PROPOSED KOINGNAAS WIND ENERGY FACILITY

NORTHERN CAPE PROVINCE

VISUAL IMPACT ASSESSMENT

AS PART OF A BASIC ASSESSMENT PROCESS

Produced for:

Just Palm Tree Power

Produced by:

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1. STUDY APPROACH

1.1. Qualification and Experience of the Practitioner

MetroGIS (Pty) Ltd, specialising in visual assessment and Geographic Information Systems, undertook this visual assessment in collaboration with V&L Landscape Architects CC.

Lourens du Plessis, the lead practitioner undertaking the assessment, has been involved in the application of Geographical Information Systems (GIS) in Environmental Planning and Management since 1990.

The team undertaking the visual assessment has extensive practical knowledge in spatial analysis, environmental modelling and digital mapping, and applies this knowledge in various scientific fields and disciplines. The expertise of these practitioners is often utilised in Environmental Impact Assessments, State of the Environment Reports and Environmental Management Plans.

The visual assessment team is familiar with the "Guidelines for Involving Visual and Aesthetic Specialists in EIA Processes" (Provincial Government of the Western Cape: Department of Environmental Affairs and Development Planning) and utilises the principles and recommendations stated therein to successfully undertake visual impact assessments. Although the guidelines have been developed with specific reference to the Western Cape province of South Africa, the core elements are more widely applicable.

Savannah Environmental (Pty) Ltd appointed MetroGIS (Pty) Ltd as an independent specialist consultant to undertake the visual impact assessment for the Proposed Koingnaas Wind Energy Facility in the Northern Cape Province. Neither the author, MetroGIS or V&L Landscape Architects will benefit from the outcome of the project decision-making.

1.2. Assumptions and Limitations

This assessment was undertaken during the planning stage of the project and is based on information available at that time.

1.3. Level of Confidence

Level of confidence[1] is determined as a function of:

- The information available, and understanding of the study area by the practitioner:
  - 3: A high level of information is available of the study area and a thorough knowledge base could be established during site visits, surveys etc. The study area was readily accessible.
  - 2: A moderate level of information is available of the study area and a moderate knowledge base could be established during site visits, surveys etc. Accessibility to the study area was acceptable for the level of assessment.
  - 1: Limited information is available of the study area and a poor knowledge base could be established during site visits and/or surveys, or no site visit and/or surveys were carried out.

- The information available, understanding of the study area and experience of this type of project by the practitioner:

[1] Adapted from Oberholzer (2005).

- 3: A high level of information and knowledge is available of the project and the visual impact assessor is well experienced in this type of project and level of assessment.
- 2: A moderate level of information and knowledge is available of the project and/or the visual impact assessor is moderately experienced in this type of project and level of assessment.
- 1: Limited information and knowledge is available of the project and/or the visual impact assessor has a low experience level in this type of project and level of assessment.

These values are applied as follows:

	Information on the project & experience of the practitioner			
Information on the study area		**3**	**2**	**1**
	3	9	6	3
	2	6	4	2
	1	3	2	1

*The level of confidence for this assessment is determined to be **9** and indicates that the author's confidence in the accuracy of the findings is high:*

- The information available, and understanding of the study area by the practitioner is rated as **3** and
- The information available, understanding of the study area and experience of this type of project by the practitioner is rated as **3**.

1.4. Methodology

The study was undertaken using Geographic Information Systems (GIS) software as a tool to generate viewshed analyses and to apply relevant spatial criteria to the proposed facility. A detailed Digital Terrain Model (DTM) for the study area was created from 20m interval contours supplied by the Surveyor General.

The approach utilised to identify issues related to the visual impact included the following activities:

- The creation of a detailed digital terrain model (DTM) of the potentially affected environment;
- The sourcing of relevant spatial data. This included cadastral features, vegetation types, land use activities, topographical features, site placement, etc;
- The identification of sensitive environments upon which the proposed facility could have a potential impact;
- The creation of viewshed analyses from the proposed development area in order to determine the visual exposure and the topography's potential to absorb the potential visual impact. The viewshed analyses take into account the dimensions of the proposed structures.

This report (visual impact assessment) sets out to identify and quantify the possible visual impacts related to the proposed facility, including related infrastructure, as well as offer potential mitigation measures, where required.

The following methodology has been followed for the assessment of visual impact:

- **Determine Potential visual exposure**

  The visibility or visual exposure of any structure or activity is the point of departure for the visual impact assessment. It stands to reason that if the proposed WEF and associated infrastructure were not visible, no impact would occur.

  Viewshed analyses of the proposed WEF facility and related infrastructure indicate the potential visibility.

- **Determine Visual Distance / Observer Proximity to the facility**

  In order to refine the visual exposure of the facility on surrounding areas/receptors, the principle of reduced impact over distance is applied in order to determine the core area of visual influence for the turbines.

  Proximity radii for the proposed development site are created in order to indicate the scale and viewing distance of the facility and to determine the prominence of the structures in relation to their environment.

  The visual distance theory and the observer's proximity to the facility are closely related, and especially relevant, when considered from areas with a high viewer incidence and a predominantly negative visual perception of the proposed facility.

- **Determine Viewer Incidence / Viewer Perception**

  The number of observers and their perception of a structure determine the concept of visual impact. If there are no observers, then there would be no visual impact. If the visual perception of the structure is favourable to all the observers, then the visual impact would be positive.

  It is therefore necessary to identify areas of high viewer incidence and to classify certain areas according to the observer's visual sensitivity towards the proposed WEF and its related infrastructure.

  It would be impossible not to generalise the viewer incidence and sensitivity to some degree, as there are many variables when trying to determine the perception of the observer; regularity of sighting, cultural background, state of mind, and purpose of sighting which would create a myriad of options.

- **Determine the Visual Absorption Capacity of the natural vegetation**

  This is the capacity of the receiving environment to absorb the potential visual impact of the proposed facility. The VAC is primarily a function of the vegetation, and will be high if the vegetation is tall, dense and continuous. Conversely, low growing sparse and patchy vegetation will have a low VAC.

  The VAC would also be high where the environment can readily absorb the structure in terms of texture, colour, form and light / shade characteristics of the structure. On the other hand, the VAC for a structure contrasting markedly with one or more of the characteristics of the environment would be low.

The VAC also generally increases with distance, where discernable detail in visual characteristics of both environment and structure decreases.

The digital terrain model utilised in the calculation of the visual exposure of the facility does not incorporate the potential visual absorption capacity (VAC) of the natural vegetation of the region. It is therefore necessary to determine the VAC by means of the interpretation of the vegetation cover, supplemented with field observations.

- **Determine the Visual impact index**

  The results of the above analyses are merged in order to determine where the areas of likely visual impact would occur. These areas are further analysed in terms of the previously mentioned issues (related to the visual impact) and in order to judge the magnitude of each impact.

- **Determine Impact significance**

  The potential visual impacts identified and described are quantified in their respective geographical locations in order to determine the significance of the anticipated impact. Significance is determined as a function of extent, duration, magnitude and probability.

2. BACKGROUND

Just Palm Tree Power is proposing the establishment of a commercial Wind Energy Facility (WEF) approximately 3km south west of the town of Koingnaas, within a De Beers mining area in the Namakwa District Municipality of the Northern Cape Province.

A WEF generates electricity by means of wind turbines that harness the wind of the area as a renewable source of energy. Wind energy generation, or wind farming as it is commonly referred to, is considered to be an environmentally friendly electricity generation option.

The effectiveness of the WEF, or amount of power generated by the facility, is dependent on the number of wind turbines erected in the area as well as the careful placement of the turbines in relation to the topography and each other in order to optimise the use of the wind resource.

Just Palm Tree Power intends to construct up to 24 wind turbines within an identified area of 100Ha. The facility will ultimately have a generating capacity of approximately 7MW.

The WEF will connect to the electricity grid at the existing De Beers owned Koingnaas substation.

A preliminary layout of the WEF main infrastructure (i.e. the wind turbines) is shown on **Map 1**.

The exact positioning or detailed layout of the components of this proposed wind energy facility will be developed by taking cognisance of the wind resource on the site as well as the environmental sensitivities and mitigation measures identified through the EIA process. A final layout of the turbines within the facility would be prepared prior to construction.

Each turbine will have a capacity of 0,3MW, and will consist of a concrete foundation, a steel tower and nacelle (hub height at a height of 35m), and a rotor (32m diameter, consisting of 3 blades of 16m in length). The rotational power generated by the turbine blades is transmitted to the generator housed within the nacelle via a gearbox and drive train. Refer to **Figure 1**.

Figure 1: Image of a wind turbine being considered for this project[2]

The layout of ancillary infrastructure has not been finalised, but will include the following:

- Cabling between the turbines, to be lain underground where practical (connecting to the existing on-site substation).
- A short power line (66/11kV) to connect the facility to the mine's Koingnaas substation via a switching yard 50m x 40m which will be constructed to convert the current from 33 kV to 11kV.
- Two alternative power line alternatives are being assessed. The preferred option (Option 2a) follows an existing mine road for the most part, except for a short section which passes west the tailings dump.
- Where required, internal access roads of approximately 6m wide will be constructed between the turbines and the existing on-site substation. Existing roads will be used wherever possible.
- A workshop area for maintenance and storage purposes, and an office facility.

[2] Image courtesy of Savannah Environmental.

It is expected, from a visual impact perspective, that the wind turbines would constitute the highest potential visual impact of the WEF.

The construction and commissioning of the WEF is expected to take 9 months. The lifespan of the facility is approximated at 20 years. Each turbine is designed to operate continuously and with low maintenance, meaning that the proposed facility will require a small workforce comprising low, semi skilled and highly skilled staff.

3. SCOPE OF WORK

The project is proposed on the farm Koingnaas 745.

The study area for the visual assessment encompasses a geographical area of 2520km² (the extent of the maps displayed below) and includes a minimum 12km buffer zone from the proposed development area.

The scope of work for this assessment includes the determination of the potential visual impacts in terms of nature, extent, duration, magnitude, probability and significance of the construction and operation of the proposed infrastructure and the recommendation of mitigation measures, where appropriate.

Anticipated issues related to the proposed Wind Energy Facility include:

- The visibility of the facility to, and potential visual impact on, observers travelling along secondary roads in close proximity[3] to the proposed WEF and within the region[4].
- The visibility of the WEF to, and potential visual impact on, the small towns of Koingnaas, Hondeklip Bay and Noop, in close proximity to the proposed WEF and within the region.
- The visibility of the facility to, and the potential visual impact on conservation areas in the region, specifically the Namaqua National Park and its *Viewshed Protection Zone.*
- The potential visual impact of the facility on the visual character of the landscape and sense of place of the region.
- The potential visual impact of the facility on tourist routes, tourist destinations and tourist potential of the region, especially in terms of events such as the Namaqualand flower displays.
- The potential visual impact of the construction of ancillary infrastructure (i.e. the overhead power line, the internal access roads, the workshop, the maintenance and storage area and the office) on observers in close proximity to the facility.
- The potential visual impact of operational, safety and security lighting of the facility at night on observers in close proximity to the facility.
- Potential visual impacts associated with the construction phase on observers in close proximity to the facility.
- Potential cumulative visual impacts of the WEF.
- Potential residual visual impacts after the decommissioning of the facility.
- The potential to mitigate visual impacts and inform the design process.

[3] For the purpose of this study, close proximity is considered to be within 6km of the proposed WEF.

