PROPOSED VREDE SOLAR PHOTOVOLTAIC FACILITY, FREE STATE PROVINCE

VISUAL ASSESSMENT – INPUT FOR SCOPING REPORT

Produced for:

Mainstream Renewable Power Developments (Pty) Ltd

On behalf of:

savannah environmental

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CONTENTS

FIGURES

MAPS

TABLES

Lourens du Plessis (t/a LOGIS) is a *Professional Geographical Information Sciences (GISc) Practitioner* registered with The South African Geomatics Council (SAGC), and specialises in Environmental GIS and Visual Impact Assessments (VIA).

Lourens has been involved in the application of Geographical Information Systems (GIS) in Environmental Planning and Management since 1990. He has extensive practical knowledge in spatial analysis, environmental modeling and digital mapping, and applies this knowledge in various scientific fields and disciplines. His GIS expertise are often utilised in Environmental Impact Assessments, Environmental Management Frameworks, State of the Environment Reports, Environmental Management Plans, tourism development and environmental awareness projects.

He holds a BA degree in Geography and Anthropology from the University of Pretoria and worked at the GisLAB (Department of Landscape Architecture) from 1990 to 1997. He later became a member of the GisLAB and in 1997, when Q-Data Consulting acquired the GisLAB, worked for GIS Business Solutions for two years as project manager and senior consultant. In 1999 he joined MetroGIS (Pty) Ltd as director and equal partner until December 2015. From January 2016 he worked for SMEC South Africa (Pty) Ltd as a technical specialist until he went independent and began trading as LOGIS in April 2017.

Lourens has received various awards for his work over the past two decades, including EPPIC Awards for ENPAT, a Q-Data Consulting Performance Award and two ESRI (Environmental Systems Research Institute) awards for *Most Analytical* and *Best Cartographic Maps*, at Annual International ESRI User Conferences. He is a co-author of the ENPAT atlas and has had several of his maps published in various tourism, educational and environmental publications.

He 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 (i.e. within the Free State Province).

1. INTRODUCTION

South Africa Mainstream Renewable Power Developments (Pty) Ltd is proposing the construction and operation of the 100MW Vrede Solar Photovoltaic (PV) Facility and Battery Energy Storage System (BESS), near the town of Kroonstad in the Moqhaka Local Municipality (Fezile Dabi District) of the Free State Province of South Africa (see **Figure 1**).

The proposed development traverses two farm portions namely:

- Remaining extent of the farm Vrede No. 1152 (F02000000000115200000).

- Portion 1 of the farm Uitval No. 1104 (F02000000000110400001).

