ESKOM HOLDINGS SOC LIMITED

THE PROPOSED TUTUKA 65MW SOLAR PHOTOVOLTAIC (PV) FACILITY AND ASSOCIATED INFRASTRUCTURES WITHIN THE LEKWA LOCAL MUNICIPALITY, GERT SIBANDE DISTRICT MUNICIPALITY, MPUMALANGA

VISUAL IMPACT ASSESSMENT
VISUAL IMPACT ASSESSMENT REPORT

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1 INTRODUCTION

1.1 GENERAL

This visual impact assessment (VIA) study forms part of the Scoping and Environmental Impact Assessment that is being undertaken for the proposed Tutuka Solar Photovoltaic PV Facility and associated infrastructures by Savannah Environmental (Pty) Ltd on behalf of Eskom Holdings SOC Limited.

In terms of the amended National Environmental Management Act (NEMA) Act No. 107 of 1998, the proposed development requires environmental authorisation. A key impact to be assessed comprises the visual impact that the facility will have on surrounding areas.

This Visual Impact Assessment Report has been prepared for inclusion in the project Environmental Impact Assessment Report following approval of the Scoping Report which included detailed methodology and assessment criteria.

1.2 LOCATION

The proposed Tutuka Solar Photovoltaic PV Facility is located between Standerton and Bethal, approximately 25 km from Standerton in Mpumalanga. The site falls within the Lekwa Local Municipality which falls within the Gert Sibande District Municipality. **(Map 1: Locality Map).**

The project will comprise of the development of 65.9MW Solar PV installation over approximately 98.8ha within the existing Eskom power station boundary. The site is situated on Portion 4, 11 and 12 of farm Pretorius Vley 374 IS.

The main activities in the vicinity of the site are agriculture, mining and power generation.

The description of the proposed site is indicated in **Table 1**:

Table 1: Description of the preferred site

	Alternative 1 (Clients Preferred Site)	Alternative 2
Land size	98.8 ha	36 ha
MW	65.9	24

The geographical co-ordinates of centre point of the proposed site are indicated in **Table 2**:

Table 2: Coordinates of the proposed preferred Solar PV Facility Site

	Alternative 1			Alternative 2		
South	26^0	47′	00.66″	26^0	46′	51.38″
East	29^0	21′	27.93″	29^0	22′	00.54″

1.3 BACKGROUND OF SPECIALIST

Jon Marshall qualified as a Landscape Architect in 1978. He is also a certified Environmental Impact Assessment Practitioner of South Africa. He has been involved in Visual Impact Assessment over a period of approximately 30 years. He has developed the necessary computer skills to prepare viewshed analysis and three dimensional modelling to illustrate impact assessments. He has undertaken visual impact assessments for major buildings, mining, industrial development, mining and infrastructure projects and has been involved in the preparation of visual guidelines for large scale developments.

A brief Curriculum Vitae outlining relevant projects is included as **Appendix I.**

1.4 BRIEF

The brief is to assess the visual impact that the facility will have on surrounding areas.

Work is to be undertaken in accordance with the following guideline documents;

a. The Government of the Western Cape Guideline for Involving Visual and Aesthetic Specialists in EIA Processes (Western Cape Guideline), which is the only local relevant guideline, setting various levels of assessment subject to the nature of the proposed development and surrounding landscape, and

b. The Landscape Institute and Institute of Environmental Management and Assessment (UK) Guidelines for Landscape and Visual Impact Assessment which provides detail of international best practice (UK Guidelines).

Refer to **Appendix II** for the Western Cape Guideline.

1.5 SPECIALIST REVIEW OF SCOPING DOCUMENT

Following the specialist review of the Scoping Document, it was recommended that the impact associated with glare that might be created by the proposed PV Array be addressed in the Visual Impact Assessment Report.

1.6 LIMITATIONS AND ASSUMPTIONS

No detailed site layouts were provided for the assessment. It was therefore assumed that the proposed solar array would be developed to cover the entire site area.

FIGURE 1, LOCALITY MAP

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2.1 AESTHETIC CHANGE TO THE LANDSCAPE

2.1.1 RELEVANT GUIDELINES

There are numerous guideline documents for visual impact assessment, most of which have a common approach. Key documents are listed in the References Section of this report.

As there are no national guidelines, the most relevant South African document was used to define the nature and extent of necessary input. The Western Cape Guidelines set levels of input subject to the likely sensitivity of a landscape as well as the scale and nature of a proposed development. It therefore provides a basis for justification and agreement of a required scope of work. This document is attached as **Appendix II** for reference.

2.1.2 LEVEL OF ASSESSMENT

From input undertaken at the scoping stage and based on the nature of the affected landscape and the proposed development, a Level 3 Assessment based on the Western Cape Guidelines was considered appropriate.

A Level 3 Assessment requires;

1. Identification of issues raised in scoping phase, and site visit;
2. Description of the receiving environment and the proposed project;
3. Establishment of view catchment area, view corridors, viewpoints and receptors;
4. Indication of potential visual impacts using established criteria;
5. Inclusion of potential lighting impacts at night;
6. Description of alternatives, mitigation measures and monitoring programmes.
7. Review by independent, experienced visual specialist (if required).

The Scoping Report indicated that this conclusion should be confirmed following a site visit.

During the site visit, it was confirmed that the proposed development will impact on the industrial landscape created by the Power Station but it also has potential to impact on surrounding agricultural areas. Whilst the power station might be categorised as a degraded landscape, surrounding agricultural areas could not be considered degraded. Because of the influence of the Power Station surrounding agricultural areas are considered to have low scenic significance in accordance with the guidelines.

The above assessment confirms the scoping conclusion that the proposed development might be expected to have moderate visual impact in accordance with the Western Cape Guidelines.

2.1.3 DETAILED METHODOLOGY

a) Identification of issues raised in scoping phase, and site visit

As only general issues have been raised by scoping, issues have largely been drawn from the site visit and discussion with the Principal Consultant.

b) Description of the receiving environment and the proposed project

The description of the receiving environment has been prepared from observations made during the site visit and from reference and analysis of available GIS data sets.

c) Establishment of view catchment area, view corridors, viewpoints and receptors

The establishment of the view catchment area or Zone of Theoretical Visibility (ZTV) as it is defined in the latest edition of the UK Guidelines (previously referred to as Viewshed), was prepared using a digital terrain model and ARCGIS Spatial Analyst software. This provides an analysis based on landform only and does not take into account distance to the horizon due to the earth's curvature, the effect of distance from the proposed lines or other objects such as vegetation or weather conditions.

The digital analysis is therefore amended following a site visit. This can either be undertaken by amending the identified area to take account of specific elements, or by making qualifications where there are conditions that affect visibility over large sections of the identified area.

Key viewpoints / receptors within the ZTV were located form desk top analysis of mapping and observations made on site.

d) Indication of potential visual impacts using established criteria;

Possible impacts that were identified during scoping include;

i. General landscape degradation or changes to landscape character areas that "the majority of people" are likely consider as negative. In this case this is likely to be a cumulative impact that would extent the influence of existing infrastructural elements to the detriment of the broader rural agricultural character. This is partly a subjective judgement as it is based on the assumption that the majority of people would prefer views over a more natural landscape (loss of rural characteristics is rated as a negative impact). It can however be measured in terms of likely extent of change.
ii. Change to the views of visual receptors. These impacts might relate to visual obstruction and / or intrusion as experienced from points or areas in the landscape that are given importance due to their use. The proposed assessment criteria are based on the assumption that the overriding character of existing views is largely that of a rural agricultural area with some existing degrading infrastructural elements such as the 400kV overhead power line that runs close to the proposed alternative sites. The criteria therefore relate to the degree of additional infrastructure that will be obvious within a key view and its influence on the character of the view.

e) Criteria for assessment of identified impacts

Criteria were proposed at the scoping stage. However, in order to ensure that the visual assessment can be readily integrated into the Environmental Impact Assessment document, the following assessment criteria have been adopted;

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional:

* local extending only as far as the development site area – assigned a score of 1;
  * limited to the site and its immediate surroundings (up to 10 km) – assigned a score of 2;
  * will have an impact on the region – assigned a score of 3;
  * will have an impact on a national scale – assigned a score of 4; or
  * will have an impact across international borders – assigned a score of 5.
- The **duration**, wherein it will be indicated whether:
  * the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  * the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  * medium-term (5–15 years) – assigned a score of 3;
  * long term (> 15 years) - assigned a score of 4; or
  * permanent - assigned a score of 5.
- The **magnitude**, quantified on a scale from 0-10, where a score is assigned:
  * 0 is small and will have no effect on the environment;
  * 2 is minor and will not result in an impact on processes;
  * 4 is low and will cause a slight impact on processes;
  * 6 is moderate and will result in processes continuing but in a modified way;
  * 8 is high (processes are altered to the extent that they temporarily cease); and
  * 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale, and a score assigned:
  * Assigned a score of 1–5, where 1 is very improbable (probably will not happen);
  * Assigned a score of 2 is improbable (some possibility, but low likelihood);
  * Assigned a score of 3 is probable (distinct possibility);
  * Assigned a score of 4 is highly probable (most likely); and
  * Assigned a score of 5 is definite (impact will occur regardless of any prevention measures).
- The **significance**, which shall be determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high.
- The **status**, which will be described as either positive, negative or neutral.
- The degree to which the impact can be reversed.
- The degree to which the impact may cause irreplaceable loss of resources.
- The *degree* to which the impact can be *mitigated.*
- The **significance** is determined by combining the criteria in the following formula:
  - S=(E+D+M)P; where S = Significance weighting, E = Extent, D = Duration, M = Magnitude, P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

f) *Inclusion of potential lighting impacts at night*

The potential for light pollution is assessed based on a comparison of the density and intensity of existing lighting and likely level of lighting associated with a proposed development.

g) *Description of alternatives, mitigation measures and monitoring programmes.*

Alternatives will be described and assessed.

Mitigation and monitoring measures will be proposed based on the nature of possible impacts and the experience of the assessor.

h) *Review by independent, experienced visual specialist (if required).*

Confirmation of the requirement for an independent review is required.

2.2 OCULAR IMPACT FROM GLARE

An indication of a possible a glare issue at the same level as the array can be gained based on simple geometry using plots of sun angle and elevation relative to the face of the solar panels. This provides a two dimensional analysis. For multiple levels such as those associated with an aircraft flight path the mathematics becomes more complex although geometry can be used to check any one point.

Sandia National Laboratories[1], provide online tools for mapping solar glare and flux (http://www.sandia.gov/about/index.html) enabling lay persons to input key data including location, extent, height and power of a proposed array as well as set angles or tracking parameters. This enables the generation of a simple glare analysis providing an indication of timing as well as intensity.

Sandia is a US Government funded research agency similar to South Africa's CSIR.

The Sandia model has therefore been used in the assessment of glare impacting on surrounding areas and receptors. Sun path data has been reviewed as part of the assessment in order to ensure that the results from the on line model can be broadly verified.

3 PROJECT MOTIVATION AND DESCRIPTION

3.1 GENERAL

The purpose of the project is to generate electricity for export into the national electricity grid.

[1] Sandia National Laboratories is operated and managed by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation. Sandia Corporation operates Sandia National Laboratories as a contractor for the U.S. Department of Energy's National Nuclear Security Administration (NNSA) and supports numerous federal, state, and local government agencies, companies, and organizations. As a Federally Funded Research and Development Center (FFRDC), Sandia may perform work for industry responding to certain types of federal government solicitations. The solicitation must allow FFRDC participation and meet the requirements of Sandia's management and operating contract with DOE/NNSA.

The project is motivated by the need to expand the renewable energy programme in line with the National Climate Change Response White Paper (2011).

The project will participate in the Department of Energy's Small Projects Renewable Energy Independent Power Producer Procurement Programme (RE-IPPPP). The RE-IPP Programme and has been designed to contribute towards the South African government's renewable energy target of 10,000GWh of renewable energy and to stimulate the renewable industry in South Africa.

3.2 PROJECT DESCRIPTION

The PV facility is intended to generate electricity by harnessing solar energy (from the sun) by utilising photovoltaic (PV) technology.

The proposed project (alternative 1) is comprised of the development of 65.9MW Solar PV installation over approximately 98.8ha within the existing Eskom power station boundary.

Alternative 2 site is located outside the current Eskom fence line and runs adjacent to the R38. It is approximately 18.5 ha in extent which would be developed with an 8MW Solar PV installation.

The main components of the proposed facility on either site will include:

- Arrays of photovoltaic (PV) panels.
- Mounting structures to support the PV panels.
- Cabling between the project components.
- Inverters/transformer enclosures.
- An on-site substation or switching station.
- A power line to facilitate the connection of the solar energy facility to the existing substation at the power station.
- Internal access roads.
- Buildings (which could include workshop area for maintenance and storage, and an on-site office)

The applicant has indicated that the full site areas will be required for the proposed development including associated infrastructure.

3.3 MAIN PROJECT COMPONENTS

A solar energy facility typically uses the following primary components:

3.3.1 Photovoltaic Panels

Solar photovoltaic (PV) panels consist primarily of glass and various semiconductor materials and in a typical solar PV project, will be arranged in rows to form solar arrays. The PV panels are designed to operate continuously for more than 25 years with minimal maintenance required. It is envisaged that the plant will operate after this design lifetime

The applicant has indicated that that 263,000 1.64m x 0.98m x 0.04m PV panels will be used on site alternative 1 and 32,000 PV panels will be used on site alternative 2. This information also indicates that they will be set at a maximum height of 3m above ground level.

3.3.2 Support Structure

The photovoltaic (PV) modules will be mounted to steel support structures. These can either be mounted at a fixed tilt angle, optimised to receive the maximum amount of solar radiation and dependent on the latitude of the proposed facility, or a tracking mechanism where at a maximum tilt angle of 45°. The applicant has indicated that the support structures will be fixed at an angle of 25° and orientated facing north.

3.3.3 Inverters

The photovoltaic effect produces electricity in direct current (DC). Therefore inverters must be used to change it to alternating current (AC) for transmission in the national grid. The inverters convert the DC electric input into AC electric output. The PV combining switchgear (PVCS), which is dispersed among the arrays, collects the power from the arrays for transmission to the project's substation.

The inverters that the Applicant intends to use on the project have a height of approximately 2.6m.

It is estimated that 130 inverters will be distributed amongst the PV array on site alternative 1 and 16 inverters will be needed for the PV array on site alternative 2. It is likely that the inverters will be bolted to concrete pads that are similar in footprint size to the inverters.

3.3.4 Transformer

The inverters feed AC current to the transformer which steps it up to up to Medium Voltage (MV) either 11kV or 22kV for on-site transmission of the power.

The applicant has indicated that the transformer will be approximately 2.6m high and will be located within a cabin. The height stated includes the cabin height.

3.3.5 Over Head Power Line

From the transformer, the power produced will be distributed to the Grid Connection via an overhead power line. No detail of this power line has been provided for the assessment other than an indication that an MV line will be used. Information provided by the Applicant does indicate that current could be stepped up to either 11kV or 22kV on site. It is assumed that standard Eskom MV structures will be used to support the overhead power line. These are typically in the order of 13m from ground level to the lowest conductor (**Appendix III**). the power line could be up to 2000m long.

3.3.6 Other Infrastructure

Other infrastructure will include a 2.6m high office building and control room, a 2m high fence and a permanent access road.

4 THE NATURE OF LIKELY VISUAL IMPACTS

As indicated in Section 2, the report addresses the following;

1. Aesthetic change to the landscape that could relate to a change in character or a change in the way that a landscape is perceived by specific receptors.
2. Ocular impacts from glare that could result in nuisance or a physical danger.

4.1 AESTHETIC CHANGE TO THE LANDSCAPE

As indicated in Section 2, the assessment will focus on;

a. Generally landscape change or degradation. This is particularly important for protected areas where the landscape character might be deemed to be exceptional or rare. However it can also be important in non-protected areas particularly where landscape character is critical to a specific use such as tourism or for general enjoyment of an area. This is generally assessed by the breaking down of a landscape into components that make up the overall character and understanding how proposed elements may change the balance of the various elements. The height, mass, form and colour of new elements all help to make new elements more or less obvious as does the structure of an existing landscape which can provide screening ability or texture that helps to assimilate new elements. This effect is known as visual absorption capacity.
b. Change in specific views within the affected area from which the character of a view may be important for a specific use or enjoyment of the area. These impacts may be broken down into visual intrusion or visual obstruction.
    - Visual intrusion is a change in a view of a landscape that reduces the quality of the view. This can be a highly subjective judgement, subjectivity has removed as far as is possible by classifying the landscape character of each area and providing a description of the change in the landscape that will occur due to the proposed development. The subjective part of the assessment is to define whether the impact is negative or positive. Again to make the assessment as objective as possible, the judgement is based on whether the level of dependency of the use in question on existing landscape characteristics.
    - Visual obstruction is the blocking of views or foreshortening of views. This can generally be measured in terms of extent.

    Due to the nature of the proposed development, visual impacts are expected to relate to a combination of intrusion and obstruction with views from areas close to the development being most likely to experience a high degree of obstruction.

4.1.1 THE NATURE OF THE DEVELOPMENT

During the construction phase, it is expected that traffic will be slightly higher than normal as trucks will be required to transport materials and equipment such as PV panels and frames to the site.

Depending on the topography of the proposed layout, site preparation will generally include the following activities:

- vegetation clearance – removal or cutting of any vegetation if present (bush cutting);
- levelling and grading of areas where the array will be sited would normally occur, The applicant has indicated that only minor grading will be required;
- levelling of hard-standing areas, e.g. for temporary laydown and storage areas, as indicated above only minor grading is likely to be necessary;
- erection of site fencing (alternative 2);
- construction of a temporary construction camp which will occur within a laydown area within the overall site.

These activities are only likely to be visible from the immediate vicinity of the site and particularly from adjacent roads.

As the site is developed, concrete bases will be constructed, the support structures will then be assembled and PV panels attached, ancillary structures and minor buildings will also be constructed.

The development will therefore appear on a progressive basis in the landscape, however once the concrete bases are constructed, the structures are likely to be assembled rapidly.

The overhead power line that will link the facility to the grid within the power station boundary are also likely to appear in the landscape progressively. This will follow the same pattern as the PV array, with concrete bases being constructed first followed by assembly of structures and finally stringing of overhead lines.

The construction phase is programmed to take 20 months.

By the end of the construction process, the array will be assembled, minor buildings constructed and overhead lines strung between towers, the full visual impact of the project will be experienced. The operational phase is highly unlikely to result in any significant additional impact. It is possible however, that crews will be visible from time to time undertaking maintenance within the facility and on individual towers.

The main visible elements therefore are likely to include;

a) Overhead power lines, and
b) The solar array located within a fence line with associated minor buildings and structures.

a) Overhead Power Lines

Refer to **Appendix III** for detail of likely standard Eskom structures to be utilised.

These structures will be located against the backdrop of other, much larger power station infrastructure including overhead HV power lines.

Plate 1 indicates an overhead power line similar to that proposed. The view is taken during a period of good visibility along the line of towers which have a spacing of +/-

250m. In total 9 towers are visible along the line before it connects to a line running at right angles. The last tower in the line which is a solid pole structure is just visible at +/- 2.5km. The towers of the line running at right angles are lattice pylons, these are barely visible.

From the photograph and considering the backdrop, the following conclusions can be drawn;

a) The visual mass of the overhead power line is unlikely to be obvious within the landscape from close views (within 2.5km).

b) The visual effects of the assumed MV 22kV transmission lines are unlikely to be significant given the backdrop against which they will be experienced.

b) The Solar Array

No layout has been provided for the proposed solar array. From experience of similar projects, it is likely that the panels will be mounted on continuous supports.

Individual supports are usually used when a tracking system is installed. The smaller structure allows the PV panels to be rotated to follow the sun during the day.

Continuous supports aligned in rows are generally used when the PV panels are fixed and are set at an angle and direction to maximise the average efficiency during the day.

From information provided, the facility will have PV panels supported in rows and set at an angle to maximise exposure to solar radiation. They will be orientated towards the north. **Refer to Plates 3, 4 and 5** for images of similar arrays.

From areas to the north a solar array, whether constructed on individual supports or continuous rows, is likely to appear as a continuous structure in the landscape.

The nature of the impact is also likely to vary with location and elevation;

- If the array is located on a hillside or if it is viewed from a higher level, the rows of PV units are likely to visually combine and will be read as a single unit. From a distance this results in a PV array having a similar appearance as a large industrial structure when viewed from above.

- From the south, east and west the dark face of the PV units are not obvious and subject to the colour of the undersides of the units, the supporting structures are likely to become more apparent. With distance however, the shadow cast by the structures is likely to be more obvious and the facility will probably appear much as the northern face, a long dark structure.

If the landscape does not have significant visual absorption capacity, because of the contrast in colour with the surrounding landscape, the array is likely to be obvious to the limit of visibility. Subject to the colour and reflectivity of the underside of the PV units and supporting structure, It is possible that a similar level of impact could also be experienced from the south, east and west.

Mitigation or screening of views is possible at least from close views. This can be achieved either by earthworks berms by planting or by a combination of both. From a distance and particularly from elevated view points, mitigation is likely to be less feasible as the height of any screen is likely to cast shadow over the PV units.

In addition to the way that a solar array may change a landscape, the nuisance factor associated with resulting glare has also been raised by stakeholders on similar projects. PV units, however, are designed to absorb as much energy as possible and are not generally designed to reflect light. This issue is generally more likely to be associated with a focussed array which tracks the sun's path during the day and uses reflective surfaces to focus energy onto receptors. It is therefore not expected that this will be a significant issue with a PV array such as the one proposed.

4.2 OCULAR IMPACTS ASSOCIATED WITH GLARE

Solar reflections are commonplace occurrences for most people either from wet roads, expanses of water, or windows and mirrors of cars and buildings.

Solar cells are designed to absorb light to generate electricity, not reflect it, and so are much less reflective than other sources of solar reflection.

Solar reflections can only occur when the sun is shining. They have virtually no significance when the sun appears very close to the reflecting object – in angular terms, i.e., in almost the same direction – as seen by an observer (i.e., the observed angle between the sun and its reflection is close to 0°) since the much brighter sun will completely mask any reflections and the observer's eyes will be attuned to brightness when looking in that direction thus reducing the apparent intensity of any reflections.

Conversely, solar reflections are at their worst when an observer is facing the reflecting object, is in shade from the bright sun so that his/ her eyes aren't attuned to brightness, and the sun is behind the observer (i.e., the angle between observed reflections and the sun is close to 180°).

There are numerous publications reporting on the subject many of which are produced by solar panel manufacturers and solar power companies. Whilst these are useful and indicate methods that are used to minimise the problem including the use of transparent non reflective polymers to the face of solar panels to reduce reflection and maximise generation efficiency, they are not impartial.

There are also numerous reports from affected individuals that are generally emotive but they do indicate that there could potentially be a glare problem associated with PV installations.

The following section, that has been extracted from a 2012 Report prepared by Stephen Shea of the solar company Suniva, clearly indicates the nature of the issue.

> *The great majority of solar modules are made with a front surface of "Solar Glass". This is a tempered "soda-lime" float glass very similar to tempered window glass except that it has a much lower Iron (Fe) content. The lower Fe content makes solar glass much more transparent than regular window glass, (which has a slightly greenish tint due to absorption of light by Fe oxide complexes within the glass). Soda lime glass has an index of refraction of about 1.50-1.52. As stated above, the reflection from the first surface is a function of index of refraction alone, and does not depend on the Fe content. Thus, while solar glass is more transparent than window glass, its reflection properties are very similarly.*
>
> *As is the case with window glass, solar glass can be treated in ways that change the index of refraction of the front surface in order to minimize reflection. This treatment can take the form of either a coating or of a chemical modification of a*

shallow layer of the glass itself. Both treatments are optically the same, but the chemical treatment lasts longer in the field because it modifies the surface of the glass, rather than being a coating on the surface that can be more easily damaged or worn away. Generally, these treatments create a front surface index of refraction between 1.20 and 1.30. Glass treated in either of these ways is referred to as "Anti-Reflective" (AR) glass. Window glass is often treated in the same manner and with optically the same effect.

So the reflectance of sunlight from solar panels is in its essence simply a variation on the commonly understood phenomenon of reflectance from glass used in, for example: building facades; skylights; automobiles and other common objects. Air has an index of refraction of 1.00, and reduction of reflection when light coming through air strikes a surface is basically a matter of reducing the index of refraction of that surface as close to 1.00 as possible (if the surface has an index of exactly 1.00, then it is optically identical to the air, and the light responds as if the interface surface is not even there). A familiar reflective material is water, which has an index of refraction of 1.333. In windless weather a quiet pond will have a very smooth, reflective surface. Reviewing the information above, one would expect that non-AR glass would be more reflective than the pond water (Index 1.52 versus Index 1.333), while AR glass would be less reflective than water (Index 1.20-1.30 versus Index 1.333).

Indeed, this is the case. Figure 2 is a chart of reflection from all three surfaces as a function of angle of incidence (where angle of incidence is measured from "normal" incidence in which the light strikes the glass or the water straight on). Note that, for all angles, the reflectance from the water surface falls between the reflectance curves for the two different types of glass. Note also, that the calculation for the water surface assumes that the water is completely still, so that all the reflection is specular (like a mirror). This is of course the worst case for glare from the water. Any wind across the water surface will "roughen" the surface and create a more diffuse reflectance and therefore less intense glare.

