PROPOSED POFADDER SOLAR THERMAL PLANT, NORTHERN CAPE PROVINCE

VISUAL ASSESSMENT

Produced for:
KaXu CSP South Africa (Pty) Ltd

Produced by:
MetroGIS (Pty) Ltd.
PO Box 384, La Montagne, 0184
Tel: (012) 349 2884/5 Fax: (012) 349 2880
E-mail: lourens@metrogis.co.za Web: www.metrogis.co.za

On behalf of:
Savannah Environmental (Pty) Ltd.
PO Box 148, Sunninghill, 2157
Tel: (011) 234 6621 Fax: 086 684 0547
E-mail: info@savannahSA.co.za Web: www.savannahSA.com

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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.

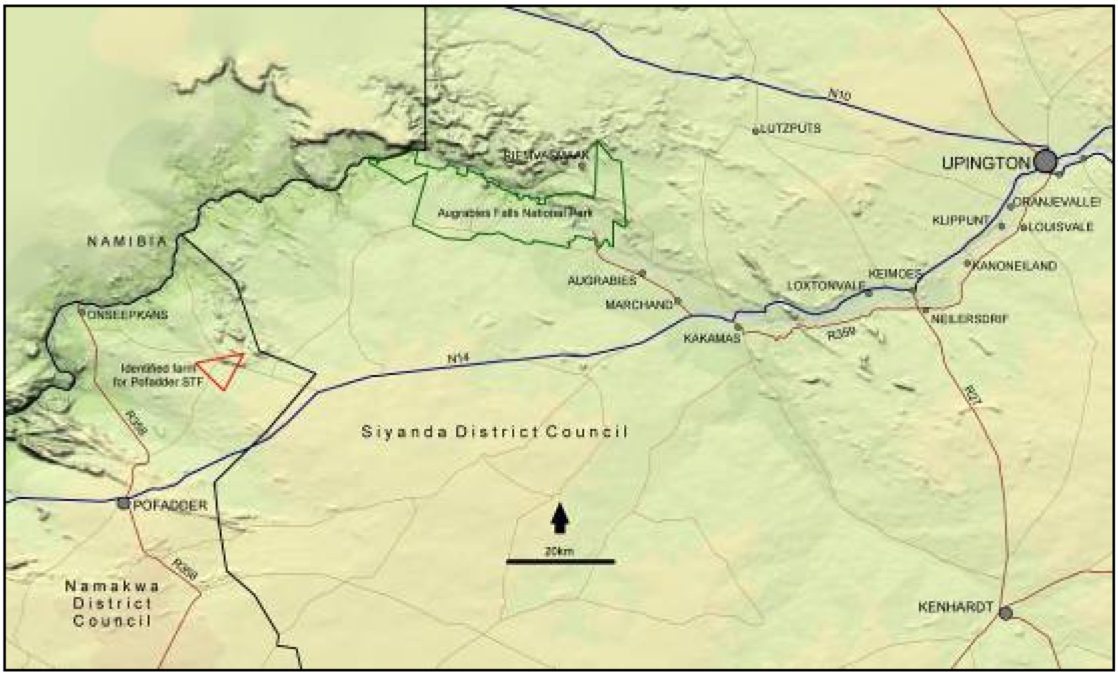
The team undertaking the visual assessment has extensive practical knowledge in spatial analysis, environmental modeling and digital mapping, and applies this knowledge in various scientific fields and disciplines. The expertise of these practitioners is often utilised in Environmental Impact Assessments, 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 Pofadder Solar thermal plant. The author, MetroGIS or V&L Landscape Architects will not benefit from the outcome of the project decision-making.

1. INTRODUCTION

KaXu CSP South Africa (Pty) Ltd (!KaXU CSP) is proposing the establishment of a solar thermal plant within the Khâi-Ma Local Municipality within the Namakwa District Municipality in the Northern Cape Province. The site is located approximately 30km (at the closest) north-east of Pofadder at a distance of approximately 15km north-west of the N14 national road. See **Map 1.**



Map 1: Locality of the proposed Pofadder Solar Thermal Plant

Solar thermal is a technology for harnessing solar energy for heat.

!KaXu CSP identified this region as a suitable location for a solar facility as it complies with the minimum Direct Normal Radiation (DNR) required by international standards to viably operate a solar facility.

The proposed facility is expected to have a development footprint of up to 11km² within the broader site of 33km² (the development footprint is the area which will be disturbed during the operational phase).

The facility is proposed to have a maximum generating capacity of 310 MW which will be comprised of a combination of the following technologies (in any combination):

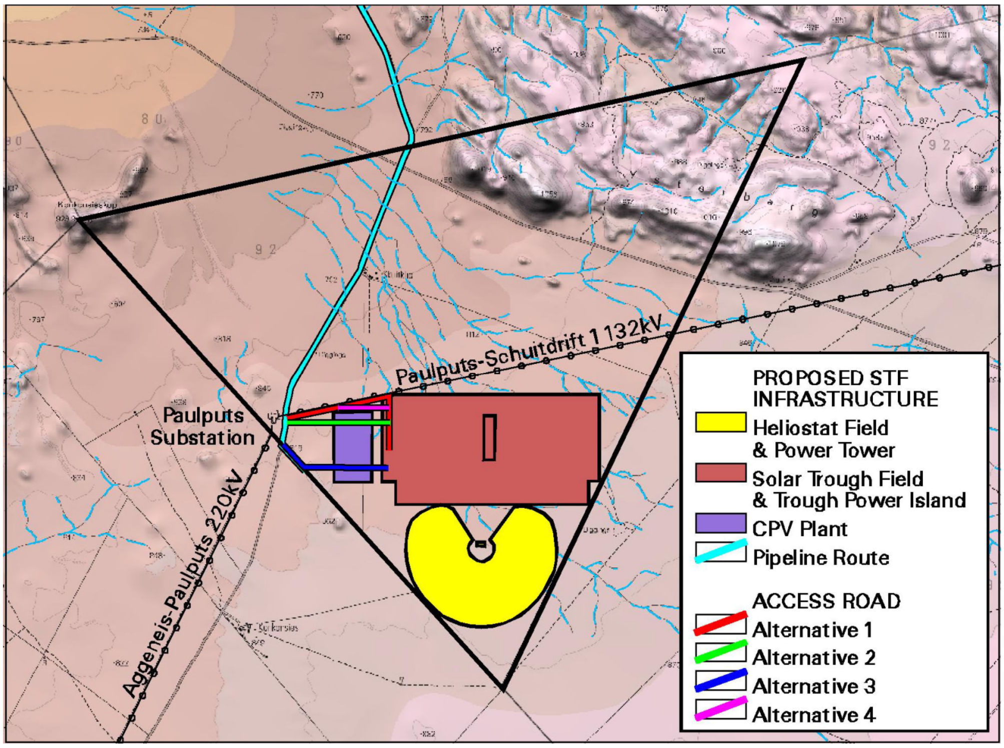
- **100MW solar trough field & trough power island:** This is a Concentrated Solar Power (CSP) system which makes use of curved, mirrored troughs which reflect direct solar radiation onto a glass tube containing a fluid (also called a receiver, absorber or collector), running the length of the trough, and positioned at the focal point of the reflectors.
- **50 MW heliostat field & power tower:** This CSP system, also known as 'central receiver' power plants or 'heliostat' and 'power tower' power plants, is a type of solar furnace using a tower to receive the focused sunlight. It uses an array of flat, movable mirrors (called heliostats) to focus the sun's rays upon a collector tower (the target).
- **10 MW Photovoltaic (PV) plant:** Photovoltaics (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. PV power generation employs solar panels (concentrating and / or tracking) comprising a number of cells containing a PV material (i.e. silicon).