[4] For the purpose of this study, the region is considered to be beyond the 6km radius of the proposed WEF.

4. THE AFFECTED ENVIRONMENT

Regionally, the proposed WEF site is located approximately 55km south of Kleinzee and less than 20km north of Hondeklip Bay. The properties lie along the coastline with the proposed WEF located less than 2km from the shore.

The study area (i.e. the extent of the maps) occurs on land that ranges in elevation from 0m a.s.l. (along the coast) to about 475 m a.s.l. (at the top of the hills). The non-perennial, westward flowing Swartlintjes and Spoeg Rivers are the main hydrological features within the study area. The Swartlintjes traverses the site some 5km to the south of the proposed turbine positions.

The terrain surrounding the proposed WEF site is generally flat, sloping gently westwards towards the shore. The terrain type of the region is described as *slightly undulating plains*. Low hills are present in the north and east of the study area, and to a lesser extent in the far south east. Refer to **Map 1**.

The desert climate of the study area is dry, receiving between 28mm and 123mm of rainfall per annum. Land cover is primarily *shrubland* with localised areas of *exposed rock and sand.* The vegetation type is *Strandveld of the West Coast.*

The small towns of Hondeklip Bay, Koingnaas and Noop are the only settlements within the study area. Large parts of the study area, and in fact the entire site for the proposed WEF, are mine-owned. As a result, significant mining activities are evident, especially within a 5km band along the coast. The study area has a very low population density of 0,9 people per km^2.

There are no numbered routes through the study area, but secondary roads do connect Hondeklip Bay and Koingnaas with one another and with the N7 which lies some 60km to the east.

Figure 2: Coastal Strandveld with mining activity in the background.

Figure 3: Coastal Strandveld with mining activity in the background.

Figure 4: Mining activity and power lines in the vicinity of Koingnaas.

Figure 5: Visual quality of the town of Koingnaas.

Besides the mining activity, industrial infrastructure is limited to a distribution power line running to the north, along the secondary road alignment. Refer to **Map 2.**

The Namaqua National Park lies less than 5km to the east of the proposed WEF, and dominates land use within the study area.

Of relevance is the location of the proposed WEF within this Park's *Viewshed Protection Zone*.

'…These are areas where developments could impact on the aesthetic quality of a visitors experience in a park. This zone is particularly concerned with visual impacts (both day and night)…

…Within these areas any development proposals should be carefully screened to ensure that they do not impact excessively on the aesthetics of the park…' [5]

Regarding this explanation, it should be noted that the proposed development area itself, which lies within a mining area, is already transformed by existing surface based mining.

The proposed WEF also lies adjacent to an area demarcated as a *Priority Natural Area* by the SANParks Planning Department. See **Map 3**.

'…Priority natural areas include areas identified for future park expansion as well as reasonably natural areas of high biodiversity value which are critical for the long-term persistence of biodiversity within the park. These include adjacent natural areas which function as an ecologically integrated unit with the park, as

[5] Extract from the *Namaqua National Park Zoning Plan*, which explains the principle of a viewshed protection zone.

well as areas critical for maintaining ecological links and connectivity with the broader landscape…'[6]

Considerations are related to biodiversity and ecological connectivity rather than visual aspects. However, this zone represents a visual buffer for the National Park, and as such influences both the visual character and sense of place of the area and of the National Park.

Figure 6: Visual quality of the Namaqua National Park.

The greater region is generally seen as having a high scenic value and high tourism value potential. It is well known for its scenic natural beauty (West Coast as a whole) and annual wild flower displays (Namaqualand)[7].

Limited tourist accommodation is available within the National Park[8], but a number of private guest houses are to be found off the various secondary roads.

All of these secondary roads are used as tourist access routes to and through the National Park and as scenic drives, especially during the flower season.

Within this scenic context, it is noteworthy that the mining areas along the coastline are significantly disturbed and visually apparent due to the scale and nature of the surface based mining. In this respect the visual quality of the receiving environment is already impacted upon to some extent.

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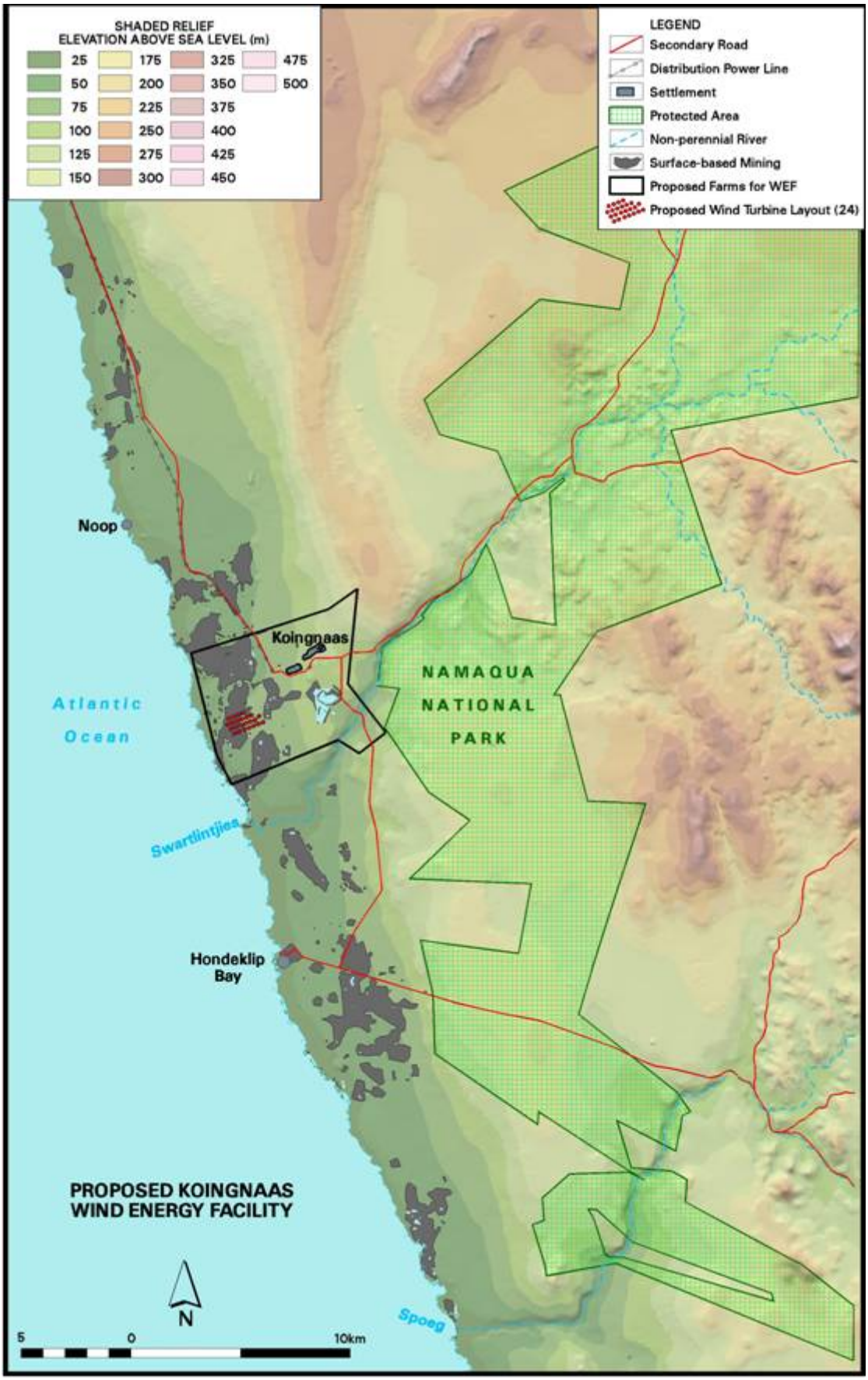
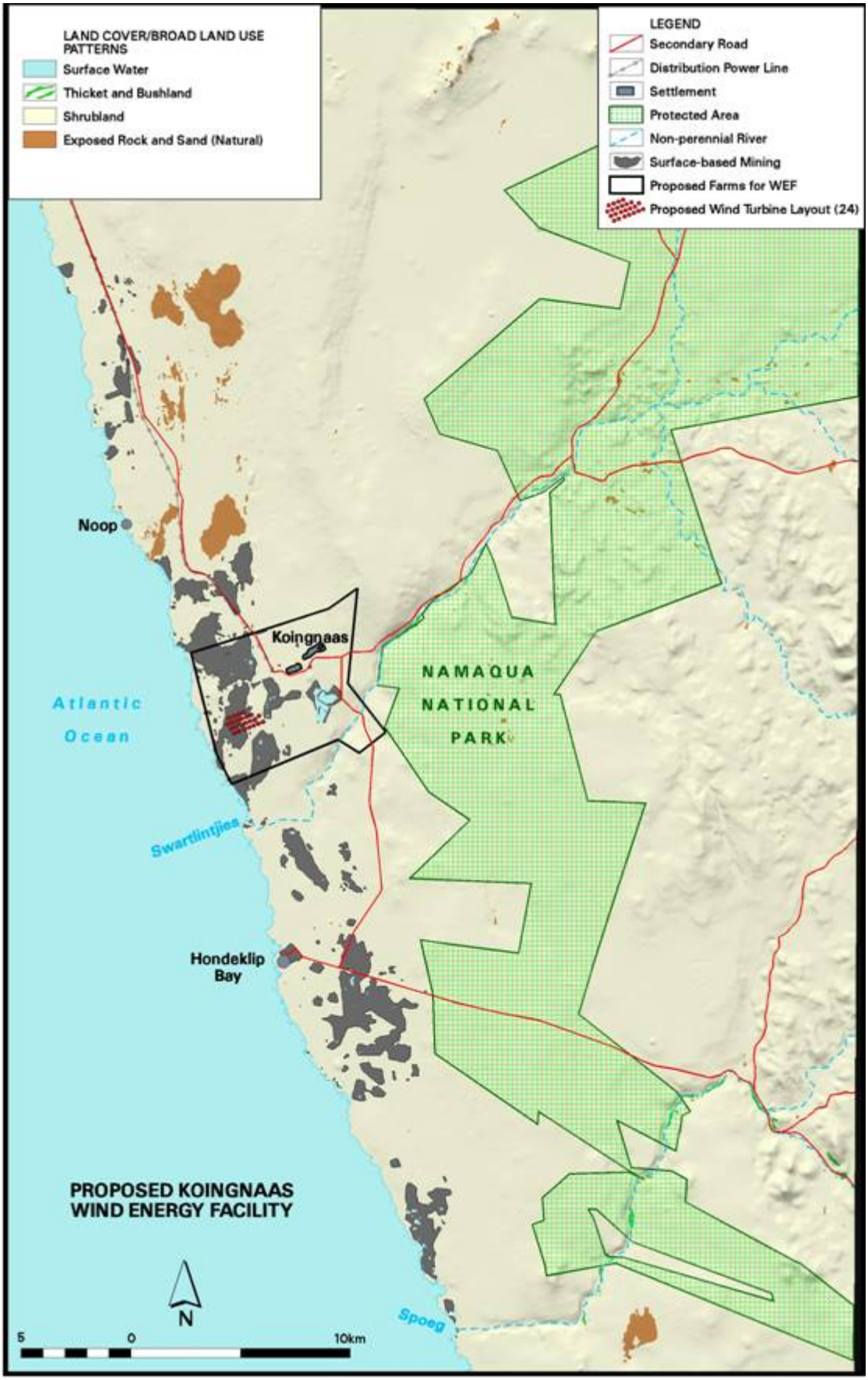
[6] Extract from the *Namaqua National Park Zoning Plan*, which explains the principle of a priority natural area.