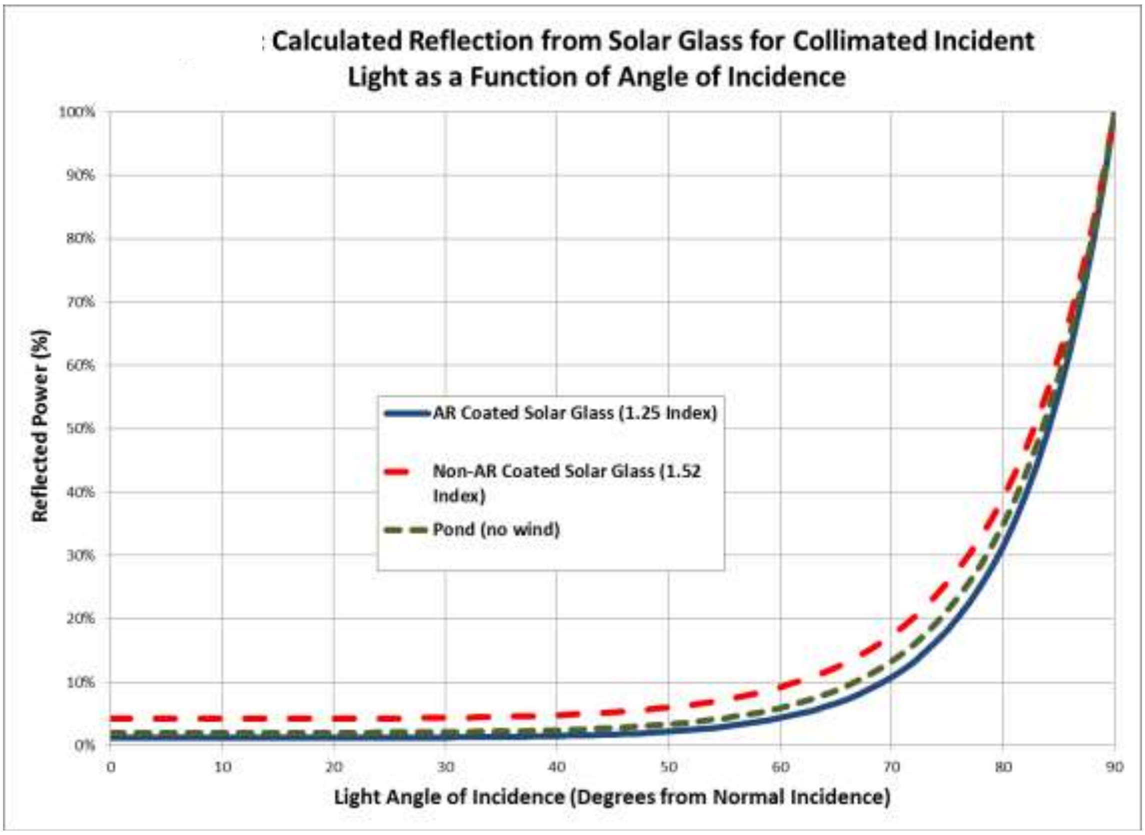


Figure 2, Reflected intensity of the light ("Power") as a percentage of the incoming intensity.

It is immediately apparent that the reflected intensity is quite low with respect to incoming intensity for incident angles below 60o to 70o, and then rises rapidly for higher (more "glancing" angles). That is, the percentage of the incoming sunlight that is reflected is low for high sun angles (most of the day) and increases for very low sun angles (near dawn and sunset). Since the sun covers a sky angle of 15o in an hour, the reflection will be above about 20% for roughly the first hour and the last hour of the day.

This indicates that the intensity of glare is likely to increase with glancing angles as less light is absorbed and more light reflected. These conditions are likely to occur when the elevation of the sun is low during early morning and late afternoon for viewers at a similar level as the array. For observers that are significantly higher than the array however, such as those on an aircraft flight path above the site, the timing of adverse conditions will vary subject to the location of the aircraft relative to the array.

Glare is also likely to be a temporary impact in most instances only causing nuisance during a certain time of day and possibly time of year. **Refer to Plate 6**.

Plate 1, view of similar line to that proposed. Note pylons on the horizon (approx 2.5km distance) are just visible.

Plate 2, PV array viewed from approximately the same ground level as the array. Note the array appears as a linear dark element in the landscape

Plate 3, PV array viewed from above. Note the array rows are read as one and have a similar impact as the roof of a large industrial building might.

Plate 4, PV array viewed from behind and the side. The dark face of the PV units are not obvious and subject to the colour of the undersides of the units, the supporting structures are likely to become more apparent. This might appear as a long industrial structure from close quarters. From a distance however, the shadow cast by the structure will be read and will probably appear similar in nature to the front view of the array.

Plate 5, PV array screened by low vegetation. It is possible to screen a PV array from close viewpoints at a similar level to ground level within the array.

Plate 6, Glare experienced in the Control Tower at Boston Regional Airport from a PV array

5 DESCRIPTION OF RECEIVING ENVIRONMENT AND RECEPTORS

5.1 ASSESSMENT LIMIT

The GIS based assessment of Zones of Theoretical Visibility does not take the curvature of the earth into account. In order to provide an indication of the likely limit of visibility due to this effect a universally accepted navigational calculation (**Appendix IV**) has been used to calculate the likely distance that the proposed structures might be visible over. This indicates that in a flat landscape a structure 4m high could be visible at a distance of approximately 7km. In order to make allowances for local ground level variations a safety margin of 3km has been added to the visibility limit buffer. From experience, the author is confident that the proposed structures are unlikely to be visible outside this buffer.

Section 4 also indicates that due to the nature of the structures involved, the proposed overhead power lines are unlikely to be obvious at a distance greater than 2.5km.

An approximate Visual Horizon of 10km is therefore considered to be appropriate for this study.

5.2 LANDSCAPE CHARACTER

Landscape character is defined as "a distinct, recognisable and consistent pattern of elements in the landscape that makes one landscape different from another".

As indicated previously, this scoping assessment was undertaken without site visits. Landscape character has therefore been defined from the author's knowledge of the area and from reference to available online mapping and aerial photography. It is thought that the key character components have been identified but they will be subject to verification

Landscape Character is a composite of a number of influencing factors including;

- Landform and drainage.
- Nature and density of development.
- Vegetation patterns.

5.2.1 Landform and Drainage

The proposed site area is located on the southern side of a shallow east west running ridge line that connects into a major north south running ridgeline to the east of the proposed alternative development sites.

The ridge on which the alternative sites are proposed rises at a gentle gradient of between 1:10 and 1:40. The ridge rises to an approximate height of 1650m amsl above the valley line below which is set at around 1580m amsl.

The main north south running ridge line to the east of the proposed development site rises to a height of approximately 1660m amsl

A second minor east west running ridgeline is located approximately 5km south of the proposed development sites.

A relatively broad north south running valley runs to the west of the site. A minor tributary of the Vaal River runs through this valley, linking into the Vaal at the northern head of the Grootdraai Dam approximately 8km to the south.

The landform described above is likely to limit visibility of the proposed development to the north, east and south and mean that it is more widely visible to the west.

Refer to Figure 3, Landform and Visual Receptors.

5.2.2 Nature and density of development.

Development within the study area can be divided into the following types;

- **Heavy industrial development** includes the adjacent Tutuka Power Station with its associated conveyors and stockpiles and the adjacent New Denmark Coal Mine.
  The main coal stockpile site lies approximately 7km to the north and north east of the Power Station and between the Power Station and the Mine. The coal stockpile is fed from the mine and is linked to the power station with an extensive conveyor system. There is also an above ground conveyor running approximately 3.5kn east of the power station linking the facility to an existing pulverised fuel ash dump.
- **Urban development** including the small settlement of Thuthukani which lies approximately 5km to the west of the proposed alternative development sites. It is assumed that this settlement largely houses workers from the power station and adjacent mine facilities.
- **Agricultural development** is the main development type surrounding the proposed site. There is a mixture of arable agriculture and grazing land. Within the agricultural landscape there are several groups of buildings including homesteads and groups of farmworkers cottages.

5.2.3 Vegetation patterns.

The site and its surroundings would naturally be a Highveld grassland area. The predominant vegetation type is therefore grassland or arable crops which create a very open landscape with views only limited by landform or the earth's curvature. The following vegetation types are also obvious but not extensive;

- Small plantations of alien trees associated with small community settlements and farmsteads. In areas these alien trees have escaped to colonise areas that are not agriculturally productive such as stream lines and boundary lines.
- Occasional groups of ornamental vegetation associated with farmsteads.

5.2.4 Landscape Character Areas, Visual Absorption Capacity and Significance

Landscape Character Areas (LCAs) are defined as "single unique areas which are the discrete geographical areas of a particular landscape type".

The affected landscape can be divided into the following general character areas that are largely defined by development.

- **Rural Landscape Character Areas.** This is a productive mixed pasture and arable agricultural landscape. It is open with small groups of mainly alien trees located around small settlements and farmsteads. There are differences within the character area associated with of agricultural practices. However There are also numerous small ridgelines that punctuate the landscape. These ridgelines are likely to be the main influencing factors with regard to the visual absorption capacity of the landscape as small undulations are likely to be all that is necessary to screen the proposed array.
- **Industrial Landscape Character Areas** are located around the heavy industrial features of the power station and the New Denmark Mine. The structures associated with the power station dominate the local landscape. The main obvious structures include;
    - The cooling towers, chimneystacks and main generating facility
    - The conveyors that transfer coal and waste pulverised fuel ash
    - The pulverised fuel ash dump
    - The coal stockpile

  These existing industrial structures are likely to provide significant screening and from middle distance and distance views could provide a backdrop to the development making it appear as part of the overall plant. The relatively low elements that are proposed are therefore likely to have little or no influence on the nature of the areas.

  The industrial area is not likely to be sensitive to the proposed development and industrial elements are likely to provide significant visual absorption capacity, either by screening the development or by ensuring that it is seen against an industrial backdrop.
- **Urban Landscape Character Areas** those are generally residential in nature. There is only one small area (Thuthukani) approximately 5km to the west of the proposed sites. This settlement is likely to mainly house personnel from the power station and the adjacent mine site. Generally settlements tend to be inward looking with views of external areas only obvious from the fringes. This generally means that development within the Industrial or Rural Landscape Character Areas is not obvious from within urban areas. The scoping report indicated that the proposed development would not be visible from Thuthukani. This was ground trothed during the site visit and this point was confirmed. Whilst Thuthukani is an obvious character zone within the surrounding landscape, it will not be directly affected.

These LCAs were ground truthed and mapped during the site visit, refer to **Figure 4.**

5.2.5 Landscape quality and importance

From review of existing mapping there do not appear to be any protected landscape areas.

5.3 LANDSCAPE CHARACTER ASSESSMENT SUMMARY

From review of existing mapping there do not appear to be any protected landscape areas.

The **Industrial Landscape Character Area**, in which the proposed development is located is a functional area first and foremost. Its only importance is related to ensuring that the industry of power production functions efficiently. The main visual elements include power station, conveyors, buildings, coal stockpile and PFA dump. The natural landscape is highly degraded.

Urban Landscape Character Areas are generally inward looking as once inside settlement areas, existing buildings and street / garden trees tend to block the majority of views of surrounding areas. Where views are possible this character area could be sensitive to the proposed development. The only urban area that could be impacted is the settlement of Thuthukani which largely accommodates local power station and mine workers. It was confirmed during the site visit that the proposed development will not be visible from this area.

The **Rural Landscape Character Areas** includes larger scale agricultural units and a diverse agricultural mix including both arable and livestock grazing. Other than road, conveyors and electrical infrastructure, the area surrounding the plant is not heavily impacted by infrastructure. Whilst this is a productive area it does appear largely undeveloped. The existing power station and associated features have already impacted on this landscape and have changed the character particularly as seen from immediately adjacent areas from which detail of the industrial elements are apparent. From a distance however, whilst the main elements of the power station are visible, they are seen in the broader more natural context of a largely undeveloped Highveld rural landscape. Even though the main industrial elements are obvious, because there is a clear division, the natural elements can be appreciated in their own right. From a pure landscape appreciation perspective, for most people, the outlook might be improved if the power station were not part of the scene, however, as long as the proposed development does not obviously expand or make the division less obvious then it is unlikely to have any significant impact on distance views

5.4 VISUAL RECEPTORS

Visual Receptors are defined as "individuals and / or defined groups of people who have the potential to be affected by the proposal".

5.4.1 Possible visual receptors

It is also possible that an area might be sensitive due to an existing use. The nature of an outlook is generally more critical to areas that are associated with recreation, tourism and in areas where outlook is critical to land values.

This section is intended to highlight possible Receptors within the landscape which due to use could be sensitive to landscape change. They include;

- Area Receptors which include;
  - Urban areas including Thuthukani. Should there be a significant impact on this area, it is possible that there could be significant objection from residents. However, should the development be visible it is also likely that residents would perhaps not be as sensitive to views of the development as people who are not associated with local industry would be.
  - Areas that are likely to be important for recreational use such as the Grootdraai Dam and surrounding areas approximately 8km to the south of the proposed development alternatives.
- Linear Receptors which include main routes through the area. It is likely that these routes will be mainly used by local people although the R38 and R39 are regional routes and are likely to carry a proportion of tourism / recreational related traffic.

- Point Receptors that include isolated and small groups of homesteads that are generally associated with and located within the Agricultural Landscape that surrounds the proposed development site.

Possible visual receptors or areas, places and routes that may be sensitive to landscape change are indicated on **Figure 3: Landform and Visual Receptors.**

From ground truthing during the site visit, it is apparent that the closest homesteads (point receptors) and the closest sections of affected regional routes (linear receptors) are likely to be most sensitive to possible landscape change. None of the identified area receptors will be impacted including Thuthukani and Grootdraai Dam will be impacted.

5.4.2 Possible glare receptors

Due to the orientation of the proposed alternative arrays to the north and azimuth of the sun glare impacts can only occur in an northerly arc from 245°to 115°(0 °= true north).

Within tis arc the following areas could be sensitive to glare;

a) A landing strip to the west of the power station that is aligned in an approximate north / south direction.
b) The R38 that runs to the east of the power station.
c) A local road to the New Denmark Colliery that runs to the west of the power station.
d) Eskom offices on the south side of the power station.

URBAN LANDSCAPE CHARACTER AREA

RURAL LANDSCAPE CHARACTER AREA

INDUSTRIAL LANDSCAPE CHARACTER AREA

FIGURE 3, LANDFORM AND VISUAL RECEPTORS

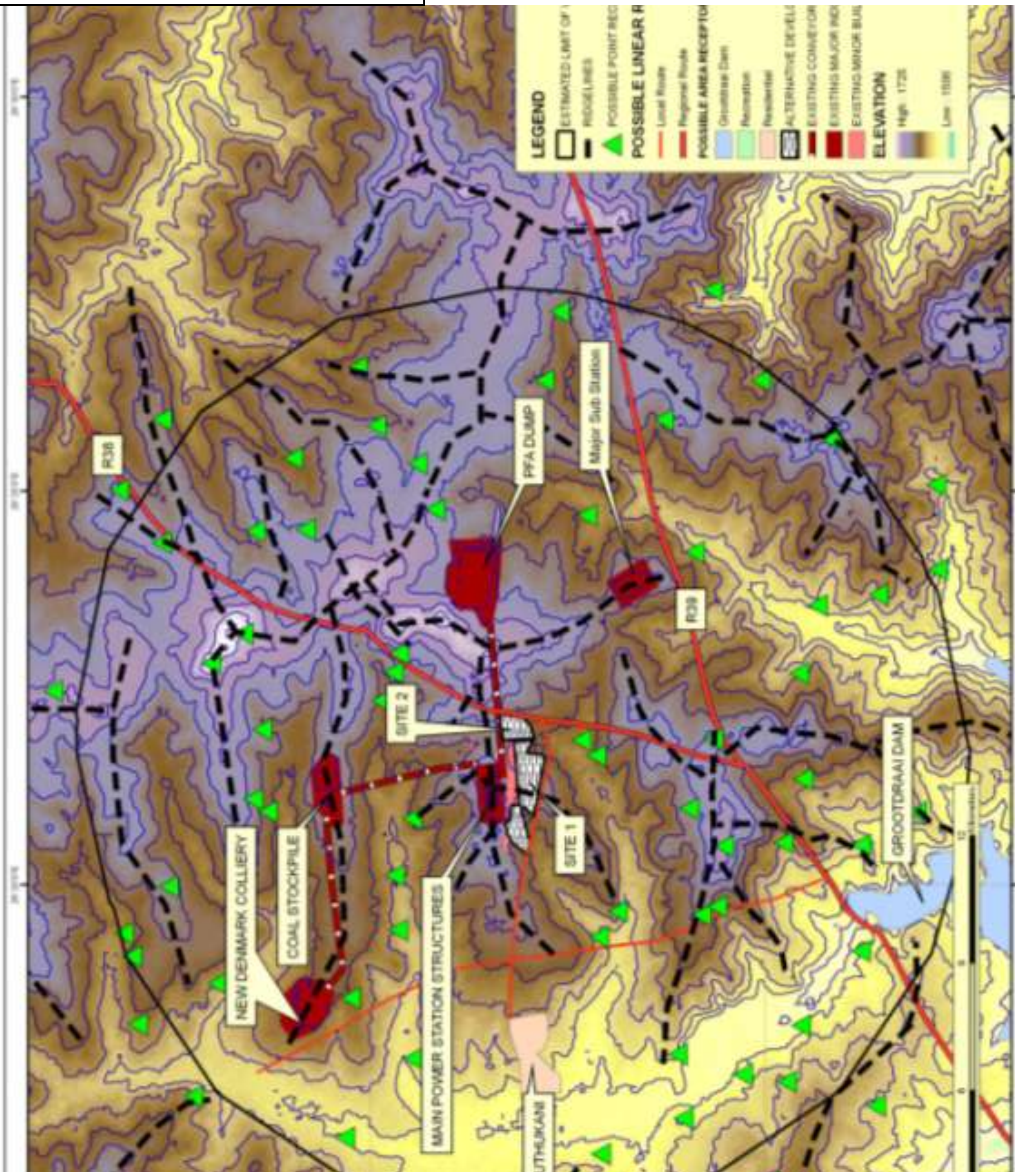
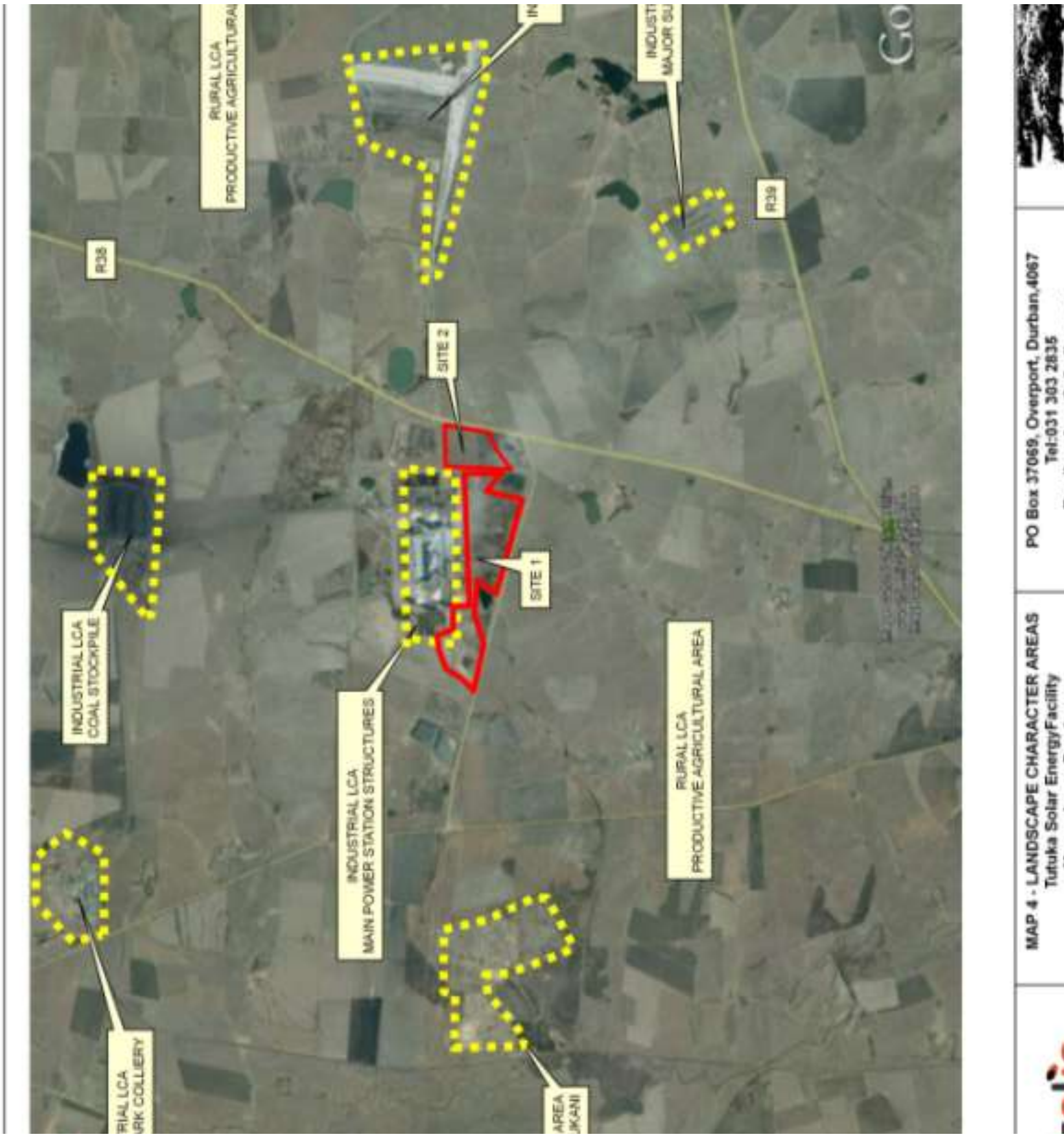


FIGURE 4, LANDSCAPE CHARACTER AREAS



6 VISIBILITY OF THE PROPOSED DEVELOPMENT

6.1 ZONES OF THEORETICAL VISIBILITY

Zones of Theoretical Visibility (ZTV) are defined as "a map usually digitally produced showing areas of land within which a development is theoretically visible".

ZVTs the proposed development have been assessed using Arc Spatial Analyst GIS.

The assessment is based on terrain data that has been derived from satellite imagery. This data was originally prepared by NASSA and is freely available on the CIAT-CCAFS website (http://www.cgiar-csi.org). This data has been ground truthed using a GPS as well as an online mapping programme.

Whilst the ZTV has been calculated from terrain data only, existing vegetation and development could have a significant modifying effect on the areas indicated.

The Approximate Visual Horizon is indicated on the ZTV map to highlight the area outside which the proposed development is unlikely to be visible.

6.2 APPROACH TO THE ASSESSMENT

6.2.1 PV Array and ancillary infrastructure

As indicated, no layout has been provided for the proposed alternative PV array sites. It has therefore been assumed that the site will be developed in its entirety.

The ZTV has therefore been calculated assuming that 3m high structures will be located from corner to corner evenly across the site. From the information provided it seems that this approach will cover all small buildings, ancillary infrastructure and fences and should be a worst case scenario.

6.2.2 MV Tie In to the National Grid

As indicated previously, no detailed information has been provided regarding the overhead power line that will be needed for each alternative site to tie in to the national grid. It is however known that this will be internal to the power station.

Given the lack of information it is not possible to provide a detailed assessment indicating the zone of theoretical visibility. The approach taken therefore is to make comment based on understanding of the requirement and the brief visibility assessment included in Section 4.

6.3 VISIBILITY OF ALTERNATIVE SITES

Figures 5 and 6 indicate the ZTV for the proposed PV array development alternatives.

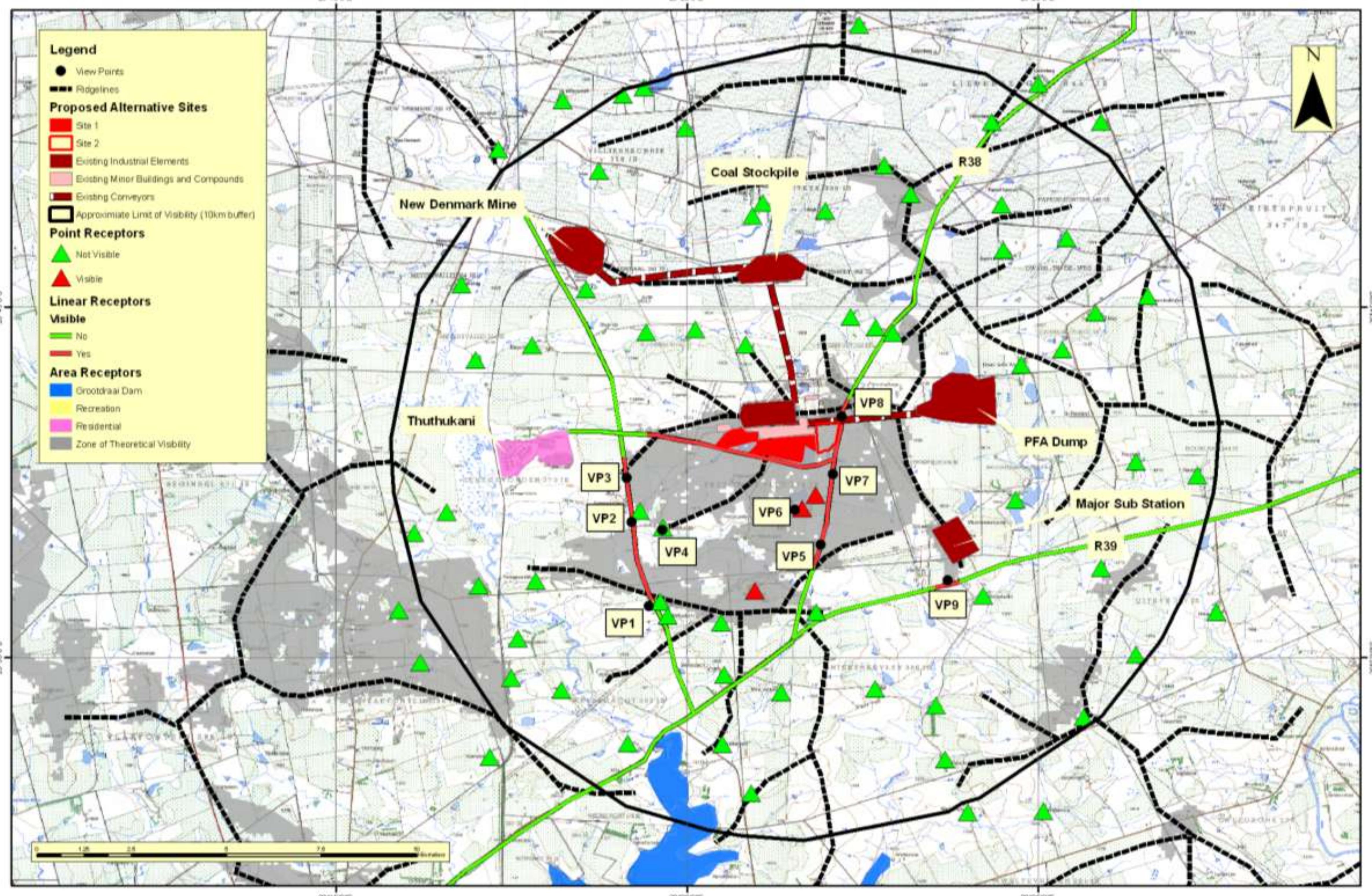
The assessment indicates that;

i. Alternatives 1 and 2 will be visible over a similar area.
ii. The proposed development could be visible intermittently from as far as the visual horizon from the north.
iii. Neither alternative will be visible from the residential area of Thuthukani or the recreational area around Grootdraai Dam.
iv. Alternative 1 is likely to be visible over a slightly wider area to the south east of the site when compared with alternative 2.
v. Alternative 2 is likely to be visible over a slightly greater area to the north of the site when compared with alternative 1.
vi. Both alternatives are likely to be visible from a small number of homesteads to the south and east of the proposed development sites.
vii. Neither alternative will be visible from the R39.
viii. Both alternatives will be visible from the R38 for a distance of approximately 5km in the vicinity of the Power Station

