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# DRAFT Environmental Impact Assessment Report for the proposed Arriesfontein Concentrated Solar Power Plant on the farm 267, near Danielskuil in the Northern Cape

## DEA Reference: 12/12/20/2646

260380 PWE – 08 - 003

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# SYNOPSIS

### Disclaimer

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**PROJECT 260380 PWE - DRAFT ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE PROPOSED CONCENTRATED SOLAR POWER PLANT ON THE FARM 267, NEAR DANIELSKUIL IN THE**

| REV | DESCRIPTION | ORIG | REVIEW | WORLEY-PARSONS APPROVAL | DATE | CLIENT APPROVAL | DATE |
|---|---|---|---|---|---|---|---|
| A | Issued for internal review | F. Humphries | L. Rautenbach | J. Harris | 2012-07-30 | N/A | |
| | | | | | | | |
| | | | | | | | |

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## ACRONYMS

| | |
|---|---|
| ARC-ISCW | Agricultural Research Council Institute for Soil, Climate and Water |
| ARI | Acute Respiratory Infections |
| BID | Background Information Document |
| CAGR | Compounded Annual Growth Rate |
| CAR | Co-ordinated Avifaunal Road-count |
| COPD | Chronic Obstructive Pulmonary Disease |
| CSP | Concentrated Solar Power |
| CWAC | Co-ordinated Waterbird Count |
| DEA | Department of Environmental Affairs |
| DNI | Direct Normal Irradiance |
| DTEEA | Department of Economic Development, Tourism and Environmental Affairs |
| EC | Electrical Conductivity |
| ECO | Environmental Control Officer |
| EDI | Electro-deionization |
| EHS | Environmental, Health and Safety |
| EIA | Environmental Impact Assessment |

| | |
|---|---|
| EIAR | Environmental Impact Assessment Report |
| EMP | Environmental Management Programme |
| ERM | Environmental Resources Management |
| FTE | Full Time Equivalent |
| GDP | Gross Domestic Product |
| GHG | Green House Gas |
| GN | Government Notice |
| GRU | Groundwater Resource Units |
| I&APs | Interested & Affected Parties |
| IDP | Integrated Development Plan |
| IPP | Independent Power Producer |
| NEMA | National Environmental Management Act |
| NERSA | National Energy Regulator of South Africa |
| NGOs | Nongovernmental Organizations |
| NGDB | National Groundwater Database |
| QDGS | Quarter Degree Square |
| RO | Reverse Osmosis |

| | |
|---|---|
| SAHRA | South African Heritage Resources Agency |
| SANBI | South African Biodiversity Institute |
| SDF | Spatial Development Framework |
| ToR | Terms of Reference |
| WUL | Water Use License |

## ABBREVIATIONS

| | |
|---|---|
| % | Percentage |
| cm | Centimetres |
| $CO_2$ | Carbon Dioxide |
| GWh | Giga Watt Hour |
| ha | Hectares |
| kg | Kilograms |
| km | Kilometres |
| $km^2$ | Square kilometres |
| kV | Kilovolt |
| m | Metres |
| mamsl | Meters above mean sea level |
| mbgl | Meters below ground level |
| MW | Mega Watts |
| $m^2$ | Square meters |
| R | South African Rand |
| $ | US Dollar |

## EFINITIONS AND TERMINOLOGY

**Alternative:**

A possible course of action, in place of another, that would meet the same purpose and need (of the proposal). Alternatives can refer to any of the following but are not limited to: alternative sites for development, alternative projects for a particular site, alternative site layouts, alternative designs, alternative processes and alternative materials.

**Cumulative Impacts:**

Impacts that result from the incremental impact of the proposed activity on a common resource when added to the impacts of other past, present or reasonably foreseeable future activities (e.g. discharges of nutrients and heated water to a river that combines to cause algal bloom and subsequent loss of dissolved oxygen that is greater than the additive impacts of each pollutant). Cumulative impacts can occur from the collective impacts of individual minor actions over a period of time and can include both direct and indirect impacts.

**Direct impacts:**

Impacts that are caused directly by the activity and generally occur at the same time and at the same place of the activity (e.g. noise generated by blasting operations on the site of the activity). These impacts are usually associated with the construction, operation or maintenance of an activity and are generally obvious and quantifiable.

**'Do nothing' alternative:**

The 'do nothing' alternative is the option of not undertaking the proposed activity or any of its alternatives. The 'do-nothing' alternative also provides the baseline against which the impacts of other alternatives should be compared.

**Environment:**

The surroundings within which humans exist and that are made up of:

- the land, water and atmosphere of the earth;
- micro-organisms, plant and animal life;
- any part or combination of (i) and (ii) and the interrelationships among and between them; and

- The physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being. This includes the economic, social, cultural, historical and political circumstances, conditions and objects that affect the existence and development of an individual, organism or group.

**Environmental Assessment:**

The generic term for all forms of environmental assessment for projects, plans, programmes or policies. This includes methods/tools such as environmental impact assessment, strategic environmental assessment, sustainability assessment and risk assessment.

**Impact:**

The positive or negative effects on human well-being and / or on the environment.

**Environmental Management:**

Ensuring that environmental concerns are included in all stages of development, so that development is sustainable and does not exceed the carrying capacity of the environment.

**Environmental Management Programme:**

An operational programme that organizes and coordinates mitigation, rehabilitation and monitoring measures in order to guide the implementation of a proposal and its on-going maintenance after implementation.

**Indirect impacts:**

Indirect or induced changes that may occur as a result of the activity (e.g. the reduction of water in a stream that supplies water to a reservoir that supplies water to that activity). These types if impacts include all of the potential impacts that do not manifest immediately when the activity is undertaken or which occur at a different place as a result of the activity.

**Interested and Affected Parties (I&APs):**

Individuals, communities or groups, other than the proponent or the authorities, whose interests may be positively or negatively affected by the proposal or activity and/or who are concerned with a proposal or activity and its consequences.

**Competent (Lead) Authority:**

The environmental authority at the national, provincial or local level entrusted in terms of legislation, with the responsibility for granting approval to a proposal or allocating resources and for directing or coordinating the assessment of a proposal that affects a number of authorities.

**Mitigate:**

The implementation of practical measures to reduce adverse impacts or enhance beneficial impacts of an action.

**Scoping:**

The process of determining the spatial and temporal boundaries (i.e. extent) and key issues to be addresses in an environmental assessment. The main purpose of scoping is to focus the environmental assessment on a manageable number of important questions. Scoping should also ensure that only significant issues and reasonable alternatives are examined.

**Significance:**

Significance can be differentiated into impact magnitude and impact significance. Impact magnitude is the measurable change (i.e. magnitude, intensity, duration and likelihood). Impact significance is the value placed on the change by different affected parties (i.e. level of significance and acceptability). It is an anthropocentric concept, which makes use of value judgments and science-based criteria (i.e. biophysical, social and economic).

**Stakeholder engagement:**

The process of engagement between stakeholders (the proponent, authorities and I&APs) during the planning, assessment, implementation and/or management of proposals or activities.

# 1. EXECUTIVE SUMMARY

SolarReserve SA (Pty) Ltd(hereafter referred to as SRSA) proposes to construct and operate the planned Arriesfontein CSP Project in the proximity of the town of Daniëlskuil in the Northern Cape. As such, SRSA has appointed WorleyParsons RSA as independent Environmental Assessment Practitioner (EAP) to conduct the Scoping and the Environmental Impact Assessment (EIA) for the proposed project. The general project details are contained in Table 1 below.

With respect to the various technologies proposed for the Arriesfontein CSP Project, an Integrated Environmental Impact Assessment (IEIA) application was submitted to Department of Environmental Affairs (DEA) in terms of the National Environmental Management Act (Act 107 of 1998) (NEMA), the National Environmental Management: Waste Act (Act 56 of 2006) (NEM:WA) and the EIA Regulations with respect to the proposed CSP technology (Ref. 12/12/20/2646).

**The site will cater for multiple solar projects, namely Photovoltaic and CSP. Although this report provides a description of both the PV and CSP developments, this report is focused on the CSP development – the PV descriptions is merely for the explanation of the cumulative effects.**

**Table 1: Project Overview**

| Requirement | Details |
|---|---|
| **General Solar Power Park Information** | |
| Description of all affected farm Portions | The Farm Arriesfontein 267, Barkley Wes RD |
| Geographical Co-ordinates | S28.28808<br>E23.78031 |
| Photos of areas that give a visual perspective of all parts of the site | Site photographs contained in **Appendix B of the EIAR (Final Scoping Report: Appendix B)** |
| Generation capacity of the facility as a whole at delivery points | Generation capacities are 100 MW, as per the Independent Power Producer (IPP) application lodged with Eskom for grid connection. |
| Solar Power Generation Technology | The Solar Power Plant will incorporate the Central Receiver Concentrated Solar technology. |
| **The Concentrated Solar Plant (CSP) Development** | |

| Requirement | Details |
|---|---|
| Power park design specifications | A circular heliostat field with a reflective surface area of approximately 1 100 000 $m^3$. Sunlight is reflected to the central receiver tower, where the heat transfer fluid, molten salts, is heated. A thermal energy collection and storage system with molten salt loop and hot and cold salt storage tanks harnesses the heat utilised in the steam generation system, which drives the steam turbine generator. The power plant will employ either hybrid or dried cooled technology. |
| Type of technology | Concentrated Solar Power Central Receiver Tower, with molten salt as the heat transfer and storage fluid |
| Structure heights | Receiver tower approximately 200 m in height, heliostats between 12 -15 m high, and overhead pylons (distribution/transmission) approximately 32 m high. |
| Surface area to be covered | Approximately 600 ha/6 $km^2$for the CSP. |
| Structure orientation | Central receiver tower, power block located within the circular heliostat field. |
| Laydown area dimensions | The Laydown area will be approximately 15 ha. |
| Assembly Plant Dimensions | Approximately 3 000 $m^2$ (200 m x 15 m). |
| Generation capacity | 100 MW approximated maximum output capacity. A more accurate capacity to be provided when plant designs have been finalised. |

The EIA process will determine the potential impact of the facility and whether it can be sustainably constructed and operated by negating potential negative impacts through the identification and implementation of suitable mitigation measures.

The proposed project aims to utilise the abundant and renewable solar resource to generate electricity and effectively create Green House Gas emission savings, whilst creating employment, skills development opportunities and stimulating the local and national economies. The experience and expertise of the Project Proponent and the successes with similar projects worldwide will introduce new technology and create knowledge and develop new skills in the country.

This Scoping Report (SR) (contained in **Appendix B**) provides the background to the project, describing the site, introducing the proposed technology and alternatives and identifying the possible impacts on the environment. It also outlines the Public Participation Process (PPP) that was followed, presented the Plan of Study (PoS) for the EIA which was adopted during the EIA phase and maderecommendations to be considered during the EIA process.

This EIAR follows on the approved SR and addresses the impacts identified in the SR. This includes the required amendments and additional information as requested by the DEA – refer to **Appendix A**. Discussions with the DEA defined the detailed scope of work required to undertake the EIA. After all information submitted the SR was accepted on the 28th of June 2012. .

SRSA made a conscious decision based on the recommendations and guidelines by the DEA to undertake approximately 14 independent specialist assessments in order to assess both significant and less significant environmental impacts proposed by the development. The anticipated impacts were assessed in detail by a range of independent specialists and mitigation measures proposed to reduce any significant impacts. These mitigation measures are included in the EMP contained in **Appendix R.**

The following detailed independent specialist studies were conducted:

- Heritage;
- Visual;
- Biodiversity;
- Avi-fauna;
- Waste;
- Surface hydrology;
- Wetland;
- Socio-economic;
- Air quality;
- Noise;
- Soils and Agriculture Potential;
- Geotechnical Assessment;
- Geohydrology;

– Tourism.

In addition to the aforementioned independent specialist assessments, an independent sensitivity mapping analysis was undertaken. This analysis characterised the development site with regards to the significant environmental aspects in order to reflect the sites suitable and unsuitable (no-go) development footprint areas. This action guided the final footprint of the CSP Plant.

The Public Participation Process (PPP) was undertaken as per the legislated procedures, as well as by employing best industry practice. All commenting authorities, stakeholders and registered Interested and Affected parties (I&AP's) were involved throughout the PPP – their inputs, issues and concerns were considered by the EAP and addressed adequately as reflected in the Issues and Response Report (I&RR) contained in **Appendix D**. Individual consultation was conducted with both the owner of the farm, Mr Gerrie Cloete as well as the Mr. Gerrit Nieuwoudt of Constantia Safaris.

The impacts identified and assessed by the specialist impact assessments and the sensitivity analysis conducted, allowed for the development of effective mitigation measures which is contained in the EMP.

The findings of these specialist impact assessments, which through the application of the proposed mitigation measures (EMP) is anticipated to decrease the impacts to such an extent that they do not pose a significant threat to the environment.

As such it is the recommendation of WPRSA that the proposed activity be authorised. .

# 2. INTRODUCTION

The ever increasing and growing demand for energy as well the need to find more sustainable and environmentally friendly energy resources have prompted developers to explore new energy generation options.

In an effort to utilise renewable energy resources, SolarReserve SA (Pty) Ltd (hereafter referred to as SRSA)is proposing to construct a 100 MW Arriesfontein CSP Project. This project on the Farm Arriesfontein 267, Barkley Wes RD, Siyanda District Municipal Region.

The proposed development site is situated approximately 32 kms outside of the town of Danielskuil. The development site is located within the institutional boundaries of the Kgatelopele Local and Siyanda District Municipalities.

In terms of the Environmental Impact Assessment (EIA) Regulations (August 2010) promulgated under Sections 24 and 24D of the National Environmental Management Act (Act No. 107 of 1998) (NEMA) various aspects of the intended development are considered listed activities which may have an impact on the environment, therefore requiring authorisation from the National Department of Environmental Affairs (DEA) prior to the commencement of such activities.

SRSA (the applicant) has appointed Worley Parsons RSA (Pty) Ltd (hereafter referred to as WPRSA) as independent Environmental Assessment Practitioners (EAP) to the project in fulfilment of legislative requirements in support of an application for Environmental Authorisation (EA).

## 2.1 PROJECT OVERVIEW

The proposed Arriesfontein CSP entails the construction and operation of a CSP development, associated infrastructure and services for the provision of renewable electricity to the national power grid.

This Greenfields project entails the transformation of agricultural land (grazing) to accommodate the proposed Solar Power plant, associated infrastructure and services. The infrastructure proposed for the entire CSP (project) includes but is not limited to inter alia:

### 2.1.1 **CSP Technology Specific Infrastructure**

The CSP technology infrastructure requirements of this technology include –

- A collector field consisting of approximately 8 000 to 15 000 dual-axis tracking heliostats, each approximately between 64 m2 - 116 m2, providing approximately 1 200 000 m2 of reflective surface area;
- An approximately 200 m tall slip-form concrete tower and thermal receiver rated at approximately 565 MW thermal (MWt);
- A thermal to electric power block with an approximately 115 MW reheat and multiple extractions high temperature subcritical steam turbine and generator;
- Two (2) molten salt thermal storage tanks;
- An air-cooled condenser and/or a cooling tower for the steam cycle in order to minimise the consumption of water;
- An evaporation pond consisting of three compartments with a combined area of approximately 8.0 ha, to completely contain all rejected water from the water treatment system and the steam cycle;
- Two liquid gas / diesel auxiliary burners for start-up;
- Two emergency diesel generators.

### 2.1.2 **Other Infrastructure**

In order for the applicant to operate the proposed facilities it is necessary that auxiliary infrastructure also be assessed and previewed in this report. Auxiliary infrastructure that will be defined as part of the CSP development includes, but is not limited to the following items –

- Water reticulation and purification works. This includes water reticulation from the Sedibeng: Vaal-Gamagara Bulk Water Supply Pipeline for industrial water use, and a water treatment and purification system to provide water for both domestic and process use;
- Sewer reticulation and treatment works;
- Roads and storm water infrastructure;

- Substation/Switching station of approximately 100 m x 100 m and overhead power lines(please note the application to DEA for the overhead distribution lines will be applied for separately from this EIA on behalf of Eskom) (DEA Reference 14/12/16/3/3/1/428) ;
- Construction camp - accommodation and sanitation facilities for approximately 600 people (both CSP and PV allocation), with respect to the CSP development it is estimated that approximately 600 people will have to be accommodated in the proposed man-camp ;
- Administrative and office buildings;
- Visitors centre;
- Equipment and materials lay down area;
- Assembly Plant;
- Concrete batching plant;
- Vehicle workshops and wash bays;
- Fuel storage area;
- Temporary general waste storage facility; and
- Hazardous material storage facility.

Prior to the commencement of any construction activities it is required that all required environmental authorizations be obtained in relation to all the relevant national legislation.

## 2.2 PURPOSE OF THIS ENVIRONMENTAL IMPACT ASSESSMENT REPORT

This EIAR follows on the Scope of Work delineated in the detailed SR and PoS which was approved by DEA on 28 June 2012 The SR outlined the scope of the project in great detail and set the scene for the detailed assessment that was conducted during the EIA phase. Existing information and input from specialists, commenting authorities and stakeholders, Interested and Affected Parties (I&APs) was used to identify and evaluate potential environmental impacts (both social and biophysical) associated with the proposed project.

No environmental fatal flaws associated with the proposed project were identified during the scoping phase. A conscious decision was made based on the recommendations and guidelines by the DEA to undertake 14 independent specialist assessments in order to assess both significant and less significant environmental impacts proposed by the development. Although the site is located on

A separate Scoping and EIA report was conducted for the PV Developments Phases 1 – 3 (DEA Ref, 12/12/20/2647, 12/12/20/2648, 12/12/20/2649). The Scoping Report for the PV developments was approved on the 16th of May 2012. The Final EIA has been submitted on the 13th of July 2012.

The detailed assessment of the anticipated impacts were undertaken with the purpose of highlighting any areas of concern regarding the proposed project during its construction and operation and proposes necessary mitigation measures of the significant impacts.

In addition to the aforementioned independent specialist assessments, an independent sensitivity mapping analysis was undertaken. This analysis characterised the development site with regards to the significant environmental aspects in order to reflect the sites suitable and unsuitable (no-go) development footprint areas. This action guided the final footprint of the CSP Plant.

This EIAR will also be used to motivate and define the previously identified, project alternatives (i.e. site, technology and layout) based on the findings of the environmental specialist reports and the suitability of the site to the type of development.

This EIAR has been compiled in accordance with the regulatory requirements stipulated in the EIA Regulations (2010), promulgated in terms of Section 24(5) of the National Environmental Management Act (NEMA) (Act No. 107 of 1998), and the National Environmental Management: Waste Act (NEM: WA) (Act 59 of 2008) as amended. The EIAR aims to:

- Provide an overall assessment of the social, physical and biophysical environments of the area affected by the proposed establishment of a CSP Plant and associated infrastructure;
- Undertake a detailed assessment of the portion of the Farm 267 (Arriesfontein), considered for the CSP Plant development, in terms of environmental criteria and impacts (direct, indirect and cumulative), and recommend a preferred location for the proposed plant (based on environmental sensitivity);
- Identify any cumulative impacts associated with the simultaneous development and operation of the CSP and PV Plant on the Farm Arriesfontein;
- Identify and recommend appropriate mitigation measures for potentially significant environmental impacts;
- Undertake a fully inclusive PPP to ensure that I&AP issues and concerns are recorded; and
- Compile a detailed Waste Assessment for the proposed project in order to identify the necessary mitigation measures and alternatives.

Fourteen (14) specialist assessments were conducted specifically, for the EIAR to identify potential impacts, propose mitigation and inform the sensitivity analysis.

## 2.3 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations underpin the approach to this EIA study:

- The information received from the stakeholders, specialist assessments and baseline environmental inputs are current and valid at the time of the study;
- A precautionary approach was adopted in instances where baseline information was insufficient or unavailable;
- Mandatory timeframes will apply to the review and adjudication of the reports by the competent authority and other government departments; and
- No land claims have been registered for the proposed site at the onset and registration of the study.

## 2.4 PROJECT PROPONENT

SolarReserve LLC is a Santa Monica, California-based developer and owner of utility-scale CSP projects utilizing exclusive, best-in-class technology with inherent storage capability. SolarReserve's primary focus is securing sites, transmission access, permitting, and power purchase agreements; engineering, procurement, and construction services; and securing financing for utility-scale CSP power projects.

The Company has developed a diverse portfolio of CSP projects and development opportunities that encompass 3 000 MW of project potential and approximately 25 individual sites of approximately 140 000 acres (56 000 ha), including some sites with multiple tower potential. SolarReserve holds an exclusive global license to the Molten Salt Power Tower technology developed by Rocketdyne, with the initial license term extending until 2027. SolarReserve has a development pipeline of more than 1 100 MW in Solar PV and a geographically diverse portfolio of more than 3 000 MW of CSP projects.

## 2.5 EIA APPROACH & METHODOLOGY

The proposed project entails the conducting of a mandatory EIA as required by the relevant environmental legislation and requires four (4) primary activities to be undertaken to ensure the successful completion of the process. These four (4) activities form the Scope of Work for the study and are described as below in Section 2.5.1 EIA Methodology:

### 2.5.1 EIA Methodology

**Activity 1: EIA Process Development and Initiation**

It is required that proper planning be done in order to ensure that the EIA is conducted according to the legislative requirements and that the process is sound. In order to develop a sound EIA process it is required that an extensive legal gap analysis is conducted and a proper program developed, scheduling all the required activities. The initiation of the EIA process must involve consultation with institutional stakeholders in order to identify potential impacts, alternatives and key burning points relating to the project early in the process. During the initiation of the EIA it is important that the project alternatives are identify and assessed.

**Activity 2: The Scoping Process**

The Scoping process must involve the identification of key issues, concerns, alternatives and impacts, over and above what was identified and assessed during the initiation phase. The vehicle for this process is the PPP, whereby I&APs has to be identified and engaged with to exchange information and to establish a platform of engagement. The information needs to form the basis from which to prepare the SR as well as the various terms of reference for the required Specialist Studies. The environmental baseline needs to be determined from which to assess the likely impacts of the proposed development. Issues raised in the course of scoping must be presented in both the SR and the Comments and Response Report (CRR).

**Activity 3: Detailed Impact Assessment**

The impacts, alternatives and issues identified during the scoping needs to be assessed during this phase of the process by means of the identified specialist assessments. Mitigation measures must be proposed and the likely residual impacts highlighted in the EIAR. It is crucial that the PPP be continued throughout this phase as well in order to involve I&APs and ensure transparency in the reporting.

**Activity 4: Environmental Management Programme**

A crucial aspect of the EIA process is the formulation of the Environmental Management Programme (EMP). This programme must be contained within the EIAR and is a concurrent activity to the Detailed Impact Assessment phase of the project. It must state the actions to be implemented during the construction, operation and decommissioning phases of the proposed project in order to achieve the mitigation targets.

### 2.5.2 Approach to the Study

A systematic approach will be adopted for the successful completion of the EIA in line with the regulated process. The diagram in **Figure 1** below indicates the sequential process that will be followed for this study.

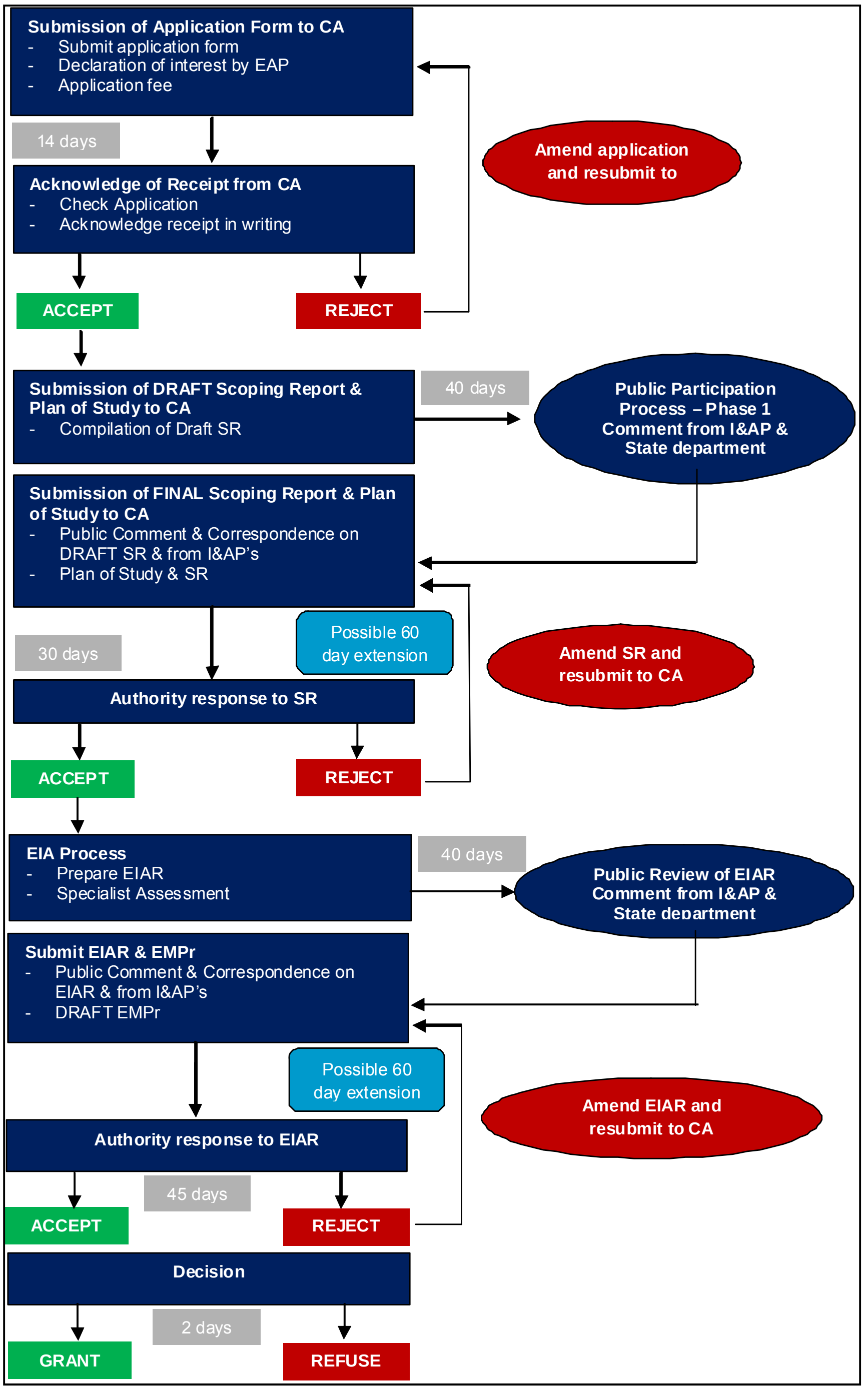


**Figure 1: EIA Process**

## 3. PROJECT DESCRIPTION

The proposed CSP plant, will entail the construction and operation of a central receiver tower plant with a projected output of up to 100 MW.

The site for the proposed project is the Farm Arriesfontein 267 Barkley Wes RD, approximately 32 km southeast of the town of Daniëlskuil, as indicated in Figure  and falls within the jurisdiction of the Kgatelopele Local Municipality of the Siyanda District. The project will be capable of producing in total approximately 100 MW of solar power.

It is anticipated that the construction of the entire plant would stretch over a 30 month period and that more than half of the total capital project costs could potentially be spent in South Africa on procurement of local materials, services, and labour. It is envisaged that the project will make a notable contribution towards the achievement of the job creation targets set in the New Growth Path by creating employment opportunities throughout the country during the peak of construction and sustainable employment opportunities during operations.

For completeness sake all technologies proposed for the site will be discussed, however only the CSP technology, which is applied for in this EIA will be discussed in detail. Please refer to Section 3.1 below for the detailed description of how the CSP technology produces electricity and the Technical Report **Appendix C.**

The CSP Technology proposed for the Solar Power Park entails the use of a central receiver tower which is equipped with an integrated thermal storage system. The proprietary receiver and storage components are provided through an exclusive license with United Technologies Corporation's subsidiary Hamilton Sundstrand Rocketdyne ("UTC" or "Rocketdyne"). The integrated salt storage technology proposed was demonstrated successfully at the SolarReserve LLC's Solar Two facility in Barstow, CA (built and operated jointly by the US Department of Energy and Rocketdyne) in the late 1990's.

SolarReserve's CSP technology generates power from sunlight by focusing the sun's thermal energy as collected by the heliostat field i.e. sun tracking mirrors onto a central receiver tower.  The molten salt is circulated through tubes in the receiver, collects the energy of the sun.  Once the molten salt has been heated to a temperature of 560 degrees Celsius it is routed to an insulated storage tank i.e. the "hot" tank, where it can be stored with minimal energy losses.  The heated, molten salt is routed from the "Hot" tank to a heat exchanger for the production of energy.  Steam is produced by the heat exchanger and expanded through the standard Rankin cycle steam turbine which rotates a generator to produce electricity.

The molten salt is hereafter circulated back to the “cold” storage tank and the cycle repeated. Due to the energy storage ability of the proposed technology, a CSP plant of this nature, sized at 100 MW, can generate electricity for up to 24 hours a day during the summer months and between 12 to 16 hours a day in the spring, autumn and winter months. The proposed plant will utilise hybrid cooling technology to condense the water used during the steam cycle. Implementing this cooling technology allows for the use of considerably less water compared to that of a wet cooled solar thermal power plant.

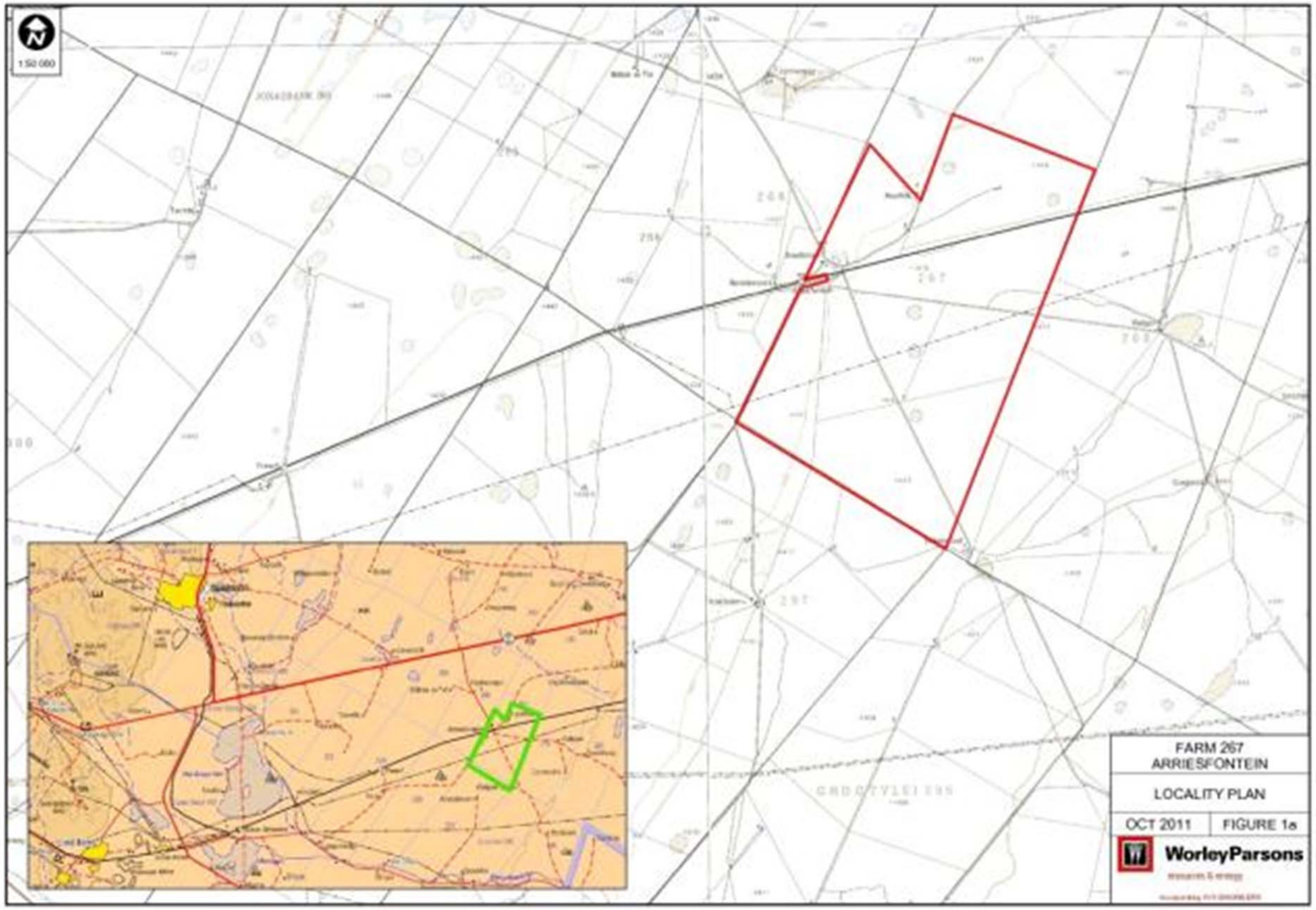


**Figure 2: Locality Map**

## 3.1 PROPERTY DESCRIPTION

The proposed development will be located on the Farm Arriesfontein 267, Barkley Wes RD (Arriesfontein). The site is situated approximately 32 km from the town of Danielskuil, and falls within the boundaries of the Kgatelopele Local Municipality of the Siyanda District, in the Northern Cape.

The farm owner is Mrs.LCM Cloete, who is the registered title deed holder. The property is registered as follows:

**Table 2: Registered Land Owner**

| Ownership | Property Description | Size (ha) | Title Deed Nr. |
|---|---|---|---|
| LCM Cloete | Farm 267Barkley Wes RD (Arriesfontein) | ± 1838.25 | T2097/1995 |

## 3.2 THE CONCENTRATED SOLAR THERMAL POWER PLANT

The CSP plant (Figure 2) primarily comprises of four subsystems as summarised below:

- Solar Collector Field - consists of all systems and infrastructure related to the control and operation of the heliostats;
- Molten Salt Circuit - includes the thermal storage tanks for storing low and high temperature liquid salt, a central solar-thermal tower receiver, pipelines and molten salt to steam heat exchangers;
- The Power Block – consists of the steam turbine and generator, as well as the air-cooled condenser and associated feedwater system; and
- Auxiliary facilities and infrastructure - consists of the switch yard, step-up transformers, power transmission lines, access routes, water supplies and facility start-up generators (gas or diesel-fired – dependent on detailed design).

The proposed project can be defined as a solar thermo-electric power plant that is embodied in the form of a CSP Plant. In short the electricity generation process can be summarised as follows:

- Heliostats reflect the solar radiation towards the central receiver tower where a large heat exchanger captures the solar heat.

- A molten salt mixture is pumped from the cold salt thermal storage tank to the central receiver where it is circulated in the heat exchanger until the temperature reaches 566ºC.
- The molten salt concentration is then transported to the hot salt thermal storage tank.
- Hot salt is pumped from the hot salt storage tank to the steam generator where heat is transferred from the salt to water in order to generate high pressure steam.
- The highly pressurised steam is then passed through a steam turbine, which is linked to an electric generator to generate electricity.

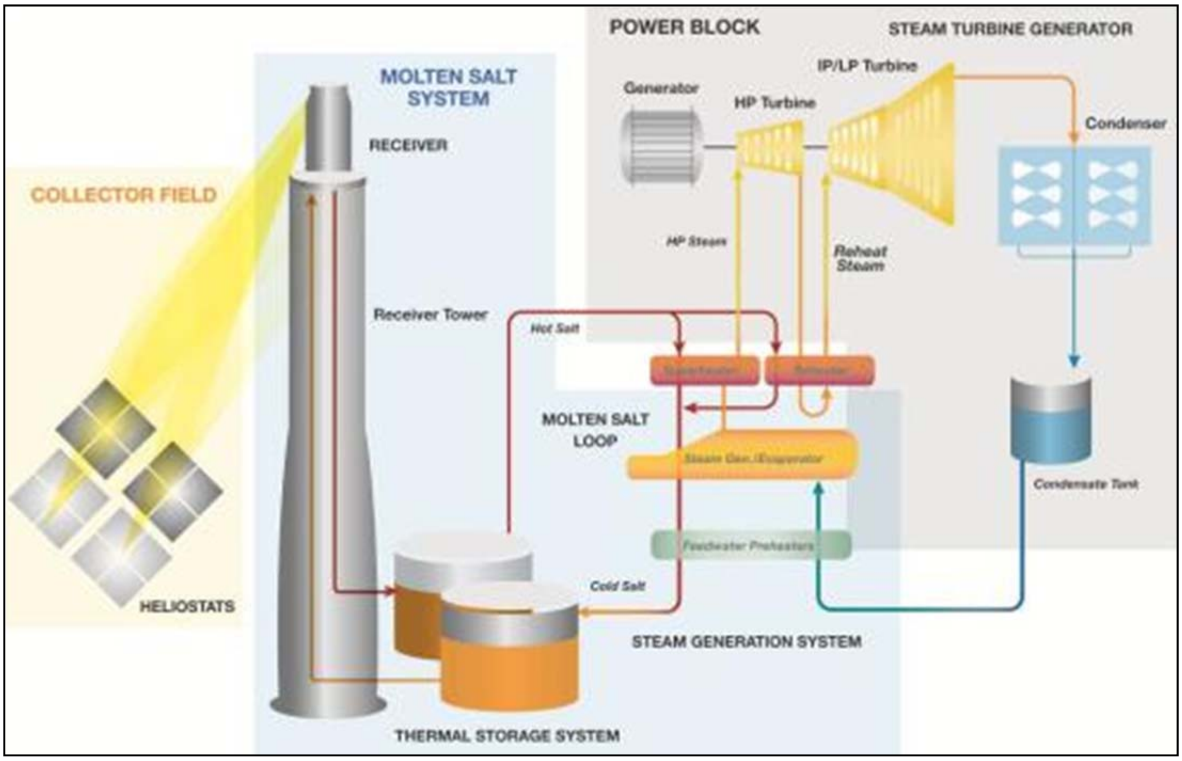


**Figure 2: Process flow of a typical Solar Thermal Energy Power Plant operation**

This project will utilise existing and proven technology that has been implemented successfully around the world.Figure 3 below shows an example of the molten salt central receiver technology. The figure depicts the Solar Two 10 MW demonstration plant that was built in the south-western region of the United States in 1995.

During the construction phase of the project it would be required that numerous temporary structures and facilities be utilised including the man camp to house the workers, ablution, cooking and dining facilities, material stores, assembly plants, workshops, vehicle wash facilities and a batch plant amongst others. The man camp will house approximately 600 people and the position of the camp is shown in Figure 5. The camp will be either on a single location or split between more than one option on the site. The selection of the option or combination of options to be utilised will be finalised in conjunction with the appointed construction contractor to ensure that the options are practical as well as environmentally sound. The options shown in Figure 5 were selected and positioned in areas of low sensitivity according to the sensitivity analysis conducted and the specialists' impact analyses.

The materials laydown area and the office building locations depicted in Figure 5 is also conceptual at this point in time and although the areas where these facilities are proposed have been assessed no final designs and plans have been drafted. These sites have been positioned in areas of low sensitivity. The position of the laydown area and offices are subject to change if they are not suitable in terms of the practical construction requirements and the positions and layouts thereof will be finalised in collaboration with the appointed construction contractor.

**Figure 3: An example of a central receiver power plant (Image courtesy NREL).**

The collector field will make use of a large number of mirrors, also called heliostats to reflect the solar radiation towards the solar receiver tower. It is expected that the collector field will be equipped with any number of heliostats ranging between 10 300 and 17 500 heliostats (dependent on the size of the heliostats), positioned concentrically to the solar receiver tower.

As each of the heliostats occupy roughly 62 $m^2$to 116 $m^2$of surface area(depending on final design) it is projected that the solar field will have a diameter of approximately 2,620 m (2.6 km), creating an estimated 1,1million $m^2$ of mirrored surface around the solar receiver tower.

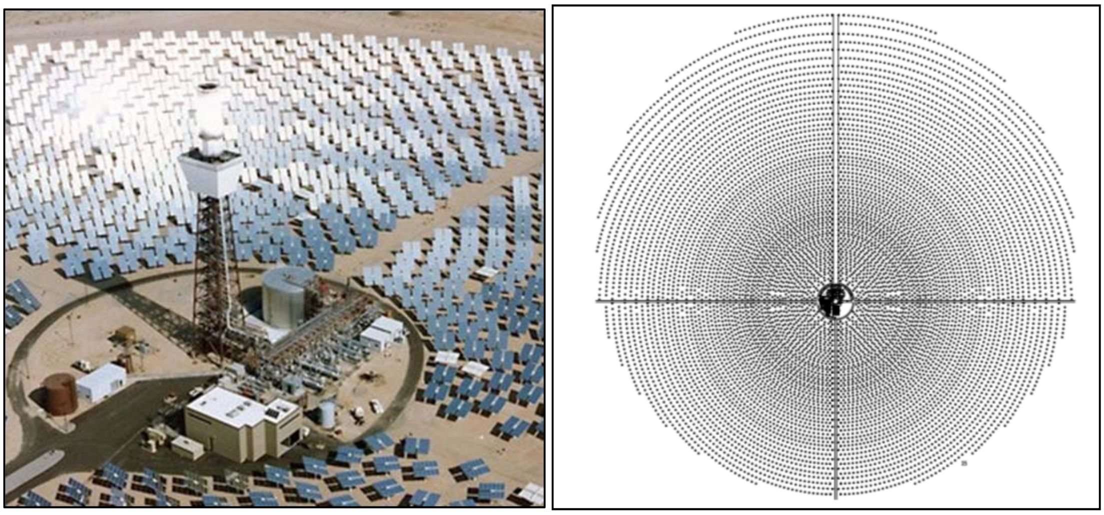

**Figure 4: Layout of collector field (*left:* typical; *right*: for 17,350 heliostats)**

All of the heliostats are automated and are designed to follow the sun's path. The heliostats are controlled from a central control point. Heliostats will be positioned in such a manner that optimum radiation reflection can occur, and so that no interference between heliostats can occur.