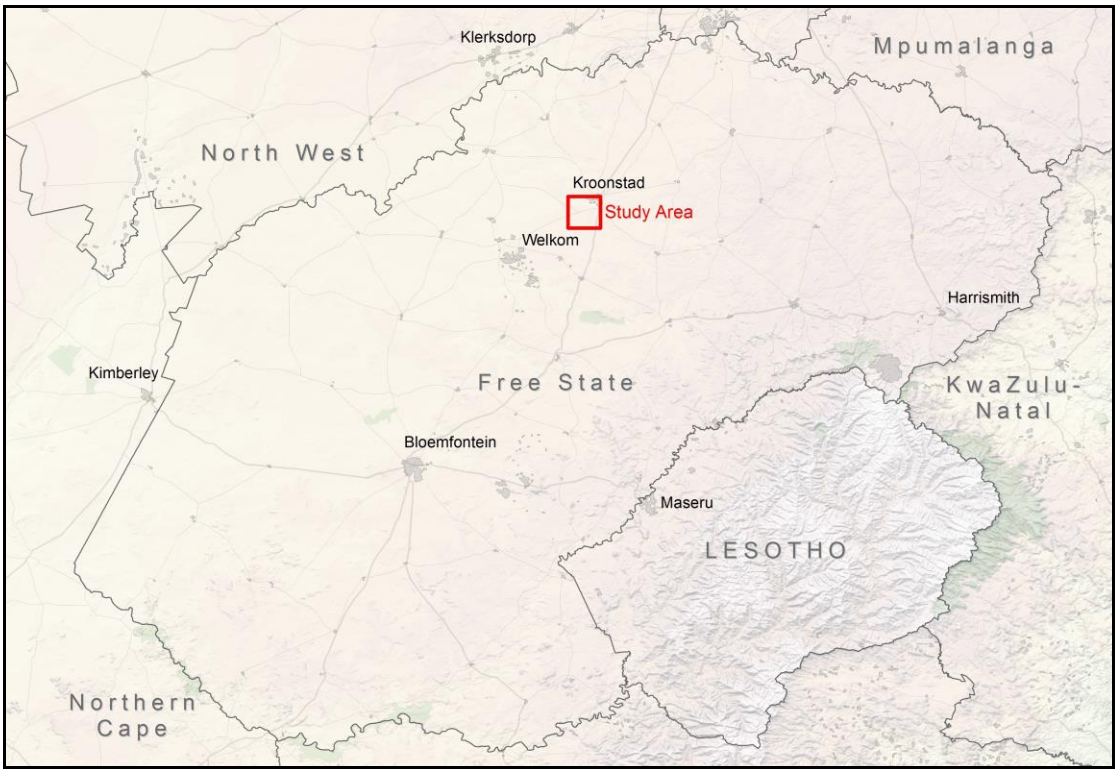


Figure 1: Regional locality of the proposed project area.

The proposed project will have a contracted capacity of up to 100MW, and will make use of PV solar technology for the generation of electricity. The project will comprise a solar field with the following key infrastructure and components:

- Solar Arrays:
  - Solar Panel Technology - Mono and/or Bifacial Photovoltaic (PV) Modules;
  - Mounting System Technology – single axis tracking, dual axis tracking or fixed axis tracking PV;
  - Underground cabling (up to 33kV);
  - Centralised inverter stations or string inverters; and
  - Power Transformers.

- Building infrastructure:
  - Offices;
  - Operational control centre;
  - Operation and Maintenance Area / Warehouse / workshop;

  - Ablution facilities;
  - Battery Energy Storage Facility; and
  - Substation building.

- Electrical infrastructure:
  - 33/132kV onsite substation including associated equipment and infrastructure; and
  - Underground cabling and overhead power lines (up to 33kV).

- Associated infrastructure:
  - Access roads and internal gravel roads;
  - Fencing and lighting;
  - Lightning protection
  - Permanente laydown area;
  - Temporary construction camp and laydown area;
  - Telecommunication infrastructure;
  - Storm water channels; and
  - Water pipelines.

The proposed grid connection infrastructure will comprise of:

- The Vrede Solar PV Facility will include an on-site facility substation to facilitate the connection between the solar PV facility and the Eskom electricity grid. A 33/132kV onsite substation including associated equipment and infrastructure will be required, comprising a footprint of up to approximately 300 x 500 (~15 ha) including the following:
  - Temporary and permanent laydown areas
  - & M Building
  - Power lines (primary and secondary);
  - Ground wires and overhead lines
  - Transformers (various)
  - Circuit breaker
  - Lightning arrester
  - Control building
  - Security fencing

- Distribution power line:
  - Two alternative routes are being considered for the Vrede Grid Connection solution. Both alternatives for the Vrede Grid Connection will loop into the Kroonstad Municipality – Kroonstad SW STN 1 132kV power line, to connect to the national grid. The assessment of the grid connection infrastructure will consider a corridor with a width of up to 260m.

The grid connection infrastructure will be applied for under a separate environmental approval process.

The 100MW Solar PV Facility will take approximately 18 - 24 months to construct and the operational lifespan of the facility is estimated at 20 years.

The proposed position of the Vrede Solar PV Facility and associated infrastructure are indicated on the maps within this report. Sample images of similar PV technology and Battery Energy Storage System (BESS) facilities are provided below.

Figure 2: Photovoltaic (PV) solar panels. (*Photo: SunPower Solar Power Plant – Prieska)*.

Figure 3: Aerial view of PV arrays. (*Photo: Scatec Solar South Africa*).

Figure 4: Aerial view of a BESS facility (*Photo: Power Engineering International)*.

Figure 5: Close up view of a BESS facility *(Photo: Greenbiz.com).*

2. SCOPE OF WORK

The scope of the work includes a scoping level visual assessment of the issues related to the visual impact.

The study area for the visual assessment encompasses a geographical area of approximately 341km² (the extent of the full page maps displayed in this report) and includes a minimum 6km buffer zone (area of potential visual influence) from the proposed development footprint.

The study area includes the town of Kroonstad, a number of homesteads or farm residences, the Kroonstad Municipal Substation, existing distribution and transmission power lines, and sections of the N1 national, the R34 arterial and R713 main roads.

3. METHODOLOGY

The study was undertaken using Geographical 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 topographical data provided by NASA in the form of a 30m SRTM (Shuttle Radar Topography Mission) elevation model.

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

- The creation of a detailed digital terrain model 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 project site 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 and activities.

This report (scoping report) sets out to identify the possible visual impacts related to the proposed Vrede Solar PV Facility from a desktop level.