[7] Namaqualand stretches from the small town of Garies in the south to the Orange River to the north, its western border is the wild Atlantic coast, the remote town of Pofadder marks the eastern border (http://www.discoverthecape.com/namaqualand/flower-route.html)

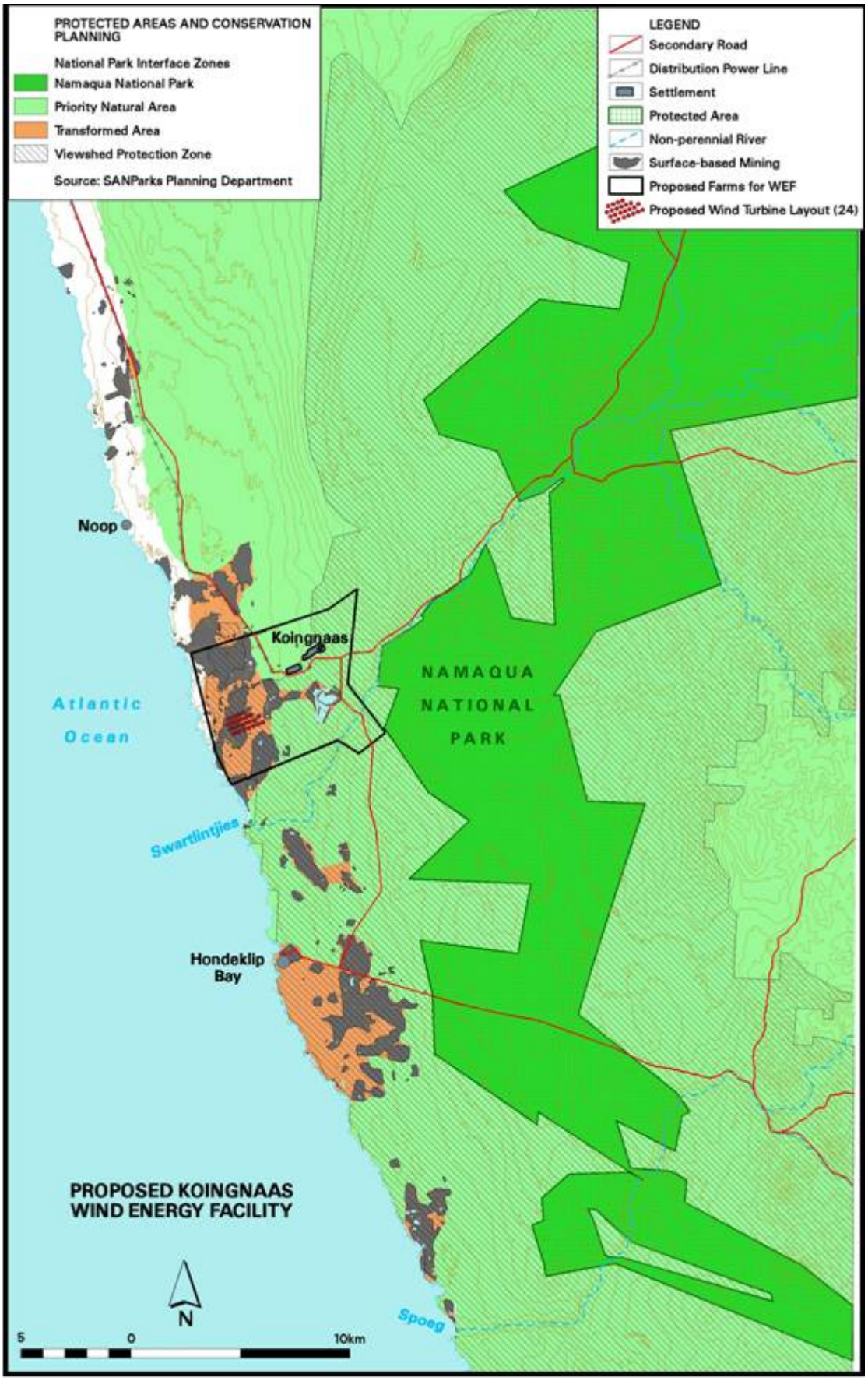
[8] The Skilpad Rest Camp and Luiperdskloof Guest Cottage are located in the east of the Park, beyond the extent of the study area (www.sanparks.co.za)



Map 1: Locality Map, Shaded Relief and Elevation above Sea Level of the study area



Map 2: Land Cover and Broad Land Use Patterns within the study area.



Map 3: Protected Areas and Conservation Planning within the study area.

5. RESULTS

5.1 Potential visual exposure

The visibility analysis was undertaken from each of the preliminary wind turbine positions (24 in total) at an offset of 35m above average ground level (i.e. the turbine hub height) in order to simulate a worst-case scenario.

The result of the viewshed analysis for the proposed WEF's provisional layout is shown on **Map 4**.

The viewshed analysis not only indicates areas from which the wind turbines would be visible (any number of turbines with a minimum of one turbine), but also indicates the potential frequency of visibility (i.e. how many turbines are exposed). The dark orange areas indicate a high frequency (i.e. 19-24 turbines may be visible) while the light yellow areas represent a low frequency (i.e. 1-2 turbines may be visible).

The highest frequency of exposure is expected along the coastal plain for about 15km to the north and to the south of the proposed facility. Areas located beyond about 10km from the coastline are almost entirely shielded from potential visual exposure due to the gradual rise in the topography to the east, away from the shore.

Visibility of the WEF will be high, with a high frequency of exposure along the secondary roads running in a north south direction, and to a lesser extent, those leading inland. All secondary roads are used as tourist access routes to and through the National Park and as scenic drives, especially during the flower season.

Beyond a distance of about 10km from the coast, potential visual exposure along secondary roads drops to nil.

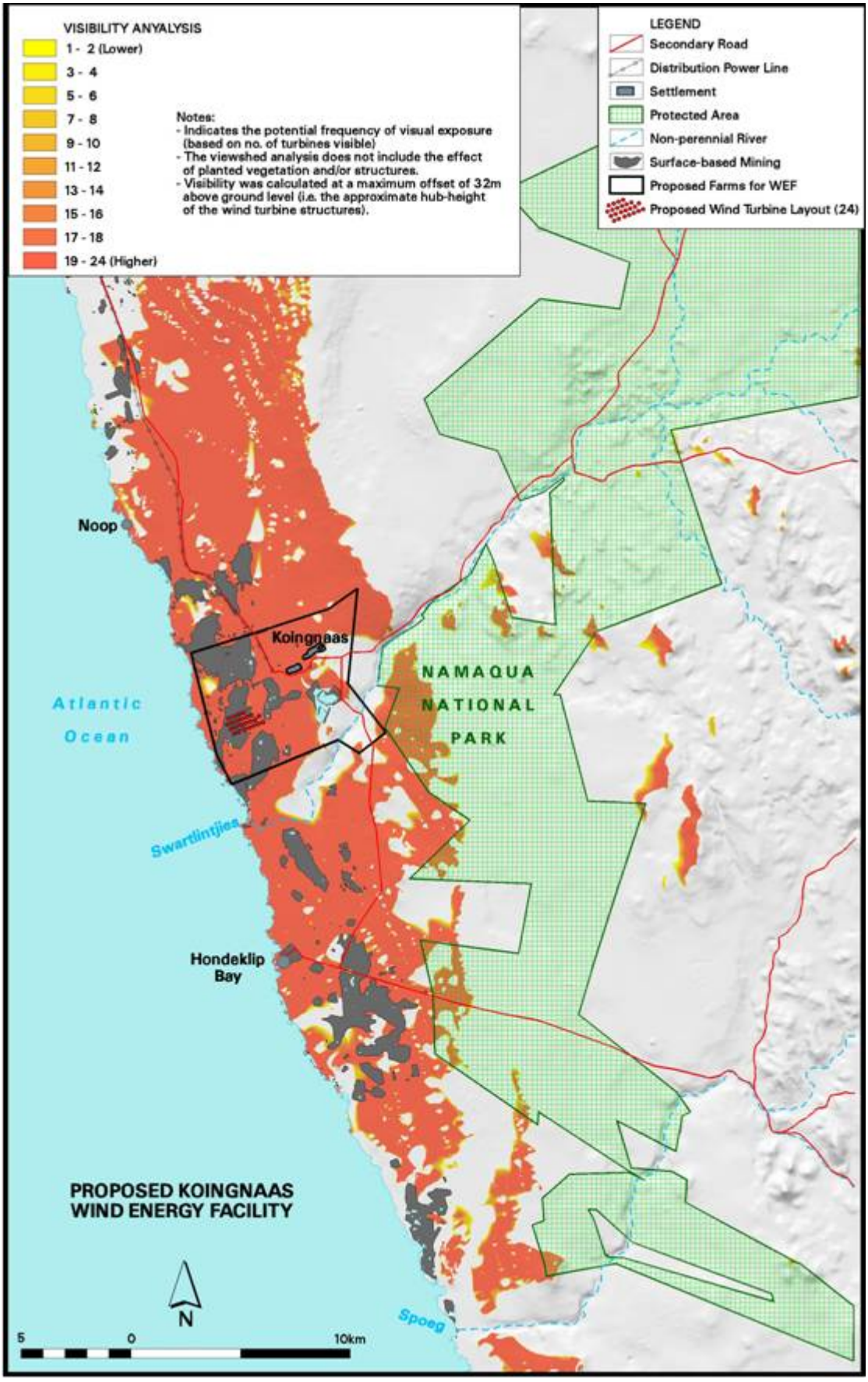
The small towns of Noop, Koingnaas and Hondeklip Bay are all expected to experience a high frequency of visual exposure.

Most of the Namqua National Park lies beyond 10km from the coast, and is thus mostly shielded from potential visual exposure. Sections along the western most boundary will be exposed to a high frequency of visual exposure, as will limited, smaller patches further inland.

Map 4 clearly illustrates the influence of the topography on the potential visual exposure of the wind turbines. The proposed WEF is located low down on the coastal plane, which means it benefits from visual screening by the rising topography to the east.

Within the above visually exposed areas, the context of the proposed WEF within an active mining area has bearing. The visual environment is already impacted upon through topographical disturbances and visual clutter (i.e. mining related buildings and infrastructure).

Nonetheless, it is anticipated that the turbine structures would be easily and comfortably visible, especially within a 6km radius of the WEF, potentially resulting in a visual impact.



Map 4: Potential Visual Exposure of the Proposed WEF.

5.2 Visual distance / observer proximity to the facility

MetroGIS determined the proximity radii based on the anticipated visual experience of the observer over varying distances. The distances are adjusted upwards for larger facilities and downwards for smaller facilities (i.e. depending on the size and nature of the proposed infrastructure). MetroGIS developed this methodology in the absence of any known and/or acceptable standards for South African wind energy facilities.

These proximity radii (calculated from the boundary lines of the farms) are shown on **Map 5** and are as follows:

- 0 – 3km - Short distance view where the facility would dominate the frame of vision and constitute a very high visual prominence.
- 3 - 6km - Medium distance views where the facility would be easily and comfortably visible and constitute a high visual prominence.
- 6 - 12km - Medium to longer distance view where the facility would become part of the visual environment, but would still be visible and recognisable. This zone constitutes a medium visual prominence.
- Greater than 12 km - Long distance view where the facility would still be visible though not as easily recognisable. This zone constitutes a low visual prominence for the facility.