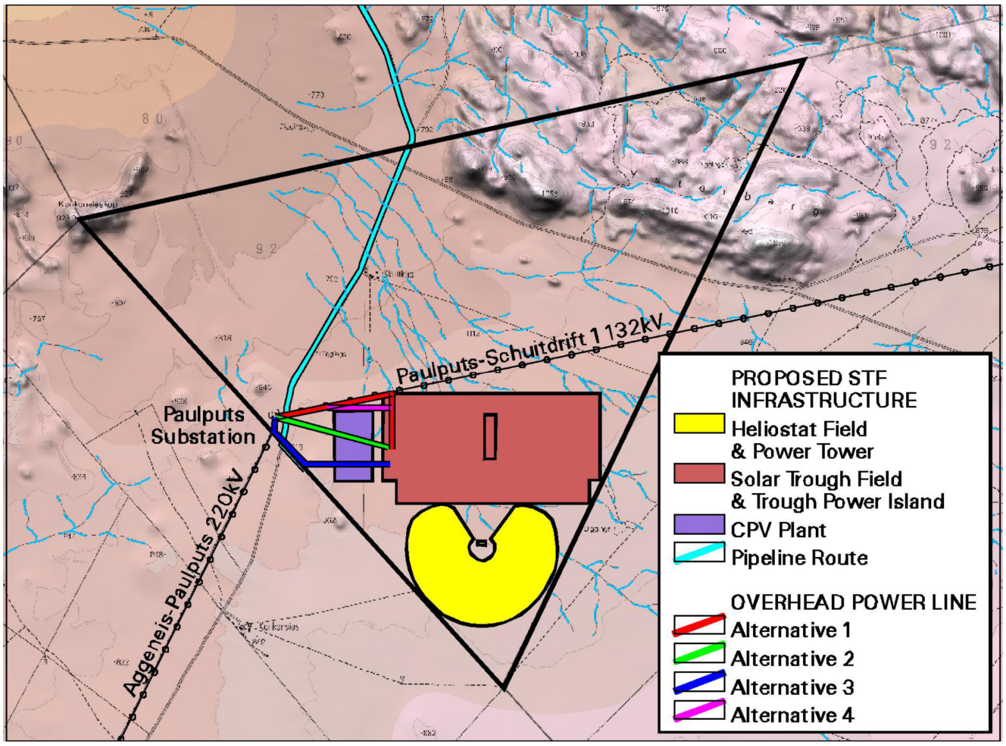
Primary infrastructure for the solar facility will include the following:

- Solar trough field (roughly 400 ha) & trough power island (roughly 10 ha)
- Heliostat field (roughly 300 ha) & power tower (roughly 0,5 ha)
- CPV plant (46 ha)

The power tower will consist of a 200 m high concrete structure with a receiver perched in the top of the concrete structure, in a cavity. This receiver in the cavity will appear white hot during daytime operations.

A layout of the proposed solar facility is shown on **Map 2**.





Map 2: Map indicating the layout of the proposed solar facility

The photographs below show infrastructure similar to the proposed solar facility:

Figure 1: Trough plant which is part of Abengoa Solar's Solúcar Platform in Sanlúcar la Mayor, Seville (Spain) [1].

Figure 2: Power tower and heliostat field which is part of Abengoa Solar's Solúcar Platform in Sanlúcar la Mayor, Seville (Spain) [2].

[1] Picture courtesy of Abengoa Solar, S.A., Seville, Spain.
[2] Picture courtesy of Abengoa Solar, S.A., Seville, Spain.

Figure 3: PV plant which is part of Abengoa Solar's Solúcar Platform in Sanlúcar la Mayor, Seville (Spain)[3].

The on-site ancillary infrastructural requirements will include:

- **A steam turbine & generator:** Concentrating solar thermal power facilities require water as the heat transfer medium for the generation of high temperature steam which is used to drive a conventional turbine and generator. This turbine and generator will be housed **within a 2-storey building** on-site.
- A generator **transformer and a small substation** outside the building, forming part of the power island.
- **Energy storage plant and vessels**: An auxiliary steam boiler (i.e. fossil fuel boiler / generator) will be included on the power island and will be fired by diesel fuel or LPG. The boiler will be able to provide steam to the process, freeze protection heat exchangers, steam turbine seal system, and other critical plant components while the solar plant is offline or during night time or cloud covered days, or when the grid connection is not available.
- **132 kV power line:** The generated power will be evacuated into the Eskom electricity grid via a 132 kV distribution line of approximately 2 km which will cross the site and will connect directly to Eskom's existing Paulputs Transmission Substation, which lies directly west of the site.
- **Evaporation pond** to receive wastewater from the generation process.
- An **access road** along the existing Eskom line.
- **Workshop, office, and storage areas** located within the boundaries of the overall site.

A **water abstraction point** and **pipeline** will be established to convey water from the Orange / Gariep River along an existing road reserve. There will also be 2 reservoirs built along the pipeline (i.e. a retention reservoir located some 6,3km from the abstraction point and a holding reservoir at the site). This infrastructure will be located outside of the development footprint for the proposed facility, but no layout has yet been finalised.

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[3] Picture courtesy of Abengoa Solar, S.A., Seville, Spain.

The construction phase of the solar plant is expected to be 2 to 3 years whilst the design lifespan of the facility is 30 years, extendible.

2. SCOPE OF WORK

The study area for the visual assessment encompasses a geographical area of $11km^2$ and includes a minimum 16km buffer zone from the proposed development area.

It does not include any major towns or built-up areas and the closest major roads are the N14 national road and the R358 main road. The study area is criss-crossed by a number of secondary (lower order local) roads. See **Map 1**.

The scope of work 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 a site visit to the affected environment. Issues related to the proposed solar facility include:

- The visibility of the facility to, and potential visual impact on, observers travelling along major routes (N14 and R358) in the area as well as the arterial roads and secondary roads within the study area.
- The visibility of the facility to, and visual impact on individual/isolated landowners/homesteads identified within the study area. (i.e. *Kwessie, Konkonsies, Oupvlakte, Nongcaip*).
- Potential cumulative visual impacts (or alternately, consolidation of visual impacts).
- The potential visual impact of operational, safety and security lighting of the facility at night on observers residing in close proximity 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.

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 solar facility and related infrastructure mentioned above, 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 contour 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, there would be no visual impact, or if the visual perception of the structure is favourable to all the observers, then the 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 within an area, and the VAC would be high if the vegetation is tall, dense and continuous. Conversely, low growing sparse and patchy vegetation would have a low VAC.

- **Determine the Visual impact index**

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

4. THE AFFECTED ENVIRONMENT

The identified site for the proposed facility is located on Portion 4 of Scuit-Klip 92. It is located approximately 36 km north-east of Pofadder, 180 km west of Upington and 100 km west of Kakamas.

The site is situated roughly on the junction of 2 secondary roads. Access to the site is gained via a secondary road which junctions off the R358 in the far south west of the study area. The R358, in turn, tees off the N14 national road, which also traverses the study area in the far south east.

Of significance is that the N14 and R358 are recognised tourist access routes within the region, giving access to visitors to the Green Kalahari, Namaqualand and Namibia (via Onseepkans).

The site location can be described as remote due to its considerable distance from any major metropolitan centres or populated areas. Very few homesteads and settlements are present within the study area (see **Map 2**). These include *Skuitklip (currently used as a feed store), Oupvlakte, Konkonsies, Kwessie and Nongcaip.*

It is uncertain whether all of the potentially affected farmsteads are inhabited or not. It stands to reason that farmsteads that are not currently inhabited will not be visually impacted upon at present. These farmsteads do, however retain the potential to be affected visually should they ever become inhabited again in the future. For this reason, the author of this document operates under the assumption that they are all inhabited.

The topography of the study area consists primarily of *plains,* with *low mountains* occurring in the north-east of the development site. The most prominent of these mountains is the Ysterberg (Iron Mountain), part of which is located on the farm Skuit-klip, and which has reportedly been quarried for granite in parts. The terrain slopes in a generally north-westerly direction towards the Orange River (the border between South Africa and Namibia) where the topography is characterised by *hills* and *low mountains*. Rocky outcrops occur to the south-west of the study area.

See **Map 2** for the shaded relief/topography map of the study area.

The area is sparsely populated (less than 1 person per km^2) and is often referred to as the *Bushmanland*. This arid, semi-desert region receives less than 150mm precipitation per annum and is therefore greatly devoid of any rain fed agriculture or cultivation. Sheep and game farming occur throughout the region at a less intensive scale.

The vegetation cover in this semi-desert region is predominantly *shrubland* with some *woodland* and *grassland* occurring to the west and south-west of the study area. See **Map 3** for the broad land cover types map of the study area.

There are very few man-made structures within the study area, with the exception of a few homesteads/farmsteads, a substation (the Paulputs Transmission substation located on the farm Skuit-klip) and a number of power lines traversing the proposed development site. The power lines include the Paulputs to Schuitdrift 1 132 kV distribution line to the north-east and the Aggeneis to Paulputs 1 220kV transmission line to the south west.