6.5 KEY VIEWPOINTS

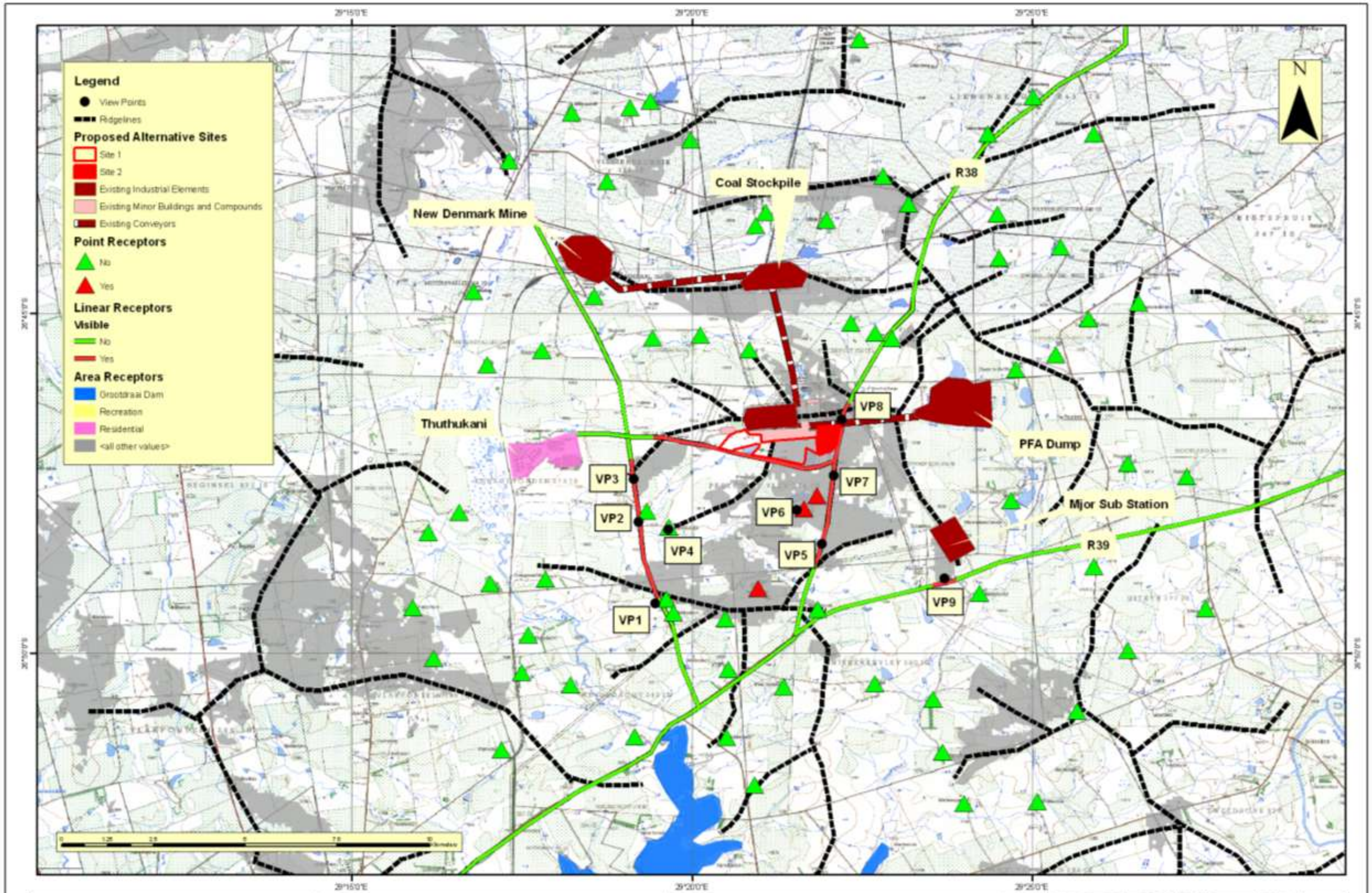
Key viewpoints that are adjudged to afford the best view of or towards the proposed site and are representative of views of the identified visual receptors / LCAs are located on **Figures 5 and 6**. Photographs from these viewpoints with the site area indicated in red are included as Plates 7 to 21 inclusive.

FIGURE 5, ZTV, SITE 1



Afzelia	ZTV SITE 1 Tutuka Solar EnergyFacility Mpumalanga Province	PO Box 37069, Overport, Durban,4067 Tel:031 303 2835 Email:andrew@afzelia.co.za Date: 19/02/2015	ENVIRONMENTAL PLANNING AND DESIGN

FIGURE 6, ZTV, SITE 2



Afzelia	ZTV SITE 2 Tutuka Solar EnergyFacility Mpumalanga Province	PO Box 37069, Overport, Durban,4067 Tel:031 303 2835 Email:andrew@afzelia.co.za Date: 19/02/2015	ENVIRONMENTAL PLANNING AND DESIGN

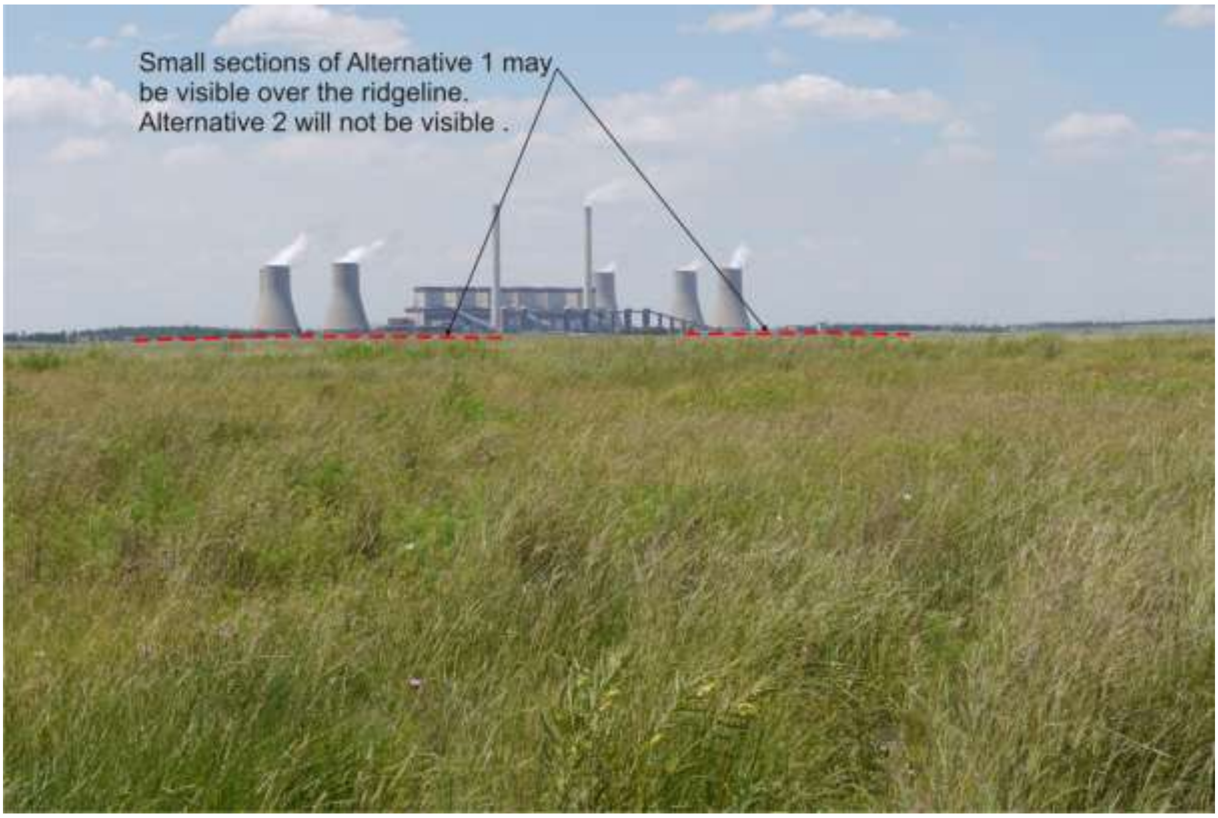


Plate 7, VP 1. View from local road and homesteads to the south west.
Alternative 1 may just be visible. Alternative 2 will not be visible.

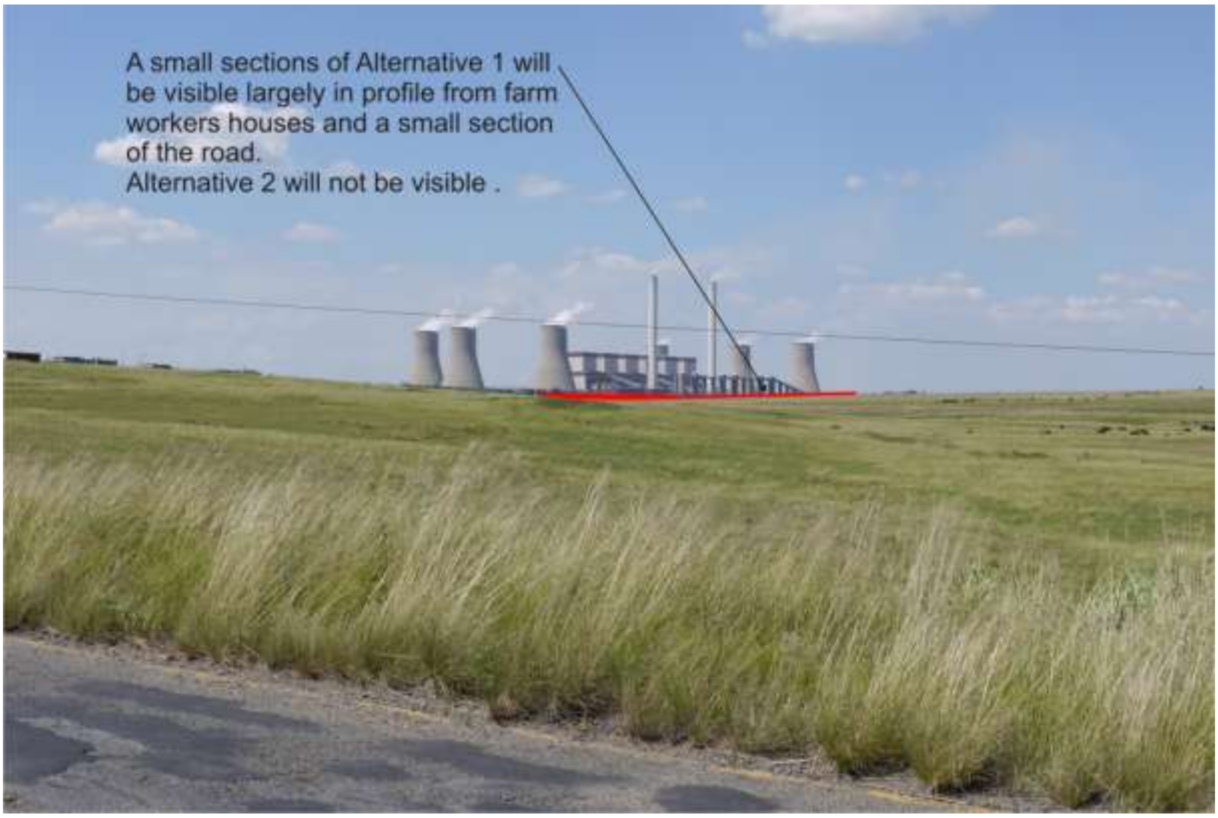


Plate 8, VP 2. View from local road and farm workers houses to the south west.
Alternative 1 will be visible largely in profile. Alternative 2 will not be visible.

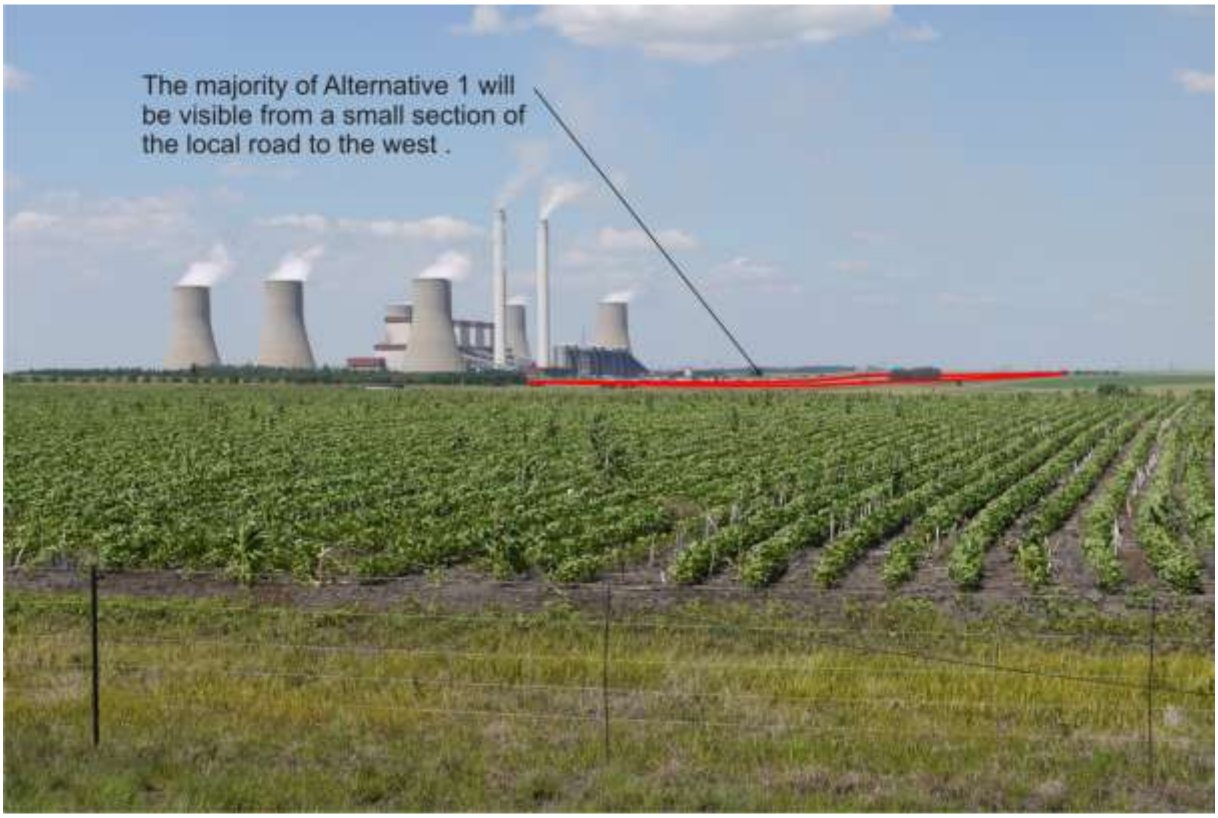


Plate 9, VP 3. View from local road to the west. Alternative 1 will be obvious from a short section of the road.

Plate 10, VP 3. View from local road to the west. A small section of Alternative 2 could be visible but will be part screened by trees and landform and is unlikely to be obvious from this viewpoint.

Plate 11, VP 4. View from local road / farmstead to the south west. Alternative 1 will largely be screened and Alternative 2 will be completely screened by the landform The majority of buildings in this farmstead face south. Only one rental property faces north towards the power station and will be affected.

Plate 12, VP 5. View from the R38 and Farmstead to the south. Alternative 1 will be visible almost in its entirety but it will be viewed against the backdrop of the existing power station.

Plate 13, VP 5. View from the R38 and Farmstead to the south. Alternative 2 will be visible almost in its entirety. It will extend the extent industrial elements visible in the landscape.

Plate 14, VP 6. View from a Farmstead to the south. Alternative 1 will be visible almost in its entirety. It will be viewed in profile against the backdrop of the existing power station.

Plate 15, VP 6. View from a Farmstead to the south. Alternative 2 will be visible almost in its entirety. It will extend the extent industrial elements visible in the landscape.

Plate 16, VP 7. View from the R38 to the south. Alternative 1 will be visible almost in its entirety. It will be viewed in profile against the backdrop of the existing power station.

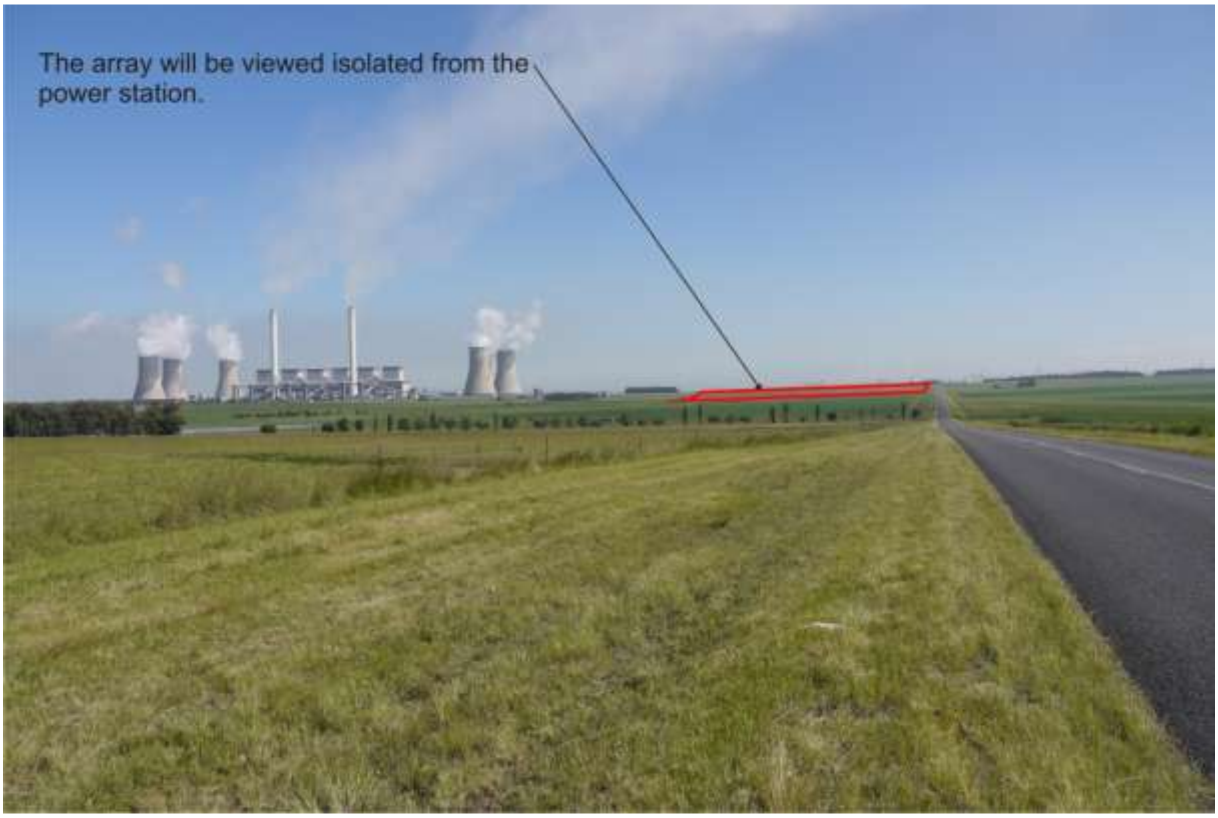


Plate 17, VP 7. View from the R38 to the south. Alternative 2 will be visible almost in its entirety. It will extend the extent industrial elements visible in the landscape.

Plate 18, VP 8. View from the R38 to the east. Alternative 1 will be visible. It will be viewed in profile and will extend the extent industrial elements visible in the landscape.

Plate 19, VP 8. View from the R38 to the east. Alternative 2 will be highly visible from the P38.

Plate 20, VP 9. View from the R39 to the south. Alternative 1 may just be visible. It will however not be obvious.

Plate 21, VP 9. View from the R39 to the south. Alternative 2 may just be visible. It will however not be obvious.

7 AREAS AFFECTED BY GLARE

Sandia National Laboratories[2], provide online tools for mapping solar glare and flux (http://www.sandia.gov/about/index.html) enabling lay persons to input key data including location, extent, height and power of a proposed array as well as set angles or tracking parameters. This enables the generation of a simple glare analysis providing an indication of timing as well as intensity.

As indicated in Section 2.2, the Sarndia National Laboratories online glare model has been used to predict areas that are likely to be affected by glare.

The array areas were plotted as well as the locations of possible receptors. Details of the array in terms of power, height, orientation and tilt were also input.

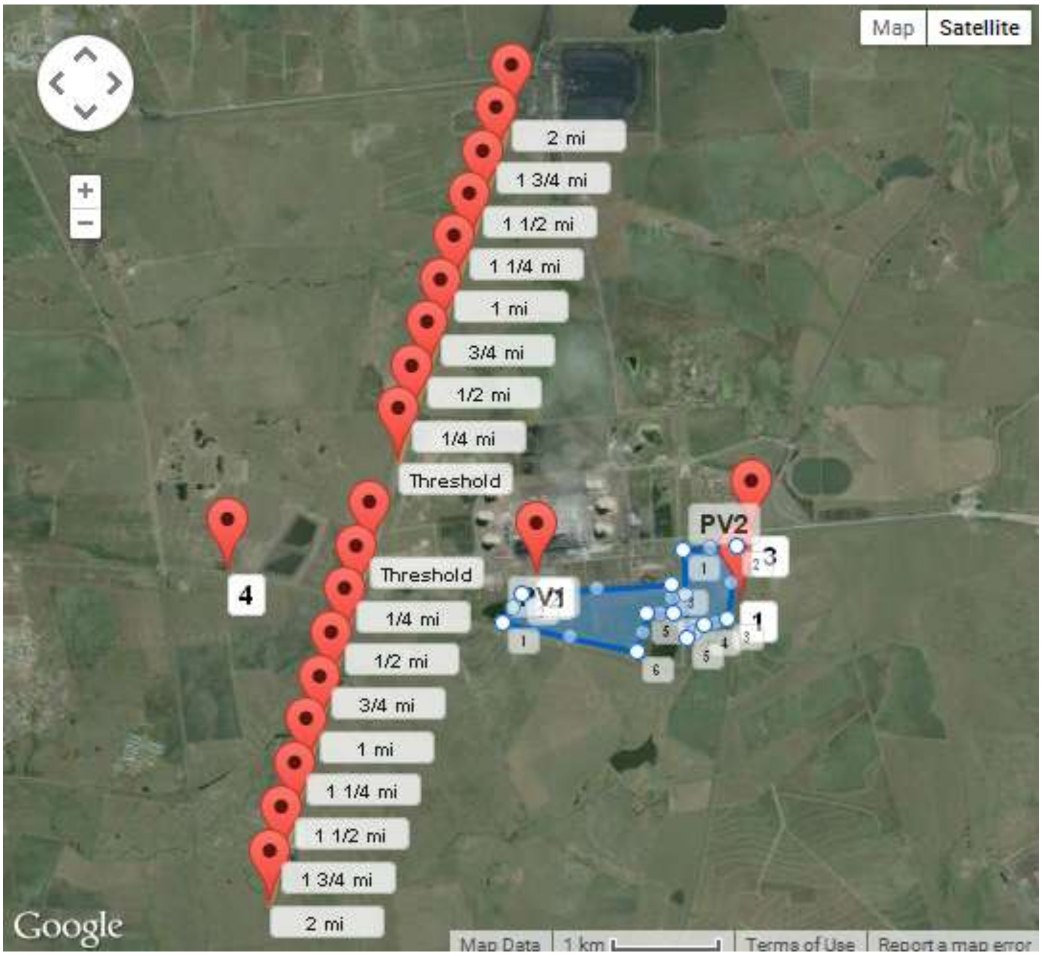


Figure 7, Location of alternative arrays and possible sensitive receivers input into the glare model

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[2] Sandia National Laboratories is operated and managed by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation. Sandia Corporation operates Sandia National Laboratories as a contractor for the U.S. Department of Energy's National Nuclear Security Administration (NNSA) and supports numerous federal, state, and local government agencies, companies, and organizations. As a Federally Funded Research and Development Center (FFRDC), Sandia may perform work for industry responding to certain types of federal government solicitations. The solicitation must allow FFRDC participation and meet the requirements of Sandia's management and operating contract with DOE/NNSA.

Points selected for analysis include;

1. Located on R38 adjacent to Alternative 2 Array.
2. Located adjacent to Eskom offices on southern side of the power station and north of Alternative 1
3. Located on the R38 on the ridgeline to the north of Alternative 2
4. Located on local road to the west of the power station
5. Points located at quarter mile centres along the northern flight path approaching the landing strip to the west of the power station.
6. Points located at quarter mile centres along the southern flight path approaching the landing strip to the west of the power station.

The model predicts likely levels of glare based on the following parameters;

- Glare to be experienced but low potential for a temporary after image to be experienced.
- Glare to be experienced with potential for a temporary after image to be experienced.
- Glare to be experienced with potential for permanent eye damage to be experienced.

A summary of the results of the analysis are indicated in Table 3 below.

The full report of from the Sandia Laboratories glare model is attached as **Appendix V.**

Table 3 Summary of findings of the glare model

Glare Receptor	Alternative 1	Alternative 2
R38	The impact ranges from a low potential for a temporary after-image on the road to the east and potential for temporary after-image to be experienced on the road to the north east between 17:00h and 18:00h between the beginning of November and beginning of March.	The impact includes the potential for temporary after-image to be experienced on the road to the north east between 17:00h and 18:00h between the beginning of September and the end of March
Local Road to west of plant	There is a small potential for an after image to be experienced between 06:00h and 07:00h during the end of February / beginning of March and the end of September and beginning of October	There is a small potential for a temporary after image to be experienced between 06:00h and 07:00h during the end of February / beginning of March and the end of September and beginning of October
Eskom Offices	The impact includes potential for a temporary after image to be experienced between 06:00h and 07:00h between the mid September and the mid March	The impact includes a low potential for a temporary after-image to be experienced between 06:00h and 07:00h between the mid September and the mid March
Northern flight path	The impact includes a low potential for a temporary after-image to be experienced on the threshold of the landing strip only between 06:30h and 07:00h during December and January	The impact includes a low potential for a temporary after-image to be experienced from 0.5miles from the end of the landing strip to the threshold of the landing strip between 06:30h and 07:00h between mid October

		and mid February.
Southern flight path	The impact includes a low potential for a temporary after-image to be experienced from 0.5miles from the end of the landing strip to the threshold of the landing strip between 06:00h and 07:00h between the beginning of October and mid March.	The impact includes a low potential for a temporary after-image to be experienced from 0.5miles from the end of the landing strip to the threshold of the landing strip between 06:00h and 06:30h at the end of March and mid September to the beginning of October.