The collection system comprises the following elements:

- Heliostats;
- Monitoring and control system
- Power and communication connections.

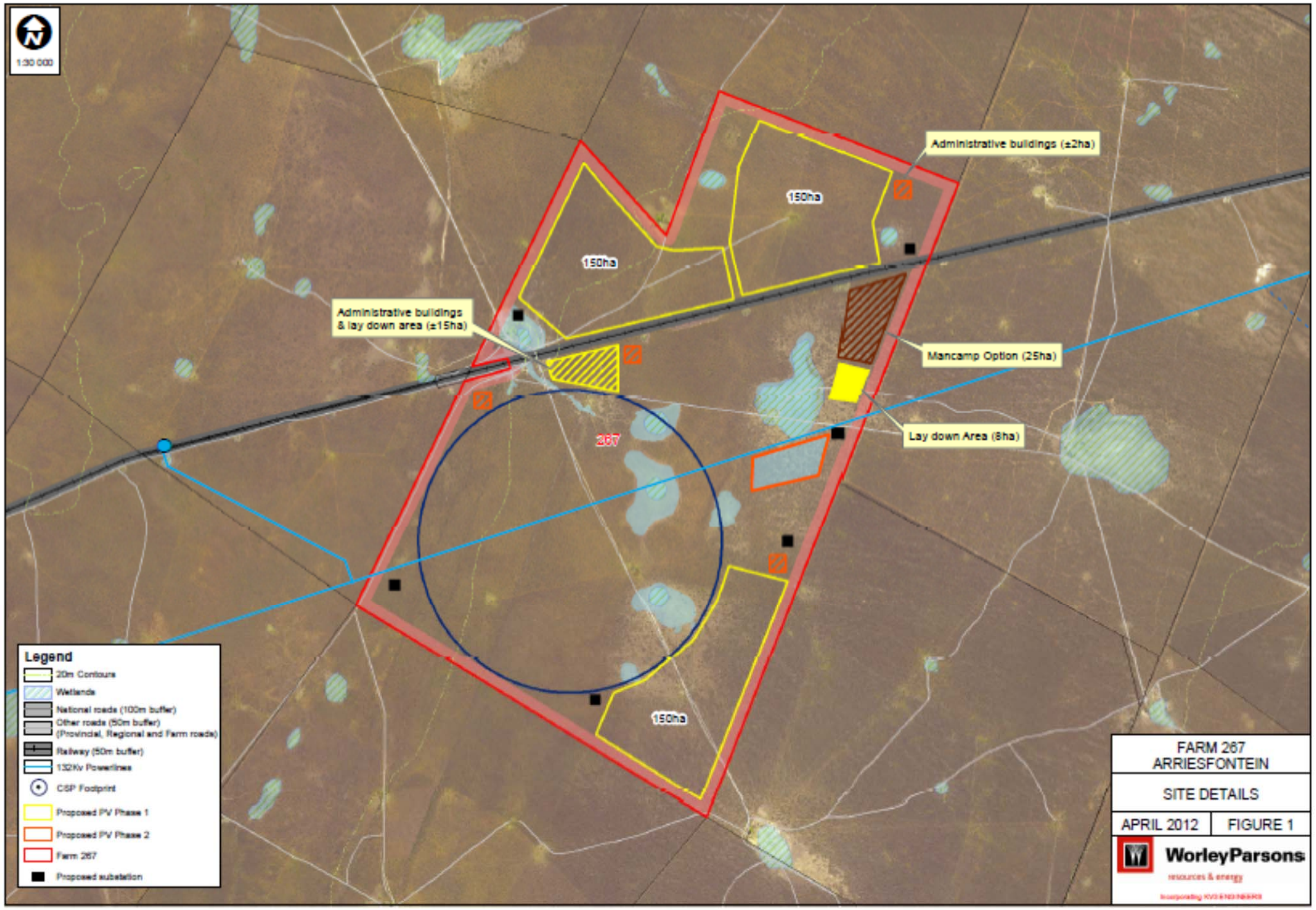


**Figure 5:: Arriesfontein Site Layout**

## 3.3 ANCILLARY INFRASTRUCTURE

Additional infrastructure will be required for the construction and operation of the proposed Solar Power Plant in support of the two (2) technologies that are to be implemented. The Section below will aim to delineate the various other infrastructure requirments and resources needed for the operation and construction of the proposed Solar Power Plant.

### 3.3.1 A Meteorological Stations (MET Station)

Prior to construcion of the proposed development a MET station has been installed by the Project Proponent since 1 November 2011 by SRSA, in order to capture and collect data on the solar resource.

### 3.3.2 Site Security

For health, safety and security reasons the CSP Plant will be enclosed via fencing or appropriate alternatives, from the surrouding area during both construction and operational phases. This will keep the community and wildlife safe from possible incedents, restrict potential tresspassing onto neighbouring farms/properties. It is furhtermore recommended that closed circuit video-surveillance system will be fitted around the plant also for safety reasons and access control gate system be implemented.

### 3.3.3 Construction Man-camp

It is anticipated that a temporary contractor’s housing facility will be constructed and utilised for the duration of the CSP construction period. It is estimated that in total, approximately a peak of 600 persons will be employed and housed by this facility – over the estimated 30 month construction period. The selection of the option or combination of options to be utilised will be finalised in conjunction with the appointed construction contractor to ensure that the options are practical as well as environmentally sound.

It is proposed that temporary/portable housing, ablution and sewer treatment facilities be procured from external service providers. Sewage will be removed from site by an authorised and licensed service provider on a regular basis, as required, as per the recommendtions stipualted in the EMP. The final design of the roads and sewage will be conducted in conjuction with the EPC contractor once preferred bidder status has been achieved.

### 3.3.4 Access Roads and Site Access

Access to the site will take place via the existing Provincial R31 road– and a short gravel road. This aspect counts in favour of the logistical components pertaining to the development of the proposed Solar Power Plant. The site is approximately 160 km from Kimberly and 32 km southeast from Daniëlskuil.

The site is served by several farm roads – some of which will have to be realigned within the farm boundaries to make way for the proposed development. Within the site area, existing farm tracks will be up-graded and new gravel roads may be constructed to facilitate movement of construction and maintenance vehicles. Development of these roads will be restricted to the proposed devleopment footprints and planned for Site access roads that are developed will be up to 6 m wide with associated infrastructure including drainage trenches adjacent to the road according to the road agency guidelines. Roads to be constructed wihin the site boundaries will be equipped with adequate drainage infrastructure i.e. stormwater trenches, these will also be fitted with silt traps if deemed necessary.

### 3.3.5 Lay-down area

A laydown area of approximately 8 ha within the property boundaries was set aside for the temporary storage of materials during the construction activities as well as the assembly of CSP modules. This area will be of a temporary nature and it is to be decommisioned once construction is finished. In addition to these laydown areas, temporary construction offices are also proposed. These offices will most likely be mobile offices and also of a temporary nature.

### 3.3.6 Building Infrastructure

The proposed Solar Power Park will require several onsite buildings to be constructed for the operational requirements. During the operational phase of the Solar Power Plant an administrative building (offices) will be required and possilbly storage space. The administrative infrastructure will be used for regular administrative duties.

### 3.3.7 Network Connection &Electrical Integration Infrastructure

It is proposed that a medium voltage collection system will be implemented to transport the electricity to a substation which will connect the facility to the national grid via an existing 132 kV Overhead transmission line which cross over the site. There is an existing 132kV electricity distribution transmission line running on the upper northern portion of the site in parallel to the railway line – which requires realignment within the farm boundaries. – these negotiations are in process with

ESKOM who will provide a cost estimate for the project integration onto the network by end July 2012. .

The relocation of these overhead distribution lines is currently being assessed – and the preferred rerouting option/alignment will follow the eastern, southern and western boundary of the site. The proposed alignment will ential that the overhead line be rerouted from where the existing 13 kV line enters the site boundary, around the site, up until wher the existing 132 kV line exits the site. The medium voltage collection system will be comprised out of overhead transmission lines (to be determined during the design phase), dependent on the distance and/or terrain conditions.

Currently there are no direct substation access points on the site, and it is proposed that the Olien Substation will be used as connection points – as there are 132 and 275kV bays available. ESKOM is still in process of assessing network capacity. The purpose of this substation is to facilitate connection of the Solar Power Park to the national grid network via the existing transmission facilities as outlined above, if a direct tie in to the existing 132kV lines is not possible.

Please refer to the Technical Report **Appendix C** for a more in depth review of the electrical connection and integration system.

### 3.3.8 Management of Hazardous Construction Materials and Waste

SRSA has assessed and recorded all possible hazardous materials and wastes for the CSP development. There will be a variety of chemicals stored and used during construction and operation of the CSP project. Chemicals will be stored in appropriate chemical storage facilities. Bulk chemicals will be stored in storage tanks, and most other chemicals will be stored in returnable delivery containers. Chemical storage and chemical feed areas will be designed to contain leaks and spills. Concrete containment pits and drain piping design will allow a full tank capacity spill without overflowing the containment. For multiple tanks located within the same containment area, the capacity of the largest single tank will determine the volume of the containment area and drain piping. Drain piping for reactive chemicals will be trapped and isolated from other drains to eliminate noxious or toxic vapours.

Safety showers and eyewash stations will be provided adjacent to, or in the vicinity of, chemical storage and use areas. Plant personnel will use approved personal protective equipment (PPE) during chemical spill containment and cleanup activities. Personnel will be properly trained in the handling of these chemicals and instructed in the procedures to follow in case of a chemical spill or accidental release. Adequate supplies of absorbent material will be stored onsite for spill cleanup.

### 3.3.9 **Water Supply and Use**

Potable water for domestic use at the facility will be sourced from Vaal-Gamagara Pipeline. Wastewater and sewage will be treated with the use of a modular sewer treatment plant with capacities to be confirmed during the detail design phase and will comply to the best industry practice guidelines and recommendations as defined in the EMP.

SRSA has investigated various options in securing water for its power plant. The sources of the water supply and water treatment requirements are outlined in this EIAR. SRSA has obtained an authorisation from the Sedibeng Water Authority, in order to draw the required water to be utilised by the proposed CSP Plant (**Refer to Annexure V**) from the Vaal-Gamagara pipeline. The water abstracted from this pipeline will be utilised for the cleaning of the heliostats, dust suppresion and human consumption in the offices and mancamps. SRSA has approached the Sedibeng Water forapproval and supply of this water source and an allocation of 350 000m$^3$per annum was awarded for use in the CSP technology.

Water will be delivered to a large raw water storage tank, also used to provide site fire protection water, and water for the potable water system. Raw water is pumped from the storage tank to the water treatment system for demineralized water production. The entire Solar Power Park will require approximately 380 000 m$^3$ per annum of raw water which will be divided between the CSP technologies and all auxilary services. The proposed conditional alignment of the Pipeline route is indicated in **Figure 7**.

The water treatment process includes two multi-stage Reverse Osmosis (RO) units, and electro-deionization (EDI) equipment. Pure demineralized water from the process is pumped into a separate demineralized water storage tank. Demineralized water is added to the de-aerator for steam plant makeup, for steam cycle blowdown quench water, and for heliostat washing. Waste water from water treatment system, including 1$^{st}$ pass RO reject and EDI, as well as a portion of the steam cycle blowdown are discharged to the evaporation ponds.

The plant will have a raw water tank with an anticipated capacity of approximately 10 000 m$^3$. The major portion of the raw water is for plant use while a smaller portion of the raw water (2 500 m$^3$) will be reserved for fire fighting water requirements. The project will operate (generate electricity) an average of about 10 - 18 hours per day, 7 days a week throughout the year, with the exception of scheduled shutdowns for maintenance. However, the water treatment plant will operate an average of approximately 60% of each day, in order to minimize water treatment system size and capital cost, and to use off-peak energy at night.

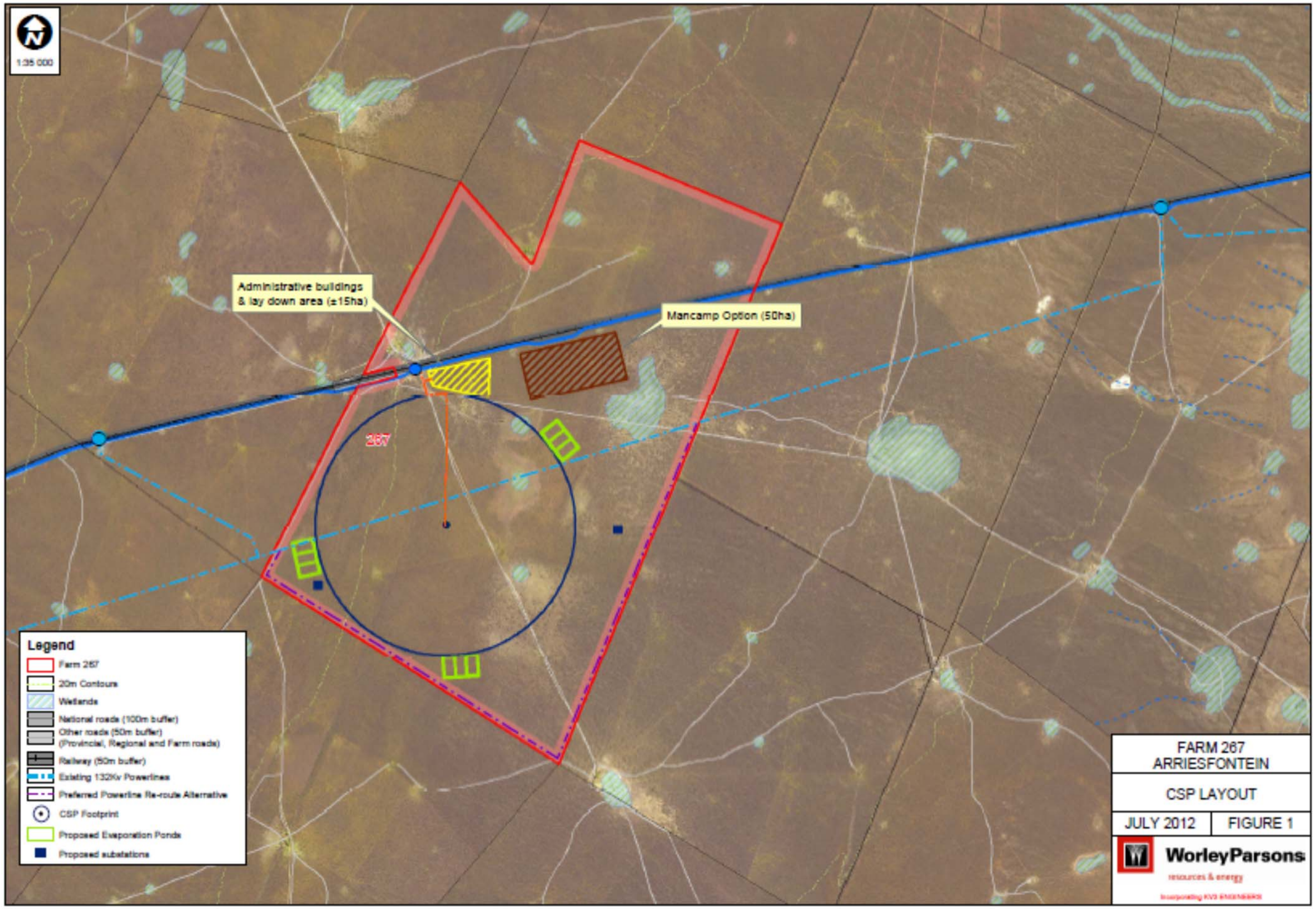


**Figure 7: Pipeline Connection and Alignment**

### 3.3.10 **Waste Management**

Waste management is the process whereby all wastes produced at the proposed Solar Power Plant are minimised or reduced, properly collected, treated (if necessary), re-used and disposed of as a final resort. Wastes expected to be generated as a result of the CSP power generation process include process and sanitary wastewater, nonhazardous waste and hazardous waste, both liquid and solid.

#### *3.3.10.1 Liquid waste*

*Wastewater Collection, Treatment, and Disposal*

The CSP Plant will generate several forms of liquid effluent as part of operations. The primary effluents sources generated include –

- Wastewater from the evaporation plant;
- Contaminated surface water i.e. stormwater and rainwater; and
- Sewage effluent.
- Brine Blow Down Water

For a 50 MW – 100 MW plant it is estimated that the total volume of discharge, inclusive of sewage water and evaporationsystem discharge is approximately 72 700 $m^3$ per year. As the proposed plant is estimated at generating 100 MW electricity these volumes can be expected to generate between 116 320 and 145 400$m^3$ per annum.

The Wastewater Purification plant will source the wastewater from four independent intake (feeder) systems as per the different types of wastewater.

- ***System 1*** will collect all the containment surface water (stormwater).
- ***System 2*** will be responsible for transporting all sewage effluent to the biological treatment system. This treatment system consists of a septic tank and biological filter.
- ***System 3*** will transport the wastes generated during the evaporation process to a wastewater treatment plant.
- Lastly, a system will be designed to collect stormwater (surface water), which will be sent to a drainage pool before it is discharged.

The treatment options for the four (4) systems are based on the types of effluent to be treated. The following treatment options have been defined for each source of effluent –

- Contaminated water treatment system will be installed to separate both clean and dirty surface water where after the different types of grease/hydrocarbon products will be treated and clean surface runoff diverted away from site.
- A biological treatment system will be implemented to treat the sewage effluent from the offices.

The Counsel for Scientific and Industrial Research (CSIR) was approached to do the waste classification for the brine that is going to be disposed of on site. The following is the findings from the study the CSIR conducted.

According to the 2nd Edition of the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (1998) most waste disposal scenarios assume a solid with no significant head of liquid on the liners of the disposal site.

The sample originates from borehole water and is assumed to contain mostly major cations and anions and little if any heavy and trace metals. Only results for these were available.The main concern for consideration should be the protection of ground and surface waters. Impacts could include human health (drinking), aquatic ecosystems, and commercial users (e.g. irrigation).

The brine sample did not delist for either the 1 or 100 ha scenarios. Even though the suitability of the classification criteria of the minimum requirements to liquid wastes is not ideal the classification shows that the liquid as such is still hazardous (moderate hazard, Hazard rating 3). The brine is an inorganic process wastes or residues and was classified as class 6 (Poisonous (toxic) substances) according to the SABS 0228 code.

### *Waste Water Plant Design Criteria*

The design criteria considered for the concept design and positioning of the evaporation pond for the CSP plant were as follows:

- The Hybrid Cooled zero discharge system will be used for the CSP plant,
- The Hybrid Cooled zero discharge system will produce an average daily flow of effluent (brine) to the evaporation ponds of 164 $m^3$/day ,
- A design safety factor of 15% was used for the sizing of the evaporation pond,

- The effluent (brine) total dissolved solids (TDS) was taken as 5 000 mg/l,
- The specific gravity of the effluent (brine) was taken as 1.28 ton/$m_3$,
- Annual rainfall for the area was used at 400 mm/annum,
- S-pan evaporation for the area was noted between 2 200 mm/annum and 2 600 mm/annum, the worst case scenario was used at 2 200 mm/annum,
- The evaporation pond must be designed in such a way that maintenance can take place without disrupting the normal processes of the CSP plant,
- The evaporation ponds must limit the possible contamination of the aquifer for the project, this will be done by the design and construction of an efficient barrier system, a leak detection system, monthly monitoring and pollution prevention measures.
- The effluent (brine) is classified with a hazardous rating of 3 and therefore the ponds will be lined with a triple liner and double drainage system as required by the Department of Water Affairs (DWA).

### *Waste Water Plant Design layout*

The preferred location for the evaporation pond is to be placed preferably in the south-western part of the farm and far away from lineaments, drainage channels and pans. Access to the pond will be created by the centre line of the heliostat circle that runs in a vertical and horizontal line from the power block. The access road will have a gravel surface. The effluent will be piped or channelled to the evaporation pond as the south-eastern corner of the site is at a lower position than the plant and therefore a gravity feed can be achieved.

The evaporation pond was designed in three (3) compartments that would enable maintenance on any of the three (3) compartments without disrupting the normal operations of the CSP plant. The three (3) compartments will have a small emergency overflow to each of the other compartments. The flow to each of the compartments will be controlled via a splitter box at the top end of the evaporation ponds. A limited amount of silt is to be expected to enter the ponds as no surface water will enter the system. Oil will be separated out of the effluent stream before it reaches the evaporation ponds.

### *Evaporation pond design*

The evaporation pond will be separated into three (3) compartments. Each compartments is sized at 112 m (b) x 200 m (l), giving a total size of 6.7 ha. The three (3) compartments will have an overflow linking each compartment to the other. A 4 m access road will be constructed around each compartment in order to allow access for a small vehicle to move around the compartments. The side slopes of the evaporation pond will be 1 (h):2 (l) on the inside slope of the pond and 1 (h):3 (l) on the outside slope. The total depth of the evaporation pond is 1.2 m that includes a 300 mm freeboard and a 105 mm allowance for crystalline salt build up.

The crystalline salt build for the evaporation pond was calculated at 233 $m^3$/annum. Over a 30 year life span of the CSP plant this calculates to approximately 105 mm depth in each compartment of the evaporation pond. The evaporation pond compartments will be used all three at the same time, however the pond size was designed that one of the compartments can be shut off for maintenance. This allowance for maintenance was calculated using the highest rainfall month.

### *Liner design*

A meeting was held with DWA and the liner requirement recommended by the department is a triple liner system with two (2) drainage layers. The site will be lined with a 2 mm High Density Polyethylene (HDPE) liner as a primary liner and two 1.5 mm HDPE liners that would serve as a secondary and tertiary liner. The three (3) layers of this liner should have a cuspated drainage layer in between that drains toward a leakage detection system.

The following figure shows the recommended liner detail.

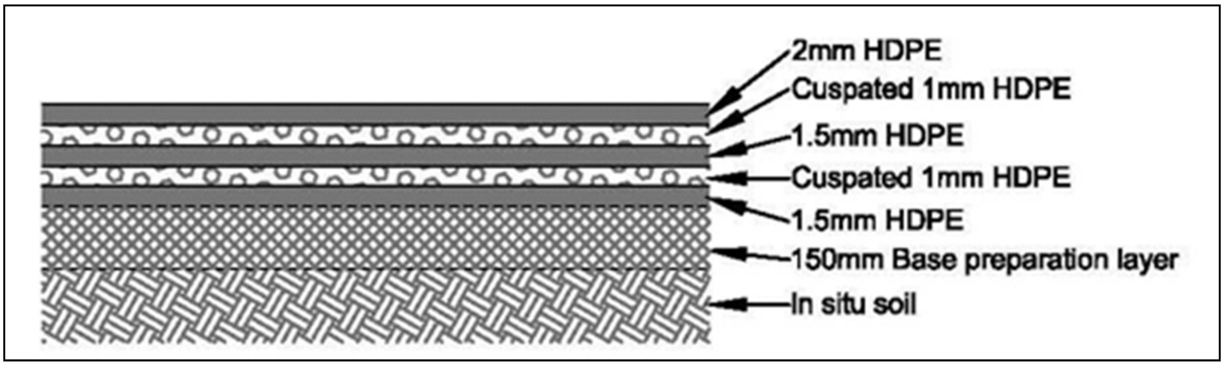


**Figure 8:: Liner Recommendation**

### *Evaporation pond positioning (Candidate site selection)*

All care was taken to position the ponds where it could cause the least amount of damage to the environment in the case of a liner failure or unexpected event. From the initial studies (annexure A and annexure it was indicated that the south – west corner of the site was preferable to construct an evaporation pond due to the aquifer vulnerability being the lowest in that area. However three 3) possible pond locations were selected over the entire site in order to ensure that the most suitable could be selected without disrupting the development of the CSP or PV project options.

The candidate sites for the evaporation pond were numbered EPCS 1 through to EPCS 3. The first candidate site for the evaporation pond (EPCS1) is the preferred location in terms of a technical perspective as it is the closest to the vertical centre line of the heliostat rings and therefore the closest to the access road.

A detailed geo-hydrological study was conducted in order to confirm the locations suitability for the establishment of the evaporation pond.

***Design alternatives***

- Atomizers

Atomizers mechanically disperse the effluent over the evaporation ponds increasing evaporation timeframes and reducing evaporation pond sizing. This is accomplished utilizing atomizing heads, cyclones and pumps to spray the brine over the evaporation pond. This technology was not considered during concept design due to the site having sufficient space for a conventional evaporation pond. This technology will also bring additional complexity to the operation of the evaporation pond in terms of personnel and mechanical and electrical installations.

- Crystallisation

The brine is released into a vessel where the pressure falls, the remaining water boils off and the salts crystallize. The salt cake, which is a fraction of the original waste stream, is then disposed of in landfill. This technology was not favoured due to the high cost and complexity of implementation for such systems as well as the disposal requirements of the salt cakes adding to the complexity of managing the waste products. Evaporation still remains the most suitable option.

- Other Technologies

Other technologies exist that could be used for the final treatment of this type of effluent (brine). These technologies were not considered for this project as they have not been applied in South Africa. The other technologies that exist are:

– **Deep well injection** - Deep well injection is presently applied worldwide for disposal of industrial, municipal and liquid hazardous wastes. In recent years this technology has been given serious consideration as an option for brine disposal from land based desalination plants.

Deep well injection has been applied successfully for brine disposal from several membrane plants in Florida; however this method of brine disposal has not been used in South Africa.

– **Solar ponds** - Development of salt gradient solar ponds as a renewable energy source began in Israel more than thirty years ago. Although limited in scope, successful power generation by this technology has been demonstrated primarily in arid and semi-arid parts of the world. Recent technical papers have also appeared, describing experimental studies in Italy and Switzerland, in which solar ponds are coupled with thermal desalination systems. In these experimental studies, the pond is used as a heat source for small multistage flash evaporator units.

The design Report is Attached as Annexure W.

### *Sanitary Waste*

the CSP will create sanitary waste streams at both the administrative building and at the operations building and maintenance areas. Each area will have a kitchen as well as the requisite quantity of toilets and or showers to support the crew size. This will only be during constrcution activities and will be adquate for the number of people on the site. At these locations, a septic tank and leach field will be used to capture and treat the flows. As and when required, the septic tank (solids holding tank) will be cleaned out by a vacuum truck and the wastes will be trucked and disposed at a licensed facility. This activity will adhere to the plant safety program as administered by plant personnel.

With respect to the handling and treatment design and operations of the proposed effluent treatment plant the following philosophy will be put in place –

– A closed loop system will be introduced and implemented with regards to the handling, treatment and reuse of treated water. It is proposed that all treated effluent be removed of site and disposed of at the Kgatelopele Local Municipal WWTW.

– Effluent treatment of sewage/sanitation water will be done in such a manner that the treated effluent will adhere to the general limit effluent standards.

As the proposed design of the Solar Power Plant is dependent on EPC contractor designs and subject to the tender system, no definite design is yet available regarding sewage handling and treatment, for the purpose of this EIAR it is however deemed accurate that all sewage will be removed via an external service provider.

### *Stormwater Management System*

The site will be serviced by a Stormwater management system which aim to separate clean and dirty surface water. All clean water will be directed away from the site, where as the contaminated water will be directed and collected within a stormwater management system. The aim of this system is to –

– Protect the health, welfare and safety of the public, and to protect property from flood hazards by safely routing and discharging stormwater away from and within the development.

– To conserve water and allow clean water to be re-absorbed in the natural environment for downstream benefit.

– To preserve the natural environment;

– To promote sustainable development within the natural environment while pursuing economic development; and

– To control runoff as to prevent pollution and contamination.

A stormwater management plan will be submitted subject to the EPC contractor site design and layout as well as the tender process.

### *3.3.10.2 Solid waste*

the CSP will produce maintenance and plant wastes typical of power generation operations. All waste to be generated on site will be subject to the pricinpal of "Reduce, reuse and recylce" as far as possible before disposal is regarded as an option. Solid wastes will be temporarily kept on site and trucked offsite for recycling or disposal at a licensed recycling facility or licensed landfill site in the vicinity.

The following principles will be applied to the temporary storage of solid waste at the source –

– A service provider will be appointed to adequately address the temporary storage of solid waste. This service provider will provide adequate and appropriate containers for the storage of solid waste.

– Waste should be sorted and stored within appropriate containers to allow for the implementation of "Reduce, Reuse and Recylce" as per the waste management plan.

- The site design will allow for designated waste storage areas. Each of these areas will be designed as to ensure environmental degradation does not occur – will be clearly marked and constructed appropriately.
- Waste will be collected on a regular basis.
- Waste will be stored in such a manner that it can be easily loaded and transported.
- Waste stored in containers need to adhere to the following –
  - Waste types will not be mixed;
  - Waste will be kept in a container that is of good condition – under no circumstances may waste containers be worn, corroded or have the potential to allow for environemtnal contamination.
  - All waste containers need to be positioned withing the designated waste areas and has to be labelled correctly.
  - Skips/waste containers may at no point in time overflow.
  - Skips/waste containers need to be adequately positioned and enclosed for rainy events.
- No waste product shall be burned on site or disposed of on site.
- Waste containers will be protected as to prevent scavenging.
- The waste management plan must allow for timely scheduled collection of wastes. Detailed records of these activities need to be kept.

# 4. PROJECT ALTERNATIVES

## 4.1 SITE LOCATION ALTERNATIVES

An integrated site selection study was done in order to identify a suitable site for the proposed solar power plant.

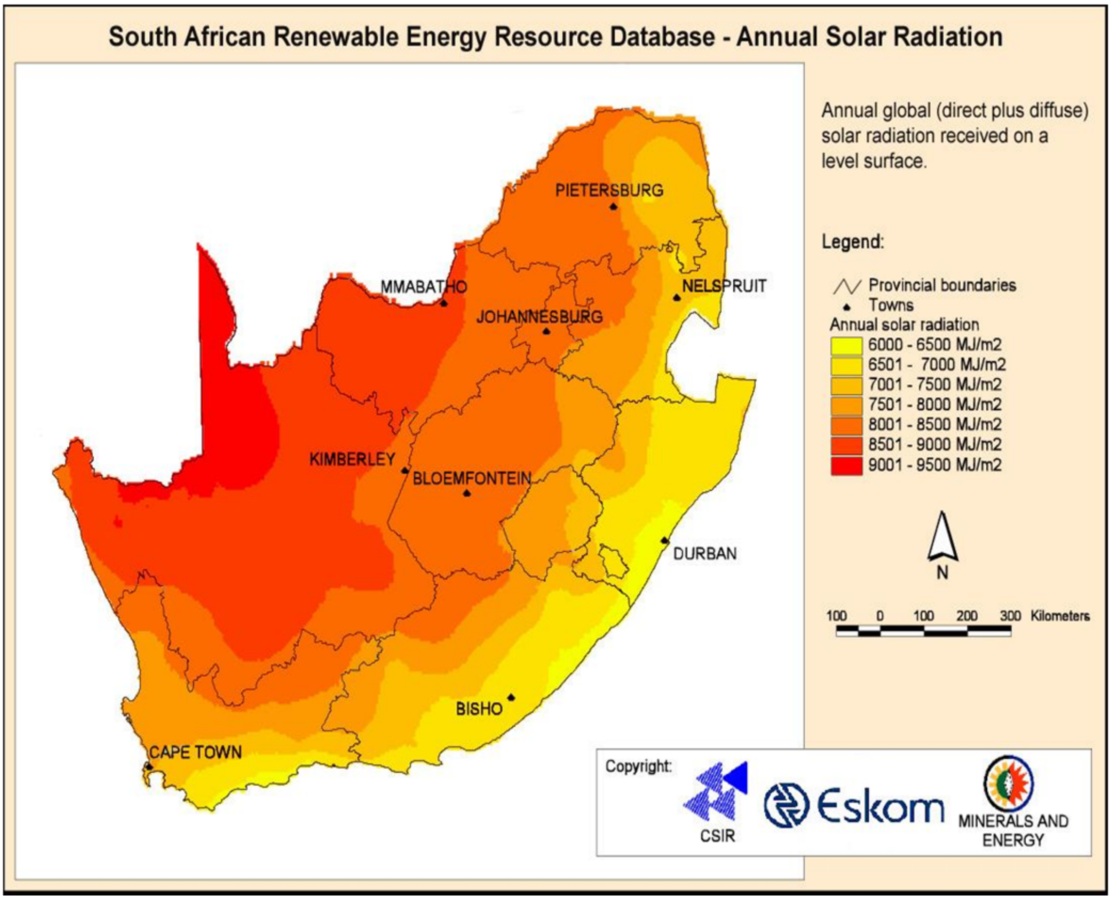


**Figure 6: Annual incoming short wave radiation for South Africa**

The proposed solar energy site on the farm Arriesfontein is considered highly desirable due to the following considerations:

– Solar resource: Analysis of available data from existing weather stations suggests that the site has sufficient solar resource to make a solar energy facility viable (**Figure 6**).

- Site extent: Sufficient land was secured under long-term lease agreements with the land owner to enable sufficient power supply and to allow for a number of heliostats to make the project feasible.
- Land suitability:
  - Sites that facilitate easy construction conditions (relatively flat land with few rock outcrops or water-bodies) were favoured during site selection.
  - The site position will strategically strengthen the national grid.
  - Avoidance of obvious environmentally sensitive areas.
- Landowner support: The selection of sites where the land owners are supportive of the development of renewable energy is essential for ensuring the success of the project.
- Consideration of the above criteria resulted in the selection of the preferred site. No further site location alternatives are considered in the EIA process.

## 4.2 SITE LAYOUT ALTERNATIVES

The CSP layout and project component design underwent a number of iterations based on technical aspects and the environmental and social considerations assessed during the EIA process. From a layout perspective, the position of the proposed site infrastructurewas determined by the consideration of the following aspects:

- Local topographical conditions;
- The position of environmentally sensitive features as assessed by the specialists depicted in the sensitivity analysis.

The detailed sensitivity analysis (contained in **Appendix Q**) was utilised to position the infrastructure in areas which would be impacted least yet be technically feasible. The assessment of the environmental attributes (specialist areas) that informed the sensitivity analysis essentially determined the site layout. The attributes that were included in the sensitivity analysis are:

- Ecology;
- Wetlands;

– Surface Hydrology;

– Soil Sensitivity;

– Visual Quality.

The layout included in **Appendix S** of the EIAR depicts the most feasible layout alternative from an environmental and technical point of view.

## 4.3 TECHNOLOGY ALTERNATIVES

### 4.3.1 Concentrated Solar Power (CSP) Systems

There are three CSP systems that were considered for the proposed project. The three (3) systems are the most prominent systems in use worldwide and each system is concisely described below. Ultimately it was determined that the power tower system is the most feasible option for the proposed site and the local conditions and the designs and calculations for the proposed plant were based on the utilisation of this system.

#### *4.3.1.1 Linear systems*

Linear CSP systems typically consist of a large number of parallel rows of parabolic (u-shaped) reflectors that track the sun from east to west during the day and concentrate the sunlight on a pipe that runs down the focal line of each trough. The concentrated sunlight is amplified 30 to 100 times its normal intensity on the pipe containing heat transfer fluid (oil). The fluid flows through the pipe and is used to boil water and generate steam. The steam is used in a conventional steam turbine to generate electricity.

Linear Fresnel reflector concentrating systems are configured similarly to that of the linear CSP. It uses Fresnel lenses and mirrors to concentrate the sunlight onto a fixed receiver tube above the mirrors. The mirrors are mounted on trackers that are configured to follow the sun and ensure that the rays are concentrated on the focal point of the receiver. The mirrors are flat or slightly curved and are not as optically efficient as the trough reflectors.

#### *4.3.1.2 Power Tower – Central Receiver Tower*

Power tower systems utilize many flat, sun-tracking heliostats (mirrors) to concentrate sunlight onto a receiver on top of a central receiver tower. Heat transfer fluid flowing through the receiver is heated by the concentrated sunlight and the heated fluid generates steam, which by means of a steam turbine generates power. Molten salt is the preferred heat transfer fluid for the power tower system due to its superior heat transfer and heat storage capabilities which enables it to be effective in generating steam even when the sun is not shining or during cloudy conditions.

#### *4.3.1.3 Dish Engine*

The dish engine uses mechanical energy rather than steam to generate electricity. A large mirrored dish tracks the sun and concentrates the sunlight onto a receiver at the focal point of the dish. The receiver is integrated into a high efficiency combustion engine that has thin tubes containing helium or hydrogen gas that expands when heated. The tubes run on the outside of the engine's four piston cylinders and open into the cylinders. As the gas is heated to high temperatures it expands in the cylinders driving the pistons and effectively drives an electric generator. This system does not lend itself to thermal storage and will only generate electricity when the sun is shining.

### 4.3.2 **Heat transfer mediums**

There are three (3) main heat transfer mediums used in utility scale concentrating solar power facilities. Oil, or Therminol, is the liquid used in a typical parabolic trough solar power project. Mmolten salt is typically not used as there are many kilometres of horizontal piping, unlike a central tower project, which has only short lengths of almost exclusively vertical tubing for these parabolic trough technology. The main heat transfer mediums used in central power tower projects are steam ("Direct Steam" method) or molten salt.

As all CSP power generation technologies require vast open space for operations and due to the nature of these technologies it was found that in order to present th comparative advantages effectivily this assessment will have to be done at the hand of the various heat transfer mediums used for power generation. These mediums are summarised in Table 3 below:

**Table 3: Comparative Advantages**

| Oil | Direct Stream | Molten Salt |
|---|---|---|
| **Issues:** | **Issues:** | **Advantages:** |
| – 1.6 km of tube per MW<br>– Sourcing Vacuum Tubes<br>– Toxic Therminol<br>– Curved, Stressed Glass<br>– Requires Natural Gas<br>– Loses Energy at Night<br>– Requires large volume of water<br>– Low temperature change<br>– No inherent storage<br>– Low quality steam | – High pressure piping (thick wall, expensive, safety)<br>– Two phase flow (erratic flow control, high stress, turbine erosion, more complex start up)<br>– Typically requires natural gas<br>– No inherent storage<br>– Complex water / steam control | – Primary heat transport<br>– Meters of tube, not kilometers<br>– Inherent storage<br>– Dispatchable / On Demand<br>– No Natural Gas required<br>– No energy loss at night<br>– High quality steam<br>– Standard steam turbine |

### 4.3.3 Cooling Alternatives

In thermal power generation there are predominantly three (3) types of cooling systems that are in use. These are wet cooling, dry cooling and hybrid cooling systems. These systems were also evaluated and compared in order to derive the most suitable alternative for the proposed project.

#### *4.3.3.1 Wet Cooling*

Evaporative wet cooling is widely considered to be the most common method for new power plants due to its economical and high performing cooling technique. This technique however consumes high volumes of water, in access of 1 million $cm^3$ per annum. Waste heat energy dissipated from the power plant is rejected to the air through evaporation of the cooling water. The cooling water evaporates in a cooling tower. As a result of the continuous evaporation, water treatment chemicals and minerals contained in the water become concentrated over time and require that a portion of the cooling water ("blowdown") be drained to remove high concentrations of accumulated salts and particulates. This is a potential source of an environmentally hazardous substance.

#### *4.3.3.2 Dry Cooling*

Dry cooling uses considerably less water than dry cooling and is becoming more prevalent in new power plants due to the limitations on water in arid areas, where most solar thermal power plants are established. All of the waste heat from the plant is rejected to the air. Air has a much lower capacity to carry heat and is considered less efficient than water as a cooling medium. Large fans are required to remove the heat from the pipe array in the cooling system and often these fans use a portion of the power generated by the plant. This effectively causes dry cooling to have a reduced thermal efficiency compared with wet cooling. The dry cooling system does not create any environmentally hazardous blowdown. In summary dry cooling uses less water but the plant produces slightly less power as a result.

#### *4.3.3.3 Hybrid Wet/Dry Cooling*

Hybrid cooling involves a combination of wet and dry cooling. Hybrid designs are aimed at reducing water consumption in comparison with wet cooling and enhance the plant's performance in warm weather when the thermal efficiency of dry cooling is least effective. Hybrid systems either involve separate wet and dry systems that operate in parallel or use water to cool the air used in the air cooled condenser. This system uses a fraction of the water of wet cooling and the turbine performance can be maintained on or close to design conditions. Considerably less blowdown will be resultant when compared with wet cooling. It is less expensive than an air-cooled plant and more expensive than a water-cooled plant.

### 4.3.4 **Conclusion**

Thorough consideration has been given to the various alternatives to ensure that they will have the minimum impact on the recieving environment. The advantages and disadvantages have been weighed up to determine the best possible engineering and environmental solution.