5.3. Viewer incidence / viewer perception

Refer to **Map 5**. Viewer incidence is calculated to be the highest along the secondary roads within the study area. Commuters using these roads could be negatively impacted upon by visual exposure to the facility.

Other than along the above roads, viewer incidence within a 12 km radius of the proposed facility is concentrated in the small towns. The remaining areas consist predominantly of vacant and mining land with a very low occurrence of observers.

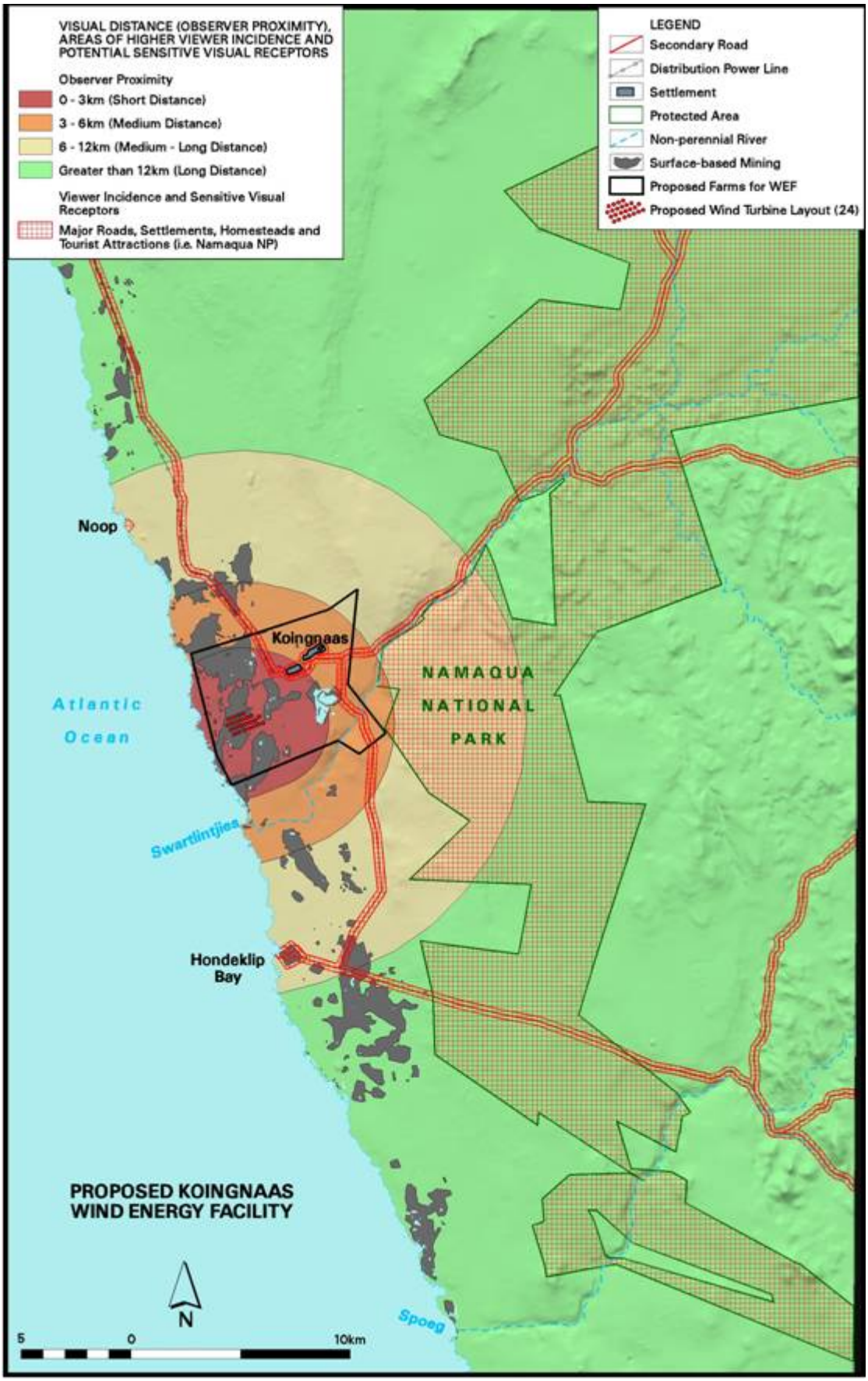
Tourists visiting and travelling through the area are also seen as possible sensitive visual receptors upon which the presence of the proposed facility could have a negative visual impact.

The main tourist destination is the Namaqua National Park, although the density of roads and accommodation within the Park itself is low. During flower season, the entire area is frequented by tourists and all of the secondary roads are used as tourist access routes and as scenic drives.

Limited tourist accommodation is available within the National Park[9], but a number of private guest houses are to be found off the various secondary roads.

The severity of the visual impact on the above receptors decreases with increased distance from the proposed facility.

[9] The Skilpad Rest Camp and Luiperdskloof Guest Cottage are located in the east of the Park, beyond the extent of the study area (www.sanparks.co.za)



Map 5: Observer Proximity to the Proposed WEF and Areas of High Viewer Incidence.

5.4. Visual absorption capacity

The desert climate of the study area is dry, receiving between 28mm and 123mm of rainfall per annum. Land cover is primarily *shrubland* with localised areas of *exposed rock and sand.* The vegetation type is *Strandveld of the West Coast.*

Overall, the Visual Absorption Capacity (VAC) of the receiving environment is deemed to be negligible by virtue of the vegetation and the relatively homogenous landform and the overall low occurrence of buildings, structures and infrastructure.

Within the existing mining areas, a degree of visual impact already exists. Topographic disturbance due to surface based mining activities as well as existing visual clutter (as a result of mining related structures and infrastructure) will result in some absorption of visual impact.

Limited VAC will therefore be taken into account within the mining areas.

5.5. Visual impact index

The combined results of the visual exposure, viewer incidence/perception and visual distance of the proposed WEF are displayed on **Map 6**. Here the weighted impact and the likely areas of impact have been indicated as a visual impact index. Values have been assigned for each potential visual impact per data category and merged in order to calculate the visual impact index.

An area with short distance, high frequency of visual exposure to the proposed facility, a high viewer incidence and a predominantly negative perception would therefore have a higher value (greater impact) on the index. This helps in focussing the attention to the critical areas of potential impact when evaluating the issues related to the visual impact.

The following is of relevance:

- The visual impact index map clearly indicates potential areas of **moderate** visual impact within a 3km radius of the proposed facility. This is mining land, already significantly impacted upon by surface-based mining.

- Areas of potentially high visual impact are limited to the western section of the small town of Koingnaas, and a small section of secondary road to the north east of the proposed WEF.

- The extent of potential visual impact is somewhat reduced between the 3km and 6km radius. Areas to the east are shielded by the topography, while areas to the north south, and south east are likely to be exposed to **low** visual impact.

  Short stretches of secondary road and the eastern part of Koingnaas may be exposed to **moderate** visual impact within this zone. One small corner of the Namaqua National Park also falls within this zone, and will thus be exposed to moderate visual impact.

  The Swartlintjes River will be visually screened for its entire length through the study area, except near to the coast, where a short stretch may be exposed to moderate visual impact.

- Between 6km and 12km, the magnitude of visual impact is mostly reduced to **very low**.

Exceptions are the secondary roads within 10km of the coastline, the towns of Hondeklip Bay and Noop, and some patches within the western Namaqua National Park. Potential visual impact within these areas is expected to be **low**.

- Remaining impacts beyond the 12km radius are expected to be **very low** to **negligible**.

It is important to note the overall high visual quality of the natural environments of the region, and specifically the Namaqua National Park. The environment possesses a harsh and rugged beauty which lends to the area to a specific sense of place and tourism value.

Within this scenic context, the existing mining areas along the coastline are disturbed and visually apparent due to the scale and nature of the surface based mining activity. In this respect the visual quality of the receiving environment is already impacted upon to some extent.

Notwithstanding, it is envisaged that the proposed facility would be visible to observers travelling along roads, residing in the small towns or visiting the region (i.e. the National Park), especially within 6km of the site.

The figure below helps to place the above explanations in context, illustrating what scale a turbine structure will be perceived at different viewing distances.