In summary this indicates that;

i. Both alternatives are likely to have a low level of impact on the northern and southern flight paths. This impact will only occur during the early morning (before 07:00h).

ii. Alternative 2 will have a low impact on the Eskom offices whereas the impact associated with Alternative 1 could be uncomfortable for office staff. It has to be noted however that the impact is likely to occur outside office hours.

iii. Glare associated with Alternatives 1 and 2 could have an adverse impact on drivers on the R38 during early evening

The Solar plot (**Figure 8**) confirms that at the times of the anticipated impacts the azimuth is approximately -100° / 100° and the elevation of the sun is below 10° at the time of low level impacts and below 20° for impacts on the flight paths. This fits with the models predictions.

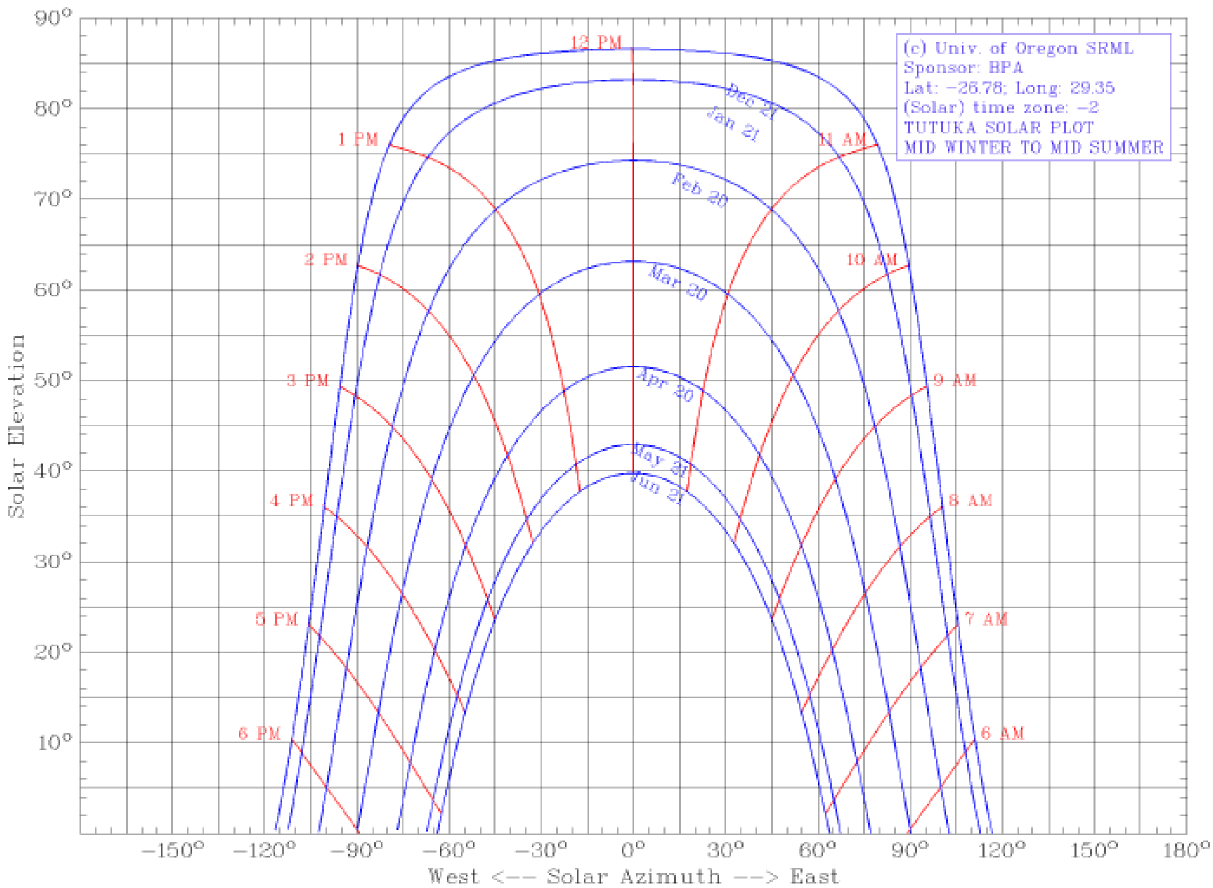

Figure 8, Tutuka Solar Plot

8 POTENTIAL VISUAL IMPACTS AND POSSIBLE MITIGATION MEASURES

Criteria for the assessment are indicated in Section 2, Methodology.

Although a separate ZTV has been developed for each alternative array, these are considered together in the assessment.

Impacts associated with development alternatives fall into three categories including;

1. Landscape degradation,
2. Change of view for visual receptors.
3. Ocular impacts associated with glare.

8.1 LANDSCAPE DEGRADATION

The key areas that could be sensitive to change of character identified at the scoping stage and confirmed during the site visit include;

1. The Urban Landscape Character Area. The main concern relates to further industrial influence at the edges of the LCA.
2. The Rural Landscape Character Area. The main concern relates to the area to the east of the Vaal River which is less degraded by industry and mining than the area to the west of the river. This area is also important as it forms part of the access corridor to the Vaal Dam.
3. The Riverine Landscape Character Area. This is an important local recreation resource. The scoping study indicated that this LCA would be subject to minimal impact. This was confirmed during the site visit when it was found impossible to obtain a view of the site from the river corridor. There will therefore be no impact on this LCA due to development of any of the site alternatives.

Table 4, Landscape Degradation Rural LCA

Nature of impact: Degradation / industrialisation of the Rural LCA.		
	Without mitigation	**With mitigation**
Extent	**<u>Alternatives 1 and 2</u>** Site and immediate surroundings **(2)**	No mitigation possible
Duration	**<u>Alternatives 1 and 2</u>** Long term **(4)**	No mitigation possible
Magnitude	**<u>Alternatives 1</u>** The proposed development is will be viewed in the context of the existing power station from most viewpoints. **(0)** **<u>Alternatives 2</u>** the proposed development will appear to extend industrial elements to the east. **(2)**	No mitigation possible
Probability	**<u>Alternatives 1</u>** Significant impact is very improbable **(1)**	No mitigation possible

	<u>Alternatives 2</u> Distinctly possible **(3)**	
Significance	**<u>Alternatives 1</u>** Very low **(6)** **<u>Alternatives 2</u>** Low **(24)**	No mitigation possible
Status	**<u>Alternatives 1 and Alternative 2</u>** Negative.	N/A
Irreplaceable loss	The project can be dismantled. Therefore there will be no irreplaceable loss.	N/A
Can impacts be mitigated?	No	
Mitigation / Management: No mitigation is possible from most viewpoints. ***Explanatory note:*** a) Alternative 1 is located directly in front of the main built elements of the power station and so from most viewpoints will be seen as part of the existing development area. b) Alternative 2 will be seen to extend an industrial element to the east and outside the current development footprint. It will therefore be seen to extend the influence of industry into the rural area.		
Cumulative Impacts: Because Alternative 2 will be seen to extend the footprint of industrial development into the Rural Landscape Character Area, this impact is largely cumulative. Alternative 1 will only be seen to extend the influence of industrial development into the Rural Landscape Character Area from limited areas but from these areas the impact will be cumulative.		
Residual Impacts: Because no mitigation is possible. The identified impacts will be residual.		

8.2 CHANGE OF VIEW FOR VISUAL RECEPTORS

The assessment indicates that the following Visual Receptors could be impacted;

1. Residential areas particularly Thuthukani.
2. Main routes (linear receptors) through the area particularly the R38 and the R39.
3. Adjacent Farmsteads particularly the closest properties to the south and east of the alternative development sites.

8.2.1 Residential Receptors

Table 5, Residential Receptors change of view.

Nature of impact: Further Industrialisation and reduction in rural character of the view from Thuthukani.		
	Without mitigation	**With mitigation**
Extent	**<u>Alternatives 1 and 2</u>** Local **(1)**	No mitigation possible
Duration	**<u>Alternatives 1 and 2</u>**	No mitigation possible

	Short term **(1)**	
Magnitude	**<u>Alternatives 1 and 2</u>** The proposed development is unlikely to be visible from the urban areas. **(0)**	No mitigation possible
Probability	**<u>Alternatives 1 and 2</u>** This impact is improbable **(1)**	No mitigation possible
Significance	**<u>Alternatives 1 and 2</u>** No impact is likely **(2)**	No mitigation necessary
Status	**<u>Alternatives 1</u>** Neutral	N/A
Irreplaceable loss	The project can be dismantled. Therefore there will be no irreplaceable loss.	N/A
Can impacts be mitigated?	Mitigation is not really necessary.	
Mitigation / Management: No mitigation measures are necessary as the development is unlikely to be visible from any area within Thuthukani.		
Cumulative Impacts: Because Alternative 2 will be seen to extend the footprint of industrial development into the Rural Landscape Character Area, this impact is largely cumulative. Alternative 1 will only be seen to extend the influence of industrial development into the Rural Landscape Character Area from limited areas but from these areas the impact will be cumulative.		
Residual Impacts: Because no mitigation is possible. The identified impacts will be residual.		

8.2.3 Linear Receptors

Table 6, Linear Receptors change of view.

Nature of impact: Impacts on main routes (linear receptors) through the area particularly the R54, R716 and R82.		
	Without mitigation	**With mitigation**
Extent	**<u>Alternatives 1 and 2</u>** Site and immediate surroundings **(2)**	N/A
Duration	**<u>Alternatives 1 and 2</u>** Long term **(4)**	N/A
Magnitude	**<u>Alternative 1</u>** The proposed development will be visible at a distance to small sections of the local road to the west and the R38. An exceptionally short view may be possible from the R39. The development will also be seen as part of the power station.**(2)** **<u>Alternative 2</u>** Will be visible to the same degree as Alternative 1 from the R39 and to a lesser degree from the local road to the west. It	N/A

	will however be developed immediately adjacent to the R38. It will be highly obvious for more than 4km and will dominate the view from the road for approximately 2km **(6)**	
Probability	**<u>Alternative 1</u>** Significant impact is improbable **(2)** **<u>Alternative 2</u>** The impact on the R38 is definite **(5)**	N/A
Significance	**<u>Alternatives 1</u>** Low **(16)** **<u>Alternatives 2</u>** High **(60)**	N/A
Status	**<u>Alternatives 1 and 2</u>** Negative.	N/A
Irreplaceable loss	The project can be dismantled. Therefore there will be no irreplaceable loss.	N/A
Can impacts be mitigated?	Mitigation is not necessary.	
Mitigation / Management: No meaningful mitigation measures possible that will reduce the change in character. However undertaking adequate site management will help to ensure that the nature of the view particularly across Site 2 from the adjacent R38 is not more negative than it needs to be. Management should include minimising litter, maximising vegetation cover beneath the PV units, maintaining storage areas away from and out of sight of the road.		
Cumulative Impacts: Because Alternative 2 will be seen to extend the footprint of industrial development into the Rural Landscape Character Area, this impact is largely cumulative. Alternative 1 will only be seen to extend the influence of industrial development into the Rural Landscape Character Area from extremely short sections of road but from these areas the impact will be cumulative.		
Residual Impacts: Because no mitigation is possible. The identified impacts will be residual.		

8.2.4 Adjacent Farmsteads

Table 7, Adjacent Farmsteads Receptors change of view.

Nature of impact: Impacts on farmsteads particularly those to the south of the proposed development.		
	Without mitigation	**With mitigation**
Extent	**<u>Alternatives 1 and 2</u>** Site and immediate surroundings **(2)**	N/A
Duration	**<u>Alternatives 1 and 2</u>** Long term **(4)**	N/A
Magnitude	**<u>Alternative 1</u>** Alternative 1 will be seen as part of the	N/A

	power station development. **(2)** **<u>Alternative 2</u>** Alternative 2 will extend the influence of industrial elements in these views. **(4)**	
Probability	**<u>Alternative 1</u>** Significant impact is very improbable. **(1)** **<u>Alternative 2</u>** Alternative 2 will extend the view over industry. **(4)**	N/A
Significance	**<u>Alternative 1</u>** Low **(8)** **<u>Alternative 2</u>** Medium **(40)**	N/A
Status	**<u>Alternative 1</u>** Neutral. **<u>Alternative 2</u>** Negative.	N/A
Irreplaceable loss	The project can be dismantled. Therefore there will be no irreplaceable loss.	N/A
Can impacts be mitigated?	No	
Mitigation / Management: Because views will be over the alternative 2 array, there is no opportunity for screening. ***Explanatory note:*** Both alternatives will be seen from the same famsteads and houses. However, alternative 2 will extend the industrial character whereas alternative 1 will be seen to be part of the existing industrial area.		
Cumulative Impacts: Because Alternative 2 will be seen to extend the footprint of industrial development into the Rural Landscape Character Area, this impact will be cumulative. Alternative 1 will not be seen to extend the influence of industrial development into the Rural Landscape Character Area this impact therefore will not be cumulative		
Residual Impacts: Because no mitigation is possible. The identified impacts will be residual.		

8.3 OCULAR IMPACTS ASSOCIATED WITH GLARE

Table 8, Impact of glare affecting surrounding areas

Nature of impact: Glare impacting on adjacent roads, Eskom offices and the airstrip flight path.

	Without mitigation	With mitigation
Extent	**<u>Alternatives 1 and 2</u>** Site and immediate surroundings **(2)**	N/A
Duration	**<u>Alternatives 1 and 2</u>** Long term **(4)**	N/A
Magnitude	**<u>Alternative 1</u>** Glare from the proposed development will have a minor impact on the airstrip flight path and Eskom offices. It could however create a dangerous situation on the adjacent R38. **(8)** **<u>Alternative 2</u>** Glare from the proposed development will have a minor impact on the airstrip flight path and the Eskom offices. It could however create a dangerous situation on the adjacent R38. **(8)**	**<u>Alternative 1</u>** **(2)** **<u>Alternative 2</u>** **(4)**
Probability	**<u>Alternative 1</u>** Significant impact is improbable **(2)** **<u>Alternative 2</u>** Significant impact is probable **(3)**	**<u>Alternative 2</u>** Significant impact is possible **(3)**
Significance	**<u>Alternative 1</u>** Medium **(42)** **<u>Alternative 2</u>** Medium **(42)**	**<u>Alternative 1</u>** Low **(24)** **<u>Alternative 2</u>** Low to Medium **(30)**
Status	**<u>Alternatives 1 and 2</u>** Negative.	N/A
Irreplaceable loss	The project can be dismantled. Therefore there will be no irreplaceable loss.	N/A
Can impacts be mitigated?	Yes	
Mitigation / Management: The use of a textured glass with anti-reflective coatings on the face of panels will help but probably will not totally mitigate the impact for either alternatives. The use of a screen fence along the R38 roadside for the length of the array would probably largely mitigate the alternative 2 impact on the adjacent road. The use of a combination of screen fence and planting on the eastern side of alternative 1 is likely to be more successful in mitigating impacts on the R38 than alternative 2 due to the amount of space available.		
Cumulative Impacts: As far as the assessor is aware there are no other major reflective surfaces that could affect these receptors. The impacts identified are therefore unlikely to be cumulative.		
Residual Impacts: Proposed mitigation measures will at least part mitigate impacts associated with glare. Low to medium residual impact s are likely to remain however.		

9 IMPACT STATEMENT

9.1 GENERAL LANDSCAPE CHANGE

The proposed development will take place within a landscape where the division between industrial and rural character is well defined.

Alternative 1 is within the power station boundary fence, is orientated along the face of the power station and from most viewpoints will be seen within an area that should be considered as part of the industrial landscape.

Alternative 2 is outside the existing power station fence and is located within an area that is seen as green / rural that abuts the to the power station complex. Development in this area therefore is likely to reduce the extent of the perceived rural area and increase the industrial area.

9.2 VISUAL RECEPTORS

Both alternative sites will be visible to a small number of farmsteads / farm workers houses, the R38 and a small section of the local road that is located to the west of the power station.

It is also possible that both alternatives may be visible to a short section of the R39, however, this view is likely to be of short duration and it is unlikely that the partial view of either development would be recognisable.

The nature of the view will however differ between alternatives;

- Alternative 1 will largely be seen within the context and appear to be part of the existing power station.
- Alternative 2 will appear to be developed within an existing green space and therefore will be seen to increase the extent of industry visible.

Alternative 2 will also be developed alongside the R38 and therefore will take industrial development almost up to the road edge. It will therefore have a greater impact than alternative 1 on this regional route.

9.3 OCULAR IMPACTS ASSOCIATED WITH GLARE

Both alternatives will have minor impacts on the local route to the west of the power station and the flight path approaches to the adjacent landing strip.

Alternative 1 will also have an impact on offices within the power station complex, however this will occur outside normal office hours.

Both alternatives are likely to have an impact on the R38 that could be problematic for drivers particularly those travelling in a north to south direction in the early evening between September and March each year. Mitigation is possible for both alternatives but is likely to be more successful for alternative 1

9.4 CUMULATIVE IMPACTS

Impacts associated with Alternative 2 are generally cumulative in that they extend the apparent influence of industrial development into the Rural Landscape Character Area.

Views of alternative 1 are generally seen within the context and as part of the existing power station. This alternative therefore appears to only influence the existing Industrial Landscape Character Area. These impacts therefore are generally not cumulative.

9.5 ALTERNATIVE FAVOURED ON VISUAL GROUNDS

On aesthetic grounds because alternative 1 will be viewed in the context of and appear to be developed within the existing industrial area at the base of the power station whereas alternative 2 will appear to extend the industrial area towards the R38, alternative 1 should be favoured.

However, the extent of the impact is limited and the quality of the rural landscape is such that development of alternative 2 would not create unacceptable impacts.

When the potential impact of glare that could affect drivers on the R38 is also considered however, this reinforces the argument that alternative 1 should be the favoured alternative on visual grounds.

10 ENVIRONMENTAL MANAGEMENT PLAN

Table 9: Management programme – Construction.

OBJECTIVE: The mitigation and possible negation of visual impacts associated with the construction of the Proposed Solar (PV) Project.		
Project Component/s	Construction site	
Potential Impact	Landscape degradation for surrounding LCAs and Sensitive Receivers (particularly alternative 2 as seen from the R38) .	
Activity/Risk Source	The viewing of the above mentioned by observers from a distance.	
Mitigation: Target/Objective	Minimise the area of disturbance	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Ensure that vegetation is not unnecessarily cleared or removed during the construction period.	Project Proponent /contractor	Early in the construction phase.
Reduce the construction period through careful logistical planning and productive implementation of resources.	Project Proponent /contractor	Early in the construction phase.
Reduce and control construction dust through the use of approved dust suppression techniques as and when required (i.e. whenever dust becomes apparent).	Project Proponent /contractor	Throughout the construction phase.
Rehabilitate all disturbed areas, construction areas, servitudes etc. immediately after the completion of construction works. If necessary, an ecologist should be consulted to assist or give input into rehabilitation specifications.	Project Proponent /contractor	Throughout and at the end of the construction phase.
Performance Indicator	Vegetation cover on and in the vicinity of the site is intact (i.e. full cover as per natural vegetation within the environment) with no evidence of degradation or erosion.	
Monitoring	Monitoring of vegetation clearing during construction (by contractor as part of construction contract). Monitoring of rehabilitated areas quarterly for at least a year following the end of construction (by contractor as part of construction contract).	

Table 10: Management programme – Operation.

OBJECTIVE: The mitigation and possible negation of visual impacts associated with the operation of the Proposed Solar (PV) Project.		
Project Component/s	The solar energy facility and ancillary infrastructure (i.e. panels, access roads, substation, workshop and power line).	
Potential Impact	Landscape degradation for surrounding LCAs and Sensitive Receivers.	
Activity/Risk Source	The viewing of the above mentioned by observers from a distance.	
Mitigation: Target/Objective	Maintain and augment existing surrounding vegetation.	
Mitigation: Action/control	**Responsibility**	**Timeframe**
Alternative 1 – undertake and maintain screen planting on eastern side of the array.	Project Proponent /operator	Throughout the operational phase.
Alternative 2 – undertake and maintain screen fencing planting on the eastern side of the array.	Project Proponent /operator	Throughout the operational phase.
Ensure that the face of PV panels is formed with textured glass coated with an anti-reflective coating in order to minimize glare.	Project Proponent /contractor	Throughout and at the end of the construction phase.
Monitor the implementation of mitigation measures, and implement remedial action as and when required.	Project Proponent /operator	Throughout the operational phase.
Maintain roads and servitudes to forego erosion and to suppress dust.	Project Proponent /operator	Throughout the operational phase.
Monitor rehabilitated areas, and implement remedial action as and when required.	Project Proponent /operator	Throughout the operational phase.
Performance Indicator	Extent and severity of glare particularly as experienced from the R38. Occurrence of rising dust being visible.	
Monitoring	Monitoring of effectiveness of screening vegetation (by operator).	

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APPENDIX I

SPECIALIST'S BRIEF CV

ENVIRONMENTAL PLANNING AND DESIGN

Name	JONATHAN MARSHALL
Nationality	British
Year of Birth	1956
Specialisation	Landscape Architecture / Landscape & Visual Impact Assessment / Environmental Planning / Environmental Impact Assessment.
Qualifications	
Education	Diploma in Landscape Architecture, Gloucestershire College of Art and Design, UK (1979) Environmental Law, University of KZN (1997)
Professional	Chartered Member of the Landscape Institute (UK) Registered Landscape Architect (South Africa) Certified Environmental Assessment Practitioner of South Africa. Member of the International Association of Impact Assessment, South Africa

Languages	English	-	Speaking	-	Excellent
		-	Reading	-	Excellent
		-	Writing	-	Excellent

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Key Experience

Jon qualified as a Landscape Architect (Dip LA) at Cheltenham (UK) in 1979. He has been a chartered member of the Landscape Institute UK since 1986. He has also been a Certified Environmental Assessment Practitioner of South Africa since 2009.

During the early part of his career (1981 - 1990) He worked with Clouston (now RPS) in Hong Kong and Australia. During this period he was called on to undertake visual impact assessment (VIA) input to numerous environmental assessment processes for major infrastructure projects. This work was generally based on photography with line drawing superimposed to illustrate the extent of development visible.

He has worked in the United Kingdom (1990 - 1995) for a major supermarket chain and prepared CAD based visual impact assessments for public enquiries for new green field store development. He also prepared the VIA input to the environmental statement for the Cardiff Bay Barrage for consideration by the UK Parliament in the passing of the Barrage Bill.

His more recent VIA work (1995 to present) includes a combination of CAD and GIS based work for a new international airport to the north of Durban, new heavy industrial operations, overhead electrical transmission lines, mining operations in West Africa and numerous commercial and residential developments.

VIA work undertaken during the last eighteen months includes assessments for proposed new mine developments in Ghana and Guinea, numerous solar plant projects for Eskom and private clients, proposed wind farm development and a proposed tourism development within the Isimangaliso Wetland Park World Heritage Site .

Jon has also had direct experience of working with UNESCO representatives on a candidate World Heritage Site and has undertaken LVIAs within and adjacent to other World Heritage Sites.