## 4.4 **NO-GO ALTERNATIVE**

The current low environmental impact associated with long term sustainable farming practices will be maintained and no change in land use or zoning would be required. The status quo needs to be measured against the proposed facility to determine whether the environmental and socio-economic benefits warrant the approval thereof or whether the status quo should be maintained.

This development alternative entails that the proposed CSP development not be constructed on the Farm Arriesfontein, thus result in the site being left as is. With South Africa's new focus on renewable energy and the targets set for this mandate, the NO-GO option will result in a zero contribution towards thetarget requirements and will furthermore provide no alleviation in terms of the current demand pressures on electricity.

The non-development of the proposed CSP plant mayimpede economic development and socio-economic progress for the surrounding communities and Kgatelopele Local Municipal region. Due to the numerous socio economic and economic benefits, the environmental technology advancement and the fact that the identified environmental impacts can be suitably mitigated it has been determined that the No-Go option can be been eliminated.

Should the Competent Authorities (CA) refuse the authorisation of the proposed Solar Power Park, the 'No Go' option will be "implemented" and the status quo of the site will remain in tact - leaving the site in its present state. The site is currently being used for agriculturalpurposes – livestock grazing. Although these activities are seemingly well managed at this point in time – this development option still has the potential for erosion and environmental degradation, as no control mechanisms will be in place to ensure that environmental consequences are kept at aminimum and grazing may be left unattended or unmanaged.

# 5. PUBLIC PARTICIPATION PROCESS

## 5.1 PUBLIC PARTICIPATION PROCESS: EIA PHASE OVERVIEW

The PPP for the project was conducted in accordance with Chapter 6 of the EIA Regulations, GNR 544 promulgated in August of 2010. The outcomes of the PPP are contained in the updated Issues and Response Report (I&RR) (**Appendix D**).The primary aims of the PPP during the EIA Phase were:

- To inform I&APs of the availability of the Draft EIAR for review;
- To identify issues, comments and concerns as raised by I&APs regarding the Draft EIAR;
- To promote transparency and an understanding of the project and its consequences; and
- To serve as a medium for interaction and communication with I&APs;

## 5.2 INTERACTION WITH KEY STAKEHOLDERS

During the EIA Phase, comments and issues raised by key stakeholders, identified during the preceding Scoping Phase, were addressed in the EIAR, kept informed of the process and were requested to give inputs on the Draft EIAR. These stakeholders included:

- National and Provincial Government Representatives:
  - Department of Environmental Affairs (DEA);
  - Department of Water Affairs (DWA);
  - Department of Agriculture, Forestry and Fisheries (DAFF);
  - South African Heritage Resources Agency (SAHRA); and
  - Relevant Northern Cape Provincial Authorities (e.g. Environment & Conservation, Agriculture).
  - Siyanda District Municipality;
  - Tsantsabane Local Municipality; and
  - Kgatelopele Local Municipality.

- Parastatals – Eskom, Civil Aviation Authority,;
- Affected and surrounding landowners;
- Environmental Non-Governmental Organizations (e.g. Wildlife Society of South Africa, BirdLifeSA);
- Community based organisations; and
- Other (i.e. Sedibeng Water. Air Traffic and Navigation Systems, Lime Acres Mine)

All I&AP information (including contact details), together with dates and details of consultations and a record of all issues raised is recorded within a comprehensive project database. This database will be updated on an on-going basis throughout the project, and will act as a record of the communication/public consultation process. It will be included in the updated CRR of the Final EIA Report.

## 5.3 REVIEW OF DRAFT EIA REPORT

The Draft EIAR was available for public review at the following locations in close proximity to the study area, which were identified as readily accessible to I&APs:

- Tsantsabane Local Municipal offices;
- Postmasburg Public Library – Bo Street, Postmasburg;
- Kgatolopele Local Municipal offices;
- Daniëlskuil Public Library – 222 Barker Street, Daniëlskuil;
- Mobile Public Library in Groenwater;

A 30-calendar day period is allowed for this review process from 2 August 2012 to 2 September 2012.Registered stakeholders and I&APs on the project database were notified of the availability of this report via post or e-mail. The report was also distributed to all the commenting authorities for review and comment in electronic or hard copy format.The availability of this draft report was also advertised through the following media:

## 5.4 MEDIA ADVERTISING

As per the statutory requirements of the 2010 EIA Regulations, the availability of the Draft EIA Report for public review was advertised in the following local newspapers on 2 August 2012:

- Sowetan (English); and
- Kalahari Bulletin (Afrikaans and English).

Copies of the Newspaper Advertisements will be included in the updated CRRin the Final EIAR.

## 5.5 SITE NOTICES

Site notices were prepared according to the requirement set out in the EIA Regulations. The site notices advertised the availability of the Draft EIAR for public review as well as the invitation to the public meeting. Site notices were placed at the entrance of the development site and at the Main road (R34) turnoff to the site.

## 5.6 PUBLIC NOTICES

Due to the proximity of project to Kgatelopele Local Municipality the PPP focused on this Municipal area. Sets of A3 public notices were placed on notice boards at the following amenities frequented by I&APs in Daniëlskuil, Postmasburg, Lime Acres and Groenwater:

- Daniëlskuil:
  - Daniëlskuil Public Library
  - OK Store
- Postmasburg:
  - Post Office
  - Public Library;
  - Pick & Pay
- Lime Acres

  - SPAR notice board
- Groenwater
  - Groenwater Super Store

Photographs of the notices placed in and around the affected area will be included in the updated CRR in the Final EIAR.

## 5.7 CONSULTATION AND PUBLIC INVOLVEMENT

I&APs were invited to the public meeting to be held in the Daniëlskuil High School hall on 16 August 2012 at 17:30. The minutes of the public meeting will be compiled, distributed to attendees of the meetings and included in the CRR of the Final EIA Report.

Networking with I&APs, will further continue throughout the duration of the project.

## 5.8 SOCIAL ISSUES TRAIL

Issues and concerns raised during the Scoping Phase were included in the CRR appended to the SR. The issues and concerns that were not addressed and resolved in the SR was included and addressed in the EIAR. All issues raised during the EIAR Phase PPP were recorded and resolved. The *IRR* will be updated and included in the Final EIAR updated with this information.

# 6. ASSESSMENT OF IMPACTS IDENTIFIED DURING THE EIA PHASE

During the EIA Phase, the preliminary identification and consideration of issues and concerns that may impact (positively and/or negatively) the biophysical and socio-economic environments was conducted. The issues that were identified as potentially significant during the EIA Phase formed the basis on which the more detailed specialist studies were conducted during the EIA Phase.In addition the less significant environmental impacts were also assessed providing a holistic assessment of the site.A screening process was conducted based on the inputs from the specialist baseline investigations to determine the most significant impacts that required further specialist assessment. Each of these potential issues identified in the Scoping Phase was assessed by the respective specialists and will be addressed in this section. The standard impact rating methodology that was providedto the different independent specialist during this EIA for the calculation of the impact significance for each identified impact is described below.

## 6.1 SIGNIFICANCE RATING METHODOLOGY

All specialists were requested to provide their feedback, recommendations, impact ratings and possible mitigation measures in a uniform format. To ensure the various specialist studies present an accurate depiction of the proposed environmental status, six (6) standard rating scales are defined, applied in order to assess and quantify the identified impacts. The rating system used for assessing impacts (or when specific impacts cannot be identified, the broader term issue should apply) is based on five (5) criteria, namely:

- The relationship between impacts/issues and impact status (Box 1);
- The relationship between impacts/issues and spatial scale (Box 2);
- The relationship between impacts/issues and temporal scale (Box 3);
- The relationship between impacts/issues and probability (Box 4);
- The relationship between impacts/issues and severity (Box 5);

These five(5) criteria are combined to describe the overall importance rating, namely the significance (Box 6).

**Box 1: Status of impacts**

| Rating | Description | Quantitative Rating |
|---|---|---|
| **Positive** | A benefit to the receiving environment. | + |
| **Neutral** | No cost or benefit to the receiving environment. | N |
| **Negative** | A cost to the receiving environment. | - |

**Box 2: Spatial scale of impacts**

| Rating | Description | Quantitative Rating |
|---|---|---|
| **None** | No impact | 0 |
| **Low** | Site Specific; Occurs within the site boundary. | 1 |
| **Medium** | Local; Extends beyond the site boundary; Affects the immediate surrounding environment (i.e. up to 5 km from Project Site boundary). | 2 |
| **High** | Regional; Extends far beyond the site boundary; Widespread effect (i.e. 5 km and more from Project Site boundary). | 3 |
| **Very High** | National and/or international; Extends far beyond the site boundary; Widespread effect. | 4 |

**Box 3: Temporal scale of impacts**

| Rating | Description | Quantitative Rating |
|---|---|---|
| **None** | No impact | 0 |
| **Low** | Short term; Quickly reversible; 0 – 5 years. | 1 |
| **Medium** | Medium term; Reversible over time; 5 – 15 years. | 2 |
| **High** | Long term; Approximate lifespan of the project: 16 -30 years. | 3 |
| **Very High** | Permanent; over 30 years and resulting in a permanent and lasting change that will remain. | 4 |

**Box 4: Probability of impacts**

| Rating | Description | Quantitative Rating |
|---|---|---|
| **None** | No impact | 0 |
| **Improbable** | Possibility of the impact materialising is negligible; Chance of occurrence <10%. | 1 |
| **Probable** | Possibility that the impact will materialise is likely; Chance of occurrence 10 – 49.9%. | 2 |
| **Highly Probable** | It is expected that the impact will occur; Chance of occurrence 50 – 90%. | 3 |
| **Definite** | Impact will occur regardless of any prevention measures; Chance of occurrence >90%. | 4 |

**Box 5: Severity of impacts**

| Rating | Description | Quantitative Rating |
|---|---|---|
| **None** | No impact | 0 |
| **Negligible / Minor** | The system(s) or party (ies) is marginally affected by the proposed development. | 1 |
| **Average** | Medium or short term impacts on the affected system(s) or party(ies). Mitigation is very easy, cheap, less time consuming or not necessary. For example, a temporary fluctuation in the water table due to water abstraction. | 2 |
| **Severe** | Medium to long term impacts on the affected system(s) or party(ies) that could be mitigated. For example constructing a narrow road through vegetation with a low conservation value. | 3 |
| **Very Severe** | An irreversible and permanent change to the affected system(s) or party(ies) which cannot be mitigated. For example, the permanent change to topography resulting from a quarry. | 4 |

**Box 6: Significance of impacts**

| Impact | | Rating | Description | Quantitative Rating |
|---|---|---|---|---|
| | Positive | High | Of the highest positive order possible within the bounds of impacts that could occur. | + 12 – 16 |
| | Positive | Medium | Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. Other means of achieving this benefit are approximately equal in time, cost and effort. | + 6 – 11 |
| | Positive | Low | Impacts is of a low order and therefore likely to have a limited effect. Alternative means of achieving this benefit are likely to be easier, cheaper, more effective and less time-consuming. | + 1 – 5 |
| No Impact | | No Impact | Zero impact. | 0 |
| | Negative | Low | Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts, mitigation is either easily achieved or little will be required, or both. Social, cultural, and economic activities of communities can continue unchanged. | - 1 – 5 |
| | Negative | Medium | Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. In the case of adverse impacts, mitigation is both feasible and fairly possible. Social cultural and economic activities of communities are changed but can be continued (albeit in a different form). Modification of the project design or alternative action may be required. | - 6 – 11 |
| | Negative | High | Of the highest order possible within the bounds of impacts that could occur. In the case of adverse impacts, there is no possible mitigation that could offset the impact, or mitigation is difficult, expensive, time-consuming or a combination of these. Social, cultural and economic activities of communities are disrupted to such an extent that these come to a halt. | - 12 - 16 |

## 6.2 DESCRIPTION OF IDENTIFIED IMPACTS

The identified impacts on environmental and social receptors arising from the proposed development include direct and indirect impacts. Impacts are also linked to the different stages of the project development i.e. construction, operation and decommissioning. The potentially significant impacts that were highlighted during Scoping are as follow:

- Loss to archaeological and cultural heritage;
- Visual and landscape impacts;
- Impact on natural vegetation and ecology;
- Avifaunal;
- Waste impacts;
- Surface hydrology;
- Wetland impacts; and
- Socio-economic impacts.

The impacts listed above were earmarked for further specialist assessment in order to assess their impacts more accurately and determine possible mitigation measures to be included in the Environmental Management Programme (EMP). In addition to the potentially significant impacts, specialist assessments were also conducted for a number of the potentially less significant impacts. This was done in order to discount any possibility of a potentially significant impact occurring as a result of the proposed project and it being left unaccounted and unmitigated causing potentially serious harm to the environment. These specialist assessments included the following:

- Air quality;
- Biodiversity and Avifaunal;
- Geotechnical;
- Soils and Agriculture Potential;

- Noise and Aesthetical;
- Waste;
- Geohydrology, Hydrology and Wetland; and
- Tourism and Socio Economic.

Through the implementation of standard environmental management measures the impacts on traffic, loss of agricultural land, and health and safety will also be addressed sufficiently in the impact assessment and controlled by the EMP.

## 6.3 POTENTIAL ENVIRONMENTAL IMPACTS

A key part of the Scoping process is the preliminary identification and consideration of issues and concerns that may impact (positively and/or negatively) with the biophysical and socio-economic environments.

The issues that are identified as potentially significant during the Scoping Phase forms the basis on which the more detailed specialist studies are conducted during the EIA Phase. Each of the potential issues identified in the Scoping Phase will be briefly described in this section.

### 6.3.1 Description of Potential Impacts

The potential impacts on environmental and social resources arising from the proposed development include direct and indirect impacts. Potential impacts will also be linked to the different stages of the project which are identified as construction, operation and decommissioning.

Table 4 provides an overview of likely aspects arising from each of the key project activities and considers their likely interaction with socio-economic and environmental resources and receptors.

**Table 4: Interaction between Project Activities and Receiving Environment**

| Project Activities | Receptor/Resource | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fauna | Flora | Soils | Hydrology | Traffic and Transport | Air Quality | Land Use and Agricultural Potential | Landscape and Visual Amenity | Heritage/Archaeology/ Palaeontology | Socio-economics |
| **Pre-construction and Construction** | | | | | | | | | | |
| Vegetation Clearance | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Construction of Access Roads | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ |
| Construction of Temp. Hard Standing | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ |
| Site Levelling and Grading | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ |
| Preparation of Solar Panel Foundations | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ |
| Underground Cables/Overhead lines | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ |
| Substation Construction | ■ | ■ | ■ | | ■ | ■ | | ■ | ■ | ■ |
| Solar Panel Delivery and Erection | ■ | | | | ■ | | | ■ | | ■ |
| Construction of Service Building | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ |
| Hard Standing Area Rehabilitation | ■ | ■ | ■ | ■ | | | ■ | ■ | | ■ |
| Waste | ■ | ■ | ■ | ■ | | | ■ | ■ | | |
| **Operation** | | | | | | | | | | |
| Solar Panel Operation | ■ | | | | | | ■ | ■ | | |
| Use of Access Tracks | ■ | | | | | | | ■ | | |
| Use of Buildings | ■ | | | | | | | ■ | | |
| Site Maintenance | ■ | | | | | | ■ | ■ | | |
| Waste | ■ | ■ | ■ | ■ | | | ■ | ■ | | |
| **Decommissioning** | | | | | | | | | | |
| Removal of Solar Panels | ■ | ■ | | | | | | ■ | | ■ |
| Removal of Foundations | ■ | ■ | | ■ | | | | ■ | | ■ |
| Removal of Access Roads | ■ | ■ | | ■ | | | | ■ | | ■ |
| Removal of Underground Cables | ■ | ■ | | | | | | ■ | | ■ |
| Waste | ■ | ■ | ■ | ■ | | | ■ | ■ | | |
| Site Restoration & Rehabilitation | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | | ■ |

*Note: This interactions matrix will be continually developed throughout the EIA process.*

*Key: Shaded box indicates potential interaction between the project and resource or receptor.*

### 6.3.2 **Potentially Significant Impacts**

The following section describes potentially significant issues raised in addition to the potential impacts described in the specialist reports below. of the CSP based on the initial site visit, discussions with the project team, issues and concerns raised by I&APs during the PPP and available information about and from experience regarding the environmental effects of similar solar energy developments. These potential impacts will be discussed in detail for the CSP in the EIAR.

It is likely that many of these impacts can be adequately addressed through the implementation of appropriate mitigation and management measures, however, some require further specialist investigation as part of the EIARas indicated. The aspects that are potentially significant include the following:

### 6.3.3 **Traffic: Potential Impacts**

#### *6.3.3.1 Impacts proposed during the Construction Phase*

There may be an increase in traffic during the construction of in the facility as some trucks and earth-moving vehicles will bring infrastructure, equipment and construction materials onto site and undertake construction activities. These may result in noise and dust pollution as well as pose a safety risk. A preliminary Traffis Management Plan is included in the EMP.

#### *6.3.3.2 Impacts proposed during the Operation Phase*

During the Operational phase there will be limited impacts with only admin staff and maintenance travveling to the site. Minimal impacts are foreseen.

#### *6.3.3.3 Impacts proposed during the Decommissioning Phase*

Large volumes of traffic will come onto the site during the decomissioning of the site. Similar impacts will be experienced in terms of traffic volumes and related impacts as during the construction phase.

### 6.3.4 **Waste Generation: Potential Impacts**

#### *6.3.4.1 Impacts proposed during the Construction Phase*

Waste from the construction activities may arise from a range of sources producing the following:

- Construction waste;
- Sanitary waste;
- Excavated material (e.g. rock and soil), and
- Domestic waste from construction workers and offices.

Several impacts may be related to the generation of waste during the construction phase. These include:

- Pollution of soils in the area due to hydrocarbon and domestic waste;
- Visual impact due to littering on the site;
- Pollution of the groundwater
- Potential health implications

#### *6.3.4.2 Impacts proposed during the Operation Phase*

Following the construction phase, there will be limited waste production during the operational phase. The anticipated wastes during operation will include:

- Domestic waste;
- Industrial waste (oil, oily rags, scrap metal replaced machine components etc.)
- Sanitary waste from the septic tanks,

### 6.3.5 **Soils, Geology: Potential Impacts**

#### *6.3.5.1 Impacts proposed during the Construction Phase*

The potential effects on soils and geology from construction and decommissioning include:

- The potential for soil properties at the site to be permanently altered due to site preparation (e.g. compaction of soil);
- Alteration of topography on a local scale through clearing and grading; and
- Site preparation and vegetation clearance activities which could cause instability and increased erosion potential.

It is not anticipated that any major watercourses or water-bodies will be directly impacted by the proposed development during construction and the water during this phase of the project will be sourced from Vaal Gamagara Pipeline.

#### *6.3.5.2 Impacts proposed during the Operation Phase*

However, removal of vegetation and the development on access roads, areas and non-permeable hard standing surfaces may impact surface water flow and run off within the site area and near surrounds during both the construction and operation phases.

#### *6.3.5.3 Impacts proposed during the Decommissioning Phase*

The decomissioning of the site will have very limited impacts as the potential source of pollutants will be removed from the site. Care should be taken during the removal of these materials to prevent spillage.

### 6.3.6 **Human Health and Safety: Potential Impacts**

As with any construction project, there is potential for impacts on human health and safety to occur as a result of accidents and unplanned events that may occur during the construction of the Solar Power Park.

The risk of injury associated with the construction of the facility will be mainly limited to the subcontractors (as the site will be secured to avoid public incursion into the active development area), but there remains some risk of injury to other site users (i.e. farm workers). Basic safety precautions and protective measures will be specified in the EMP which, in turn, will be incorporated into sub-contractor health and safety plans.

# 7. SPECIALIST ASSESSMENTS FOR POTENTIALLY SIGNIFICANT IMPACTS

This section of the EIAR will provide the findings of the various Specialist Investigation with regards to the identification of potential impacts as well as providing an impact rating and possible mitigation measures for the various impacts.

## 7.1 AVIFAUNAL IMPACT ASSESSMENT

The site consists primarily of uniform, arid vegetation types.  Very few permanent water bodieswere observed on site. The South AfricanBird Atlas Project (SABAP) recorded 12 Red Listed Species across all four squares, ofwhich five (5) are classified as Vulnerable, and seven (7) as Near Threatened. One additional species,the White Stork, is also included as it is protected internationally under the BonnConvention on Migratory Species. Various other species relevant to the project wereidentified and include raptors, doves, pigeons and aerial foragers such as swallows andswifts.

In general, SABAP 2 data showed low counting effort for study site and immediate surrounds, however it did reveal the presence of an additional two Red Listed Species.The focal species for the study were determined to be the following: *Lesser Kestrel, Lanner Falcon, Kori Bustard, Secretarybird, Greater Flamingo, White Stork, Martial Eagle, Northern Black Korhaan, Namaqua Dove, Rock Martin, Little Swift, Barn Swallow, European Bee-eater, Namaqua Sandgrouse, Sothern Pale-chanting Goshawk, and South African Shelduck* .

### 7.1.1 Terms of Reference

The following terms of reference for theavifaunal study were adopted:

- Identification of sensitive sites: The bird sensitive sections of the study area will be identified.
- Describe affected environment and determine status quo: The existing environment will be described and the bird communities most likely to be impacted will be identified. Different bird micro-habitats will be described as well as the species associated with those habitats.
- Describe focal species: Threatened bird species (as per red data book status), will be identified, and species most likely to be impacted upon will be identified.
- Identification of impacts: The potential impact on the birds will be identified.

- Assess and rate the identified impacts. The significance of the potential impacts will be rated according to a set of pre-determined criteria.

- Assess alternatives. A comparative assessment of the avifaunal impacts related to proposed project alternatives.

- Propose and explain mitigation measures: Practical mitigation measures will be recommended and discussed.

#### *7.1.1.1 Methodology*

The following section describes the process and criteria used to assess the site during the scoping phase in terms of avifaunal impact.

- The study was initially conducted from a desk top level. Using various GIS layers, 1:50 000 topographical maps and Google earth images, key features within the study area were identified and a map of the site and surrounding area was created using ARCGIS 9.3.

- The various data sets discussed below under "sources of information" were collected and examined.

- This data was examined to determine presence of sensitive Red Data species in the study area.

- Abundance of the species most sensitive to this project (not necessarily red listed species) was determined.

- The area was visited, and thoroughly traversed, to obtain a first-hand perspective of the site, and to determine which bird micro-habitats are present and relevant to the study. This involved driving the study area, taking photographs, recording species at various observation points, and walking certain accessible areas.

- Proximity of the site to water was assessed, as was the presence of small water features (e.g. dams, pans or water troughs) within the site boundary.

- The impacts of the proposed project on birds were then predicted.

- Possible mitigation measures for significant impacts were discussed.

### 7.1.2 Impact Assessment and Identification

#### *7.1.2.1 Issues relating to the 100MV CSP plant:*

CSP facilities potentially have greater impact on birds than PV facilities because of the associated central receiver tower, standby focal points and heliostats. Briefly, some of the anticipated avifaunal issues involved with the Arriesfontein Solar ThermalEnergy project are now described below.

– Collision with the heliostats (mirrors)

  Reflective surfaces are particularly prone to collisions in the same way as householdwindows. The CSP plant will consist of hundreds or thousands of heliostat mirrorsand can be expected to result in some collisions.

– Collision with the central receiver tower

  Almost any infrastructure that stands proud in the landscape will result in a certainnumber of collisions by birds. In this case, the central receiver tower will standapproximately 200 m tall, a significant height, particularly in this landscape. Amitigating factor is that it will be a solid concrete tower and should be relativelyvisible to birds.

– Roosting on the central receiver tower

  Birds could potentially use the top of the tower as a roosting site at night. It is likelythat they would only come in to roost after the plant has been shut down in theevenings, and would leave the roost before the plant starts up in the morning.

– Burning when in vicinity of the central receiver

  The central receiver will glow white hot when the plant is operational which might potentially result in birds in the vicinity being burnt.

– Burning when entering the “standby focal points”

  During testing, maintenance and daily start up procedures, the heliostats are focused in groups onto focal or standby points in the sky, usually at roughly the same heightas the central receiver (approximately 200 m). In the case of the CSP plant, therewill be numerous standby points. McCrary et al found that 19% of the birds thatwere found dead at Solar One were burned in standby points. Avian foragers such asswifts and swallows accounted for 46% of these mortalities. The more time a birdspends in the air the more chance there is of it flying into a standby point. Theheight at which species fly is also critical, species likely to fly at this height includethe swifts, swallows, and martins.

– Loss of habitat

The CSP plant will take up an area of approximately 6 km2. This would obviously behabitat previously available to the birds in the area.The vegetation in this area will not be fully cleared automatically. Rather, only the areas where infrastructure has to be constructed should be cleared. Obviously construction activities on site will flatten and impact on certain areas of vegetation even if it is not cleared. Similar habitat is abundant in the greater area and it is anticipated that the bird species will move to surrounding areas.

– Disturbance

Construction activities will no doubt disturb the birds in the area, particularly breeding birds – however due to the uniformity of the broader area, these birds can quite easily move off and find similar habitat nearby.

– Pollution caused by leaching of chemical substances into waste water evaporation ponds

This could be lethal to birds using these ponds. Artificial evaporation pondsserve as an additional attractant to water birds, which could increase cumulativecollision, burning or poisoning impacts.

– Nesting of Sociable Weavers and other species on the plant infrastructure

The extent to which this occurs will need to be monitored closely. This is an impact of the birds on the plant rather than the plant on the birds. It is hoped that the constant moving and cleaning of the heliostats will make them unattractive nesting substrate for the birds. No nests were observed within the site boundaries.

It is important to stress that most of the above impacts – and certainly the first five (5) listedimpacts – will probably only become significant when large numbers of birds are in thevicinity of the CSP plant. For example one swallow being burnt in a focal point would hardlybe considered a significant impact. However, if a large flock of swallows congregated –perhaps due to a nearby roost site – a large number of birds could be burnt and thesignificance would be greatly amplified. For this reason, the more sensitive species in termsof the above impacts are likely to be the gregarious, flocking species.

#### *7.1.2.2 Issues relating to the associated infrastructure*

The EWT believes that the impacts of the associated infrastructure such as overhead distribution power, seperately EIA in process, lines on birds may in fact outweigh the impacts of the CSP plant itself, depending on the length of new infrastructure that needs to be constructed. The proximity of site to the existing power line and road infrastructure is therefore very important. The closer the final site is to existing infrastructure, the less new infrastructure will need to be built. Briefly, the impacts of the associated infrastructure are as follows:

- *New power line:*

Collision of large terrestrial birds with any new overhead power lines is likely to occur and is anticipated to be the most significant threat posed by associated infrastructure. Species most likely to be affected are flamingos, bustards, korhaans and other large terrestrial species. The significance of this impact depends on the length and routing of any new lines to be built. The exact routings of associated new lines were not available at the time of writing, and the impact therefore cannot be fully assessed at this stage.

Electrocution of birds on pylons will depend entirely upon the exact pylon structure that for the new line – detail of which was not available at the time of this study. Electrocution risk is determined by the phase-phase and phase-earth clearances on a pole structure which differ greatly between different structures. Again, if the structure used is dangerous to birds, the significance of this impact will vary with the length of the line.

Nesting of birds on pylons is in fact a positive impact on avifauna, but may impact negatively on the quality of electrical supply by causing electrical faults. In the case of Sociable Weaver nests, the nest material may pose problems to the pylons structural integrity through added weight, and there is an increased fire risk due to the fuel load of these massive nests.

Disturbance of avifauna through construction and maintenance activities associated with the power line is not likely to be significant.

Habitat destruction by construction activities is likely to occur, but not likely to be significant.

- *New road/s*

Disturbance of avifauna is likely to occur to some extent, but not likely to be too significant as there is already a gravel district road (along the rail line to the west of the site) as well as various tracks through the farm and it is unlikely that extensive new roads would be, again depending on the exact layout of the CSP and PV plants within the farm.

Habitat destruction caused by road construction will have some impact on avifauna, but as discussed elsewhere the habitat in this landscape is relatively uniform and so this impact is unlikely to be too significant.This infrastructure is likely to have very similar impacts to the roads discussed above, except on a smaller scale. Should new pipelines be required for water supply to the PV Plant impacts of this on avifauna will be minor habitat destruction and minor disturbanc.

- *New pipe line/s*

Disturbance of avifauna through construction and maintenance activities along the new pipeline routing options as well as the potential destruction of habitat destruction during construction.

#### *7.1.2.3 Amplification Impacts*

In this arid, relatively uniform landscape, large congregations of birds are unlikely unless a strong attractant exists, such as water.

#### *7.1.2.4 Birds attracted to open water evaporation ponds:*

In this landscape, any source of water is hugely important for all animals – including birds. The CSP plant involves open water sources such as evaporation ponds, this will attract more birds into the immediate area thus heightening the risk of the above impacts occurring. This is supported by the fact that 45% of all species recorded in 150 ha around Solar One, were only recorded at the ponds. The importance of the evaporation ponds at Solar One to birds is further illustrated by the fact that 107 bird species were recorded in the vicinity of Solar One, whilst the avian community in similar habitat elsewhere is usually less than 20 species.

It is clear then that the presence of open water ponds close to the CSP plant would drastically increase the potential for avifaunal impacts.

#### *7.1.2.5 Birds mistakenly attracted to heliostats*

In these arid regions the daily activity schedule of many animals and birds revolves around securing their required daily intake of water. For example, Namaqua Sandgrouse (medium report rate in the study area) fly in flocks to water sources during mid to late morning. There is a possibility that birds such as these may mistake the heliostats or PV panels for water sources when flying high above and descend to investigate. In the case of the Sandgrouse, they would typically circle several times once they have located a water source, before descending. If the heliostats are mistaken for water, these birds would most likely circle through one or more focal points and may well be burnt to death.

**Table 5: Rating of Construction Phase impacts:**

| Impact | Scale | Duration | Magnitude | Probability | PS pre-mitigation | Recommended Mitigation | PS after mitigation |
|---|---|---|---|---|---|---|---|
| **Habitat Loss (CSP Plant)** | 1 | 4 | 6 | 5 | 55 (Moderate) | Not possible | 55 (Moderate) |
| **Habitat Loss (New roads)** | 1 | 4 | 4 | 5 | 45 (Moderate) | Not possible | 45 (Moderate) |
| **Habitat Loss (Pipelines)** | 1 | 2 | 4 | 5 | 35 (Moderate) | Not possible | 35 (Moderate) |
| **Habitat Loss (Overhead Power lines)** | 1 | 4 | 4 | 5 | 45 (Moderate) | Not possible | 45 (Moderate) |
| **Disturbance (during construction of all phases and infrastructures)** | 2 | 2 | 6 | 4 | 40 (Moderate) | Strict control should be maintained over all activities during construction, in particular heavy machinery and vehicle movements, and staff. Sensitive zones described elsewhere in this report, should be avoided where possible. It is difficult to mitigate properly for this as some disturbance is inevitable.<br>During Construction, if any of the “Focal Species” identified in this report are observed to be roosting and/or breeding in the vicinity, the EWT is to be contacted for further instruction. | 32 (Moderate) |

**Table 6: Rating of Operational Phase impacts**

| Impact | Scale | Duration | Magnitude | Probability | PS pre-mitigation | Recommended Mitigation | PS after mitigation |
|---|---|---|---|---|---|---|---|
| **Collision with heliostats** | 1 | 4 | 10 | 5 | 75 (High) | Unlikely that mitigation of this impact will be possible, but this will need to be confirmed once the plant is operational and some experience is gained | 75 (High) |
| **Collision with Central Receiver Tower** | 1 | 4 | 10 | 5 | 75 (High) | Unlikely that mitigation of this impact will be possible, but this will need to be confirmed once the plant is operational and some experience is gained | 75 (High) |
| **Burning in vicinity of central receiver tower** | 1 | 4 | 10 | 5 | 75 (High) | Unlikely that mitigation of this impact will be possible, but this will need to be confirmed once the plant is operational and some experience is gained | 75 (High) |
| **Burning in focal points** | 1 | 4 | 10 | 5 | 75 (High) | Unlikely that mitigation of this impact will be possible, but this will need to be confirmed once the plant is operational and some experience is gained | 75 (High) |
| **Nesting** | 1 | 4 | 4 | 3 | 27 (Low) | Positive impact on avifauna. No mitigation required. | 27 (Low) |

| Impact | Scale | Duration | Magnitude | Probability | PS pre-mitigation | Recommended Mitigation | PS after mitigation |
|---|---|---|---|---|---|---|---|
| **Electrocution of birds on pylons** | 1 | 4 | 10 | 3 | 45 (Moderate) | *Wherever possible, lines connecting turbines should be placed underground Any overhead power lines which are built, and which are 132kV or lower, should use a "bird friendly" monopole structure, fitted with a bird perch, as per Eskom standard guidelines.* | 15 (Low) |
| **Disturbance of sensitive species (e.g. during maintenance and operations).** | 2 | 4 | 6 | 4 | 48 (Moderate) | Strict control should be maintained over all activities during operation, in particular heavy machinery and vehicle movements, and staff. Sensitive zones described elsewhere in this report, should be avoided where possible. It is difficult to mitigate properly for this as some disturbance is inevitable. If any of the "Focal Species" identified in this report are observed to be roosting and/or breeding in the vicinity, the EWT is to be contacted for further instruction. | 40 (Moderate) |

| Impact | Scale | Duration | Magnitude | Probability | PS pre-mitigation | Recommended Mitigation | PS after mitigation |
|---|---|---|---|---|---|---|---|
| **Collision of large terrestrial birds with overhead power lines** | 1 | 4 | 10 | 4 | 60 (High) | *Wherever possible, lines connecting turbines should be placed underground*. Mark relevant sections of line (i.e. within the Medium-High Sensitivity zones-fig10 above) with appropriate marking devices. The exact spans will be finalised as part of the EMP phase, once power-line routes are finalised and pylon positions are pegged. | 30 (Moderate) |

**Table 7: Rating of Closure Phase impacts:**

| Impact | Scale | Duration | Magnitude | Probability | PS pre-mitigation | Recommended Mitigation | PS after mitigation |
|---|---|---|---|---|---|---|---|
| **Disturbance of sensitive species** | 2 | 2 | 4 | 4 | 32 (Moderate) | Strict control should be maintained over all activities during decommissioning, in particular heavy machinery and vehicle movements, and staff. Sensitive zones described elsewhere in this report, should be avoided where possible.<br>If any of the "Focal Species" | 16 (Low) |

| Impact | Scale | Duration | Magnitude | Probability | PS pre-mitigation | Recommended Mitigation | PS after mitigation |
|---|---|---|---|---|---|---|---|
| | | | | | | identified in this report are observed to be roosting and/or breeding in the vicinity, the EWT is to be contacted for further instruction. | |

### 7.1.3 **Sensitivity Rating**

An avifaunal sensitivity map has been compiled (see **Figure** ), showing areas of medium-high, low and unknown sensitivities. Recommendations with regard to these sensitivity "zones" has been discussed below. It is recommended that infrastructure is not built or developed in the zone of medium to high sensitivity.

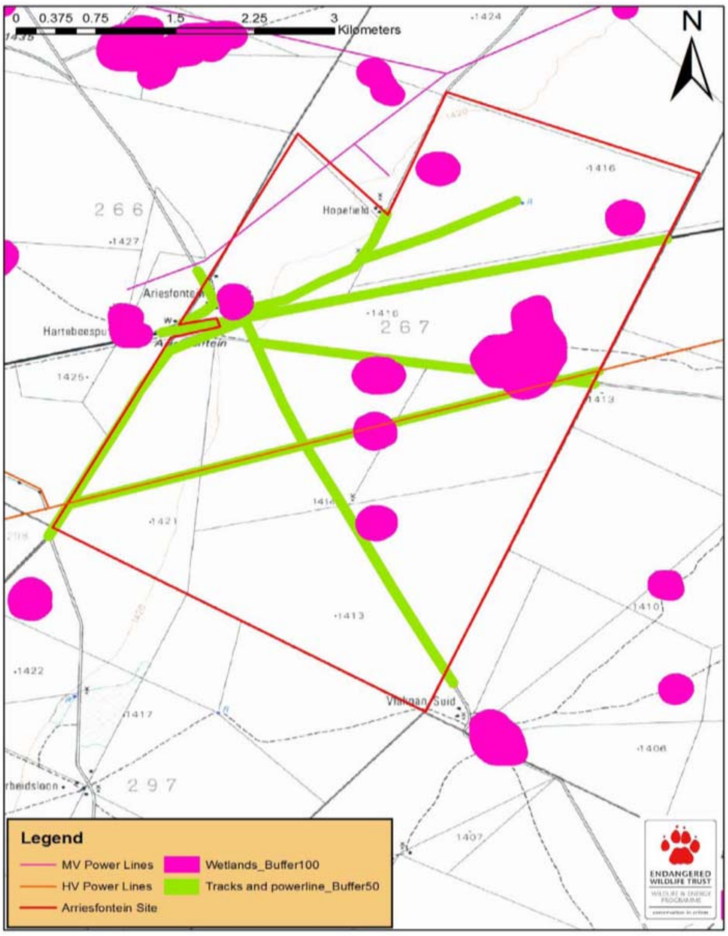


**Figure 10: A map showing various avifaunal sensitivity zones within the proposed development site.**

Medium-High sensitivity: These zones include 100 m buffers around water bodies, such as dams and pans, No construction of infrastructure in these areas (as indicated in the map above- **Figure** should be permitted. However, upon consultation with EWT, construction of infrastructure may be possible, with caution, within certain areas of these zones. Should associated infrastructure, such as pipe-lines or power lines pass through these areas, mitigation as discussed elsewhere must be implemented. Importantly, should any over-head powerlines pass through these areas; they should be fitted with collision mitigation in the form of "bird flight diverters". The confidence with which these "Medium-High sensitive" areas were identified was moderate to low.

Low Sensitivity: These zones are made up of a linear infrastructure corridors. Existing roads/tracks and power lines have been buffered by 50 m, on each side, to indicate these zones. These zones are likely to be of low sensitivity; however any species may pass through these zones, especially the roads, if levels of human movement are low. New linear infrastructure should follow these corridors where possible.

Unknown Sensitivity: These are the remaining areas of the study site. These are designated "unknown" sensitivity for the following reasons: no obvious avifaunal features or patterns could be identified during the study; any of the identified focal species may at some point utilize or pass through these areas, and; the precautionary principle has been adopted. It is likely that the majority of these areas are "Low" sensitivity for birds. These unknown sensitivity areas are preferred for construction.

### 7.1.4 Comparison of Alternatives

For the purpose of the proposed EIA only the following types of alternative options will beconsidered:

– The layout of the heliostat field.

– The CSP technology to be used.

– The option of not implementing the activity (i.e. “No-go”).

For the proposed CSP Plant, three (3) possible layout positions on the proposed site will beassessed as alternatives. Three (3) possible technology alternatives have been identified asdevelopment options and will be considered and assessed. The no-go alternative will alsobe assessed in order to reflect the potential impact if the proposed project will not beimplemented.

#### *7.1.4.1 No-go Alternative*

The current status quo would be maintained by not implementing the proposed CSP and PVPlant. The current farming activities will continue and the land use will not change. Presenceand abundance of bird species, as described in the Avifaunal Scoping Report, would remainthe same. Purely in terms of impacts on avifauna, this option would have the least impacts.

#### *7.1.4.2 Location and Layout Options*

The options for the proposed location of the CSP plant are limited to the farm Arriesfontein267. No alternative site locations have been assessed. However more than one position forthe layout of the heliostat field within the farm have been presented and are discussedbriefly below. All three options are shown in figures 11 to 13 below, and are to the south ofthe sites, south of the railway line.

Option A is positioned as far south and east as possible within the site. Its centre point (i.e.the Central Receiver Tower) will be positioned on or very close to an existing farm track,which may result in less disturbance and habitat destruction during initial construction. Itwill impact upon two small pans. Option B is positioned as far west as possible within thesite. It will impact upon two small pans, as well as one medium sized pan. Option C ispositioned centrally and more to the north. It will impact upon two small pans and onemedium pan, and is also located closest to the relatively large pan/wet area that lies to thenorth of the farm road that runs east to west through the centre of the site.

