments of the **Enon Formation** (Ke, Uitenhage Group) of Late Jurassic or Early Cretaceous age. In the southeastern half of the plateau area, the Enon sediments are overlain by a surface veneer of pebbly, reddish brown soils of the so-called **Bluewater Bay Formation** (T-Qb) that, as mentioned earlier, are now recognised as karstic weathering products of the Neogene (Late Tertiary) Alexandria Formation (Maud & Botha 2000, Goedhart and Hattingh 1997, Almond 2010). It seems likely on the basis of satellite images (Figure 12.2) that these "Bluewater Bay" residual deposits occur more extensively over the coastal plain than suggested by the 1: 250 000 geological map. The southwestern and northeastern margins of the

Enon plateau are typically highly dissected by numerous small streams, as clearly seen in satellite images. The near-coastal stretch of the Kabeljousrivier along the western margin of the Ubuntu study area is incised into readily-weathered, clay-rich sediments of the **Ceres Subgroup** (Dc = Lower Bokkeveld Group). These Early Devonian marine rocks appear as a brownish band in satellite images of the Kabeljousrivier Valley and have a sharp, unconformable contact with the overlying Uitenhage Group to the east (Figure 12.2). The northwestern corner of the Ubuntu study area (Farm Klein Zuurbron) extends for a short distance onto the more rugged uplands of Table Mountain Group rocks building the western wall of the Gamtoos Basin (pale grey on satellite images). The main rock unit represented here is the Early Devonian **Baviaanskloof Formation** (S-Db) of coastal fluvial to shallow marine origin at the top of the Table Mountain Group succession. The Baviaanskloof rocks consist mainly of impure sandstones (*wackes*) with minor mudrocks and resistant-weathering quartzites. A small area of Silurian braided fluvial sandstones and quartzites of the underlying **Skurweberg Formation** (Ss) may also be present in the extreme west. These cleaner-washed quartzitic sediments tend to weather more prominently and ruggedly than the more clay-rich Baviaanskloof "passage beds" directly above them.

The quartz-rich, resistant-weathering Table Mountain Group sediments to the west of the study area form the tapering southeastern portion or *nose* of a NW-SE trending mega-anticline (Klipfonteinberge) of the Cape Fold Belt that plunges southeastwards towards Jeffrey's Bay (Figure 12.3). As clearly seen from the zigzag trace of the Baviaanskloof Formation (S-Db), the termination of the mega-anticline is rippled or dissected into a series of smaller-scale SE-trending folds. Dips within the Table Mountain succession here are therefore likely to be highly variable, from horizontal to steep. As is clearly apparent from aerial and satellite images (Figure 12.2), the folded, resistant-weathering Table Mountain Group rocks have been extensively planed-off by erosion to form a gently seawards-sloping surface (pseudo-peneplain) at around 200m amsl. This corresponds to the marine-planed "George terrace" of ill-defined Tertiary age that extends eastwards across the Uitenhage Group infill of the Gamtoos Basin, as discussed earlier.

12.3.2 Table Mountain Group

Useful overviews of Table Mountain Group geology in general include Rust (1967, 1981), Hiller (1992), Malan & Theron (1989), Broquet (1992), Johnson *et al.*, (1999), De Beer (2002), Thamm & Johnson (2006), and Tankard *et al.*, (1982, 2009). For the Port Elizabeth sheet area specifically, these rocks are briefly described by Toerien and Hill (1989) and Le Roux (2000) as well as in older sheet explanations such as those by Engelbrecht *et al.* (1962) and Haughton *et al.*, (1937). Also useful are various reports by the South African Committee for Stratigraphy (SACS), such as those by Malan *et al.* (1989), Malan and Theron (1989) and Hill (1991). The Skurweberg and Baviaanskloof Formations are both subdivisions of the **Nardouw Subgroup**, the upper part of the Table Mountain Group (Malan & Theron 1989).

The **Skurweberg Formation (Ss)** is dominated by very pale, weathering-resistant sandstones and quartzites that typically show well-developed unidirectional (current) cross-bedding and sometimes thin quartz pebble lenticles (These last far less common in the Eastern than Western cape outcrops). Bedding is often thick (thicknesses of one or more meter are common) and although thin, lenticular, dark mudrock intervals also occur, these are rarely exposed at outcrop. Sedimentological features within this formation indicate deposition across an extensive sandy alluvial braidplain.

The **Baviaanskloof Formation (S-Db)** is typically less clean-washed than the older subunits of the Nardouw Subgroup, giving darker hues and more recessive weathering patterns. Sandstones are often (but not invariably) greyish, impure wackes and may be massive or ripple cross-laminated. Dark grey to black carbonaceous and micaceous mudrock intervals are quite common but rarely well exposed (A c. 15m-thick band of micaceous shale within the upper Baviaanskloof Formation in the Gamtoos area is mentioned by Haughton *et al.*, 1937, for example). The heterolithic "passage beds" of the Baviaanskloof Formation incorporate the sedimentary transition between the fluvial-dominated lower units of the Nardouw Subgroup and the marine shelf sediments of the Lower Bokkeveld Group. Locally abundant shelly fossils such as articulate brachiopods, trace fossils as well as wave ripple lamination demonstrate the shallow marine origins of at least some of the upper sandstones, while the dark mudrocks with dense mats of vascular plant remains may be lagoonal in origin (See following section).