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

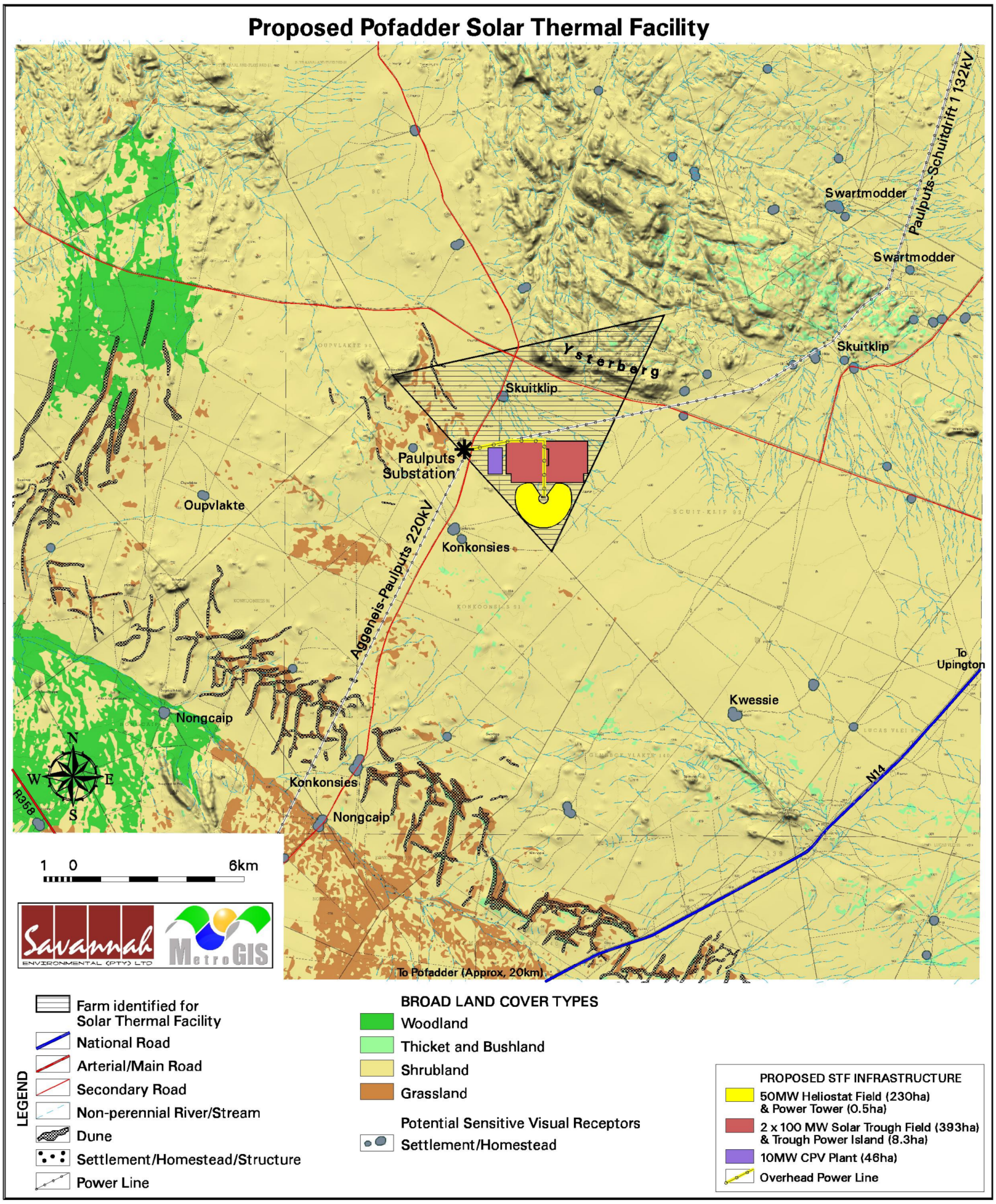
Figure 4: Photograph of the proposed site taken from the access road from the south west (looking in a north easterly direction).

Several potentially sensitive areas were identified through Scoping Phase. These include the following:

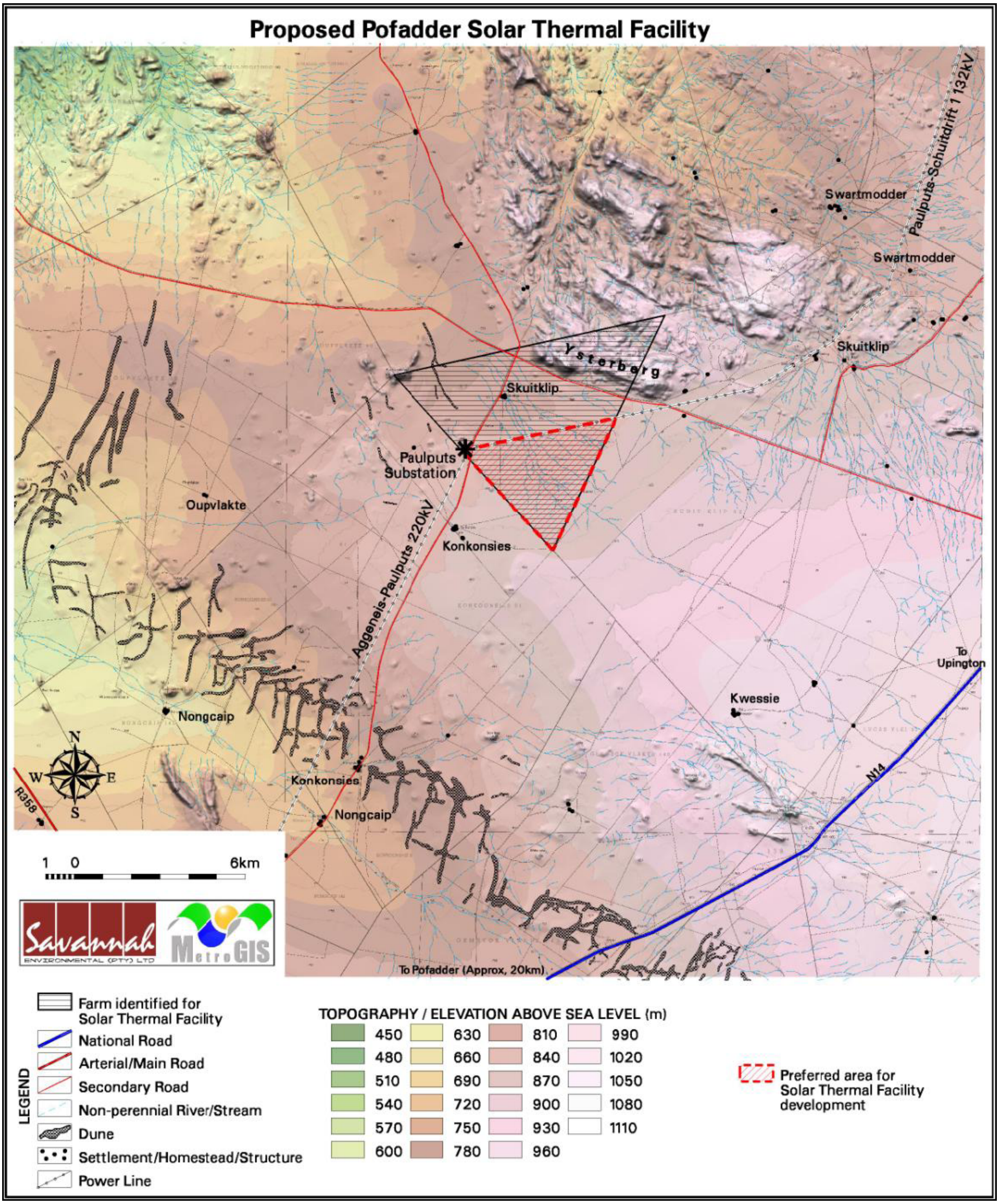
- Areas containing vegetation of conservation importance, based primarily on the location of the site within the Gariep Centre of Floristic Endemism.
- Areas classified as mountains, ridges, or steep slopes: Some of the steeper scarp slopes in the north-western portion of the study area are steep enough to be sensitive to erosion and downslope impacts.
- Areas along natural drainage lines: Dry river beds and drainage lines are an important habitat for a number of species in the study area, including those with a restricted distribution or species with an elevated conservation status.

Considering the above, the southern corner of the triangular shaped study site is the preferred area of Portion 4 of the Farm Skuit-Klip 92 for the proposed solar thermal plant development. See **Map 4** below.

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



Map 3: Land cover types and vegetation cover of the broader study area



Map 4: Preferred Development Zone within the Site

5. RESULTS

5.1 Potential Visual Exposure

The potential visual exposure analysis was undertaken from actual positions as set out in the layout of the facility. The heights of the power tower 200m and heliostats (12m) were used during the generation of the viewshed, as these represent the largest and potentially the most visibly prominent infrastructure within the proposed facility. The potential visual exposure of the PV panels and the troughs, which are similar in size to the heliostats, are also accommodated within the heliostat field viewshed.