<u>Relevant Visual Impact Assessment Projects</u>

1. **Bhangazi Lake Tourism Development** – Visual impact assessment for a proposed lodge development within the Isimangaliso Wetland Park World Heritage Site. This work is ongoing.
2. **Quarry Development for the Upgrade of Sani Pass –** Visual Impact Assessments for two proposed quarry developments on the edge of the uKhalamba-Drakensburg World Heritage Site.
3. **Mtubatuba to St Lucia Overhead Power Line** – Visual Impact Assessment for a proposed power line bordering on the Isimangaliiso Wetland Park World Heritage Site for Eskom.
4. **St Faiths 400/132 kV Sub-Station and Associated Power Lines** - Visual Impact Assessment for a proposed new major sub-station and approximately 15km of overhead power line for Eskom.
5. **Isundu 765/400 kV Sub-Station and Associated Power Lines** - Visual Impact Assessment for a proposed new major sub-station for Eskom. This work is ongoing.
6. **Clocolan to Ficksburg Overhead Power Line** – Visual Impact Assessment for a proposed power line for Eskom.
7. **Solar Plant Projects including Photovoltaic and Concentrating Solar Power Plants** – Numerous projects for Eskom and private clients in the Northern Cape, Limpopo, Mpumalanga and the Free State.
8. **Moorreesburg Wind Farm.** Visual impact assessment for a proposed new wind farm in the Western Cape.
9. **AngloGold Ashanti, Dokyiwa (Ghana)** – Visual Impact Assessment for proposed new Tailings Storage Facility at a mine site working with SGS as part of their EIA team.
10. **Camperdown Industrial Development** - Visual Impact Assessment for proposed new light industrial area to the north o Camperdown for a private client.
11. **Wild Coast N2 Toll Highway** – Peer review of VIA undertaken by another consultant.
12. **Gamma to Grass Ridge 765kv transmission line** – Peer review of VIA undertaken by another consultant.
13. **Gateway Shopping Centre Extension (Durban)** – Visual Impact Assessment for a proposed shopping centre extension in Umhlanga, Durban.
14. **Kouroussa Gold Mine (Guinea)** – Visual impact assessment for a proposed new mine in Guinea working with SGS as part of their EIA team.
15. **Mampon Gold Mine (Ghana)** - Visual impact assessment for a proposed new mine in Ghana working with SGS as part of their EIA team.
16. **Telkom Towers** – Visual impact assessments for numerous Telkom masts in KwaZulu Natal
17. **Dube Trade Port, Durban International Airport** – Visual Impact Assessment for a new international airport.
18. **Sibaya Precinct Plan** – Visual Impact Assessment as part of Environmental Impact Assessment for a major new development area to the north of Durban.
19. **Umdloti Housing** – Visual Impact Assessment as part of Environmental Impact Assessment for a residential development beside the Umdloti Lagoon to the north of Durban.
20. **Tata Steel Ferrochrome Smelter** - Visual impact assessment of proposed new Ferrochrome Smelter in Richards Bay as part of EIA undertaken by the CSIR.
21. **Diamond Mine at Rooipoort Nature Reserve near Kimberley** – Visual impact assessment for a proposed diamond mine within an existing nature reserve for De Beers.
22. Durban Solid Waste Large Landfill Sites **– Visual Impact Assessment of proposed development sites to the North and South of the Durban Metropolitan Area. The project utilised 3d computer visualisation techniques.**
23. Hillside Aluminium Smelter, Richards Bay **- Visual Impact Assessment of proposed extension of the existing smelter. The project utilised 3d computer visualisation techniques.**
24. **Estuaries of KwaZulu Natal Phase 1 and Phase 2 –** Visual character assessment and GIS

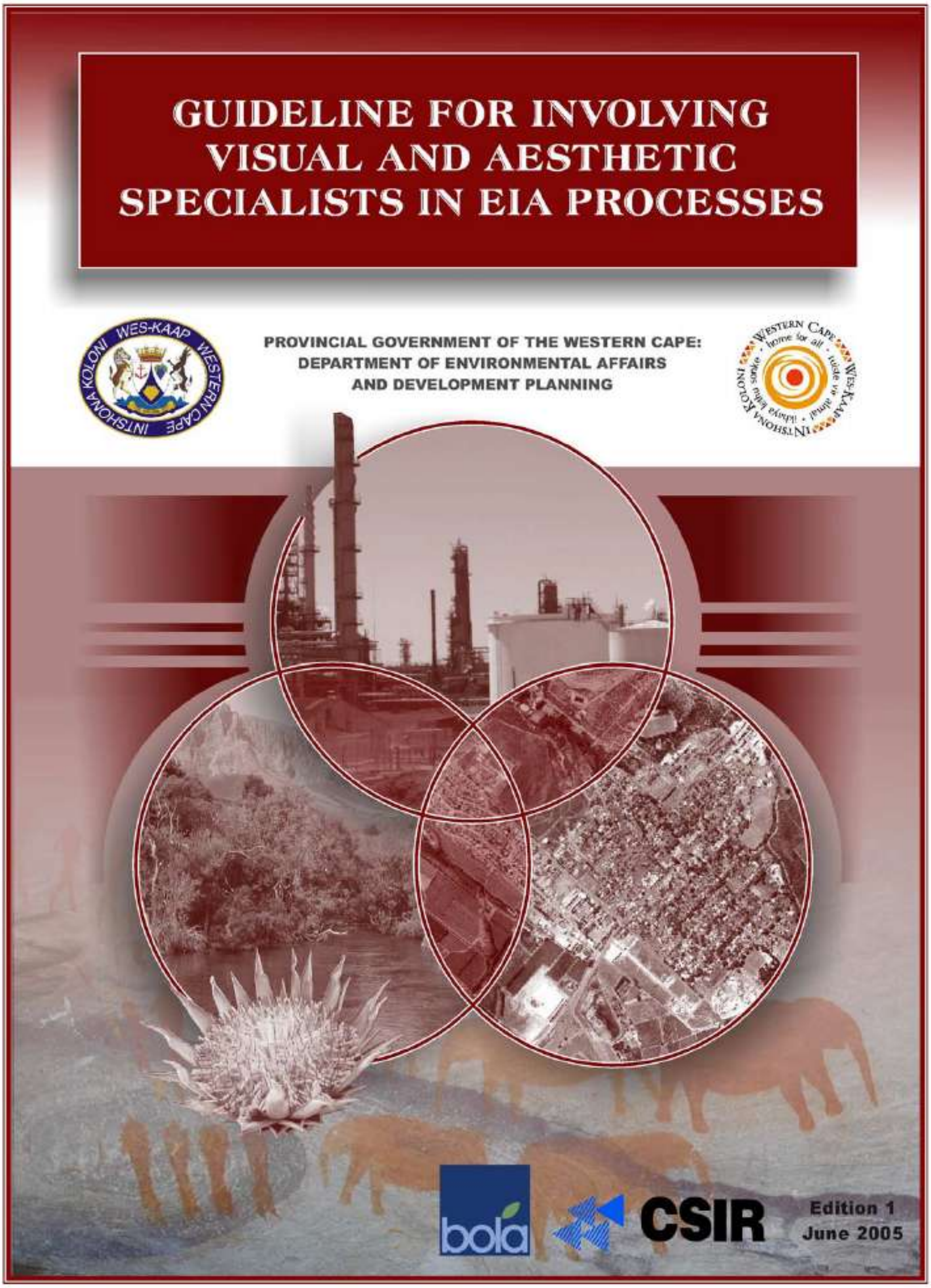
mapping as part of a review of the condition and development capacity of eight estuary landscapes for the Town and Regional Planning Commission. The project was extended to include all estuaries in KwaZulu Natal.

25. **Signage Assessments** – Numerous impact assessments for proposed signage developments for Blast Media.
26. **Signage Strategy** – Preparation of an environmental strategy report for a national advertising campaign on National Roads for Visual Image Placements.
27. **Zeekoegatt, Durban** - Computer aided visual impact assessment. Acted as advisor to the Province of KwaZulu Natal in an appeal brought about by a developer to extend a light industrial development within a 60 metre building line from the National N3 Highway.
28. **La Lucia Mall Extension** - Visual impact assessment using three dimensional computer modelling / photo realistic rendering and montage techniques for proposed extension to shopping mall for public consultation exercise.
29. **Redhill Industrial Development** - Visual impact assessment using three dimensional computer modelling / photo realistic rendering and montage techniques for proposed new industrial area for public consultation exercise.
30. **Avondale Reservoir** - Visual impact assessment using three dimensional computer modelling / photo realistic rendering and montage techniques for proposed hilltop reservoir as part of Environmental Impact Assessment for Umgeni Water.
31. **Hammersdale Reservoir** - Visual impact assessment using three dimensional computer modelling / photo realistic rendering and montage techniques for proposed hilltop reservoir as part of Environmental Impact Assessment for Umgeni Water.
32. **Southgate Industrial Park, Durban** - Computer Aided Visual Impact Assessment and Landscape Design for AECI.
33. **Sainsbury's Bryn Rhos (UK)** - Computer Aided Visual Impact Assessment/ Planning Application for the development of a new store within the Green Wedge North of Swansea.
34. **Ynyston Farm Access (UK)** - Computer Aided Impact Assessment of visual intrusion of access road to proposed development in Cardiff for the Land Authority for Wales.
35. **Cardiff Bay Barrage (UK)** - Concept Design, Detail Design, Documentation, and Visual Input to Environmental Statement for consideration by Parliament in the debate prior to the passing of the Cardiff Bay Barrage Bill. The work was undertaken for Cardiff Bay Development Corporation.
36. **A470, Cefn Coed to Pentrebach (UK)** - Preparation of frameworks for the assessment of the impact of the proposed alignment on the landscape for The Welsh Office.
37. **Sparkford to Illchester Bye Pass (UK)** - The preparation of the landscape framework and the draft landscape plan for the Department of Transport.
38. **Green Island Reclamation Study (Hong Kong)** - Visual Impact Assessment of building massing, Urban Design Guidelines and Masterplanning for a New Town extension to Hong Kong Island.
39. **Route 3 (Hong Kong)** - Visual Impact Assessment for alternative road alignments between Hong Kong Island and the Chinese Border.
40. **China Border Link (Hong Kong)** - Visual Impact Assessment and initial Landscape Design for a new border crossing at Lok Ma Chau.
41. **Route 81, Aberdeen Tunnel to Stanley (Hong Kong)** - Visual Impact Assessment for alternative highway alignments on the South side of Hong Kong Island.

APPENDIX II

GUIDELINES FOR INVOLVING VISUAL AND AESTHETIC SPECIALISTS IN EIA PROCESSES

(Preface, Summary and Contents for full document go to the Provincial Government of the Western Cape, Department of Environmental Affairs and Development Planning web site, http://eadp.westerncape.gov.za/your-resource-library/policies-guidelines)


GUIDELINE FOR INVOLVING
VISUAL AND AESTHETIC
SPECIALISTS IN EIA PROCESSES
PROVINCIAL GOVERNMENT OF THE WESTERN CAPE:
DEPARTMENT OF ENVIRONMENTAL AFFAIRS
AND DEVELOPMENT PLANNING
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GUIDELINE FOR INVOLVING VISUAL AND AESTHETIC SPECIALISTS IN EIA PROCESSES

Edition 1

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Stakeholders engaged in the guideline development process:

These guidelines were developed through a consultative process and have benefited from the inputs and comments provided by a wide range of individuals and organizations actively working to improve EIA practice. Thanks are due to all who took the time to engage in the guideline development process.

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PREFACE

The purpose of an Environmental Impact Assessment (EIA) is to provide decision-makers (be they government authorities, the project proponent or financial institutions) with adequate and appropriate information about the potential positive and negative impacts of a proposed development and associated management actions in order to make an informed decision whether or not to approve, proceed with or finance the development.

For EIA processes to retain their role and usefulness in supporting decision-making, the involvement of specialists in EIA needs to be improved in order to:

- Add greater value to project planning and design;
- Adequately evaluate reasonable alternatives;
- Accurately predict and assess potential project benefits and negative impacts;
- Provide practical recommendations for avoiding or adequately managing negative impacts and enhancing benefits;
- Supply enough relevant information at the most appropriate stage of the EIA process to address adequately the key issues and concerns, and effectively inform decision-making in support of sustainable development.

It is important to note that not all EIA processes require specialist input; broadly speaking, specialist involvement is needed when the environment could be significantly affected by the proposed activity, where that environment is valued by or important to society, and/or where there is insufficient information to determine whether or not unavoidable impacts would be significant.

The purpose of this series of guidelines is to improve the efficiency, effectiveness and quality of specialist involvement in EIA processes. The guidelines aim to improve the capacity of roleplayers to anticipate, request, plan, review and discuss specialist involvement in EIA processes. Specifically, they aim to improve the capacity of EIA practitioners to draft appropriate terms of reference for specialist input and assist all roleplayers in evaluating whether or not specialist input to the EIA process is appropriate for the type of development and environmental context. Furthermore, they aim to ensure that specialist inputs support the development of effective, practical Environmental Management Plans where projects are authorised to proceed (refer to *Guideline for Environmental Management Plans*).

The guidelines draw on best practice in EIA in general, and within specialist fields of expertise in particular, to address the following issues related to the timing, scope and quality of specialist input. The terms "specialist involvement" and "input" have been used in preference to "specialist assessment" and "studies" to indicate that the scope of specialists' contribution (if required) depends on the nature of the project, the environmental context and the amount of available information and does not always entail detailed studies or assessment of impacts.

The guidelines draw on best practice in EIA in general, and within specialist fields of expertise in particular, to address the following issues related to the timing, scope and quality of specialist input. The terms "specialist involvement" and "input" have been used in preference to "specialist

assessment" and "studies" to indicate that the scope of specialists' contribution depends on the nature of the project, the environmental context and the amount of available information.

	ISSUES
TIMING	▪ When should specialists be involved in the EIA process; i.e. at what stage in the EIA process should specialists be involved (if at all) and what triggers the need for their input?
SCOPE	▪ Which aspects must be addressed through specialist involvement; i.e. what is the purpose and scope of specialist involvement? ▪ What are appropriate approaches that specialists can employ? ▪ What qualifications, skills and experience are required?
QUALITY	▪ What triggers the review of specialist studies by different roleplayers? ▪ What are the review criteria against which specialist inputs can be evaluated to ensure that they meet minimum requirements, are reasonable, objective and professionally sound?

The following guidelines form part of this first series of guidelines for involving specialists in EIA processes:

- Guideline for determining the scope of specialist involvement in EIA processes
- Guideline for the review of specialist input in EIA processes
- Guideline for involving biodiversity specialists in EIA processes
- Guideline for involving hydrogeologists in EIA processes
- Guideline for involving visual and aesthetic specialists in EIA processes
- Guideline for involving heritage specialists in EIA processes
- Guideline for involving economists in EIA processes

The *Guideline for determining the scope of specialist involvement in EIA processes* and the *Guideline for the review of specialist input in EIA processes* provide generic guidance applicable to any specialist input to the EIA process and clarify the roles and responsibilities of the different roleplayers involved in the scoping and review of specialist input. It is recommended that these two guidelines are read first to introduce the generic concepts underpinning the guidelines which are focused on specific specialist disciplines.

Who is the target audience for these guidelines?

The guidelines are directed at authorities, EIA practitioners, specialists, proponents, financial institutions and other interested and affected parties involved in EIA processes. Although the guidelines have been developed with specific reference to the Western Cape province of South Africa, their core elements are more widely applicable.

What type of environmental assessment processes and developments are these guidelines applicable to?

The guidelines have been developed to support project-level EIA processes regardless of whether they are used during the early project planning phase to inform planning and design decisions (i.e. during pre-application planning) or as part of a legally defined EIA process to obtain statutory approval for a proposed project (i.e. during screening, scoping and/or impact assessment). Where specialist input may be required the guidelines promote early, focused and appropriate involvement of specialists in EIA processes in order to encourage proactive consideration of potentially significant impacts, so that negative impacts may be avoided or effectively managed and benefits enhanced through due consideration of alternatives and changes to the project.

The guidelines aim to be applicable to a range of types and scales of development, as well as different biophysical, social, economic and governance contexts.

What will these guidelines not do?

In order to retain their relevance in the context of changing legislation, the guidelines promote the principles of EIA best practice without being tied to specific legislated national or provincial EIA terms and requirements. They therefore do not clarify the specific administrative, procedural or reporting requirements and timeframes for applications to obtain statutory approval. They should, therefore, be read in conjunction with the applicable legislation, regulations and procedural guidelines to ensure that mandatory requirements are met.

It is widely recognized that no amount of theoretical information on how best to plan and coordinate specialist inputs, or to provide or review specialist input, can replace the value of practical experience of coordinating, being responsible for and/or reviewing specialist inputs. Only such experience can develop sound judgment on such issues as the level of detail needed or expected from specialists to inform decision-makers adequately. For this reason, the guidelines should not be viewed as prescriptive and inflexible documents. Their intention is to provide best practice guidance to improve the quality of specialist input.

Furthermore, the guidelines do not intend to create experts out of non-specialists. Although the guidelines outline broad approaches that are available to the specialist discipline (e.g. field survey, desktop review, consultation, modeling), specific methods (e.g. the type of model or sampling technique to be used) cannot be prescribed. The guidelines should therefore not be used indiscriminately without due consideration of the particular context and circumstances within which an EIA is undertaken, as this influences both the approach and the methods available and used by specialists.

How are these guidelines structured?

The specialist guidelines have been structured to make them user-friendly. They are divided into six parts, as follows:

- **Part A**: Background;
- **Part B**: Triggers and key issues potentially requiring specialist input;
- **Part C**: Planning and coordination of specialist inputs (drawing up terms of reference);
- **Part D**: Providing specialist input;
- **Part E**: Review of specialist input; and
- **Part F**: References.

Part A provides grounding in the specialist subject matter for all users. It is expected that authorities and peer reviewers will make most use of Parts B and E; EIA practitioners and project proponents Parts B, C and E; specialists Part C and D; and other stakeholders Parts B, D and E. Part F gives useful sources of information for those who wish to explore the specialist topic.

SUMMARY

This guideline document, which deals with specialist visual input into the EIA process, is organised into a sequence of interleading sections. These follow a logical order covering the following:

- the background and context for specialist visual input;
- the triggers and issues that determine the need for visual input;
- the type of skills and scope of visual inputs required in the EIA process;
- the methodology, along with information and steps required for visual input;
- finally, the review or evaluation of the visual assessment process.

Part A is concerned with defining the visual and aesthetic component of the environment, and with principles and concepts relating to the visual assessment process. The importance of the process being logical, holistic, transparent and consistent is stressed in order for the input to be useful and credible.

The legal and planning context within which visual assessments take place indicate that there are already a number of laws and bylaws that protect visual and scenic resources. These resources within the Western Cape context have importance for the economy of the region, along with the proclaimed World Heritage Sites in the Province.

The role and timing of specialist visual inputs into the EIA process are outlined, with the emphasis being on timely, and on appropriate level of input, from the early planning stage of a project, through to detailed mitigation measures and management controls at the implementation stage.

Part B deals with typical factors that trigger the need for specialist visual input to a particular project. These factors typically relate to:

(a) the nature of the receiving environment, in particular its visual sensitivity or protection status;
(b) the nature of the project, in particular the scale or intensity of the project, which would result in change to the landscape or townscape.

The correlation between these two aspects are shown in a table, in order to determine the varying levels of visual impact that can be expected, i.e. from little or no impact, to very high visual impact potential.

Part C deals with the choice of an appropriate visual specialist, and the preparation of the terms of reference (TOR) for the visual input. Three types of visual assessment are put forward, each requiring different expertise, namely:
Type A: assessments involving large areas of natural or rural landscape;
Type B: assessments involving local areas of mainly built environment;
Type C: assessments involving smaller scale sites with buildings, or groups of buildings.

The scope of the visual input would in summary relate to the following:

- the issues raised during the scoping process;
- the time and space boundaries, i.e. the extent or zone of visual influence;

- the types of development alternatives that are to be considered;
- the variables and scenarios that could affect the visual assessment;
- the inclusion of direct, indirect and cumulative effects.

Approaches to the visual input relate to the level of potential impact and range from minimal specialist input, to a full visual impact assessment (VIA). A list of the typical components of a visual assessment is given, and the integration with other studies forming part of the EIA process is discussed.

Part D provides guidance for specialist visual input, and on the information required by specialists. Notes on predicting potential visual impacts are given, along with suggested criteria for describing and rating visual impacts. The assessment of the overall significance of impacts, as well as thresholds of significance are discussed.

Further aspects that need to be considered by visual specialists in EIA processes include:

- affected parties who stand to benefit or lose,
- risks and uncertainties related to the project,
- assumptions that have been made, and their justification,
- levels of confidence in providing the visual input or assessment,
- management actions that can be employed to avoid or mitigate adverse effects and enhance benefits, and
- the best practicable environental option from the perspective of the visual issues and impacts.

Finally, pointers for the effective communication of the findings are given.

Part E lists specific evaluation criteria for reviewing visual input by a specialist, where this becomes necessary. Further guidance on this is given in the document on *Guideline for the review of specialist input in EIA processes.*

CONTENTS

APPENDIX III

TYPICAL ESKOM OVERHEAD POWERLINE SUPPORTS

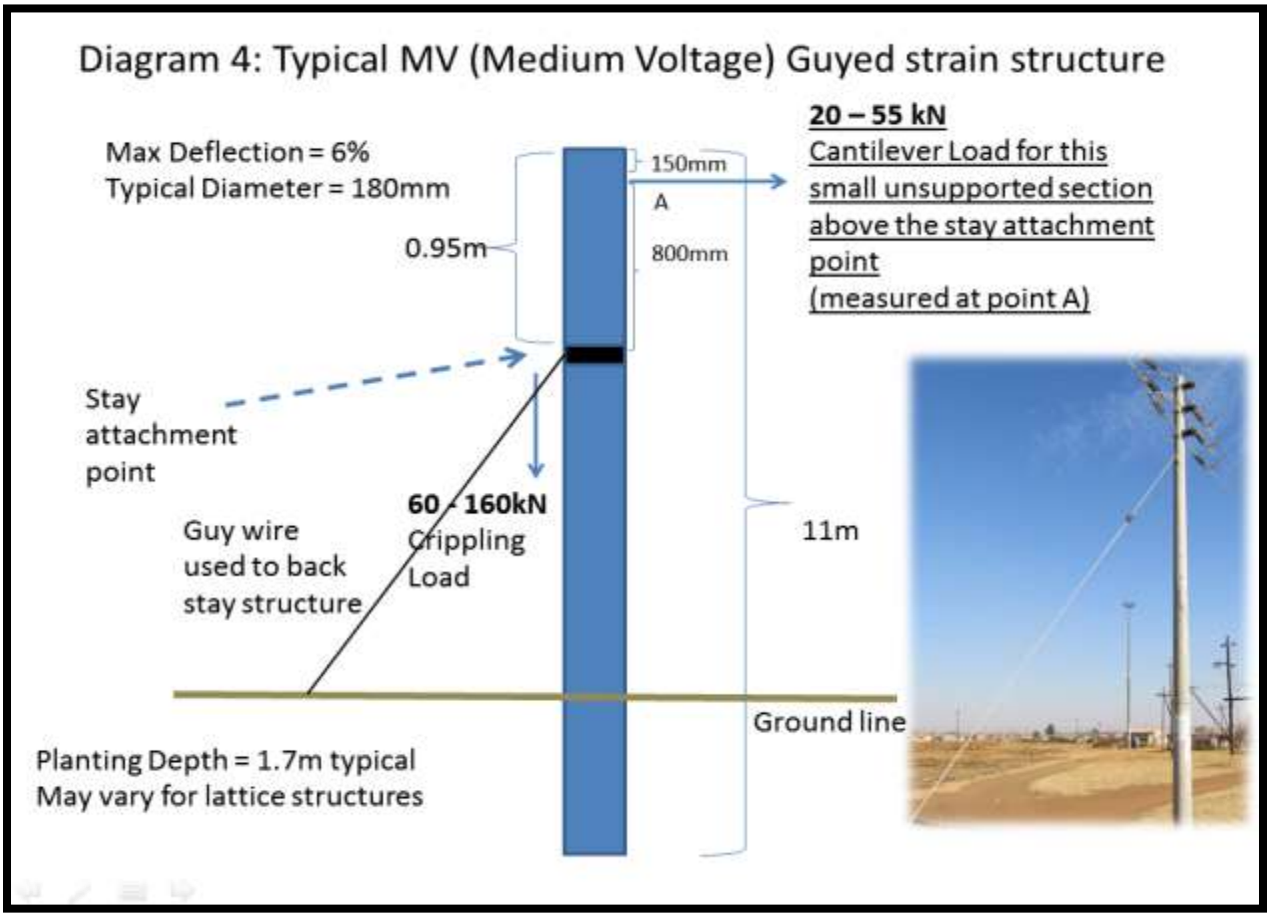
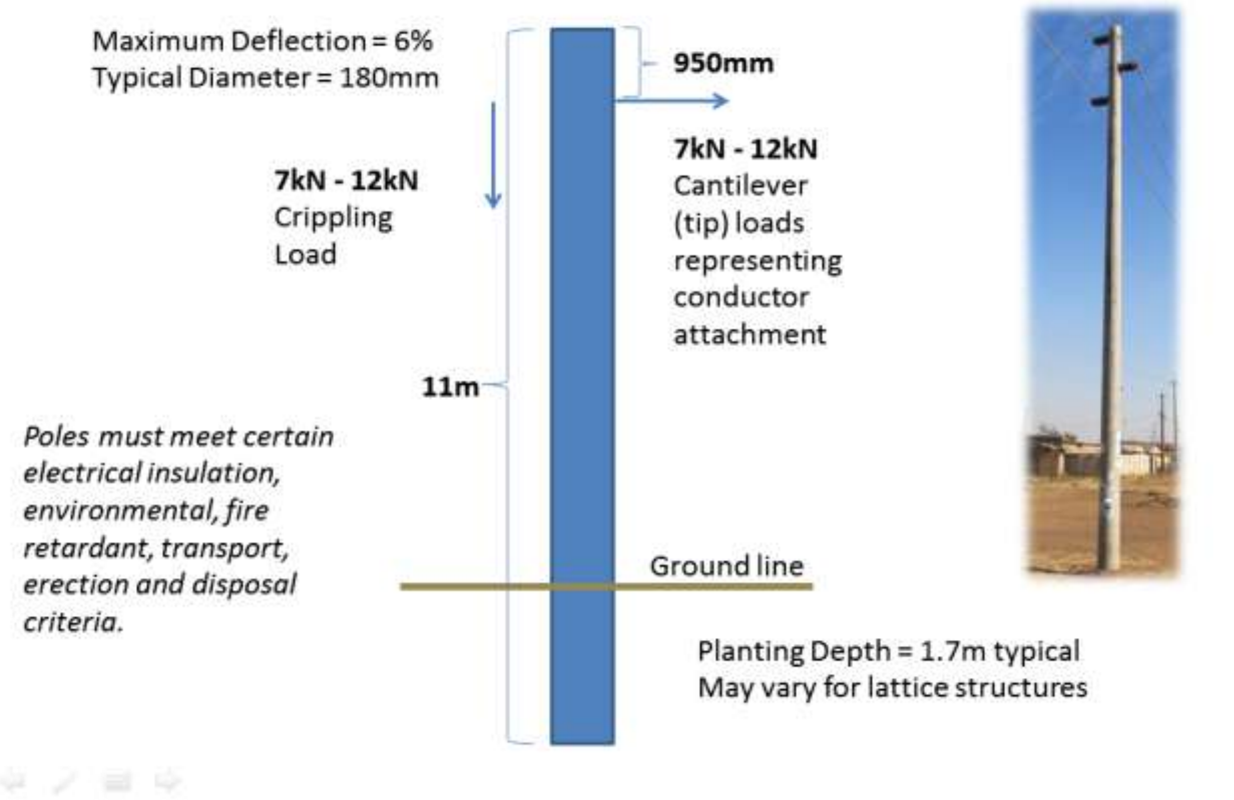


Diagram 4: Typical MV (Medium Voltage) Guyed strain structure
20 – 55 kN
Cantilever Load for this small unsupported section above the stay attachment point
(measured at point A)
Max Deflection = 6%
Typical Diameter = 180mm
150mm
A
0.95m
800mm
Stay attachment point
60 - 160kN
Crippling Load
Guy wire used to back stay structure
11m
Ground line
Planting Depth = 1.7m typical
May vary for lattice structures

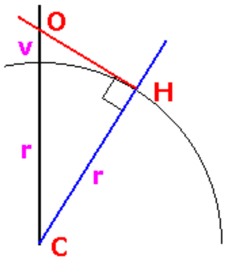
Diagram 3: Typical MV (Medium Voltage) Intermediate structure



APPENDIX IV

FORMULA FOR DERIVING THE APPROXIMATE VISUAL HORIZON

The Mathematics behind this Calculation



This calculation should be taken as a guide only as it assumes the earth is a perfect ball 6378137 metres radius. It also assumes the horizon you are looking at is at sea level. A triangle is formed with the centre of the earth (C) as one point, the horizon point (H) is a right angle and the observer (O) the third corner. Using Pythagoras's theorem we can calculate the distance from the observer to the horizon (OH) knowing CH is the earth's radius (r) and CO is the earth's radius (r) plus observer's height (v) above sea level.

Sitting in a hotel room 10m above sea level a boat on the horizon will be 11.3km away. The reverse is also true, whilst rowing across the Atlantic, the very top of a mountain range 400m high could be seen on your horizon at a distance of 71.4 km assuming the air was clear enough.