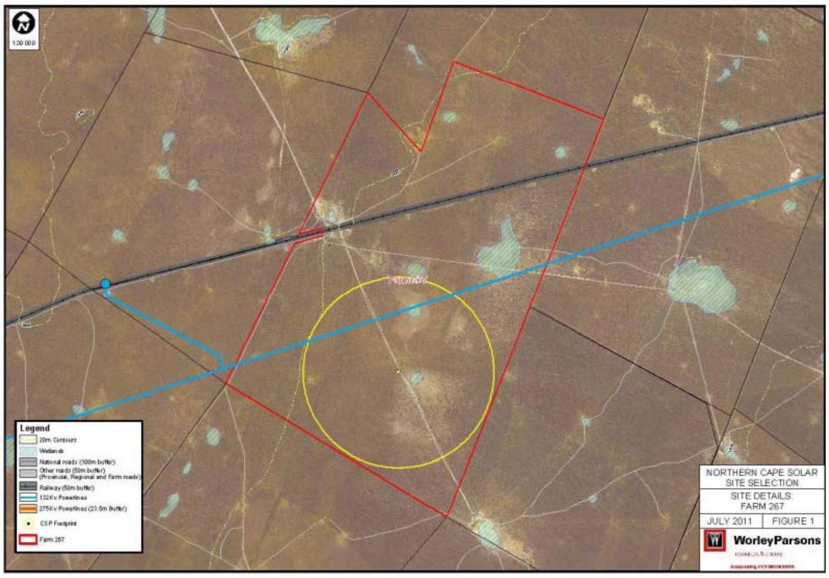


**Figure 7:Layout Option A for the heliostat field within the proposed development site.**

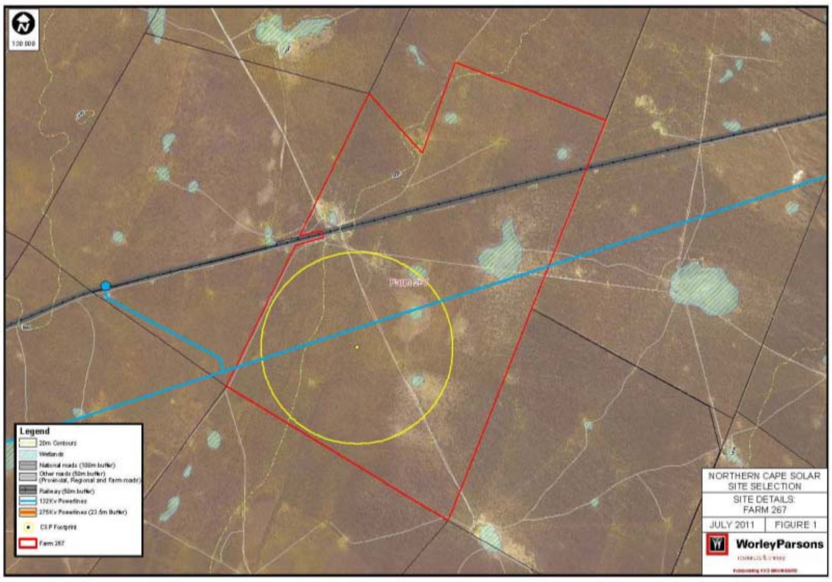


**Figure 8: Layout Option B for the heliostat field within the proposed development site**

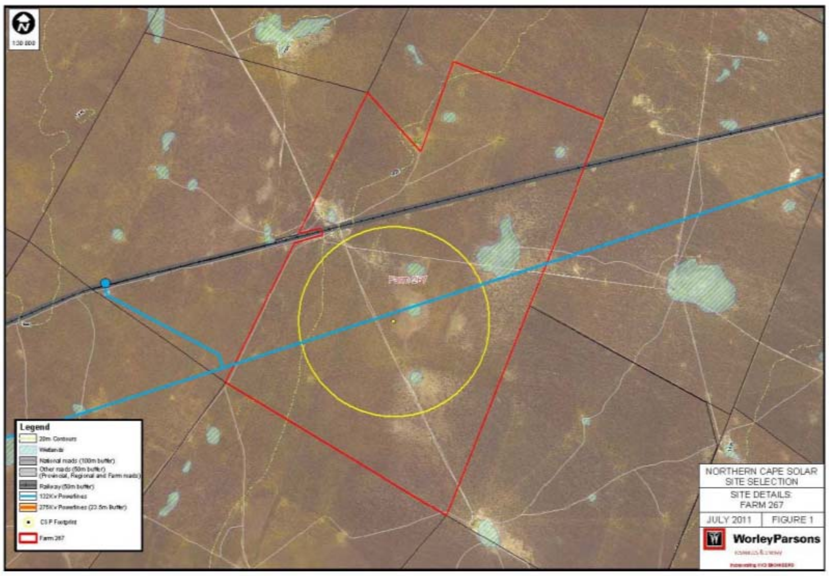


**Figure 9:: Layout Option C for the heliostat field within the proposed development site**

In order to rank these layout options a table was compiled and the options were given arating on a scale of 1 to 5, with 1 being the least preferred and 5 being the most highlypreferred option.

**Table 8: Preference rating for the 3 CSP layout options.**

| Layout Option | Preference Rating |
|---|---|
| Layout A | 4 |
| Layout B | 3 |
| Layout C | 1 |

As can be seen from the discussions and table above, Option A is slightly preferredover Option B, both of which are acceptable from an avifaunal perspective, whileOption C is least preferred.

#### *7.1.4.3 Technology Options*

The three (3) technology alternatives that are being considered relates to the waterconsumption of the plant and particularly the consumption of the cooling systems. Thecooling system is the only variable in terms of water consumption. The three cooling systemoptions are dry, wet and hybrid cooling. The estimated water consumption during theconstruction phase remains constant irrespective of the cooling option chosen. Theconsumption during operation however will be influenced by the selected cooling system.The dry system consumes approximately 90% less water than the wet system andmoderately less than the hybrid cooling system and the availability of water will be adetermining factor of the option to be selected (Solar Reserve, 2011-BID).

It is unlikely that there will be any direct impacts on avifauna, relating to the type of coolingsystem chosen. However, as birds are dependent on water, the wet system may have morenegative, indirect impacts on avifauna, through the possible depletion of water availabilityand wetland habitats. This of course is dependent on the source of the water used.

### 7.1.5 **Conclusion**

The site is situated within the arid Northern Cape, with uniform vegetation of only one types (Ghaap Plateau Vaalbosveld) found on the study site. The uniformity of the site resulted in few microhabitats available for birds.

However, an important microhabitat present was that of natural seasonal pans, which are more extensive in the broader area. This fact, along with the presence of CWAC sites to the west of the study area, means that it is possible for waterfowl and other bird species associated with water, may be attracted to additional water sources (e.g. evaporation ponds) created by the CSP project. It is also possible, although no such studies have yet been conducted in South Africa, that bids may mistake the heliostat field for water, and collide with the panels. Species of most concern in the area, include thefollowing identified Focal Species: Lesser Kestrel, White-backed Vulture, Kori Bustard, Secretarybird, Greater Flamingo, White Stork, Martial Eagle, Northern Black Korhaan, Namaqua Dove, Rock Martin, Little Swift, Barn Swallow, European Bee-eater, Namaqua Sandgrouse, Sothern Pale-chanting Goshawk, and South African Shelduck. An assessment of the impacts of the proposed CSP and PV plants on avifauna at the proposed Arriesfontein site revealed the following key findings:

– Collisions of birds with heliostats and/or the central receiver tower of the CSP plant, both had a high significance rating. It is unlikely that mitigation of these impacts will be possible, but this will need to be confirmed once the plant is operational and some experience is gained.

- Burning of birds in focal points and/or in the vicinity of the central receiver tower of the CSP plant has a high significance rating. Again, it is unlikely that mitigation of this impact will be possible, but this will need to be confirmed once the plant is operational and some experience is gained.
- Habitat destruction and disturbance of bird will be of moderate significance. This can be mitigated by ensuring that the construction Environmental Management Plan incorporates guidelines as to how best to minimize this impact.

#### *7.1.5.1 Impacts associated with new power lines:*

Collision of birds with overhead power lines is likely to be of high significance without mitigation. This will be mitigated for by marking the relevant sections of line with appropriate marking devices, thus reducing the impact to that of moderate significance. These sections of line will be identified as part of the EMP

Assuming that "bird-friendly" monopole structures are used, as detailed elsewhere in this report, electrocution of birds on pylons is likely to be of low significance.

#### *7.1.5.2 Impacts associated with new roads, pipe lines:*

Habitat destruction and disturbance of birds will be of moderate significance. This will be mitigated by ensuring that the construction EMP incorporates guidelines as to how best to minimize this impact.An avifaunal sensitivity analysis of the site found areas of "medium-high", "low" and "unknown" sensitivities. Medium-High sensitivity zones are associated with seasonal pans and wetlands, and it is recommended that where possible infrastructure is not built or developed in these zones. The majority of the site was found to be of "unknown" sensitivity. It was recommended that where possible, new linear infrastructure should follow existing linear infrastructure, which was designated as a "low" sensitivity zone.

A final recommendation is that a detailed monitoring protocol, for the operational phase of the project, be incorporated in to the final project EMP. The EWT should be consulted during the EMP phase, to assist in compiling such a monitoring program. The monitoring will involve regular inspections of the plant, to collect any bird carcasses.

This will insure that any bird mortalities are recorded and reported, and may assist with the implementation of future, additional mitigation strategies.In conclusion, the lack of any operational CSP plants or PV plants of this nature in South Africa, make the assessment of impacts of this project difficult. However, the EWT believes that it is necessary to adopt renewable energy technologies in South Africa, and it is necessary to construct such projects, and monitor their impacts (if any) on avifauna.

This will allow pro-active learning, which can inform additional mitigation where necessary on the project, as well as informing future avifaunal studies of similar projects. Therefore, without finding any fatal flaws and if the mitigations recommended in this report are followed, the development is acceptable from an avifaunal perspective, and it is recommended that this project proceeds.

### 7.1.6 Mitigation Measures

Strict control should be maintained over all activitiesduring construction, in particular heavy machinery andvehicle movements, and staff. Sensitive zones describedelsewhere in this report, should be avoided wherepossible. It is difficult to mitigate properly for this as somedisturbance is inevitable. During construction, if any ofthe “Focal Species” identified in this report are observedto be roosting and/or breeding in the vicinity, the EWT isto be contacted for further instruction.

Wherever possible, lines connecting turbines should beplaced underground. Mark relevant sections of line (i.e.within the Medium-High Sensitivity zones) with appropriate marking devices. The exact spans will befinalised as part of the EMP phase, once power-line routesare finalised and pylon positions are pegged. A seperate EIA is being conducted by SiVest for the the overhead power lines.

Wherever possible, lines connecting turbines should be placed underground Any overhead power lines which are built, and which are 132kV or lower, should use a “bird friendly” monopole structure, fitted with a bird perch, as per Eskom standard guidelines.

## 7.2 BIODIVERSITY: FLORISTIC IMPACT ASSESSMENT

The regional vegetation is described as Ghaap Plateau Vaalbosveld (Mucina & Rutherford, 2006), with a Least Threatened conservation status ascribed; with only an estimated 1% transformed. The SANBI database indicated the known presence of only 8 plant species within the ¼ degree grid that is sympatric to the study area, reflecting a poor floristic knowledge of the region.

A total of 116 plant species were recorded during the field investigations and appears to be representative of the regional vegetation type. The physiognomically dominant woody stratum is represented by 10 tree and 16 shrub species. A well-developed herbaceous stratum is represented by 56 forbs and 23 grass species. The perennial spring is occupied by seven (7) sedge species. The floristic diversity comprises 44 families, dominated by Poaceae, Asteraceae and Fabaceae.

No Red Data species are known to occur in the ¼ degree grids in which the study areas are located, reflecting poor sampling records for the region. Furthermore, habitat types encountered in the study area are typical of the region and no habitat type of unique quality is present that is particularly apposite for the potential presence of Red Data flora species. The following species are present in the study area and are protected under the National Forests Act of 1998:

– Acacia erioloba; and

– Oleaeuropaea subsp. africana

It is therefore necessary to conduct a survey that will determine the number and relevant details pertaining to protected tree species on the property for the submission of application forms to NCDENC and DAFF prior to the disturbance of these individuals.

Results of the photo analysis and site investigations revealed the presence of the following macro habitat types and habitat variations:

– Degraded Habitat, including;

– Excavations/ Spoils heaps (Low floristic Sensitivity);

– Road Infrastructure/ Railways/ Homestead (Low floristic Sensitivity);

– Natural Woodland Habitat, including

– (Searsialancea) Open Woodland (Medium floristic Sensitivity);

– (Tarchonanthuscamphoratus) Closed Shrubveld (Medium floristic Sensitivity);

– Wetland Habitat, including:

– Natural Spring (High floristic Sensitivity); and

– Endorheic Pans & Wetlands (Medium-high floristic Sensitivity).

The study area comprises extensive areas of shrubveld/ woodland that is representative of the regional vegetation type. The general woodland vegetation exhibit little signs of degradation, but also little sensitive floristic attributes. This woodland habitat is well represented in the surrounding region. Contained within the major terrestrial woodland community are small endorheic pans that represent an azonal habitat form. These areas are characterised by temporary and intermittent inundation subsequent to severe rain showers. A perennial spring is situated in the central-western part of the study area, representing the only feature of high floristic sensitivity. It is unlikely that this feature will be affected by the proposed development, but every precaution should be taken to prevent peripheral impacts from affecting the status of this feature.

Degraded and transformed habitat of the study area does not contain any floristic features of sensitivity, in fact, alien and invasive species predominate in these areas. The control of these species is strongly recommended.

### 7.2.1 Terms of Reference

The Terms of Reference for the **floristic assessment** are as follows:

- Obtain all relevant Précis and Red Data flora information;
- Conduct a photo analysis of the proposed area;
- Identify floristic variations;
- Survey habitat types to obtain a broad understanding of the floristic diversity;
- Assess the potential presence of Red List flora species according to information obtained from SANBI;
- Incorporate existing knowledge of the region into the assessment;
- Describe broad habitat variations present in the study area in terms of biophysical attributes and phytosociological characteristics;
- Compile a floristic sensitivity analysis;
- Incorporate results into the Biodiversity Impact Evaluation;
- Map all relevant aspects;
- Provide pertinent recommendations; and

– Present all results in a suitable format.

### 7.2.2 Impact Assessment & Identification

No impacts were identified that could lead to a beneficial impact on the floristic environment of the study area since the proposed development is largely destructive as it involves the alteration of natural habitat or further degradation of habitat that is currently in a climax status.

Impacts resulting from the proposed development on floristic attributes of the study area are largely restricted to the physical effects of habitat clearance prior to the commencement of construction activities. Direct impacts include any effect on populations of individual species of conservation importance and on overall species richness. This includes impacts on genetic variability, population dynamics, overall species existence or health and on habitats important for species of concern. In addition, impacts on sensitive or protected habitat are included in this category, but only on a local scale. These impacts are mostly measurable and easy to assess, as the effects thereof are immediately visible and can be determined to an acceptable level of certainty.

In contrast, indirect impacts are not immediately evident and can consequently not be measured at a moment in time. In addition, the extent of the effect is frequently at a scale that is larger than the actual site of impact. A measure of estimation is therefore necessary in order to evaluate the importance of these impacts. Lastly, impacts of a cumulative nature places direct and indirect impacts of this projects into a regional and national context, particularly in view of similar or resultant developments and activities.

#### *7.2.2.1 Direct Impacts on Flora Species of Conservation Importance*

This is a direct impact since it results in the physical damage or destruction of Red Data species/ communities, areas where these species are known to occur or areas that are considered particularly suitable for these species. Plant species of conservation importance, in most cases, do not contribute significantly to the biodiversity of an area in terms of sheer numbers, as there are generally few of them, but a high ecological value is placed on the presence of such species in an area as they represent an indication of pristine habitat conditions. Conversely, the presence of pristine habitat conditions can frequently be accepted as an indication of the potential presence of species of conservation importance, particularly in moist habitat conditions.

Red Data species are particularly sensitive to changes in their environment, having adapted to a narrow range of specific habitat requirements. Changes in habitat conditions resulting from human activities is one of the greatest reasons for these species having a threatened status. Surface transformation/

degradation activities within habitat types that are occupied by flora species of conservation importance will ultimately result in significant impacts on these species and their population dynamics. Effects of this type of impact are usually permanent and recovery or mitigation is generally not perceived as possible.

One of the greatest limitations in terms of mitigating or preventing this particular impact, is the paucity of species specific information that describe their presence, distribution patterns, population dynamics and habitat requirements. To allow for an accurate assessment, it is usually necessary to assess the presence/ distribution, habitats requirements, etc. associated with these species in detail and over prolonged periods; something that is generally not possible during EIA investigation such as this. However, by applying ecosystem conservation principles to this impact assessment and subsequent planning and development phases, potential impacts will be limited largely.

The likelihood of Red Data flora species occurring within the study area is moderate to low. Protected tree species (National Forest Act) are present within the study area, albeit at low densities.

#### *7.2.2.2 Loss or Degradation of Natural Vegetation/ Sensitive or Protected Habitat*

The loss or degradation of natural vegetation or habitat that are regarded sensitive as a result of restricted presence in the larger region (atypical habitat) represents a potential loss of habitat and biodiversity on a local and regional scale. Sensitive habitat types might include mountains, ridges, koppies, wetlands, rivers, streams, pans and localised habitat types of significant physiognomic variation and unique species composition. These areas represent centres of atypical habitat and contain biological attributes that are not frequently encountered in the greater surrounds. A high conservation value is generally ascribed to floristic communities and faunal assemblages that occupy these areas as they contribute significantly to the biodiversity of a region.

The endorheic pans present in the study area are included in this category, but the floristic status was found to be sub-optimal because of constant grazing pressure.

#### *7.2.2.3 Impacts on Surrounding Habitat/ Species & Ecosystem Functioning*

Surrounding areas and species present in the direct vicinity of the study area could potentially be affected by indirect impacts resulting from construction and operational activities. This indirect impact also includes adverse effects on any processes or factors that maintain ecosystem health and character, including the following:

– Disruption of nutrient-flow dynamics;

- Introduction of chemicals into the ground- and surface water through leaching;
- Impedance of movement of material or water;
- Habitat fragmentation;
- Changes to abiotic environmental conditions;
- Changes to disturbance regimes, e.g. increased or decreased incidence of fire;
- Changes to successional processes;
- Effects on pollinators; and
- Increased invasion by plants and animals not endemic to the area.

Changes to factors such as these may lead to a reduction in the resilience of ecological communities and ecosystems or loss or changes in ecosystem function. Furthermore, regional ecological processes, particularly aquatic processes that is dependent on the status and proper functioning of the drainage line, is regarded important.

It is well known that the status of a catchment is largely determined by the status of the upper reaches of the rivers. Small drainage lines, such as the one on this property, might be insignificant on a regional scale, but the combined status of numerous such small drainage lines will determine the quality of larger rivers further downstream.

#### *7.2.2.4 Impacts on SA's Conservation Obligations & Targets*

This impact is regarded a cumulative impact since it affects the status of conservation strategies and targets on a local as well as national level and is viewed in conjunction with other types of local and regional impacts that affects conservation areas or threatened areas. The importance of vegetation types is based on the conservation status ascribed to regional vegetation types (VEGMAP, 2006) and because impacts that result in irreversible transformation of natural habitat is regarded significant.

However, only a moderate disruption of ecosystem functioning is assumed in the 'Least Threatened' vegetation types that occupy the study area.The location of the study area within the Griqualand West Centre of Endemism was taken into consideration in the assessment of this impact.

#### *7.2.2.5 Increase in Local & Regional Fragmentation/ Isolation of Habitat*

Uninterrupted habitat is a precious commodity for biological attributes in modern times, particularly in areas that are characterised by moderate and high levels of transformation. The loss of natural habitat, even small areas, implies that biological attributes have permanently lost that ability of occupying that space, effectively meaning that a higher premium is placed on available food, water and habitat resources in the immediate surrounds. This, in some instances, might imply that the viable population of plants in a region will decrease proportionally with the loss of habitat, eventually decreasing beyond a viable population size.

The danger in this type of cumulative impact is that effects are not known or is not visible with immediate effect and normally when these effects become visible, they are usually beyond repair. Impacts on linear areas of natural habitat affect the migratory success of animals in particular.The general region is characterised by low levels of transformation and habitat fragmentation. However, it is known that other similar developments are planned in the region. The level of fragmentation and habitat isolation is therefore likely to increase to some extent within the next few years.

#### *7.2.2.6 Increase in Environmental Degradation, Pollution (soils, surface water)*

Cumulative impacts associated with this type of development could lead to initial, incremental or augmentation of existing types of environmental degradation, including impacts on the air, soil and water present within available habitat. Pollution of these elements might not always be immediately visible or readily quantifiable, but incremental or fractional increases might rise to levels where biological attributes could be affected adversely on a local or regional scale. In most cases, these effects are not bound and is dispersed, or diluted over an area that is much larger than the actual footprint of the causal factor. Similarly, developments in untransformed and pristine areas are usually not characterised by visibly significant environmental degradation and these impacts are usually most prevalent in areas where continuous and long-term impacts have been experienced.The nature of the development is such that pollution and degradation of the surrounding areas are expected to some extent.

### 7.2.3 **Floristic Sensitivity Rating**

Floristic sensitivity values are presented in Table 9. These estimations are used to ascribe a sensitivity index value to units of the respective variations. Habitat sensitivity is categorised as follows:

**Low** No natural habitat remaining; this category is usually represented by developed areas, nodal and linear infrastructure, areas of agriculture or cultivation, areas where exotic species dominate exclusively, mining land (particularly surface mining), etc. The possibility of these areas reverting to a natural state is regarded impossible, even with the application of detailed and expensive rehabilitation activities. Similarly, the likelihood of plant species of conservation importance occurring in these areas is regarded negligent.

**Medium – low** All areas where the natural habitat has been degraded, with the important distinction that the vegetation has not been decimated and a measure of the original vegetation remain, albeit dominated by secondary climax species. The likelihood of plant species of conservation importance occurring in these areas is regarded low. These areas also occur as highly fragmented and isolated patches, typical to cultivated fields, areas that have been subjected to clearing activities and areas subjected to severe grazing pressure. The species composition of these areas is typically low and is frequently dominated by a low number of species, or invasive plants.

**Medium** Indigenous natural habitat that comprehend habitat with a high diversity, but characterised by moderate to high levels of degradation, fragmentation and habitat isolation;

Also include areas where flora species of conservation importance could potentially occur, but habitat is regarded marginal;

**Medium – high** Indigenous natural vegetation that comprehend a combination of the following attributes:

- The presence of habitat that is suitable for the presence of these species;
- Areas that are characterised by a high/ moderate-high intrinsic floristic diversity;
- Areas characterised by moderate to low levels of habitat fragmentation and isolation;
- Regional vegetation types that are included in the lower conservation categories, particularly prime examples of these vegetation types;

– Low to moderate levels of habitat transformation;

– A moderate to high ability to respond to disturbance factors;

It may also include areas that are classified as protected habitat, but that are of a moderate status;

**High** Indigenous natural vegetation that comprehend for a combination of the following attributes:

– The presence of plant species of conservation importance, particularly threatened categories (Critically Endangered, Endangered, Vulnerable);

– Areas where 'threatened' plants are known to occur, or habitat that is highly suitable for the presence of these species;

– Regional vegetation types that are included in the 'threatened' categories (Critically Endangered, Endangered, Vulnerable), particularly prime examples of these vegetation types;

– Habitat types are protected by national or provincial legislation (Lake Areas Act, National Forest Act, draft Ecosystem List of NEM:BA, Mountain Catchment Areas Act, Ridges Development Guideline, Integrated Coastal Zone Management Act, etc.);

– Areas that have an intrinsic high floristic diversity (species richness, unique ecosystems), with particular reference to Centres of Endemism;

These areas are also characterised by low transformation and habitat isolation levels and contribute significantly on a local and regional scale in the ecological functionality of nearby and dependent ecosystems, with particular reference to catchment areas, pollination and migration corridors, genetic resources.  A major reason for the high conservation status of these areas is the low ability to respond to disturbances (low plasticity and elasticity characteristics).

**Table 9: Floristic Sensitivity Estimation**

| Floristic sensitivity estimations for the respective habitat types | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Criteria | RD species | Landscape sensitivity | Status | Species diversity | Functionality/ fragmentation | TOTAL | SENSITIVITY INDEX | SENSITIVITY CLASS |
| **Community** | **Criteria Ranking** | | | | | | | |
| Degraded Habitat | 1 | 1 | 1 | 3 | 2 | 45 | 14% | low |
| *Searsia* Open Woodland | 4 | 5 | 7 | 7 | 7 | 178 | 56 | medium |
| *Tarchonanthus* Closed Shrubveld | 4 | 5 | 7 | 8 | 8 | 186 | 58% | medium |
| Natural Spring | 7 | 10 | 7 | 8 | 10 | 262 | 82% | high |
| Endorheic Pans & Wetlands | 6 | 10 | 5 | 7 | 9 | 232 | 73% | medium-high |

**Table 10: Floristic Impact Evaluation – Construction Phase**

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| **Construction Phase: Clearance of Land** | | | | | | | | | | | | |
| Direct impacts on flora species of conservation importance | 6 | 5 | 3 | 4 | 56 | M | 6 | 5 | 2 | 4 | 52 | M |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 5 | 3 | 4 | 56 | M | 4 | 5 | 2 | 4 | 44 | M |
| Loss/ degradation of surrounding habitat | 6 | 4 | 3 | 3 | 39 | M | 6 | 4 | 2 | 2 | 24 | L |
| Impacts on SA's conservation obligations & targets | 4 | 5 | 3 | 3 | 36 | M | 4 | 5 | 3 | 3 | 36 | M |
| Increase in local and regional fragmentation/ isolation of habitat | 4 | 5 | 2 | 5 | 55 | M | 4 | 5 | 2 | 5 | 55 | M |
| Increase in environmental degradation, pollution (soils, surface water) | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| **Construction Phase: Construction of Required Solar Infrastructure** | | | | | | | | | | | | |
| Direct impacts on flora species of conservation importance | 6 | 5 | 3 | 2 | 28 | L | 8 | 5 | 2 | 2 | 30 | L |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 5 | 2 | 2 | 26 | L | 6 | 5 | 2 | 2 | 26 | L |
| Loss/ degradation of surrounding habitat | 6 | 4 | 2 | 3 | 36 | M | 4 | 4 | 2 | 2 | 20 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 6 | 4 | 2 | 3 | 36 | M | 4 | 4 | 2 | 2 | 20 | L |
| **Construction Phase: Construction of Access Roads** | | | | | | | | | | | | |
| Direct impacts on flora species of conservation importance | 6 | 5 | 3 | 2 | 28 | L | 4 | 5 | 2 | 2 | 22 | L |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 5 | 2 | 2 | 26 | L | 6 | 5 | 2 | 2 | 26 | L |
| Loss/ degradation of surrounding habitat | 6 | 4 | 2 | 3 | 36 | M | 4 | 4 | 2 | 2 | 20 | L |
| Impacts on SA's conservation obligations & targets | 4 | 5 | 3 | 2 | 24 | L | 4 | 5 | 3 | 2 | 24 | L |
| Increase in local and regional fragmentation/ isolation of habitat | 4 | 4 | 3 | 2 | 22 | L | 6 | 4 | 2 | 2 | 24 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 4 | 4 | 3 | 2 | 22 | L | 4 | 4 | 2 | 2 | 20 | L |
| **Construction Phase: Presence of Personnel within a Natural Environment** | | | | | | | | | | | | |

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| Direct impacts on flora species of conservation importance | 6 | 5 | 3 | 3 | 42 | M | 8 | 5 | 2 | 2 | 30 | L |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 5 | 2 | 3 | 39 | M | 8 | 5 | 2 | 2 | 30 | L |
| Loss/ degradation of surrounding habitat | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 4 | 4 | 2 | 3 | 30 | L | 4 | 4 | 2 | 2 | 20 | L |
| **Construction Phase: Placement of Power Lines, Cables, Water Pipelines, etc.** | | | | | | | | | | | | |
| Direct impacts on flora species of conservation importance | 6 | 5 | 3 | 2 | 28 | L | 6 | 5 | 2 | 2 | 26 | L |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 5 | 2 | 3 | 39 | M | 6 | 5 | 2 | 2 | 26 | L |
| Loss/ degradation of surrounding habitat | 6 | 5 | 2 | 3 | 39 | M | 6 | 5 | 2 | 2 | 26 | L |
| Impacts on SA's conservation obligations & targets | 4 | 5 | 3 | 2 | 24 | L | 4 | 5 | 2 | 2 | 22 | L |
| Increase in local and regional fragmentation/ isolation of habitat | 4 | 5 | 2 | 2 | 22 | L | 4 | 5 | 2 | 2 | 22 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 4 | 4 | 2 | 3 | 30 | L | 4 | 4 | 2 | 2 | 20 | L |
| **Construction Phase: Chemical Contamination** | | | | | | | | | | | | |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| Loss/ degradation of surrounding habitat | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| **Construction Phase: Storage of Materials** | | | | | | | | | | | | |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| Loss/ degradation of surrounding habitat | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 4 | 4 | 2 | 3 | 30 | L | 4 | 4 | 2 | 2 | 20 | L |
| **Construction Phase: Generation & Handling of Waste** | | | | | | | | | | | | |
| Direct impacts on flora species of conservation importance | 6 | 4 | 2 | 2 | 24 | L | 6 | 4 | 2 | 2 | 24 | L |

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 4 | 2 | 2 | 24 | L | 6 | 4 | 2 | 2 | 24 | L |
| Loss/ degradation of surrounding habitat | 4 | 4 | 2 | 2 | 20 | L | 4 | 4 | 2 | 2 | 20 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 4 | 4 | 2 | 2 | 20 | L | 4 | 4 | 2 | 2 | 20 | L |

**Table 11: Floristic Impact Evaluation – Operational Phase**

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| **Operational Phase: Presence of Personnel within a Natural Environment** | | | | | | | | | | | | |
| Direct impacts on flora species of conservation importance | 6 | 5 | 3 | 2 | 28 | L | 8 | 5 | 2 | 2 | 30 | L |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 5 | 2 | 2 | 26 | L | 8 | 5 | 2 | 2 | 30 | L |
| Loss/ degradation of surrounding habitat | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 4 | 4 | 2 | 3 | 30 | L | 4 | 4 | 2 | 2 | 20 | L |
| **Operational Phase: Chemical Contamination** | | | | | | | | | | | | |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| Loss/ degradation of surrounding habitat | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| **Operational Phase: Storage of Materials for Maintenance** | | | | | | | | | | | | |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| Loss/ degradation of surrounding habitat | 6 | 4 | 2 | 3 | 36 | M | 6 | 4 | 2 | 2 | 24 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 4 | 4 | 2 | 3 | 30 | L | 4 | 4 | 2 | 2 | 20 | L |
| **Operational Phase: Generation & Handling of Waste** | | | | | | | | | | | | |
| Direct impacts on flora species of conservation importance | 6 | 4 | 2 | 2 | 24 | L | 6 | 4 | 1 | 2 | 22 | L |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 6 | 4 | 2 | 2 | 24 | L | 6 | 4 | 1 | 2 | 22 | L |
| Loss/ degradation of surrounding habitat | 4 | 4 | 2 | 2 | 20 | L | 4 | 4 | 2 | 2 | 20 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 4 | 4 | 2 | 2 | 20 | L | 4 | 4 | 2 | 2 | 20 | L |

**Table 12: Floristic Impact Evaluation – Decommissioning Phase**

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| **Closure & Decommissioning: Removal of Infrastructure** | | | | | | | | | | | | |
| Direct impacts on flora species of conservation importance | 4 | 5 | 1 | 2 | 20 | L | 2 | 5 | 1 | 2 | 16 | L |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 4 | 4 | 1 | 2 | 18 | L | 2 | 4 | 1 | 2 | 14 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 4 | 4 | 1 | 2 | 18 | L | 2 | 4 | 1 | 2 | 14 | L |
| **Closure & Decommissioning: Rehabilitation Activities** | | | | | | | | | | | | |
| Direct impacts on flora species of conservation importance | 4 | 5 | 1 | 2 | 20 | L | 2 | 5 | 1 | 2 | 16 | L |
| Loss/ degradation of surrounding habitat | 4 | 5 | 2 | 3 | 33 | M | 2 | 4 | 2 | 2 | 16 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 4 | 5 | 2 | 3 | 33 | M | 2 | 4 | 2 | 2 | 16 | L |

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| **Closure & Decommissioning: Presence of Personnel within a Natural Environment** | | | | | | | | | | | | |
| Direct impacts on flora species of conservation importance | 4 | 5 | 2 | 2 | 22 | L | 2 | 5 | 2 | 2 | 18 | L |
| Loss or degradation of natural vegetation, sensitive or protected habitat | 4 | 4 | 2 | 2 | 20 | L | 2 | 4 | 2 | 2 | 16 | L |
| Loss/ degradation of surrounding habitat | 4 | 4 | 2 | 2 | 20 | L | 2 | 4 | 2 | 2 | 16 | L |
| Increase in environmental degradation, pollution (soils, surface water) | 4 | 4 | 2 | 2 | 20 | L | 2 | 4 | 2 | 2 | 16 | L |

### 7.2.4 Conclusion

The study area comprises extensive areas of shrubveld/ woodland that is representative of the regional vegetation type. The general woodland vegetation exhibit little signs of degradation, but also little sensitive floristic attributes. A medium floristic sensitivity is ascribed to the natural terrestrial habitat types that were identified in the study area. This medium floristic sensitivity took cognisance of the location of the study area within the Griqualand West Centre of Endemism as well as the 'Least Threatened' status ascribed to Ghaap Plateau Vaalbosveld. Except for a number of protected trees that occur scattered in the area, the chance of encountering flora species of a high conservation status is regarded relative low. This woodland habitat is well represented in the surrounding region.

Contained within the major terrestrial woodland community are small endorheic pans that represent an azonal habitat form. These areas are characterised by temporary and intermittent inundation subsequent to severe rain showers. The floristic characteristics of these areas are dominated by species that are adapted to temporary inundation. The status of these areas is however slightly degraded due to intensive grazing by cattle livestock. A ***medium-high floristic sensitivity*** is ultimately ascribed to these pans, which is mostly based on the wetland association of these features. Aerial imagery indicates that numerous other small pans are present in the surrounding areas.

A perennial spring is situated in the central-western part of the study area, representing the only feature of high floristic sensitivity. It is unlikely that this feature will be affected by the proposed development, but every precaution should be taken to prevent peripheral impacts from affecting the status of this feature. Degraded and transformed habitat of the study area does not contain any floristic features of sensitivity, in fact, alien and invasive species predominate in these areas. The control of these species is strongly recommended.

Results of the impact assessment reflect moderately significant impacts will likely to occur during the construction phase. These impacts are mostly associated with habitat clearance prior to the commencement of construction. Impacts associated with the operational and decommissioning phases are regarded localised and of relative low significance. The loss of this natural, terrestrial woodland is not expected to result in significant impacts on the floristic environment beyond the boundaries of the site. The implementation of generic mitigation measures is expected to ameliorate likely impacts to an acceptable level. It should however be noted that the removal of Protected tree species (Acacia erioloba and Olea europaea subsp. africana) is subject to the submission of relevant applications to NCDENC and DAFF as per the National Forests Act (Act no 84 of 1998).

Towards this purpose it will be necessary to conduct a survey to determine the density of protected tree species on the property. Wetland habitat types, because of a higher floristic sensitivity ascribed to them, as well as a lower representation in the surrounding region, should be excluded from the propose development as far as technically feasible. Other mitigation measures recommended to protect these features mostly include the prevention of contamination from surrounding developments.

No plant species that are included in any of the threatened categories (Critically Endangered - Possibly Extinct, Critically Endangered, Endangered, Vulnerable) were encountered during the survey period.

Results of the impact assessment indicate that ***moderately significant impacts*** are likely to occur during the construction phase. These impacts are mostly associated with habitat clearance prior to the commencement of construction. Impacts associated with the operational and decommissioning phases are regarded localised and of ***relative low significance***. The loss of this natural, terrestrial woodland is not expected to result in significant impacts on the floristic environment beyond the boundaries of the site. The implementation of generic mitigation measures is expected to ameliorate likely impacts to an acceptable level. Wetland habitat types, because of a higher floristic sensitivity ascribed to them, as well as a lower representation in the surrounding region, should be excluded from the propose development as far as technically feasible. Other mitigation measures recommended to protect these features mostly include the prevention of contamination from surrounding developments.

### 7.2.5 Mitigation Measures

#### *7.2.5.1 Site Specific Mitigation Measures*

**Mitigation Measure 1 -** Exclude as much as technically feasible of sensitive habitat from the proposed development;

**Mitigation Measure 2 -** Implement a suitable buffer zone (at least 30m) between the edge of these areas habitat and any type of development or surface disturbance;

**Mitigation Measure 3 -** Prevent all and any influx of water into wetland habitat;

**Mitigation Measure 4 -** Prevent contamination of natural habitat, wetland and endorheic pans from any source of pollution;

**Mitigation Measure 5 -** Locate, remove and relocate all plant species of conservation importance that are present within development areas. A site assessment is recommended whereby the study area is scrutinised for the presence of any of these protected trees. All individuals will be geo-referenced and applications for the removal/ relocation will be submitted to relevant authorities.

#### *7.2.5.2 General Aspects*

**Mitigation Measure 6 -** Appoint an Environmental Control Officer (ECO) prior to commencement of construction. Responsibilities should include, but not necessarily be limited to, ensuring adherence to EMP guidelines, guidance of activities, planning, reporting;

**Mitigation Measure 7 -** Compile and implement environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation. Biodiversity monitoring should be conducted at least twice per year (Summer, Winter) in order to assess the status of natural habitat and effects of the development on the natural environment;

#### *7.2.5.3 Environmental Control Officer*

**Mitigation Measure 8 -** Have overall responsibility for the implementation of the EMP;

**Mitigation Measure 9 -** Ensure that the developer and all contractors are aware of specifications, legal constraints and general standards and procedures pertaining to the project specifically with regards to the environment;

**Mitigation Measure 10 -** Ensure that all stipulations within the EMP are communicated and adhered to by the developer and contractors;

**Mitigation Measure 11 -** Monitor the implementation of the EMP throughout the project by means of site inspections and meetings. This will be documented as part of the site meeting minutes;

**Mitigation Measure 12 -** Be fully conversant with the EIA for the project, the conditions of the EA, all relevant environmental legislation and with the EMP;

**Mitigation Measure 13 -** Ensure that periodic environmental performance audits are undertaken on the project implementation;

**Mitigation Measure 14 -** Convey the contents of the EMP to the site staff and discuss the contents in detail with the Project Manager and Contractors;

**Mitigation Measure 15 -** Take appropriate action if the specifications contained in the EMP are not followed;

**Mitigation Measure 16 -** Monitor and verify that environmental impacts are kept to a minimum, as far as possible;

**Mitigation Measure 17 -** Compile progress reports on a regular basis, with input from the Site Manager, for submission to the Project Manager, including a final post-construction audit carried out by an independent auditor/consultant.

#### *7.2.5.4 Fences & Demarcation*

**Mitigation Measure 18 -** Demarcate construction areas by semi-permanent means/ material, in order to control movement of personnel, vehicles, providing boundaries for construction sites in order to limit spread of impacts;

**Mitigation Measure 19 -** No painting or marking of rocks or vegetation to identify locality or other information shall be allowed, as it will disfigure the natural setting. Marking shall be done by steel stakes with tags, if required;

#### *7.2.5.5 Fire*

**Mitigation Measure 20 -** The Project team will compile a Fire Management Plan (FMP) and Contractors directed by the ECO will submit a FMP. The Project FMP shall be approved by local Fire Protection Association, and shall include *inter alia* aspects such as relevant training, equipment on site, prevention, response, rehabilitation and compliance to the National Veld and Forest Fire Act, Act No. 101 1998;

**Mitigation Measure 21 -** Prevent all open fires;

**Mitigation Measure 22 -** Provide demarcated fire-safe zones, facilities and suitable fire control measures;

**Mitigation Measure 23 -** Use of branches of trees, shrubs or any vegetation for fire making purposes is strictly prohibited;

**Mitigation Measure 24 -** The irresponsible use of welding equipment, oxy-acetylene torches and other naked flames, which could result in veld fires, or constitute a hazard and should be guided by safe practice guidelines; and

**Mitigation Measure 25 -** The use of fire as a management tool should be guided and instructed by a qualified ecologist.

#### *7.2.5.6 Roads & Access*

**Mitigation Measure 26 -** Access is to be established by vehicles passing over the same track on natural ground. Multiple tracks are not permitted;

**Mitigation Measure 27 -** A road management plan should be compiled prior to the commencement of construction activities;

**Mitigation Measure 28 -** Dust control on all roads should be prioritised;

**Mitigation Measure 29 -** No roads should be allowed within ecologically sensitive areas.

#### *7.2.5.7 Workers & Personnel*

**Mitigation Measure 30 -** Provide temporary on-site ablution, sanitation, litter and waste management and hazardous materials management facilities;

**Mitigation Measure 31 -** Abluting anywhere other than in provided toilets shall not be permitted. Under no circumstances shall use of the veld be permitted;

#### *7.2.5.8 Vegetation Clearance & Operations*

**Mitigation Measure 32 -** All individuals/ stands of Protected Trees must be identified and clearly marked prior to the start of construction or maintenance procedures;

**Mitigation Measure 33 -** The landowner must immediately take steps to remove alien vegetation as per Conservation of Agricultural Resource Act, namely:

- Uprooting, felling or cutting;
- Treatment with a weed killer that is registered for use in connection with such plants in accordance with the directions for the use of such a weed killer;
- The application of control measures regarding the utilisation and protection of veld in terms of regulation 9 of the Act;
- The application of control measures regarding livestock reduction or removal of animals in terms of regulations 10 and 11of the Act;
- Any other method or strategy that may be applicable and that is specified by the executive officer by means of a directive.
- According to the Conservation of Agricultural Resource Act (No. 43 of 1983) as amended, the person applying herbicide must be adequately qualified and certified as well as registered with the appropriate authority to apply herbicides.