The on-site ancillary infrastructure (i.e. the 2-storey generator building, the transformer and substation, the energy storage plant and vessels, the power line, the evaporation pond, the access road and the workshops and offices) are all smaller than the power tower, and will thus fall within this structure's viewshed.

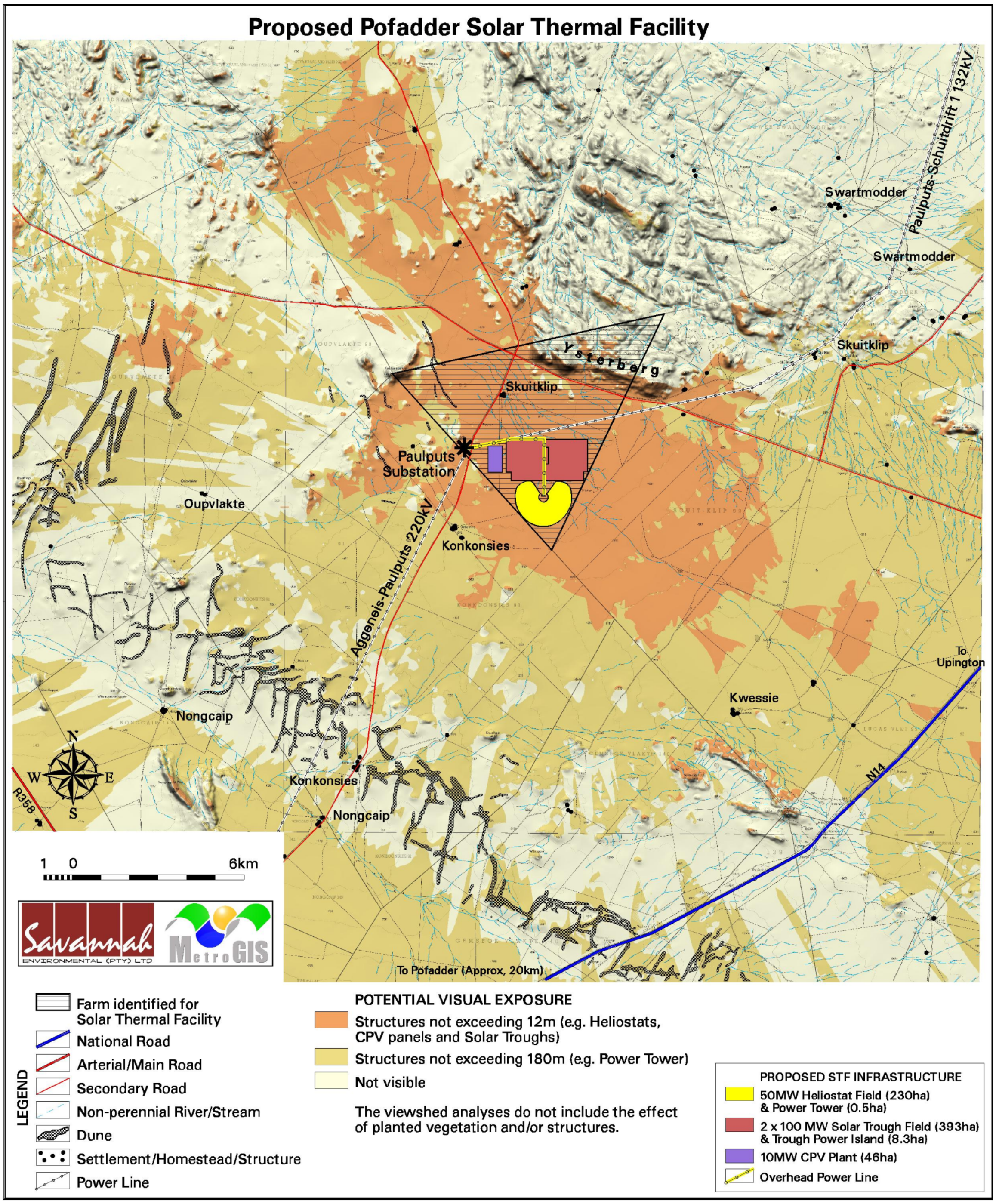
The joint visual exposure of the power tower and the heliostats are indicated on **Map 5**. The darker shading indicates areas from which the power tower, the heliostats, the PV panels, the parabolic troughs and the on-site ancillary infrastructure would potentially be visible. The lighter shading indicates areas from which only the larger power tower would be visible.

It is clear from this viewshed analysis that the facility (specifically the power tower) would be exposed to a large geographical area due to the relatively flat topography. This is particularly relevant to the south, north-west and east. Visibility is limited from the north and north-east, where the topography of the Ysterberg provides visual screening.

It is anticipated that the power tower, as well as the smaller infrastructure (i.e. the heliostats, the PV panels, the parabolic troughs and the larger buildings) will be visible from the area immediate surrounding the facility and the Paulputs Substation to the immediate west of the proposed plant.

The power tower, or parts thereof, may be visible from sections of the N14 and R358 as well as from relatively continuous stretches of the secondary roads traversing the study area.

It is envisaged that the power tower would be easily and comfortably visible, especially within a 16km radius of the site and would constitute a high visual prominence, potentially resulting in a high visual impact. It should be noted, however that the nature of the impact is subjective. This means that some visual receptors may consider the visual impact to be positive rather than negative, depending on their frame of reference and their intention for visiting the area (for example if they are in the region with the purpose of visiting the facility, they might see the visual prominence as a positive thing).



Map 5: Potential visual exposure of the solar facility

The potential visual exposure as illustrated is a theoretical representation of where visual receptors would be able to see the facility from. This does not take into consideration local factors such as vegetation, orientation of structures and localised topographical features.

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 solar energy facilities.

The proximity radii (calculated from the outer extent of the proposed development area) are shown on **Map 6** and are as follows:

- 0 - 4 km - Short distance view where the solar facility would dominate the frame of vision and constitute a very high visual prominence.
- 4 - 8 km - Medium distance view where the solar facility would be easily and comfortably visible and constitute a high visual prominence.
- 8 - 16 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 high to medium visual prominence.
- Greater than 16 km - Long distance view of the facility where solar facility would still be visible though not as easily recognisable. This zone constitutes a medium visual prominence for the facility.

5.3. Viewer Incidence / Viewer Perception

For the purpose of this study, only two categories were identified as having differing observer incidences and/or perceptions. These are indicated on **Map 6**:

- The **first** category is that of relatively low viewer incidence, but potential negative perception[4]. This includes the homesteads / settlements within the study area. These include Konkonsies (north) in close proximity of the proposed facility. Kwessie, Nongcaip (west & east) Skuitklip (east) and Konkonsies (south) lie further afield.