APPENDIX V

REPORT PRODUCED BY SANDIA LABORATORIES GLARE MODEL

Solar Glare Hazard Analysis Flight Path Report

Generated July 12, 2015, 3:31 a.m.

Flight path: NORTH APPROACH

Glare found

Print

Analysis & PV array parameters

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	70000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	198.11
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7843110094	29.3480014801	5290.19	9.0	5299.19
2	-26.782088954	29.3498039246	5304.11	9.0	5313.11
3	-26.781246094	29.363193512	5305.06	9.0	5314.06
4	-26.7836980329	29.3632793427	5292.64	9.0	5301.64
5	-26.7835447883	29.3609619141	5293.18	9.0	5302.18
6	-26.7866862618	29.3601036072	5286.93	9.0	5295.93

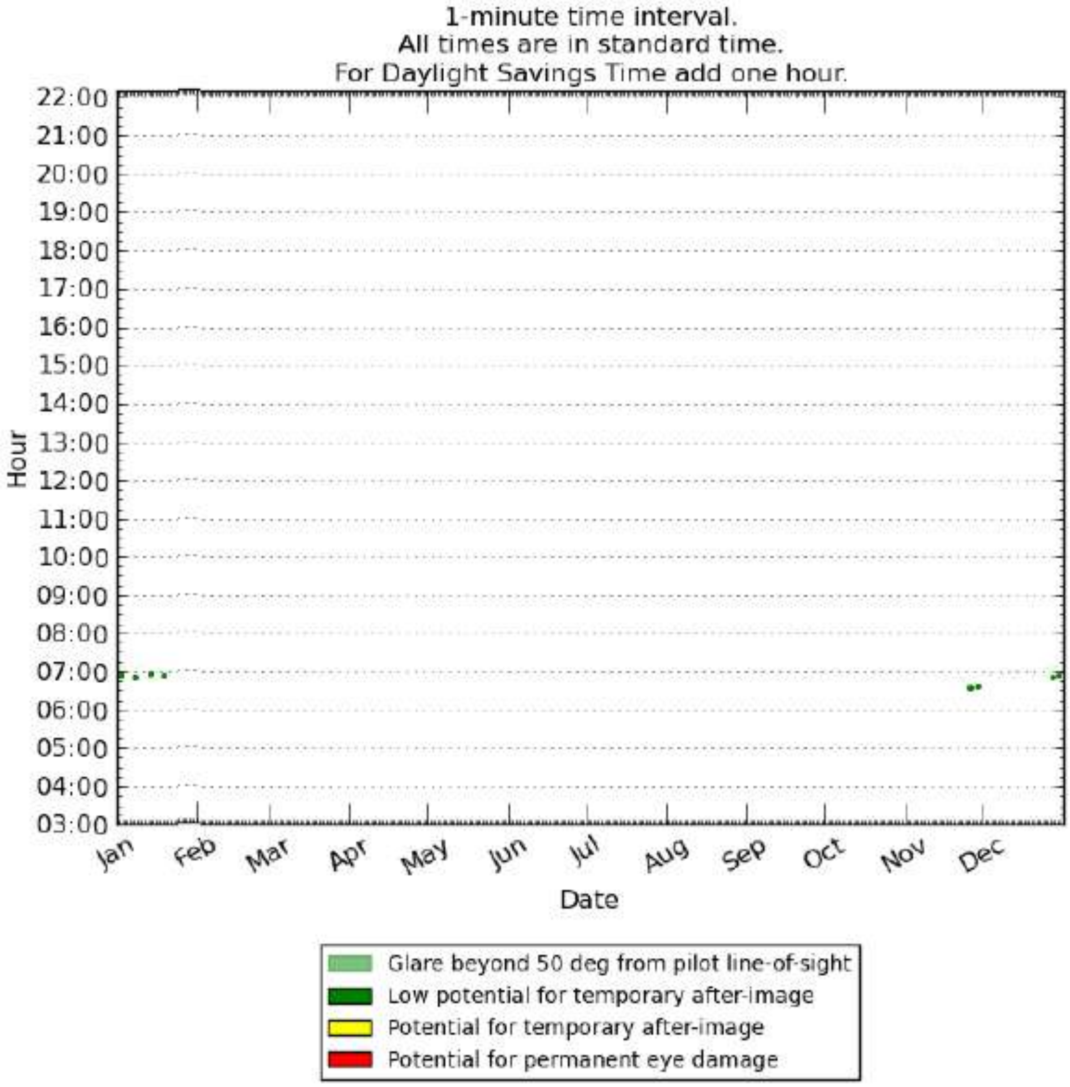
Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	-26.7715144394	29.3386459351	5328.08	50.0	Yes
1/4 mi	-26.7680797153	29.3399055744	5312.29	134.97	No
1/2 mi	-26.7646449912	29.3411652138	5282.28	234.17	No
3/4 mi	-26.7612102671	29.3424248531	5261.4	324.22	No
1 mi	-26.757775543	29.3436844925	5261.39	393.4	No
1 1/4 mi	-26.7543408189	29.3449441318	5250.62	473.36	No
1 1/2 mi	-26.7509060948	29.3462037712	5281.58	511.57	No
1 3/4 mi	-26.7474713708	29.3474634105	5314.05	548.29	No
2 mi	-26.7440366467	29.3487230499	5329.75	601.76	No

Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.

Threshold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Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

Solar Glare Hazard Analysis Flight Path Report

Generated July 12, 2015, 3:32 a.m.

Flight path: SOUTH APPROACH

Glare found

Print

Analysis & PV array parameters

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	70000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	15.83
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7843110094	29.3480014801	5290.19	9.0	5299.19
2	-26.782088954	29.3498039246	5304.11	9.0	5313.11
3	-26.781246094	29.363193512	5305.06	9.0	5314.06
4	-26.7836980329	29.3632793427	5292.64	9.0	5301.64
5	-26.7835447883	29.3609619141	5293.18	9.0	5302.18
6	-26.7866862618	29.3601036072	5286.93	9.0	5295.93

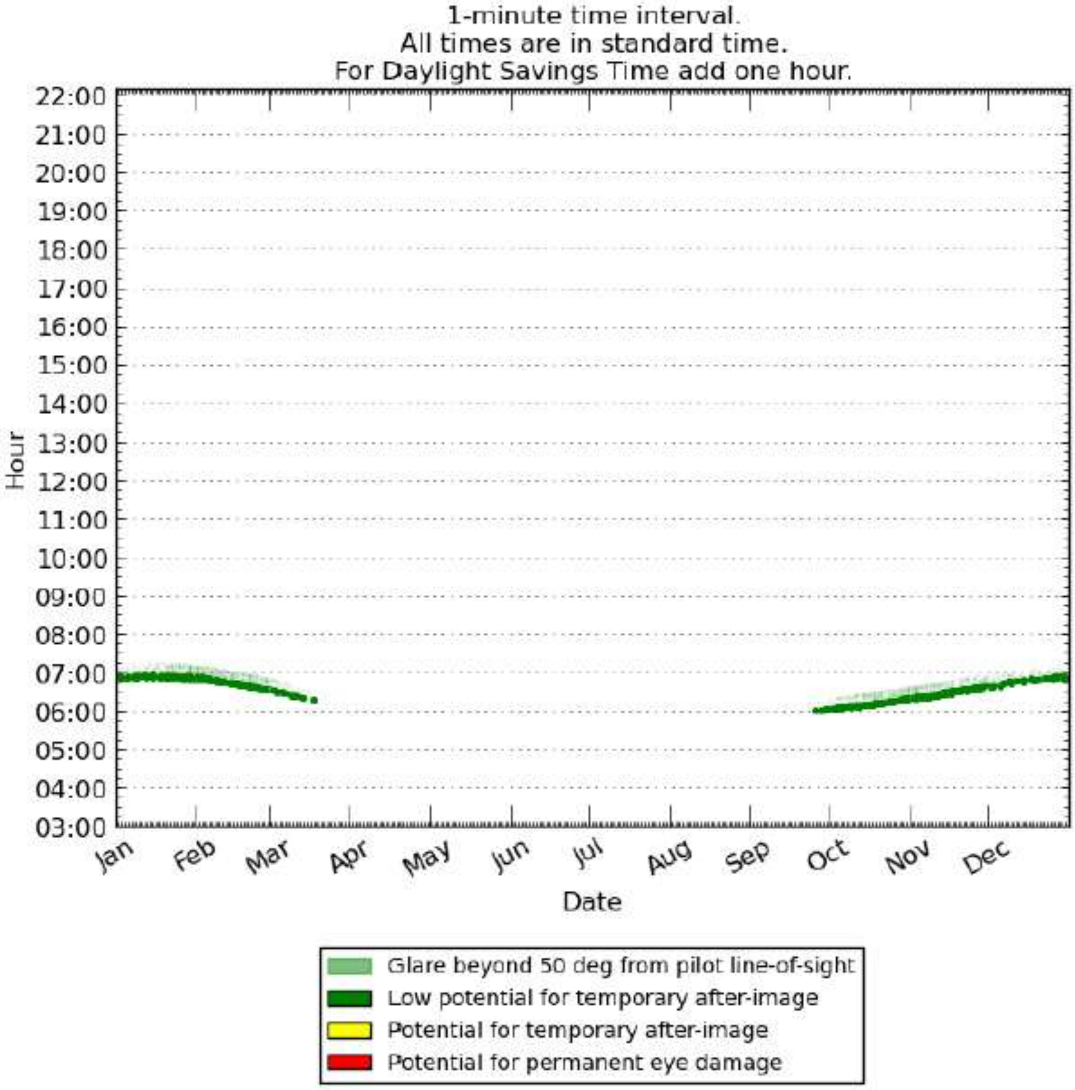
Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	-26.7790239787	29.3359851837	5346.56	50.0	Yes
1/4 mi	-26.782500672	29.3348796965	5309.99	155.74	Yes
1/2 mi	-26.7859773654	29.3337742092	5273.79	261.13	Yes
3/4 mi	-26.7894540588	29.332668722	5255.29	348.81	No
1 mi	-26.7929307522	29.3315632348	5254.0	419.27	No
1 1/4 mi	-26.7964074456	29.3304577475	5261.41	481.04	No
1 1/2 mi	-26.799884139	29.3293522603	5275.74	535.89	No
1 3/4 mi	-26.8033608324	29.328246773	5242.59	638.23	No
2 mi	-26.8068375258	29.3271412858	5218.44	731.55	No

Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.

Threshold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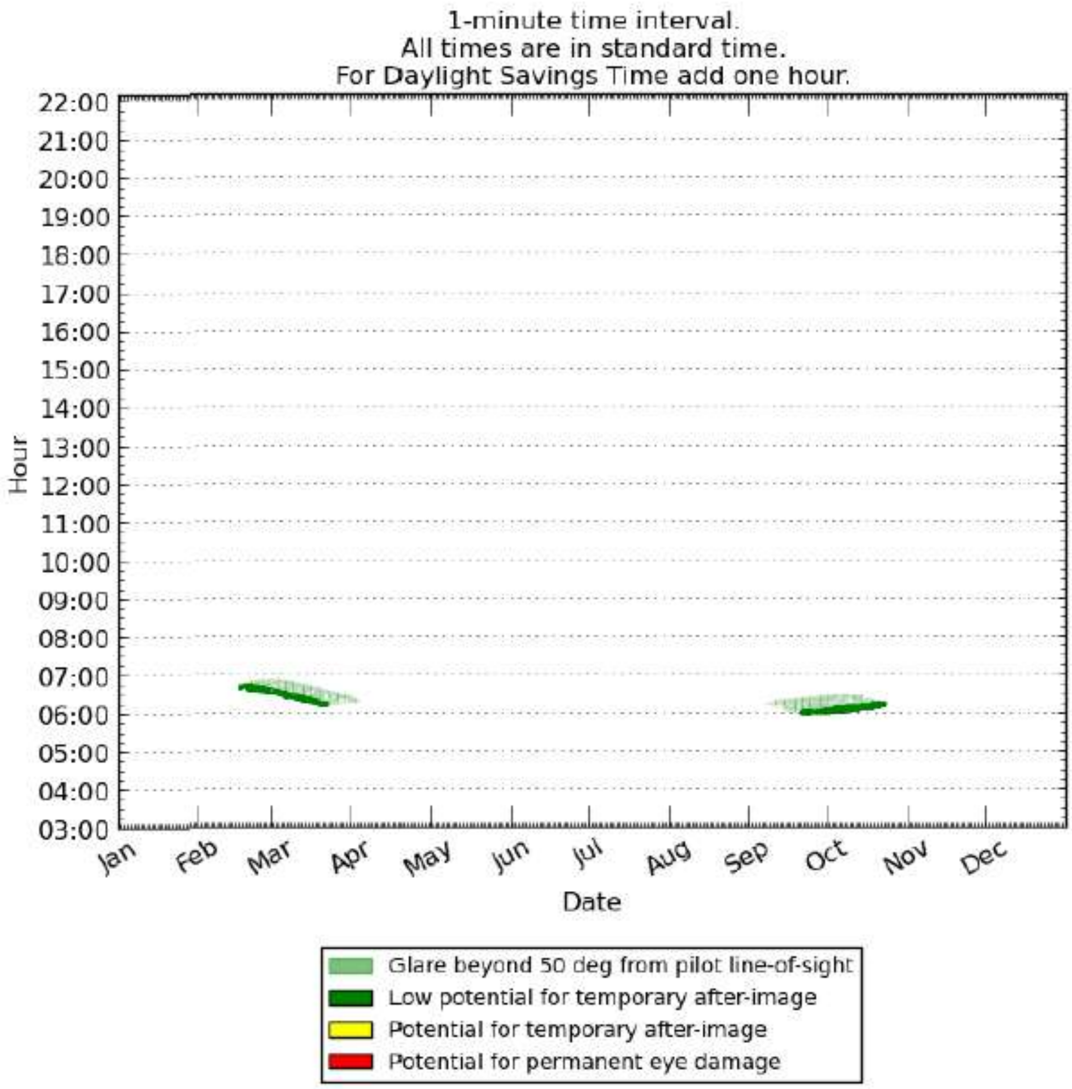
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/4 mi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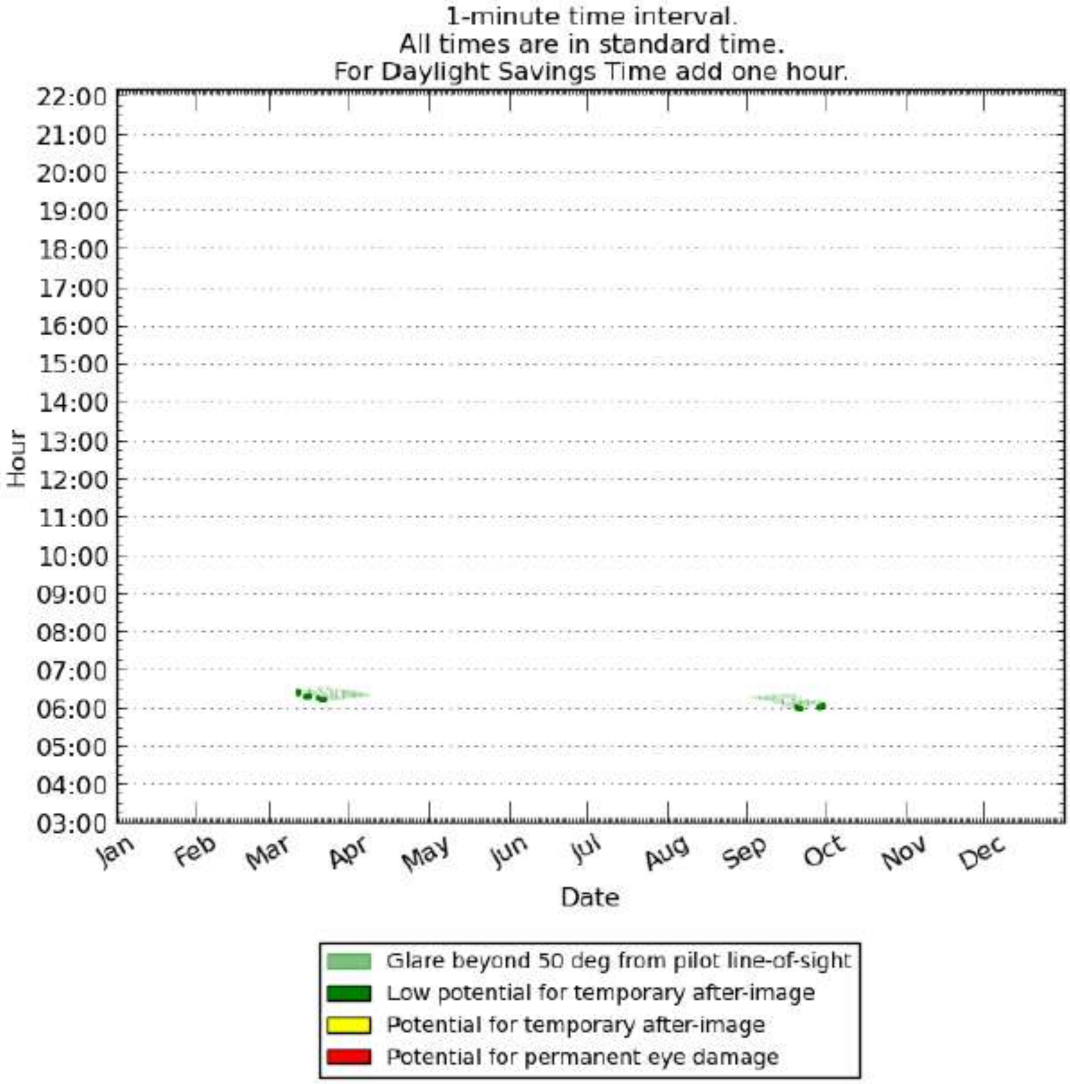
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/2 mi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Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

Solar Glare Hazard Analysis Report

Generated July 12, 2015, 3:25 a.m.

Glare found

Print

Inputs

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	70000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3

Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7843110094	29.3480014801	5290.19	9.0	5299.19
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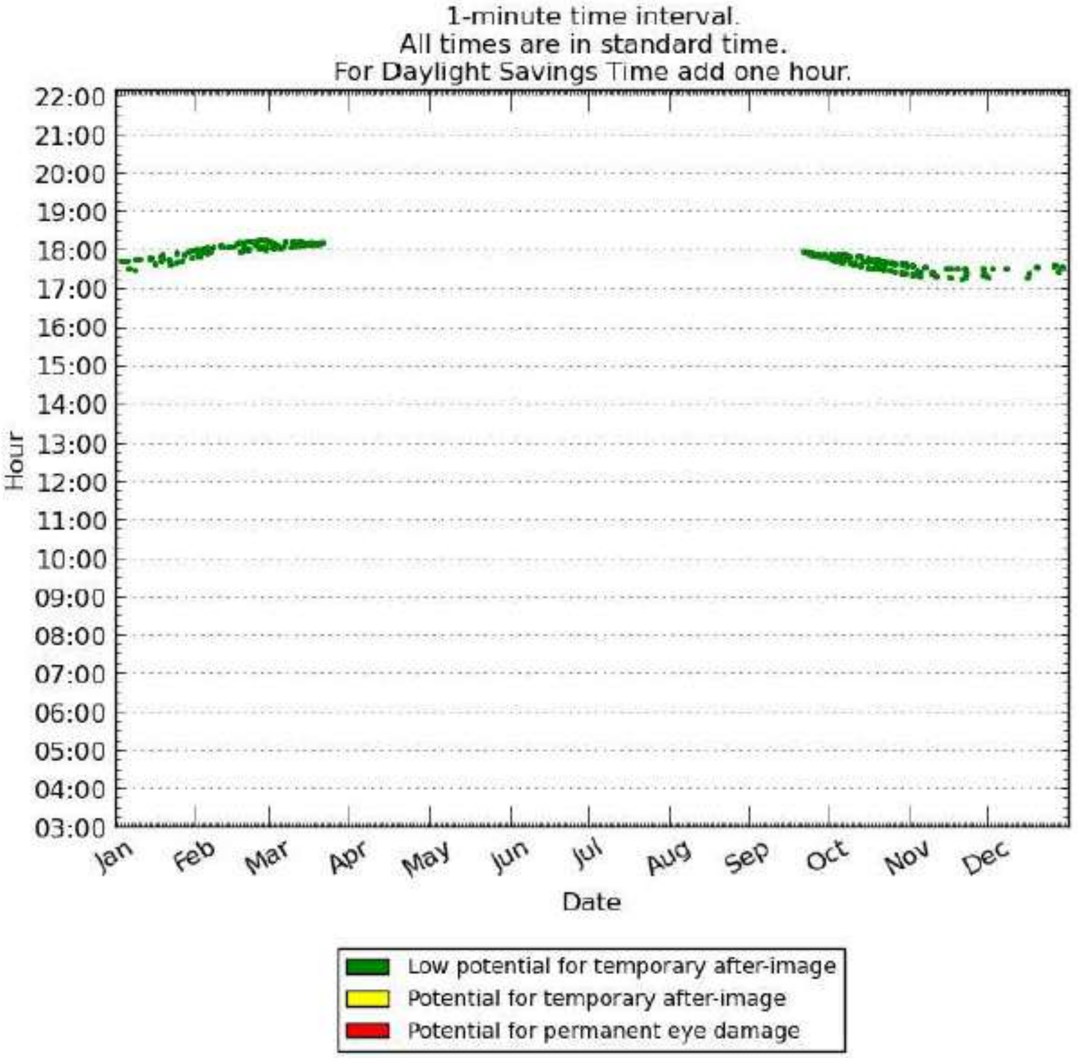
4	-26.7836980329	29.3632793427	5292.64	9.0	5301.64
5	-26.7835447883	29.3609619141	5293.18	9.0	5302.18
6	-26.7866862618	29.3601036072	5286.93	9.0	5295.93

Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)
1	-26.7825486932	29.3692016602	5299.38	5.0

Glare Occurrence Plot

All times are in standard time. For Daylight Savings Time add one hour.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Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

Solar Glare Hazard Analysis Report

Generated July 12, 2015, 3:27 a.m.

Glare found

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Inputs

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	70000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3

Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7843110094	29.3480014801	5290.19	9.0	5299.19
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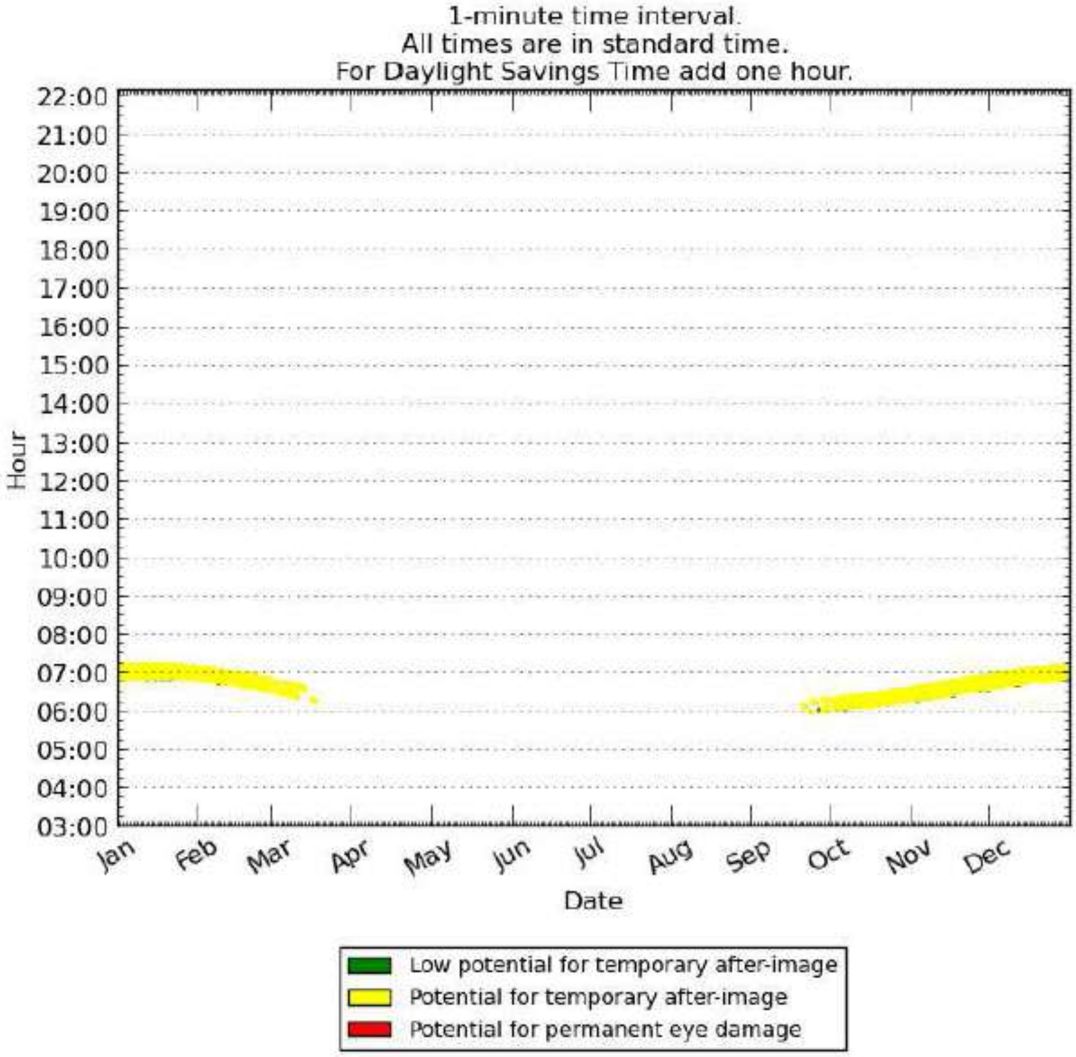
3	-26.781246094	29.363193512	5305.06	9.0	5314.06
4	-26.7836980329	29.3632793427	5292.64	9.0	5301.64
5	-26.7835447883	29.3609619141	5293.18	9.0	5302.18
6	-26.7866862618	29.3601036072	5286.93	9.0	5295.93

Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)
2	-26.780633101	29.3509626389	5317.46	5.0

Glare Occurrence Plot

All times are in standard time. For Daylight Savings Time add one hour.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Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

Solar Glare Hazard Analysis Report

Generated July 12, 2015, 3:29 a.m.