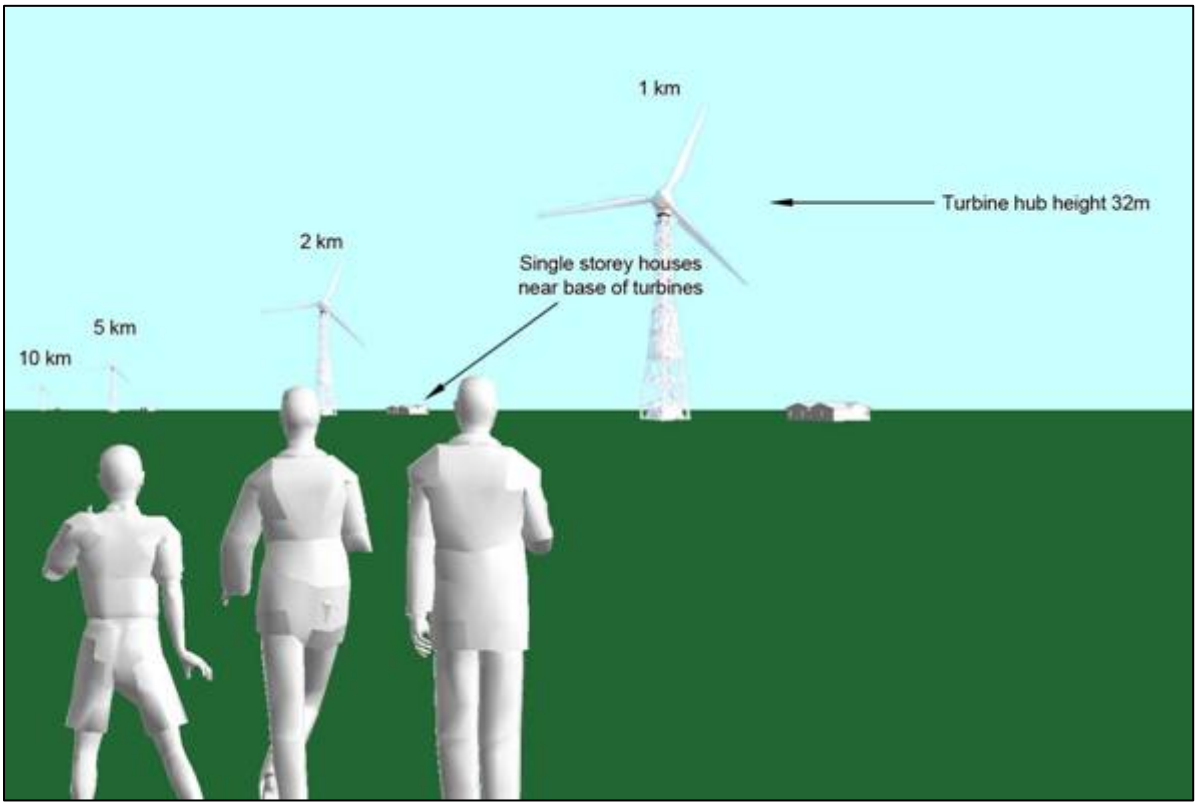
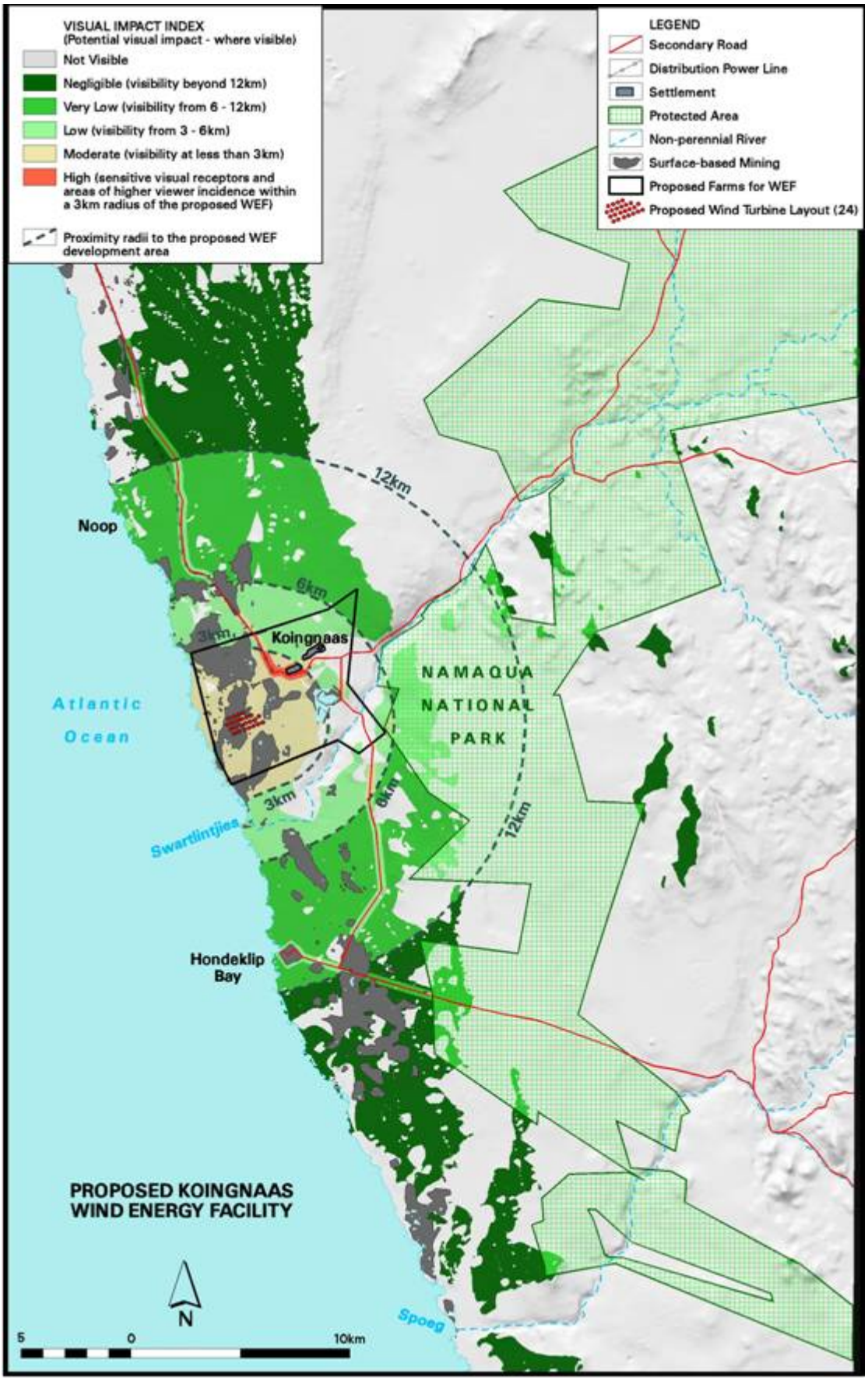


Figure 7: Visual experience of a wind turbine structure at a distance of 1km, 2km, 5km and 10km.



Map 6: Visual Impact Index of the Proposed WEF.

5.6 Visual impact assessment: methodology

The previous section of the report identified specific areas where likely visual impacts would occur. This section will attempt to quantify these potential visual impacts in their respective geographical locations and in terms of the identified issues (see Chapter 2: SCOPE OF WORK) related to the visual impact.

The methodology for the assessment of potential visual impacts states the **nature** of the potential visual impact (e.g. the visual impact on users of major roads in the vicinity of the proposed WEF) and includes a table quantifying the potential visual impact according to the following criteria:

- **Extent** - site only (very high = 5), local (high = 4), regional (medium = 3), national (low = 2) or international (very low = 1)
- **Duration** - very short (0-1 yrs = 1), short (2-5 yrs = 2), medium (5-15 yrs = 3), long (>15 yrs = 4), and permanent (= 5)
- **Magnitude** - None (= 0), minor (= 2), low (= 4), medium/moderate (= 6), high (= 8) and very high (= 10)
- **Probability** – very improbable (= 1), improbable (= 2), probable (= 3), highly probable (= 4) and definite (= 5)
- **Status** (positive, negative or neutral)
- **Reversibility** - reversible (= 1), recoverable (= 3) and irreversible (= 5)
- **Significance** - low, medium or high

The **significance** of the potential visual impact is equal to the **consequence** multiplied by the **probability** of the impact occurring, where the consequence is determined by the sum of the individual scores for magnitude, duration and extent (i.e. **significance = consequence (magnitude + duration + extent) x probability**).

The significance weighting for each potential visual impact (as calculated above) is as follows:

- <30 points: Low (where the impact would not have a direct influence on the decision to develop in the area)
- 31-60 points: Medium/moderate (where the impact could influence the decision to develop in the area)
- >60: High (where the impact must have an influence on the decision to develop in the area)

*Please note that due to the declining visual impact over distance, the **extent** (or spatial scale) rating is reversed (i.e. a localised visual impact has a higher value rating than a national or regional value rating). This implies that the visual impact is highly unlikely to have a national or international extent, but that the local or site-specific impact could be of high significance.*

5.7 Visual impact assessment: primary impacts

5.7.1 The WEF

Potential visual impact on users of secondary roads in close proximity to the proposed facility.

Visual impacts on secondary roads within a radius of 6km of the proposed facility are expected to be of **moderate** significance.

The VAC of the topographic disturbance (due to surface based mining activities) and visual clutter (as a result of mining related structures and infrastructure) in the immediate vicinity of the proposed WEF will reduce the probability of this impact occurring.

The table below illustrates this impact assessment.

Table 1: Impact table summarising the significance of visual impacts on users of secondary roads in close proximity to the proposed facility.

Nature of Impact: Potential visual impact on users of secondary roads in close proximity to the proposed facility		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	High **(8)**	N/a
Probability	Probable **(3)**	N/a
Significance	Moderate **(48)**	N/a
Status (positive, neutral or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated	No	N/a
Mitigation: Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 years.		
Cumulative impacts: The construction of 24 wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the existing mining as well as the power line infrastructure already present in the area. Two other WEF's are proposed further north near Kleinzee. These are also undergoing EIA. Should either or both of these WEF's be approved and constructed, then they, in addition to the proposed Koingnaas WEF will result in a cumulative visual impact within the region.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

Potential visual impact on residents of small towns in close proximity to the proposed facility.

The visual impact on the town of Koingnaas is expected to be of **moderate** significance.

Ordinarily, visual clutter within a more urban context will offer some absorption of the visual impact. However, the town is so small that this amelioration will be negligible.

The VAC of the topographic disturbance (due to surface based mining activities) and visual clutter (as a result of mining related structures and infrastructure) in the immediate vicinity of the proposed WEF will reduce the probability of this impact occurring.

The table below illustrates this impact assessment.

Table 2: Impact table summarising the significance of visual impacts on residents of small towns in close proximity to the proposed facility.

Nature of Impact: Potential visual impact on residents of small towns in close proximity to the proposed facility		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	High **(8)**	N/a
Probability	Probable **(3)**	N/a
Significance	Moderate **(48)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated during operational phase?	No	N/a
Mitigation: Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 years.		
Cumulative impacts: The construction of 24 wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the existing mining as well as the power line infrastructure already present in the area. Two other WEF's are proposed further north near Kleinzee. These are also undergoing EIA. Should either or both of these WEF's be approved and constructed, then they, in addition to the proposed Koingnaas WEF will result in a cumulative visual impact within the region.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

Potential visual impact on sensitive visual receptors (users of roads and residents of small towns) within the region

The visual impact users of secondary roads and on small towns within the region (i.e. beyond the 6km radius), is expected to be of **low** significance.

The VAC of the topographic disturbance (due to surface based mining activities) and visual clutter (as a result of mining related structures and infrastructure) in the immediate vicinity of the proposed WEF will reduce the probability of this impact occurring.

The table below illustrates this impact assessment.

Table 3: Impact table summarising the significance of visual impacts on sensitive visual receptors within the region.

Nature of Impact: Potential visual impact on sensitive visual receptors within the region		
	No mitigation	***Mitigation considered***
Extent	Regional **(3)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Moderate **(6)**	N/a
Probability	Improbable **(2)**	N/a
Significance	Low **(26)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated during operational phase?	No	N/a
Mitigation: Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 years.		
Cumulative impacts: The construction of 24 wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the existing mining as well as the power line infrastructure already present in the area. Two other WEF's are proposed further north near Kleinzee. These are also undergoing EIA. Should either or both of these WEF's be approved and constructed, then they, in addition to the proposed Koingnaas WEF will result in a cumulative visual impact within the region.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

Potential visual impact on the Namaqua National Park.

The visual impact on tourists and visitors to the Namaqua National Park is expected to be **low**.

Of relevance is the location of the proposed WEF within this Park's *Viewshed Protection Zone*. However, it should also be noted that this area, which lies within a mining area, is already transformed by existing surface based mining.

Table 4: Impact table summarising the significance of visual impacts on the Namaqua National Park.

Nature of Impact: Potential visual impact on the Namaqua National Park.		
	No mitigation	***Mitigation considered***
Extent	Regional **(3)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Low **(4)**	N/a
Probability	Improbable **(2)**	N/a
Significance	Low **(22)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated during operational phase?	No	N/a
Mitigation: Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 years.		
Cumulative impacts: The construction of 24 wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the existing mining as well as the power line infrastructure already present in the area. Two other WEF's are proposed further north near Kleinzee. These are also undergoing EIA. Should either or both of these WEF's be approved and constructed, then they, in addition to the proposed Koingnaas WEF will result in a cumulative visual impact within the region.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

5.7.2 Ancillary infrastructure

Potential visual impact of ancillary buildings and access roads on observers in close proximity to the proposed facility.

The construction of the workshop, maintenance and storage area, the office and internal access roads (where new roads are required) may be visible to observers in close proximity to the WEF.

Although no dedicated viewshed has been generated for the above infrastructure, it will all be located within the proposed WEF development footprint, and will be overshadowed by the much taller wind turbine structures. It is thus expected that the area of potential visual exposure will lie within that of the primary infrastructure (i.e. the turbines).

The VAC of the topographic disturbance (due to surface based mining activities) and visual clutter (as a result of mining related structures and infrastructure) in the immediate vicinity of the proposed WEF will reduce the probability of this impact occurring.

The table below illustrates the assessment of this anticipated impact, which is likely to be of **low** significance.