**Mitigation Measure 34 -** The size of areas subjected to land clearance will be kept to a minimum;

**Mitigation Measure 35 -** Only areas as instructed by the Site Manager must be cleared and grubbed;

**Mitigation Measure 36 -** Cleared vegetation and debris that has not been utilised will be collected and disposed of to a suitable waste disposal site. It will not be burned on site;

**Mitigation Measure 37 -** All vegetation not required to be removed will be protected against damage;

**Mitigation Measure 38 -** Removal of vegetation/ plants shall be avoided until such time as soil stripping is required and similarly exposed surfaces must be re-vegetated or stabilised as soon as is practically possible;

**Mitigation Measure 39 -** Monitoring the potential spread of declared weeds and invasive alien vegetation to neighbouring land and vice versa and protecting the agricultural resources and soil conservation works are regulated by the Conservation of Agricultural Resources Act (No 43 of 1983)and must be addressed on a continual basis, through an alien vegetation control and monitoring programme;

**Mitigation Measure 40 -** Remove and store topsoil separately in areas where excavation/ degradation takes place. Topsoil should be used for rehabilitation purposes in order to facilitate regrowth of species that occur naturally in the area;

**Mitigation Measure 41 -** Stored topsoil will be free of deleterious matter such as large roots, stones, refuse, stiff or heavy clay and noxious weeds, which would adversely affect its suitability for planting;

**Mitigation Measure 42 -** No spoil material will be dumped outside the defined site;

**Mitigation Measure 43 -** Disturbance of vegetation must be limited to areas of construction;

**Mitigation Measure 44 -** The removal or picking of any protected or unprotected plants shall not be permitted and no horticultural specimens (even within the demarcated working area) shall be removed, damaged or tampered with unless agreed to by the ECO;

**Mitigation Measure 45 -** Ensure proper surface restoration and resloping in order to prevent erosion, taking cognisance of local contours and landscaping;

**Mitigation Measure 46 -** Exposed areas with slopes less than 1:3 should be rehabilitated with a grass mix that blends in with the surrounding vegetation;

**Mitigation Measure 47 -** The grass mix should consist of indigenous grasses adapted to the local environmental conditions;

**Mitigation Measure 48 -** The re-vegetated areas should be temporarily fenced to prevent damage by grazing animals;

**Mitigation Measure 49 -** Re-vegetated areas showing inadequate surface coverage (less than 30% within eight months after re-vegetation) should be prepared and re-vegetated from scratch;

**Mitigation Measure 50 -** Damage to re-vegetated areas should be repaired promptly;

**Mitigation Measure 51 -** Exotic weeds and invaders that might establish on the re-vegetated areas should be controlled to allow the grasses to properly establish;

#### *7.2.5.9 Waste*

**Mitigation Measure 52 -** As far as possible, waste should be avoided, reduced, re-used and/or recycled. Where this is not feasible, all waste (general and hazardous) generated during the construction of the power station may only be disposed of at appropriately licensed waste disposal sites (in terms of Section 20 of the Environment Conservation Act, No 73 of 1989 and in accordance with the new waste act: National Environmental Waste Management Act 2008);

**Mitigation Measure 53 -** Prevent and advocate against the indiscriminate disposal of rubbish, litter or rubble;

**Mitigation Measure 54 -** The burning of general waste material under any circumstances is not to be allowed;

**Mitigation Measure 55 -** The use of small on-site incinerators for waste burning should be investigated, and if found feasible, be implemented;

**Mitigation Measure 56 -** Waste will be sorted at source (i.e. the separation of tins, glass, paper etc); recycled waste of this sort will be collected by an accredited waste removal contractor;

**Mitigation Measure 57 -** A stormwater management plan will be compiled that will address, inter alia, capturing and storage of stormwater;

**Mitigation Measure 58 -** All runoff water from fuel deposits, workshops, vehicles washing areas and other equipment must be collected and directed through oil traps to settlement ponds. These ponds must be suitably lined and should be cleaned as soon as practicable, and the sludge disposed off at a suitable waste site;

**Mitigation Measure 59 -** No wastewater or water containing any chemical or pollutant should be released from, or escape as effluent, from the site.

## 7.3 BIODIVERSITY: FAUNAL IMPACT ASSESSMENT

A total of 80 animal species was recorded during the site investigation. This diversity includes one (1) scorpion, one (1) dragonfly, one (1) termite, one (1) beetle, three (3) butterflies, one (1) bee, one frog, eight (8) reptiles, 45 birds and 18 mammals. The 80 species found to occur in the study area did not include any Red Data species. Additionally, invertebrates of 22 families were also confirmed to occur in the study area. The animals (species and families) observed in the study area are, for the most part, typical arid savanna species and representative of savanna animal communities that are widespread in the regional areas of the Ghaap Plateau Vaalbosveld and in the larger extent of the Eastern Kalahari Bushveld Bioregion.

A total of 96 Red Data animals are known to occur in the Northern Cape Province (butterflies, frogs, reptiles and mammals) and birds in the Q-grid 2823BD. This includes 18 listed as Data Deficient (DD), 31 as Near Threatened (NT), 36 as Vulnerable (VU), 5 as Endangered (EN) and 6 as Critically Endangered (CR). It is estimated that 74 of the 96 animals listed have a low probability of occurring in the study area, 12 have a moderate-low probability, six (6) a moderate probability, three (3) a moderate-high and one (1) species a high probability of occurring in the study area.

The following habitat types are indicated:

- Degraded Habitat, including;

  Excavations/ Spoils heaps (Low faunal Sensitivity);

  Road Infrastructure/ Railways/ Homestead (Low faunal Sensitivity);

- Natural Woodland Habitat, including

  (Searsialancea) Open Woodland (Medium faunal Sensitivity);

  (Tarchonanthuscamphoratus) Closed Shrubveld (Medium faunal Sensitivity);

- Wetland Habitat, including:

Natural Spring (High faunal Sensitivity); and

Endorheic Pans & Wetlands (Medium-high faunal Sensitivity).

Very little of the study area has been transformed and the habitat contained within the study area is largely representative of the regional habitat. Over-grazing has resulted in some degradation of the natural woodland and endorheic pans, but most of the original ecological characteristics and ecosystem processes of the Ghaap Plateau Vaalbosveld is still found in the study area.

The natural woodland and wetland habitats found in the study area is also well connected to other untransformed woodland areas; the region in which the study area is located is characterised by large areas of untransformed faunal habitat of varying levels of degradation (mostly as a result of overgrazing).The animals observed in the study area during the field investigation did not include any unique species as far as the region of the study area is concerned. Most of the species recorded in the study area are in fact also present in extensive parts of South Africa. A high proportion is also present in the arid regions of the country. Except for the livestock present in the study area, no introduced or alien animal species were observed during the field investigation.

During the field investigation, none of the calcareous pans had significant surface water; it is reasonable to assume that the species richness of these areas will increase significantly when the presence of surface water attracts a variety of water birds and invertebrates.The following impacts resulting from the proposed development are expected to affect the faunal attributes of the study area:

- Direct impacts on Red Data fauna species;
- Loss or Degradation of natural faunal habitat & in surrounding areas;
- The disruption of ecological connectivity and migration routes of larger, flightless animals as well as territorial infringement; and
- Direct impacts on common fauna species & interactions with structures & personnel.

### 7.3.1 Terms of Reference

The Terms of Reference for the **faunal assessment** are as follows:

- Obtain available faunal distribution records and Red Data faunal information
- Survey the site to obtain a broad overview of available faunal habitat types;
- Assess the potential presence of Red Data fauna species;

- Incorporate existing knowledge of the region;
- Describe the status of available habitat in terms of faunal attributes, preferences and conservation potential;
- Compile a faunal sensitivity analysis;
- Incorporate results into the Biodiversity Impact Evaluation;
- Map all relevant aspects; and
- Present all results in a suitable format.

### 7.3.2 Faunal Impact Assessment

The following impacts resulting from the proposed development are expected to affect the faunal attributes of the study area:

- Direct impacts on Red Data fauna species;
- Loss or Degradation of natural faunal habitat & in surrounding areas;
- The disruption of ecological connectivity and migration routes of larger, flightless animals as well as territorial infringement; and
- Direct impacts on common fauna species & interactions with structures & personnel.

#### *7.3.2.1 Direct impacts on Red Data Fauna Species*

Threatened animals contribute significantly to the ecological diversity of a region since their presence usually provides an indication of a relatively pristine environment. Although regarded as a direct and significant impact, developments such as this are unlikely to affect these animals directly since they are generally mobile and will ultimately be able to migrate away from impacts that result from the proposed development. Significantly, however, the loss of suitable habitat that is available to them represents a significant impact on the status of these animals.

Aspects of these animals that will also be affected include migration patterns and suitable habitat for breeding and foraging purposes. Since these requirements are frequently stricter than most generalist species, impacts on their habitat are likely to be more significant than for most other, common fauna species.No Red Data species were observed during the survey period and the Red Data assessment ofthis report indicates that it is unlikely that Red Data fauna species will occupy extensive parts of the study area.

#### *7.3.2.2 Loss or Degradation of Natural Faunal Habitat & in Surrounding Areas*

Natural habitat of the study area as well as surrounding areas will be affected adversely by direct impacts resulting from construction and operational activities. Particular reference is made to the loss of habitat resulting from surface clearing activities, the construction of infrastructure as well as less obvious impacts such as leaching of chemicals into the groundwater and surface water, generation of huge amounts of dust and spillages.

Also of importance is the loss of habitat that are not necessarily considered suitable for Red Data species, but where a high diversity of animals are likely to occupy the area. Extensive areas that exhibit low fragmentation and isolation factors are included in this category. This impact also includes adverse effects on any processes or factors that maintain ecosystem health and character, including the following:

- Disruption of nutrient-flow dynamics;
- Introduction of chemicals into the ground- and surface water through leaching;
- Impedance of movement of material or water;
- Habitat fragmentation;
- Changes to abiotic environmental conditions;
- Changes to disturbance regimes, e.g. increased or decreased incidence of fire;
- Changes to successional processes;
- Effects on pollinators; and
- Increased invasion by plants and animals not endemic to the area.

Changes to the natural habitat may lead to a reduction in the resilience of ecological communities and ecosystems and changes in ecosystem function. Furthermore, regional ecological processes, particularly aquatic processes that is dependent on the status and proper functioning of the wetland habitat types, is particularly important. A high conservation value is generally ascribed to floristic faunal assemblages that occupy these areas as they contribute significantly to the biodiversity of a region.

#### *7.3.2.3 Disruption of Ecological Connectivity & Migration Routes*

The region is characterised by low transformation and fragmentation levels. It is therefore reasonable to assume that animals that utilises the existing areas of natural habitat will migrate extensively across the region. Foraging, available water, food sources, breeding patterns and seasonal/ climate changes include some of the more obvious explanations for migration patterns of animals.

While most of the larger mammal species (ungulates) are restricted in their movement by fences, small and medium sized animals, that include predators, burrowing species, small mammals, invertebrate species, reptiles, amphibians, etc. utilises all available natural habitat as either corridors, 'stepping stones' or habitat. Loss of current migration routes or connectivity areas (stepping stones) within the study area will likely affect the migration pattern of some species. While larger animals are not likely to be affected significantly, smaller animals might not be able to cross or avoid certain types of development/ infrastructures. Particular reference is made to the disruption of migration patterns of flightless animals.

#### *7.3.2.4 Impacts on Common Fauna & Interactions with Structures & Personnel*

Activities that are known to transpire from human–animal conflicts are likely to affect animals that utilise surrounding areas. Unwanted activities might include poaching, snaring, killing by accidental contact, capturing, effects of domestic cats and dogs, roadkills, etc. While the tolerance levels of common animal species is generally of such a nature that surrounding areas will suffice in habitat requirements of species forced to move from the area of impact, some species would not able to relocate, such as ground living and small species.

It should be noted that animals generally avoid contact with human structures, but do grow accustomed to structures after a period. An aspect that is of concern is the presence of vehicles on access and infrastructure roads, leading to accidental death of animals, particularly amongst nocturnal animals.

The presence of personnel within the development area during construction and operational phases will inevitably result in some contact with animals. Therefore, encounters with dangerous animals (such as snakes) remain likely. In addition, the presence of domestic dogs and cats is generally associated with humans. These animals are frequently accountable for killing of natural fauna. It is also regarded moderately likely that the natural faunal component might be attracted to the artificial habitat that is created by the development. The establishment of human abodes generally result in the presence of foraging rodents, which is likely to attract smaller predators, raptors, owls, and snakes. The lack of understanding from personnel frequently results in the unnecessary killing of these animals.

### 7.3.3 **Faunal Habitat Sensitivity Assessment**

During the field assessment, the study area was investigated and assessed in terms of the following biodiversity attributes:

- Habitat status: level of habitat transformation and degradation vs. pristinefaunal habitat;

- Habitat diversity: the number of different faunal habitat types (both on micro- and macro-scale) found within the proposed site and bordering areas;
- Habitat linkage: the degree to which the faunal habitat of the proposed site is linked to other natural areas enabling movement of animals to and from the habitat found on site;
- Red Data species: the degree to which suitable habitat for the red data species likely to be found in the study area (larger study area) is located on each site; and
- Sensitive faunal habitat: the relative presence of faunal sensitive habitat type elements such as surface rock associated with outcrops and hills as well as wetland elements.

Faunal habitat sensitivities are grouped into sensitivity classes based on the calculated averages:

- Low - 0-20%
- Medium-low - 20-40%
- Medium - 40-60%
- Medium-high- 60-80%
- High - 80-100%

**Table 13: Faunal Habitat Sensitivity**

| Faunal Habitat Sensitivities for the study area | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Habitat Type** | **Status** | **Diversity** | **Linkage** | **Red Data** | **Sens** | **Ave** | **Sens Class** |
| Degraded Habitat | 1 | 1 | 2 | 2 | 1 | 14% | Low |
| Endorheic Pans & Wetlands | 7 | 7 | 8 | 5 | 8 | 70% | Medium-high |
| Natural Spring | 8 | 9 | 8 | 7 | 9 | 84% | High |
| Natural Woodland | 4 | 5 | 8 | 7 | 5 | 58% | Medium |

**Table 14: Faunal Impact Evaluation – Construction Phase**

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| **Construction Phase: Footprint Clearance** | | | | | | | | | | | | |
| Impacts on RD fauna species | 8 | 5 | 2 | 3 | 45 | M | 8 | 5 | 2 | 2 | 30 | L |
| Degradation of natural faunal habitat | 4 | 5 | 2 | 5 | 55 | M | 4 | 5 | 2 | 4 | 44 | M |
| Disruption of ecological connectivity | 4 | 4 | 2 | 5 | 50 | M | 4 | 4 | 2 | 5 | 40 | M |
| Direct impacts & interactions with structures & personnel | 4 | 4 | 2 | 5 | 50 | M | 4 | 4 | 2 | 3 | 30 | L |
| **Construction Phase: Establishment of Infrastructure** | | | | | | | | | | | | |
| Impacts on RD fauna species | 8 | 4 | 2 | 4 | 56 | M | 8 | 4 | 2 | 4 | 56 | M |
| Loss/ Degradation of faunal habitat & in surrounding areas | 4 | 5 | 2 | 3 | 33 | M | 4 | 5 | 2 | 3 | 33 | M |

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| Disruption of ecological connectivity & migration routes | 4 | 4 | 2 | 3 | 30 | L | 4 | 4 | 2 | 3 | 30 | L |
| Direct impacts & interactions with structures & personnel | 4 | 4 | 2 | 5 | 50 | M | 4 | 4 | 2 | 5 | 50 | M |
| **Construction Phase: Establishment of Linear Infrastructure (Roads, Pipelines, Powerlines, etc.)** | | | | | | | | | | | | |
| Impacts on RD fauna species | 8 | 4 | 2 | 3 | 42 | M | 8 | 4 | 2 | 3 | 42 | M |
| Loss/ Degradation of faunal habitat & in surrounding areas | 4 | 5 | 2 | 2 | 22 | L | 4 | 5 | 2 | 2 | 22 | L |
| Disruption of ecological connectivity & migration routes | 4 | 4 | 3 | 3 | 33 | M | 4 | 4 | 3 | 3 | 33 | M |
| Direct impacts & interactions with structures & personnel | 4 | 4 | 3 | 5 | 55 | M | 4 | 4 | 3 | 5 | 55 | M |
| **Construction Phase: Generation and Handling of Waste** | | | | | | | | | | | | |
| Loss/ Degradation of faunal habitat & in surrounding areas | 4 | 4 | 2 | 4 | 40 | M | 4 | 4 | 2 | 4 | 40 | M |

**Table 15: Faunal Impact Evaluation - Operations Phase**

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| **Operational Phase: Maintenance and Generation Activities** | | | | | | | | | | | | |
| Impacts on RD fauna species | 8 | 5 | 4 | 2 | 34 | M | 8 | 5 | 2 | 2 | 30 | L |
| Loss/ Degradation of faunal habitat & in surrounding areas | 4 | 4 | 2 | 3 | 30 | L | 4 | 4 | 2 | 2 | 20 | L |
| Disruption of ecological connectivity & migration routes | 4 | 4 | 2 | 4 | 40 | M | 4 | 4 | 2 | 2 | 20 | L |

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| **Operational Phase: Maintenance and Generation Activities** | | | | | | | | | | | | |
| Direct impacts & interactions with structures & personnel | 4 | 4 | 2 | 4 | 40 | M | 4 | 4 | 2 | 2 | 20 | L |
| **Operational Phase: Transportation** | | | | | | | | | | | | |
| Loss/ Degradation of faunal habitat & in surrounding areas | 4 | 4 | 2 | 3 | 30 | L | 4 | 4 | 2 | 3 | 30 | L |
| Disruption of ecological connectivity & migration routes | 4 | 4 | 2 | 3 | 30 | L | 4 | 4 | 2 | 3 | 30 | L |
| Direct impacts & interactions with structures & personnel | 4 | 4 | 4 | 4 | 48 | M | 4 | 4 | 2 | 4 | 40 | M |
| **Operational Phase: Generation and handling of waste** | | | | | | | | | | | | |
| Loss/ Degradation of faunal habitat & in surrounding areas | 2 | 4 | 2 | 3 | 24 | L | 2 | 4 | 2 | 2 | 16 | L |
| Disruption of ecological connectivity & migration routes | 2 | 4 | 2 | 2 | 16 | L | 2 | 4 | 2 | 2 | 16 | L |

**Table 16: Faunal Impact Evaluation – Closure and Decommissioning Phase**

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| **Closure & Decommissioning: Removal of Infrastructure** | | | | | | | | | | | | |
| Loss/ Degradation of faunal habitat & in surrounding areas | 4 | 4 | 2 | 3 | 30 | L | 2 | 4 | 2 | 2 | 16 | L |
| Disruption of ecological connectivity & migration routes | 4 | 4 | 3 | 3 | 33 | M | 2 | 4 | 2 | 2 | 16 | L |
| Direct impacts & interactions with structures & personnel | 4 | 4 | 2 | 3 | 30 | L | 2 | 4 | 2 | 2 | 16 | L |

| POTENTIAL ENVIRONMENTAL IMPACT | Environmental Significance Before Mitigation | | | | | | Environmental Significance After Mitigation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | S | P | TOTAL | SP | M | D | S | P | TOTAL | SP |
| **Closure & Decommissioning: Rehabilitation** | | | | | | | | | | | | |
| Loss/ Degradation of faunal habitat & in surrounding areas | 2 | 4 | 2 | 2 | 16 | L | 2 | 4 | 2 | 2 | 16 | L |
| Disruption of ecological connectivity & migration routes | 2 | 4 | 2 | 2 | 16 | L | 2 | 4 | 2 | 2 | 16 | L |
| Direct impacts & interactions with structures & personnel | 4 | 4 | 2 | 3 | 30 | L | 2 | 4 | 2 | 2 | 16 | L |
| **Closure & Decommissioning: Residual Impacts Post Closure** | | | | | | | | | | | | |
| Loss/ Degradation of faunal habitat & in surrounding areas | 4 | 5 | 2 | 2 | 22 | L | 2 | 5 | 2 | 2 | 18 | L |
| Direct impacts & interactions with structures & personnel | 4 | 5 | 2 | 3 | 33 | M | 2 | 5 | 2 | 2 | 18 | L |

### 7.3.4 **Conclusion**

Very little of the study has been transformed and the habitat contained within the study area is largely representative of the regional habitat. Over-grazing has resulted in some degradation of the natural woodland and endorheic pans, but most of the original ecological characteristics and ecosystem processes of the Ghaap Plateau Vaalbosveld is still found in the study area. The natural woodland and wetland habitats found in the study area is also well connected to other untransformed woodland areas; the region in which the study area is located is characterised by large areas of untransformed faunal habitat of varying levels of degradation (mostly as a result of overgrazing).

The animals observed in the study area during the field investigation did not include any unique species as far as the region of the study area is concerned. Most of the species recorded in the study area are in fact also present in extensive parts of South Africa. A high proportion is also present in the arid regions of the country. Except for the livestock present in the study area, no introduced or alien animal species were observed during the field investigation.

During the field investigation, none of the calcareous pans had significant surface water; it is reasonable to assume that the species richness of these areas will increase significantly when the presence of surface water attracts a variety of water birds and invertebrates.

### 7.3.5 **Mitigation Measures**

Ensure that the loss of faunal habitat is restricted to the development site itself. Infrastructure and related activities must be confined to the development site and not allowed to spread to nearby sensitive areas. Fences must be erected prior to construction and all personnel and contractors should be instructed as to the physical boundaries pertaining to their respective disciplines and measures set in place to ensure that they keep to these boundaries. In addition, erosion control measures must be put in place from the commencement of construction to ensure that artificial erosion associated with the activities of the project (construction, operation and decommissioning) does not degrade the natural ecological state of the faunal habitats bordering the study area and the various areas of activity.

Frequent policing of fences and areas bordering the mining area must be implemented with severe penalties to offenders that kill animals. Sensitizing personnel to the presence and handling of animals must form part of the induction. The construction of fences around all areas related to the project where personnel have daily access (construction, operation and decommission) is of the utmost importance. Regular inspection of these fences to ensure the fences' integrity and patrol of the borders and surrounding areas next to the site for the presence of snares etc. will limit the impact of poaching and snaring. Communication with farmers whose properties border the operational areas to create awareness of potential poaching problems in the area is important.

All impacts must be limited to the site only; no land use changes or otherwise disturbances of animals outside of the study area should be allowed; vehicles should yield to larger animals on access roads. Wherever linear structures (roads and pipelines) bisect natural areas of untransformed faunal habitat measures should be put in place to ensure continued movement of all faunal groups needing to cross these manmade barriers.

#### *7.3.5.1 Site Specific Mitigation Measures*

**Mitigation Measure 1 -** Exclude as much of the highly sensitive habitat from the development as possible. Cognisance of the wetland ecologist/ specialist is regarded imperative in this regard. This should be done during the planning phase;

**Mitigation Measure 2 -** Implement a suitable buffer zone (at least 30m) between the edge of sensitive habitat and any type of development or surface disturbance;

**Mitigation Measure 3 -** Implement a suitable buffer zone around wetland habitat, taking cognisance of recommendations from the wetland report;

**Mitigation Measure 4 -** Prevent contamination of surrounding areas of natural habitat, from stockpiling, conveyor lines, water treatment facilities or any other source of pollution;

#### *7.3.5.2 Roads & Access*

**Mitigation Measure 5 -** Access is to be established by vehicles passing over the same track on natural ground. Multiple tracks are not permitted;

**Mitigation Measure 6 -** A road management plan should be compiled prior to the commencement of construction activities;

**Mitigation Measure 7 -** No roads should be allowed within ecologically sensitive areas. The use of roads around ecologically sensitive areas for the purpose of buffers should be done with circumspect particularly in view of accidental killing of animals;

#### *7.3.5.3 Animals*

**Mitigation Measure 8 -** No animal may be hunted, trapped, snared or captured for any purpose whatsoever. Fences and boundaries should be patrolled weekly in order to locate and remove snares/ traps;

**Mitigation Measure 9 -** Vehicular traffic should not be allowed after dark in order to limit accidental killing of nocturnal animals;

**Mitigation Measure 10 -** Speed of vehicles should be limited to allow for sufficient safety margins;

**Mitigation Measure 11 -** Dangerous animals should be handled by a competent person;

**Mitigation Measure 12 -** Compile a graphic list of potentially dangerous animals and present this to all workers as part of site induction;

**Mitigation Measure 13 -** Sensitize all personnel to the presence, characteristics and behaviour of animals on the site;

**Mitigation Measure 14 -** Include suitable procedures in the event of encountering potentially dangerous animals on the site;

**Mitigation Measure 15 -** Ensure that a snake handler and/ or anti venom serum is available at all times, together with a competent person to administer this serum;

**Mitigation Measure 16 -** No domestic pets should be allowed on the site.

## 7.4 HYDROLOGICAL IMPACT ASSESSMENT

The project area is situated within a small confined catchment, draining in a south easterly direction to the Vaal River. The contributing catchment area for the project covers an area of approximately 93.44 $km^2$ and has an estimated mean annual runoff volume in the order of 663 ML/year. There are no major water storage, diversion or supply infrastructure within the project area, other than small water containers and temporary ponds.

No surface water licenses are present within the catchment area, and what little surface water that is used, is used for livestock. The majority of the catchment area is used purely for grazing along with small pockets of land supporting mixed uses.

### 7.4.1 Terms of Reference

The approach used to assess impacts is similar to the approach adopted for mining projects throughout South Africa. The approach was to undertake a predominantly desktop assessment of the surface hydrology in the study area, where selected climatic data for the region was obtained, and baseline catchment data for the proposed project area was reviewed. A limited field survey confirmed the desktop findings.

Limited information was available on surface hydrology near the proposed project area. The most important sources of available data used in this report were the following:

- Google TM earth satellite images;
- Climatic data regarding temperature, rainfall, evaporation, humidity etc;
- Water resource software and legislation; and
- Arriesfontein Scoping Report on the surface hydrology (Knight Piésold, 2011).

A field survey was undertaken in February 2012. The field survey was used to observe and collect baseline data on surface hydrology. The visit took place towards the end of the wet season which allowed for an investigation of the surface hydrological system. Selected photographs of the study area are shown in **Appendix J**.

The likely surface hydrology impacts of the proposed development were evaluated using the following criteria:

- P = Probability: 0=none; 1=improbable; 2=low probability; 3=medium probability; 4=highly probable; 5=definite or don't know.
- D = Duration: 1=immediate and/or unique impact; 2=short-term (0 to 5 years) and/or infrequent impact; 3=medium-term (5 to 15 years) and/or frequent impact; 4=long-term (impact ceases after operational life) and/or very frequent impact; 5=permanent and/or continuous impact.

– S = Scale: 1=site only; 2=local; 3=Regional; 4=National; 5=International.

– M = Magnitude: 0=none; 2=minor; 4=low; 6=moderate; 8=high; 10=very high or don't know.

– S = Significance: The overall significance of each impact was determined by combining the consequence of the impact and the probability of occurrence i.e.: Significance = Consequence (duration + scale + magnitude) x probability.

The scores were interpreted as follows:

| Total Score | Significance |
|---|---|
| 60 ≤ | Score High Environmental Significance |
| 30 ≤ Score < 60 | Moderate Environmental Significance |
| Score < 30 | Low Environmental Significance |

### 7.4.2 Impact Assessment and Identification

The assessment of impacts is considered reliable.There are no sensitive habitats within the proposed development area.Grazing and trampling by livestock (mostly cows) have significant impacts on the stability of the landscape, and associated erosion and increased turbidity. Furthermore, defecation by livestock is likely to impact on surface water quality, particularly during low-flow periods. This threat is considered to be of minimal significance. It is deemed to be minimal due to low runoff from the site.

This section details the expected environmental impacts of the proposed development on surface water hydrology. Impacts are arranged in order of decreasing overall significance.

**Table 17: Project Elements and Potential Impacts**

| Action | Possible Impacts |
|---|---|
| Site stormwater control | Hardening of catchments with impermeable surfaces (in the plant area and associated infrastructure) will increase base and peak runoff. Erosion risks associated with stormwater disposal. |

| Action | Possible Impacts |
|---|---|
| Potential transport of contaminants via stormwater | Drainage of the plant area could result in contaminants entering the downstream environment |
| Un-natural drainage of surface water | This may result in drainage of surface water features (e.g. ponds). |
| Development on watercourses | It is apparent that the solar footprint does encroach on some drainage lines introducing many impacts relating to flood risk, water quality and the need for responsible stormwater management. |
| Fresh water supply | The natural unavailability of fresh water may result in significant measures introduced by the project to obtain fresh water from distant sources. These measures are likely to introduce a new range of impacts (e.g. construction of pipelines from distant sources) |
| Stormwater management | Accurate hydrological assessment will be required to ensure that plant stormwater runoff is effectively controlled under extreme rainfall conditions. |
| Stormwater management infrastructure | Stormwater management may result in the re-alignment of natural streams. This may lead to reduced sediment volumes being transported downstream, thus affecting the downstream landscape. |

#### *7.4.2.1 Construction Phase: Removal of Vegetation*

Significant vegetation cover will be removed during the construction phase of the project. This will result increase runoff from the project area, which may in turn result in increased erosion. The overall significance of this impact, in the absence of mitigation, is rated as High for the Construction Phase.

#### *7.4.2.2 Construction Phase: Risks of Erosion and Pollution*

Construction of the solar power project is certain to cause a localised, short-term deterioration in surface water quality. Construction activities are likely to increase the likelihood of accidental spills of hydrocarbons (oils, diesel etc), and other potentially hazardous chemicals. Furthermore, equipment maintenance and washing could affect surface water quality. Such spills and uncontrolled discharge of polluted water could have localised, short-duration impacts on downstream environment. The overall significance of this impact, in the absence of mitigation, is rated as **Low** for the Construction Phase.

#### *7.4.2.3 Construction Phase: Clean/Dirty Water Separation*

Operation of the solar power project may lead to dirty plant runoff mixing with clean natural runoff. This is will lead to contamination of clean surface and ground water.The overall significance of this impact, in the absence of mitigation, is rated as **Moderate** for the Operational Phase.

#### *7.4.2.4 Operational Phase: Hardening of the Project Area*

Operation of the solar power project may cause an increase in the runoff volumes from the project areas. This is may lead to increased levels of erosion in the areas surrounding the project area.The overall significance of this impact, in the absence of mitigation, is rated as Moderate for the **Operational Phase**.

#### *7.4.2.5 Operational Phase: Risks of Pollution*

The operational phase of the solar power project may result in reduced water quality runoff from the project area. This runoff could extend, as far downstream as the Orange River. Other concerns include accidental spills. There is a likelihood of accidental spills of hydrocarbons (oils, diesel etc), and other potentially toxic chemicals through surface runoff during operation. Furthermore, increased traffic is certain to increase the likelihood of accidental spills. These spills, if not mitigated, could have severe, localised, but short-duration impacts on local flora and fauna, particularly downstream of the project area. The control of process water, including cooling water is very important and if uncontrolled, may lead to polluting of the surface water resources.The overall significance of this impact, in the absence of mitigation, is rated as **Moderate** for the Operational Phase.

#### *7.4.2.6 Operational Phase: Altered Sediment Transport*

The drainage lines running through the project area are seldom active, but may be considered geomorphologically important because they carry large loads of sediment during spate events. This process of mobilising and redistributing sediments shapes the landscape. The proposed project is likely to impede this process by rerouting the flow of stormwater and the sediments, which may result in impacts on the downstream landscapes.The overall significance of this impact is rated as **Low**.

#### *7.4.2.7 Operational Phase: Clean/Dirty Water Separation*

Operation of the solar power project may lead to dirty plant runoff mixing with clean natural runoff. This is will lead to contamination of clean surface and ground water.The overall significance of this impact, in the absence of mitigation, is rated as **Low** for the Operational Phase.

#### *7.4.2.8 Closure and Decommissioning Phase: Risks of Erosion and Pollution*

Construction of the solar power project is certain to cause a localised, short-term deterioration in surface water quality, as discussed in the construction phase (see above).The overall significance of this impact, in the absence of mitigation, is rated as **Moderate** for the Closure Phase.

**Table 18: Potential Hydrology Impacts**

| Potential Environmental Impacts | Criteria | | | | | Score | Significance before Mitigation | | | Significance after Mitigation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | P | D | S | M | TOTAL | LOW | MOD | HIGH | LOW | MOD | HIGH |
| Construction Phase | | | | | | | | | | | | |
| Removal of Vegetation | -ve | 5 | 2 | 1 | 10 | 65 | | | | | | |
| Risk of Erosion and Pollution | -ve | 4 | 2 | 2 | 8 | 48 | | | | | | |
| Clean/Dirty Water Contamination | -ve | 2 | 2 | 2 | 8 | 24 | | | | | | |
| Operational Phase | | | | | | | | | | | | |
| Hardening of the project site | -ve | 4 | 5 | 1 | 6 | 48 | | | | | | |
| Risk of pollution | -ve | 3 | 4 | 1 | 6 | 33 | | | | | | |
| Altered Sediment transport | -ve | 4 | 4 | 1 | 2 | 28 | | | | | | |
| Clean/Dirty Water Contamination | -ve | 3 | 4 | 2 | 6 | 36 | | | | | | |
| Closure | | | | | | | | | | | | |
| Risk of Pollution | -ve | 3 | 4 | 2 | 8 | 42 | | | | | | |
| Risk of Erosion | -ve | 3 | 5 | 1 | 8 | 42 | | | | | | |

*N = Nature, P = Probability, D = Duration, S = Scale, M = Magnitude*

### 7.4.3 Conclusion

The project is situated in a hydrologically unsensitive area in terms of surface water hydrology but in terms of groundwater it is imporatant as there are dolomitic aquifrers in the area. These aquifers are already extensively exploited by mining, agriculture and domestic users. The drainage lines are seldom active, but are geomorphologically important due to the large loads of sediment they carry during spate events. The proposed Solar Power Park is likely to impede this process by re-routing the flow of stormwater and the sediments that these drainage lines carry, with consequent implications for the abundance and species composition of plants and in extreme cases, may lead to erosion problems or damage to infrastructure.

The site does not have the potential to yield fresh water supply by means of run-off collection thus prompting that an external service provider be obtained for development purposes. None of the ephemeral drainage lines present in the study area were considered as they do not support aquatic flora or fauna – however cognisance needs to be taken of these during stormwater management. The site did not present any sensitive habitats nor were any fatal project flaws identified in terms of hydrology.

### 7.4.4 Recommended Mitigation Measures

The fact that the site is positioned well away from significant watercourses largely limits the hydrological impacts to issues pertaining to site stormwater control. Responsible civil engineering design of stormwater management will mitigate any impacts.

The following mitigation measures are aimed at preventing sedimentation and pollution of watercourses:

- Activities on the banks of the streams should be avoided as far as possible;
- Watercourse crossings and stormwater management infrastructure should be implemented along access roads. The infrastructure should not alter the flow of water in the watercourses;
- Adequate measures must be implemented to reduce the contamination of clean runoff with dirty plant runoff;
- It is expected that the watercourses will encroach into the project area. Mitigation measures, such as diversion canals and berms, will have to be implemented to avoid soil erosion;
- Soil erosion control measures, such as protection berms, should be employed where necessary;

- Containment and stormwater management measures should be implemented by the contractor to prevent the loss of topsoil;
- Land clearing should be kept to a minimum and limited to development areas; and
- No development may be located within 100 m of a watercourse or within the 1:50 year floodlines. This may not be appropriate to this project area.
- Any surface water storage will be subjected to significant rates of evaporation. Stored surface water should be used as it becomes available or should be stored in a covered reservoir.

Appropriate pollution control measures should be incorporated into the design and costing of the proposed development. These include:

- Oil traps to minimise hydrocarbon pollution of surface and groundwater;
- Bunding of all facilities that store hazardous materials, and;
- Adequate washing and ablution facilities.
- Site Specific Stormwater Management - The plant design will have to be sensitive to peak rainfall.

#### *7.4.4.1 Construction Phase*

**Zoning:** Work areas and sensitive areas should be zoned and demarcated accordingly. By adequately zoning the project area, land clearing can be reduced to the minimum necessary for project development.

**Control Pollution:** Standard procedures to control and minimise surface and groundwater pollution should be implemented. These include:

- Maintain oil traps;
- Maintain bunding of all facilities that store hazardous materials;
- Maintain washing and ablution facilities;
- Provide and maintain solid waste collection facilities;
- Provide spill kits and monitor spills; and

– Monitor vehicle oil leaks.

#### *7.4.4.2 Operational Phase*

**Control Pollution:** Standard procedures to control and minimise surface and groundwater pollution should be implemented, as recommended for the construction phase (see above). The strategy to minimise contamination and pollution is to separate the clean and dirty runoff. The runoff entering the project area is considered clean together with possible sections within the project area while plant areas are considered dirty.

**Water Conservation Programme:** A water conservation programme should be developed and implemented. The programme should monitor water use and runoff. The project experiences very low rainfall. As such measures should be taken to store rainfall and surface runoff from within the project area. This water can then be treated and reused in the plant. It is unlikely that rain harvesting will meet the demands of the project but it will assist in reducing the overall demand.

#### *7.4.4.3 Closure Phase*

Softening of the project area and the removal of all permanent infrastructure will mitigate increased runoff from the project area. The removal of infrastructure may lead to increased erosion. Measures should be implemented to re-vegetate the project area to its original condition to limit further erosion.

## 7.5 GEOHYDROLOGICAL IMPACT ASSESSMENT

In October 2011 SRK Consulting was appointed by WorleyParsons RSA (Pty) Ltd on behalf of SolarReserve SA (Pty) LTD, to conduct a detailed groundwater resource assessment and provide specialist input to the Waste Management Licence Application, Environmental Impact Assessment and the Water Use Licence required for a proposed Concentrated Solar Power Plant (CSPP) on the farm Arriesfontein (the site) near Lime Acres in the Northern Cape Province. The Geohydrological report is attached as **Appendix H**.

SolarReserve SA (Pty) LTD, a renewable energy developer is proposing the development of a CSP with an electricity generation of 100 MW on the Farm 267, Arriesfontein, Barkley Wes RD, within the Kgatelopele Local Municipality and the Siyanda District Municipality in the Northern Cape. The proposed site is situated approximately 32 km south-east of Danielskuil (Figure 1). The proposed CSPP will be constructed on an area that covers between 600 and 800 ha of the site, including all ancillary facilities.

Towns (Daniëlskuil and Lime Acres) and mines (Idwala Lime, PPC Lime and Finch) in the area are largely dependent on groundwater with a lesser portion of the demand being supplied by the Vaal-Gamagara pipeline. Farms are totally dependent on groundwater for domestic use, stock watering and some small-scale irrigation.

### 7.5.1 Terms of Reference

The following scope of work and deliverables provided by WorleyParsons apply:

1. To provide a detailed description of the site topography, geological and geo-hydrological characteristics of the study area;
2. Depiction and characterization of the groundwater regime in a regional geological and geohydrological context indicating the overall characteristics of the geological settings and aquifer parameters, and identification of immediate groundwater users;
3. Data obtained from the hydrocensus survey as well as the data obtained from the National Groundwater Archive (NGA) to be incorporated into the GIS database for interpretation;
4. A desktop study to be undertaken for the analysis of data obtained from the National Groundwater Archive (NGA);
5. Site visit for purposes of the hydrocensus and consultation with relevant landowners to obtain additional (to the NGA) borehole data, if available;
6. Determination of pre-project groundwater quality by means of baseline groundwater quality monitoring and sampling;
7. Assess the potential impacts (direct, indirect and cumulative) of the proposed development and the significance thereof on groundwater resources and downstream water users in the general area.
8. Description of groundwater management measures related to all project phases;
9. Compile a groundwater monitoring protocol and a report containing groundwater data and analysis;
10. A groundwater model illustrating the above mentioned analysis will be required;
11. Recommendations on any further studies / additional scope of work that may be required during or after the EIA process.

### 7.5.2 Water Use

#### *7.5.2.1 Operational*

During normal operational conditions the preferred CSPP will require approximately 272 400 m3 per year with peak consumption of approximately 44.5 m3/hr. The preferred plant operates on dry cooling as well as hybrid cooling depending on power plant operational point and cooling requirements. This provides an optimal solution between achieving required plant efficiencies and using as little water as possible. The plant is also optimized to re-use water where possible and the total system discharge from the plant is fed to an evaporation pond, a yearly total of approximately 59 600 m3.

#### *7.5.2.2 Construction*

During the construction phase water is needed to ensure and maintain soils/surfaces are kept hydrated (wet) during earthmoving operations to minimise dust generation. For a 100 MW CSPP it is estimated that approximately 117 500 m3 of water will be required for the entire construction phase, which is estimated to extend over a period of 30 months, i.e. an average of 3 917 m3/month or ~130 m3/day.

### 7.5.3 Waste Water

The CSPP will generate several forms of liquid effluent as part of operations. The primary effluents sources generated include:

- Wastewater from the evaporation plant;
- Contaminated surface water i.e. stormwater and rainwater; and
- Sewage effluent.

For a 100 MW plant it is estimated that the total volume of discharge, inclusive of sewage water and evaporation system discharge will be between 116 320 and 145 400m3 per annum.