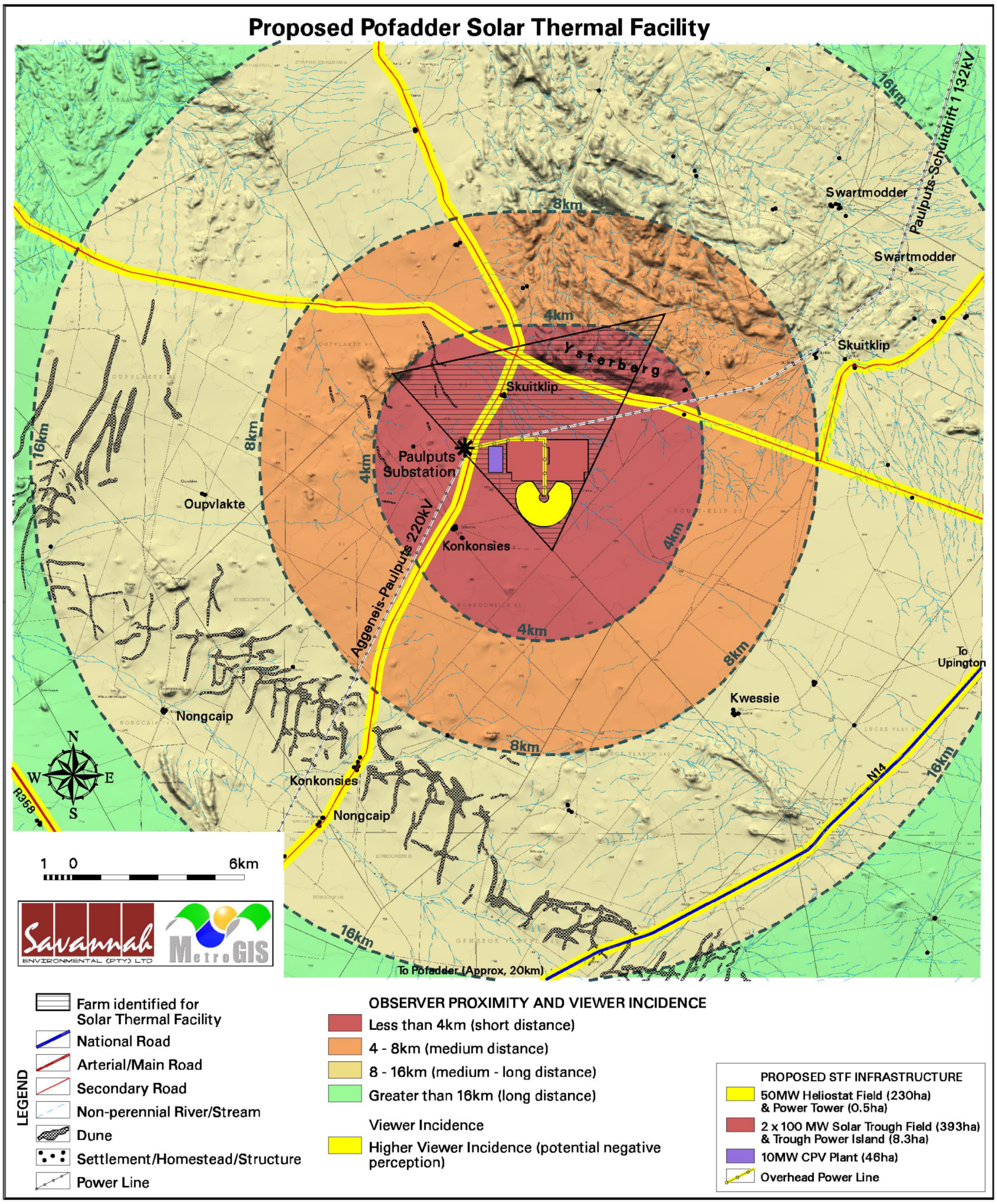
  Observers residing in these areas are accustomed to the wide natural expanses and vistas afforded by this rural region. Developments of the scale of the power tower (i.e. 200m tall) may constitute a negative visual impact, as receptors are unaccustomed to this type of visual prominence.

  Viewers from Konkonsies could be exposed to a cumulative impact, as the Paulputs Substation and the Aggeneis-Paulputs power line already constitute visual intrusion.

- The **second** category comprises corridors along the main roads in the area. These areas include 200m buffer zone along the national, arterial, and secondary roads, and are expected to support a higher frequency of observers. These buffers represent the area with the highest potential sightings of the solar facility.

  Views from the southern parts of these corridors are considered more significant, since the facilities will be viewed against the backdrop of the Ysterberg topography.

[4] It must be noted that no complaints pertaining to potential visual impact of the construction and operation of the proposed solar facility, as far as the author is aware, were received from individual landowners in the study area during the public participation process or otherwise.



Map 6: Observer proximity to the proposed solar facility and areas of high viewer incidence.

5.4. Visual Absorption Capacity of the Natural Vegetation

The vegetation units present in the study area surrounding the solar facility (predominantly *Thicket and Bushland* and *Shrubland*) are on average only 2m high. This, coupled with the sparse distribution of the plant species, the dimensions of the facility and height of structures, it was determined 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 solar facility are displayed on **Map 7.**

Here the weighted impact and the likely areas of impact are indicated as a visual impact index. Values were 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.

Category 1 *– residential areas / built up / settlement areas*

Konkonsies (north) will be subject to close range views, where it could be expected that the power tower will be visible. These observers will experience a **high** visual impact. It is not likely that on-site ancillary infrastructure will be visible (this includes the 2-storey generator building, the transformer and substation, the energy storage plant and vessels, the power line, the evaporation pond and the workshops and offices).

The settlements of Kwessie, Nongcaip (east and west), Skuitklip (east) and Konkonsies (south) are expected to be exposed to medium to long distance views of the power tower only. It is not anticipated that the other primary infrastructure (i.e. the heliostats, the CPV panels or the troughs) or on-site ancillary infrastructure will be visible from this distance. These observers will experience a **moderate** visual impact.

It should be noted that the visual impact index does not take into account visual clutter and structures that obstruct long distance views within built-up areas. For this reason it can be assumed that the solar facility would not be visible from all areas within the settlements, but have a higher visual incidence from the outskirts.

Category 2 *– corridors / roads*

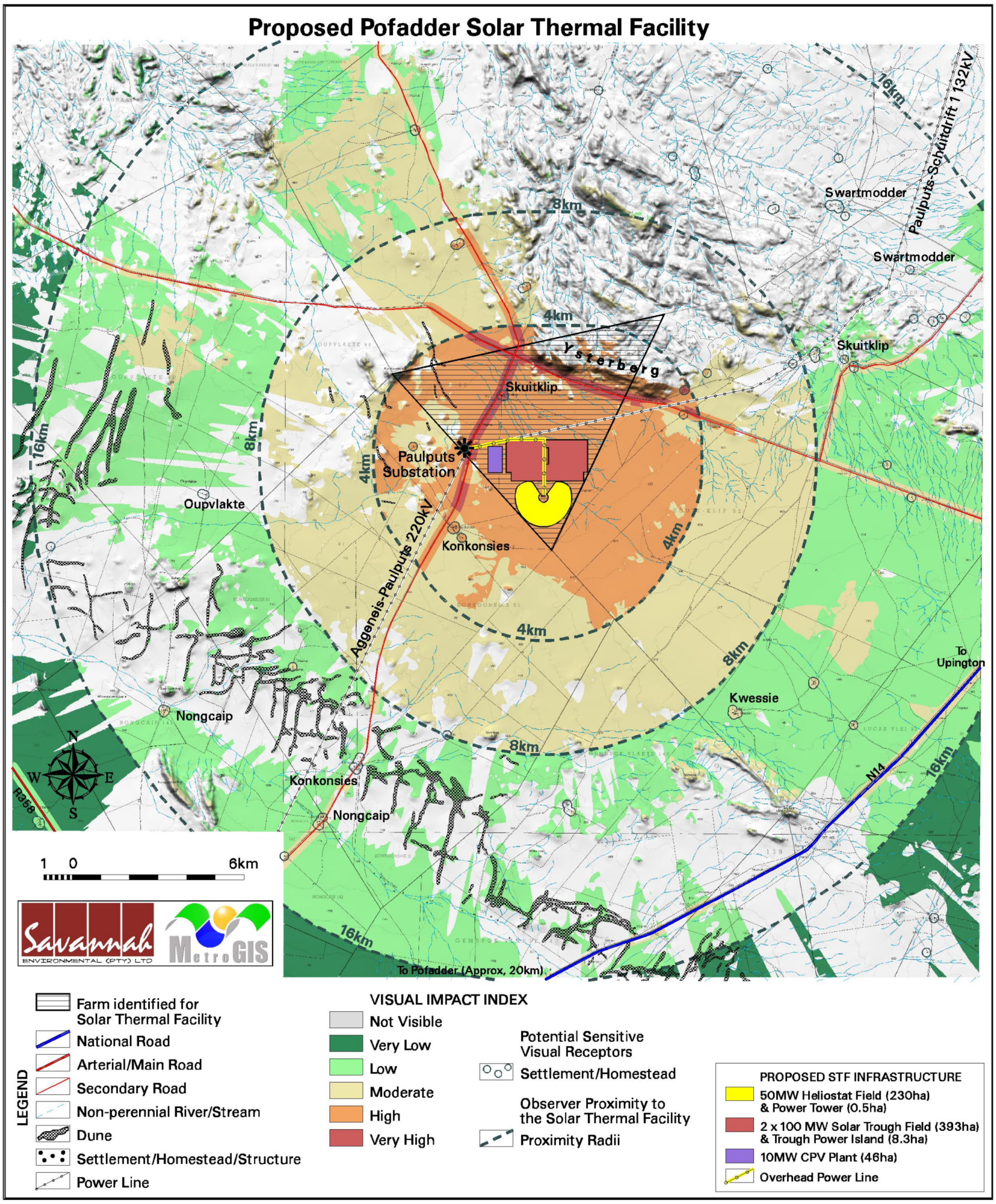
Users of the secondary roads in close proximity to the facility (i.e. within 4 km) would be exposed to a **very high** potential visual impact as a result of the power tower and the other primary infrastructure (i.e. the heliostats, the CPV panels and the troughs) as well as the on-site ancillary infrastructure. This includes those sections of secondary road passing through the site in the north and in the west. It should be noted, however, that these secondary roads do not carry high volumes of motorists.