Table 5 Impact table summarising the significance of visual impact of the ancillary buildings and access roads.

Nature of Impact: Potential visual impact of the ancillary buildings.		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Low **(4)**	N/a
Probability	Improbable **(2)**	N/a
Significance	Low **(24)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated during operational phase?	No	N/a
Mitigation: Planning: layout and construction of roads and infrastructure with due cognisance of the topography. Construction: rehabilitation. Decommissioning: removal of the unnecessary ancillary buildings and ripping and rehabilitation of the road and servitude after 20 years.		
Cumulative impacts: The construction of ancillary infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the existing mining as well as the power line infrastructure already present in the area.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

Potential visual impact of the power line option 2a

The preferred option for the overhead power line (Option 2a) will run from the switching yard at the proposed WEF to the existing Koingnaas Substation (located just west of Koingnaas adjacent to the secondary road).

No dedicated viewshed has been generated for this infrastructure, however, the power line will follow an existing road alignment for most of its length. In general, placing the new infrastructure adjacent to existing infrastructure is considered preferable from a visual perspective, as this will negate the need for additional disturbance and thus reduce potential additional visual impact.

The table below illustrates the assessment of the anticipated visual impact of the new power line, which is likely to be of **moderate** significance.

Table 6 Impact table summarising the significance of visual impact of the power line option 2a.

Nature of Impact: Potential visual impact of the power line option 2a.		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Moderate **(6)**	N/a
Probability	Probable **(3)**	N/a
Significance	Moderate **(42)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated during operational phase?	No	N/a
Mitigation: Planning: Implementing the preferred option for the alignment of the power line, along an existing road. Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 years.		
Cumulative impacts: The construction of 24 wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the existing mining as well as the power line infrastructure already present in the area.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

5.7.3. Lighting Impacts

The area surrounding the proposed facility has a relatively low incidence of receptors. In this respect, light trespass and glare from the security and after-hours operational lighting for the facility infrastructure will have some significance for residents and tourists in the area.

Guest houses and tourist accommodation along secondary roads are likely to be sensitive visual receptors.

Another source of glare light, albeit not as intense as direct lighting, is the aircraft warning lights mounted on top of the hub of the wind turbines. These lights are less aggravating due to the toned-down red colour, but have the potential to be visible from a great distance.

The Civil Aviation Authority (CAA) prescribes these warning lights and the potential to mitigate their visual impacts is low (see discussion on '*the potential to mitigate visual impacts'* below). The WEF is not required to have a light fitted to each turbine, but it is compulsory to have synchronous flashing / fading lights on the turbines representing the outer perimeter of the facility. In this manner, fewer warning lights may be utilised to delineate the facility as one large obstruction, thereby lessening the potential visual impact.

The regulations for the CAA's *Marking of Obstacles* should be strictly adhered to (unless otherwise agreed with the CAA), as the failure to comply with these guidelines may result in the developer being required to fit additional light fixtures at closer intervals thereby aggravating the visual impact.

Last is the potential lighting impact known as sky glow. Sky glow is the condition where the night sky is illuminated when light reflects off particles in the atmosphere such as moisture, dust or smog. The sky glow intensifies with the increase in the amount of light sources. Each new light source, especially upwardly directed lighting, contribute to the increase in sky glow. The WEF may contribute to the effect of sky glow in an otherwise dark environment.

Mitigation of this impact entails the pro-active design, planning and specification of lighting for the facility by a lighting engineer. The correct specification and placement of lighting and light fixtures for both the turbines and the ancillary infrastructure will go far to contain rather than spread the light.

Of relevance to all of the above, however, is the location of the proposed WEF within an active mining area. In this respect, some visual impact as a result of lighting already exists. This existing lighting impact will reduce the probability of the new impact occurring.

The table overleaf illustrates the assessment of this anticipated impact, which is likely to be of **moderate** significance, and may be mitigated to **low.**

Table 7: Impact table summarising the significance of visual impact of lighting on visual receptors in close proximity of the proposed WEF

Nature of Impact: Potential visual impact of lighting on visual receptors in close proximity of the proposed WEF.		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	Moderate **(6)**	Moderate **(6)**
Probability	Probable **(3)**	Improbable **(2)**
Significance	Moderate **(42)**	Low **(28)**
Status (positive or negative)	Negative	Negative
Reversibility	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No
Can impacts be mitigated during operational phase?	No	No
Mitigation: Planning: pro-active design and planning Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 years.		
Cumulative impacts: In context of the existing mining in the area, which generates its own lighting impact at night, the impact of the WEF lighting will contribute to a regional increase in lighting impact.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

5.7.4. Construction Impacts

Potential visual impact of construction on visual receptors in close proximity to the proposed facility.

The duration of the construction phase of the WEF is expected to take a total of 9 months to complete (a conservative estimation not taking natural weather conditions etc. into account). During this time there will be a noticeable increase in heavy vehicles utilising the roads to the development site that may cause, at the very least, a visual nuisance to other road users and land owners in the area.

In this environment, dust from construction work is also likely to represent a significant visual impact.

The VAC of the topographic disturbance (due to surface based mining activities) and visual clutter (as a result of mining related structures and infrastructure) in the immediate vicinity of the proposed WEF will reduce the probability of this impact occurring.

The table below illustrates the assessment of this anticipated impact, which is likely to be of **moderate** significance, and may be mitigated to **low.**

Table 8: Impact table summarising the significance of visual impact of construction on visual receptors in close proximity to the proposed facility.

Nature of Impact: Potential visual impact of construction on visual receptors in close proximity to the proposed facility.		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	Local **(4)**
Duration	Very short term **(1)**	Very short term **(1)**
Magnitude	Moderate **(6)**	Low **(4)**
Probability	Probable **(3)**	Improbable **(2)**
Significance	Moderate **(33)**	Low **(18)**
Status (positive or negative)	Negative	Negative
Reversibility	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No
Can impacts be mitigated during construction phase?	Yes	N/a
Mitigation: Construction: Proper planning, management and rehabilitation of the construction site		
Cumulative impacts: In context of the existing mining in the area, which generates heavy vehicle traffic on the secondary roads, the construction phase of the WEF will contribute to a regional increase in heavy vehicles on the roads in the region.		
Residual impacts: None.		

5.8 Visual impact assessment: secondary impacts

5.8.1 The WEF and ancillary infrastructure

Potential visual impact of the proposed facility on the visual character and sense of place of the region.

Sense of place refers to a unique experience of an environment by a user, based on his or her cognitive experience of the place. Visual criteria, and specifically the visual character of an area (informed by a combination of aspects such as topography, level of development, vegetation, noteworthy features, cultural / historical features, etc) play a significant role.

A visual impact on the sense of place is one that alters the visual landscape to such an extent that the user experiences the environment differently, and more specifically, in a less appealing or less positive light.

Specific aspects contributing to the sense of place of this region include the rugged natural beauty of the west coast environment and the undeveloped, wide open spaces beyond.

It should be noted, however, that this sense of place is lost within the 5km wide strip along the coast line, within which the proposed WEF is located. The visual quality of this zone has been altered due to topographic disturbance (as a result of surface based mining activities) and visual clutter (as a result of mining related structures and infrastructure). This existing disturbed state will reduce the probability of this impact occurring.

Therefore, the anticipated visual impact of the facility on the regional visual character, and by implication, on the sense of place, is expected to be **low**. The table overleaf illustrates this impact assessment.

Table 9: Impact table summarising the significance of visual impacts on the visual character and sense of place of the region.

Nature of Impact: Potential visual impact of the proposed facility on visual character and sense of place of the region		
	No mitigation	***Mitigation considered***
Extent	Regional **(3)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Low **(4)**	N/a
Probability	Improbable **(2)**	N/a
Significance	Low **(22)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated during operational phase?	No	N/a
Mitigation: Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 years.		
Cumulative impacts: The construction of 24 wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the existing mining as well as the power line infrastructure already present in the area. Two other WEF's are proposed further north near Kleinzee. These are also undergoing EIA. Should either or both of these WEF's be approved and constructed, then they, in addition to the proposed Koingnaas WEF will result in a cumulative visual impact within the region.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

Potential visual impact of the proposed facility on tourist routes, tourist destinations and tourism potential within the region.

The west coast as a whole is seen as a tourist destination, and in this respect, many of the secondary roads along the coast attract 4x4 tourists in search of adventure.

In addition, the annual Namaqualand Flower displays afford the area a unique aesthetic appeal, and a resultant tourism value and potential. This tourism potential may not yet be optimised within the study area, but limited tourist facilities do exist in the small coastal towns and within the National Park. There is certainly potential for more to develop.

Visual intrusion through the development of industrial type infrastructure within this environment could jeopardise the area's tourism value and potential. It is important to note, however, that the existing surface based mining has already done much to alter the visual quality of the 5km strip along the coastline, within which the facility is proposed to be located.

Therefore, the anticipated visual impact of the facility on existing tourist routes, as well as on the tourism potential of the region takes cognisance of the visual status quo of the mining areas, and is expected to be **low**.

The table below illustrates this impact assessment.

Table 10: Impact table summarising the significance of visual impacts on tourist routes, tourist destinations and tourist potential within the region.

Nature of Impact: Potential visual impact of the proposed facility on tourist routes, tourist destinations and tourist potential within the region.		
	No mitigation	***Mitigation considered***
Extent	Regional **(3)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Low **(4)**	N/a
Probability	Improbable **(2)**	N/a
Significance	Low **(22)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable **(3)**	N/a
Irreplaceable loss of resources?	No	N/a
Can impacts be mitigated during operational phase?	No	N/a
Mitigation: Decommissioning: removal of the wind turbines and ancillary infrastructure after 20 years.		
Cumulative impacts: The construction of 24 wind turbines together with the associated infrastructure will increase the cumulative visual impact of industrial type infrastructure within the region. This is relevant in light of the existing mining as well as the power line infrastructure already present in the area. Two other WEF's are proposed further north near Kleinzee. These are also undergoing EIA. Should either or both of these WEF's be approved and constructed, then they, in addition to the proposed Koingnaas WEF will result in a cumulative visual impact within the region.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

5.9 The potential to mitigate visual impacts

- The primary visual impact, namely the appearance of the Wind Energy Facility (mainly the wind turbines) is not possible to mitigate. The functional design of the structures cannot be changed in order to reduce visual impacts.

  Alternative colour schemes (i.e. painting the turbines sky-blue, grey or darker shades of white) are not permissible as the CAA's *Marking of Obstacles* expressly states, "*Wind turbines shall be painted bright white to provide the maximum daytime conspicuousness*". Failure to adhere to the prescribed colour specifications will result in the fitting of supplementary daytime lighting to the wind turbines, once again aggravating the visual impact. The overall potential for mitigation is generally low or non-existent.

- Mitigation of visual impacts associated with the development of new internal access roads (where these are required) include careful planning, taking due cognisance of the topography. Construction of roads should be undertaken with adequate drainage structures in place to forego potential erosion problems.

- Access roads and ancillary buildings and structures not required for the post-decommissioning use of the site may be removed and the scars ripped and rehabilitated during decommissioning.

- The potential negative impact of the overhead power line may be mitigated by implementing the preferred option (option 2a), which follows an existing mine road for the most part and passes west of the large tailings dump.

- Mitigation of lighting impacts includes the pro-active design, planning and specification lighting for the facility by a lighting engineer. The correct specification and placement of lighting and light fixtures for both the turbines and the ancillary infrastructure will go far to contain rather than spread the light.