The treatment options are based on the types of effluent to be treated. The following treatment options have been defined for each source of effluent:

- Contaminated water treatment system will be installed to separate both clean and dirty surface water where after the different types of grease/hydrocarbon products will be treated and clean surface runoff diverted away from site.
- A biological treatment system will be implemented to treat the sewage effluent from the offices.

### 7.5.4 **Geo-hydrology**

#### *7.5.4.1 Aquifer Type*

Groundwater in this area occurs mainly in semi-confined fractured-rock aquifers, also known as secondary aquifers. These aquifers are formed by jointing and fracturing of the otherwise solid bedrock by compressional and tensional forces that operate in the Earth's crust from time to time. The fractures are formed by faulting, folding, intrusion of dolerite dykes and other geological forces. Slightly acidic rainwater infiltrates along these joints and fractures and slowly dissolves the alkaline rocks to eventually form solution cavities. Solution cavities commonly also form on contact zone of dolomite with other rock types like chert and black shale.

Unconfined intergranular aquifers (also known as primary aquifers) occur in and near drainage channels and in some pans where the groundwater levels are shallow and within the unconfined unconsolidated sediments and weathered zone. These areas have been leached by water and are characterized by loose, unconsolidated material extending to well below 10 m bgl. The unconsolidated deposits and weathered zone on the site are, however, limited in both horizontal and vertical extend and consist mainly of clay and silt. These result in a poorly developed, low yielding primary aquifer that is vulnerable to droughts. Therefore, the primary aquifer in this area can be regarded as insignificant.

#### *7.5.4.2 NGA Data*

The geohydrological information retrieved from the NGA is summarized in Appendix A of the Geo-hydro report. The data indicate that borehole yields are highly variable and four of the 115 boreholes identified have yields >12 ℓ/s. The average borehole yield of the successful boreholes is 2.02 ℓ/s compared to the median yield of 0.43 ℓ/s, which emphasize the fact that the average borehole yield is skewed by a few extraordinary high yielding boreholes. Therefore the median yield is a much better indication of the yield that can be expected from a successful borehole in this area. The median yield correlates well with DWA's yield map which suggests an average yield of 0.1 - 0.5 ℓ/s for successful boreholes.

Average borehole depths for this area are >50 m bgl whilst the median depth is ~40 m bgl. This again indicates that the average borehole depth is skewed by a few deep boreholes (>200 mbgl) drilled on the farms Rooipan and Geluk. The localities of the NGA boreholes in the study area are indicated in Figure 5.

Field measured electrical conductivities (ECs) are generally well below 200 mS/m except for a few nomalous ECs recorded on the farms Jonasbank, Weiveld and Farm 266. The very high EC (for this area) of 404 mS/m recorded at Jonasbank is suspected to be a result of pollution from soakaway pits, kraals and or stock water points. Depth to water table ranges from 2.7 to 26.6 m bgl with a median depth of 6.4 m bgl. The deeper water levels are most likely a result of abstraction.

#### *7.5.4.3 Hydrocensus Results*

Seven boreholes and one non-perennial spring were surveyed on the site. Of these three were equipped with windpumps, one with a submersible pump and one with a plunger pump for stock watering purposes. The two high yielding boreholes AFN3 and AFN4 have been vandalized and can no longer be used as production boreholes. All three high yielding boreholes (AFN3, AFN4 and AFN5) are close to dolerite dykes. The relatively deep water level measured in borehole AFN6 could be due to a recovering water level after pumping having been measured. According to the owner, borehole AFN5 becomes artesian after good rains.

Groundwater is mainly abstracted for stock watering purposes, except for the groundwater flowing out at the Arriesfontein non-perennial spring during wet spells. A small ~0.25 ha field planted with lucerne was observed on the adjacent farm Hartebeesput, but the owner could not be located and the borehole(s) supplying the irrigation water could therefore not be visited. The owners of three adjacent farms (Mr. Johan Visser of Hartebeesput, Mr. Keith Williams of Arbeidsloon and Mr. Kobus van Niekerk of Kristalpan) could not be located and the fourth, Mr. Gerrit Nieuwoudt owner of the farms Constantia, Vlakpan and Hopefield, was busy with farming activities and could not meet with SRK's personnel doing the hydrocensus. These owners, except for Mr Nieuwoudt, are only part time farmers who reside in towns as far as Douglas and Hopetown. Kristalpan (Vlakpan Suid on map) is south-east of Arriesfontein, Arbeidsloon south and Hartebeesput immediately west thereof. Mr Gerrit Nieuwoudt stays on Constantia south-east of the property. Vlakpan is located east of Arriesfontein and Hopefield north-east thereof. (The latter was part of Arriesfontein, but has been sold off to Mr Nieuwoudt).

#### *7.5.4.4 Current Abstraction*

The estimated current abstraction from the site is summarised in Table 3. For the three windpumps a 24 h/d operation at 12% of the maximum yield (which is determined by the cylinder size) was assumed. This assumption is based on the author's personal experience in the Karoo area. The Arriesfontein (spring) flow during the hydrocensus was estimated as 0.5 ℓ/s. Unfortunately, the flow could not be measured as the spring is partially submerged by the outflow, which accumulates in a pan where it largely evaporates. According to the owner this spring only flows during exceptional wet periods and has only flowed during 1974-1976, 1988 and since the beginning of 2011. No large scale irrigation takes place in the area and most of the farms are uninhabited. Based on the assumptions a total current abstraction of approximately 26 500 m3/a is calculated for the site. During normal to dry years the spring does not flow and therefore the total groundwater abstraction for this area will only be ~10 700 m3/a.

#### *7.5.4.5 Groundwater Resource Potential*

The site falls within the western part of the Quaternary Drainage Region D92A (see Figure 4) for which the amount of water available under General Authorisation is listed under Zone A of the Groundwater Taking Zones, where no water may be taken from this drainage regions except as set out under Schedule 12 and small industrial users3 (DWAF, 2004 and DWA, 2012). Therefore, if the water demand is to be satisfied from the groundwater resources, a Water Use Licence Application will have to be submitted.

Three GRUs were defined for this area. These are based on surface drainage, measured groundwater elevations and lineaments such as faults and dykes. The GRA2 grid datasets (DWAF, 2005) were used to derive the MAP, effective recharge and groundwater resource potential for each GRU. As boreholes cannot intersect all the available recharge in an area, an exploitability factor (DWAF, 2005) was used to calculate the volume of groundwater that can actually be abstracted through boreholes. Current abstraction based on the hydrocensus data was subtracted from this value to determine the current Groundwater Exploitation Potential, for so-called wet and dry periods.

The GRA2 data indicate that the three Ariesfontein GRUs (C92A-1, C92A-2 and C92A-3) have a combined estimated average mean recharge of ~188 000 m3/a for dry periods and ~282 000 m3/a for wet periods. The average groundwater exploitation potential for these GRUs is ~528 000 m3/a for dry periods and ~566 000 m3/a for wet periods. The volume of water that is potentially stored in the aquifers of the three GRUs is ~17.6 million m3, whilst the potential storage of the upper 5 m4 is ~1.2 million m3.

Average annual recharge values vary between 11 mm/a in the extreme north-western corner of the site and 9 mm/a in the south-eastern corner thereof.

#### *7.5.4.6 Depth to Water Table and Inferred Groundwater Flow Directions*

The hydrocensus data indicate that the depth to water level at the site varies between ground surface (Arriesfontein spring) and ~30 m bgl. On the site the depth to water level is predominantly between 2.0 and 3.5 m bgl, except in boreholes where there is pumping. These data and data from the NGA were used to plot the groundwater elevations on the topographical map, from which the groundwater flow directions were inferred (Figure 10). The groundwater elevations generally mimics the surface elevation contours and generally flows from higher lying to lower lying areas. The inferred flows are from the higher lying areas west of the property towards east and the lower lying Riet River south thereof. The general direction of groundwater flow can be diverted by NE-SW striking dolerite dykes to form springs in low laying areas.

#### *7.5.4.7 Groundwater Quality*

The groundwater salinity, expressed as EC in mS/m, of the site and surrounds is shown in Figure 11 (page 28). The map suggests that the groundwater quality throughout the area falls in the range 70 – 300 mS/m. Field measured ECs at equipped boreholes and the spring at Arriesfontein vary between 76 and 173 mS/m, which correlates well with this suggested value. Based on field measured ECs only the groundwater from borehole AFN5 is unsuitable for long term human consumption5. The variable groundwater quality is likely caused by pollution from over flowing dams and kraals.

Groundwater samples were taken at the existing boreholes AFN2, AFN5 and AFN7, as well as the new boreholes ANE1 to 4, and delivered to M&L Laboratories in Johannesburg for chemical analysis. The results are summarised and compared to the South African National Standards for Drinking Water (SANS 241-2011) in Table 10 and the analysis certificates are attached in Appendix F. Overall the water from the new boreholes, especially the two boreholes earmarked for water supply (ANE1 and ANE3) is of good quality and chemically fit for human consumption. The arsenic concentration of AFN2 and AFN7 were suspiciously high for the samples collected during the hydrocensus. In comparison the arsenic concentrations of samples taken during the pumping tests were below detection limit for all the samples, including AFN7. The initially high concentrations are suspect and probably a measuring error or the unit was incorrectly stated on the analysis certificate.

### 7.5.5 Aquifer Vulnerability

Aquifer vulnerability was determined by evaluating seven parameters (DWAF, 2005), namely:

- Depth to groundwater;
- Recharge;
- Aquifer media;
- Soil media;
- Topography;
- Impact on vadose zone; and
- Hydraulic conductivity.

Aquifer vulnerability is defined as the likelihood for contamination to reach a specified position in the groundwater system after being introduced at some point above the uppermost aquifer. The aquifers at Arriesfontein are classified as having very high vulnerability to contamination. Though not indicated on the map, the lowest vulnerability occur in the southern part of the farm where the groundwater levels are deeper, whilst the highest vulnerability occurs at the homestead where the groundwater level is very shallow and leached zones associated with the well-defined dyke allow rapid vertical infiltration of contaminated surface water.

In view of this aquifer vulnerability, care should be taken to establish the facilities with the highest contamination risk, e.g. the evaporation ponds, as far as possible away from the high risk areas, i.e. dykes and areas with shallow groundwater levels. The best position for these facilities will be in the southern and south-eastern parts of the site where the aquifer vulnerability is lowest due to relatively deep water levels.

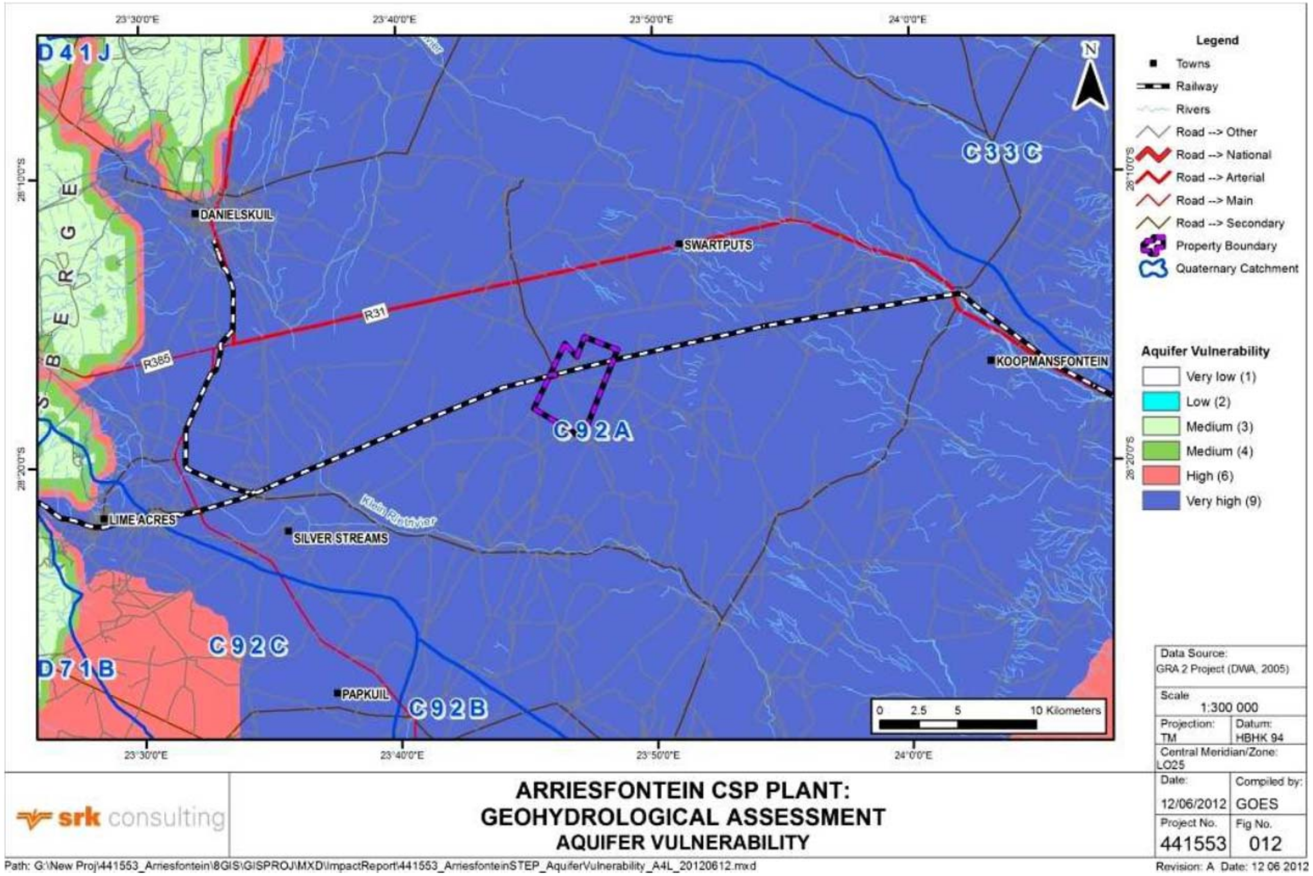


**Figure 11: Aquifer Vulnerability**

### *7.5.5.1 Conceptual Model*

The geological information, hydrocensus information and drilling results were used to compile a three dimentional (3-D) conceptual geohydrological model of the site. This 3-D model is shown in Figure 13 below. The drilling results indicate the depth of the weathered zone to be approximately 25 m and the depth to water table approximately 3 m. Groundwater movement is in a south-easterly direction and the intrusive dolerite dykes with their lower T compartmentalised the aquifers to a certain extent. Drilling and test pumping results also indicates that the highest yields and transmissivities are associated with the fractured/leached contract zones of the dolerite dykes. These contact zones are expected to vary in horizontal thickness of between 25 and 100 m, the latter being representative the wider Arriesfontein Dyke. The upper weathered dolerite zone also forms an aquifer, albeit of a lower yield and T. Potential paths for contaminants to reach the groundwater are:

- The fractured/leached dyke contact zones;
- The weathered dolomite; and
- Existing boreholes where safeguards such as sanitary seals and concrete collars have not been installed. Note: These have been installed at the new boreholes.

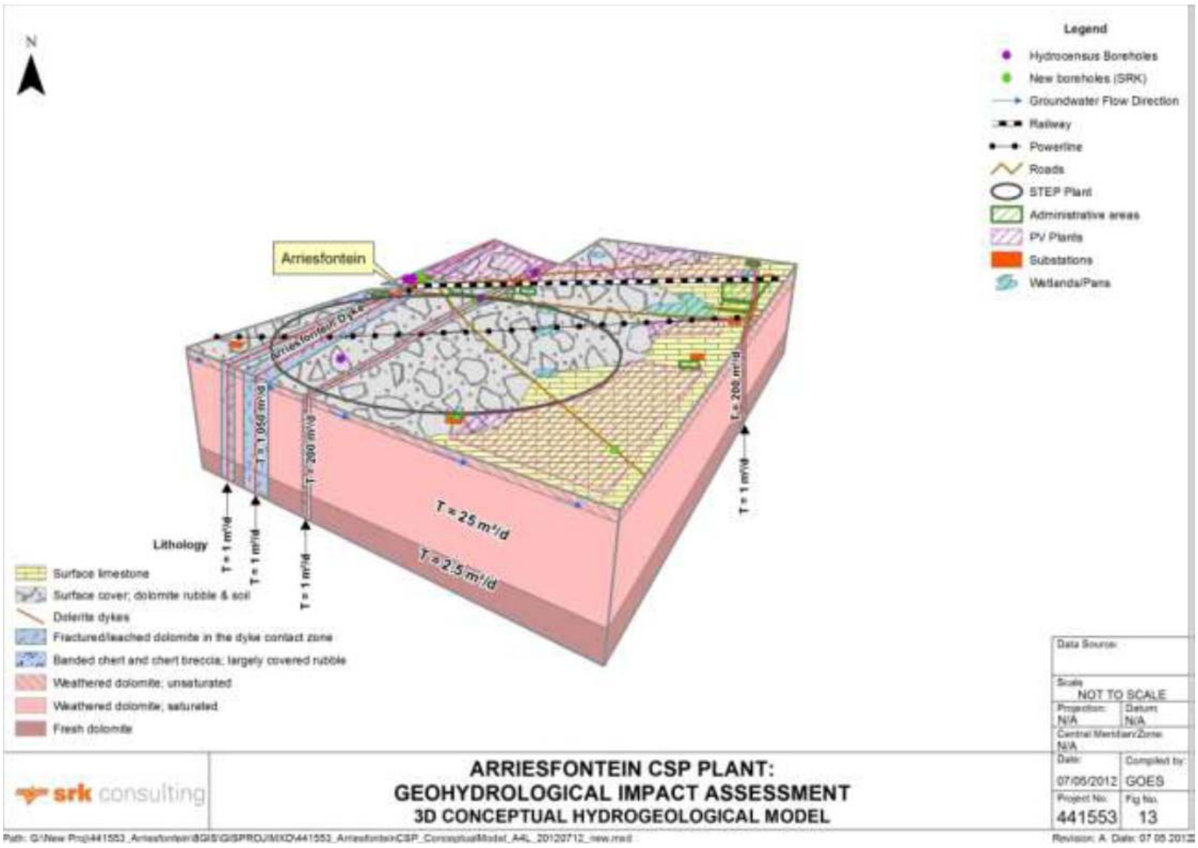


**Figure 12: 3D Conceptual Hydrogeological Model**

### 7.5.6 **Possible Impacts and Mitigation Measures**

The following possible groundwater related impacts have been identified for the proposed Arriesfontein CSPP:

1. Abstraction of groundwater for water supply might negatively impact on the boreholes of other nearby water users; and
2. Contamination of the aquifers by spills, leakages and accidental releases of hazardous substances associated with construction and operation of the proposed CSPP. These substances include:

a. Fuel and lubricants, paints, solvents and chemicals such as sodium and potassium nitrate. The Plant will operate as a zero discharge site and waste water and liquid effluent will be contained in lined evaporation ponds. There will be no discharge to watercourses.
b. Domestic wastewater, which is water that does not contain a human organic waste component. Sewage is defined as human organic waste, usually within a water suspension. Sources of domestic wastewater and sewage are the toilets, washrooms and offices. Domestic wastewater and sewage will be captured in combined waste streams and directed to a sewage package treatment plant. The sewage package treatment plant will be required to achieve legislated effluent quality discharge standards. Effluent will be pumped to the evaporation ponds. The fully treated solids will be disposed at a suitably licensed waste disposal facility; and
c. Solid waste. The conventional hierarchy of waste reduction and management will be employed and waste materials will be disposed at a suitably licensed waste disposal facility.

Potential pathways that have been identified for contaminants to potentially migrate to the groundwater are:

- Fault zones and dolerite dyke contact zones, especially the highly transmissive Arriesfontein Dyke and the other dykes crossing the property;

- Zones where the weathered bedrock extents to below the water table, which is the whole site; and

- Existing and abandoned boreholes which are not equipped with sanitary seals of bentonite and concrete collars.

Table 20 indicates possible groundwater impacts during the construction, operation and decommissioning phases of the CSPP without any mitigation measures taken. Mitigation measures need to be implemented to minimise identified impacts during all phases of the project life-cycle (construction, operation and decommissioning). These measures are also indicated in this table.

Table 21 indicates the severity of the impacts with the proposed mitigation measures applied. It is clear that these measures significantly reduce the risk of groundwater contamination. Therefore it is essential that these measures be implemented as part of the normal plant operation.

The potential environmental impact significance are summarised in Table 19.

**Table 19: Summary of the Potential Environmental Impact Significance**

| POTENTIAL ENVIRONMENTAL IMPACT | CRITERIA | | | | | SCORE | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|---|---|
| | Nature | P | D | S | M | TOTAL | L | M | H |
| CONSTRUCTION | - | 3 | 3 | 1 | 6 | 30 | | M | |
| CONSTRUCTION MITIGATION | - | 2 | 2 | 1 | 4 | 14 | L | | |
| OPERATION | - | 3 | 4 | 1 | 6 | 33 | | M | |
| OPERATION MITIGATION | - | 2 | 4 | 1 | 6 | 22 | L | | |
| CLOSURE | - | 3 | 2 | 1 | 4 | 21 | L | | |
| CLOSURE MITIGATION | + | 2 | 2 | 1 | 4 | 14 | L | | |

From a hydrogeological impact perspective the construction and operation phases of the proposed project poses moderate potential environmental impact significance. If mitigated the potential environmental impact significance for both these phases are reduced to low. The closure phase poses low potential environmental impact significance.

### Table 20: Possible Groundwater Impact Significance Rating Without Mitigation Measures

<table>
<tr><th rowspan="2">Phase</th><th rowspan="2">Impact description</th><th colspan="2">Status of Impacts</th><th colspan="2">Spatial Scale</th><th colspan="2">Duration</th><th colspan="2">Magnitude</th><th colspan="2">Probability</th><th colspan="2">Significance</th></tr>
<tr><th>Rating</th><th>Quan-tative Rating</th><th>Rating</th><th>Quan-tative Rating</th><th>Rating</th><th>Quan-tative Rating</th><th>Rating</th><th>Quan-tative Rating</th><th>Rating</th><th>Quan-tative Rating</th><th>Rating</th><th>Quan-tative Rating</th></tr>
<tr><td rowspan="3">Construction</td><td>Oil and Fuel spills</td><td>Negative</td><td>-</td><td>Site only</td><td>1</td><td>Medium-term</td><td>3</td><td>High</td><td>8</td><td>Medium</td><td>3</td><td>Moderate</td><td>36</td></tr>
<tr><td>Salt spills while transporting and filling system with salt</td><td>Negative</td><td>-</td><td>Site only</td><td>1</td><td>Short-term</td><td>2</td><td>Low</td><td>4</td><td>Medium</td><td>3</td><td>Low</td><td>21</td></tr>
<tr><td colspan="13">Essential mitigation measures:<ul><li>Place oil traps under stationary machinery, Only re-fuel machines at fuelling station, Construct structures to trap fuel spills at fuelling station, Immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only</li><li>Place plastic sheets on surface where salt is uploaded or unloaded to collect spilled salt</li><li>A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.</li><li>Ensure vehicles and equipment are in good working order and drivers and operators are trained.</li><li>Ensure that good housekeeping rules are applied.</li></ul></td></tr>
<tr><td rowspan="5">Operational</td><td>Groundwater abstraction</td><td>Negative</td><td>-</td><td>Local</td><td>2</td><td>Long-term</td><td>4</td><td>Low</td><td>4</td><td>Low</td><td>2</td><td>Low</td><td>20</td></tr>
<tr><td>Oil and Fuel spills</td><td>Negative</td><td>-</td><td>Site only</td><td>1</td><td>Long-term</td><td>4</td><td>High</td><td>8</td><td>Medium</td><td>3</td><td>Moderate</td><td>39</td></tr>
<tr><td>Salt spills while transporting and topping system with salt</td><td>Negative</td><td>-</td><td>Site only</td><td>1</td><td>Long-term</td><td>4</td><td>Moderate</td><td>6</td><td>Medium</td><td>3</td><td>Moderate</td><td>33</td></tr>
<tr><td>Accidental spills/leakage from evaporation ponds</td><td>Negative</td><td>-</td><td>Site only</td><td>1</td><td>Long-term</td><td>4</td><td>Moderate</td><td>6</td><td>Medium</td><td>3</td><td>Moderate</td><td>33</td></tr>
<tr><td colspan="13">Essential mitigation measures:<ul><li>Infrastructure that might pose a contamination risk to the groundwater, e.g. fuel tanks, generators, waste water treatment works, chemical stores and waste water evaporation ponds must be placed more than 150 m away from the dolerite dyke contacts.</li><li>Minimise waste water by the appropriate engineering design and re-use for other purposes where possible.</li><li>A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.</li></ul></td></tr>
</table>

| Phase | Impact description | Status of Impacts | | Spatial Scale | | Duration | | Magnitude | | Probability | | Significance | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Rating | Quan-tative Rating | Rating | Quan-tative Rating | Rating | Quan-tative Rating | Rating | Quan-tative Rating | Rating | Quan-tative Rating | Rating | Quan-tative Rating |
| | • Ensure vehicles and equipment are in good working order and drivers and operators are trained.<br>• Place oil traps under stationary machinery, Only re-fuel machines at fuelling station, Construct structures to trap fuel spills at fuelling station, Immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only, Implementation of a wet stock management system to detect losses timeously, or preferably fuel storage tanks should be above ground.<br>• Place plastic sheets on surface where salt is uploaded or unloaded to collect spilled salt.<br>• Effluent and waste water from the plant must be deposited in evaporation ponds. These ponds must be constructed away from vulnerable areas, fault zones and permeable formations to prevent ponding and ingress of contaminated water. The ponds must be properly lined to prevent vertical infiltration of contaminated water.<br>• A groundwater monitoring system must be implemented to monitor groundwater quality and water levels.<br>• Sewerage tanks and/or infiltration pits must be constructed far away from permeable formations and significant aquifer systems.<br>• Ensure that good housekeeping rules are applied. | | | | | | | | | | | | |
| Decommissioning | Oil and Fuel spills | Negative | - | Site only | 1 | Short-term | 2 | Low | 4 | Medium | 3 | Low | 21 |
| | Salt spills while cleaning evaporation ponds | Negative | - | Site only | 1 | Short-term | 2 | Low | 4 | Medium | 3 | Low | 21 |
| | **Essential mitigation measures:**<br>• A procedure for the storage, handling and transport of different hazardous materials must be drawn up and strictly enforced.<br>• Ensure vehicles and equipment are in good working order and drivers and operators are trained.<br>• Place oil traps under stationary machinery, Only re-fuel machines at selected re-fuelling points, construct structures to trap fuel spills at re-fuelling points, Immediately clean oil and fuel spills and dispose contaminated material (soil, etc.) at licensed sites only<br>• Place plastic sheets on surface where salt is uploaded to collect spilled salt<br>• Evaporation ponds and the Solar Power Tower must be cleaned out, demolished and the area rehabilitated. This material must be disposed at a suitable, licensed waste disposal site.<br>• Sewerage tanks and/or infiltration pits must be rehabilitated.<br>• Ensure that good housekeeping rules are applied. | | | | | | | | | | | | |

**Table 21: Possible Groundwater Impact Significance Rating With Mitigation Measures**

| Phase | | Status of Impacts | | Spatial Scale | | Duration | | Magnitude | | Probability | | Significance | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Potential Environmental Impact Description | Rating | Quan-tative Rating | Rating | Quan-tative Rating | Rating | Quan-tative Rating | Rating | Quan-tative Rating | Rating | Quan-tative Rating | Rating | Quan-tative Rating |
| Construction | Oil and Fuel spills | Negative | - | Site only | 1 | Short-term | 2 | Low | 4 | Low | 2 | Low | 14 |
| | Salt spills while transporting and filling system with salt | Negative | - | Site only | 1 | Short-term | 2 | Low | 4 | Low | 2 | Low | 14 |
| Operational | Groundwater abstraction | Negative | - | Local | 2 | Long-term | 4 | Low | 4 | Low | 2 | Low | 20 |
| | Oil and Fuel spills | Negative | - | Site only | 1 | Long-term | 4 | High | 8 | Low | 2 | Low | 26 |
| | Salt spills while transporting and topping system with salt | Negative | - | Site only | 1 | Long-term | 4 | Moderate | 6 | Low | 2 | Low | 22 |
| | Spills from evaporation ponds | Negative | - | Local | 2 | Long-term | 4 | Moderate | 6 | Low | 2 | Low | 24 |
| Decommissioning | Oil and Fuel spills | Negative | - | Site only | 1 | Short-term | 2 | Low | 4 | Low | 2 | Low | 14 |
| | Salt spills while cleaning evaporation ponds | Negative | - | Site only | 1 | Short-term | 2 | Low | 4 | Low | 2 | Low | 14 |

### 7.5.7 **No-Go Option**

If construction of the proposed CSP Plant does not go ahead the current status quo of the groundwater resources will remain, as will the existing sources of contamination, i.e. stock watering points and pens, on-site sanitation facilities at farm dwellings. The contaminants from these sources are unlikely to pose a serious risk to the environment as is confirmed by the baseline data on groundwater chemistry.

### 7.5.8 **Groundwater Monitoring Programme**

To monitor the potential impact of the development on the groundwater resource, boreholes ANE1, ANE2, ANE3 and ANE4, as well as existing boreholes AFN2, AFN4, AFN5, AFN6 and AFN7, should be included in a monitoring programme.An additional (25 m deep) monitoring borehole should be drilled approximately 20 m downstream (southeast) of the evaporation ponds. Monitoring should include the following:

- Boreholes where a pump is installed must be equipped with a conduit pipe (25 – 35 mm ID class 6 irrigation pipe) attached to the pump's rising pipes and installed to ~1 m above the pump inlet. This will prevent the dipmeter probe from becoming stuck around the rising pipes and electrical cables. A water level dipmeter with 1 cm calibration and 50 m cable will have to be purchased by the Plant operator for this.

- The water level and volumes abstracted must also be recorded at all production boreholes on at least a monthly basis. Best results are obtained if automatic flow meters and water level recorders set to take hourly readings are installed.

- Water samples must also be collected at these boreholes on a six-monthly basis and submitted to SANAS accredited laboratories for analysis of the macro-chemistry. The monitoring borehole 20 m downstream of the evaporation ponds can be equipped with an automatic recorder to monitor water level, water temperature and electrical conductivity on a hourly basis. This setup will give and early warning of contamination occurring (e.g. a leaking membrane) so that corrective action can be taken timeously and at an early stage of it is occurring.

- Rainfall should also be recorded on-site preferably by installation of an automatic rain gauge/weather station.

- The monitoring data must be evaluated on an annual basis by a geohydrologist, the numerical model recalibrated and a monitoring report compiled.

- Monitoring must continue post closure of the facility for at least five years on a six-monthly basis to establish trends and assess the accuracy of the predictions on contaminant transport given in this report. The data must be evaluated on an annual basis by a geohydrologist and after five years assessed to determine if monitoring needs to continue at six-monthly intervals or can be reduced to an annual basis.

### 7.5.9 Conclusions

Based on the information discussed in this report the following can be concluded regarding the groundwater conditions at Arriesfontein:

- Local geological observations during the hydrocensus and lineament mapping from Google Earth images indicate that several NE-SW striking dolerite dykes are present in the area. These structures may allow surface water to rapidly percolate down to the groundwater table;
- Two E-W striking dykes intersect the above-mentioned dykes to form groundwater compartments or GRUs;
- Maximum immediate yields of boreholes drilled in this area vary largely between 0 (dry) and >20 ℓ/s;
- All the high yielding boreholes are linked to dolerite dykes and their conductive fracture/leached contact zones;
- Only seven boreholes and one spring were identified during the hydrocenus of which five are operative. Access could not be obtained to the other boreholes on adjacent properties.
- An estimated 26,500 m3 of groundwater is abstracted per annum from the site with the non-perennial Arriesfontein Spring yielding ~15,800 m3 (~60%) thereof when flowing. This spring only flows during and shortly after extremely wet years;
- No large scale irrigation occurs on the site or the surrounding farms and groundwater abstracted from boreholes is mainly used for stock watering purposes;
- Groundwater quality, measured as salinity (EC),in the surveyed area is generally good and varies between 76 and 173 mS/m. This quality is fit for long term human consumption except the 173 mS/m measured at borehole AFN5, which is only fit for short term human consumption;

- Groundwater levels in the area are shallow (<5 m bgl) except for borehole AFN6 where it was ~30 mbgl during the hydrocensus. This relative deep water level of the latter was caused by pumping from a low yielding borehole;

- The GRA2 data indicate that the three Ariesfontein GRUs (C92A-1, C92A-2 and C92A-3) have a combined estimated average mean recharge of ~188 000 m3/a for dry periods and ~282 000 m3/a for wet periods. The average groundwater exploitation potential for these GRUs is ~528 000 m3/a for dry periods and ~566 000 m3/a for wet periods. In comparison to this, the water requirements of the proposed CSP amount to 272 400 m3/a. Numerical flow modelling indicates that the anticipated demand can be obtained from the groundwater resource without unacceptable impacts to the aquifers and adjacent water users;

- The volume of water that is potentially stored in the aquifers of the three GRUs is ~17.6 million m3, whilst the potential storage of the upper 5 m is ~1.2 million m3;

- The General Authorisation for taking of groundwater from Drainage Region D92A is zero, except for Schedule 1 and small scale industrial purposes. Therefore, if any groundwater is to be abstracted from the groundwater resources in this area for the proposed CSP, a Water Use Licence Application will have to be submitted to the DWA;

- Simulated abstraction of 272 400 m3/a from boreholes ANE1 (560 m3/d) and ANE2 (186 m3/d) indicates that after five years of pumping a 0.5 m zone of drawdown could extend ~5.5 km in a northeast - south-westerly direction parallel to the dykes and ~3.2 km in a northwest - southeast direction across the dykes. The Arriesfontein Spring and wetland, which is approximately 100 m east of borehole ANE1, and is known to only flow after years of above normal rainfall, would experience a water level drop of approximately 2.5 m. Four of the boreholes on the neighbouring farm to the west of the site may also experience a water level drop of between 1.5 and 2 m, which is unlikely to negatively affect the productivity of these boreholes.

- Steady state conditions are reached after approximately 10 years with the 0.5 m zone of drawdown extending ~5.8 km in a northeast - southwest direction and ~3.9 km in a northwest - southeast direction. The four boreholes on the neighbouring farm to the west of the site may experience a water level drop of between 1.5 and 2 m, whilst a fifth borehole may experience a drop of between 0.5 and 1 m. The drop in water level is unlikely to negatively affect the productivity of these boreholes, the reason being that in this area the water strikes are mostly much deeper (>10 m bgl) whereafter the rest water level rises to between 0.5 and 3.5 m bgl.

- Potential pathways that have been identified for contaminants to potentially migrate to the groundwater table are:

  - o Fault zones and dolerite dyke contact zones, especially the highly transmissive Arriesfontein Dyke and the other dykes crossing the property;
  - o Zones where the weathered bedrock extends to below the water table, which covers the whole site; and
  - o Existing and abandoned boreholes which are not equipped with sanitary seals of bentonite and concrete collars.

- Simulating contaminant transport by assuming a 100% contamination and pollution of the groundwater, i.e. a worst case scenario similar to an unlined pond, which is highly unlikely to occur, indicates that the contaminant plume will slowly move in a south-easterly direction and is not affected by abstraction from boreholes ANE1 and ANE2.

- After five years, pollution from the evaporation ponds will be limited to <200 m from the ponds and mainly downstream (south-east) thereof. After 15 years the contamination plume will have expanded to ~350 m south-east of the evaporation ponds and would have extended to beyond the site boundary by ~100 m. After 30 years the contamination plume will have expanded to ~540 m south-east of the ponds and extended ~130 m beyond the site boundary.

- To prevent a potential contaminant plume from extending beyond the site boundary, the proposed evaporation pond should be moved approximately 300 m away from the boundary to a position just south-east of borehole ANE4.

- No wetlands or water supply boreholes should be affected by the contaminant plume, even after 30 years. Simulations of abstraction and contaminant transport have indicated that these potential impacts will be limited to the site or close to the site.

- From a geohydrological impact perspective the construction and operational phases of the proposed project poses moderate potential environmental impact significance. If mitigated the significance rating for both these phases are reduced to low. The closure phase poses low potential environmental impact significance.

- From an aquifer vulnerability point of view the proposed layout for the CSP is favourable as long as possible sources of groundwater pollution, e.g. the lined waste water evaporation ponds are contained to the south-western part of the farm and kept away from areas where dykes/lineaments and wetlands/pans have been identified. Best area for the evaporation pond will be the south-western part of the farm where aquifer vulnerability is the lowest. The groundwater level in this area is expected to be >3 m bgl with argillaceous material expected in the upper part of the geological profile, which will give some protection from surface pollution.

### 7.5.10 **Recommendations**

Based on the above conclusions the following actions are recommended:

1. The evaporation ponds should preferably be placed in the south-eastern part of the farm and far away from lineaments, drainage channels and pans;

2. Heliostats and PV panels can be placed all over the area as these do not pose a groundwater pollution hazard;

3. All existing boreholes (used and unused) must be properly sealed at the surface to prevent surface pollution of the groundwater. This measure will also prevent bees from invading the borehole

4. In order to safeguard the groundwater supplies from contamination and equipment from theft and damage, a zone of protection in an area of at least 50 m x 50 m, centred on the actual borehole should be established. The following measures must be applied in this protection zone:

   - No pit latrines, VIP's, soak-aways or septic tanks – to prevent effluent from percolating into the aquifer and borehole;

   - No storage of fuel, lubricants or other hazardous substances without a leak prove;

   - Production boreholes for domestic use must be equipped with a sanitary seal – to prevent contaminated surface water and spilled fuel from percolating down the casing into the borehole;

   - The concrete collar around borehole casing must be at least 100 mm higher than the floor or surface level to prevent spilled fuel, water from leakages, wash water, etc to enter the borehole;

   - No ponding of surface water must be allowed, i.e. the area must be sloped for surface water to drain away from this zone;

   - Vegetation, other than trees and large bushes, should be maintained in this zone – Note: Roots of bushes and trees growing near boreholes often grows into the borehole where it can cause considerable problems;

- o The borehole and pumping equipment must be housed in a lockable pump house. For this purpose a removable cage manufactured out of galvanised steel mesh and corrugated steel sheets is recommended. This cage, rather than a brick building, is recommended as it can be readily removed in case the borehole is damaged or if it needs to be re-developed and cleaned.

- o The production boreholes, as well as other monitoring boreholes in the area, must be properly sealed to prevent entry of reptiles, insects, birds and small rodents.

- o The entire area should be properly fenced with a lockable gate to prevent unauthorised entry and to exclude animals. The gate must be positioned and of such a type that allows easy vehicle access.

- o A signboard must be erected on the gate warning people of the dangers and that unauthorised entry is not allowed.

## 7.6 WETLAND IMPACT ASSESSMENT

The site is characterised by several small pans, however no rivers or drainage lines were identified during the wetland assessment. The assessment found that the site is situated in a sub-quarternary catchment area classified as FEPA, indicating that the river draining the cathment is still in a largely natural and pristine condition – and that the river is considered important in terms of achieving biodiversity targets for river ecosystems and threatened or near threatened species. The Wetland report is attached as **Appendix P**.

### 7.6.1 Terms of Reference

- Review of proposed development layout plans;
- Identification of expected and possible impacts, including cumulative impacts;
- Recommendations of proposed mitigation and/or management of all wetlands and other aquatic ecosystems;
- Recommendations for bio-monitoring;
- Compile a report detailing all the above information

### 7.6.2 Impact Assessment and Identification

#### *7.6.2.1 Wetland Delineation*

The delineated wetlands are illustrated in Figure 10below. Approximately 5.5% of the study area was classified as wetland, with most of the wetland area consisting of shallow, ephemeral pans.

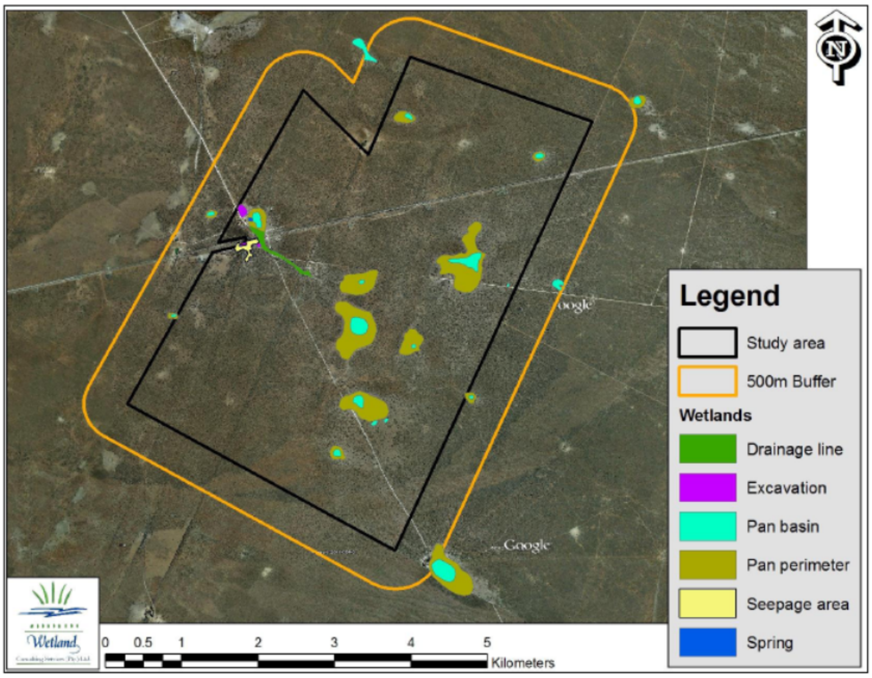


**Figure 10: Delineated Wetlands**

A total of 12 pans, ranging in size from 0.1 ha to over 23 ha in size, were identified on site. In addition to the pans a small drainage line and associated seepage area, as well as a natural spring were delineated on site. The natural spring, which according to anecdotal evidence would appear to be permanent, is the only natural source of permanent surface water on site and within the general area of the site. The spring is thought to be a lithologically controlled spring and likely the result of a dolerite dyke.