4. THE AFFECTED ENVIRONMENT

The project is proposed on a site on the remaining extent of the farm Vrede 1152 and Portion 1 of the farm Uitval 1104, located approximately 11.5km from the Kroonstad central business district (at the closest). These farms have a surface area of 538ha, but the identified development area (project site) is approximately 279ha. The ultimate development footprint, including the PV modules, internal roads, buildings and other associated infrastructure will be approximately 195ha (i.e. 70% of the development area assessed in this visual assessment). The footprint of the battery storage area will be 2ha and the on-site substation 1ha.

The entire proposed Solar PV Facility project is located in a rural area, currently zoned as agriculture, at a distance of approximately 9km from the Kroonstad Municipal 132/66kV Substation (at the closest).

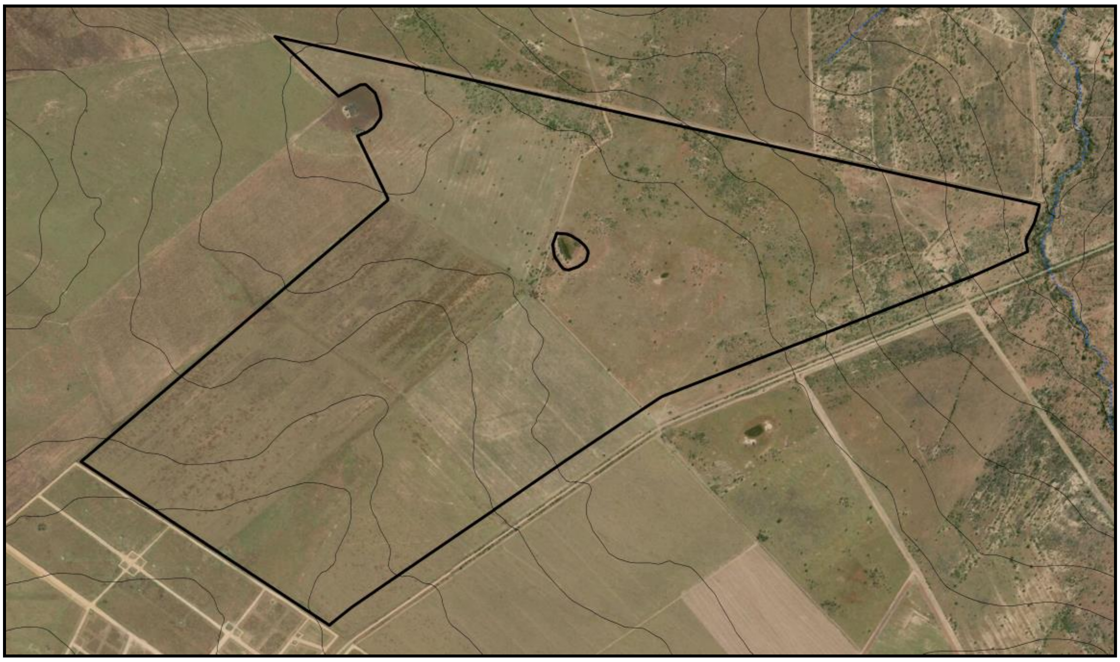


Figure 6: Aerial view of the proposed development area.

Topography, hydrology and vegetation

The study area occurs on land that ranges in elevation from 1,318m (in the north) to 1,459m in the south. The proposed development site itself is located at an average elevation of 1,423m above sea level. The general slope of the study area is even (flat), although the site traverses across a weak ridge that spans in a south-easterly to north-westerly direction. The region is generally referred to as the *Highveld* with the terrain morphology described as *plains* and *slightly irregular undulating plains and hills*.

The Vals River is the only perennial river within the study area. There are a number of non-perennial streams of which the *Blomspruit* is the most prominent. This stream and a number of other smaller streams in closer proximity to the project site feed into the Vals River, north of the site. Further to the aforementioned drainage lines the most prominent hydrological features are the man-made farm dams occurring throughout the study area.

The natural land cover within the study area is predominantly grassland interspersed with open woodland, with wetlands in the lower lying reaches of the drainage lines mentioned above. The site itself is a combination of natural grassland and woodland (eastern section), and old farm lands to the west. Large tracts of the study area have been transformed by dryland agriculture (primarily maize farming) as well as irrigated crop farming (crop circles).

The entire study area is located in the *Dry Highveld Grassland Bioregion* and the dominant vegetation type is described as *Central Free State Grassland*. The most transformed part of the study area, to the south-west, is known as *Vaal-Vet Sandy Grassland.*

Refer to **Maps 1** and **2** for the topography and land cover maps of the study area.

Land use and settlement patterns

The study area has a rural and predominantly natural character and the main land use activity, outside of the Kroonstad city limits, is maize farming. The region is similarly sparsely populated outside of the Kroonstad urban centre, with a population density of less than ten people per km^2. Farm residences, or homesteads, dot the landscape at an irregular interval. These homesteads are generally located at great distances from each other (i.e. more than 2.5km apart).