Glare found

Print

Inputs

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	70000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3

Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

PV array vertices

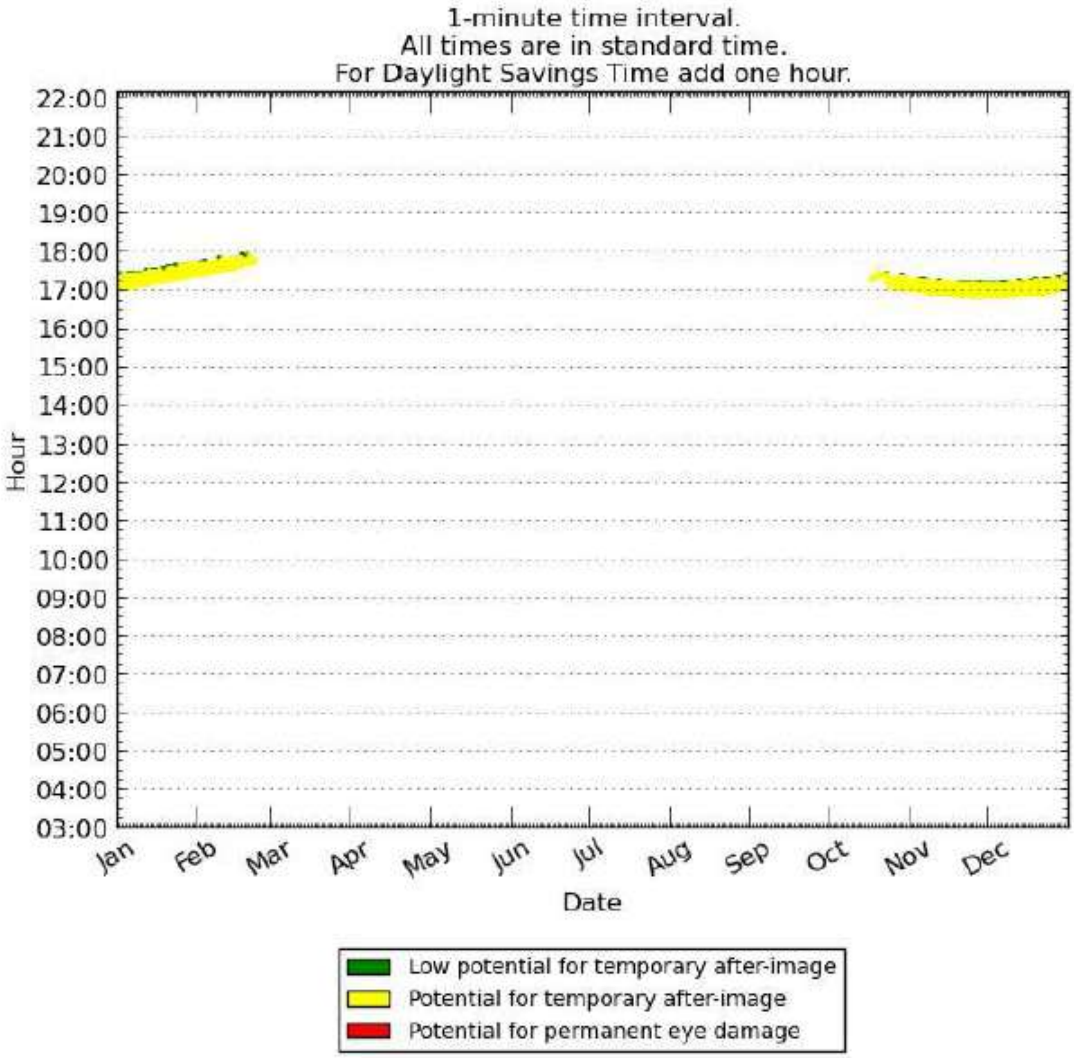
id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7843110094	29.3480014801	5290.19	9.0	5299.19
2	-26.782088954	29.3498039246	5304.11	9.0	5313.11
3	-26.781246094	29.363193512	5305.06	9.0	5314.06
4	-26.7836980329	29.3632793427	5292.64	9.0	5301.64
5	-26.7835447883	29.3609619141	5293.18	9.0	5302.18
6	-26.7866862618	29.3601036072	5286.93	9.0	5295.93

Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)
3	-26.7773765202	29.3701887131	5353.24	5.0

Glare Occurrence Plot

All times are in standard time. For Daylight Savings Time add one hour.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Date
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

Solar Glare Hazard Analysis Report

Generated July 12, 2015, 3:30 a.m.

Glare found

Print

Inputs

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	70000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3

Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

PV array vertices

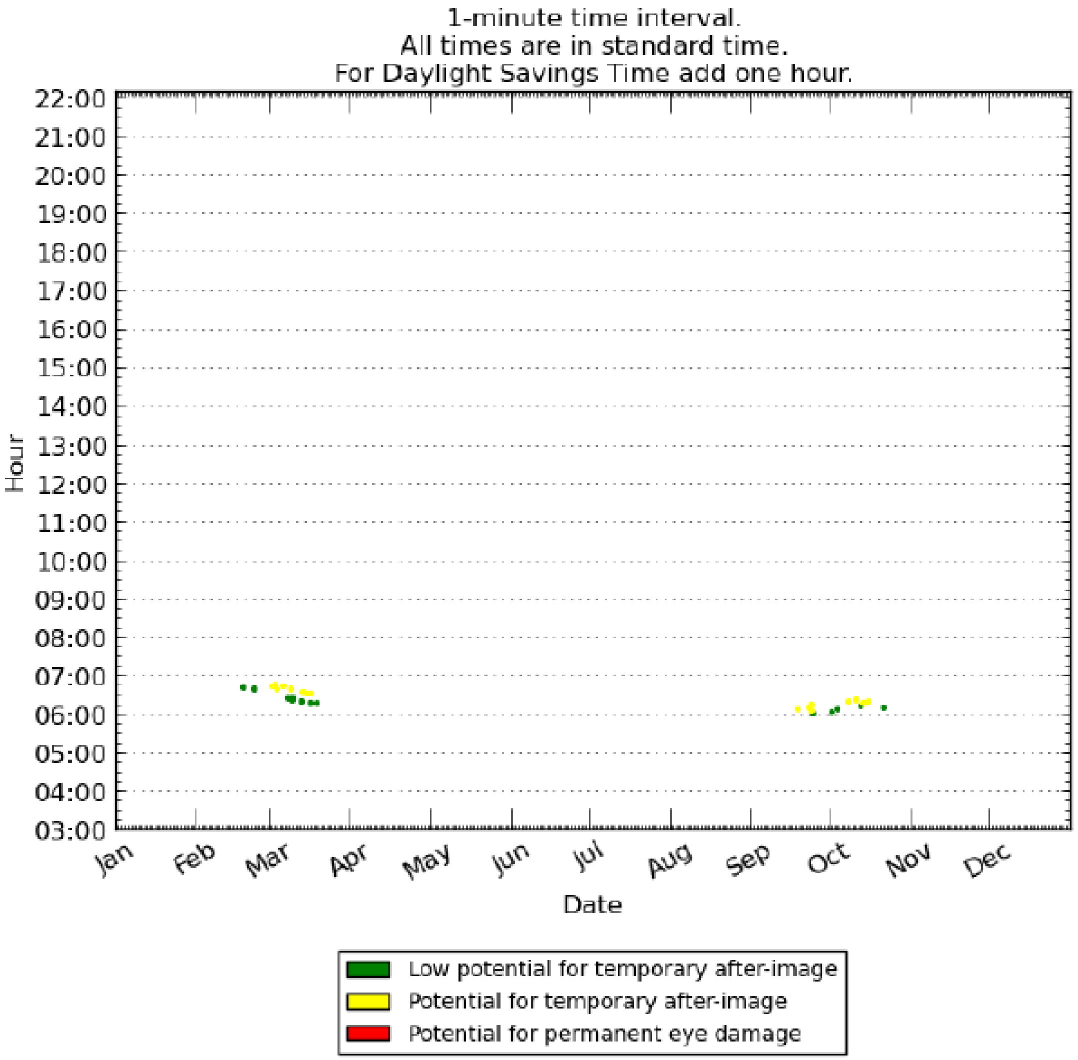
id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7843110094	29.3480014801	5290.19	9.0	5299.19
2	-26.782088954	29.3498039246	5304.11	9.0	5313.11
3	-26.781246094	29.363193512	5305.06	9.0	5314.06
4	-26.7836980329	29.3632793427	5292.64	9.0	5301.64
5	-26.7835447883	29.3609619141	5293.18	9.0	5302.18
6	-26.7866862618	29.3601036072	5286.93	9.0	5295.93

Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)
4	-26.7803649155	29.3234109879	5314.34	5.0

Glare Occurrence Plot

All times are in standard time. For Daylight Savings Time add one hour.


1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
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Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

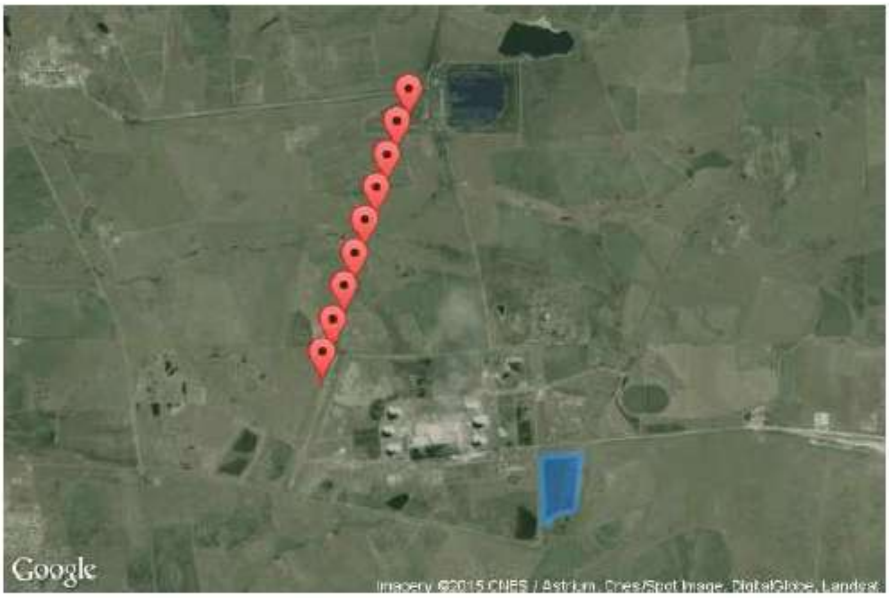
Solar Glare Hazard Analysis Flight Path Report

Generated July 12, 2015, 3:37 a.m.

Flight path: NORTH APPROACH

Glare found

Print



Analysis & PV array parameters

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	38000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	198.11
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7786408509	29.3642234802	5332.36	9.0	5341.36
2	-26.7782577219	29.3689441681	5343.39	9.0	5352.39
3	-26.7840811436	29.3681716919	5290.58	9.0	5299.58
4	-26.7845408747	29.3660259247	5293.01	9.0	5302.01
5	-26.7856901943	29.364566803	5292.86	9.0	5301.86

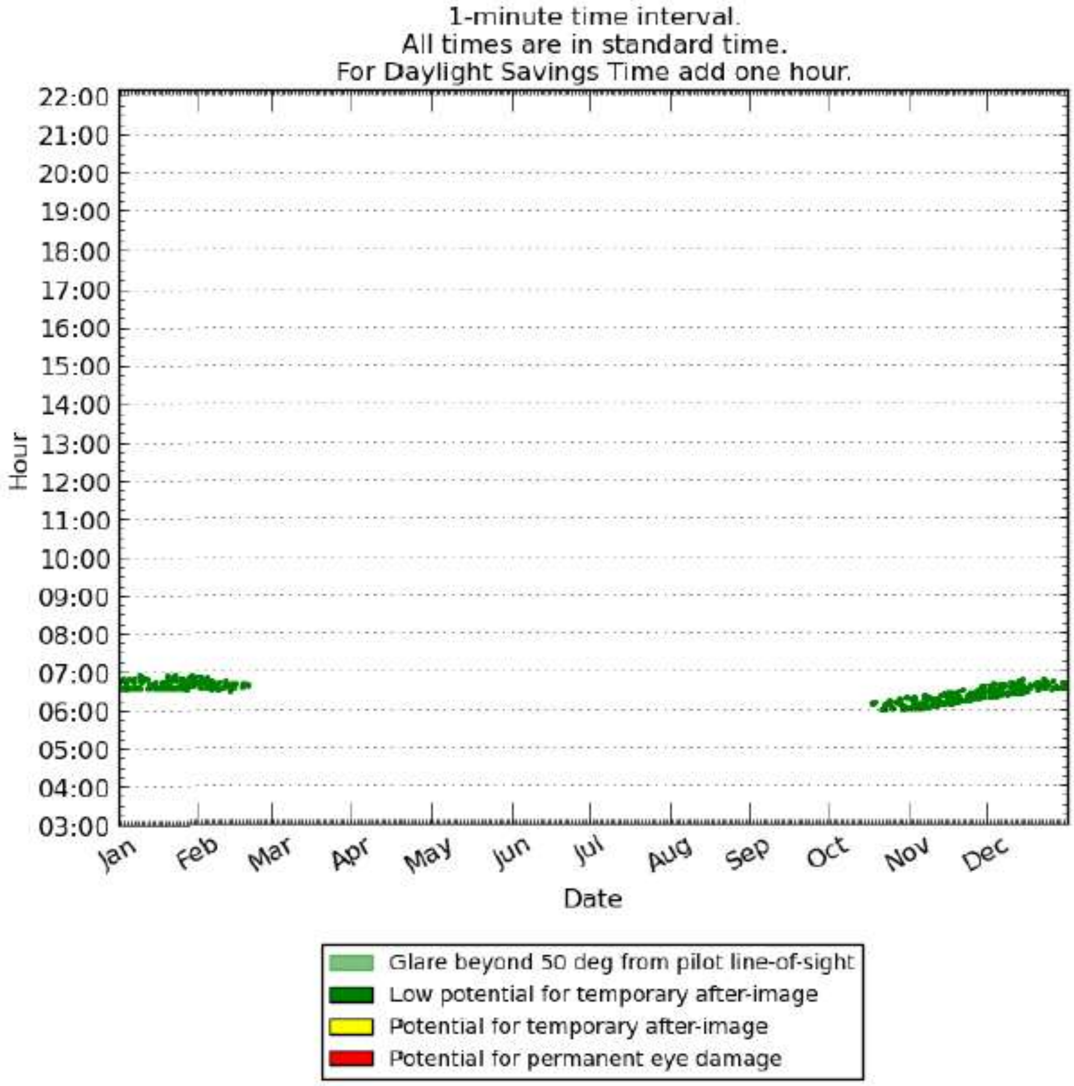
Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	-26.7715144394	29.3386459351	5328.08	50.0	Yes
1/4 mi	-26.7680797153	29.3399055744	5312.29	134.97	Yes
1/2 mi	-26.7646449912	29.3411652138	5282.28	234.17	Yes
3/4 mi	-26.7612102671	29.3424248531	5261.4	324.22	No
1 mi	-26.757775543	29.3436844925	5261.39	393.4	No
1 1/4 mi	-26.7543408189	29.3449441318	5250.62	473.36	No
1 1/2 mi	-26.7509060948	29.3462037712	5281.58	511.57	No
1 3/4 mi	-26.7474713708	29.3474634105	5314.05	548.29	No
2 mi	-26.7440366467	29.3487230499	5329.75	601.76	No

Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.

Threshold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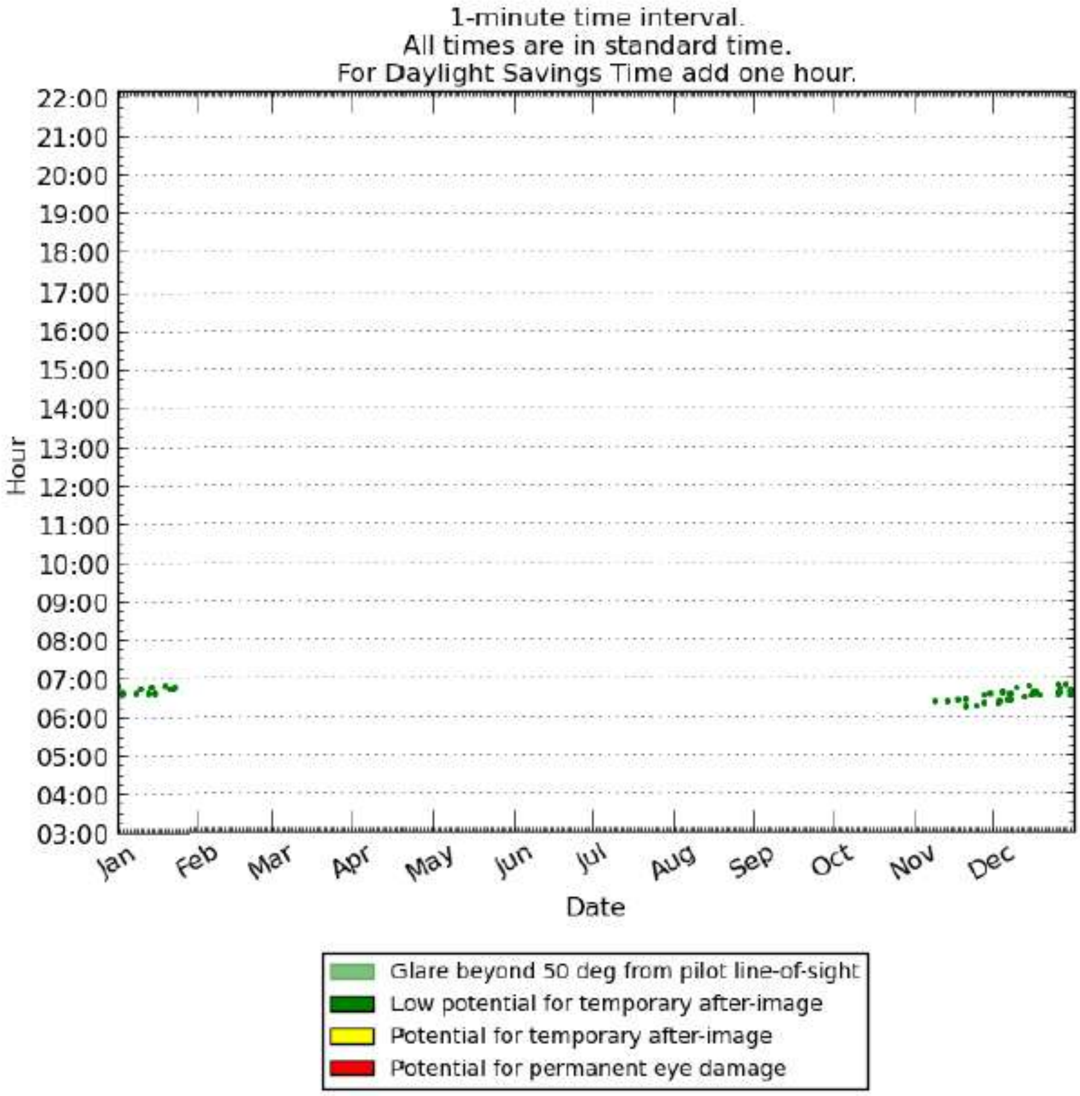
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/4 mi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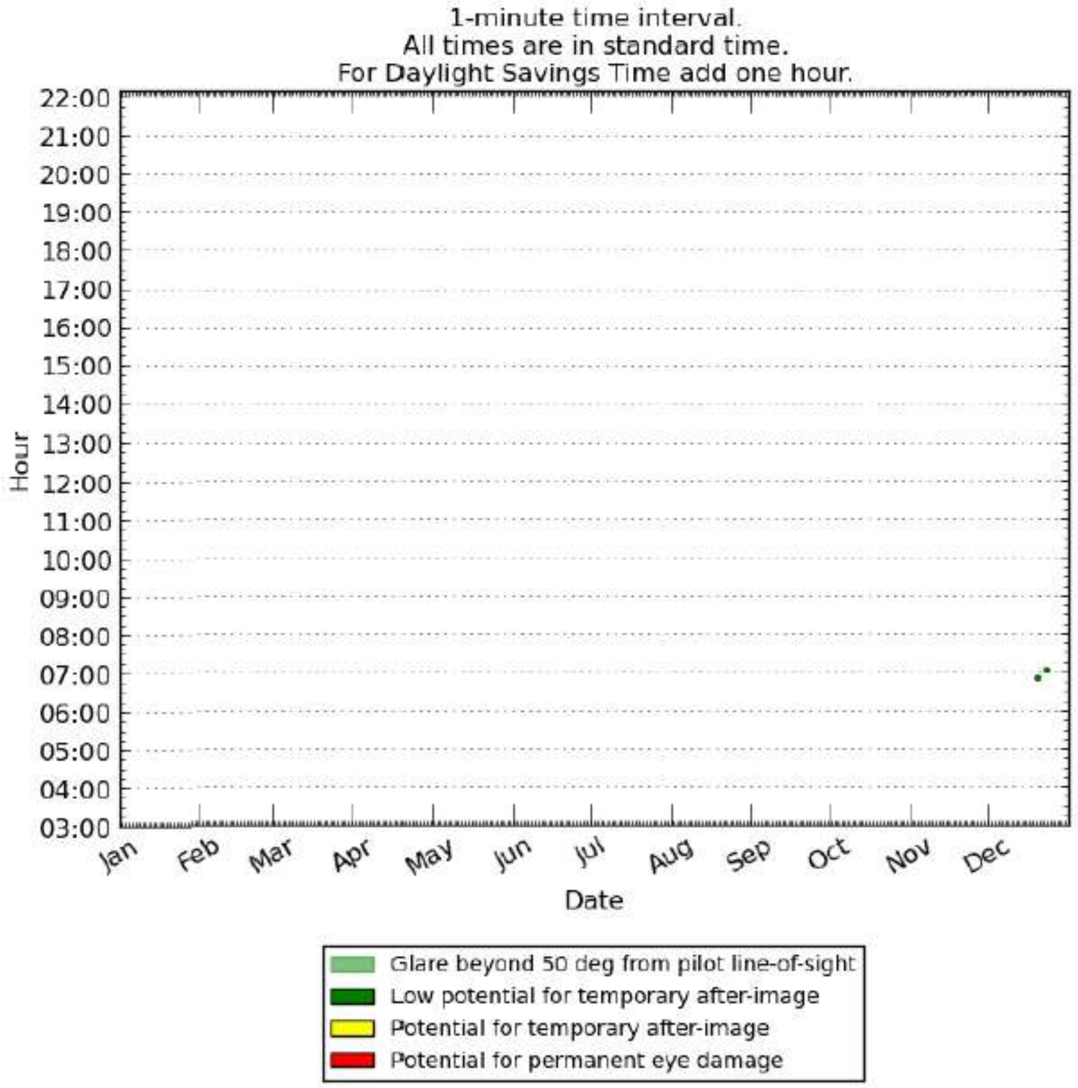
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/2 mi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Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

Solar Glare Hazard Analysis Flight Path Report

Generated July 12, 2015, 3:39 a.m.

Flight path: SOUTH APPROACH

Glare found

Print

Analysis & PV array parameters

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	38000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3
Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

Flight path parameters

Direction (deg)	15.83
Glide slope (deg)	3.0
Consider pilot visibility from cockpit	False

PV array vertices

id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7786408509	29.3642234802	5332.36	9.0	5341.36
2	-26.7782577219	29.3689441681	5343.39	9.0	5352.39
3	-26.7840811436	29.3681716919	5290.58	9.0	5299.58
4	-26.7845408747	29.3660259247	5293.01	9.0	5302.01
5	-26.7856901943	29.364566803	5292.86	9.0	5301.86

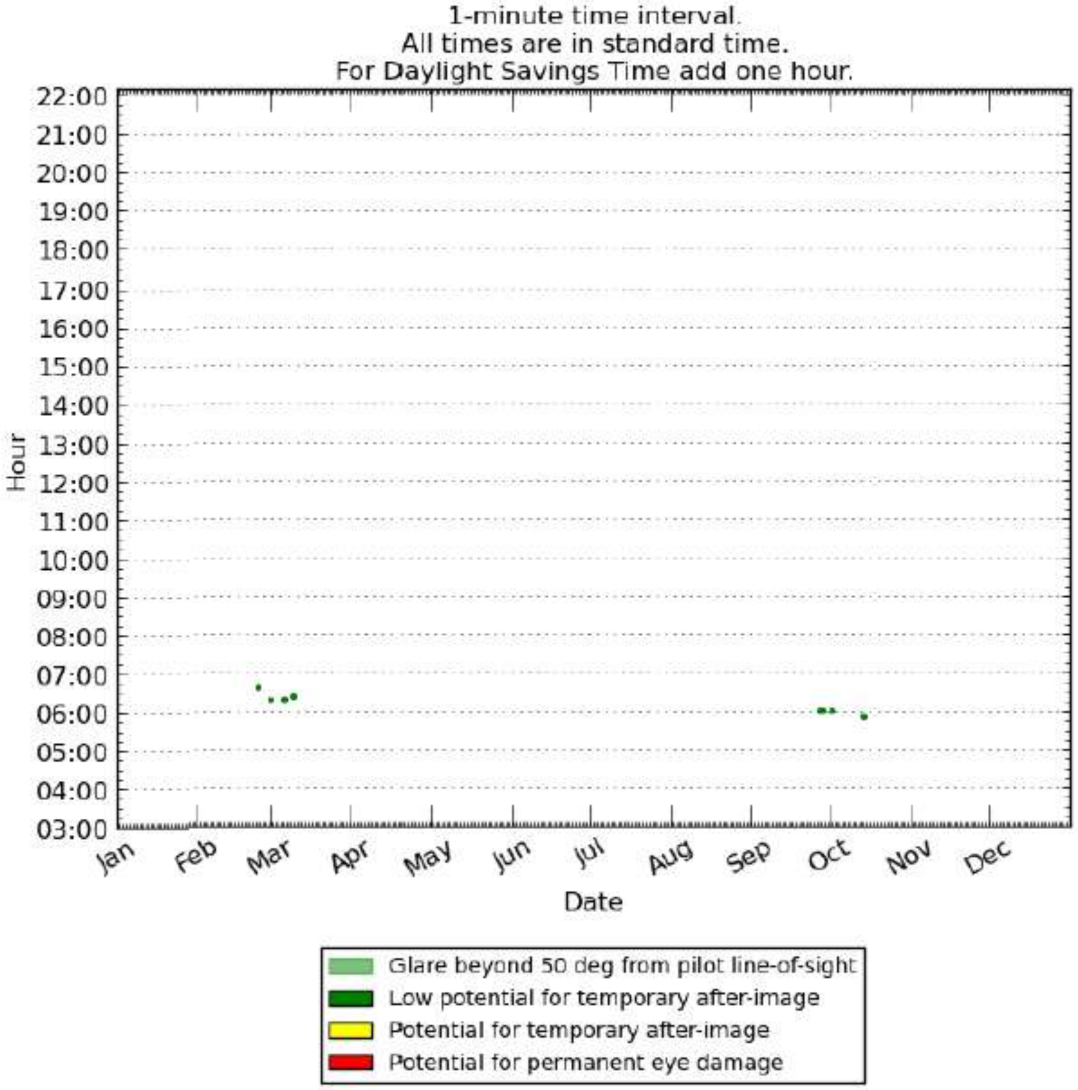
Flight Path Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)	Glare?
Threshold	-26.7790239787	29.3359851837	5346.56	50.0	Yes
1/4 mi	-26.782500672	29.3348796965	5309.99	155.74	Yes
1/2 mi	-26.7859773654	29.3337742092	5273.79	261.13	Yes
3/4 mi	-26.7894540588	29.332668722	5255.29	348.81	No
1 mi	-26.7929307522	29.3315632348	5254.0	419.27	No
1 1/4 mi	-26.7964074456	29.3304577475	5261.41	481.04	No
1 1/2 mi	-26.799884139	29.3293522603	5275.74	535.89	No
1 3/4 mi	-26.8033608324	29.328246773	5242.59	638.23	No
2 mi	-26.8068375258	29.3271412858	5218.44	731.55	No

Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.