**Table 22: Potential Hydrology Impacts**

| Wetland Type | Area (ha) | % of wetland area | % of study area |
|---|---|---|---|
| Drainage line | 4.50 | 4.83% | 0.27% |

| Wetland Type | Area (ha) | % of wetland area | % of study area |
|---|---|---|---|
| Pan Basin | 12.99 | 13.94% | 0.77% |
| Pan Perimiter | 72.63 | 77.92% | 4.29% |
| Seepage area | 2.86 | 3.07% | 0.17% |
| Spring | 0.23 | 0.24% | 0.01% |
| **Total** | **93.21** | **100%** | **5.51%** |

In **Figure 10** above, the pans have been classified into the pan basin and the pan perimeter, though a single functional pan unit consists of both the pan basin and the perimeter. The pan basin is the flat, lowest point of the pan that is flooded most regularly, and in the case of the pans on site, was usually either characterised by bare soil, or was dominated by sedges. The pan perimeter slopes slightly towards the pan basin and was characterised in most cases byheavily grazed, short grassland on shallow rocky soil. Both exposed calcrete and dolomite were encountered along most of the pan perimeters.

The rocky nature of the soils made auguring largely impossible to depths greater than approximately 20 cm, making wetland delineation based on soil indicators difficult. The heavily grazed soils as well as the ephemeral nature of the systems given the semi-arid climate of the area also allowed only limited use of the vegetation as indicators. *Wetlands were thus delineated based on available vegetation indicators as well as landform setting.* In general, the entire treeless clearings surrounding the pan basins were classified as wetlands as the extended presence of water in these areas and the accumulation over time of salts due to the evaporation of water precludes the establishment of trees and shrubs, specifically the dominant shrub of the area, Tarchonanthus camphoratus, from these areas. The pan perimeters, though not necessarily conforming to the typical wetland characteristics in terms of hydric indicators in the soil, are nonetheless water driven habitats and thus classified as wetlands.

At the time of the site visit (25-27 January 2012) all of the pans were dry, with the exception of the pan adjacent to the natural spring. The small drainage line delineated on site feeds into the pan adjacent to the natural spring and is crossed by both the railway and the gravel access road to the farm via culverts. The drainage line is characterised by a shallow, poorly defined, rocky drainage channel that is lined on either side by occasional Rhus lancea and Ziziphus mucronata trees that represent a narrow riparian zone. Some surface water was observed within the upper reaches of the drainage line on site, though this was attributed to a leaking water pipe crossing the drainage line from north to south, presumably to supply cattle drinking troughs. A small hillslope seepage wetland drains into the drainage line from the west along the railway line. This seepage wetland was delineated based on the presence of numerous stands of Juncaceae within the wetland area.

When comparing the pans on site as captured in the NWI with the pans in the surrounding area, it is clear that the pans, ranging in size from 1.5 ha to 3.8 ha, fall within the most common size classes of pans within the area and the ***habitat represented by these pans is thus well represented within the surrounding landscape as well***. The lack of defined drainage channels in the area is as a result of the flat terrain of the area. Dolomitic areas are also often characterised by freely draining soils and significant groundwater recharge areas as rainfall infiltrates through the soil profile and into groundwater. Within the general Ghaap Plateau area ground water recharge is estimated as 6.3% of MAP (in quarternary catchment C92A recharge is estimated at 6.5%) (DWAF, 2006), which compares favourably to areas such as the Mpumalanga Highveld which, despite lower potential evaporation, has only 1-5% of MAP recharged to groundwater (Hodgson, 2007).The poor drainage of the area is further highlighted by Middleton et al. (1990) who indicate the study area as falling within an endorheic area. An endorheic area can be defined as a closed drainage basin (DWAF, 1999) that retains water and has no surface water outflow to other water bodies such as rivers. Rainfall falling within such an endorheic area is thus expected to be lost to groundwater infiltration and evapo-transpiration.

#### *7.6.2.2 Functional Assessment*

In the previous section, the importance of the wetlands on site in terms of biodiversity maintenance was briefly highlighted. This is considered to be the most important function of the wetlands on site. As the wetlands, **most specifically the pans, are inwardly draining systems and not connected to any downstream water resources, the wetlands / pans do not to play an important role in flood attenuation or flow regulation, functions that are typically attributed to wetlands**.

**A further function often attributed to wetlands, that of water quality enhancement, is also not considered to be a significant function performed by the wetlands on site.** In fact, as water evaporates from the pans following heavy rainfall events, salts are concentrated over time and the quality of water deteriorates, though this deterioration is a perfectly natural phenomenon. In terms of direct use values, the only use made of the wetlands on site is in terms of providing grazing to livestock, and in the case of the permanent spring, the provision of water.

#### *7.6.2.3 Present Ecological Status (PES) Assessment*

The pans within the Arriesfontein study area are located within a mostly natural landscape utilised only for livestock grazing; in this particular case cattle. Impacts to the pan wetlands have thus been limited, with the hydrology driving and maintaining these systems still largely intact. Two (2) of the pans are crossed close to their perimeter by minor farm roads, and some small excavations have taken place within one (1) or two (2) of the pans, though the impact of these activities to the pans' integrity is considered to be minimal. The biggest impact to the pans is considered to be from livestock grazing and trampling, though even this impact is assessed as being of minor significance.

As such, the overall condition of the pans within the Arriesfontein study area is considered to be in an A/B category, indicating largely natural to pristine systems, with the only exception being the pan adjacent to the natural spring, which is considered moderately modified (PES category C). The drainage line and the seepage wetland and associated spring area have been more significantly impacted as they are crossed by both the railway line and the public gravel road. In addition, some excavations have taken place within these wetlands and the vegetation is considered to be considerably altered. Both the drainage line and the seepage wetland are rated as moderately modified, PES C. The results of the PES assessment are illustrated in the figures and tables below.

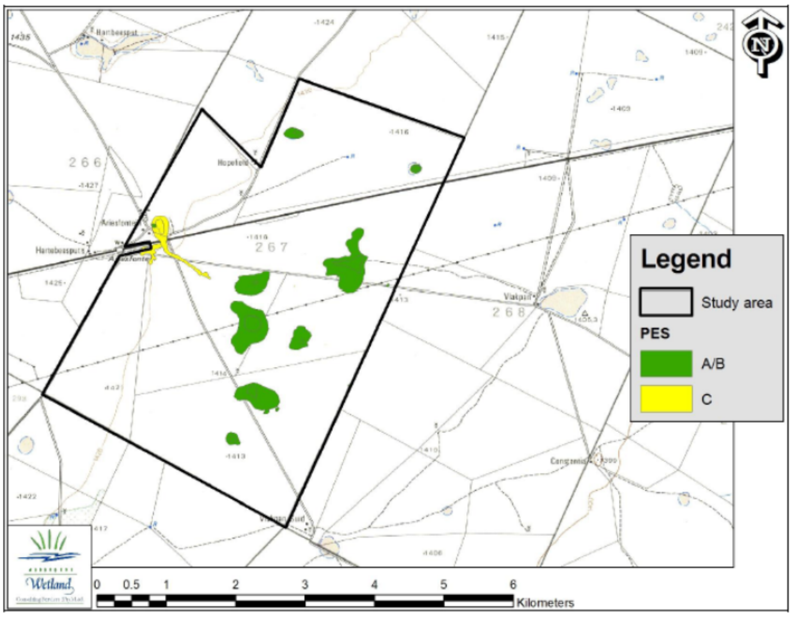


**Figure 11: PES Rating of Wetlands**

**Table 23: Potential Hydrology Impacts**

| HGM Unit | Threat Descriptions | | | Score Summary | |
|---|---|---|---|---|---|
| | Hydrology | Geomorphology | Vegetation | Overall Score | PES Category |
| Pans | 1 | 0.3 | 1.5 | 0.94 | A/B |
| Drainage line | 3.5 | 0.7 | 3.7 | 2.76 | C |
| Seep and Spring | 3 | 1 | 6.9 | 3.54 | C |

**Table 24: Wetland PES Assessment**

| Description | Combined Impact | PES Category |
|---|---|---|

| | Score | |
|---|---|---|
| Unmodified, natural | 0 – 0.9 | A |
| Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place | 1 – 1.9 | B |
| Moderately modified. A moderate change in ecosystem process and loss of natural habitats has taken place but the natural habitat remains predominately intact. | 2 – 3.9 | C |
| Largely modified. Large change in ecosystem processes and loss of natural habitat and biota has taken place. | 4 – 5.9 | D |
| The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural features are still recognisable. | 6 – 7.9 | E |
| Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota. | 8 -10 | F |

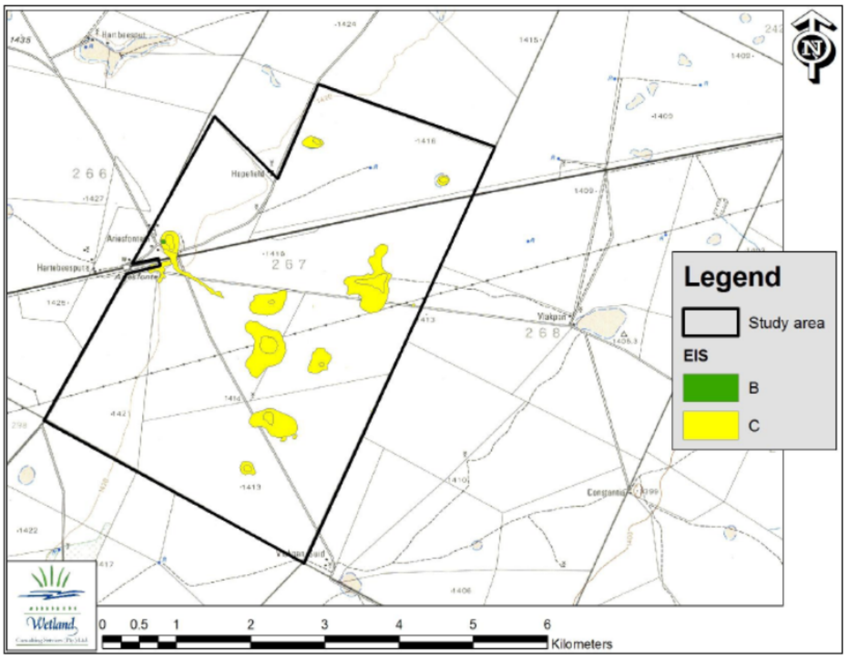


**Figure 12: EIS Assessment of Wetlands**

A map showing the proposed infrastructure developments in relation to the site and the delineated wetland habitat is provided in **Figure 12** above. As indicated, approximately 46.5 ha of wetland habitat falls within the footprint of the proposed developments and will be lost. It is further likely that wetland habitat outside the direct development footprint but within close proximity to the footprint will be disturbed during the construction process.

The development of a power plant within an arid climate such as which characterises the Northern Cape will also require that substantial quantities of water are imported to the area to support the proposed development. Water will be required during construction activities, for steam generation and cooling in the CSP Plant, for washing of heliostats and PV modules, as well as potable water for the power plant staff.

The impacts expected due to the proposed developments are summarised below. All of the expected impacts have been grouped into the stage of the project in which they are expected to occur, though some of the impacts are likely to occur across several stages.

1. Construction Phase:
   - Loss and disturbance of wetland habitat;
   - Increased sediment movement into the wetlands on site;
   - Water quality deterioration; and
   - Increased flows and erosion within the drainage line.
2. Operational Phase:
   - Water quality deterioration
   - Increased flows within the water course
   - Stormwater discharge

#### *7.6.2.4 Construction Phase – Loss and disturbance of wetland habitat*

Approximately 46.5 ha of wetland habitat falls directly within the footprint of the proposed heliostat field surrounding the CSP Plant. It is expected that this wetland habitat will be permanently destroyed. 3 pans fall completely or partially within the footprint of the development, with a further two pans partially affected. It is likely that the remaining portions of the partially impacted pans will no longer be functional following completion of the development, thus increasing the extent of wetlands lost to 54.2 ha. In addition, wetland habitat immediately adjacent to the construction footprints is also likely to be disturbed during the construction phase. This impact is directly related to the development of the CSP plant.

There appears to be no means to mitigate against the loss of wetland habitat falling within the footprint of the proposed developments. The only means to avoid this impact would be to consider a different site where no wetlands are present, though given the number of pans in the area, this might also prove difficult. It is also not viable to attempt to maintain the wetlands within theheliostat field as the wetlands, when inundated, would attract waterfowl which would then be exposed to collision fatalities with the heliostats and the central tower of the CSP.

In order to prevent disturbance and damage to the remaining wetlands on site, it is however recommended that a 50 m buffer zone be demarcated around all wetlands not directly affected by the proposed development. This buffer zone should be excluded from all construction related activities on site (i.e. no stockpiles, constructor's camps etc. should be located within the wetlands or their buffer zones). If required, the wetlands and associated buffer zones should be fenced off. A normal 5 strand cattle fence is recommended as this will allow for free movement of small wildlife such as Suricate, Ground Squirrel and Porcupine, which were found to be common on site. A map showing the unaffected wetlands with a 50 m buffer zone is provided below.

This impact is expected to be of **High significance**.

| Description | | Spatial Scale | | Temporal Scale | | Probability | | Severity | | Significance | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Negative | - | Low | 1 | Very High | 4 | Definite | 4 | Very Severe | 4 | High | -13 |

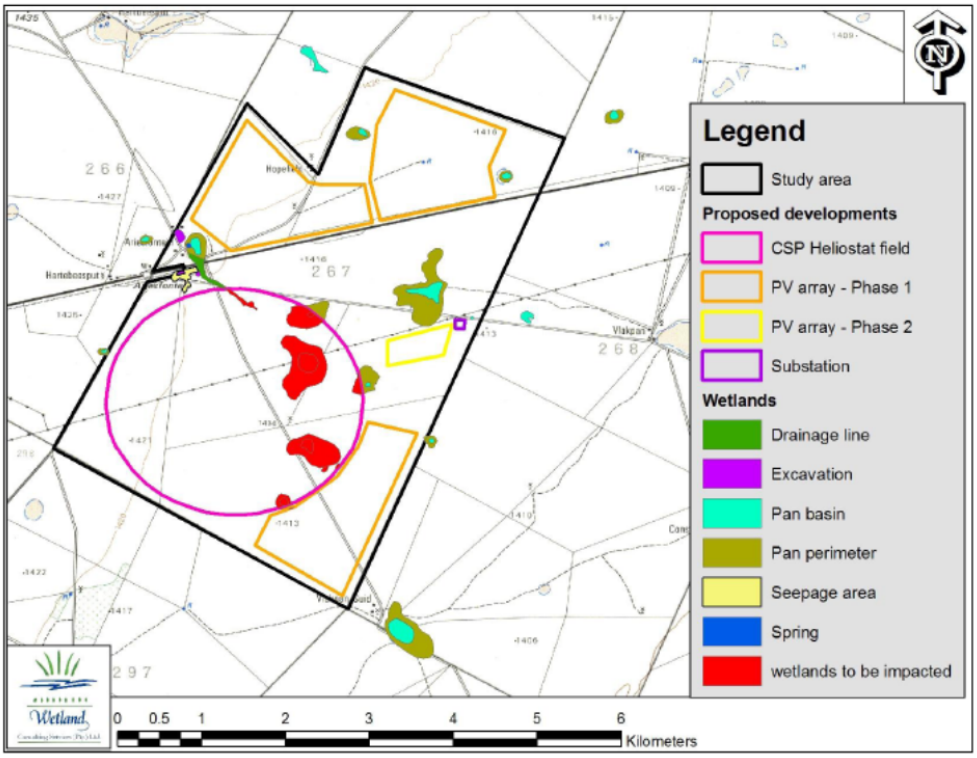


**Figure 13:Unaffected Affected**

### *7.6.2.5 Construction Phase – Increased sedimentation*

During the construction phase it is expected that most of the 600 ha footprint of the proposed CSP Plant arrays will be cleared of vegetation and some earthworks will likely also take place on site. These activities will expose the disturbed, bare soil to erosion by wind and water. As the construction phase is expected to run over at least 30  months, this will include at least two (2) rainfall seasons.

High intensity rainfall events which result in surface runoff could result in significant volumes of sediment being transported off the construction site and intodownslope water courses. However, given the flat terrain of the site and the poor drainage off the site, it is unlikely that significant concentrated run-off will develop, with the possible exception of the drainage line. Transported sediment loads are thus expected to be reduced and are unlikely to be transported into any downstream wetlands

This impact is expected to be of **Low significance**.

| Description | | Spatial Scale | | Temporal Scale | | Probability | | Severity | | Significance | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Negative | | Low | 1 | Low | 1 | Probable | 2 | Minor | 1 | Low | 5 |

#### 7.6.2.6 Construction Phase – Water quality deterioration

Numerous hazardous substances will be used and stored on site during the construction phase of the project. These substances will include: diesel, oil, cement, salt mixture for the CSP Plant etc. Spillages or leaks of these substances could enter downslope water courses via surface run-off during high intensity storm events or groundwater via infiltration, leading to water quality deterioration within the receiving water courses and making the water less fit for use by downstream water users as well as being deleterious to aquatic biodiversity.

This impact is expected to be of **Medium significance**.

| Description | | Spatial Scale | | Temporal Scale | | Probability | | Severity | | Significance | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Negative | | Local | 2 | Medium | 3 | Probable | 2 | Average | 1 | Medium | 9 |

#### 7.6.2.7 Construction Phase - Increased flows within the watercourse

Significant volumes of water will be imported to the study area during construction. This water will be used mostly for dust suppression, heliostat cleaning and compaction purposes, as well as other uses. Large volumes of the water are thus likely to infiltrate into the soil of the area.

This could lead to increased surface run-off during rainfall events as the soil becomes saturated more easily, as well as increased seepage of water through the soil profile and into groundwater. The drainage line and downslope pan are the most likely systems to be impacted in this regard, with increased flows likely to lead to changes in vegetation.

The dry climate of the area and high evaporation rates of the area will however limit the significance of this impact considerably, as much of the imported water used on site will probably be lost to evaporation before it enters any of the wetlands.

This impact is expected to be of **Medium significance**.

| Description | | Spatial Scale | | Temporal Scale | | Probability | | Severity | | Significance | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Negative | | Low | 1 | Low | 2 | Probable | 2 | Average | 2 | Medium | 7 |

#### *7.6.2.8 Operational Phase – Water quality deterioration*

A number of activities will pose a potential water quality hazard during the operational phase:

– The molten salt circuit

– Diesel storage on site

– Water treatment facilities, specifically the discharge of treated or untreated water

– The evaporation pond

The molten salt circuit is a closed system and no discharge of any salt from the system will take place. Both the heated salt and the cool salt tanks will be located within a bunded area that will have a total capacity of 110% the volume of the tank contents, i.e. the bunded area will be of sufficient capacity to contain the entire molten salt used in the plant should the system fail. The molten salt system should thus not pose a significant threat to water quality in adjacent wetlands. It is understood that no water will be discharged from the facilities on site. All dirty water will be routed to the respective wastewater treatment plants, and all treated water will be either re-used or discharged to the evaporation dams.

The evaporation dams will contain dirty water and waste from the water treatment plants and are likely to be highly saline. Leakage or overflow from these dams will infiltrate the soil and could end up in the groundwater, resulting in water quality deterioration, specifically increased salinity, though other pollutants are also likely to occur. This could lead to water quality deterioration at the spring.

This impact is expected to be of **Medium significance**.

| Description | | Spatial Scale | | Temporal Scale | | Probability | | Severity | | Significance | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Negative | | High | 3 | Medium | 2 | Probable | 2 | Severe | 3 | Medium | 10 |

#### *7.6.2.9 Operational Phase - Stormwater discharge*

SiVest Engineering was appointed to compile a stormwater management plan for the proposed CSP Project. A detailed stormwater management plan will be compiled prior to the commencement of construction activities. The stormwater management plan is included in the EMP as **Appendix B.**

In addition, the occurrence of dolomite might pose restrictions on the means of conveying and discharging stormwater. It is thus likely that stormwater will need to be conveyed in cement lined canals and trenches. The discharge of stormwater is likely to occur as a point source discharge and be of higher velocity and concentration than pre-development flows and thus poses a significant erosion risk at the point of discharge. There is no drainage line leaving the site that could be used to discharge stormwater into as the site is located within an endorheic area. The stormwater would thus need to be discharged into terrestrial areas or one of the adjacent pans. This might however not be advisable given the location on dolomites and would need to be commented on by the engineers.

This impact is expected to be of **Medium significance**.

| Description | | Spatial Scale | | Temporal Scale | | Probability | | Severity | | Significance | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Negative | | Medium | 2 | High | 3 | Highly Probable | 3 | Average | 2 | Medium | 10 |

### 7.6.3 Ecological Importance and Sensitivity (EIS) Assessment

Ecological Importance and Sensitivity is a concept introduced in the reserve methodology to evaluate a wetland in terms of:

- Ecological Importance;
- Hydrological Functions; and
- Direct Human Benefits

These scoring assessments for these three (3) aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze et al (2008) on the assessment of wetland ecological goods and services (the WET-EcoServices tool). In terms of direct human use benefits all of the wetlands on site, with the exception of the spring, are considered to be of Low importance, as the only use the wetlands are currently providing is grazing for livestock.

Though heavily grazed, the pans are expected to be characterised by low vegetation cover for most of the year compared to the surrounding terrestrial landscape and are devoid of Tarchonanthus camphoratus trees, which are an important browsing food for livestock in the area, and are thus considered of moderate to low grazing importance. The spring is considered to be of Moderate importance in terms of direct human use benefits as a source of water supply. It is likely to have been of High to Very High importance in the past prior to the installation of boreholes and groundwater abstraction in the area.

As indicated under the functional assessment above, the hydrological functions performed by the wetlands on site are limited given the fact that the wetlands are mostly inwardly draining pans and are further located within an endorheic area and as such are not connected to other surface water features of the area. The wetlands are also not expected to play an important role in groundwater recharge, which is likely to be higher in the surrounding terrestrial areas. All of the wetlands are thus considered to rate as being of Low importance in terms of hydrological/functional benefits.

The wetlands are considered most important in terms of their biodiversity support functions. Although no Red Data species were observed within the wetlands during the course of the field work, the wetlands are nonetheless considered important from a biodiversity perspective for the reasons provided above. The importance of the wetlands in this regard is also not purely attached to the individual wetlands, but to the wetlands as a collective group. Loss of any one of the wetlands, though seen individually they may seem small and common within the area, will contribute to the fragmentation of wetland habitat and surface water sources within the area and reduce the capacity of the entire area to support wetland dependant species. The wetlands are thus considered to be of Moderate ecological importance and sensitivity, with the spring being rated as being of High importance and sensitivity.

**Table 25: Wetland EIS Assessment**

| Wetland Type | Ecological Importance & Sensitivity | Hydrological/Functional Importance | Direct Humans Use | Overall EIS Score |
|---|---|---|---|---|
| Pans | C | D | D | C |
| Drainage Lines | C | D | D | C |
| Seepage Area | C | D | D | C |
| Spring | B | D | C | B |

### 7.6.4 Conclusion

Approximately 5.5% of the study area was classified as wetland, with most of the wetland area consisting of shallow, ephemeral pans. A total of 12 pans, ranging in size from 0.1 ha to over 23 ha in size, were identified on site. In addition to the pans, a small drainage line and associated seepage area, as well as a natural spring were delineated on site.

The pans are expected to play an important role in biodiversity support within the landscape, and this is taken to be their most valuable function. The hydrologically isolated nature of the systems (inwardly draining systems within an endorheic area) limits these wetlands from playing a significant role in typical wetland functions such as flood attenuation, stream flow augmentation, water quality enhancement sediment trapping and so on.

Most of the wetland systems on site are considered to still be in a largely natural state, with the exception of the drainage line and pan located in close proximity to the old farm house which have been impacted by the road and railway crossing and are considered moderately modified. Development of the proposed Solar Power Plant is expected to result in a number of impacts to the wetlands, most notably the expected loss of wetland habitat and biodiversity where the delineated wetlands fall within the footprints of the proposed development. A number of additional impacts were identified, though it is expected that the majority of these could be successfully mitigated through the implementation of a detailed water management strategy with a zero discharge policy.

### 7.6.5 Mitigation Measures

The following mitigation measures should be implemented:

- Major vegetation clearing activities and earthworks should be undertaken during the dry season as far as practically possible.
- The footprint of vegetation clearing should be limited to the direct footprint of the proposed developments and should be phased. The construction servitude should be fenced off prior to the commencement of construction activities and all construction activities should be limited to this servitude.
- Where possible vegetation clearing should be limited to removal of trees and shrubs only (if required), with the grass layer maintained as far as possible.
- Access roads and construction roads should include regular low level humps to slow down stormwater flow and direct stormwater off the road surfaces and into adjacent grassland at regular intervals to minimise erosive energy of stormwater runoff.
- Stormwater infrastructure should include sediment traps.
- Water usage on site should be minimised and re-use of water should be maximised. No discharge of dirty water should be allowed.
- All potentially polluting and hazardous substances used and stored on site should be stored in clearly demarcated areas.

- Storage areas for diesel, oil and other polluting substances must have adequate spillage containment measures to contain any spills within the direct area of the spill. Ideally, all potentially polluting substances should be stored in bunded areas of sufficient capacity to contain the full volume plus 10% of the storage containers.

- All re-fuelling areas and workshops should make use of drip trays to capture fuel and oil spills during re-fuelling or during vehicle maintenance and repairs.

- Stormwater should be diverted around the storage areas of polluting substances to prevent contamination of clean stormwater.

- Sufficient quantities of spill clean-up materials (e.g. Drizit or Spillsorb) should always be available on site. Once used, absorbent material and contaminated soil should be disposed of at a registered hazardous waste disposal site.

- The evaporation dam should be lined with a suitable plastic liner (or series of liners) to ensure no seepage or leakage of water out of the dam occurs. The dam should be of sufficient capacity to ensure that no overflow of the dam will occur up to and including the 1:100 year storm event. The dam should be regularly inspected and cleaned to ensure that capacity is not decreased due to sedimentation. All sediments/brine cleaned from the dam should be disposed of in a registered hazardous waste facility. It is recommended that the evaporation dam be covered by a net (as used by koi farmers) to prevent access to birds.

- The following guidelines apply to the use of polluting substances on site, and specifically to the use of cement and concrete:

  - Carefully control all on-site operations that involve the use of cement and concrete.

  - Limit cement and concrete mixing to single sites where possible.

  - Use plastic trays or liners when mixing cement and concrete: Do not mix cement and concrete directly on the ground.

  - Dispose of all visible remains of excess cement and concrete after the completion of tasks. Dispose of in the approved manner (solid waste concrete may be treated as inert construction rubble, but wet cement and liquid slurry, as well as cement powder must be treated as hazardous waste)

There appears to be no means to mitigate against the loss of wetland habitat falling within the footprint of the proposed developments. The only means to avoid this impact would be to consider a different site where no wetlands are present, though given the number of pans in the area, this might also prove difficult. It is also not viable to attempt to maintain the wetlands within the heliostat field as the wetlands, when inundated, would attract waterfowl which would then be exposed to collision fatalities with the heliostats and the central tower of the CSP.

In order to prevent disturbance and damage to the remaining wetlands on site, it is however recommended that a 50 m buffer zone be demarcated around all wetlands not directly affected by the proposed development. This buffer zone should be excluded from all construction related activities on site (i.e. no stockpiles, constructor's camps etc. should be located within the wetlands or their buffer zones). If required, the wetlands and associated buffer zones should be fenced off. A normal five (5) strand cattle fence is recommended as this will allow for free movement of small wildlife such as Suricate, Ground Squirrel and Porcupine, which were found to be common on site. A map showing the unaffected wetlands with a 50 m buffer zone is provided below.

The diesel storage tanks on site should be housed in a designated area that will allow for easy containment and clean-up of any spills that could occur on site, ideally in a bunded area. Drip trays should be used at all refuelling sites to capture small spills during refuelling. Emergency spill procedures must be clearly defined and all staff should be familiar with these procedures. Sufficient quantities of absorbent material should be easily available on site for containment of small spills.

No discharge of any treated or untreated water may take place on site unless authorised by the DWA.

- A detailed stormwater management plan must form part of the proposed development plan.
- The direct infiltration of rainwater into the soil should be encouraged to minimise generation of stormwater.
- Engineering safety standards for stormwater management on dolomitic areas must be complied with.
- Stormwater discharge points must be suitably protected against erosion through use of for example reno mattresses, energy dissipaters etc.

## 7.7 SOILS& AGRICULTURE POTENTIAL IMPACT ASSESSMENT

The area comprises a mixture of red, sandy soils, sometimes deep, in the west, withshallow calcareous soils in the east, as can be seen from the information containedin **Table 26**. The very low rainfall in the area means that the onlymeans of cultivation would be by irrigation and the Google Earth image of the areashows absolutely no signs of any agricultural infrastructure and certainly none ofirrigation.

The climatic restrictions mean that this part of the Northern Cape is suited at bestfor grazing and here the grazing capacity is low, around 20 ha/large stock unit(ARC-ISCW, 2004). The soils report is attached as **Appendix L**.

### 7.7.1 **Terms of Reference**

To provide a description of the environment that may be affected by the activity and the manner in which the environment may be affected by the proposed project

- A description and evaluation of environmental issues and potential impacts (including direct, indirect and cumulative impacts) that have been identified;
- Direct, indirect and cumulative impacts of the identified issues must be evaluated within the Scoping Report in terms of the following criteria:
  - 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), regional, national or international;
- A statement regarding the potential significance of the identified issues based on the evaluation of the issues/impacts;
- A comparative evaluation of the identified feasible alternatives, and nomination of a preferred alternative for consideration in the EIA phase;
- Identification of potentially significant impacts to be assessed within the EIA phase and details of the methodology to be adopted in assessing these impacts.

The objectives of the study are;

- To obtain all existing soil information and to produce a soil map of the specified area as well as
- To assess broad agricultural potential.

### 7.7.2 Impact Assessment and Identification

A summary of the dominant soil characteristics of each land type is given in **Table 26** below. The distribution of soils with high, medium and low agricultural potential within each land type is also given, with the dominant class shown in bold type.

**Table 262: Soil types in study area**

| Land Type | Dominant soils | Depth (mm) | Percent of land type | Characteristics | Agric. Potential (%) |
|---|---|---|---|---|---|
| **Ae9** | Hutton 33 | 450 – 1000<br>200 - 450 | 37%<br>32% | Red, sandy soils, occasionally on hardpan calcrete<br>Red-brown, sandy topsoils on hard rock and calcrete | High:0.0<br>Mod: 41.4<br>**Low: 58.6** |
| **Fc4** | Mispah 22<br>Mispah 20 | 100-250<br>100-250 | 71%<br>12% | Grey-brown, sandy, calcareous topsoils on calcrete<br>Grey-brown, sandy, calcareous topsoils on rock | High:0.0<br>**Mod: 0.0**<br>Low: 100 |

The impact can be summarized as follows:

**Table 27: Impact Significance Table**

| | | |
|---|---|---|
| **Natureof impact** | Loss of agricultural land | Land that is no longer able to be utilized due to construction of infrastructure |
| **Status of impact** | Neutral (N) | No cost or benefit to receiving environment |
| **Spatial Scaleof impact** | Low (1) | Confined to site boundary |
| **Time Scaleof impact** | High (3) | Lifespan of project |
| **Probabilityof impact** | Probable (2) | Likely to materialise |
| **Severityof impact** | Average (2) | Mitigation & rehabilitation will be possible |
| **Significance of impact** | Medium (8) | |
| **Mitigation factors** | The main mitigation would be to ensure that as little pollution or other non-physical disturbance occurs. | |

It does not appear, from a soils aspect, that there are any especially sensitive areas ("fatal flaws") within the site that should be avoided. Due mainly to the low potential soils and prevailing climatic limitations for agriculture, it is extremely unlikely that any sort of detailed soil investigation will be necessary.

### 7.7.3 Conclusion

Due mainly to the prevailing unfavourable climatic conditions for arable agriculture,as well as the prevalence of soils with limited depth, it is not envisaged that any more detailed soil investigation will be required.

### 7.7.4 Mitigation Measures

The main mitigation would be to ensure that as little pollution or other non-physical disturbance occurs. As far as the soils are concerned, the predominance of shallower, calcareous soils in the east (land type Fc4) means that this area is most recommended for placement of infrastructure if possible.

## 7.8 AIR QUALITY ASSESSMENT

### 7.8.1 Terms of Reference

It was requested that the impact assessment include the following as part of the scope of work:

- Describe the baseline conditions that exist in the study area and identify any sensitive areas that will need special consideration;
- Predict and assess the potential air quality and health impacts associated with dust and fumes generated during the construction phase of the proposed project;
- Identify and list legislative and permit requirements applicable to the potential impacts of the proposed project;
- Recommend suitable mitigation measures.

### 7.8.2 **Impact Assessment and Identification**

#### *7.8.2.1 Baseline Air Pollution Concentrations*

As far as is known, no ambient air quality monitoring at and in the vicinity of the proposed site has been carried out. Some information on background concentration of particulate matter in the Southern African region was provided by the SAFARI 2000 project, during which several over flights at 5 km altitude were made over the countries of the region. (Eatough et.al.,2003). The average concentration of particulate matter observed from five samples collected over South Africa early in August was 18.7±3 μg/m³ and from two samples collected after 22 August (and thus presumably more impacted by biomass burning) was 42.1±3.1 μg/m³.

At that altitude, it can be accepted that good mixing has taken place and that this measurement is equivalent to PM10. Individual source contributions to this figure are difficult to determine; from the composition of the samples a large contribution from biomass burning is evident. The conclusion to be drawn is that background PM10 will make up a material portion of the total PM10 in the area and that the contribution of this background PM10 to cumulative impact is season-dependent. The Air Quality Report is attached as **Appendix X.**

#### *7.8.2.2 Surrounding Receptors*

Apart from a number of homesteads, the area is considered to have very few receptors that could potentially be impacted by the proposed facility.

#### *7.8.2.3 Solar Radiation*

Solar radiation measurements have historically not formed part of the meteorological network at Mafikeng. As an alternative, Clemence (1992) used over 20 000 daily radiation observations from a wide geographic range of stations, and derived a relationship for southern Africa to estimate solar radiation from:

- Extra-terrestrial radiation;
- Maximum daily temperature; and
- Temperature range.

Since there will be no combustion activities, material handling, storage of volatile liquids or any other activities, including significant vehicular movements, that could produce air pollution during the operational phase of the PV plant, the only air pollution impacts are anticipated to occur during the construction phase.

Airborne particulates could give rise to both health and nuisance impacts. Nuisance impacts generally relate to soiling of property, washing, vehicles, etc. by the gravitational settling of dust introduced into the air by the mechanical action of extraction and transportation equipment or generated by wind erosion, whereas sensitive individuals may also suffer respiratory irritation at relatively low concentration levels.In addition, there is also the possibility that significant dust deposition immediately adjacent to construction activities and haul roads may affect sensitive vegetation by potentially stunting their growth.

### 7.8.3 **Predicted Air Impacts**

The UK's Atmospheric Dispersion Modelling System (ADMS) was assumed to be applicable to the study area. The ADMS model was developed by the Cambridge Environmental Research Consultants (CERC). ADMS 4 is a New Generation air dispersion model which means that it differs in a number of aspects from the regulatory models traditionally used. The most important differences are (i) the description of atmospheric stability as a continuum rather than as discrete classes (the atmospheric boundary layer properties are described by two parameters; the boundary layer depth and the Monin- Obukhov length, rather than in terms of the single parameter Pasquill Class) and (ii) in allowing more realistic asymmetric vertical plume behaviour under unstable atmospheric conditions. Dispersion under convective meteorological conditions uses a skewed Gaussian concentration distribution(shown by validation studies to be a better representation than a symmetric Gaussian expression). Two cases were modelled or a 12 x 12 km modelling domain on a 150 m grid :

- Case 1: Construction activities are occurring for the CSP and phase 1 of the PV installation simultaneously over an area of 750 ha; vehicle movements and worst-month wind erosion assuming 50% vegetation cover are assumed..
- Case 2: Construction is completed; worst-month wind erosion (50% vegetation cover assumed) occurs over the completed project area of 1 050 ha.

#### *7.8.3.1 Construction air quality impacts*

It is estimated that the construction period resulting in particulate emissions would be approximately 12 months. This includes clearance of the site and perhaps a limited amount of earthworks, since the site is already fairly flat and level. The site is flat, with gradients across the whole area not exceeding 2%. While the soils are sandy, they are only moderately erodible (GCS (2008) referenced in Wood, 2011).

It is estimated that 70 delivery vehicles would be required per 5MW of capacity, spread over a year. That makes 2 450 vehicles over say 200 weekdays, assuming that the CSP and phase 1 of the PV installations will occur simultaneously. That makes about 12 delivery vehicles a day (24 trips). There will also be a number of other vehicles arriving and leaving the site. These numbers are not known, but for the purposes of this assessment, it was assumed to be 50 other trips per day.

It is assumed that the panels would be brought to site using 10-tonne trucks. These trucks would be travelling along the R31 and turn off on to a dirt road leading to the site.

Wind erosion may also become a significant impact, particularly during the windy months of August and September. Wind erosion becomes significant with wind speeds of 20 km/hr and higher. Wind erosion is also a strong function of the frequency of disturbance and the degree of ground cover. Frequent disturbances break any natural crusting of the surface and therefore increase the erodible fraction.

Construction would also require the use of heavy trucks and smaller equipment such as generators and compressors. Such engines can be sources of nitrogen oxides, fine particulate matter and odorous gases. While it is unlikely that the emissions from these sources would cause substantial air quality impacts, there is a potential for diesel engine exhaust to cause impacts at off-site locations.

The factors that influence the rate of generation of pollutants include the:

- Intensity of activity for example, tonnes/hr of material processed;
- Process being undertaken;
- Vehicle or wind speed;
- Number of wheels of vehicles;
- Material properties for example, particle size distribution, moisture content;
- Surface roughness;
- Drop height;
- Stockpile height;
- Area exposed to wind; and
- Presence of barriers or other control measures.

The predicted highest daily contribution due to the construction activities exceeds the NAAQS for a limited area outside the project boundary, but is not expected to reach any sensitive receptors. It must also be borne in mind that conservative assumptions have been made i.e. no mitigation on unpaved roads and the maximum monthly wind erosion value. The predicted annual average contribution to PM10 concentration and dust fall rate are all within the respective standard/guideline limits.

#### *7.8.3.2 Operational air quality impacts*

All predicted concentration and deposition contributions are within the respective standard/guideline limits.

#### *7.8.3.3 Other Emissions*

Some phases of construction could cause odours that are detectible to some people at a distance from the project site. This would be particularly true during asphalt paving operations. However, asphalt odours would be short-term in nature. Burning waste may also include plastic containers and bags, which can give off odorous and in some instances poisonous gases. The practise of burning waste vegetation from land-clearing and other waste products (e.g. cement bags) can result in significant airborne contaminants. As for the airborne dust particles, these emissions can cause soiling, health problems and visibility problems outside the project boundary.

### 7.8.4 **RECOMMENDED MITIGATION MEASURES**

It was identified in the previous section the most significant air pollution, with respect to health risk and soiling potential (i.e. dust fallout), would potentially occur during the construction phase. The main focus of this section is therefore on the management plans and emission reduction methods which are recommended to minimise the impact beyond the plant boundary.

It is essential to have effective dust and emission controls for every potentially dust generating activity to protect the health and safety of the workforce on site as well as reduce statutory nuisance and health risk to local residents and people in the vicinity.

#### *7.8.4.1 Construction Emission Minimisation Plan*

An emission minimisation plan is regarded essential in the situation where construction activities are conducted very close to residential and other sensitive receptors. Although the currently proposed project is relatively far removed from any large residential areas a management plan is still recommended since it construction would have the potential to impact at the nearby farmsteads. The plan should have, as a minimum, watering schedules of unpaved roads and other activities which could be mitigated with water sprays.

Dust and gaseous generating activities should be detailed to an extent that a risk matrix can be developed. This process would allow the developer to categorise the level of risk of their particular planned work and prioritise each activity. This categorisation could be in the form of the matrix, where for example, the probability of releasing dust or particles is given a value between 1 and 5 (corresponding to “improbable”, “unlikely”, “likely”, “very likely”, “almost certain”) and similarly, severity is given a value ranging from 1 to 5 corresponding to “negligible”, “slight”, “moderate”, “high” and “very high”.