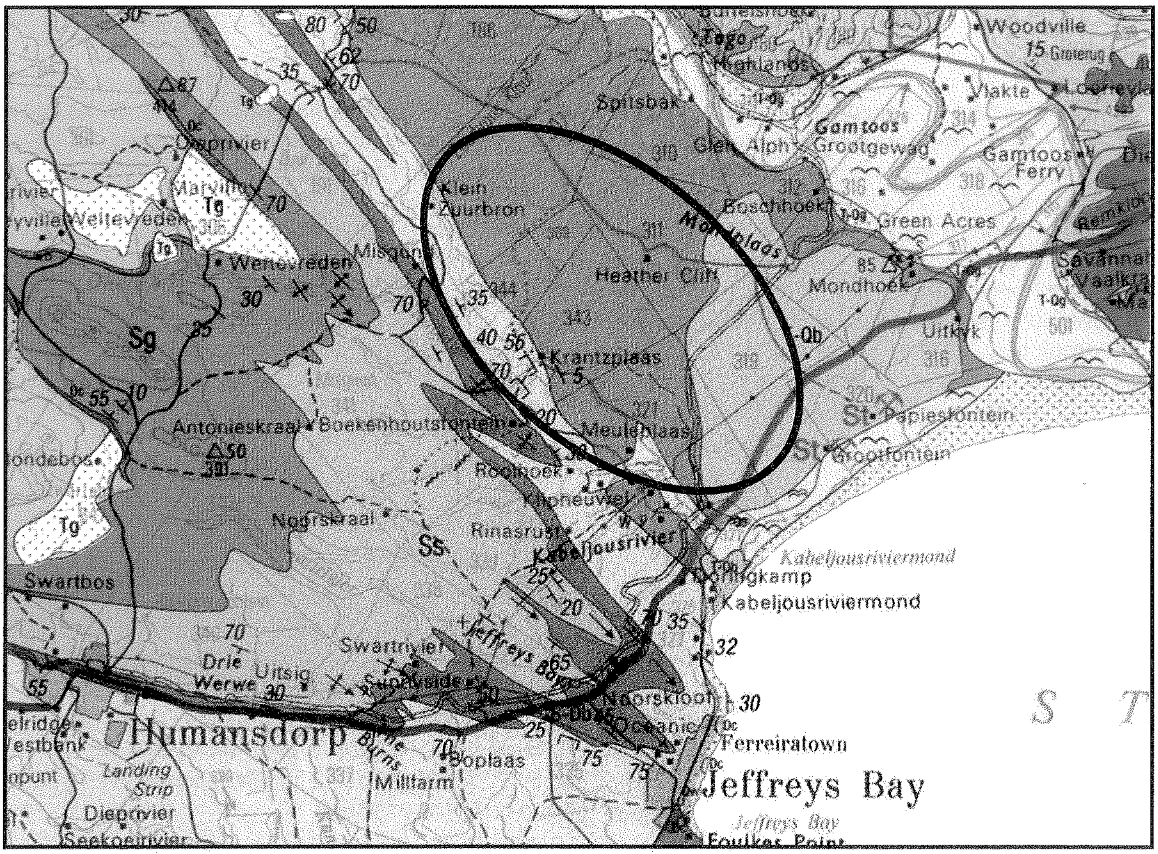


Fig. 12.3. **Geological map of the coastal region north of Jeffrey's Bay, Eastern Cape Province, extracted from 1: 250 000 geological map sheet 3324 Port Elizabeth (Council for Geoscience, Pretoria). The *approximate* location of the proposed Ubuntu Wind Energy Project is indicated by the black ellipse. *N.B.* The modern course of the N2 trunk road is not indicated on this map.**

MAJOR GEOLOGICAL UNITS:

Table Mountain Group:	Sg (greenish-blue) = Goudini Formation Ss (mid-blue) = Skurweberg Formation S-Db (dark blue) = Baviaanskloof Formation
Bokkeveld Group:	Dc (pale blue) = Ceres Subgroup (Lower Bokkeveld Group)
Uitenhage Group:	Ke (deep orange) = Enon Formation
Algoa group:	T-Qb (pale brown) = "Bluewaterbay Formation", now recognised as weathering products of the Alexandria Formation

12.3.3 Bokkeveld Group

The Bokkeveld Group, the middle unit of the Cape Supergroup, is a thick (*c.* 1.5 to 3.5km) succession of fossiliferous sedimentary rocks which was deposited in shallow marine to coastal settings during the Early to Middle Devonian Period, about 400 to 375 million years ago These sediments accumulated on an area of continental shelf – the Cape Basin – which then lay towards the southern edge of the supercontinent Gondwana at moderately high palaeolatitudes (*c.* 70°S). Key accounts of Bokkeveld Group geology and sedimentology are given by Theron (1972), Tankard and Barwis (1982), Theron and Loock (1988), Theron and Thamm (1990), Theron and Johnson (1991), Broquet (1992) as well as Thamm and Johnson (2006).

The **Ceres Subgroup** (Dc) in the Port Elizabeth sheet area represents the Lower, Early to Mid Devonian portion of the Bokkeveld Group. It comprises three thick (300-500 m) units of dark grey mudrocks that alternate with thinner (50-200 m) sandstone-dominated units (Haughton *et al.* 1937, Le Roux 2000). The mudrocks are often silty, micaceous and highly cleaved. Sandstones (technically mostly impure wackes) frequently preserve sedimentological evidence of storm deposition, such as wave ripples and relicts of hummocky or swaley cross-lamination. Due to limited bedrock exposure, individual formations within the Ceres Subgroup are not mapped separately here. Levels of Cape-age (*i.e.* Permo-Triassic) tectonic deformation, including folding and cleavage, as well as of Tertiary weathering are generally high, often seriously compromising the palaeontological heritage of these beds (See Section 12.4.3 below).

12.3.4 Uitenhage Group

The continental sediments of the Uitenhage Group were laid down in a spectrum of depositional settings on or close to the margins of the newly developing African continent during the Late Jurassic to Early Cretaceous Period (Du Toit 1954, McLachlan & McMilllan 1976, Tankard *et al.* 1982, Dingle *et al.* 1983, Shone 2006). They include coarse breccio-conglomerates deposited in piedmont fans ("fanglomerates") and highly energetic braided rivers, pebbly conglomerates and sandstones in meandering river channels, overbank mudrocks (mainly silty alluvium) with occasional lacustrine mudrocks too. Thin to 4 m-thick volcanic tuffs or tuffites (volcanic ash mixed with siliciclastic sediment) have also been recorded from the Uitenhage Group succession.

The Uitenhage Group sediments on the western side of the Gamtoos Basin near Jeffrey's Bay are mapped on the 1: 250 000 Port Elizabeth sheet as belonging to the **Enon Formation** (**J-Ke**), unconformably overlying the Lower Bokkeveld Group rocks to the west (Figure 12.3). The Enon Formation is characterized by coarse, immature fanconglomerates or breccio-conglomerates of Late Jurassic to Early Cretaceous age. Successions with intermittent cross-bedded sandstone interbeds and well-developed pebble imbrication were deposited within high-energy braided river systems. Larger clasts consist primarily of poorly-sorted Cape Supergroup quartzites, are often well-rounded and secondarily stained with iron oxides, and may be cracked as a result of overburden pressure. The Enon Formation within the Gamtoos Basin reaches thicknesses of some two kilometres or more (Toerien & Hill 1989). In the vicinity of the Kabeljous River Haughton *et al.* (1937, p. 29) mention basal Uitenhage beds consisting of "greenish and buff sandy marls which may represent weathered Bokkeveld rocks almost *in situ*". Within the Ubuntu study area the Enon Formation is likely to be poorly exposed over much of the gently sloping coastal plateau, where it is additionally mantled by a veneer of Bluewater Bay residual soils (see below). Exposure levels are likely to be better in the gullied terrain along the western margin of the plateau (*i.e.* eastern slopes of the Kabeljousrivier Valley).