The development area is easily accessible from the N1 national road via the R34 arterial road, the Hennenman road and the S172 secondary (gravel) road.

The only protected area in the study area borders the proposed development area to the north. This is the Boslaagte Private Nature Reserve (farm Oshoek 47) that includes the Lechwe Lodge. This is the only tourist facility or destination identified within the study area (excluding Kroonstad itself). This lodge functions as a venue that can accommodate up to 300 people and provides overnight lodging.

In spite of the rural and natural character of the study area, there is a large number of overhead power lines associated with the Kroonstad Municipal Substation. These include:

- Kroonstad Municipal/Theseus 1 132kV
- Serfontein Traction/Virginia Terminal 1 88kV
- Kroonstad Municipal/Kroonstad SW Station 1 132kV

The former two power lines traverse east of the proposed project site at a distance of approximately 1.5km (at the closest).

Other than these power lines there is also a railway line crossing the study area to the industrial area west of the Kroonstad CBD.

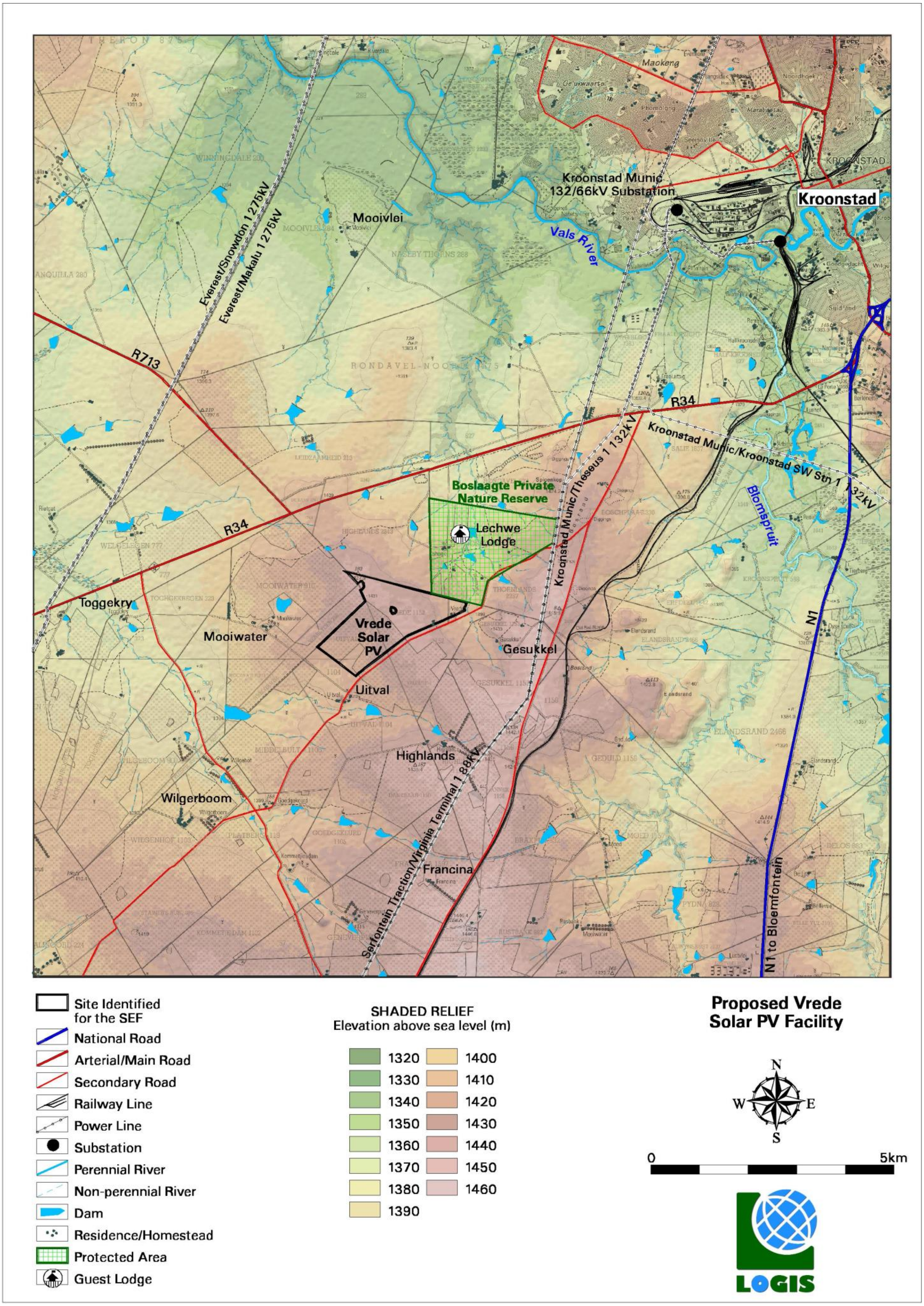
The photographs below aid in describing the general environment within the study area and surrounding the proposed Vrede Solar PV Facility[1].