The above secondary roads will potentially experience **high** visual impact for short sections between the 4km and 8km radius, dropping to a **moderate** impact. Beyond the 8km radius, primary infrastructure (including the power tower, the heliostats, the troughs and the PV panels) may be visible for these stretches, as may some secondary infrastructure.

A section of the N14 national road which lies between 8km and 16km of the site will be exposed to views of the power tower, and thus experience **moderate** visual impact, if any. It is not anticipated that the other primary infrastructure or on-site ancillary infrastructure will be visible from this distance.

A section of the R358 lies more than 16km from the facility, and will thus be potentially exposed to only **low** to **very low** visual impact.

Of significance is that the N14 and R358 are utilised as tourist access routes within the region, giving access to visitors to the Green Kalahari, Namaqualand, and Namibia (via Onseepkans).



Map 7: Visual impact index of the proposed solar facility.

5.6 Visual Impact Assessment

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 (= 2), low (= 4), medium/moderate (= 6), high (= 8) and very high (= 10)
- **Probability** – very improbable (= 1), improbable (= 2), probable (= 3), highly probable (= 4) and definite (= 5)
- **Status -** positive, negative and neutral
- **Reversibility** - reversible, recoverable and irreversible
- **Significance** - low, medium and 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 extent, duration and magnitude (i.e. **significance = consequence (extent + duration + magnitude) 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 power tower 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.

5.6.1 The Solar Facility (specifically the power tower)

Potential visual impact on users of secondary roads in proximity of the solar facility.

Potential visual impact on the secondary roads in close proximity (i.e. within 8km) to the proposed solar facility is expected to be **high**.

The tables below illustrate this impact assessment.

Table 1 Impact table summarising the significance of visual impact on users of secondary roads in close proximity of the solar facility.

Nature of Impact: Potential visual impact on users of secondary roads in proximity of the solar facility		
	Without Mitigation	**_After Mitigation_**
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Very high **(10)**	N/a
Probability	High **(4)**	N/a
Significance	High **(72)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable	
Irreplaceable loss of resources?	No	
Can impacts be mitigated during operational phase?	No	
Mitigation: Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years (not considered in above "after mitigation" assessments).		
Cumulative impacts: None.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

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

The visual impact of the proposed solar facility on homesteads and settlements is found to be **high** for those within 8km of the facility.

The tables below illustrate this impact assessment.

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

<table>
<tr><td colspan="3">Nature of Impact:
Potential visual impact residents of settlements and homesteads in close proximity of the solar facility</td></tr>
<tr><td></td><td>Without Mitigation</td><td>After Mitigation</td></tr>
<tr><td>Extent</td><td>Local (4)</td><td>N/a</td></tr>
<tr><td>Duration</td><td>Long term (4)</td><td>N/a</td></tr>
<tr><td>Magnitude</td><td>High (8)</td><td>N/a</td></tr>
<tr><td>Probability</td><td>High (4)</td><td>N/a</td></tr>
<tr><td>Significance</td><td>High (64)</td><td>N/a</td></tr>
<tr><td>Status (positive or negative)</td><td>Negative</td><td>N/a</td></tr>
<tr><td>Reversibility</td><td colspan="2">Recoverable</td></tr>
<tr><td>Irreplaceable loss of resources?</td><td colspan="2">No</td></tr>
<tr><td>Can impacts be mitigated during operational phase?</td><td colspan="2">No</td></tr>
<tr><td colspan="3">Mitigation:
Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years (not considered in above “after mitigation” assessments).</td></tr>
<tr><td colspan="3">Cumulative impacts:
None.</td></tr>
<tr><td colspan="3">Residual impacts:
None. The visual impact will be removed after decommissioning.</td></tr>
</table>

Potential visual impact on users of major roads and residents of settlements and homesteads within the region.

The visual impact of the proposed solar facility on users of the national, arterial, and secondary roads, as well as residents of settlements and homesteads which lie beyond 8km of the site is found to be **moderate**.

Of significance is that the N14 and R358 are recognised tourist access routes within the region, giving access to visitors to the Green Kalahari, Namaqualand, and Namibia (via Onseepkans).

The table below illustrates this impact assessment.

Table 3 Impact table summarising the significance of visual impacts on residents of towns, settlements, and homesteads within the region

Nature of Impact: Potential visual impact on users of major roads and residents of settlements, and homesteads within the region (>8km)		
	Without Mitigation	***After Mitigation***
Extent	Regional **(3)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Moderate **(6)**	N/a
Probability	High **(4)**	N/a
Significance	Moderate **(52)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable	
Irreplaceable loss of resources?	No	
Can impacts be mitigated during operational phase?	No	
Mitigation: Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years (not considered in above "after mitigation" assessments).		
Cumulative impacts: None.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

5.6.2 Ancillary infrastructure

Potential visual impact of on-site ancillary infrastructure on visual receptors in close proximity of the solar facility.

The on-site ancillary infrastructure proposed for the solar facility includes the following:

- Steam turbine & generator housed within a 2 storey building,
- Generator transformer and a small substation,
- Energy storage plant and vessels,
- 132 kV power line,
- Evaporation pond,
- An access road and
- Workshop, office, and storage areas.

Although no dedicated viewshed has been generated for the above infrastructure, it is all located within the development site. It is thus anticipated that the area of potential visual exposure will lie within that of the primary infrastructure (i.e. specifically the power tower, heliostats, PV panels and troughs). The potential visual impact of this on-site ancillary infrastructure is expected to be **medium** in close proximity (i.e. within 4km) of the proposed facility.

The table below illustrates this impact assessment.

Table 4 Impact table summarising the significance of visual impacts of the on-site ancillary infrastructure on visual receptors in close proximity of the solar facility

Nature of Impact: Potential visual impact of on-site ancillary infrastructure on visual receptors in close proximity of the solar facility (<4km)		
	Without Mitigation	***After Mitigation***
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	High **(8)**	N/a
Probability	Probable **(3)**	N/a
Significance	Medium **(48)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable	
Irreplaceable loss of resources?	No	
Can impacts be mitigated during operational phase?	Yes	
Mitigation: Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years (not considered in above "after mitigation" assessments).		
Cumulative impacts: None.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

Potential visual impact of off-site ancillary infrastructure on visual receptors in close proximity of the solar facility.

The off-site ancillary infrastructure proposed for the solar facility includes the following:

- A water abstraction point on the Orange / Gariep River at Raap en Skraap's existing abstraction point (existing),
- An underground pipeline to convey water via an existing road reserve.
- 2 reservoirs along the pipeline (i.e. a retention reservoir located some 6km from the abstraction point and a holding reservoir on site)

This off-site infrastructure will be located outside of the development footprint for the proposed facility, but no layout has yet been finalised. The small visual impact of this infrastructure is not included in this assessment.

5.7. Secondary visual impacts

5.7.1. Lighting impacts

Potential visual impact of lighting on visual receptors in close proximity of the solar facility.

The area earmarked for the placement of the solar facility has a relatively small number of populated places (settlements and farmsteads).

The power tower glows white hot during the day but the effect will be low, in the context of daylight.

Although these are not densely populated areas, the light trespass and glare from the security and after-hours operational lighting will have some significance. Furthermore, the sense of place and rural ambiance of the local area increases its sensitivity to such lighting intrusions.

A second source of light pollution stemming from the solar facility will be in the form of 'glare light', which is not as intense as flood lighting. The source of this lighting is the aircraft warning lights mounted on top of the power tower. 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 impact is low. Only the power tower will require such lights, which means the impact of these should also be low.

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, contributes to the increase in sky glow. The solar facility may contribute to the effect of sky glow in an otherwise dark environment.

The anticipated impacted of lighting is expected to be **moderate**, and may be mitigated to **low.** The table below illustrates this impact assessment.