12.3.5 Algoa Group

Geologically recent karstic (*ie* solution) weathering of the lime-rich, coastal-marine **Alexandria Formation** has led to the development of pebbly, reddish-brown residual soils over much of its inland outcrop area (Maud & Botha 2000, Almond 2010). These weathering products were formerly identified as a separate, bipartite *fluvial* unit of Plio-Pleistocene age with calcrete horizons that was named the **Bluewater Bay Formation** (Le Roux 1987, 1989). This unit is mapped as such (T-Qb) on the 1: 250 000 Port Elizabeth geology sheet but not on the later 1: 50 000 scale geological maps where it is indicated as pedogenic gravels overlying the Alexandria Formation (circular symbols). Incised "channels" cutting into the Alexandria Formation and infilled with cross-bedded coarse "Bluewater Bay" gravels are illustrated by Le Roux (1989). Maud and Botha (2000) suggest that these surface deposits comprise a composite of *in situ* karstic weathering products (including coarse solution-hollow infills) as well as fluvial sediments of late Neogene age. Goedhart and Hattingh (1997) have developed an explanatory scheme showing how residual pebbly and sandy weathering products of the Alexandria Formation infill solution cavities within the calcretised limestones following periods of humid climate leaching. In the Port Elizabeth area the superficial "Bluewater Bay" deposits average 1.2 m in thickness, but this varies greatly due to the presence of numerous incised channel-fill and solution pipe structures up to 7 m deep (Le Roux 1987c, 1989, 2000).

12.4 PALAEONTOLOGICAL HERITAGE

In this section of the PIA report the recorded fossil record of each geological formation that is mapped within the study area, as listed in Section 12.3 above, is outlined, together with an indication of its overall sensitivity to development (Based on Almond *et al.*, 2008; see also the summary of the fossil heritage in Table 12.1).

The bulk of the thick **Table Mountain Group** succession is composed of quartz arenites and pebbly sandstones of alluvial braidplain facies that are unlikely to yield fossils, especially given their early to mid-Palaeozoic age and the poor exposure of mudrock units. Biostratigraphically significant body fossils are recorded from marine-dominated parts of the succession, *i.e.* the Cederberg Formation of latest Ordovician (Hirnantian) age and the Baviaanskloof Formation of Early Devonian (Lochkovian / Pragian) age (Broquet 1992, Hiller 1992, Theron 1993). Only the second of these is represented in the study area.

It should be emphasized that the Table Mountain Group rocks within the southern Cape Fold Belt have frequently experienced fairly extreme levels of tectonism, including intense folding, faulting, jointing, brecciation and cleavage development, the last especially within finer-grained facies (*i.e.* mudrocks). These effects, combined with low grade regional or dynamic metamorphism and deep, intense weathering since the break-up of Gondwana (*e.g.* leaching, secondarily mineralization, notably by iron and manganese compounds), have conspired to severely compromise the preservation of fossils even within that minority of Table Mountain Group rocks that may originally have contained a fairly rich palaeontological heritage.

12.4.1 Skurweberg Formations (Silurian) (Ss)

Overall palaeontological sensitivity = LOW

The fossil record of the lower Nardouw Subgroup, dominated by braided fluvial sandstones, is very sparse indeed. This largely non-marine unit reflects major global regression (low sea levels) during the Silurian Period, peaking during the latter part of the period (Cooper 1986). Sporadic, low diversity ichnoassemblages from thin, marine-influenced stratigraphic intervals have been recorded from all three Nardouw formations in the Western Cape by Rust (1967, 1981) and Marchant (1974). There are also scattered, often vague reports of trace fossils in geological sheet explanations and SACS reports (*e.g.* Malan *et al.* 1989, De Beer *et al.* 2002). Most involve "pipe rock" (*Skolithos* ichnofacies) or various forms of horizontal epichnial burrows, including possible members of the *Scolicia* group which may be attributable to gastropods. Also recorded are typical Early Silurian palmate forms of the annulated burrow *Arthrophycus*, poorly preserved "bilobites" (bilobed arthropod scratch burrows, some of which are probably attributable to trilobites), gently curved epichnial furrows and possible arthropod tracks (Almond 2008). It is possible that more diverse ichnoassemblages - and even microfossils (*e.g.* organic-walled acritarchs) from subordinate mudrock facies where these have not been deeply weathered or tectonised - may eventually be recorded from the more marine-influenced outcrops of the eastern Cape Fold Belt. However, exposure of these recessive-weathering finer-grained sediments is generally very poor.

12.4.2 Baviaanskloof Formation (Early Devonian) (S-Db)

Overall palaeontological sensitivity = MODERATE

A distinctive marine shelly invertebrate faunule of Early Devonian, Malvinokaffric aspect characterises the upper portion of the Baviaanskloof Formation from the Little Karoo eastwards along the Cape Fold Belt. It is dominated by the globose, finely-ribbed articulate brachiopod *Pleurothyrella africana*. Rare homalonotid trilobites, a small range of articulate and inarticulate brachiopods, nuculid and other bivalves, plectonotid "gastropods" and bryozoans also occur within impure brownish-weathering wackes (Haughton *et al.,* 1937, Boucot *et al.* 1963, Rossouw *et al.* 1964, Johnson 1976, Toerien & Hill 1989, Hill 1991, Theron *et al.* 1991, Almond *in* Rubidge *et al.* 2008). In many cases fossil shells are scattered and disarticulated, but *in situ* clumps of pleurothyrellid brachiopods also occur. This shelly assemblage establishes an Early Devonian (Pragian / Emsian) age for the uppermost Nardouw Subgroup, based on the mutationellid brachiopod *Pleurothyrella* (Boucot *et al.* 1963, Theron 1972, Hiller & Theron 1988). Haughton *et al.* (1937) record "numerous moulds of small lamellibranchs" within the Baviaanskloof Formation of the Elands River Valley, to the northwest of Port Elizabeth. Whether these truly represent small bivalves, or rather rounded mudflake impressions or brachiopod moulds, remains to be confirmed.

Trace fossils within the Baviaanskloof Formation include locally abundant, mud-lined burrows (*Palaeophycus*, *Rosselia*) and rare giant rusophycid burrows of Devonian aspect (*R. rhenanus*) that are attributed to homalonotid trilobites. Recently, dense assemblages of primitive vascular plants with forked axes and conical terminal "sporangia" that are provisionally ascribed to the genus *Dutoitia* have been collected from Baviaanskloof Formation mudrocks near Cape St Francis, Eastern Cape (Dr Mark Goedhart, Council for Geoscience, Port Elizabeth, pers. comm., 2008, *cf* Hoeg 1930, Anderson & Anderson 1985). These are currently the oldest known fossil vascular plants in southern Africa and are likely to co-occur with organic-walled microfossils such as spores, though these have not been looked for to date.

12.4.3 Ceres Subgroup (Early Devonian) (Dc)

Overall palaeontological sensitivity = HIGH

The lower part of the Ceres Subgroup, especially in the less deformed outcrop areas of the Western Cape, is known for its rich fossil assemblages of shallow marine invertebrates of the Malvinokaffric Faunal Province of Gondwana (Cooper 1982, Oosthuizen 1984, Hiller & Theron 1988, Theron & Johnson 1991, MacRae 1999, Almond *in* De Beer *et. al.* 2002, Thamm & Johnson 2006, Almond 2008). Key fossil groups here include trilobites, brachiopods, various subgroups of molluscs (bivalves, gastropods, nautiloids *etc*), and echinoderms (starfish, brittle stars, crinoids, carpoids *etc*), with several minor taxa including corals, conulariids, tentaculitids and rare fish remains, among others. These shelly fossil assemblages – generally preserved as impressions or moulds – are especially abundant within the finer-grained, mudrock-dominated units such as the Gydo and Voorstehoek Formations in their more distal (offshore) outcrop areas. Remarkably diverse and well-preserved assemblages of marine trace fossils (burrows, trackways *etc*) occur in heterolithic (*i.e.* interbedded sandstone and mudrock) facies of the northern, more proximal outcrop area of the Bokkeveld Group (Swart 1950, Theron 1972, Oosthuizen 1984, Almond 1998a, 1998b, De Beer *et al.* 2002, Almond 2008).