Figure 7: The project site as seen from the S172 secondary road.

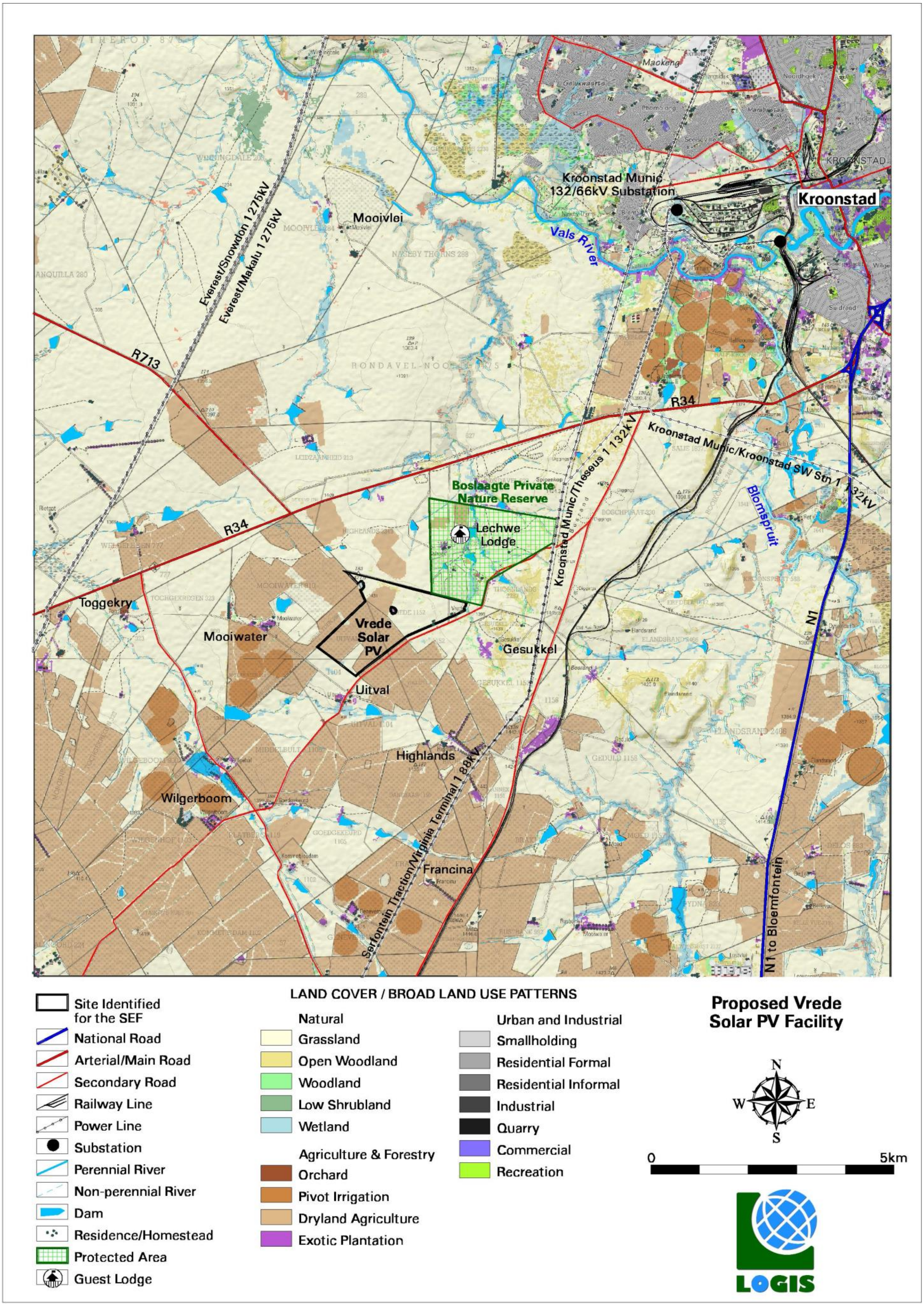
[1] Sources: DEAT (ENPAT Free State), NBI (Vegetation Map of South Africa, Lesotho and Swaziland), NLC2018 (ARC/CSIR), REEA_OR_2020_Q2 and SAPAD2019-20 (DEA).

Figure 8: Lechwe Lodge. (*Photo*: *Jan Venter*).

Figure 9: Access road to the Vrede development area



Map 1: Shaded relief map of the study area.