Table 5 Impact table summarising the significance of visual impacts of lighting on visual receptors in close proximity of the solar facility

Nature of Impact: Potential visual impact of lighting on visual receptors in close proximity of the solar facility		
	Without Mitigation	***After Mitigation***
Extent	Local **(4)**	N/a
Duration	Long term **(4)**	N/a
Magnitude	Medium **(6)**	N/a
Probability	Probable **(3)**	N/a
Significance	Medium **(42)**	N/a
Status (positive or negative)	Negative	N/a
Reversibility	Recoverable	
Irreplaceable loss of resources?	No	
Can impacts be mitigated during operational phase?	Yes	
Mitigation: Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years (not considered in above "after mitigation" assessments).		
Cumulative impacts: The addition of facility and infrastructure lighting to the lighting impact already present at the Eskom substation may result in a cumulative impact of lighting in an otherwise dark environment.		
Residual impacts: None. The visual impact will be removed after decommissioning.		

5.7.2. Potential visual impacts associated with the construction phase

The construction phase of a project potentially causes the most disturbances within the receiving environment. During this time there will be a noticeable increase in heavy vehicles utilising the roads to the development site that may cause, at the very least, a visual nuisance to other road users and land owners in the area.

5.8. The potential to mitigate visual impacts

- The primary visual impact, namely the appearance of the facility (specifically the power tower), is not possible to mitigate. The largest structure, being the power tower, will be impossible to hide. The heliostats (with a footprint area of about 130m² each) as well as the PV panels and the troughs are also large, and their functional design cannot be changed in order to reduce visual impacts. All other structures and on-site ancillary infrastructure will fall within the viewshed of the larger structures.

  Considering the topography of the land and the VAC of the vegetation, very little can be done to mitigate the visual impacts caused by these structures. Furthermore, the functional design of these structures and the dimensions of the facility cannot be changed in order to reduce visual impacts. Therefore, the potential for mitigation is low.

  The aesthetic quality of the power tower could be enhanced through architectural input in the design of the structure.

- The visual impact of the power line is not possible to mitigate, but it is anticipated that this impact will be somewhat absorbed by the existing power line infrastructure.

- The visual impact of off-site ancillary structures such as the pipeline can be successfully mitigated by placing the pipe underground, and rehabilitating the vegetation within the pipeline servitude. This has the further advantage of negating possible visual impacts associated with vegetation clearing and potential unsightly erosion scarring.

  It will not be possible to mitigate the visual impact of the proposed off-site reservoir, but these should, if possible, be located in areas topographically screened by users of major and secondary roads, and residents of homesteads and settlements.

- The mitigation of secondary visual impacts caused by security and functional lighting, and construction activities may be mitigated through careful planning and management.

  Mitigation of lighting impacts includes the pro-active design, planning, and specification of the lighting for the facility. The correct specification and placement of lighting and light fixtures for the 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.

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

  - Reduce the construction period, if possible, through careful planning and productive implementation of resources.
  - Restrict the activities and movement of construction workers and vehicles to the immediate construction site.
  - Ensure that the general appearance of construction activities, construction camps (if required) and lay-down areas are maintained by means of the timely removal of rubble and disused construction materials.
  - Restrict construction activities to daylight hours, as per the requirements of the Environment Conservation Act, in order to negate or reduce the visual impacts associated with lighting.

6. PHOTO SIMULATIONS

Photo simulations were undertaken (in addition to the above spatial analyses) in order to illustrate the potential visual impact of Pofadder Solar Thermal Plant 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 plant and its related infrastructure 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 Solar Thermal Plant. The simulations are based on the dimensions and layout as indicated on Figure 1 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 approximate viewing distances indicated were measured from the closest plant infrastructure to the vantage point.

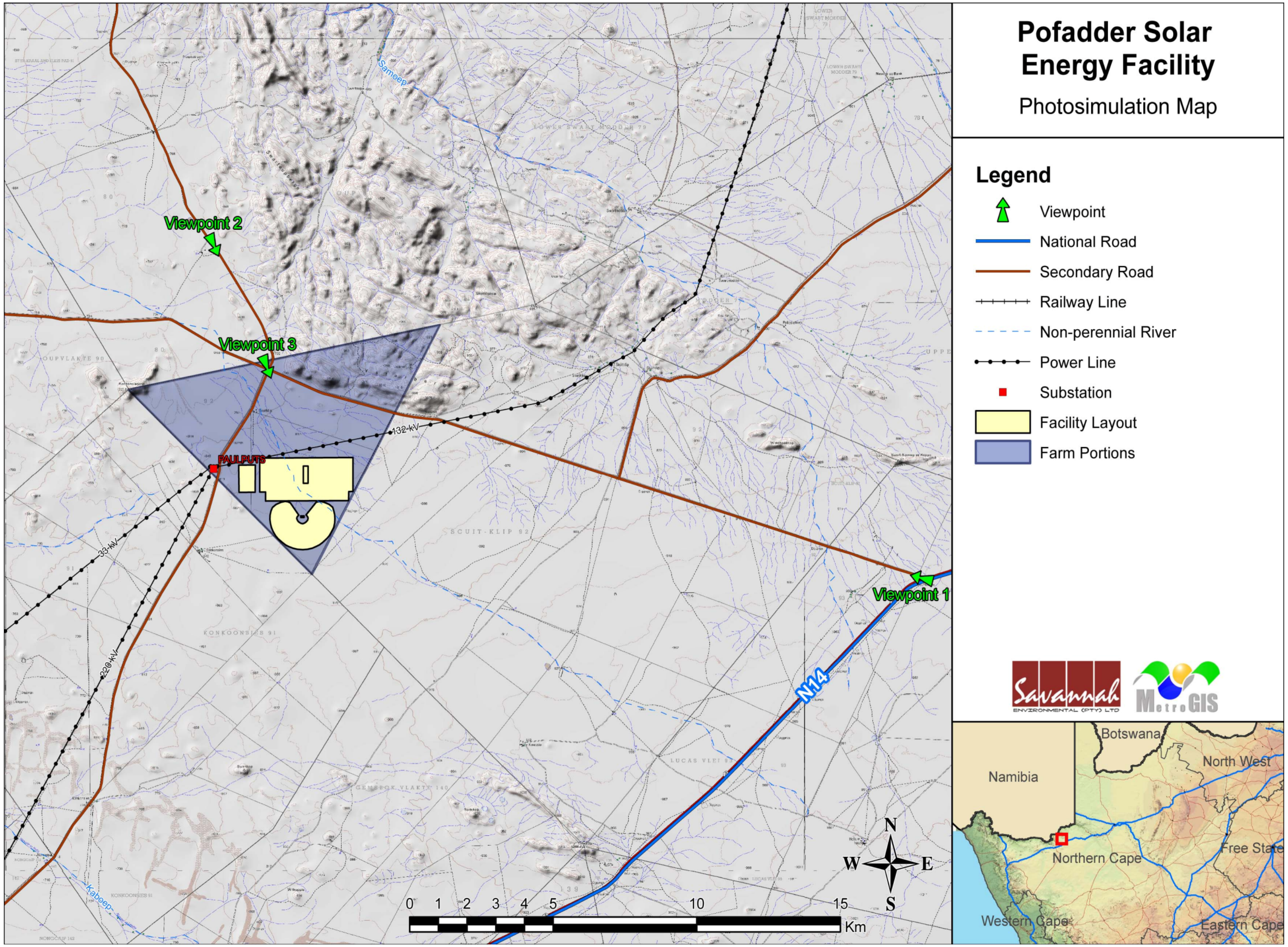
The simulated views show the placement of the plant during the longer-term operational phase of the facility's lifespan. It is assumed that the necessary post-construction phase rehabilitation and mitigation measures, as proposed by the various specialists in the environmental impact assessment report,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

It is imperative that the vegetation within and surrounding the site 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, access road, 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 plant and the structures therein is viewed. Each panoramic overview indicates the section that was enlarged to show a more detailed view of the plant.

The camera used was a standard Canon EOS 300D with an 18-55mm lens. Photos intended for panoramas were 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) compensates for the focal length on each photo used in the panorama through a largely automated process (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 simulated plant and infrastructure, as shown on the photographs, was 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 plant.



Map 8: Photograph positions for Photo Simulations.

6.1 West north-westerly view

Viewpoint 1 (long distance view)

Viewpoint 1 is located at the junction of the N14 and the road that links this with Onseepkans, which runs through the north-eastern tip of the proposed development site. The point from which the photo was taken is approximately 16km to the south east of the proposed plant and about 45 km (as the crow flies) from the outskirts of Pofadder.

This view is indicative of a long range view that residents and commuters travelling along the N14 from Lutzburg to Pofadder, as well as those travelling north-west along the secondary road towards Oseepkans, will see of the Solar Thermal Plant.

The viewing direction is west north-westerly and only the power tower will be visible in the distance.