Shelly fossils have not been extensively recorded from the more distal, southern outcrop area of the Bokkeveld Group, however, including the Port Elizabeth sheet area (*cf* Le Roux 2000). This may be due to the prevalence here of offshore, deeper water facies but important secondary influences include:

- deep chemical weathering of sediments beneath the "African Surface" which has obliterated many of the fossil moulds;
- intensive tectonic deformation of the Bokkeveld succession, with pervasive cleavage formation within the normally fossiliferous mudrocks; (*N.B.* Most fossils are preserved and seen on bedding planes, which are rarely exposed here, rather than secondary cleavage planes which cut across fossil-rich layers); and
- the extensive mantle of drift deposits (including alluvium, downwasted lag gravels, soil and pedocretes) covering the Bokkeveld bedrock.

It is, therefore, notable that Haughton *et al.* (1937, p. 24) record a low diversity shelly invertebrate faunule from "Bokkeveld slates west of the Kabeljouws River". The faunule consists entirely of distorted articulate and inarticulate brachiopods, including *Australoceolia*, chonetids, *Schuchertella* ("*Orthothetes*"), *Australospirifer* and *Orbiculoidea*. Any further, well-localized records of Bokkeveld fossils from new excavations in this region would be of scientific interest.

12.4.4 Enon Formation (Late Jurassic / Early Cretaceous) (Ke)

Overall palaeontological sensitivity = LOW

The palaeontological heritage of the coarse-grained facies (conglomerates, breccias) within the Uitenhage Group is currently unclear because of the uncertain stratigraphic position of many records with respect to currently accepted lithostratigraphy. Key references to the earlier literature are given by Du Toit (1956), McLachlan and McMillan (1976), Tankard *et al.* (1982) and Dingle *et al.* (1983). In general, the proximal Uitenhage "red bed" sediments deposited in colluvial fans and energetic braided river systems such as the Enon Formation are fossil-poor. In the eastern Gamtoos Basin lignites, pollens and a range of plant compression fossils are recorded from the Uitenhage Group beds, but these appear to stem from the Kirkwood Formation rather than the Enon Formation proper (These two units were not distinguished by Haughton *et al.*, 1937; the reference by Le Roux, 2000, to fossil wood from the Enon is, therefore, probably erroneous; *cf* also McLachlan & McMillan 1976, Dingle *et al.* 1983). Silicified wood has been recorded, however, from conglomerates of the Enon Formation near Worcester and Nuy in the Western Cape (Sönghe 1934, McLachlan & McMillan 1976, Gresse & Theron 1992). Charred wood fragments are also reported as common within the Enon of the Algoa Basin (Rogers & Du Toit 1909, Haughton & Rogers 1924) while unidentifiable carbonized miospores from borehole cores in the same basin are mentioned by Scott (1976a, b). The "greenish and buff sandy marls" at the base of the Enon succession at the Kabeljousrivier are of potential palaeontological interest and should be monitored for fossils (*e.g.* plant compressions) if these beds are intersected by excavations during construction of the proposed wind energy facility.

12.4.5 Caenozoic superficial deposits

Overall palaeontological sensitivity = LOW

Neogene to Recent alluvial deposits, such as those along the Kabeljousrivier, may also contain fossil remains of various types (Table 12.1). In coarser sediments (*e.g.* conglomerates) these tend to be robust, highly disarticulated and abraded (*e.g.* rolled bones, teeth of vertebrates) but well-preserved skeletal remains of plants (*e.g.* wood, roots) and invertebrate animals (*e.g.* freshwater molluscs and crustaceans) as well various trace fossils may be found within fine-grained alluvium. Human artefacts such as stone tools that can be assigned to a specific interval of the archaeological time scale (*e.g.* Middle Stone Age) can be of value for constraining the age of Pleistocene to Recent drift deposits like alluvial terraces. Elevated, ancient alluvial "High Level Gravels" tend to be coarse and to have suffered extensive reworking (*e.g.* winnowing and erosional downwasting), so they are generally unlikely to contain useful fossils.

12.5 IMPACT AND RECOMMENDATIONS

The Ubuntu Wind Energy Project study area is largely underlain by coarse fluvial conglomerates and sandstones of the Late Mesozoic Enon Formation (Uitenhage Group) that are very sparsely fossiliferous. In the southeastern, near-coastal sector of the study area the Enon sediments of the plateau are covered by a thin mantle of Bluewater Bay residual soils (Late Caenozoic Algoa Group) that are also relatively unfossiliferous. Therefore the impact of construction work on the coastal plateau, where most of the wind turbines and associated infrastructure are likely to be situated, is likely to be **very low** and specialist palaeontological mitigation is not recommended here. This also applies to the small outcrop area of Table Mountain Group rocks on the western side of the study area, close to the Kabeljousrivier Valley.

On the other hand, beds of sandy marls towards the base of the Enon succession near the Kabeljousrivier may prove to be fossil-rich (e.g. plant compressions). Marine sediments of the Devonian Bokkeveld Group underlying the Kabeljousrivier Valley on the western margin of the study area have yielded invertebrate fossils (various brachiopods) in the past. Any substantial fresh excavations into Enon and Bokkeveld rocks in the Kabeljousrivier Valley area should be sampled, recorded and monitored by a qualified palaeontologist during the construction phase of this development, at the developers expense.

Should substantial fossil remains be exposed at any stage during development, these should be safeguarded - *in situ*, if feasible – and recorded by the responsible ECO (photos, GPS readings). SAHRA should be alerted as soon as possible so that appropriate mitigation measures may be considered.

Table 12.1. Fossil record of rock units represented in the Ubuntu study area, largely modified from the SAHRA palaeotechnical report on the Palaeontological Heritage of the Eastern Cape (Almond *et al.*, 2008). The palaeontological sensitivity of formations indicated in blue is rated as LOW, whereas that of formations indicated in green is rated as MODERATE and red indicates (originally) HIGH palaeontological sensitivity (See also following page).

GROUP	*FORMATION & AGE*	*ROCK TYPES*	*FOSSIL BIOTA*	*COMMENTS*
UNNAMED	**Alluvium** Neogene - Recent	Bouldery to pebbly alluvial gravels, sands,silts	Disarticulated to well-articulated skeletal remains (bones, teeth) or mammals, reptiles (*e.g.* tortoises), ostrich egg shells, freshwater molluscs, crabs, plant remains, trace fossils (*e.g.* rhizoliths, termitaria and other invertebrate burrows, vertebrate tracks), microfossils (*e.g.* pollens, spores, ostracods)	"High Level Gravels" are coarse, often semi-consolidated, ancient fluvial deposits at high elevations above the modern drainage systems.
ALGOA GROUP	**"Bluewater Bay Formation" (T-Qb)** Late Caenozoic	Reddish-brown, pebbly residual soils, downwasted and fluvial conglomerates	Rare fossil shells weathered out from original Alexandria Formation limestones *plus* land snails, freshwater mussels	Now recognised as weathering product of the Miocene – Pliocene Alexandria Formation
UITENHAGE GROUP	**Enon Formation (Ke)** Late Jurassic / Early Cretaceous	Coarse pebbly to bouldery fanglomerates and braided river conglomerates with minor lenticular sandstones, often reddened	Very sparse transported fragments of bone, teeth, silicified or coalified wood. Microfossils include palynomophs.	Some older "Enon" fossil records probably refer rather to the slightly younger, finer-grained Kirkwood Formation.
BOKKEVELD GROUP	**Ceres Subgroup (Dc)** Early to Mid Devonian	Shallow marine siliciclastics (interbedded mudrock- and sandstone-dominated formations)	Diverse shelly invertebrate biotas and trace fossils, rare fish remains and vascular plants; microfossils (*e.g.* foraminiferans).	Fossil heritage in coastal zone often compromised by tectonic deformation (*e.g.* folding, cleavage), deep weathering and low levels of bedrock exposure.

GROUP		FORMATION & AGE	ROCK TYPES	FOSSIL BIOTA	COMMENTS
TABLE MOUNTAIN GROUP	NARDOUW SUBGROUP	**Baviaanskloof Fm (Sb, S-Db)** Early Devonian	Shallow marine "dirty" sandstones and subordinate mudrocks	Low diversity, brachiopod-dominated shelly marine faunas (also bivalves, trilobites, tentaculitids, bryozoans, gastropods, crinoids, trace fossils). Possible primitive vascular plants. Microfossils likely within mudrocks (*e.g.* organic-walled acritarchs).	Correlated with Rietvlei Fm in the western Cape Basin Early Devonian age well-established on fossil evidence.
		Skurweberg Fm (Ss, Sk) Silurian	Braided fluvial pebbly sandstones with thin subordinate mudrocks, especially in shallow marine- /estuarine- influenced parts of succession and towards the east	Sparse marine / estuarine or possibly fluvial trace fossil assemblages (trilobite burrows, Skolithos "pipe rock", horizontal burrows) within more mudrock-rich part of succession (W. Cape). Microfossils likely within mudrocks (e.g. organic-walled acritarchs).	Previously also known as the Kouga Fm (Sk)

TABLE 12.1 continued. Fossil record of rock units represented in the Ubuntu study area, largely modified from the SAHRA palaeotechnical report on the Palaeontological Heritage of the Eastern Cape (Almond *et al.*, 2008). The palaeontological sensitivity of formations indicated in blue is rated as LOW, whereas that of formations indicated in green is rated as MODERATE and red indicates (originally) HIGH palaeontological sensitivity.

Environmental Impact Assessment for the proposed Ubuntu Wind Energy Project near Jeffrey's Bay, Eastern Cape: Draft Environmental Impact Assessment Report

Chapter 13: Supporting Technical Inputs

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CHAPTER 13. SUPPORTING TECHNICAL INPUTS

This chapter provides supporting technical inputs on the potential impacts of the proposed Ubuntu wind energy project on the site's agricultural production and resource base.

13.1 INTRODUCTION

Johann Lanz was contracted by CSIR and WKN-Windcurrent SA to undertake an agricultural study of the site of the proposed Ubuntu wind energy project on the farms Zuurbron & Vlakteplaas located approximately 10 kilometres north north west of Jeffrey's Bay (See Figure 13.1).

The aim of the agricultural study was to investigate the potential impacts of the proposed development on the site's agricultural production and resource base. The terms of reference for the study were set out in correspondence from the Department of Environmental Affairs dated 07/07/2011, DEA ref: 12/12/20/1752. These terms of reference are taken from the department of agriculture, forestry and fisheries draft document: *Regulations for the evaluation and review of applications pertaining to wind farming on agricultural land.*

These terms of reference include:

- Mapping of soil forms and identification of the following soil characteristics
    - soil depth
    - soil colour
    - clay content
    - limiting factors
- Indication of the slope of the site;
- Identification of land use, developments and access routes on and surrounding the site;
- Assessment of the status of the land including erosion, vegetation and degradation;
- Description of water availability, source and quality;
- Identification of possible land use options for the site and discussion of why agriculture should or should not be the land use of choice; and
- An assessment of the impact of the development on agriculture.

13.2 METHODOLOGY

The field investigation was aimed at achieving an understanding of soil types and soil variation across the site. It did not comprise a detailed soil mapping exercise, based on a grid of profile test pits, but was based on an overview assessment, which involved driving and walking fairly extensively across the sites, investigating several exposed cuttings, assessing topography, surface conditions and geological maps, and drilling a number of (shallow) auger holes. The exposed cuttings included deep, old and existing quarry excavations, a deep road cutting and several culvert cuttings which provided access to sub soil horizons. The field assessment was complimented by the soil scientist's experience of a previous detailed soil mapping exercise undertaken on the neighbouring property. The investigation focused on the area of impact, that is where turbine and other infrastructure locations are proposed, and not on additional parts of the effected farms. The field assessment was done between 13th and 15th July 2011. A total of 23 sample points were investigated and recorded across the site.

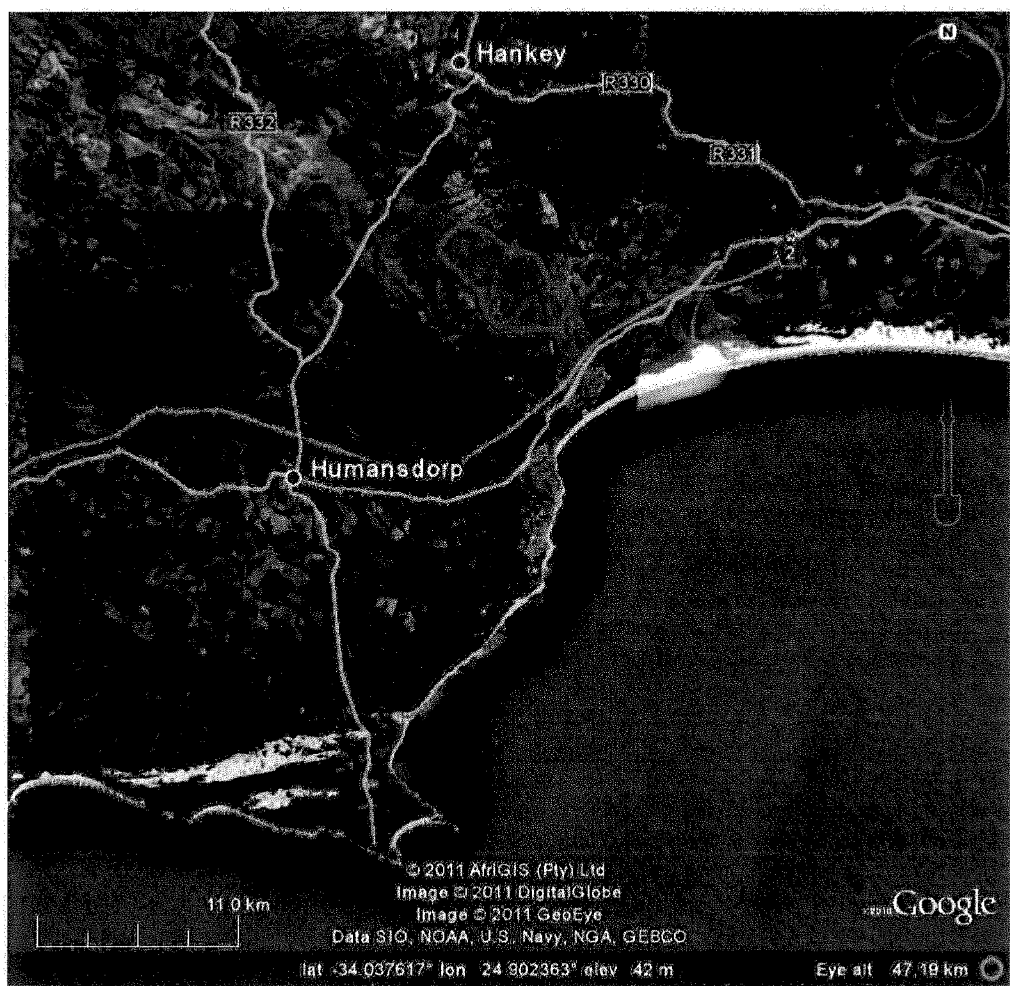

Figure 13.1: Locality map of the proposed Ubuntu wind energy project. Site shown in red.

This soil investigation methodology was considered completely adequate to gain a sufficiently accurate assessment of the agricultural soil capability across the site. A more detailed soil investigation, while able to map more detailed soil boundaries, is unlikely to have added anything significant to the assessment of agricultural soil capability for the purposes of determining the impact of wind farming on agricultural productivity.

The evaluation of soils for agricultural suitability is an evaluation of the soil's inherent physical and chemical fertility. The evaluation is done largely in terms of the presence or absence of soil limitations that will limit crop growth. The following factors play an important role in the assessment of agricultural suitability: root development potential, which is dependent on soil depth and structure; water holding capacity; drainage; workability; and soil organic matter content. An overall assessment of each soil is made taking all these factors into account, to give an assessment of soil capability. A distinction is made between soil capability and land capability. Soil capability only takes soil factors into account. Land capability is the combination of soil capability and climate factors.

13.3 SOIL CONDITIONS AND AGRICULTURAL CAPABILITY OF THE SITE

The positions of all investigated sample points for the site are indicated in Figure 13.2. Data from the profiles of each sample are provided in Table 13.1. Photographs of site conditions and representative soil profiles are given in Figures 13.3 to 13.8.

The proposed wind farm is located on an elevated, flat plateau. The area is underlain by fluvial conglomerates of the Mesozoic Enon Formation (Uitenhage Group) that are characterised by an abundance of rounded cobble stones of various sizes. The soils are predominantly residual soils that have been derived from the weathering of these underlying conglomerates and are characterised by an abundance (±80%) of the rounded cobble stones throughout the profile. The soil material between the stones has a clay content of approximately 8% with a medium sand grade. They are well drained soils with a brown A horizon and yellow-brown to orange B horizon. Most of the soils do not have a specific depth limiting horizon within 80cm of the soil surface.

The soils are classified in terms of the South African soil classification system as Clovelly soil form. They fall within this soil form, not because of a high degree of weathering but because they are young, well drained soils derived from parent material with a low clay forming potential and consequently develop non-structured yellow-brown profiles.

Although the majority of the area comprises these residual soils where active downward weathering is taking place, there are localised, small valley areas where eroded material has accumulated. These soils are less well drained and have non-stony upper soil horizons. Investigated soil in such areas was classified as Tukulu soil form.

Apart from this variation, soil conditions are very uniform across the site. The proposed turbines are all located on the plateau area and not in the valleys.

In terms of soil limitations to agricultural production, the soils are limited by the very high stone content which serves as a mechanical limitation to cultivation. It also severely limits the total water holding capacity and nutrient holding capacity of the soils, which is further limited by the low clay content as well. The soils are therefore categorised as medium agricultural potential.

Table 13.1: Soil data from all investigated sample profiles on the site. Top soil refers to the A horizon and sub soil to the B horizon. Effective depth is indicated as > the hole depth, where this did not reach a limiting horizon.

No	Form & family	Effective depth (depth to limiting horizon) (cm)	Type of limiting horizon	Sand grade & clay %		Slope %	Soil potential category	Sample type	GPS co-ordinates Lat/Lon hddd.ddddd°
				top soil	sub soil				
1	Clovelly 2100	>150		med, 9	med, 9	1	medium	quarry	S33.90443 E24.87341
2	Clovelly 2100	>80		med, 9	med, 9	1	medium	culvert	S33.90538 E24.87595
3	Clovelly 2100	>80		med, 9	med, 9	1	medium	culvert	S33.90635 E24.87878
4	Clovelly 2100	>80		med, 9	med, 9	1	medium	culvert	S33.91048 E24.88600
5	Clovelly 2100	>80		med, 9	med, 9	1	medium	culvert	S33.91556 E24.89058
6	Clovelly 2100	>25		med, 15		1	medium	auger	S33.91790 E24.89242
7	Clovelly 2100	>80		med, 8	med, 8	1	medium	culvert	S33.92143 E24.89575
8	Clovelly 2100	>80		med, 8	med, 8	1	medium	culvert	S33.92402 E24.89975
9	Clovelly 2100	>80		med, 8	med, 8	1	medium	culvert	S33.92556 E24.90354
10	Clovelly 2100	>80		med, 8	med, 8	1	medium	culvert	S33.92877 E24.91110
11	Clovelly 2100	>80		med, 6	med, 8	3	medium	culvert	S33.93153 E24.91537
12	Tukulu 2110	>60		med, 8	med, 8	1	medium	auger	S33.93305 E24.91815
13	Clovelly 2100	80	cemented layer	med, 8	med, 8	5	medium	quarry	S33.93476 E24.91696
14	Clovelly 2100	>100		med, 8	med, 8	3	medium	cutting	S33.93406 E24.91940
15	Clovelly 2100	>80		med, 8	med, 8	7	medium	culvert	S33.93833 E24.92653
16	Clovelly 2100	>15		med, 8		2	medium	auger	S33.93926 E24.93637
17	Clovelly 2100	130	cemented layer	med, 8	med, 8	2	medium	quarry	S33.95153 E24.94040
18	Clovelly 2100	>60		med, 8	med, 8	2	medium	ditch	S33.95828 E24.92592
19	Clovelly 2100	>15		med, 8		1	medium	auger	S33.95028 E24.90171
20	Clovelly 2100	>15		med, 8		1	medium	auger	S33.93398 E24.89651

No	Form & family	Effective depth (depth to limiting horizon) (cm)	Type of limiting horizon	Sand grade & clay %		Slope %	Soil potential category	Sample type	GPS co-ordinates Lat/Lon hddd.ddddd°
				top soil	sub soil				
21	Clovelly 2100	>15		med, 8		1	medium	auger	S33.92496 E24.87934
22	Clovelly 2100	>15		med, 8		1	medium	auger	S33.91567 E24.87160
23	Clovelly 2100	>15		med, 8		1	medium	auger	S33.92561 E24.91688

Notes:

1. *Sample positions that differed from the norm were sample 6 which was in a pan area and which had accumulated a deeper, richer, non-stony A horizon, and sample 12 in a valley area of sand accumulation which was non-stony throughout the investigated depth, and of a different soil form.*
2. *In the quarry cuttings of samples 13 and 17, the cemented layer was present in places but not throughout.*

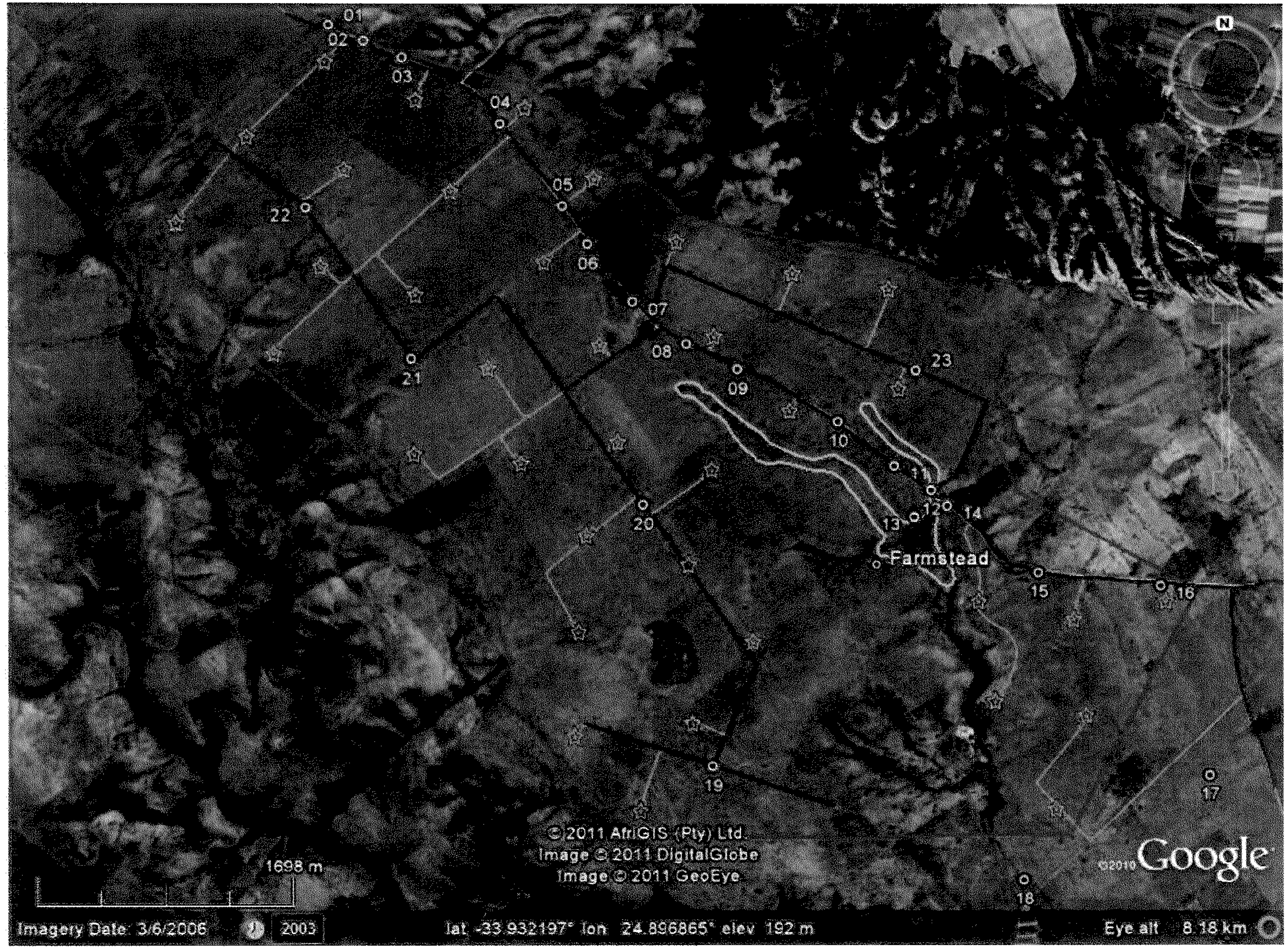

Figure 13.2: Google Earth Map of Wind Farm Site. The map shows the proposed positions of all turbines as green stars, soil investigation points are numbered in yellow, existing access roads are blue, proposed new access roads are orange, and the boundary of the Tukulu soil form, which differs from the Clovelly form on the remainder of the site, is light brown.

The agricultural potential of an area is influenced by both soil and climate parameters. Land capability is the combination of soil capability and climate factors. On the AGIS data base, the site has a land capability classification as: Non-arable, low to moderate potential grazing land. On the South African National Grazing Capacity Map the site is within zone 431, and classified as having a grazing capacity of 6 hectares per large stock unit.

Figure 13.3: Typical Clovelly soil profile, sample 13.

Figure 13.4: Piece of still cemented, un-weathered conglomerate, from which the soils have been derived.

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5th October 20..

Rezoning and Subdivision of Farm 1048/6 in Kidds Beach

BASIC ASSESSMENT REPORT

Prepared on behalf of Slipknot Investments 74 (Pty) Ltd by XL@Consulting cc

Changing the World,
One Person at a Time...

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Ref. No.: AR/7/544/2/11
Report Date: 27/07/2011


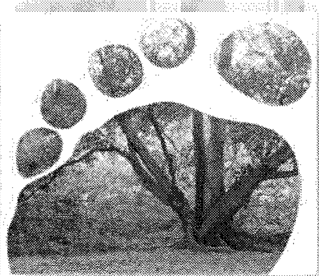
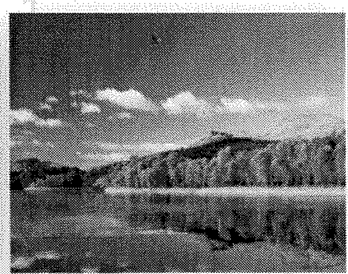

Figure 13.5: Landscape of site with public road.

Figure 13.6: Showing abundant surface stone where it has been exposed by cattle trampling.

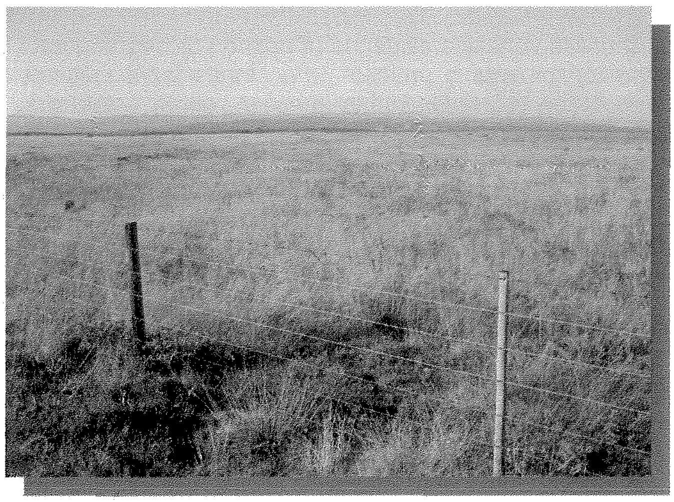

Figure 13.7: Camp with established permanent pasture.

Figure 13.8: Camp with natural veld pasture.

13.4 CURRENT LAND USE AT THE SITE

The entire site and its immediate surroundings are currently used as dry land grazing for beef cattle. There are no irrigated areas on the site. The area is divided into fenced grazing camps. On some of these, permanent pastures of various grasses have been established. On others natural veld is utilized as grazing. Wheat cultivation took place on some of the area, but was stopped more than twenty years ago because it was not economically viable. There is one farm stead on the site with an old barn and labourers cottages. In terms of access routes, there is a public gravel road that runs through the site, and private access roads to the grazing camps have been established for the cattle farming. All access roads are in good condition. Access roads and buildings are shown in Figure 13.2.

13.5 STATUS OF THE LAND

The land is generally in good condition. There is very little evidence of erosion or degradation of any kind. Apparently wind erosion of the topsoil was a problem when lands were cultivated annually (Frank Weitz, *pers. comm.*) Vegetation is predominantly grasses, either established, permanent pastures or land that probably had greater thicket cover, but that was cleared in the past.

13.6 POSSIBLE LAND USE OPTIONS FOR THE SITE

Dry land grazing for beef cattle is the only agricultural land use that is currently considered economically viable for the site, and so should be the land use of choice. This can easily be continued concurrently with the wind farming, providing a multiple land use option that increases revenue from the land.

13.7 WATER AVAILABILITY

The northern part of the farm Zuurbron, 4 km north west of the wind farm site and north of the R330 to Hankey, has a good quantity and quality of water available from three boreholes located there. These are used for irrigation lands in that part of the farm, and are used to supply stock water and the farmstead water to the wind farm site.

13.8 IMPACTS OF THE WIND FARM ON AGRICULTURE

The following impacts on agriculture are identified and discussed:

13.8.1 Permanent loss of agricultural land on the turbine footprints, roads and other infrastructures

A small amount of the land will be lost to current and future agricultural production. The extent of this is given in Table 13.2. The permutations of turbine size and number must still be finalised for the development. The calculation given in Table 13.2 is based on the maximum footprint area of the various options, which is a total of 15 hectares for the site. The total site area is 4,200 hectares. The approximate total area of agricultural land lost to the wind farm therefore represents a mere 0.36% of the agricultural land on the site.

Table 13.2: Calculation of the wind farm footprint on agricultural land.

	Length (m)	Width (m)	Area (m^2)	Number	Area (ha)
New roads	12000	4.5	54000	1	5.4
Hard standing for crane	50	40	2000	40	8
Foundation	20	20	400	40	1.6
Total					15

Mitigation: For all excavations that are to be returned to agricultural use (e.g. buried cables), the upper 20cm of the soil must be stripped, stockpiled separately, and then re-spread over the surface of the excavation after backfilling with excavated subsoil. The wind farm should utilise existing roads wherever possible and the length of any new roads should be minimised. **Note**: this has already been done in the proposed layout.

Significance: This impact is considered to be of low significance given that the area of land that will be lost to agriculture is very small, especially in relation to available land, that the land lost is only of medium agricultural potential, that current agricultural activities can be continued with very minimal disturbance, and that any potential future agricultural activities that are viable under the existing natural agricultural resource base (climate, water and soil) are also unlikely to be significantly disturbed by the existence of the wind farm.

13.8.2 Interruption of current agricultural activities

Activities associated with the construction and operation of the wind farm may interrupt current agricultural activities.

Mitigation: The layout of the wind farm should be such that it poses minimum interruption of agricultural activities. Turbine positions should not block access to farming operations and kraals in particular. **Note**: this has already been done in the proposed layout.

Significance: As current agricultural activities will be able to continue con-currently with all phases of the wind farm development, with very minimal disturbance, this impact is considered to be of low significance.

13.8.3 Disturbance of run-off and resultant potential impact on erosion

The construction of hard stands, foundations and new roads can increase surface run-off and potentially lead to erosion.

Mitigation: Drainage systems for the control of run-off water where necessary must be put into place during the construction of the wind farm.

Significance: Much of the land is flat and well drained so run-off and potential erosion is not a large threat. Where necessary, on sloping areas, drainage systems can easily be put in place. This impact is therefore considered to be of low significance.

13.9 CONCLUSIONS

An overview investigation of soil conditions and agricultural capability at the site of the proposed Ubuntu Wind Energy Project north of Jeffrey's Bay was done. The aim of this study was to investigate the potential impacts of the proposed development on the site's agricultural production and resource base. This included an investigation of soils and other agricultural resources across the site.

The soil investigation was based predominantly on an investigation of existing cuttings on the site, in combination with assessing topography, geology and surface conditions, but shallow auger holes were also used in places. This soil investigation methodology was considered completely adequate to gain a sufficiently accurate assessment of the agricultural soil capability across the site.

Soil conditions and agricultural capability are very uniform across the site. The soils are well drained, yellow-brown, sandy soils with abundant stone throughout the profile, and are classified as Clovelly soil form in terms of the South African soil classification system. These soils are limited by the very high stone content which serves as a mechanical limitation to cultivation. It also severely limits the total water holding capacity and nutrient holding capacity of the soils, which is further limited by the low clay content. The soils are therefore categorised as having medium agricultural potential. The land capability (which includes both soil and climate factors) is classified as non-arable, low to moderate potential grazing land. It is classified as having a grazing capacity of 6 hectares per large stock unit.

Impacts on agricultural potential and productivity were identified as:

1. Loss of agricultural land;
2. Interruption of current agricultural activities; and
3. Disturbance of run-off and resultant potential impact on erosion

The approximate loss of agricultural land was determined as only 15 hectares which represents a mere 0.36% of the agricultural land on the site. Mitigation measures were recommended for some of the impacts. All the identified impacts on agricultural potential and productivity were considered to be of low significance.

In conclusion, the proposed wind farm seems to represent an opportunity for multiple land use on the site, with a very low level of disturbance to current or likely future agricultural productivity.