Map 2: Land cover and broad land use patterns.

5. VISUAL EXPOSURE/VISIBILITY

The result of the viewshed analysis for the proposed facility is shown on the map below (**Map 3**). The viewshed analysis was undertaken from 129 vantage points within the proposed development site at an offset of respectively 2.5m and 4m above ground level. This was done in order to determine the general visual exposure (visibility) of the area under investigation, simulating the maximum height of the proposed structures (PV panels and inverters) and BESS associated with the facility.

It must be borne in mind that the viewshed analyses were done from vantage points distributed across the entire proposed Vrede development site, which represents a larger area (277ha) than the actual proposed development footprint (approximately 195ha). The viewshed area on Map 3 therefore provides a worst case scenario in terms of the visual exposure of the proposed Solar PV Facility. It is anticipated that the ultimate visual exposure may be less, if the viewshed analyses were recreated from the more restricted footprint area alone.

The viewshed analysis will be further refined once a preliminary and/or final layout is completed and will be regenerated for the actual position of the infrastructure on the site and actual proposed infrastructure during the EIA phase of the project.

Map 3 also indicates proximity radii from the footprint of the proposed structures/activities in order to show the viewing distance (scale of observation) of the facility in relation to its surrounds.

The viewshed analysis does not include the effect of vegetation cover or existing structures on the exposure of the proposed facility, therefore signifying a worst-case scenario.

Results

The core area of potential visual exposure is primarily contained within a 1km radius of the proposed development site. The facility is expected to be very visible from the S172 secondary road within this zone and may potentially be visible from parts of the Boslaagte Private Nature Reserve.

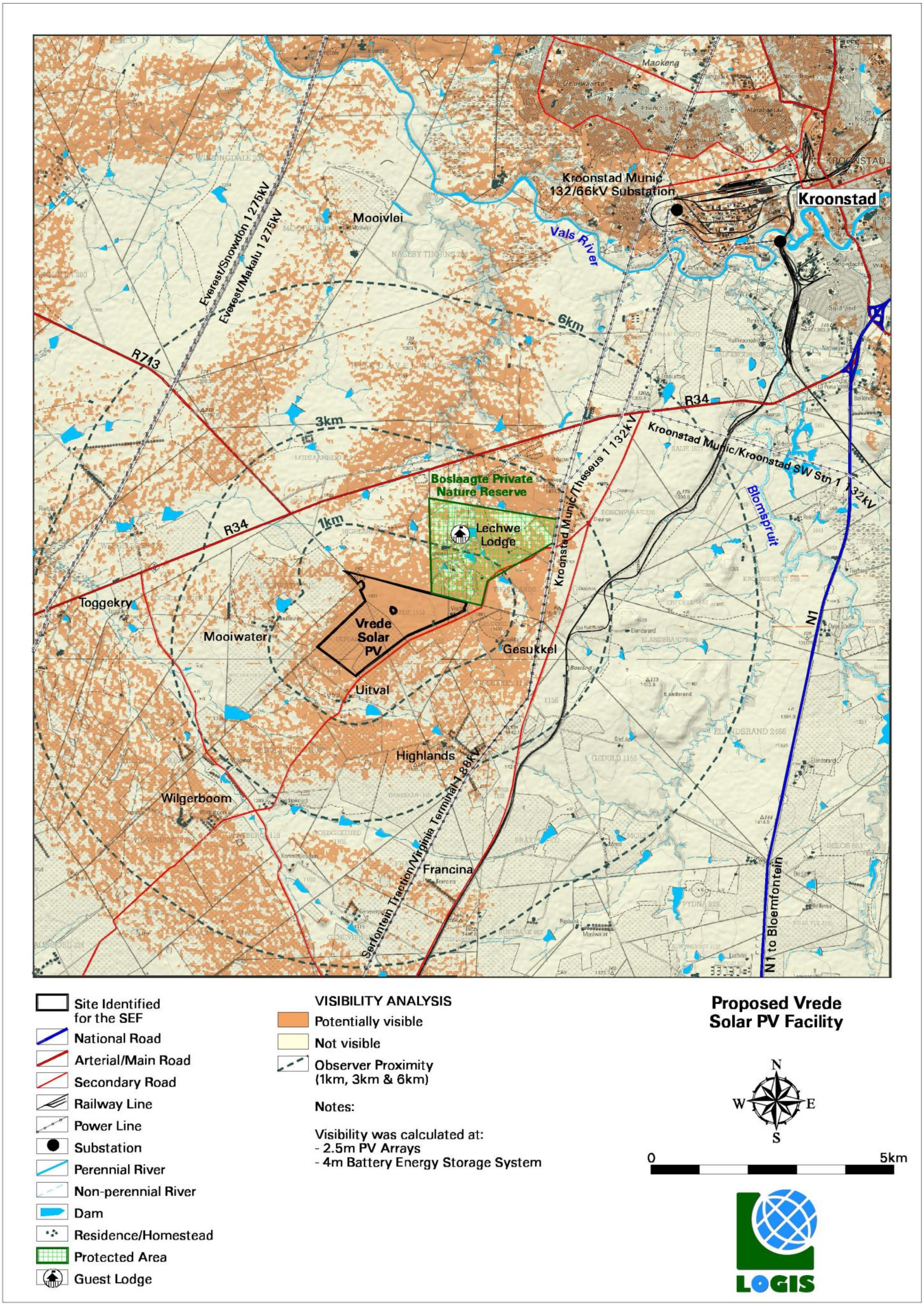
Within a 1 – 3km radius the facility may be visible from the Lechwe Lodge, and the Mooiwater, Gesukkel and Highlands homesteads. It may also be visible from a short section of the R34 arterial road.