Threshold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All times are in standard time.
For Daylight Savings Time add one hour.
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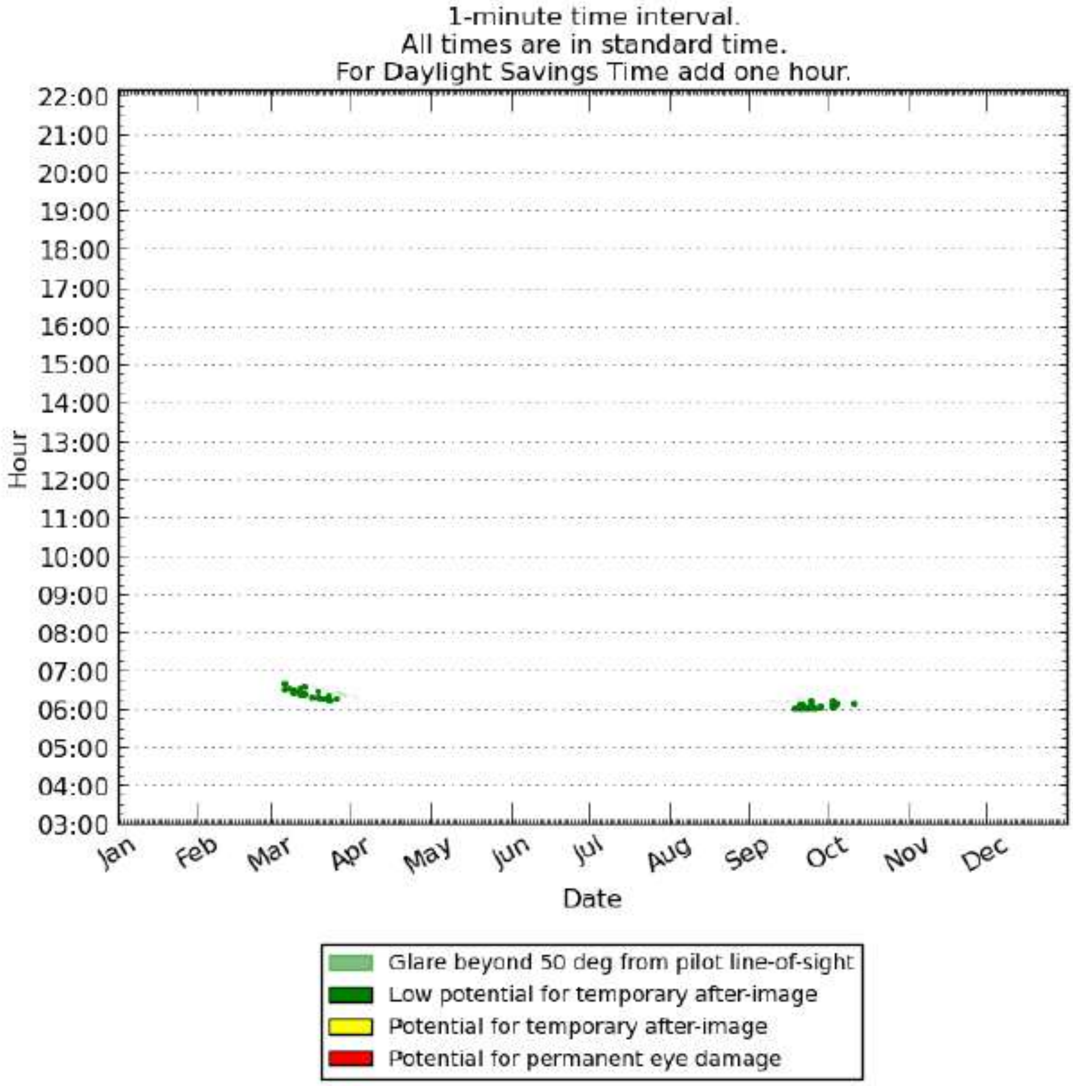
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/4 mi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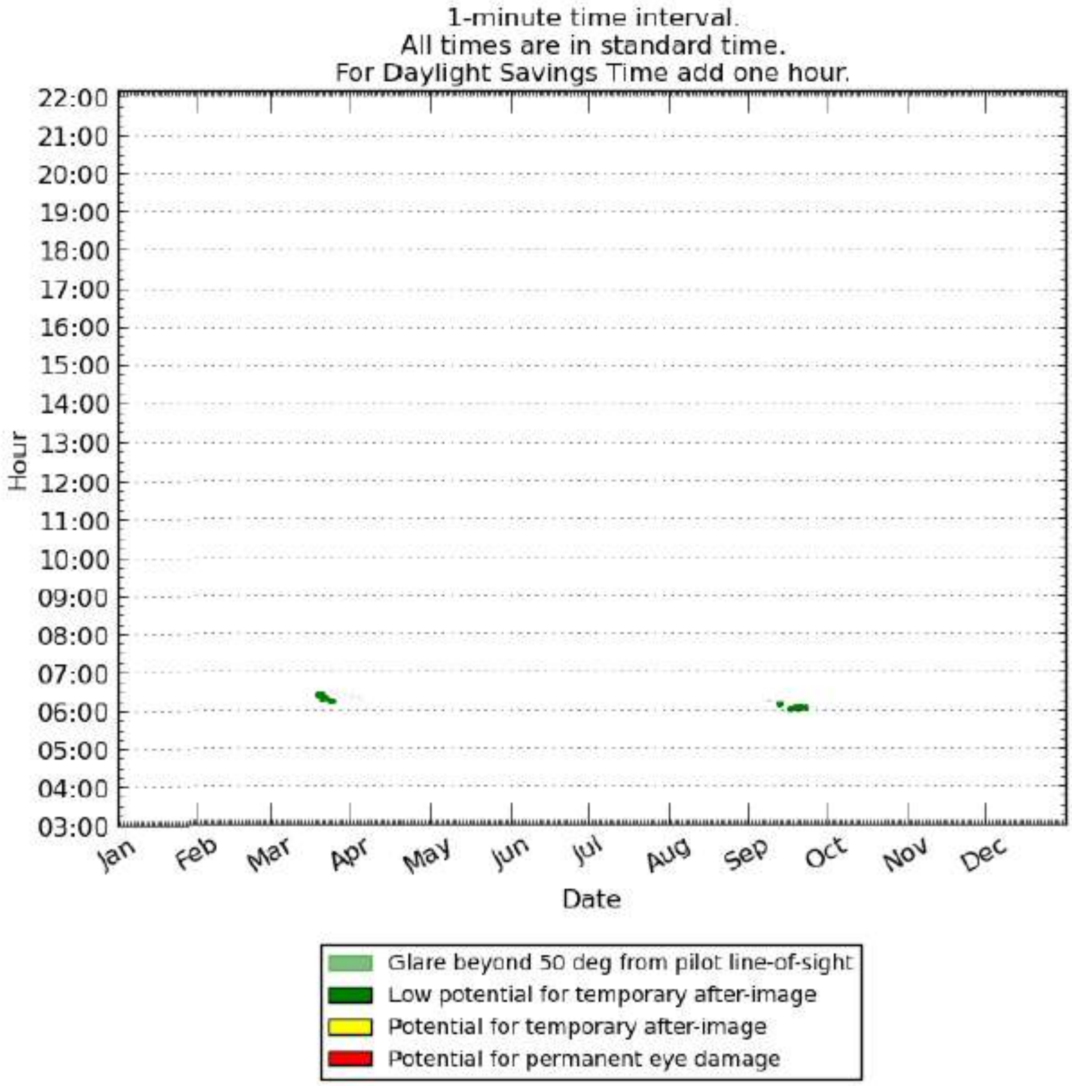
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

1/2 mi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Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

Solar Glare Hazard Analysis Report

Generated July 12, 2015, 3:33 a.m.

Glare found

Print

Inputs

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	38000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3

Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

PV array vertices

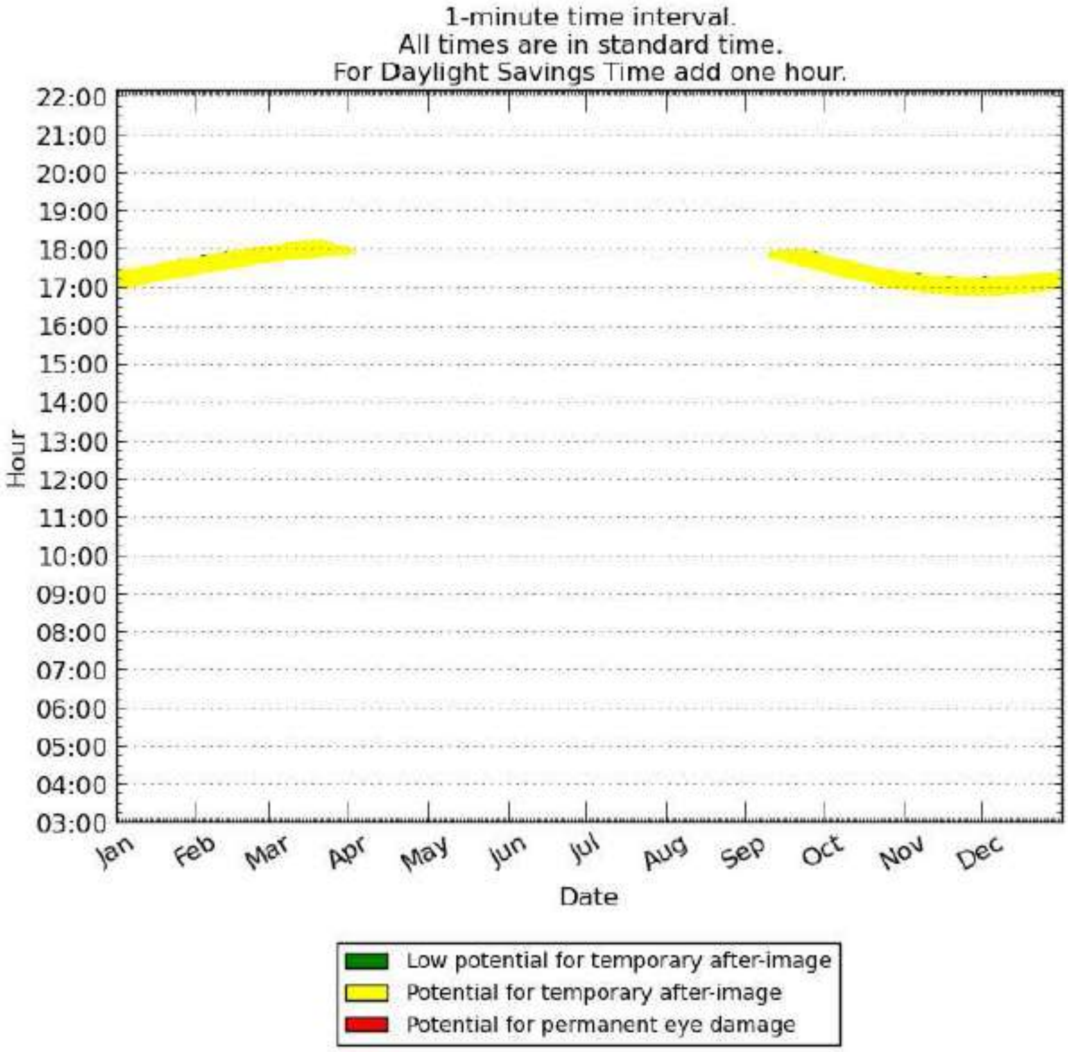
id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7786408509	29.3642234802	5332.36	9.0	5341.36
2	-26.7782577219	29.3689441681	5343.39	9.0	5352.39
3	-26.7840811436	29.3681716919	5290.58	9.0	5299.58
4	-26.7845408747	29.3660259247	5293.01	9.0	5302.01
5	-26.7856901943	29.364566803	5292.86	9.0	5301.86

Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)
1	-26.7825486932	29.3692016602	5299.38	5.0

Glare Occurrence Plot

All times are in standard time. For Daylight Savings Time add one hour.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Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

Solar Glare Hazard Analysis Report

Generated July 12, 2015, 3:34 a.m.

Glare found

Print

Inputs

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	38000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3

Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

PV array vertices

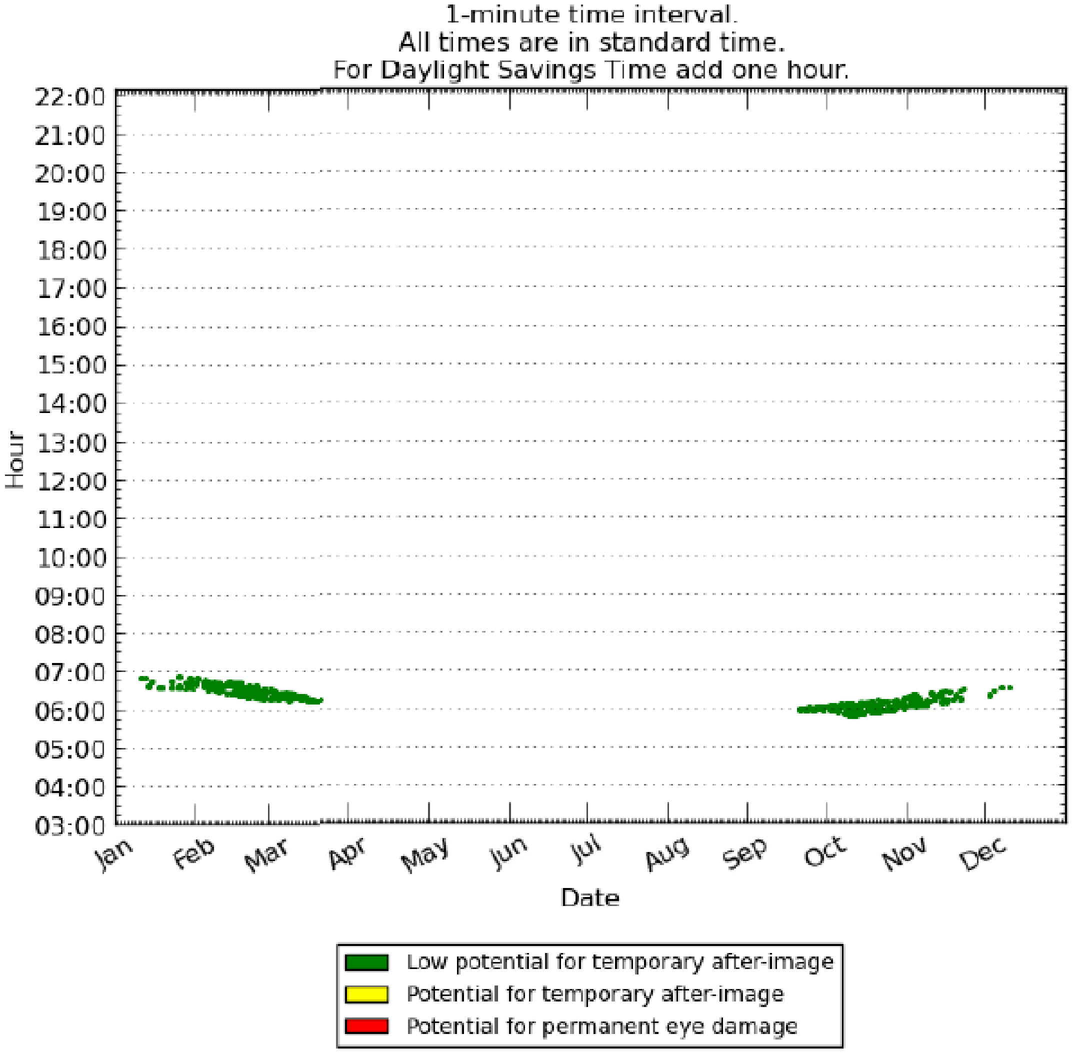
id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7786408509	29.3642234802	5332.36	9.0	5341.36
2	-26.7782577219	29.3689441681	5343.39	9.0	5352.39
3	-26.7840811436	29.3681716919	5290.58	9.0	5299.58
4	-26.7845408747	29.3660259247	5293.01	9.0	5302.01
5	-26.7856901943	29.364566803	5292.86	9.0	5301.86

Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)
2	-26.780633101	29.3509626389	5317.46	5.0

Glare Occurrence Plot

All times are in standard time. For Daylight Savings Time add one hour.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Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

Solar Glare Hazard Analysis Report

Generated July 12, 2015, 3:35 a.m.

Glare found

Print

Inputs

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	38000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3

Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

PV array vertices

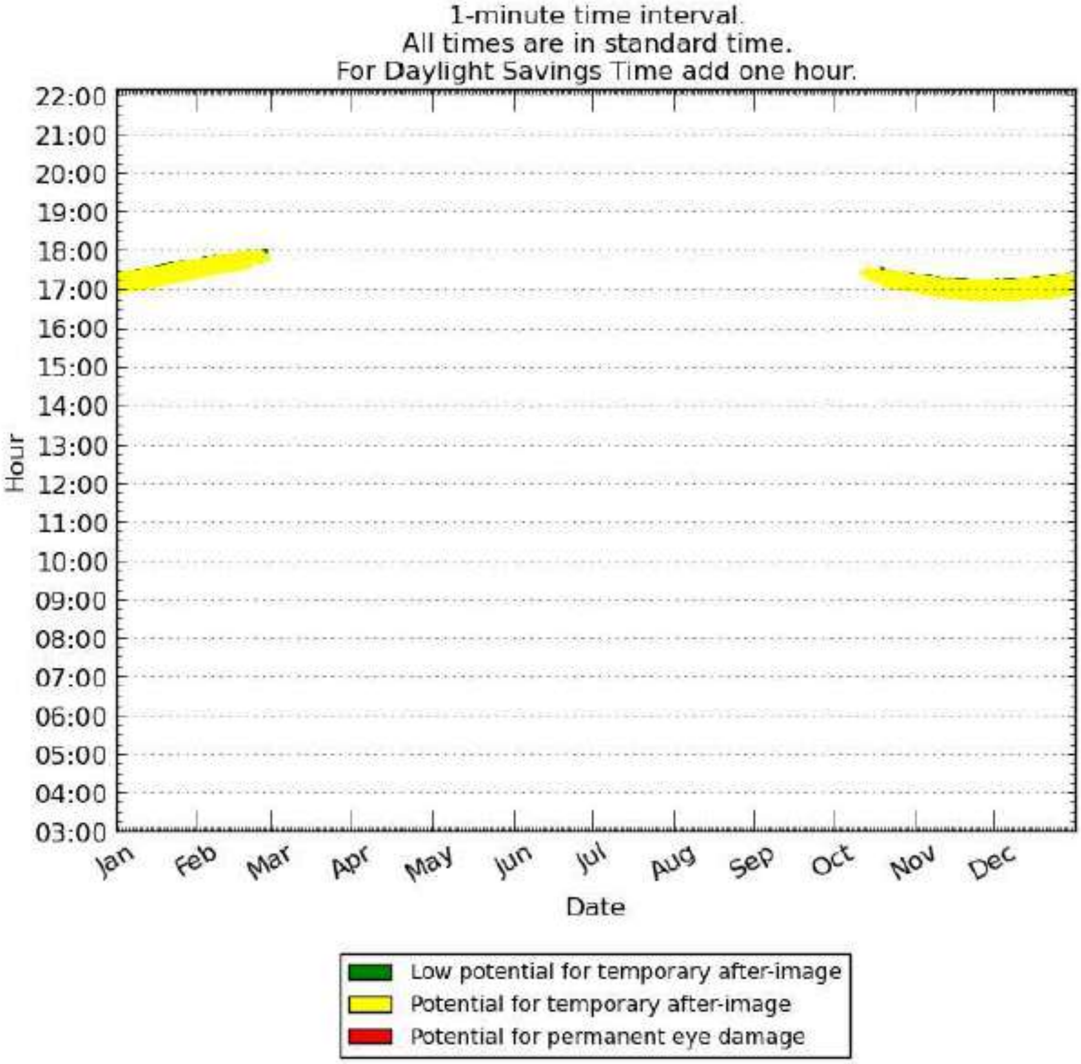
id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7786408509	29.3642234802	5332.36	9.0	5341.36
2	-26.7782577219	29.3689441681	5343.39	9.0	5352.39
3	-26.7840811436	29.3681716919	5290.58	9.0	5299.58
4	-26.7845408747	29.3660259247	5293.01	9.0	5302.01
5	-26.7856901943	29.364566803	5292.86	9.0	5301.86

Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)
3	-26.7773765202	29.3701887131	5353.24	5.0

Glare Occurrence Plot

All times are in standard time. For Daylight Savings Time add one hour.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Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage

Solar Glare Hazard Analysis Report

Generated July 12, 2015, 3:36 a.m.

Glare found

Print

Inputs

Analysis name	TUTUKA
PV array axis tracking	none
Orientation of array (deg)	0.0
Tilt of solar panels (deg)	25.0
Rated power (kW)	38000.0
Vary reflectivity	True
PV surface material	Smooth glass without ARC

Timezone offset	2.0
Subtended angle of sun (mrad)	9.3

Peak DNI (W/m^2)	1000.0
Ocular transmission coefficient	0.5
Pupil diameter (m)	0.002
Eye focal length (m)	0.017
Time interval (min)	1
Correlate slope error with material	False
Slope error (mrad)	10.0

PV array vertices

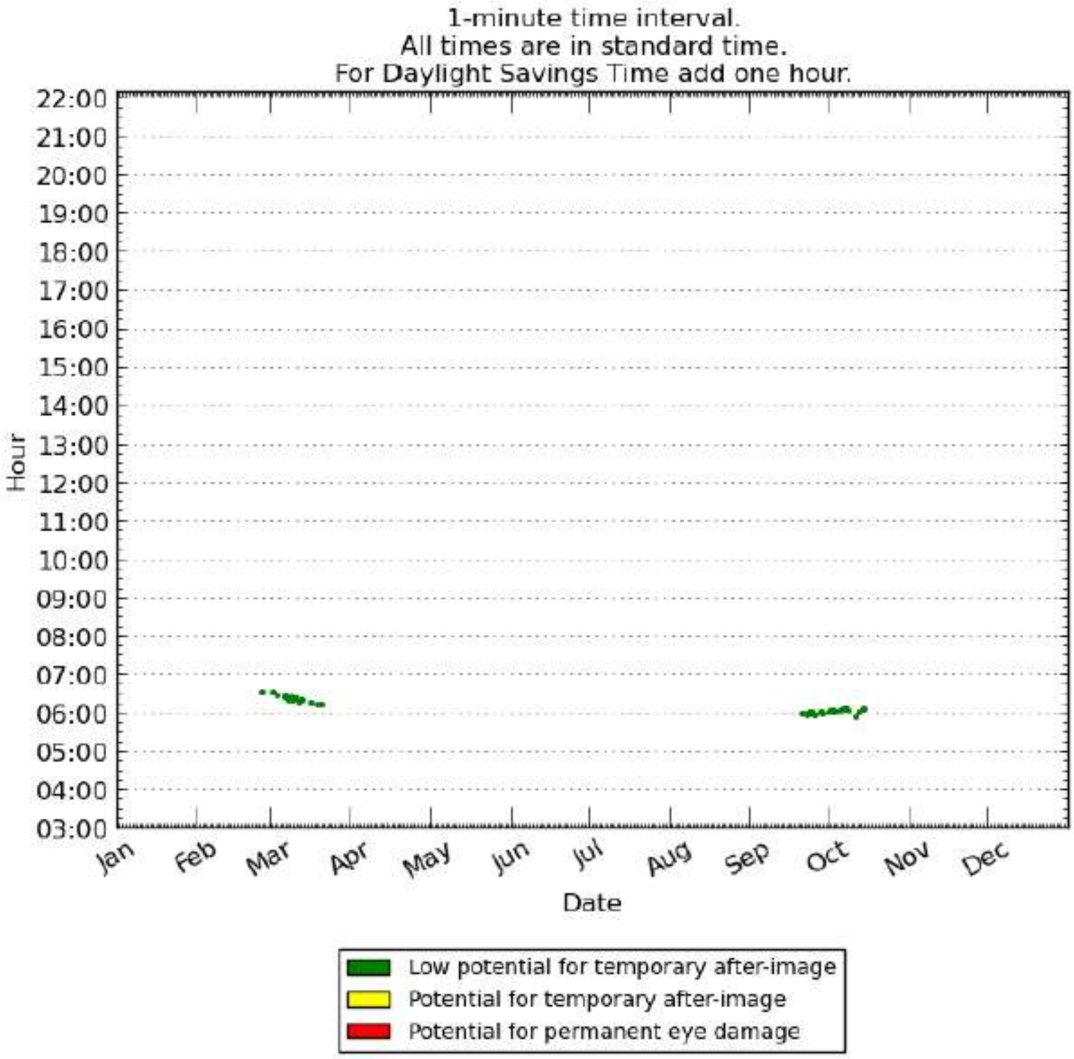
id	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Height of panels above ground (ft)	Total elevation (ft)
1	-26.7786408509	29.3642234802	5332.36	9.0	5341.36
2	-26.7782577219	29.3689441681	5343.39	9.0	5352.39
3	-26.7840811436	29.3681716919	5290.58	9.0	5299.58
4	-26.7845408747	29.3660259247	5293.01	9.0	5302.01
5	-26.7856901943	29.364566803	5292.86	9.0	5301.86

Observation Points

	Latitude (deg)	Longitude (deg)	Ground Elevation (ft)	Eye-level height above ground (ft)
4	-26.7803649155	29.3234109879	5314.34	5.0

Glare Occurrence Plot

All times are in standard time. For Daylight Savings Time add one hour.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Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage