KAROO RENEWABLE ENERGY FACILITY

VISUAL IMPACT ASSESSMENT

Produced for:
South African Renewable Green Energy (Pty) Ltd (SARGE)

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CONTENTS

MAPS

FIGURES

TABLES

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 Karoo Renewable Energy Facility. Neither the author, MetroGIS or V&L Landscape Architects will benefit from the outcome of the project decision-making.

1. INTRODUCTION

South African Renewable Green Energy (Pty) Ltd (SARGE) is proposing the establishment of a Renewable Energy Facility about 34km south of Victoria West. The site under investigation straddles the provincial boundary between the Western Cape and the Northern Cape.

The proposed facility includes the generation of wind energy and solar energy. Both wind energy generation, or wind farming as it is commonly referred to, and solar generated energy, are considered to be environmentally friendly electricity generation options.

SARGE intends to construct up to 150 wind turbines and an array of photovoltaic (PV) panels over an identified area of approximately 200km^2. The proposed facility would have a generating capacity of up to 500MW. Each component would have the following generation capacities:

- Individual **wind turbines** with a generating capacity of up to 3MW each;
- **Photovoltaic (PV) panels** with a total generating capacity of up to 50MW.

A preliminary layout of the facility main infrastructure (i.e. the wind turbines and photovoltaic plant) is shown on **Map 1**. The layout of supplementary infrastructure has not been finalised, but will include the following:

- Two **on-site substations**, each of which has two alternative routes for the power line, as follows:

  - Substation 1 Option 1: Located in close proximity and north east of the existing Biesiespoort Substation, with an immediate turn-in line to the Hutchinson/Biesiespoort 1132 kV line.
  - Substation 1 Option 2: Located in close proximity and north east of the existing Biesiespoort Substation, with an overhead powerline linking it to the Biesiespoort Substation.
  - Substation 2 Option 1: Located close to the eastern corner of the proposed site, with an immediate turn-in line to the Droerivier-Hydra 2 400 kV power line.
  - Substation 2 Option 2: Located close to the eastern corner of the proposed site with an overhead line running adjacent and parallel to the existing Droerivier-Hydra 2 line linking it to the existing Victoria Substation.
- **Foundations** to support both the turbine towers as well as the PV panels;
- **Cabling** between the project components, to be lain underground where practical;
- **Internal access roads**; and
- A **workshop / lay down area** for maintenance and storage.

It is expected, from a visual impact perspective, that the wind turbines (up to 150 turbines may be constructed) would constitute the highest potential visual impact of the facility.

Each wind turbine is expected to consist of a concrete foundation, a steel tower, a hub (placed at approximately 125m above ground level) and three 55m long blades attached to the hub. Variations of the above dimensions may occur, depending on the preferred supplier or commercial availability of wind turbines at the time of construction.

Photovoltaic technology is used to generate electricity by converting solar radiation into direct current electricity using semiconductors (i.e. silicon) through the photovoltaic effect. PV technology refers to the use of multiple PV cells which are linked together to form PV panels. The proposed PV panels will have a tracking functionality which will allow them to follow the movement of the sun during the day.

Figure 1 shows a scaled model of the proposed turbines, and **Figure 2** shows PV panels similar to that which will be employed in the Karoo Renewable Facility. Actual panel size and field layout may differ as a result of site specifics.

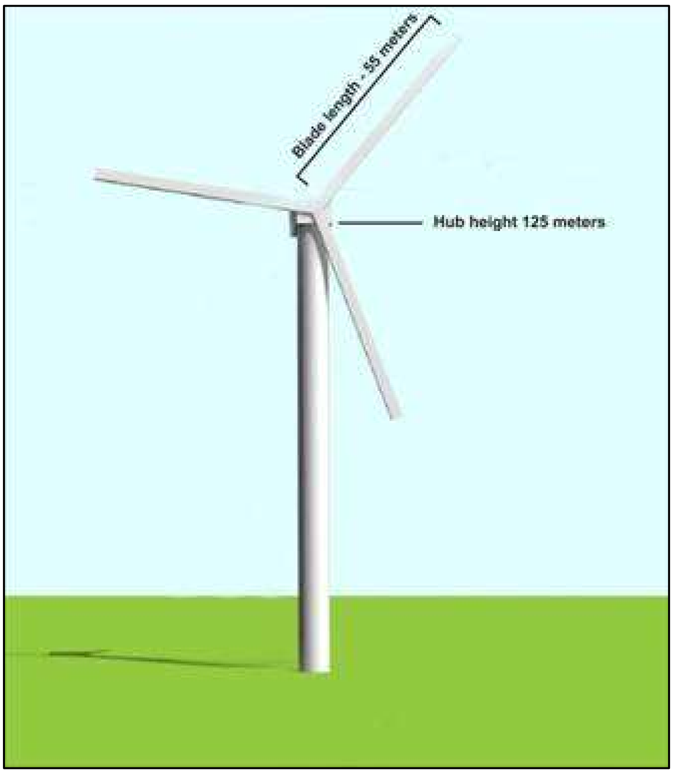
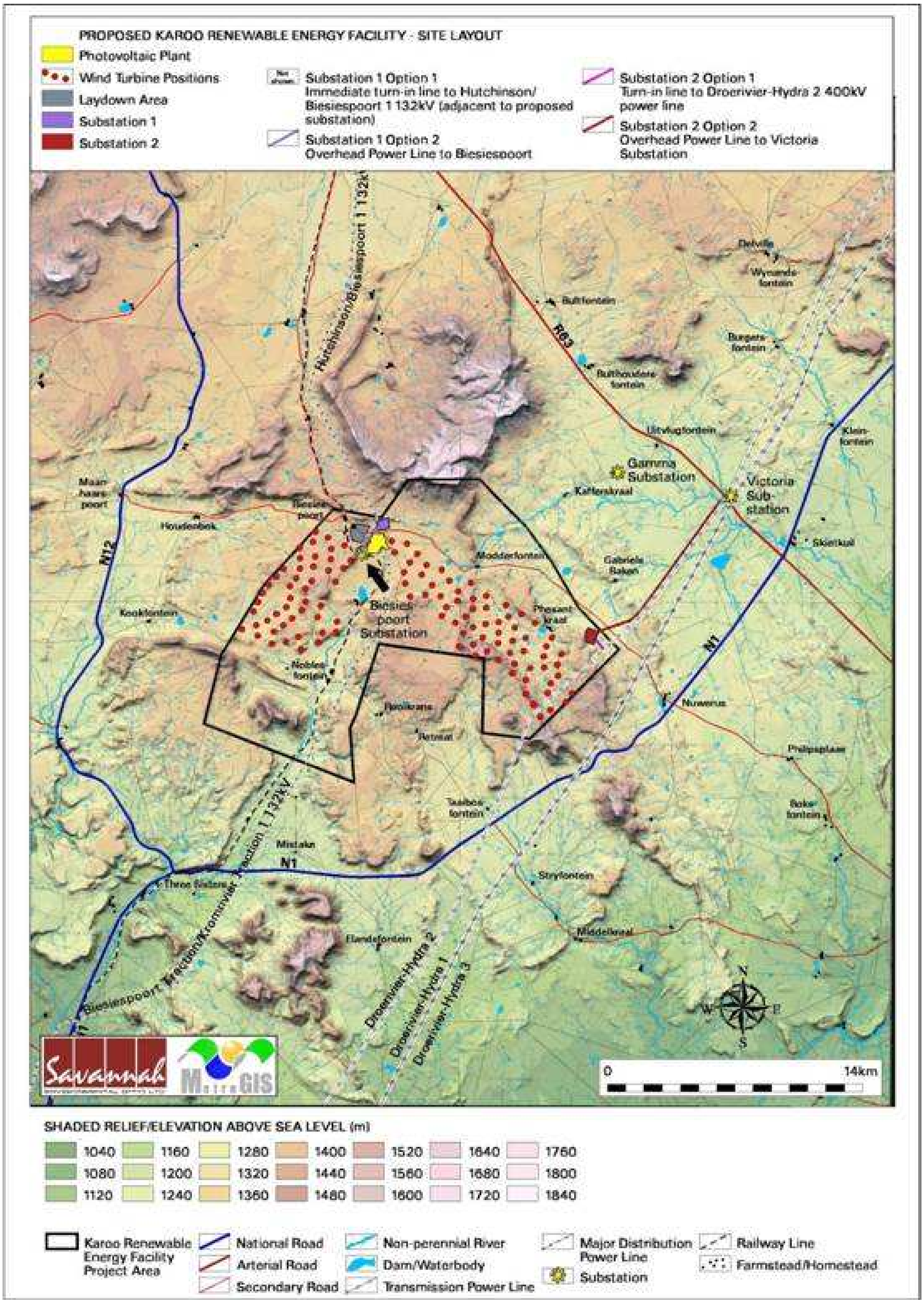


Figure 1: Scaled model of typical wind turbines

Figure 2: Photograph of typical Photovoltaic panels



Map 1: Locality map and proposed layout of the facility showing the proposed WEF and PV Plant locations as well as shaded relief (topography and elevation above sea level).

2. SCOPE OF WORK

The study area for the visual assessment encompasses a geographical area of 2434km² (the extent of the maps displayed below) and includes a minimum 20km buffer zone from the proposed development area.

National roads that traverse the area include the N12 and the N1. The R63 arterial route bypasses the site in the north east, and 4 lower order secondary roads traverse the area. A railway line runs through the western half of the site in a north south direction.

The area does not include any urban centre, but does host a number of scattered settlements and homesteads.

Industrial infrastructure includes several transmission and major distribution power lines (running in a north south direction) as well as three distribution substations.

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.

In this regard, specific issues related to the visual impact were identified during the Scoping phase, and verified during a site visit to the affected environment. These issues related include the following:

- The visibility of the facility to, and potential visual impact on observers travelling along the national roads (N1 and N12), arterial routes (R63) and secondary roads in close proximity to the proposed facility as well as within the region.
- The visibility of the facility to, and visual impact on settlements and homesteads on and in close proximity to the proposed facility (i.e. including *Noblesfontein, Modderfontein, Phesantkraal, Biesiespoort and Gabriels Baken)* as well as within the region.
- The potential impact of the facility on the visual character or sense of place of the region, with specific reference to the tourist routes (N1 and N12) and potential tourist destinations.
- The potential visual impact of ancillary infrastructure (i.e. the substations, associated power lines, internal access roads etc.) on observers in close proximity to the proposed facility.
- The potential visual impact of operational, safety and security lighting of the facility at night on observers residing on observers on and in close proximity to the proposed facility site.
- The potential visual impact of shadow flicker on observers on and in close proximity to the proposed facility.
- Potential cumulative visual impacts.
- Potential residual visual impacts after the decommissioning of the facility.
- The visual absorption capacity of the natural vegetation (if applicable).
- Potential visual impacts associated with the construction phase.
- The potential to mitigate visual impacts and inform the design process.

3. 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.

Site visits were undertaken to source information regarding land use, vegetation cover, topography and general visual quality of the affected environment. It further served the purpose of verifying the results of the spatial analyses and to identify other possible mitigating/aggravating circumstances related to the potential visual impact.

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 solar facility and associated infrastructure were not visible, no impact would occur.

  Viewshed analyses of the proposed solar facility and the related infrastructure, based on a 20 m interval digital terrain model of the study area, 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 each type of structure.

  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 solar facility 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 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 were further analysed in terms of the previously mentioned issues (related to the visual impact) and in order to judge the severity of each impact.

4. THE AFFECTED ENVIRONMENT

The project is proposed on portions of the following farms:

- Noblesfontein 227 (Northern Cape);
- Annex Noblesfontein 234 (Northern Cape);
- Ezelsfontein 235 (Northern Cape);
- Rietkloofplaaten 239 (Northern Cape);
- Modderfontein 228 (Northern Cape) and
- Phaisantkraal 1 (Western Cape).

The first five farms fall within the Pixley ka Seme District Municipality (Northern Cape), while the last mentioned falls within the Central Karoo District Municipality (Western Cape).

The farm portions are located approximately 34 km south of Victoria West, 77km north-east of Beaufort West, and about 70km from Richmond.

The proposed development site encompasses a surface area of approximately 200km^2. The final surface area to be utilised for the facility would be smaller (less than 2% of the site), with the footprint of disturbance depending on the final site layout and the placement of the wind turbines, PV Plant and ancillary infrastructure.

National roads that traverse the area include the N12 to the west of the site (linking Victoria West and Beaufort West) and the N1 to the south east of the site (linking Richmond and Beaufort West). The R63 arterial route bypasses the site in the north east, and a number of lower order secondary roads traverse the area, with one running across the northern part of the site. See **Map 1**.

The study area occurs on land that ranges in elevation from 1040m in the south west to 1840m (at the top of the hills). The topography is classed as *lowlands with mountains*.

The terrain surrounding the site is mostly flat, but frequently interrupted with clusters of prominent hills or *inselbergs*. The well known tourist attraction and landmark known as the Three Sisters is in fact a cluster of such hills, and is located about 12km south of the site.

Some of the upper tributaries of the Sout River originate in the study area. These originate to the west of the site close to the N12 and flow southwards. Similarly, the upper origins of the Buffel River originate to the east of the site and flow southwards. Refer to **Map 1**.

In addition to the natural hydrology discussed above, a number of smaller farm dams occur on the site and within the surrounding area.

The region experiences arid climatic conditions, with about 155mm precipitation per year.

Land cover is dominated by *shrubland*, with some *thicket, bushland and bush clumps* along the drainage lines. Small, isolated pockets of irrigated agriculture also occur within the study area.

Karroid broken veld is the dominant vegetation type in the study area, becoming *false upper karoo* in the north, with very limited disturbance. Refer to **Map 2.**

No conservation areas are present in the study area.

Of significance is the presence of identified *'tall hills and mountains'* within the boundaries of the site. These steep slope faces have an elevated nature and inherent scenic quality, rendering them visually sensitive.

The main economic activity in this rural environment is livestock farming. The towns of Victoria West, Beaufort West and Richmond (located outside of the actual study area) account for the highest population concentrations within the region, which has an average of 1,6 persons per km^2.

The study area itself consists of a landscape of wide-open expanses and minimal development. Exceptions occur where transmission power lines traverse the study area. These include the Biesiespoort Traction / Kromrivier Traction 1 132 kV line running through the site, the Droerivier-Hydra lines (1, 2 and 3) to the east of the site and the Hutchinson / Biesiespoort 1 132 kV line running north.

The photographs below show the area identified for the Karoo Renewable facility footprint and gives a good indication of the wide-open expanse and unrestricted vistas afforded by the terrain.

Figure 3: Photograph of the proposed site in the medium distance indicating the visual quality of the receiving environment.

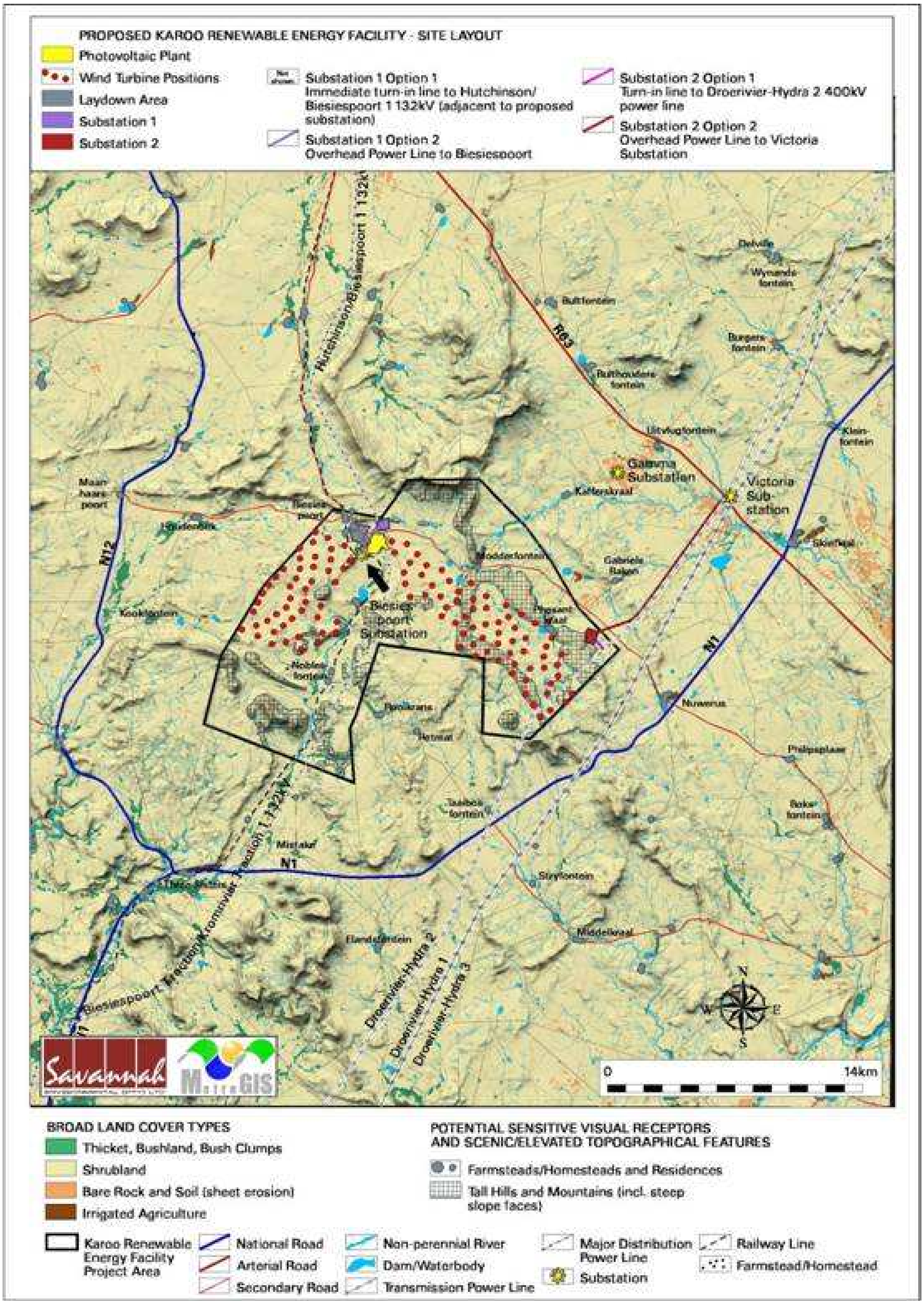
Figure 4: Typical natural vegetation of the receiving environment.

Figure 5: Typical settlement or homestead occurring within the study area.

Figure 6: Existing overhead power line infrastructure to the south-east of the proposed site.

Figure 7: The Victoria Substation to the north-east of the site, adjacent to the R63.

Sources: DEAT (ENPAT Northern and Western Cape), NBI (Vegetation Map of South Africa, Lesotho and Swaziland) and NLC2000 (ARC/CSIR).



Map 2: Land types and vegetation cover of the broader study area [1].

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[1] Note that this map also indicates outstanding topographical features such as tall hills and mountains (including steep slope faces) that are rated sensitive due to their elevated nature and inherent scenic quality.

5. RESULTS

5.1 Potential visual exposure

The visibility analysis was undertaken from actual positions as set out in the provisional layout of the facility. Separate viewsheds were generated for the wind turbines (set at 125m above average ground level - the approximate hub heights of the proposed turbines) and the PV plant (set at 6m above average ground level – the maximum height of the proposed PV panels).

Wind Turbines:

The result of the viewshed analysis for the proposed turbine layout is shown on **Map 3**.

This 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. 95-113 turbines may be visible), while the light yellow areas represent a low frequency (i.e. 1-9 turbines may be visible).

It is clear from the viewshed analysis that the turbines would be exposed to a large geographical area within this region. This is a result of the proposed facility's location on an elevated site within a relatively flat surrounding topography.

It is anticipated that the turbines will be visible with a high frequency of visibility on most of the site itself, as well as immediately adjacent areas to the west, north east and south. Areas to the south west, south east and the north appear to be somewhat screened from visual impact by topography.

Similarly exposed areas likely to experience a high frequency of visual exposure include zones to the north west, north east, and to a lesser extent, to the south. Of relevance is the high level of visual exposure from steep slopes facing in the direction of the site.

The turbines will be visible with a lower frequency of exposure from large, but discontinuous areas in most directions, but particularly to the west, south, north east and east of the site. These visually exposed areas are broken by the hilly topography.

The turbines will also be visible (with a lower frequency) from discontinuous sections of the N1 and the N12. The R63 will be exposed to higher frequencies of visual exposure where it bypasses closest to the site.

The facility will be visible from almost the entire section of secondary road linking the N1 and N12, running below the escarpment. The other secondary roads within the study area will be visually exposed in limited sections, and at a lower frequency of exposure.

In addition, settlements and homesteads, especially those within a 10km radius (and including those within the site itself) will be visually exposed, with a low to moderate frequency of exposure.

Within the visually exposed areas, it is envisaged that the nature of the structures, the largely natural state of the environment and the rural character of the study area would result in a significant visual contrast within the receiving environment.

The turbine structures would be easily and comfortably visible, especially within a 5km radius of the facility, and would constitute a high visual prominence, potentially resulting in a high visual impact.

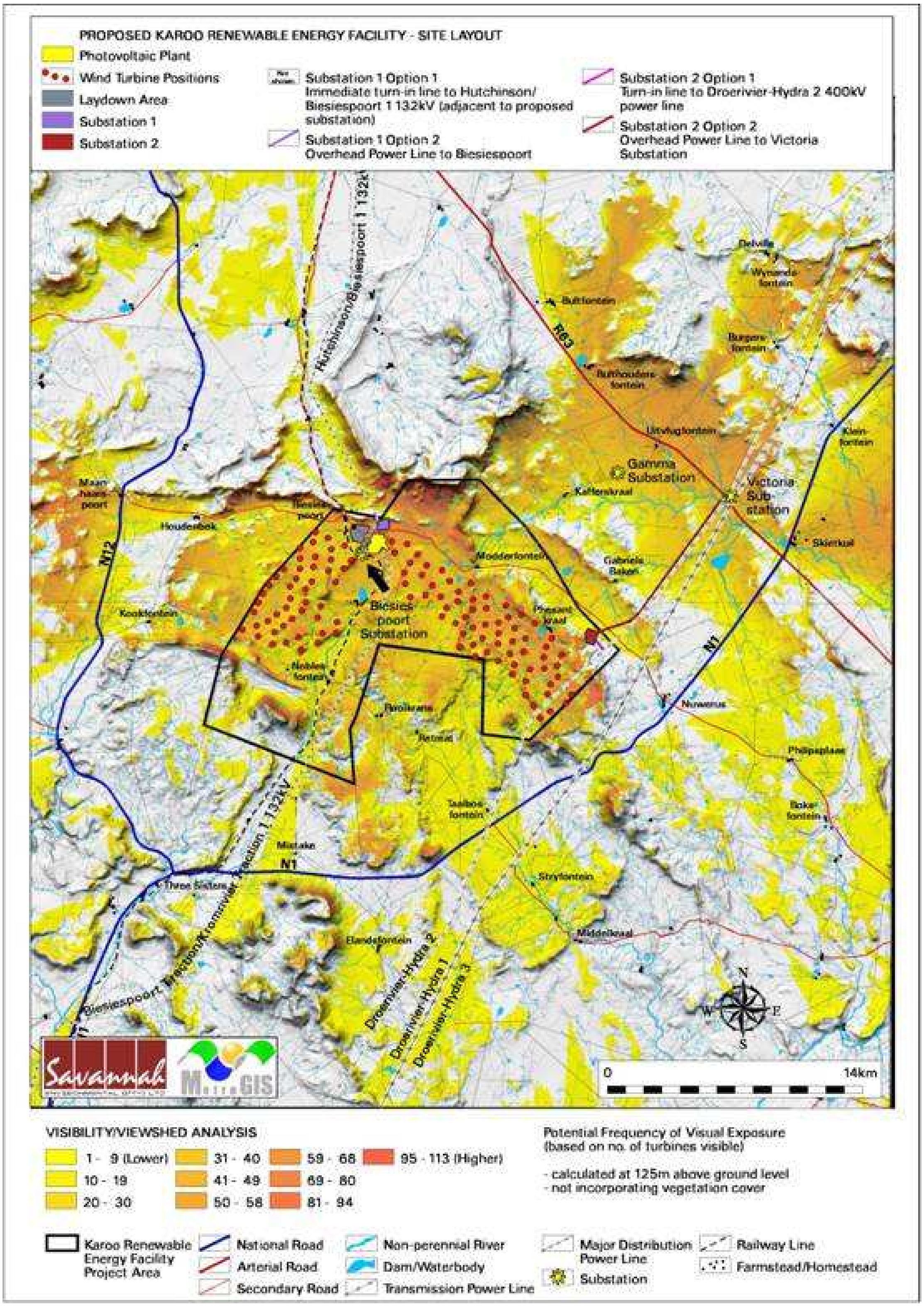
Photovoltaic Plant:

The result of the viewshed analysis for the proposed PV Plant is shown on **Map 4**.

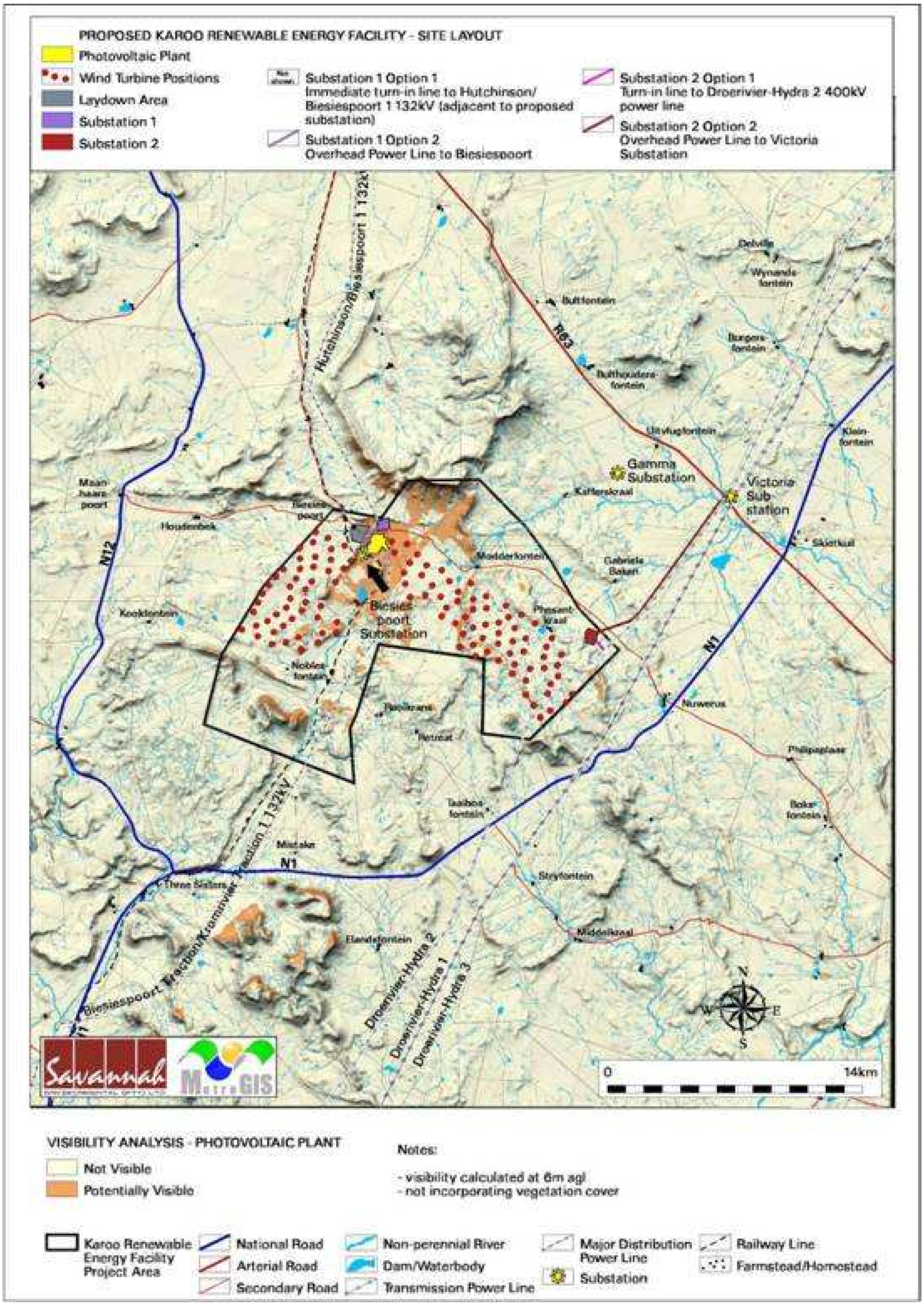
This viewshed analysis indicates areas from which the proposed plant would be visible. It is clear from the analysis that the PV plant would be visually exposed to small, contained areas, predominantly within the site itself, as well as from the south facing slopes of the escarpment to the immediate north west.

An isolated zone to the south includes a number of visually exposed areas situated on the steep slopes facing in the direction of the site. This is some distance from the site, however (i.e. 6km).

The turbines represent the most visually prominent aspect of the proposed facility, and when their potential viewshed area (Map 3) is compared with that of the PV plant (Map 4), it is clear that the PV plant will fall within, and be covered by the viewshed of the turbines.



Map 3: Potential visual exposure of the proposed turbines.



Map 4: Potential visual exposure of the proposed PV plant.

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 or solar energy facilities.

Because the turbine structures represent the most visually prominent aspect of the proposed facility, the proximity radii for a Wind Energy Facility have been applied. These proximity radii (calculated from the boundary lines of the farms) are shown on **Map 5** and are as follows:

- 0 - 5 km - Short distance view where the facility would dominate the frame of vision and constitute a very high visual prominence.
- 5 - 10 km - Medium distance views where the facility would be easily and comfortably visible and constitute a high visual prominence.
- 10 - 20 km - 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 20 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 national and arterial roads (i.e. the N12, N1 and R63) as well as the secondary roads within the study area (i.e. especially the gravel road running to the north of the facility, linking the N1 and N12 highways). Commuters and tourists using these roads could be negatively impacted upon by visual exposure to the Facility.

Other than along the above roads, viewer incidence within a 10 km radius of the proposed Facility is concentrated in a number of settlements and homesteads.

The remaining areas consist predominantly of vacant natural land (grazing) and rural settlements and homesteads with a low occurrence of observers.

During the scoping phase of this project, contact was made with numerous interested and affected parties, particularly residents. Throughout this interaction, both local communities and local viewer perception of the proposed facility was found to be neutral[2].

Tourists travelling through the area are seen as possible sensitive visual receptors upon which the construction of the proposed facility could have a negative visual impact. Specific reference is made to the Three Sisters koppies, visible from the national road, and which represent a visual landmark and tourist attraction in the area. The severity of the visual impact on these receptors decreases with increased distance from the proposed facility.

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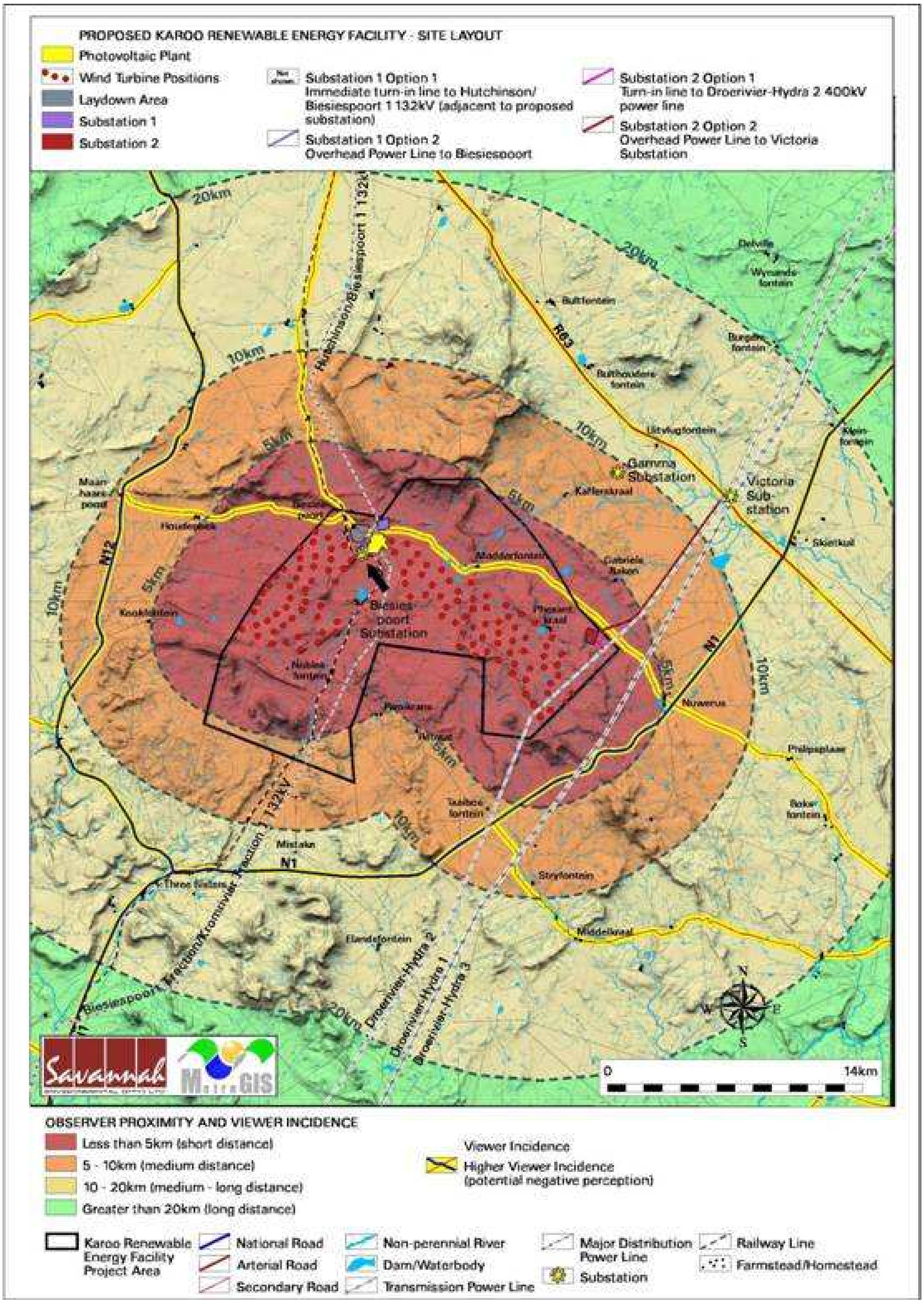
[2] This perception was confirmed by Public Participation Facilitator, Ingrid Snyman from *Batho Earth* (Personal Communication).



Map 5: Observer proximity to the proposed facility and areas of high viewer incidence.

5.4. Visual Absorption Capacity of the natural vegetation

The vegetation present in the study area surrounding the facility (predominantly *Shrubland)* is on average only 2 m high. *Thicket, Bushland and Bush Clumps* is mostly limited to the drainage lines. This, coupled with the dimensions of the proposed facility, implies that the Visual Absorption Capacity (VAC) is low to negligible for virtually the entire study area.

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 visual impact index map clearly indicates the core area of potentially **high** visual impact within a 5km radius of the proposed Facility.

Potential areas of **very high** visual impact within the 5km radius include almost the entire length of the gravel road joining the N1 and N12 (running below the escarpment and north of the facility as well as the '*tall hills and mountains'* on and adjacent to the site.

In addition, the following settlements and homesteads are likely to experience very high visual impact:

- Biesiespoort (on the site);
- Modderfontein (on the site);
- Phesantkraa (on the site);
- Gabriels Baken (north east of the site) and
- Noblesfontein (on the site).

Limited stretches of the N1, N12 and other secondary roads between 5km and 10km from the Facility are likely to experience a **high** visual impact due to the higher frequency of observers travelling along these roads.

It is important to note that the above national roads function as important national and provincial tourist access routes, and as such carry tourists into and through the region.

Visually exposed '*tall hills and mountains,'* as well as settlements and homesteads between 5km and 10km of the proposed development, are also likely to experience high visual impact. The latter include the following:

- Kafferskraal;
- Strydfontein;
- Taaibosfontein;
- Retreat;
- Rooikrans;
- Kookfontein and

- Maanhaarspoort

Between 10km and 20km from the proposed facility, potential visual impacts are expected to be **moderate** within visually exposed settlements and homesteads, including the following:

- Bultfontein;
- Bulthoudersfontein;
- Uitvlugfontein;
- Skietkuil;
- Philipsplaas and
- Elandsfontein.

Limited stretches of the N1 and the N12, as well as very short stretches of secondary roads will also experience moderate visual impact.

Remaining impacts, where they occur at all, are expected to be **low** to **very low**.

It is, however, important to note the rugged beauty of the area, especially the wide open vistas, expanses and distinct koppies (the Three Sisters cluster of koppies is a local tourist attraction and landmark visible from the national road). This gives the area an inherent tourism potential, albeit one that has not yet been realised or optimised.

The construction of the turbines (and to a lesser degree the PV plant) in close proximity to features of natural beauty is likely to result in a negative visual impact on the natural scenic beauty of the area, and in fact of the region, which remains largely undeveloped and natural.

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

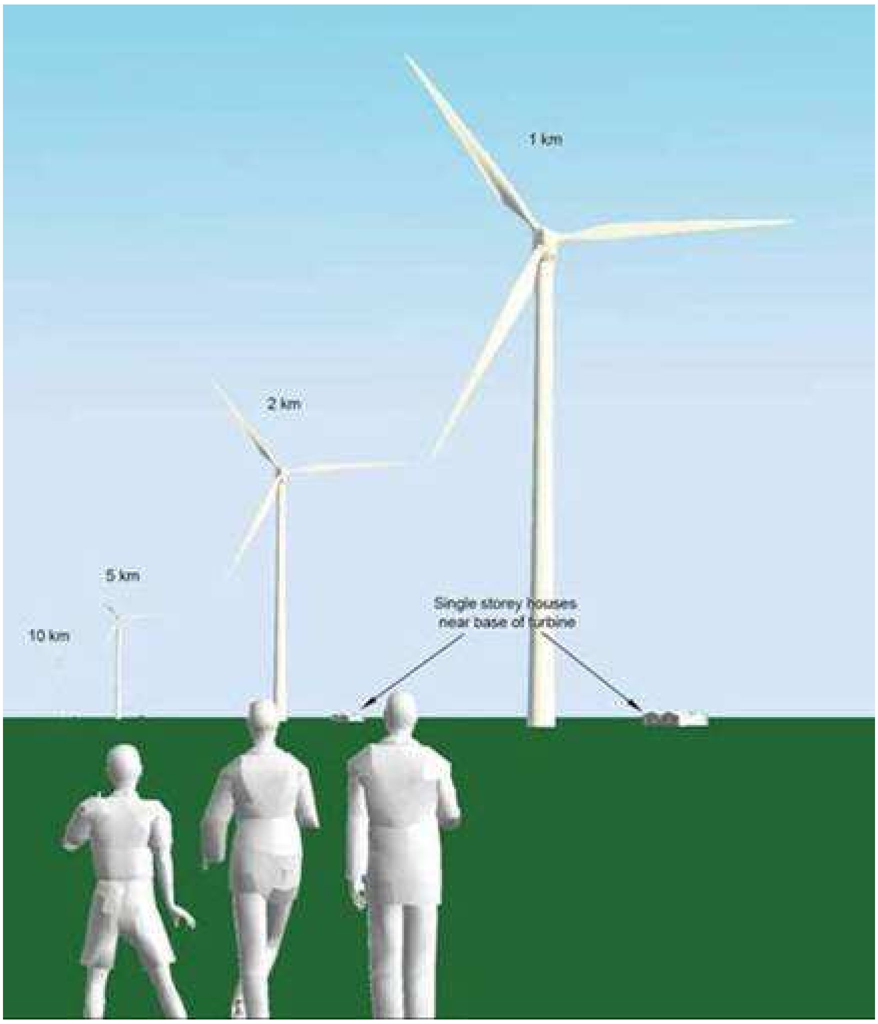
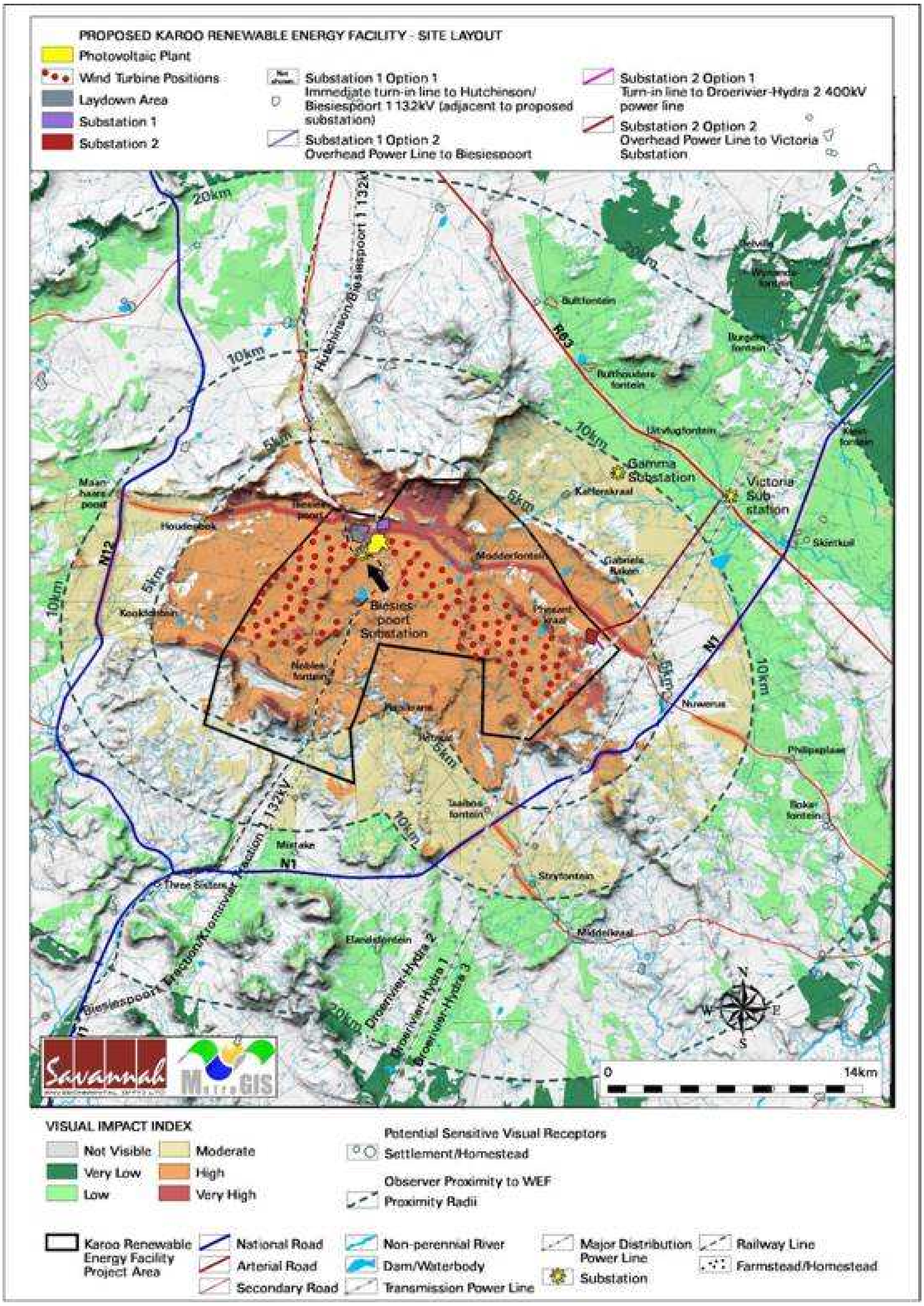


Figure 8: Visual experience of a wind turbine structure at a distance of 1km, 2km, 5km and 10km.



Map 6: Visual impact index of the proposed facility.

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 solar facility) 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 (= 1), low (= 2), medium/moderate (= 3), high (= 4) and very high (= 5)
- **Probability** - none (= 0), improbable (= 1), low probability (= 2), medium probability (= 3), high probability (= 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.*

No mitigation measures (e.g. painting the structures a sky blue colour) is proposed as the colour scheme and lighting fixtures are legally required by the Civil Aviation Authority and cannot be altered.

5.7 Visual impact assessment: primary impacts

5.7.1 The Turbines and PV Plant

Potential visual impact on users of national, arterial and secondary roads in close proximity to the facility.

Potential visual impact on users of major and secondary roads in close proximity to the proposed facility (i.e. within 5km) is expected to be **high** both before and after mitigation.

The table below illustrates this impact assessment.

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

Nature of Impact: Potential visual impact on users of national, arterial and secondary roads in close proximity to the facility		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	Very high **(10)**	Very high **(10)**
Probability	High **(4)**	High **(4)**
Significance	High **(72)**	High **(72)**
Status (positive, neutral or negative)	Negative	Negative
Reversibility	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No
Can impacts be mitigated	No	No
Mitigation: Planning: Decommissioning: removal of the wind turbines, PV plant and ancillary infrastructure after 20 to 30 years.		
Cumulative impacts: The construction of 150 wind turbines, the PV plant, the substations and other associated infrastructure will increase the cumulative visual impact of electricity related infrastructure within the region. This is relevant in light of the existing power line infrastructure already present in the area, albeit limited in extent and scale.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

Potential visual impact on residents of settlements and homesteads on and in close proximity to the facility.

The visual impact of the proposed facility on settlements and homesteads within 5km of the site is expected to be of **high** significance both before and after mitigation.

The table below illustrates this impact assessment.

Table 2: Impact table summarising the significance of visual impacts on residents of settlements and homesteads in close proximity to the facility.

Nature of Impact: Potential visual impact on residents of settlements and homesteads in close proximity to the facility		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	Very high **(10)**	Very high **(10)**
Probability	High **(4)**	High **(4)**
Significance	High **(72)**	High **(72)**
Status (positive or negative)	Negative / Positive	Negative / Positive
Reversibility	Recoverable **(3)**	Recoverable **(3)**
Irreplaceable loss of resources?	No	No
Can impacts be mitigated during operational phase?	No	No
Mitigation: Planning: Decommissioning: removal of the wind turbines, PV plant and ancillary infrastructure after 20 to 30 years.		
Cumulative impacts: The construction of 150 wind turbines, the PV plant, the substations and other associated infrastructure will increase the cumulative visual impact of electricity related infrastructure within the region. This is relevant in light of the existing power line infrastructure already present in the area, albeit limited in extent and scale.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

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

The visual impact users of roads and on residents of settlements and homesteads within the region (i.e. beyond the 5km radius) is expected to be of **moderate** significance both before and after mitigation.

The table below illustrates this impact assessment.

Table 3: Impact table summarising the significance of visual impacts on sensitive visual receptors (users of roads and residents of settlements and homesteads) within the region

Nature of Impact: Potential visual impact on sensitive visual receptors (users of roads and residents of settlements and homesteads)within the region		
	No mitigation	***Mitigation considered***
Extent	Regional **(3)**	Regional **(3)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	High **(8)**	High **(8)**
Probability	Probable **(3)**	Probable **(3)**
Significance	Moderate **(45)**	Moderate **(45)**
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: Decommissioning: removal of the wind turbines, PV plant and ancillary infrastructure after 20 to 30 years.		
Cumulative impacts: The construction of 150 wind turbines, the PV plant, the substations and other associated infrastructure will increase the cumulative visual impact of electricity related infrastructure within the region. This is relevant in light of the existing power line infrastructure already present in the area, albeit limited in extent and scale.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

5.7.2 Ancillary infrastructure

Potential visual impact of the substations on observers in close proximity to the facility.

The two substations could represent a potential visual impact - areas of vegetation will need to be removed for these structures, which are in essence industrial type structures in a natural environment.

Although no dedicated viewshed has been generated for the substations, these structures will all be located within the proposed WEF development footprint, and will be overshadowed by the much taller wind turbine structures. The proposed substations are also either close to existing subs (Biesiespoort) or to transmission power lines.

It is thus expected that the area of potential visual exposure will lie within that of the turbines.

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

Table 4: Impact table summarising the significance of visual impact of the substations.

Nature of Impact: Potential visual impact of the substations		
	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: Decommissioning: removal of the wind turbines, PV plant and ancillary infrastructure after 20 to 30 years.		
Cumulative impacts: The construction of 150 wind turbines, the PV plant, the substations and other associated infrastructure will increase the cumulative visual impact of electricity related infrastructure within the region. This is relevant in light of the existing power line infrastructure already present in the area, albeit limited in extent and scale.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

Potential visual impact of the power lines on observers in close proximity to the facility.

There are two power line options for linking each of the two substations to the grid.

No dedicated viewshed has been generated for the power line alternatives. However, for all options, those sections of the alignment within the proposed WEF development footprint will be overshadowed by the taller wind turbine structures. It is thus expected that the area of potential visual exposure will lie within that of the turbines.

The only exception to this is power line **substation 2, option 2**, which links with the Victoria Substation some 12km to the north east of the site. This option does follow an existing distribution power line corridor (Droerivier – Hydra 2), but being a transmission line, will include taller and larger infrastructure than that of the existing distribution power line.

A comparison of the visual impactions of the 4 alternatives is based primarily on the extent (length) of the new power line infrastructure required.

In this respect, **substation 1, option 1** for and **substation 2, option 1** are favoured, as these entail only short stretches of power line. Both of these options are favoured from a visual perspective.

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

Table 5: Impact table summarising the significance of visual impact of the power lines

Nature of Impact: Potential visual impact of the power lines.		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	Low **(4)**	Low **(4)**
Probability	Improbable **(2)**	Improbable **(2)**
Significance	Low **(24)**	Low **(24)**
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: Selection of alignment option1 for substations 1 and 2. Decommissioning: removal of the wind turbines, PV plant and ancillary infrastructure after 20 to 30 years.		
Cumulative impacts: The construction of 150 wind turbines, the PV plant, the substations and other associated infrastructure will increase the cumulative visual impact of electricity related infrastructure within the region. This is relevant in light of the existing power line infrastructure already present in the area, albeit limited in extent and scale.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

Potential visual impact of the internal access roads on observers in close proximity to the facility.

Within the facility's footprint, access roads will be required, firstly to construct each turbine and the PV plant (construction phase), and secondly to maintain the turbines and PV plant (operational phase).

This network of roads has the potential of manifesting as a network of landscape scarring, and thus a potential visual impact within the viewshed areas. This is especially relevant for steep slopes where cut and fill is required to build access roads to turbines located in high lying areas and on steep slopes. This has the potential to be a significant visual intrusion within the landscape.

The layout and construction of the internal access roads in sympathy with the topography, to avoid unnecessary cut and fill, will go far to ameliorate this potential visual impact.

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 6: Impact table summarising the significance of visual impact of the internal access roads.

Nature of Impact: Potential visual impact of the internal access roads.		
	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: • • Layout and construction of roads and infrastructure with due cognisance of the topography. Construction: rehabilitation. Decommissioning: ripping and rehabilitation of the road and servitude.		
Cumulative impacts: The construction of access roads will increase the cumulative visual impact of disturbance due to vegetation clearing and disturbance within the region.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

5.7.3. Lighting

Potential visual impact of lighting at night on observers in close proximity to the facility.

The area earmarked for the placement of the substations will be within the development footprint. Although the surrounding area has a relatively low incidence of populated places, light trespass and glare from the security and after-hours operational lighting (flood lights) for the substations will have some significance for residents in the area.

Another source of glare light, albeit not as intense as flood 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 facility is not required to have a light fitted to each turbine, but it is compulsory to have synchronous flashing 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 facility 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 lighting for the facility by a lighting engineer. The correct specification and placement of lighting and light fixtures for the turbines, the substations and other ancillary infrastructure will go far to contain rather than spread the light.

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 at night on observers in close proximity to the facility.

Nature of Impact: Potential visual impact of lighting at night on observers in close proximity to the facility.		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	Moderate **(6)**	Moderate **(6)**
Probability	High **(4)**	Improbable **(2)**
Significance	Moderate **(56)**	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 lighting design and planning Decommissioning: removal of the wind turbines, PV plant and ancillary infrastructure after 20 to 30 years.		
Cumulative impacts: The construction of 150 wind turbines, the PV plant, the substations and other associated infrastructure will increase the cumulative visual impact of electricity related infrastructure within the region. This is relevant in light of the existing power line infrastructure already present in the area, albeit limited in extent and scale.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

5.7.4. Shadow Flicker

Potential visual impact of shadow flicker on visual receptors in close proximity to the facility.

Shadow flicker occurs when the sky is clear, and when the rotor blades of a wind turbine are between the sun and the receptor (i.e. when the sun is low). As the rotor blades move, the receptor will experience a flicker of light and shadow as the blades pass in front of the sun. This flicker of shadow and light could be experienced as disturbing and irritating.

De Gryse in Scenic Landscape Architecture (2006) found that "*most shadow impact is associated with 3-4 times the height of the object*". Based on this research, a 500m buffer along the edge of the facility is submitted as the zone within which there is a risk of shadow flicker occurring.

The preliminary layout for the turbines indicates that the settlements of Phesantkraal and Biesiespoort fall within this zone, and could thus experience shadow flicker during limited periods.

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

Table 8: Impact table summarising the significance of visual impact of shadow flicker on visual receptors in close proximity to the facility

Nature of Impact: Potential visual impact of shadow flicker on visual receptors in close proximity to the facility		
	No mitigation	***Mitigation considered***
Extent	Local **(4)**	Local **(4)**
Duration	Long term **(4)**	Long term **(4)**
Magnitude	Minor **(2)**	None **(0)**
Probability	Improbable **(2)**	Very improbable **(1)**
Significance	Low **(20)**	Low **(18)**
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: Relocation of turbines to beyond 500m from any settlement, homestead or public road. Decommissioning: removal of the wind turbines, PV plant and ancillary infrastructure after 20 to 30 years.		
Cumulative impacts: The construction of 150 wind turbines, the PV plant, the substations and other associated infrastructure will increase the cumulative visual impact of electricity related infrastructure within the region. This is relevant in light of the existing power line infrastructure already present in the area, albeit limited in extent and scale.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

5.7.5. Construction

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

The duration of the construction phase of the facility is dependent on the number of turbines being constructed as well as the scale and extent of the proposed PV plant. During the construction period, 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.

Mitigation entails proper management of the construction site to forego residual visual impacts. The following principles are of relevance:

- Reduce the construction period through careful planning and productive implementation of resources.
- Plan the placement of lay-down areas and 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.

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

Nature of Impact: Potential visual impact of construction on visual receptors in close proximity to the 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	High **(4)**	Improbable **(2)**
Significance	Moderate **(44)**	Low **(18)**
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:

Construction:

- Reduce the construction period through careful planning and productive implementation of resources.
- Plan the placement of lay-down areas and temporary construction camps in order to minimise visual impact.
- Restrict the activities and movement of construction workers and vehicles to the immediate construction site.
- 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 (if possible) in order to negate or reduce the visual impacts associated with lighting.

Cumulative impacts:

The construction of 150 wind turbines, the PV plant, the substations and other associated infrastructure will increase the cumulative visual impact of electricity related infrastructure within the region. This is relevant in light of the existing power line infrastructure already present in the area, albeit limited in extent and scale.

Residual impacts:

None. The visual impact will be removed after decommissioning.

5.8 Visual impact assessment: secondary impacts

5.8.1 The Turbines and PV Plant

Potential visual impact of the proposed facility on visual character and sense of place within 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 area and the wide open vistas and expanses.

The anticipated visual impact of the facility on the regional visual character, and by implication, on the sense of place, is expected to be **moderate**.

The table below illustrates this impact assessment.

Table 10: Impact table summarising the significance of visual impacts on visual character and sense of place within the region.

Nature of Impact: Potential visual impact of the proposed facility on visual character and sense of place within the region		
	No mitigation	***Mitigation considered***
Extent	Regional **(3)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Moderate **(6)**	N/a
Probability	Probable **(3)**	N/a
Significance	Moderate **(39)**	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 to 30 years.		
Cumulative impacts: The construction of 150 wind turbines, the PV plant, the substations and other associated infrastructure will increase the cumulative visual impact of electricity related infrastructure within the region. This is relevant in light of the existing power line infrastructure already present in the area, albeit limited in extent and scale.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

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

The aesthetic appeal of the local natural features (scenic mountains), the remote location of the area, its undeveloped nature and its unique sense of place afford the area a level of tourism potential. Although this tourism potential has not yet been realised or optimised, the N1 and N12 represent national tourist access routes which are fully optimised and utilised by tourists.

In this respect, reference is made to the Three Sisters, a cluster of hills which is visible from the national road, and which has come to be a tourist attraction and landmark in the area. This landmark lies to the south of the N1 (i.e. in a direction opposite to that of the proposed facility), and the viewing position does not lie within the anticipated viewshed.

Visual intrusion through the development of industrial type infrastructure within this environment could jeopardise the area's tourism value and potential.

The anticipated visual impact of the facility on existing tourist routes, as well as on the tourism potential of the region, is expected to be **low**.

The table below illustrates this impact assessment.

Table 11: Impact table summarising the significance of visual impacts on tourist routes and tourist potential within the region.

Nature of Impact: Potential visual impact of the proposed facility on tourist routes 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 to 30 years.		
Cumulative impacts: The construction of 150 wind turbines, the PV plant, the substations and other associated infrastructure will increase the cumulative visual impact of electricity related infrastructure within the region. This is relevant in light of the existing power line infrastructure already present in the area, albeit limited in extent and scale.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

5.9 The potential to mitigate visual impacts

- The primary visual impact, namely that of the wind turbines is not possible to mitigate completely. 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.

  Although mitigation potential is low overall, turbines located on steep slopes and in elevated positions represent an additional aggravation of anticipated visual impact.

  It is logical, therefore, that the sympathetic placement of turbines with respect to the topography may ameliorate the anticipated visual impact of the WEF.

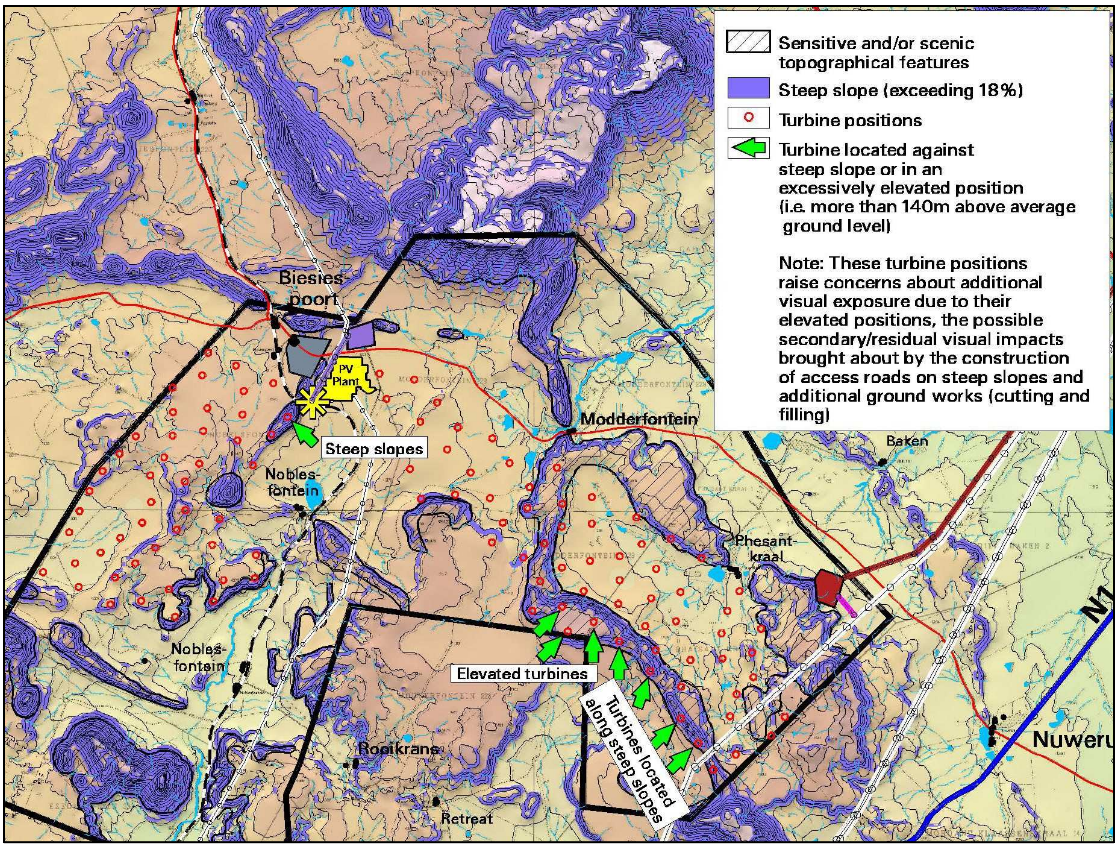
  Such a measure would reduce the magnitude of the visual impact of the WEF overall, and is considered to be good planning practice from a visual perspective. Furthermore, the relocation of turbines from steeper high lying areas to more moderate low lying slopes will ameliorate visual impacts anticipated as a result of cut and fill required for road and platform building.

  At the same time, however, it is also acknowledged that the turbines are positioned for optimal exposure to wind, and that relocating these to lower lying areas could compromise the efficiency of the turbines, and in turn the feasibility of the WEF.

  Therefore, it is recommended that those turbines representing the greatest concern with respect to visual impact be repositioned to lower lying areas and more moderate slopes.

  Turbines of concern include 3 located in a particularly elevated position (i.e. on top of a landform more than 140m above the surrounding area) and 5 located on slopes in excess of 18 degrees.

  See **Map 7** overleaf.



Map 7: Map indicating turbine positions of concern.

- The potential negative impact of the power lines may be mitigated by implementing power line option 1 for both substation 1 and 2. These options entail immediate turn-in lines with minimal additional infrastructure requirements.

- Mitigation of visual impacts associated with the construction of internal access roads include careful planning, taking due cognisance of the topography. Roads should be laid out along the contour wherever possible, and should never traverse slopes at 90 degrees. Construction of roads should be undertaken with adequate drainage structures in place to forego potential erosion problems.

  Access roads not required for the post-decommissioning use of the site should be ripped and rehabilitated during decommissioning.

- 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 the turbines, the PV plant and the ancillary infrastructure will go far to contain rather than spread the light. Additional 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 negative visual impacts of shadow flicker may be completely negated by ensuring that all wind turbines are located 500m or more from any inhabited settlement, homestead or public road. Beyond the 500m buffer, shadow flicker becomes negligible.

- Visual impacts associated with the construction phase, albeit temporary, should be managed according to the following principles:
  - 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.

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

The possible mitigation of 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 Karoo Renewable combined solar and wind energy Facility, 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 **Figure 2** and **Map 1** respectively.

The photograph positions are indicated on the map 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 as detailed layout and design information is not finalised.

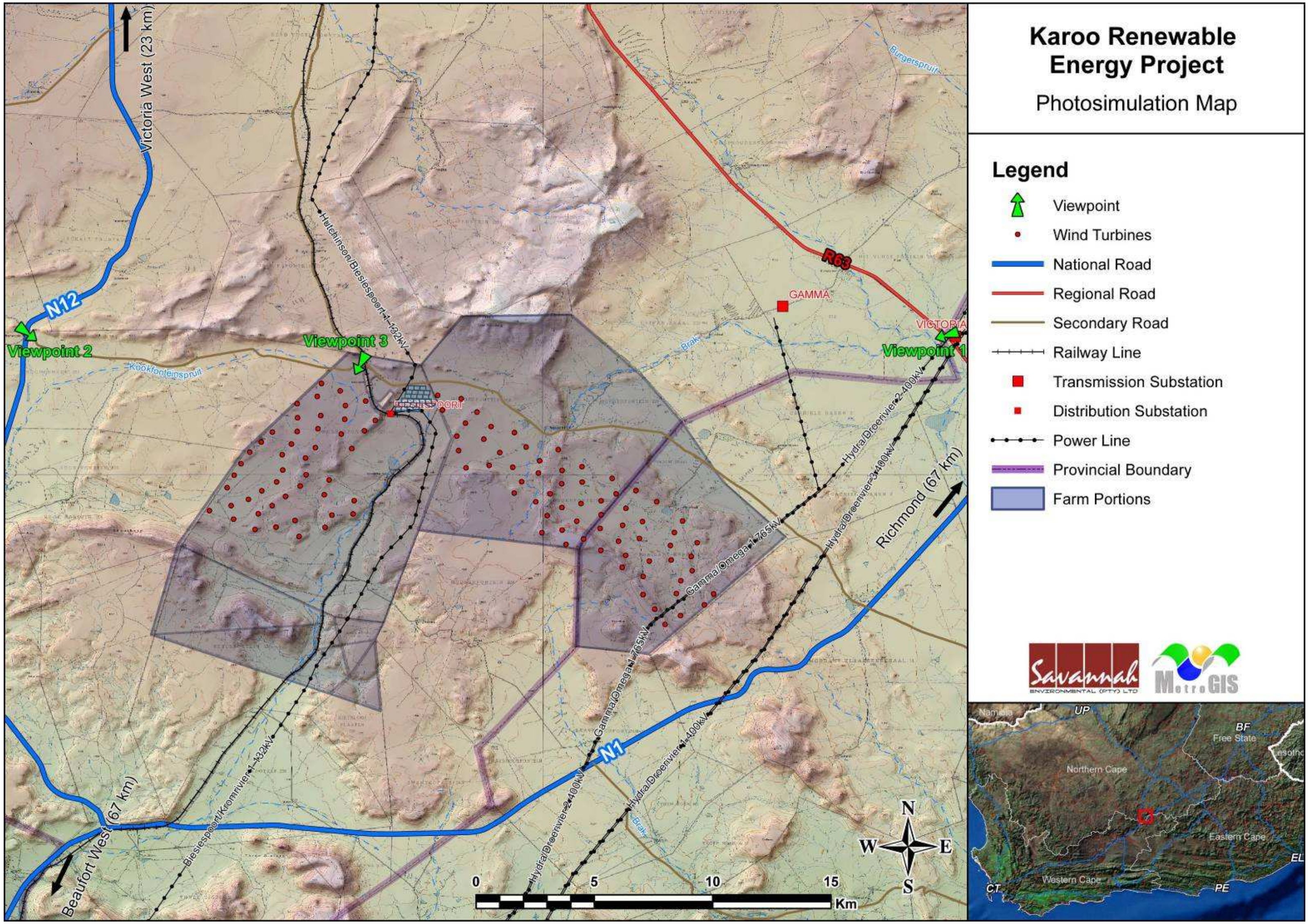
Each photographic simulation is preceded by a panoramic overview of the landscape from the specified viewpoint being discussed. The panoramic overview allows for a more realistic viewer scale that would be representative of the distance over which the turbines are viewed. Each panoramic overview indicates the section that was enlarged to show a more detailed view of the WEF (the solar component is not included in the photo simulations, due to the much smaller size of the infrastructure).

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. Furthermore, points can be extruded to create lines of any specified length; lines may be extruded to create 3D polygons; and 3D polygons may be extruded to create 3D volumes.

- 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 8: Photograph positions for Photo Simulations

6.1 West south westerly view

Viewpoint 1 (medium to long distance view)

Viewpoint 1 is located on the R63, opposite the existing Victoria Substation. This position is approximately 13 km away from the facility and is indicative of what will be seen by residents and commuters using the R63 to commute between Victoria West and the N1 national road.

The viewing direction is west south westerly and approximately 65 wind turbines will be partially to fully visible in the middle distance. From this view it is clear that the visual impact is absorbed somewhat, by the topography (hills and mountains) in the medium distance.

This view is representative of middle to long distance visual experience that both residents of Victoria West as well as travellers utilising the R63 will have of the proposed facility.

Figure 9a: Pre-construction panoramic overview from Viewpoint 1.

Figure 9b: Post-construction panoramic overview from Viewpoint 1 (showing photo sections).

Figure 9c: View 1a (enlarged photograph section from Viewpoint 1).

Figure 9d: View 1b (enlarged photograph section from Viewpoint 1).

6.2. South easterly view

Viewpoint 2 (Medium distance view)

Viewpoint 2 is located along the N12 national road running north/south to the west of the proposed facility, adjacent to Maanhaarspoort. The photo point is located on the northern side of the junction of the N12 and the gravel road linking it to the N1.

This viewpoint is approximately 10km from the proposed facility. The viewing direction is south-easterly and approximately 35 wind turbines will be partially to fully visible in the middle distance.

This view is indicative of what will be seen by residents, commuters and tourists utilising the N12 between Victoria West and Beaufort West.

Figure 10a: Pre-construction panoramic overview from Viewpoint 2.

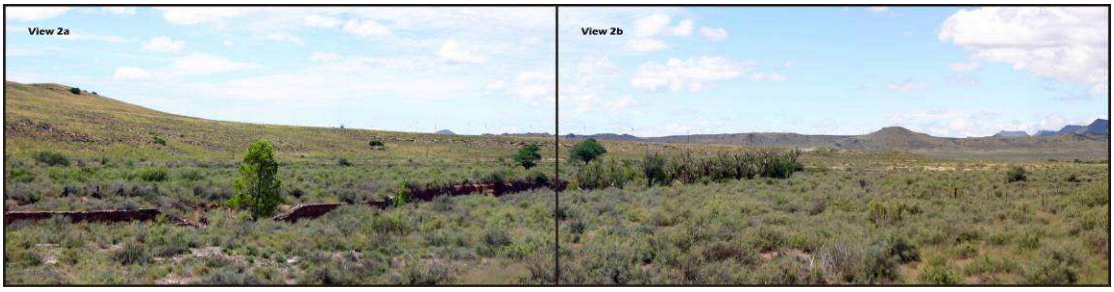


Figure 10b: Post-construction panoramic overview from Viewpoint 2 (showing photo sections).