Figure 5a: Pre construction panoramic overview from Viewpoint 1.

Figure 5b: Post construction panoramic overview from Viewpoint 1 (indicating enlarged photograph sections).

Figure 5c: View 1a (enlarged photograph section from Viewpoint 1).

Figure 5d: View 1b (enlarged photograph section from Viewpoint 1).

6.2 South south-easterly view

Viewpoint 2 (medium distance view)

Viewpoint 2 is located on a secondary road to the north of the proposed Pofadder Solar Thermal Plant, leading to Styr-kraal. This position lies approximately 7 km from the closest of the plant infrastructure and is indicative of what will be seen by residents and commuters moving from Styr-kraal towards the facility as well as potential guests making use of the facilities at the Keboes Fruit Farms Guest House.

The viewing direction is south south-easterly and the power tower will be clearly visible in the landscape. Portions of the solar trough field, heliostat field as well as the troughs may also be visible from this distance.

Figure 6a: Pre construction panoramic overview from Viewpoint 2.

Figure 6b: Post construction panoramic overview from Viewpoint 2 (indicating enlarged photograph sections).

Note Konkonsieskop is visible in view 2a of the above photograph.

Figure 6c: View 2a (enlarged photograph section from Viewpoint 2). *Note Konkoonsieskop visible the photograph*

Figure 6d: View 2b (enlarged photograph section from Viewpoint).

6.3 South south-easterly view

Viewpoint 3 (close distance view)

Viewpoint 3 is located on the 4 way intersection of the road running from the N14 to Oseepkans, the northern access point to the plant and the road that leads to the Keboes Fruit Farms Guest House. This photo was taken from a position on the northern boundary of the proposed development site and lies approximately 3 km away from the closest plant infrastructure and is indicative of what will be seen from close range.

The viewing direction is south south-easterly and large portions of the solar trough field, heliostat field as well as the power tower will be visible in the landscape.

Figure 7a: Pre construction panoramic overview from Viewpoint 3.

Figure 7b: Post construction panoramic overview from Viewpoint 3 (showing photo sections).

Figure 7c: View 3a (enlarged photograph section from Viewpoint 3).

Figure 7d: View 3b (enlarged photograph section from Viewpoint 3).

7. ASSESSMENT OF ALTERNATIVES

In both instances (i.e. for both the access road and the overhead power line), the preferred alternative would be Alternative 1. These alternatives both follow the Paulputs-Schuitdrift 1 132kV power line, thereby consolidating the existing linear infrastructure within the region.

8. CONCLUSIONS AND RECOMMENDATIONS

The construction and operation of the Pofadder Solar Thermal Plant (primarily the power tower) will have a visual impact on the natural scenic resources of this region, since infrastructure of this scale is not present in this environment.

However, the author is of the opinion that the solar 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 positive 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 novel and futuristic design that invokes a curiosity factor not generally present with other conventional power generating plants. The advantage being that the solar 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.

This opinion should however not detract from the fact that the power tower would be visible for a large area that incorporates potentially sensitive visual receptors. Of additional significance is that the N14 and R358 are recognised tourist access routes within the region.

There are not many recommendations as to the mitigation of the visual impact of the facility. This includes the primary and on-site ancillary infrastructure (although visibility of this infrastructure is expected to be limited), but refers especially the power tower.

The following is, however recommended:

- The aesthetic quality of the power tower should be enhanced through architectural input in the design of the structure.
- The visual impact of the pipe line should be mitigated by placing the pipe underground, and rehabilitating the vegetation within the pipeline servitude.
- The proposed off-site reservoir should, if possible, be located in areas topographically screened by users of major and secondary roads, and residents of homesteads and settlements.
- Light fixtures should be properly planned, placed and maintained in order to reduce visual impacts associated with glare and light trespass.
- All disturbed areas should be properly rehabilitated, and all infrastructure and the general surrounds should be maintained in a neat and appealing way.
- The construction phase of the facility should be sensitive to potential observers near the construction site. The placement of lay-down areas, batching plants and temporary construction camps should be carefully

considered in order to not negatively influence the perception of the future facility.

- Secondary visual impacts associated with the construction phase, such as the sight of construction vehicles, dust and construction litter, must be managed to reduce visual impacts. The use of dust-suppression techniques on the access roads, timeous removal of rubble and litter, and the erection of temporary screening will assist in doing this.
- The facility should be dismantled upon decommissioning and the site and surrounding area should be rehabilitated to its original (current) visual status.

9. IMPACT STATEMENT

In light of the results and findings of the Visual Impact Assessment undertaken for the proposed Pofadder Solar Thermal Plant, it is acknowledged that the natural and relatively unspoiled rural views surrounding the site will be impacted upon, primarily by the power tower, for the entire operational lifespan (approximately 30 years) of the facility[5].

The potential visual impact of the power tower on users of national, arterial and secondary roads in close proximity of the solar facility will be of high significance, as will the potential visual impact on residents of settlements and homesteads in close proximity to the proposed facility.

Within the region, the anticipated visual impact on users of major roads and residents of settlements and homesteads will be moderate.

In terms of the on-site ancillary infrastructure, the potential visual impact is expected to be medium, but much of this will be overshadowed by the much taller power tower as well as the heliostats, PV panels and troughs.

This anticipated visual impact is not, however, considered to be a fatal flaw from a visual perspective, considering the low incidence of visual receptors in the region and the contained area of potential visual exposure.

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

10. 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. The management plan primarily focuses on the mitigation and management of potential secondary visual impacts, due to the fact that the primary visual impact (especially the power tower and heliostats) has very low or limited mitigation potential.

[5] It suffices to say that should the power tower not be part of this development proposal, the anticipated visual impact would be significantly reduced.

Table 6: Management plan – Pofadder Solar Thermal Plant – Views onto the facility

OBJECTIVE: The mitigation and possible negation of the additional visual impacts associated with the construction and operation of the Pofadder Solar Thermal Plant.

Project component/s	Development site and the power tower	
Potential Impact	Views onto new primary and on-site ancillary infrastructure	
Activity/risk source	The viewing of the abovementioned by observers on or near the site	
Mitigation: Target/Objective	Reduced direct views onto structures Improved visual quality of the power tower	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Architectural input into planning and design of the power tower.	!KaXu CSP	Planning
Performance Indicator	Architectural design components of the power tower.	
Monitoring	Monitoring of vegetation establishment and soil stability.	

Table 7: Management plan – Pofadder Solar Thermal Plant – Visual Scarring

OBJECTIVE: The mitigation and possible negation of the additional visual impacts associated with the construction of the Pofadder Solar Thermal Plant.		
Project component/s	Construction site, access road and power line	
Potential Impact	Potential scarring and erosion due to the unnecessary removal of vegetation	
Activity/risk source	The viewing of the abovementioned by observers on or near the site	
Mitigation: Target/Objective	Minimal disturbance to vegetation cover in close vicinity to the proposed roads	
Mitigation: Action/control	Responsibility	Timeframe
Adopt responsible construction practices aimed at containing the construction activities to specifically demarcated areas thereby limiting the removal of natural vegetation to the minimum.	!KaXu CSP / contractors	Construction
Limit access to the construction sites to existing access roads.	!KaXu CSP /contractors	Construction / operation
Rehabilitate all disturbed areas to acceptable visual standards.	!KaXu CSP /contractors	Construction / operation
Maintain the general appearance of the facility in an aesthetically pleasing way.	!KaXu CSP	Operation
Performance Indicator	Vegetation cover that remains intact with no erosion	
Monitoring	Monitoring of vegetation clearing during the construction phase	

Table 8: Management plan – Pofadder Solar Thermal Plant – Lighting impacts

OBJECTIVE: The mitigation and possible negation of the potential visual impact of lighting at the solar facility		
Project component/s	Solar facility lighting fixtures	
Potential Impact	The potential night time visual impact of lighting fixtures on observers in proximity to the site	
Activity/risk source	The effects of glare and light trespass on motorists and observers	
Mitigation: Target/Objective	The containment of light emitted in order to eliminate the risk of additional night time visual impacts Minimal usage of security and other lighting	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Ensure that proper planning is undertaken regarding the placement of lighting structures and that light fixtures only illuminate areas inside the substation sites. Undertake regular maintenance of light fixtures.	!KaXu CSP / lighting engineer !KaXu CSP	Planning / construction Operation
Performance Indicator	The effective containment of the light on the site and no complaints from observers.	
Monitoring	The monitoring of the condition and functioning of the light fixtures during the operational phase of the project	

11. REFERENCES / DATA SOURCES

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