Within a 3 – 6km radius the visual exposure is largely restricted to higher lying areas south-west and north of the site. The facility may be visible from the Francina, Wilgerboom and Toggekry homesteads and may also be visible from the R713 main road. Other than these receptors, most of the visual exposure will be relatively scattered within vacant open space.

At distances exceeding 6km the intensity of visual exposure is expected to be very low and highly unlikely due to the distance between the object (development) and the observer. Further to this, most of these areas are not inhabited and generally devoid of observers.

Conclusion

In general terms it is envisaged that the structures, where visible from shorter distances (e.g. less than 3km), and where sensitive visual receptors may find themselves within this zone, may constitute a high visual prominence, potentially resulting in a moderate to high visual impact. The incidence rate of sensitive visual receptors is however expected to be quite low, due to the generally remote location of the proposed development and the low number of potential observers. This statement needs to be confirmed during the EIA phase of the project and the potential visual impacts must be investigated in terms of their nature, extent, duration, magnitude, probability and significance.



Map 3: Map indicating the potential (preliminary) visual exposure of the proposed Vrede Solar PV Facility .

6. ANTICIPATED ISSUES RELATED TO THE VISUAL IMPACT

Anticipated issues related to the potential visual impact of the proposed Vrede Solar PV Facility include the following:

- The visibility of the facility to, and potential visual impact on, observers travelling along the arterial and secondary roads within the study area.
- The visibility of the facility to, and visual impact on residents of homesteads within the study area.
- The potential visual impact of the facility on the visual character or sense of place of the region.
- The potential visual impact of the facility on tourist routes or tourist destinations (e.g. the Boslaagte Private Nature Reserve and Lechwe Lodge).
- The potential visual impact of the construction of ancillary infrastructure (i.e. internal access roads, buildings, etc.) on observers in close proximity to the facility.
- The visual absorption capacity of the natural vegetation (if applicable).
- Potential cumulative visual impacts with specific reference to the construction of the Vrede Solar PV Facility and the Rondawel Solar PV Facility approximately 3.6km north-east of the site.
- The potential visual impact of operational, safety and security lighting of the facility at night on observers residing in close proximity of the facility.
- Potential visual impact of solar glint and glare as a visual distraction and possible air travel hazard.
- Potential visual impacts associated with the construction phase.
- The potential to mitigate visual impacts and inform the design process.

It is envisaged that the issues listed above may potentially constitute a significant visual impact at a local and/or regional scale. These need to be assessed in greater detail during the EIA phase of the project.

Table 1: Impact table summarising the potential primary visual impacts associated with the Vrede Solar PV Facility.

Impact

Visual impact of the facility on observers in close proximity to the proposed Solar PV Facility infrastructure and activities. Potential sensitive visual receptors include:

- Visitors to the Boslaagte Private Nature Reserve and Lechwe Lodge
- Residents of homesteads and farm dwellings (if present in close proximity to the facility)
- Observers travelling along the S172 secondary and the R34 arterial roads

Issue	Nature of Impact	Extent of Impact	No-Go Areas
The viewing of the Solar PV Facility infrastructure and activities	The potential negative experience of viewing the infrastructure and activities within a predominantly natural/rural setting	Primarily observers situated within a 3km radius of the facility	N.A.

Description of expected significance of impact

Extent: Local
Duration: Long term
Magnitude: Moderate to High
Probability: Probable
Significance: Moderate to High
Status (positive, neutral or negative): Negative
Reversibility: Recoverable
Irreplaceable loss of resources: No
Can impacts be mitigated: Yes

Gaps in knowledge & recommendations for further study

A finalised layout of the Solar PV Facility and ancillary infrastructure are required for further analysis. This includes the provision of the dimensions of the proposed structures and ancillary equipment.