- Mitigation of visual impacts associated with the construction phase, albeit temporary, entails proper planning, management and rehabilitation of the construction site.

- Secondary impacts anticipated as a result of the proposed facility (i.e. visual character, sense of place, tourism value and tourism potential) are not possible to mitigate.

- Once the WEF has exhausted its life span, the main facility and all associated infrastructure not required for the post rehabilitation use of the site may be removed and all disturbed areas appropriately rehabilitated.

The possible mitigation of both primary and secondary visual impacts as listed above should be implemented and maintained on an ongoing basis.

6. PHOTO SIMULATIONS

Photo simulations were undertaken (in addition to the above spatial analyses) in order to illustrate the potential visual impact of the proposed Koingnaas WEF within the receiving environment.

The purpose of the photo simulation exercise is to support the findings of the VIA, and is not an exercise to illustrate what the facility will look like from all directions.

The photo simulations indicate the anticipated visual alteration of the landscape from various sensitive visual receptors located at different distances from the facility. The simulations are based on the wind turbine dimensions and layout as indicated on **Map 1**. The photograph positions are indicated on **Map 7** below and should be referenced with the photo simulation being viewed in order to place the observer in spatial context.

The simulated views show the placement of the wind turbines during the longer-term operational phase of the facility's lifespan. It is assumed that the necessary post-construction phase rehabilitation and mitigation measures, as proposed by the various specialists in the environmental impact assessment report, have been undertaken.

It is imperative that the natural vegetation be restored to its original (current) status for these simulated views to ultimately be realistic. These photographs can therefore be seen as an ideal operational scenario (from a visual impact point of view) that should be aspired to. The additional infrastructure (e.g. the proposed power lines, substation, access roads, etc.) associated with the facility is not included in the photo simulations.

Each photographic simulation is preceded by a panoramic overview of the landscape from the specified viewpoint being discussed. The panoramic overview allows for a more realistic viewer scale that would be representative of the distance over which the turbines are viewed. Where relevant, each panoramic overview indicates the section that was enlarged to show a more detailed view of the WEF.

The simulated wind turbines, as shown on the photographs, were adapted to the atmospheric conditions present when the original photographs were taken. This implies that factors such as haze and solar glare were also simulated in order to realistically represent the observer's potential view of the facility.

The following technical data are of relevance:

- The camera used to take the initial photographs is a standard Canon EOS 1000D with an 18-55mm lens. Photos intended for panoramas are taken with focal length at 55mm to minimize edge distortion and to facilitate the panoramic software’s stitching process.

- Canon’s stitching software (Photostitch v3.1.21) is used to create the panoramas. This software automatically compensates for slight variations in the focal length on each photo used in the panorama (i.e. the camera model, focal length, F-number, etc are embedded into each photo, so the software recognizes these parameters and adjusts the output image accordingly).

- The photo simulation process begins with the DTM, as this is effectively the "ground surface" of the virtual environment. The accuracy of the DTM in representing the Earth's surface is very much dependent on the quality of available contour data as this is what it is derived from. The raster DTM that is used to show shaded relief in a map is usually the same dataset that is used as the virtual ground surface.

- The DTM is visualised in 3D with an application called ArcScene. ArcScene works in much the same way as ArcMap except that the geometry and attributes of shapefiles cannot be edited, and of course, that is displayed in a Cartesian plane. Any existing shapefile can be added into the 3D environment and will automatically be displayed in its correct geographic position. Shapes that do not contain Z-values (height above mean sea level) can be assigned height values using the DTM. Point shapefiles, for example, will typically already have X/Y coordinates but can be placed at the virtual ground level, or at any height above ground level as specified in the attribute table. Lines and polygons work in the same way, thus enabling any vector shapefile to be "draped" onto the 3D terrain surface.

- 3D models from such applications as 3D StudioMax or Sketchup are compatible with the ArcScene environment and work by assigning a model to be rendered at points geographically specified by a point shapefile. Each model itself consists of many polygons, and depending on the number of models used, can impact severely on a computer's performance in displaying the virtual environment.

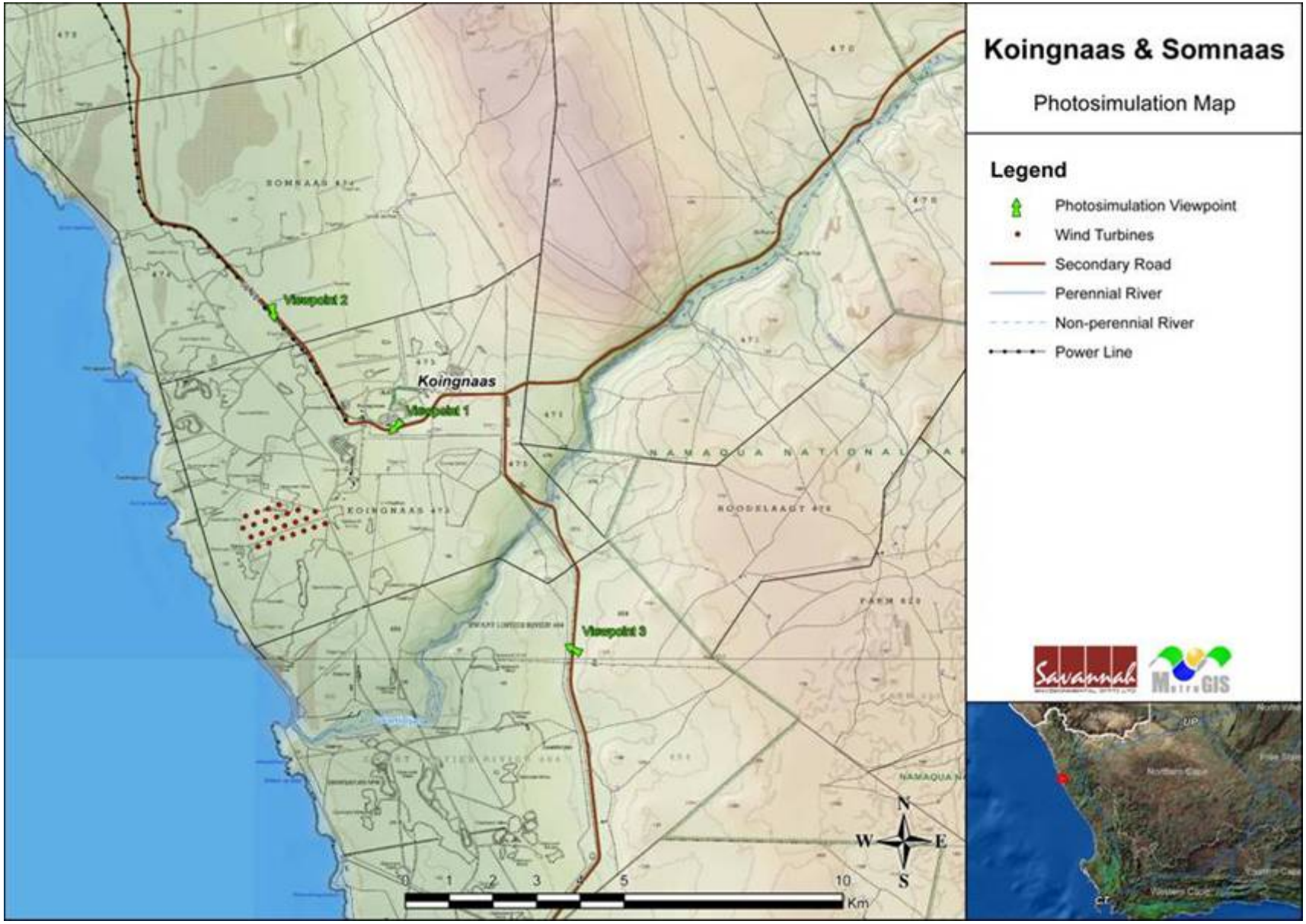
- For the purposes of placing wind turbines onto a virtual landscape, a layout of the exact turbine positions is required in the form of a point shapefile. This shapefile is added three times to the environment. The first instance is displayed as a point at ground level to indicate where the turbine tower meets the ground level. The second instance is extruded to half the height of the tower and displayed in a certain colour. The third instance is extruded from half to the full height of the tower and displayed in a different colour. Thus, from any virtual viewpoint on the landscape, it can be determined which turbines will be in full view and which will be partially obscured by undulations of the terrain. The terrain can also be made semi-transparent to check whether anything is completely obscured.

- Each photo viewpoint is then recreated within the virtual environment by setting the "camera" coordinates to those of the GPS coordinates logged when each photo was taken. Several other data may be added for landmark purposes, such as roads, rivers, power lines, or even trees if they can be accurately digitized. The virtual output is then rendered at a focal length matching that of the photos originally used to create the panoramas (using a field-of-view calculator that also compensates for the digital equivalent of 35mm film cameras). Several virtual "snapshots" are taken in sequence in the same manner as for the panoramic photos as the virtual output suffers from the same edge distortion as a photo. These are then stitched in the same manner as the photographs.

- Both the panoramic photos and the virtual simulation output are now graphic formats that are loaded into Adobe Photoshop. Some enhancements of the panoramas may be necessary as weather conditions tend to adversely affect image quality. The horizon and landscape of the virtual viewpoint is then matched up to what can be seen in the panoramas and sample images of the wind turbines are then overlaid where the extruded points are visible. Scaling is maintained since the top and mid-point of the tower are usually visible, so the ground point can be

established even though it may be obscured by the landscape. Some graphic editing is usually necessary to address such things intervening vegetation or power lines as well as sufficient blurring to mimic the effect of distance.

- The scene is then typically rendered twice as "before" and "after" views.



Map 7: Photograph positions for Photo Simulations.

6.1 Viewpoint 1

Viewpoint 1 is located on the secondary road which bypasses Koingnaas in the south. The point is located approximately 3km away from the closest turbine and is indicative of a close range view that residents of and visitors to Koingnaas will potentially see when travelling towards the town from the east. The viewing direction is south westerly and 12 turbines are fully to partially visible in the landscape.

Figure 8a: Pre construction panoramic overview from Viewpoint 1

Figure 8b: Post construction panoramic overview from Viewpoint 1.
This viewpoint is located 3km away from the closest turbine. Note the Visual Absorption Capacity of the existing topographic disturbance (as a result of surface based mining activities) and visual clutter (as a result of mining related structures and infrastructure).

6.2 Viewpoint 2

Viewpoint 2 is located on the secondary road which runs parallel to the coast, giving access to Koingnaas and Hondeklip Bay from the north. The point is located about 3km north west of Koingnaas, and is approximately 4,5km away from the closest turbine. This viewpoint is indicative of a medium distance view that residents of and visitors to Koingnaas and Hondeklip Bay will potentially see when travelling towards the town from the north. The viewing direction is southerly and 21 turbines are fully to partially visible in the landscape.

Figure 9a: Pre construction panoramic overview from Viewpoint 2

Figure 9b: Post construction panoramic overview from Viewpoint 2 (indicating enlarged photograph sections).
This viewpoint is located 4,5km away from the closest turbine. Note the Visual Absorption Capacity of the existing topographic disturbance (as a result of surface based mining activities) and visual clutter (as a result of mining related structures and infrastructure).

Figure 9c: View 2a (enlarged photograph section from Viewpoint 2).

Figure 9d: View 2b (enlarged photograph section from Viewpoint 2).

6.3 Viewpoint 3

Viewpoint 3 is located on the secondary road linking Hondeklip Bay and Koingnaas. The point is located about 6km from the closest turbine and is indicative of a medium to long range view that residents of and visitors to the area would have of the turbines lying to the north west.

It is also representative of what visitors to the Namaqua National Park may be exposed to in the far western reaches of the park. The viewing direction is north westerly and 24 turbines are fully to partially visible in the landscape.

Figure 10a: Pre construction panoramic overview from Viewpoint 3

Figure 10b: Post construction panoramic overview from Viewpoint 3.
This viewpoint is located 6km away from the closest turbine. Note the Visual Absorption Capacity of the existing topographic disturbance (as a result of surface based mining activities) and visual clutter (as a result of mining related structures and infrastructure).

7. CONCLUSION AND RECOMMENDATIONS

The construction and operation of the Proposed Koingnaas Wind Energy Facility and its associated infrastructure will have a visual impact on the study area, specifically within 6km of the proposed facility.

The author is, however, of the opinion that the WEF has an advantage over other more conventional power generating plants (e.g. coal-fired power stations). The facility utilises a renewable source of energy (considered as an international priority) to generate power and is therefore generally perceived in a more favourable light. It does not emit any harmful by-products or pollutants and is therefore not negatively associated with possible health risks to observers.

The facility further has a generally unfamiliar novel and futuristic design that invokes a curiosity factor not generally present with other conventional power generating plants. The advantage being that the WEF can become an attraction or a landmark within the region, that people would actually want to come and see. As it is impossible to hide the facility, the only option would be to promote it.

The facility will indeed be visible within an area that incorporates sensitive visual receptors, but the extent of visual exposure is limited, the number of visual receptors is very low and the visual quality of the immediate visual environment is compromised due to existing surface based mining activities. This has a mitigating effect on the visual impact.

There are not many options as to the mitigation of the visual impact of the core facility. No amount of vegetation screening or landscaping would be able to hide structures of these dimensions situated on this site.

The following is, however recommended:

- Internal access roads (where required) should be planned with due cognisance of the topography and the construction of roads should be undertaken with adequate drainage structures in place to forego potential erosion problems.

- Access roads and ancillary buildings and structures not required for the post-decommissioning use of the site should be removed and the scars ripped and rehabilitated during decommissioning.

- The preferred option (option 2a) for the power line, which follows an existing mine road (passes west of the large tailings dam), must be implemented.

- A lighting engineer must be consulted to assist in the planning, placement and specification of light fixtures for the facility and all ancillary infrastructure in order to reduce visual impacts associated with glare and light trespass. Mitigation measures include the following:

    - Shielding the sources of light by physical barriers (walls, vegetation, or the structure itself);
    - Limiting mounting heights of lighting fixtures, or alternatively using foot-lights or bollard level lights;
    - Making use of minimum lumen or wattage in fixtures;
    - Making use of down-lighters, or shielded fixtures;

- Making use of Low Pressure Sodium lighting or other types of low impact lighting.
- Making use of motion detectors on security lighting. This will allow the site to remain in relative darkness, until lighting is required for security or maintenance purposes.

- The construction phase, albeit temporary, and the construction site must be planned, managed and rehabilitated so as to reduce / minimise visual impact during the phase. Mitigation measures include the following:

    - Reduce the construction period through careful planning and productive implementation of resources.
    - Plan the placement of lay-down areas and any potential temporary construction camps in order to minimise vegetation clearing.
    - Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads.
    - Ensure that rubble, litter and disused construction materials are managed and removed regularly.
    - Ensure that all infrastructure and the site and general surrounds are maintained in a neat and appealing way
    - Reduce and control construction dust through the use of approved dust suppression techniques.
    - Restrict construction activities to daylight hours in order to negate or reduce the visual impacts associated with lighting.
    - Rehabilitate all disturbed areas, construction areas, road servitudes and cut and fill slopes to acceptable visual standards.

- Once the WEF plant has exhausted its life span, the main facility and all associated infrastructure not required for the post rehabilitation use of the site should be removed and all disturbed areas appropriately rehabilitated.

8. IMPACT STATEMENT

In light of the results and findings of the Visual Impact Assessment undertaken for the Proposed Koingnaas Wind Energy Facility, it is acknowledged that the views surrounding the site will be visually impacted upon for the entire operational lifespan (approximately 20 years) of the facility.

Of note is that the topographic disturbance (due to surface based mining activities) and visual clutter (as a result of mining related structures and infrastructure) in the immediate vicinity of the proposed WEF constitutes an existing visual impact. In this respect, the visual impact is somewhat ‘absorbed’ on the one hand, but contributes to the cumulative visual impact of industrial type infrastructure on the other.

The following is a summary of impacts remaining, assuming mitigation as recommended is exercised:

- The potential visual impact of the facility on users of secondary roads in close proximity to the proposed facility will be of **moderate** significance.
- The anticipated visual impact on residents of small towns in close proximity to the proposed facility will be of **moderate** significance.
- Within the greater region, the potential visual impact on sensitive visual receptors (i.e. users of roads and residents of small towns) will be of **low** significance.

- Potential visual impact on conservation areas, and specifically the Namaqua National Park will be of **low** significance.
- In terms of ancillary infrastructure, the anticipated visual impact of the workshop, maintenance and storage area, the office and internal access roads (where new roads are required) will be of **low** significance, while that of the power line will be of **moderate** significance..
- Similarly, visual impacts related to lighting will be of **low** significance.
- The anticipated visual impact of construction is also expected to be of **low** significance.
- In terms of secondary visual impacts, the significance of the anticipated impact on the visual character and sense of place of the region will be of **low** significance, as will the anticipated impact on tourist routes, tourist destinations and tourism potential.

The anticipated visual impacts listed above (i.e. post mitigation impacts) are not considered to be fatal flaws from a visual perspective, considering the relatively contained area of potential visual exposure, the low occurrence of visual receptors and the already transformed nature of the mining areas.

It is therefore recommended that the development of the facility as proposed be supported, subject to the implementation of the recommended mitigation measures (Chapter 6) and management actions (Chapter 8).

Furthermore, it is the opinion of the author that the anticipated visual impact is not likely to detract from the regional tourism appeal, numbers of tourists or tourism potential of the area. Receptors will be exposed to the proposed facility for a very short period of their journey, and it is unlikely that the facility will be visible from many tourist destinations..

9. MANAGEMENT PLAN

The management plan tables aim to summarise the key findings of the visual impact report and to suggest possible management actions in order to mitigate the potential visual impacts.

Table 11: Management plan – Planning.

OBJECTIVE: The mitigation and possible negation of visual impacts associated with the planning of the Proposed Koingnaas WEF.

Project component/s	WEF and ancillary infrastructure (i.e. workshop, maintenance and storage area, the office, internal access roads and power line).		
Potential Impact	Primary visual impact of the core facility due to the presence of the workshop, maintenance and storage area, the office, internal access roads and power line in the landscape as well as the visual impact of lighting at night.		
Activity/risk source	The viewing of the above mentioned by observers on or near the site as well as within the region.		
Mitigation: Target/Objective	Optimal planning of infrastructure so as to minimise visual impact.		
Mitigation: Action/control		Responsibility	Timeframe
Plan internal access roads with due cognisance of the topography.		Just Palm Tree Power / design consultant	Planning.
Consult a lighting engineer in the planning and placement of light fixtures for the turbines and the ancillary infrastructure.		Just Palm Tree Power / design consultant	Planning.
Performance Indicator	No ancillary infrastructure is apparent from surrounding areas and lighting impact is minimal.		
Monitoring	Not applicable.		

Table 12: Management plan – Construction.

OBJECTIVE: The mitigation and possible negation of visual impacts associated with the construction of the Proposed Koingnaas WEF.

Project component/s	Construction site.		
Potential Impact	Visual impact of general construction activities, and the potential scarring of the landscape due to vegetation clearing and resulting erosion.		
Activity/risk source	The viewing of the above mentioned by observers on or near the site.		
Mitigation: Target/Objective	Minimal visual intrusion by construction activities and intact vegetation cover outside of immediate works areas.		
Mitigation: Action/control		Responsibility	Timeframe
Reduce the construction period through careful planning and productive implementation of resources.		Just Palm Tree Power / contractor	Construction
Plan the placement of lay-down areas and temporary construction equipment camps in order to minimise vegetation clearing.		Just Palm Tree Power / contractor	Construction
Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads.		Just Palm Tree Power / contractor	Construction
Ensure that rubble, litter and disused construction materials are managed and removed regularly.		Just Palm Tree Power / contractor	Construction
Ensure that all infrastructure and the site and general surrounds are maintained in a neat and appealing way.		Just Palm Tree Power / contractor	Construction
Reduce and control construction dust through the use of approved dust suppression techniques.		Just Palm Tree Power / contractor	Construction
Restrict construction activities to daylight hours in order to negate or reduce the visual impacts associated with lighting.		Just Palm Tree Power / contractor	Construction
Rehabilitate all disturbed areas, construction areas, road servitudes and cut and fill slopes to acceptable visual standards.		Just Palm Tree Power / contractor	Construction
Performance Indicator	Vegetation cover on and in the vicinity of the site is intact with no evidence of degradation or erosion.		
Monitoring	Monitoring of vegetation clearing during construction. Monitoring of rehabilitated areas post construction.		

Table 13: Management plan – Operation.

OBJECTIVE: The mitigation and possible negation of visual impacts associated with the operation of the Proposed Koingnaas WEF.		
Project component/s	WEF and ancillary infrastructure (i.e. workshop, maintenance and storage area, the office, internal access roads and power line).	
Potential Impact	Visual impact of facility degradation and vegetation rehabilitation failure.	
Activity/risk source	The viewing of the above mentioned by observers on or near the site.	
Mitigation: Target/Objective	Well maintained and neat facility.	
Mitigation: Action/control	Responsibility	Timeframe
Maintain the general appearance of the facility in an aesthetically pleasing way.	Just Palm Tree Power / operator	Operation.
Monitor rehabilitated areas, and implement remedial action as and when required.	Just Palm Tree Power / operator	Operation.
Performance Indicator	Well maintained and neat facility with intact vegetation on and in the vicinity of the facility.	
Monitoring	Monitoring of rehabilitated areas.	

Table 14: Management plan – Decommissioning.

OBJECTIVE: The mitigation and possible negation of visual impacts associated with the decommissioning of the Proposed Koingnaas WEF.		
Project component/s	WEF and ancillary infrastructure (i.e. workshop, maintenance and storage area, the office, internal access roads and power line).	
Potential Impact	Visual impact of residual visual scarring and vegetation rehabilitation failure.	
Activity/risk source	The viewing of the above mentioned by observers on or near the site.	
Mitigation: Target/Objective	Infrastructure required for post decommissioning use of the site and rehabilitated vegetation in all disturbed areas.	
Mitigation: Action/control	Responsibility	Timeframe
Remove infrastructure not required for the post-decommissioning use of the site,	Just Palm Tree Power / operator	Operation.
Rip and rehabilitate access roads not required for the post-decommissioning use of the site.	Just Palm Tree Power / operator	Operation.
Monitor rehabilitated areas, and implement remedial action as and when required.	Just Palm Tree Power / operator	Operation.
Performance Indicator	Site with intact vegetation on and in the vicinity of the facility.	
Monitoring	Monitoring of rehabilitated areas.	

10. REFERENCES / DATA SOURCES

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