Figure 10c: View 2a (enlarged photograph section from Viewpoint 2).

Figure 10d: View 2b (enlarged photograph section from Viewpoint 2).

6.3. South westerly view

View 3 (Short distance view)

Viewpoint 3 is located on the gravel road that runs between the N12 and N1 national roads, approximately 1km north-west of the Biesiespoort Railway Station.

This view is indicative of what will be seen by workers, residents and commuters either utilising the train or travelling between the N1 and 12.

The viewing direction is south-westerly and approximately 42 wind turbines will be partially to fully visible in the foreground, close to the viewer.

This view is representative of a short distance visual experience that residents, farmers, commuters (using the train) and potential tourists utilising the area around the Biesiespoort Substation will have of the facility.

Figure 11a: Pre-construction panoramic overview from Viewpoint 3.

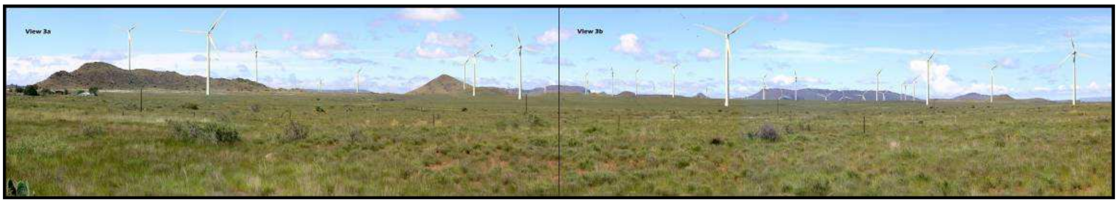


Figure 11b: Post-construction panoramic overview from Viewpoint 3 (showing photo sections).

Figure 11c: View 3a (enlarged photograph section from Viewpoint 3).

Figure 11d: View 3b (enlarged photograph section from Viewpoint 3).

7. CONCLUSIONS AND RECOMMENDATIONS

The construction and operation of the Karoo Renewable Energy Facility and its associated infrastructure will have a visual impact on the natural scenic resources and rural character of the study area, and particularly within 5km of the proposed facility.

The author is, however, of the opinion that the facility 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 (especially the wind turbines) that invokes a curiosity factor not generally present with other conventional power generating plants. The advantage being that the facility 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.

Lastly, it is of relevance that the local communities resident in the area have been neutral in terms of the proposed facility[3], and as such do not view the facility in a negative light.

Notwithstanding, the positive aspect should not distract from the fact that the facility would be visible for a large area that incorporates various sensitive visual receptors that should ideally not be exposed to the type or scale of structures under consideration.

In this respect, the landscape character, sense of place and tourism value of the region is of relevance. This includes not only the N1 and N12 tourist access routes, but also the tourism potential of the region.

There are not many options as to the mitigation of the visual impact of the facility. No amount of vegetation screening or landscaping would be able to hide structures of these dimensions situated on this site. Of particular concern are 3 turbines located in a particularly elevated position (i.e. on top of a landform more than 140m above the surrounding area) and 5 turbines located on slopes in excess of 18 degrees.

In the medium to long distance, the visual impact of the wind turbines may be absorbed where these are viewed against the backdrop of mountainous topography. This is only relevant, however, where the turbines do not break the skyline created by the mountainous terrain beyond.

The following mitigation measures are recommended:

- The 8 turbines of concern should be repositioned to lower lying areas and more moderate slopes.
- Power line option 1 for both substation 1 and 2 should be favoured.
- Internal access roads should be planned with due cognisance of the topography. Roads should be laid out along the contour wherever possible, and should never traverse slopes at 90 degrees. Construction of roads

[3] This perception was confirmed by Public Participation Facilitator, Ingrid Snyman from *Batho Earth* (Personal Communication).

should be undertaken with adequate drainage structures in place to forego potential erosion problems.
- A lighting engineer should be consulted to assist in the planning and placement of light fixtures for the turbines, the PV plant and the ancillary infrastructure in order to reduce visual impacts associated with glare and light trespass.
- Turbines located within 500m of any inhabited settlement, homestead or public road should be relocated to beyond this distance in order to negate the potential impact of shadow flicker.
- All activities associated with the construction phase, albeit temporary, should be managed so as to reduce / minimise visual impact during the phase.
- All construction areas, specifically trenches, road servitudes and cut and fill slopes should be appropriately rehabilitated after construction. This rehabilitation must also be monitored and maintained during operation.

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

8. IMPACT STATEMENT

In light of the results and findings of the Visual Impact Assessment undertaken for the proposed Karoo Renewable Energy Facility, it is acknowledged that the rural, natural and relatively unspoiled views surrounding the site will be transformed for the entire operational lifespan (approximately 25 years) of the facility.

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

- The potential visual impact of the facility on users of national, arterial and secondary roads in close proximity to the proposed facility will be of **high** significance.
- The anticipated visual impact on residents of settlements and homesteads will be of **high** significance.
- Within the greater region, the potential visual impact on sensitive visual receptors (i.e. users of roads and residents of settlements and homesteads) will be of **moderate** significance.
- In terms of ancillary infrastructure, the anticipated visual impact of the 2 substations, the power lines and the internal access roads will be of **low** significance.
- Similarly, visual impacts related to lighting will be of **low** significance, as will that of shadow flicker.
- 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 will be of **moderate** significance, while the anticipated impact on tourist routes and tourism potential will be of **low** significance.

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 and the low occurrence of visual receptors.

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 travelling along the N1 and N12 or the tourism potential of the area. These receptors will be exposed to the proposed facility for a very short period of their journey.

It is therefore recommended that the development of the facility as proposed be supported, subject to the implementation of the recommended mitigation measures (chapter 7) and management actions (chapter 9).

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 12: Management plan – Planning

<table>
<tr><td colspan="3">OBJECTIVE: The mitigation and possible negation of visual impacts associated with the planning of the Karoo Renewable Energy Facility.</td></tr>
<tr><td>Project component/s</td><td colspan="2">Wind Turbines, PV plant and ancillary infrastructure (i.e. substations, power lines and access roads).</td></tr>
<tr><td>Potential Impact</td><td colspan="2">Primary visual impact of the core facility due to the presence of wind turbine structures, power lines and access roads in the landscape as well as the visual impact of shadow flicker and lighting at night.</td></tr>
<tr><td>Activity/risk source</td><td colspan="2">The viewing of the above mentioned by observers on or near the site as well as within the region.</td></tr>
<tr><td>Mitigation: Target/Objective</td><td colspan="2">Optimal placement of turbines and planning of infrastructure so as to minimise visual impact.</td></tr>
<tr><td>Mitigation: Action/control</td><td>Responsibility</td><td>Timeframe</td></tr>
<tr><td>Relocate turbines of concern to lower lying areas and moderate slopes.</td><td>SARGE / design consultant</td><td>Planning.</td></tr>
<tr><td>Relocate turbines located within 500m of any inhabited settlement, homestead or public road to beyond this distance.</td><td>SARGE / design consultant</td><td>Planning.</td></tr>
<tr><td>Implement power line option 1 for both substation 1 and 2</td><td>SARGE / design consultant</td><td>Planning.</td></tr>
<tr><td>Plan internal access roads with due cognisance of the topography.</td><td>SARGE / design consultant</td><td>Planning.</td></tr>
<tr><td>Consult a lighting engineer in the planning and placement of light fixtures for the turbines, the PV plant and the ancillary infrastructure.</td><td>SARGE / design consultant</td><td>Planning.</td></tr>
<tr><td>Performance Indicator</td><td colspan="2">Additional power line infrastructure is minimal and hardly visible, and no internal access roads are visible from surrounding areas. Lighting impact is minimal and no shadow flicker impact on road users or homesteads.</td></tr>
<tr><td>Monitoring</td><td colspan="2">Not applicable.</td></tr>
</table>

Table 13: Management plan – Construction

OBJECTIVE: The mitigation and possible negation of visual impacts associated with the construction of the Karoo Renewable Energy Facility.		
Project component/s	Construction site.	
Potential Impact	Visual impact of general construction activities, and the potential scarring of the landscape due to vegetation clearing.	
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.	SARGE / contractor	Construction
Plan the placement of lay-down areas and temporary construction equipment camps in order to minimise vegetation clearing.	SARGE / contractor	Construction
Restrict the activities and movement of construction workers and vehicles to the immediate construction site and existing access roads.	SARGE / contractor	Construction
Ensure that rubble, litter and disused construction materials are managed and removed regularly.	SARGE / contractor	Construction
Ensure that all infrastructure and the site and general surrounds are maintained in a neat and appealing way	SARGE / contractor	Construction
Reduce and control construction dust through the use of approved dust suppression techniques.	SARGE / contractor	Construction
Restrict construction activities to daylight hours in order to negate or reduce the visual impacts associated with lighting.	SARGE / contractor	Construction
Rehabilitate all disturbed areas, construction areas, road servitudes and cut and fill slopes to acceptable visual standards.	SARGE / 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 14: Management plan – Operation

OBJECTIVE: The mitigation and possible negation of the potential visual impacts associated with the operation of the Karoo Renewable Energy Facility		
Project component/s	The Karoo Renewable Energy Facility.	
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. Monitor rehabilitated areas, and implement remedial action as and when required.	SARGE / operator SARGE / operator	Operation. 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 15: Management plan – Decommissioning

OBJECTIVE: The mitigation and possible negation of the potential visual impacts associated with the decommissioning of the Karoo Renewable Energy Facility		
Project component/s	The Karoo Renewable Energy Facility.	
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, Rip and rehabilitate access roads not required for the post-decommissioning use of the site. Monitor rehabilitated areas, and implement remedial action as and when required.	SARGE / operator SARGE / operator SARGE / operator	Operation. Operation. 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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