Additional spatial analyses are required in order to create a visual impact index that will include the following criteria:

- Visual exposure
- Visual distance/observer proximity to the structures/activities
- Viewer incidence/viewer perception (sensitive visual receptors)
- Visual absorption capacity of the environment surrounding the infrastructure and activities

Additional activities:

- Identify potential cumulative visual impacts
- Undertake a site visit
- Recommend mitigation measures and/or infrastructure placement alternatives

Refer to the Plan of Study for the EIA phase of the project below.

7. CONCLUSION AND RECOMMENDATIONS

The fact that some components of the proposed Vrede Solar PV Facility may be visible does not necessarily imply a high visual impact. Sensitive visual receptors within (but not restricted to) a 3km buffer zone from the facility need to be identified and the severity of the visual impact assessed within the EIA phase of the project.

It is recommended that additional spatial analyses be undertaken in order to create a visual impact index that will further aid in determining potential areas of visual impact. This exercise should be undertaken for the core Solar PV Facility as well as for the ancillary infrastructure, as these structures (e.g. the BESS structures) are envisaged to have varying levels of visual impact at a more localised scale. The site-specific issues (as mentioned earlier in the report) and potential sensitive visual receptors should be measured against this visual impact index and be addressed individually in terms of nature, extent, duration, probability, severity and significance of visual impact.

This recommended work must be undertaken during the Environmental Impact Assessment (EIA) Phase of reporting for this proposed project. In this respect, the Plan of Study for the EIA is as follows:

Visual Impact Assessment (VIA)

The VIA is determined according to the nature, extent, duration, intensity or magnitude, probability and significance of the potential visual impacts, and will propose management actions and/or monitoring programs, and may include recommendations related to the solar energy facility layout.

The visual impact is determined for the highest impact-operating scenario (worst-case scenario) and varying climatic conditions (i.e. different seasons, weather conditions, etc.) are not considered.

The VIA considers potential cumulative visual impacts, or alternatively the potential to concentrate visual exposure/impact within the region.

The following VIA-specific tasks must be undertaken:

- **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 (or where) the proposed facility and associated infrastructure were not visible, no impact would occur.

The viewshed analyses of the proposed facility and the related infrastructure are based on a 30m SRTM digital terrain model of the study area.

The first step in determining the visual impact of the proposed facility is to identify the areas from which the structures would be visible. The type of structures, the dimensions, the extent of operations and their support infrastructure are taken into account.

- **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 this type of structure.

Proximity radii for the proposed infrastructure 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 (anticipated) negative visual perception of the proposed facility.

- **Determine viewer incidence/viewer perception (sensitive visual receptors)**

The next layer of information is the identification of areas of high viewer incidence (i.e. main roads, residential areas, settlements, etc.) that may be exposed to the project infrastructure.

This is done in order to focus attention on areas where the perceived visual impact of the facility will be the highest and where the perception of affected observers will be negative.

Related to this data set, is a land use character map, that further aids in identifying sensitive areas and possible critical features (i.e. tourist facilities, protected areas, etc.), that should be addressed.

- **Determine the visual absorption capacity of the landscape**

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 discernible detail in visual characteristics of both environment and structure decreases.

- **Calculate the visual impact index**

The results of the above analyses are merged in order to determine the areas of likely visual impact and where the viewer perception would be negative. An area with short distance visual exposure to the proposed infrastructure, a high viewer incidence and a predominantly negative perception would therefore have a higher value (greater impact) on the index. This focusses the attention to the critical areas of potential impact and determines the potential **magnitude** of the visual impact.

Geographical Information Systems (GIS) software is used to perform all the analyses and to overlay relevant geographical data sets in order to generate a visual impact index.

- **Determine impact significance**

The potential visual impacts are quantified in their respective geographical locations in order to determine the significance of the anticipated impact on identified receptors. Significance is determined as a function of extent, duration, magnitude (derived from the visual impact index) and probability. Potential cumulative and residual visual impacts are also addressed. The results of this section are displayed in impact tables and summarised in an impact statement.

- **Propose mitigation measures**

The preferred alternative (or a possible permutation of the alternatives) will be based on its potential to reduce the visual impact. Additional general mitigation measures will be proposed in terms of the planning, construction, operation and decommissioning phases of the project.

- **Reporting and map display**

All the data categories, used to calculate the visual impact index, and the results of the analyses will be displayed as maps in the accompanying report. The methodology of the analyses, the results of the visual impact assessment and the conclusion of the assessment will be addressed in this VIA report.

- **Site visit**

A site visit must be undertaken in order to verify the results of the spatial analyses and to identify any additional site specific issues that may need to be addressed in the VIA report.

8. REFERENCES/DATA SOURCES

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