An activity that has a negligible severity of impact and low probability of releasing dust is categorised as low risk. This could include one that is far removed from sensitive receptors and very limited dust generation, e.g. casting concrete on the eastern side of the property. A high risk would be an activity that has the capability of generating significant amounts of dust and it is towards the western side. This may be scraping activity on a windy day.

Mitigation measures that the developer puts in place will help to reduce the impact of a highrisk site to medium or low. Mitigation measures need to take into account seasonal variations, and specifically the occurrence of rainy and windy months. As shown in Section 2.2.3, most rain occurs during December to March, with the least rain from June to September. Summer has the most calm wind days with autumn and winter the lowest occurrence of calm wind periods. The strongest winds occur during spring.

As part of the management plan, a method statement should be completed. The contents should be built on the issues identified in the risk matrix, and should include the following

- Inventory of all dust generating activities and emission control methods to be used;
- Identification of an authorised on-site person responsible person for air pollution –most likely the appointment responsible for health and safety;
- Details and procedure on using a site log book (to record information including exceptional incidents causing dust episodes and action taken, identification and details of vehicle washing, site inspections); and
- Details of any fuel stored on site.

#### *7.8.4.2 Predicted Impact Reduction of Construction Emissions*

The predicted impacts from wheel entrainment constitute approximately a small fraction of the TSP and PM10 emissions. However, these emissions are likely to concentrated in small areas. It is therefore recommended to apply dust suppression on the access roads. Typical dust mitigation measures include regular watering of service roads, speed reduction, minimising material handling operations and early rehabilitation of disturbed surfaces. Untreated plain water is commonly used for roadway dust control.

The study by Rosbury and Zimmer (1983a, 1983b) showed that watering once per hour resulted in a control efficiency of about 40%. Doubling the application rate increased the control effectiveness by about 15% to55%. Thomson and Visser (2002), based on the context of South African coal mines, determined the degree of dust control achieved by watering as a function of the amount of water applied, the time between applications, traffic volumes, weather conditions, wearing course material and the extent of water penetration into the wearing course. They determined that on average degree of dustiness, a 50% reapplication is required at three-hour intervals in the winter and every hour and a half in the summer.

Better success can normally be achieved with chemical dust suppressants (primarily salts and lignins), in excess of 80% (Rosbury and Zimmer 1983a, 1983b).However, even with chemical treatment of the road surfaces, re-entrainment of material spillage can become a problem if chemicals are applied with infrequent watering. Therefore, in situations where spillage cannot be controlled, watering alone is better for dust control.

#### *7.8.4.3 Operational Emission Minimisation Plan*

The potential exists for dust to be generated due to wind erosion of exposed areas at the site after construction. Although it was predicted not to be as significant as during the construction phase, these emissions can be mitigated quite effectively by covering the area with a ground cover (e.g. indigenous grass). It is recommended to cover the site as much as practically possible, but not less than 15%.

### 7.8.5 **Conclusions**

The impact assessment considered potential air pollution emissions during both the construction and operational phases of the proposed photovoltaic power plant. The main conclusion is that the most significant quantity of air emissions could potentially be generated during the construction period, and more specifically fugitive dust.

#### *7.8.5.1 Construction Phase*

The emissions expected during the construction phase include:

- Airborne particulate emissions
    - Land clearing, excavations and grading
    - Entrained dust from construction vehicles, including haul trucks, excavators, bulldozers, compactors, etc.
    - Vehicles travelling along unpaved roads

  - Wind erosion of exposed areas and stockpiles
  - Crushing plant and cement batching, if these were to be used
  - Tailpipe exhausts from vehicles and smaller equipment such as generators and compressors
- Gaseous emissions
  - Combustion products from - On-road and off-road vehicles and Power generators and compressors
  - Volatile organic emissions from asphalt preparation and paving operations, if these were to be used
  - Potential burning of waste

The impact would include both fallout dust and respirable particulates. Larger dust particles can cause a nuisance both within the construction site and outside its boundary, for example through deposition on cars, windows, properties, washing, swimming pools, etc. Respirable dust particulates can be carried further distances, causing health problems not just to construction workers but also to people living and working in the local neighbourhood.

#### *7.8.5.2 Operational Phase*

The emissions expected during normal operation of the photovoltaic power plant will be minimal, and may include:

- Airborne particulates
  - Vehicle activities (tailpipe emissions and wheel entrainment)
  - Windblown dust from cleared un-vegetated areas
- Gaseous emissions
  - Vehicles emissions (tailpipes and evaporative emissions)
  - Emissions potentially from paint and solvent usage

Of these, the only significant pollution would be due to wind erosion of exposed areas. Other air emissions were considered to be insignificant and were not investigated any further. The highest air concentration PM10 daily average levels predicted were less than the SANAAQS daily average limit value is 75 μg/m³.

### 7.8.6 **Recommendations**

Given that construction activities are expected to produce the most significant impact, it is essential to have effective dust and emission controls for every potentially dust generating activity to protect the health and safety of the workforce on site as well as reduce statutory nuisance and health risk to people in the vicinity. Based on the predicted impacts, it is recommended that the construction dust emissions be reduced by 75% to ensure that air concentration (PM10) and fallout rates would be within acceptable limits.

Typical dust mitigation measures include regular watering of service roads, speed reduction, minimising material handling operations and early rehabilitation of disturbed surfaces. Untreated plain water is commonly used for roadway dust control. Chemical treatment of road surfaces could also be considered to reduce fugitive dust.

The degree of dust control achieved by watering is a function of the amount of water applied, the time between applications, traffic volumes, weather conditions, wearing-course material and the extent of water penetration into the wearing course. The amounts and frequency can only be determined once a more detailed construction plan is available. Generally, it has-been found that a 50% emission reduction can be achieved with three-hour watering intervals in the winter and every hour and a half in the summer (between rainy days). Doubling these rates can achieve emission controls of 75%.

Regular inspection and an appropriate maintenance plan must be in place to maintain the effectiveness of the emission control.

The practise of burning domestic and construction waste, including plastic containers and cement bags, must not be allowed since these can give off odorous and in some instances poisonous gases.

Skips must be kept covered. All waste leaving the site has to be covered appropriately. Anywaste residues on the outside of the removal truck must be removed before leaving the site.

During operation, windblown dust can be mitigated quite effectively by covering the area witha ground cover (e.g. indigenous grass). It is recommended to cover the site as much as practically possible, but not less than 15%.

## 7.9 GEOTECHNICAL ASSESSMENT

A Geotechnical Assessment was conducted by Moore Spence Jones (Pty) Ltd. The intention of this report (contained in Appendix G) was to provide preliminary geological and inferred geotechnical information based on a desk study of available information. The published geological maps of the area show the site to be underlain by virgin dolomitic rocks and Kalahari sand.

The following conclusions were found:

- The site comprises approximately 1850 ha of open veld with concentrated areas of dense vegetation and small existing structures. A number of fence lines and gravel roads traverse the site and an existing railway and power line runs through the site.
- Topographically the site is generally flat. Restricted and minor bulk excavations to create construction platforms will not be extensive.
- The majority of bulk and restricted excavations should be provisionally classed as ‘soft’ excavation according to SABS 1200D to an average depth of 0.80 m (but can be shallower than 0.5 m below surface in localised areas). Thereafter, heavy ripping due to estimated intermediate to hard excavation classification.
- Suitable foundation horizons occur at an average nominal depth of 0.8 m but can be shallower than 0.5 m below surface and generally the transported layers are not suitable for founding, even for lightly-loaded structures.
- Groundwater seepage should not be a problem during bulk earthworks and restricted foundation excavations.
- The use of materials for construction purposes is generally favourable.

The primary finding of the geotechnical report was that no fatal flaw was encountered with regards to the geotechnical stability but the main constraint would be the shallow bedrock and resistance to excavation.

- Suitable allowable bearing capacity in excess of 250 kPa for conventional pad foundations for the structures exists at an average depth of 0.80 m below existing ground levels on calcrete and weathered dolomite bedrock.

- Hard excavation and possible blasting should be expected below an average depth of 0.80 m below existing ground level. However, conditions < 0.80 m should be expected over the majority of the site.

- In view of the above shallow bedrock conditions, the popular European foundation method of rammed piles are not recommended at this site.

- Finally it is important to note that the information given in this preliminary report relates specifically to the positions of the inspection pits put down on site and also in conjunction with the proposed FFL and structural loads. It is possible that variations in the subsoil conditions may be encountered elsewhere on site during construction. These variations must be taken into consideration during on site supervision and construction. For this reason it is important that Moore Spence Jones be appointed to evaluate these variations and the effect on the development so that unnecessary expense and delays can be avoided.

## 7.10 HERITAGE IMPACT ASSESSMENT

The Heritage Scoping Report, as the first phase of the total Heritage Impact Assessment (HIA), has shown that the area between Postmasburg and Daniëlskuil generally referred to as the Ghaapplato has a rich history of occupation from the Stone Age with hunter gatherers to the Thlaping and Thlaro during the Iron Age period. The 1800's saw the rise of the Griqua people in the area and their loss of sovereignty after 1880 to Cape rule. The field work that feeds into the Heritage Impact has utilised the findings of the Scoping report to guide this work. The field work identified a total of 3 heritage sites of which none will require mitigation as all of them fall outside the development footprints. The Heritage Impact Assessment is Attached as **Appendix I.**

### 7.10.1 Terms of Reference

The aim of the study is to identify possible heritage sites and finds that may occur in the proposed development area. The Heritage Impact Assessment aims to inform the EIA in the development of a comprehensive EMP to assist the developer in managing the discovered heritage resources in a responsible manner, in order to protect, preserve, and develop them within the framework provided by the National Heritage Resources Act of 1999 (Act 25 of 1999) (NHRA).

### 7.10.2 Impact Assessment and Identification

The findings can be compiled as follow and is combined to produce a heritage sensitivity map for the project:

### *7.10.2.1 Palaeontology*

The study area for the proposed Arriesfontein solar power plant near Daniëlskuil is underlain at depth by Early Precambrian marine carbonate sediments of the Ghaap Group that are only sparsely fossiliferous (e.g. microbial mounds or stromatolites). Most of the study area is mantled by Late Caenozoic superficial deposits including Quaternary to Recent calcretes (pedogeniclimestones) and down wasted rock rubble of comparable age, all of which are of low to very low paleontological sensitivity. Extensive, deep excavations are unlikely to be involved in this sort of solar power plant project.


**Figure 14 –** Headstone in cemetery dating to 1932

The overall impact significance of the proposed development is therefore likely to be LOW and no no-go areas or buffer zones for paleontological heritage resources have been identified by this desktop study. No further specialist paleontological studies, monitoring or mitigation are recommended for this development.

### *7.10.2.2 Archaeology*

The possibility of archaeological finds in the study area has been indicated by previous research and field work in the greater Daniëlskuil area.

This is confirmed by an initial site visit by an archaeologist from PGS to the study area. Concentrations of Stone Age artefact around the pans and dry runs. Mr. Cloete indicated that a local teacher, and tenant on his farm, had a great interest in archaeology and spent numerous hours on Arriesfontein investigating the pan areas and identifying Stone Age Scatters. This fact along with the evidence of stone artefacts found during the site visit indicates the possibility of sensitive archaeological areas being present in the study area.

#### *7.10.2.3 Historical*

Discussion with the current owner Mr Gerrie Cloete, also revealed a rich history around the farm with the Arriesfontein fountain (Figure 15) playing a major role on the transport routes in the area. The fountain was utilised as an outspan when the transport route followed the current rail line that passes just to the south of the fountain and farmstead. Mr Cloete further indicated that the original farmstead was situated just to the west of the fountain in the area where the current farm workers houses and cemetery of the Roc family are situated (**Figure 22** and Figure 16).

**Figure 15 – View of the fountain on Arriesfontein**

An eavaluation othe available information and the site visit data enabled the development of a heritage sensitivity map (**Figure 22**) to guide further investigations during the EIA phase of the project that entails detailed field work in the study area.

**Figure 16 – Cemetery situated just east of the original farmstead area**

### 7.10.3 **Sensitivity Rating**

Due to the nature of cultural remains, with the majority of artefacts occurring below surface, a controlled-exclusive surface survey was conducted over a period of four (4) days on foot by a team of archaeologists of PGS.

#### *7.10.3.1 Identified Heritage Sites*

During the field work only three sites of heritage significance were identified. All three (3) fall outside the development footprint and is situated just north of the Arriesfontein train station but within the study area.

The three sites can be seen as an extended farm complex with the main farmstead (**AF1**), cemetery (**AF2**) and the workers housing (**AF3**). With regards to the Farm History, the establishment of the farmstead and infrastructure was due to the Arriesfontein fountain that is visible in **Figure 17**. The Roux family started a, outspan (stopover) for transport wagons due to the all year presence of water on the property. The original house and outspan area was around the position of AF3 to the south of AF2 in the region of the dry pan on the property.


**Figure 17 – View of greater farmstead and outspan (Fountain indicated by red dot)**

**AF1: GPS Coordinates:**S28 16 48.3 E23 46 05.1

The site consists of the Arriesfontein farmstead with the main house and outbuildings on the property (**Figure 19**). Indication from the current owner is that the original house and core of the current mains farmhouse was constructed in the 1920's when the Roux family moved over from the original farmhouse area close to **AF3**, to the east of **AF1**. The main dwelling is older than 60 years and protected under Section 34 of the NHRA.

**Figure 18 – View of farmstead from access road**

The main historical architectural structure has a **heritage significance rating of Generally Protected GPC**.

**Table 28: Impact Significance Table**

| POTENTIAL ENVIRONMENTAL IMPACT | CRITERIA | | | | | S | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | P | D | S | M | TOTAL | L | M | H |
| CONSTRUCTION | - | 2 | 2 | 1 | 4 | 14 | L | | |
| CONSTRUCTION MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |
| OPERATION | - | 1 | 1 | 1 | 4 | 6 | L | | |
| OPERATION MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |
| CLOSURE | - | 1 | 1 | 1 | 2 | 4 | L | | |
| CLOSURE MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |

**Figure 19 – Aerial view of farmstead layout with shed and kraal visible to the south of the main house.**

**AF 2: GPS Coordinates:** S28 16 43.0 E23 46 10.8

The site consist of formal graves all aligned east west (**Figure 20**). The oldest of the graves date from 1932 (**Figure 21**) and belongs to the Roux family, whom was associated with the farm from the late 1800's to early 1940's. The cemetery is protected under Section 36 of the NHRA.

**Figure 20** – View of cemetery


**Figure 21** – Headstone in cemetery dating to 1932

The CSP is not situated in close proximity to the cemetery and will therefore not have any significant impact. Heritage significance of the site is seen as of High significance and rated as **Grade 3B**.

**Table 29: Impact Significance Table**

| POTENTIAL ENVIRONMENTAL IMPACT | CRITERIA | | | | | S | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | P | D | S | M | TOTAL | L | M | H |
| CONSTRUCTION | - | 2 | 2 | 1 | 4 | 14 | L | | |
| CONSTRUCTION MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |
| OPERATION | - | 1 | 1 | 1 | 4 | 6 | L | | |
| OPERATION MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |
| CLOSURE | - | 1 | 1 | 1 | 2 | 4 | L | | |
| CLOSURE MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |

**AF3: GPS Coordinates:** S28 16 42.1 E23 46 07.1

The site is currently utilised as farm workers housing and consists of two stone and brick build structures and a kraal.  To the north west of the main dwelling on site the remains and foundation of a third structure is present. The bricks and stone utilised during the building of the structures indicate that the dwellings are most probably older than 60 years and protected under Section 34 of the NHRA.

**Figure 22– View of structures on site**


**Figure 23** – **Layout of structures at AF3**

Although a CSP development has been proposed in close proximity to the site a direct impact on it is not foreseen. The structures have a heritage significance rating of Generally Protected GP.C.

**Table 30: Impact Significance Table**

| POTENTIAL ENVIRONMENTAL IMPACT | CRITERIA | | | | | S | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | P | D | S | M | TOTAL | L | M | H |
| CONSTRUCTION | - | 2 | 2 | 1 | 4 | 14 | L | | |
| CONSTRUCTION MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |
| OPERATION | - | 1 | 1 | 1 | 4 | 6 | L | | |
| OPERATION MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |
| CLOSURE | - | 1 | 1 | 1 | 2 | 4 | L | | |
| CLOSURE MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |

**Table 31: Foreseen impact on known heritage resources**

| POTENTIAL ENVIRONMENTAL IMPACT | CRITERIA | | | | | S | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | P | D | S | M | TOTAL | L | M | H |
| CONSTRUCTION | - | 2 | 2 | 1 | 4 | 14 | L | | |
| CONSTRUCTION MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |
| OPERATION | - | 1 | 1 | 1 | 4 | 6 | L | | |
| OPERATION MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |
| CLOSURE | - | 1 | 1 | 1 | 2 | 4 | L | | |
| CLOSURE MITIGATION | - | 1 | 4 | 1 | 2 | 7 | L | | |

**Table 32: Foreseen impact on new heritage resources discovered during project activities**

| POTENTIAL ENVIRONMENTAL IMPACT | CRITERIA | | | | | S | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | P | D | S | M | TOTAL | L | M | H |
| CONSTRUCTION | - | 2 | 5 | 1 | 4 | 20 | L | | |
| CONSTRUCTION MITIGATION | - | 1 | 5 | 1 | 4 | 10 | L | | |
| OPERATION | - | 1 | 1 | 2 | 4 | 7 | L | | |
| OPERATION MITIGATION | - | 1 | 4 | 0 | 2 | 6 | L | | |
| CLOSURE | - | 1 | 1 | 2 | 2 | 5 | L | | |
| CLOSURE MITIGATION | - | 1 | 4 | 0 | 2 | 6 | L | | |

By implementing the recommended management measures and general guidelines the impact on the known and possible subsurface heritage resources can be minimised and managed to within acceptable impact limits.

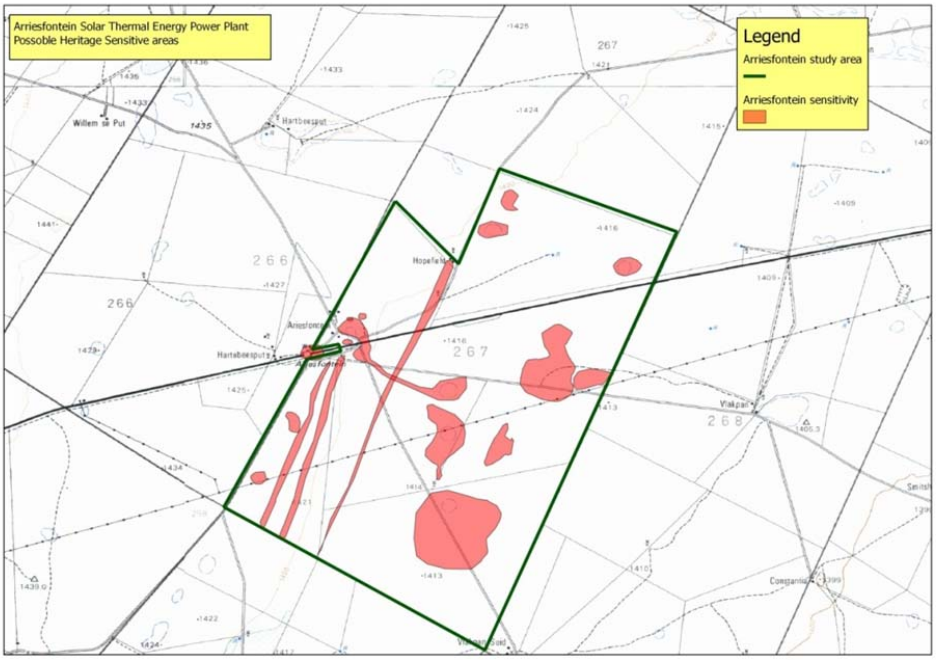


**Figure 24– Heritage Sensitivity Map**

## 7.10.4 **Conclusion**

The Heritage Scoping Report, that forms part of the HIA, has shown that the area between Postmasburg and Daniëlskuil generally referred to as the Ghaapplato has a rich history of occupation from the Stone Age with hunter gatherers to the Thlaping and Thlaro during the Iron Age period. The 1800's saw the rise of the Griqua people in the area and their loss of sovereignty after 1880 to Cape rule.

The field work that feeds into the Heritage Impact has utilised the findings of the Scoping report to guide this work. The field work identified a total of thee (3) heritage sites of which none will require mitigation as all of them fall outside the development footprints.

By implementing the recommended management measures and general guidelines the impact on the known and possible subsurface heritage resources can be minimised and managed to within acceptable impact limits.

The possibility of heritage resources occurring in the study area can however not be excluded and at a minimum a small training section on possible heritage resource that could be encountered, included in the on-site induction for construction staff.

If during construction any possible finds are made, the operations must be stopped and a qualified archaeologist be contacted for an assessment of the find.

### 7.10.5 **Mitigation Measures**

#### *7.10.5.1 General Management Guidelines*

1. The National Heritage Resources Act (Act 25 of 1999) states that, any person who intends to undertake a development categorised as-

    (a) the construction of a road, wall, transmission line, pipeline, canal or other similar form of linear development or barrier exceeding 300 m in length;

    (b) the construction of a bridge or similar structure exceeding 50m in length;

    (c) any development or other activity which will change the character of a site-

        (i) exceeding 5 000 $m^2$ in extent; or

        (ii) involving three or more existing erven or subdivisions thereof; or

        (iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or

        (iv) the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority;

    (d) the re-zoning of a site exceeding 10 000 $m^2$ in extent; or

    (e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority, must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development.

In the event that an area previously not included in an archaeological or cultural resources survey is to be disturbed, the South African Heritage Resources Agency (SAHRA) needs to be contacted. An enquiry must be lodged with them into the necessity for a Heritage Impact Assessment.

2. In the event that a further heritage assessment is required it is advisable to utilise a qualified heritage practitioner preferably registered with the Cultural Resources Management Section (CRM) of the Association of Southern African Professional Archaeologists (ASAPA).

   This survey and evaluation must include:

   (a) The identification and mapping of all heritage resources in the area affected;

   (b) An assessment of the significance of such resources in terms of the heritage assessment criteria set out in section 6 (2) or prescribed under section 7 of the National Cultural Resources Act;

   (c) An assessment of the impact of the development on such heritage resources;

   (d) An evaluation of the impact of the development on heritage resources relative to the sustainable social and economic benefits to be derived from the development;

   (e) The results of consultation with communities affected by the proposed development and other interested parties regarding the impact of the development on heritage resources;

   (f) If heritage resources will be adversely affected by the proposed development, the consideration of alternatives; and

   (g) Plans for mitigation of any adverse effects during and after the completion of the proposed development.

3. It is advisable that an information section on cultural resources be included in the SHEQ training given to contractors involved in surface earthmoving activities. These sections must include basic information on:

   a. Heritage;

   b. Graves;

   c. Archaeological finds; and

   d. Historical Structures.

This module must be tailor made to include all possible finds that could be expected in that area of construction.

4. In the event that a possible find is discovered during construction, all activities must be halted in the area of the discovery and a qualified archaeologist contacted.

5. The archaeologist needs to evaluate the finds on site and make recommendations towards possible mitigation measures.

6. If mitigation is necessary, an application for a rescue permit must be lodged with SAHRA.

7. After mitigation an application must be lodged with SAHRA for a destruction permit. This application must be supported by the mitigation report generated during the rescue excavation. Only after the permit is issued may such a site be destroyed.

8. If during the initial survey sites of cultural significance is discovered, it will be necessary to develop a management plan for the preservation, documentation or destruction of such a site. Such a program must include an archaeological/paleontological monitoring programme, timeframe and agreed upon schedule of actions between the company and the archaeologist.

9. In the event that human remains are uncovered or previously unknown graves are discovered a qualified archaeologist needs to be contacted and an evaluation of the finds made.

10. If the remains are to be exhumed and relocated, the relocation procedures as accepted by SAHRA needs to be followed. This includes an extensive social consultation process.

The definition of an archaeological/paleontological monitoring programme is a formal program of observation and investigation conducted during any operation carried out for non-archaeological reasons. This will be within a specified area or site on land, inter-tidal zone or underwater, where there is a possibility that archaeological deposits may be disturbed or destroyed. The programme will result in the preparation of a report and ordered archive.

**Table 33: Roles and responsibilities of archaeological and heritage management**

| ROLE | RESPONSIBILITY | IMPLEMENTATION |
|---|---|---|
| A responsible specialist needs to be allocated and should sit in at all relevant meetings, especially when changes in design are discussed, and liaise with SAHRA. | The client | Archaeologist and a competent archaeology supportive team |
| If chance finds and/or graves or burial grounds are identified during construction or operational phases, | The client | Archaeologist and a competent archaeology |

| ROLE | RESPONSIBILITY | IMPLEMENTATION |
|---|---|---|
| a specialist must be contacted in due course for evaluation. | | supportive team |
| Comply with defined national and local cultural heritage regulations on management plans for identified sites. | The client | Environmental Consultancy and the Archaeologist |
| Consult the managers, local communities and other key stakeholders on mitigation of archaeological sites. | The client | Environmental Consultancy and the Archaeologist |
| Implement additional programs, as appropriate, to promote the safeguarding of our cultural heritage. (i.e. integrate the archaeological components into employee induction course). | The client | Environmental Consultancy and the Archaeologist, |
| If required, conservation or relocation of burial grounds and/or graves according to the applicable regulations and legislation. | The client | Archaeologist, and/or competent authority for relocation services |
| Ensure that recommendations made in the Heritage Report are adhered to. | The client | The client |
| Provision of services and activities related to the management and monitoring of significant archaeological sites. | The client | Environmental Consultancy and the Archaeologist |
| After the specialist/archaeologist has been appointed, comprehensive feedback reports should be submitted to relevant authorities during each phase of development. | Client and Archaeologist | Archaeologist |

### *7.10.5.2 All phases of the project*

#### **Archaeology**

Based on the findings of the HIA, all stakeholders and key personnel should undergo an archaeological induction course during this phase. Induction courses generally form part of the employees' overall training and the archaeological component can easily be integrated into these training sessions. Two courses should be organised – one aimed more at managers and supervisors, highlighting the value of this exercise and the appropriate communication channels that should be followed after chance finds, and the second targeting the actual workers and getting them to recognize artefacts, features and significant sites. This needs to be supervised by a qualified archaeologist. This course should be reinforced by posters reminding operators of the possibility of finding archaeological/paleontological sites.

The project will encompass a range of activities during the construction phase, including ground clearance, establishment of construction camps area and small scale infrastructure development associated with the project.

It is possible that cultural material will be exposed during operations and may be recoverable, but this is the high-cost front of the operation, and so any delays should be minimised. Development surrounding infrastructure and construction of facilities results in significant disturbance, but construction trenches do offer a window into the past and it thus may be possible to rescue some of the data and materials. It is also possible that substantial alterations will be implemented during this phase of the project and these must be catered for. Temporary infrastructure is often changed or added to the subsequent history of the project. In general these are low impact developments as they are superficial, resulting in little alteration of the land surface, but still need to be catered for.

During the construction phase, it is important to recognize any significant material being unearthed, making and to make the correct judgment on which actions should be taken. A responsible archaeologist/palaeontologist must be appointed for this commission. This person does not have to be a permanent employee, but needs to sit in at relevant meetings, for example when changes in design are discussed, and notify SAHRA of these changes. The archaeologist would inspect the site and any development recurrently, with more frequent visits to the actual workface and operational areas.

In addition, feedback reports can be submitted by the archaeologist to the client and SAHRA to ensure effective monitoring. This archaeological monitoring and feedback strategy should be incorporated into the Environmental Management Plan (EMP) of the project. Should an archaeological/paleontological site or cultural material be discovered during construction (or operation), such as burials or grave sites, the project needs to be able to call on a qualified expert to make a decision on what is required and if it is necessary to carry out emergency recovery. SAHRA would need to be informed and may give advice on procedure. The developers therefore should have some sort of contingency plan so that operations could move elsewhere temporarily while the material and data are recovered. The project thus needs to have an archaeologist/palaeontologist available to do such work. This provision can be made in an archaeological/paleontological monitoring programme.

**Graves**

In the case where a grave is identified during construction the following measures must be taken.

Mitigation of graves will require a fence around the cemetery with a buffer of at least 20 m.

If graves are accidentally discovered during construction, activities must cease in the area and a qualified archaeologist be contacted to evaluate the find. To remove the remains a rescue permit must be applied for with SAHRA and the local South African Police Services must be notified of the find.

Where it is then recommended that the graves be relocated a full grave relocation process that includes comprehensive social consultation must be followed.

The grave relocation process must include:

i. A detailed social consultation process, that will trace the next-of-kin and obtain their consent for the relocation of the graves, that will be at least 60 days in length;

ii. Site notices indicating the intent of the relocation

iii. Newspaper Notice indicating the intent of the relocation

iv. A permit from the local authority;

v. A permit from the Provincial Department of health;

vi. A permit from the South African Heritage Resources Agency if the graves are older than 60 years or unidentified and thus presumed older than 60 years;

vii. An exhumation process that keeps the dignity of the remains intact;

viii. An exhumation process that will safeguard the legal implications towards the developing company;

ix. The whole process must be done by a reputable company that are well versed in relocations;

x. The process must be conducted in such a manner as to safeguard the legal rights of the families as well as that of the developing company.

## 7.11 NOISE IMPACT ASSESSMENT

The terrain may be classified as flat to mildly undulating across the farm and the surrounding areas. The main topographical feature in the area is the Klein Riet River, which flows in a west to east direction through the study area. There is a range of low hills to the west of Daniëlskuil and to the north of Lime Acres. The land falls gently south-eastwards towards the Klein Riet River. The Noise Impact Assessment is attached as **Appendix K**.

The land use in the study area is predominantly agricultural with mines to the west of the development site. The main farming endeavour is cattle. Other significant land uses in the area are:

1. **Residential**: The town of Daniëlskuil is located approximately 32 kilometres north-east of the development site. The urban settlement (township) of Lime Acres serving the Lime Aces Mine lies approximately 17 kilometres west of the development site. Additionally numerous farmhouses and farm labourer houses throughout the area.

2. **Educational**. There are a number of schools in Daniëlskuil and Lime acres, and a farm school to the north of the development site.

3. **Tourism:** There are a number of game farms and lodges in the area. Constantia Safaris is located on the farm immediately to the east of the development site.

4. The **industrial** area of Daniëlskuil is located in the southern sector of the town, with the Idwala Limestone Mine and Factory lies just south of Daniëlskuil. Additionally the Lime Acres Mine lies to the west of the development site.

There are a number of major roads and secondary roads servicing the area:

- Provincial Road TR07001 (Route R385) from Postmasburg to Route R31.
- Provincial Road TR00503 (Route R31) from intersection with road TR07001 (Route R385).
- Provincial Road TR00504 (Route R31) from Kuruman to Daniëlskuil to intersection with Road TR07001.
- Provincial Road MR00803 (Route R385).
- The access road to Arriesfontein Station is also the access road to the development site.

Two railway lines pass through the study area:

- The Postmasburg – Barkly West railway line is aligned in an east-west direction through the central portion of the farm Arriesfontein. The line carries 14 trains per day (data obtained from Transnet Freight Rail). The Arriesfontein Siding is located on the western boundary of the farm Arriesfontein.
- There is an industrial spur line from the Idwala Lime Mine just south of Daniëlskuil, joining the main Postmasburg – Barkly West railway line at the Silver Streams Siding.

#### *7.11.1.1 Factors of Acoustical Significance*

The relatively flat topographical features in the study area provide little acoustic shielding between the possible development sites and the adjacent noise sensitive areas. Noise will tend to be channelled along the shallow drainage valleys in the area. The main meteorological aspect that will affect the transmission (propagation) of the noise is the wind. The wind can result in periodic enhancement downwind or reduction upwind of noise levels. Analysis of the wind records for the area indicates that the main prevailing winds blow from the northeast (48% of the time) and the northwest (21%). Approximately 6,7% still periods are experienced annually.

Atmospheric temperature inversions have a significant effect on the noise propagation character of the area. Temperature inversions tend to increase noise levels at some distance from a source. A temperature inversion is formed when air near the ground is cooler than the air above. This occurs mainly at night or to a lesser extent during cloudy days away from large bodies of water. Stable conditions with high humidity and very low velocity wind conditions are necessary. As cool air is denser than warm air, sound rays are refracted towards the cooler air, that is, towards the ground.

#### *7.11.1.2 Noise Sensitive Receptors*

The residential, educational and recreational land uses are considered to be noise sensitive receptors (NSR). For this study, the position of houses/dwellings/game lodges on the farms was taken off 1:50 000 topographical cadastral maps and verified as far as possible using Google Earth. Even though the latest editions were used, the relevant maps are 30 years out of date and there may be new dwellings and/or some of the existing shown buildings may be derelict. During the field survey for the noise measurement survey, such aspects were noted where possible.

The following 1:50 000 topographical cadastral maps were used:

- SOUTH AFRICA 1:50 000 Sheet 2823AB, GROENWATER Second Edition 1989.
- SOUTH AFRICA 1:50 000 Sheet 2823BA, DANIËLSKUIL Second Edition 1982.
- SOUTH AFRICA 1:50 000 Sheet 2823BB, SWARTPUTS Second Edition 1982.
- SOUTH AFRICA 1:50 000 Sheet 2823AD, LIME ACRES Second Edition 1982.
- SOUTH AFRICA 1:50 000 Sheet 2823BC, SILVERSTREAMS Second Edition 1982.
- SOUTH AFRICA 1:50 000 Sheet 2823BD, ARRIESFONTEIN Second Edition 1982

### 7.11.2 **Terms of Reference**

The terms of reference (TOR) are as follows:

- A sufficiently detailed quantitative (by measurement) and qualitative assessment within the area of influence of the planned Arriesfontein Solar Power Plant was to be undertaken at the development site in order to enable a full appreciation of the nature, magnitude, extent and implications of the potential noise impact.

- The level of investigation was to that of an Environmental Impact Assessment (EIA).

- The evaluation covered the CSP and PV Plant site and proximate appurtenant works.

- All aspects of the investigation were to conform to the requirements of relevant environmental legislation and noise standards.

- The potential impacts of the pre-construction, construction and operational phases of the project were to be assessed.

- Mitigation measures were to be identified. These were to be in concept only and not in detail.

### 7.11.3 **Impact Assessment and Identification**

The assessment of the noise impact was guided by the requirements of the South African National Standard SANS 10328 titled Methods for Environmental Noise Impact Assessments and the Noise Control Regulations. A comprehensive assessment using the appropriate noise impact descriptors (standards) has been undertaken. The noise impact criteria used in this investigation specifically take into account those as specified in the South African National Standard SANS 10103 The Measurement and Rating of Environmental Noise with Respect to Land Use and Speech Communication, as well as those in the National Noise Control Regulations.

For this study, the position of houses/dwellings/game lodges on the farms was taken off 1:50 000 topographical cadastral maps and verified as far as possible using Google Earth. Even though the latest editions were used, the relevant maps are 30 years out of date and there may be new dwellings and/or some of the existing shown buildings may be derelict. During the field survey for the noise measurement survey, such aspects were noted where possible.

#### *7.11.3.1 Assessment of the Pre-Construction Phase*

Activities during the planning and design stages that have possible impact implications in the study area are related to field surveys (such as seismic testing and geological test borehole drilling for large building/structure foundation investigations). As these survey activities will be of short duration and take place during the day, they are unlikely to cause any noise impact.

### *7.11.3.2 Assessment of the Construction Phase*

The potential noise climate was established in general for the construction of the CSP Plant and PV Plants inclusive of appurtenant works such as the construction of new access roads. It is likely that the construction of three PV Plants and the CSP Plant will be staged in four phases.

Although some of the details of the planned Plant have not yet been finalised, general concepts have been used in the noise impact evaluation and these are adequate to provide a sound basis for the analysis of typical noise conditions and impacts that are likely to prevail on the project. Data related to construction have been sourced from various consultants and also based on the experience that JKA has had working on similar sites.

Construction will likely be carried out during the daytime only (07h00 to 18h00 or 20h00). It should however be noted that certain activities may occasionally extend into the late evening period, while others such as de-watering operations may need to take place over a 24-hour period. The construction of the central concentration tower may also be a continuous pour of concrete using a sliding shutter. It is estimated that construction will take place over a period of three years and at the earliest the whole Plant could be commissioned by Year 2015.

The following are likely to be the main construction related sources of noise for the CSP Plant, the PV Plant and related infrastructure for each of the four phases of construction:

- Construction camp establishment. This will be for the site offices, workshops and possibly the accommodation camp for the workers on site.
- Activities related to the relocation of services.
- Excavation of building basements and service trenches. Blasting may be required in places but in general pneumatic breakers will be used where rock is encountered.
- Piling operations for large buildings/structures.
- Erection of shuttering for concrete.
- Fixing of steel reinforcing.
- Placing and vibration of concrete. Poker vibrators will be used.
- Stripping of shuttering after concrete pour.
- Erection of structural steelwork.

– Finishing operations on buildings. Cladding, services installation, etc.

– Installation of generating plant and ancillary plant.

– General movement of heavy vehicles such as concrete delivery vehicles, mobile cranes, mechanical dumpers and water trucks (dust suppression) around the site.

– De-watering pumps. A 24-hour operation may sometimes be necessary.

– Road construction equipment. Scrapers, dozers, compactors, etc. (Construction of the internal road system and access roads).

– Construction site fabrication workshops and plant maintenance workshops.

– Construction material and equipment delivery vehicles.

– Concrete batching plant and asphalt batching plant on site.

The level and character of the construction noise will be highly variable as different activities with different plant/equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site. Typical noise levels generated by various types of construction equipment are given in **Table 34**.These noise levels assume that the equipment is maintained in good order. Conservative attenuation conditions (related to intervening ground conditions and screening) have been applied.

**Table 34: Typical noise levels generated by construction equipment**

| Plant/Equipment | Typical Operational Noise Level at Given Offset (dBA) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5m | 10m | 25m | 50m | 100m | 250m | 500m | 1 000m |
| Air compressor | 91 | 85 | 77 | 71 | 65 | 57 | 51 | 46 |
| Compactor | 92 | 86 | 78 | 72 | 66 | 58 | 52 | 46 |
| Concrete mixer | 95 | 89 | 81 | 75 | 69 | 61 | 55 | 49 |
| Concrete vibrator | 86 | 80 | 72 | 66 | 60 | 52 | 46 | 40 |
| Conveyor belt | 77 | 71 | 63 | 57 | 51 | 43 | 37 | 32 |
| Crusher (aggregate) | 90 | 84 | 76 | 70 | 64 | 56 | 50 | 44 |
| Crane (mobile) | 93 | 87 | 79 | 73 | 67 | 59 | 53 | 47 |
| Dozer | 95 | 89 | 81 | 75 | 69 | 61 | 55 | 49 |

| Plant/Equipment | Typical Operational Noise Level at Given Offset (dBA) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5m | 10m | 25m | 50m | 100m | 250m | 500m | 1 000m |
| Loader | 95 | 89 | 81 | 75 | 69 | 61 | 55 | 49 |
| Mechanical shovel | 98 | 92 | 84 | 78 | 72 | 64 | 58 | 52 |
| Pile driver | 110 | 104 | 97 | 91 | 85 | 77 | 71 | 65 |
| Pump | 86 | 80 | 72 | 66 | 60 | 52 | 46 | 40 |
| Pneumatic breaker | 98 | 92 | 84 | 78 | 72 | 64 | 58 | 52 |
| Rock drill | 108 | 102 | 94 | 88 | 82 | 74 | 68 | 62 |
| Roller | 84 | 78 | 70 | 64 | 58 | 50 | 44 | 38 |
| Trucks | 87 | 81 | 73 | 67 | 64 | 60 | 57 | 54 |

Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction site layout, work programme for the various components, work modus operandi and type of equipment have not been finalised.

Using baseline data from typical construction sites, the ambient noise conditions at various offsets from the following main construction activities are predicted:

– Noise from concrete batching plant.

– General concrete construction in the various proposed plant areas.

**Table 35: Predicted Ambient noise levels at given offsets from some specific construction activities**

| Equipment | Sound pressure level at given offset(dBA) | | | | | |
|---|---|---|---|---|---|---|
| | 500m | 1000m | 1500m | 2000m | 2500m | 3000m |
| Concrete Batching Plant | 53.6 | 46.0 | 41.1 | 37.5 | 34.7 | 32.3 |
| Concreting Operations | 57.2 | 49.1 | 43.9 | 40.1 | 37.1 | 34.6 |

The nature of the noise impact from the large building construction sites is likely to be as follows:

- Source noise levels from many of the construction activities will be high. Noise levels from all work areas will vary constantly and in many instances significantly over short periods during any day working period.

- Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction site layout, work programme for the various components, work modus operandi and type of equipment have not been finalised. Working on a worst case scenario basis, it is estimated that the ambient noise level from general construction activities could negatively affect noise sensitive sites within a distance of 1 380 m of the construction site. Night-time construction could have a significant impact on noise sensitive sites within a radius of 3 000 m of the construction site.

- There may be significant noise nuisance effects during the day from intermittent loud noises on people living in the area. If there is any night-time construction, fairly significant impacts will be experienced. Preliminary investigation has shown that there are several noise sensitive receptors in the vicinity of the development site.

- It has been estimated that the construction activities at the site could, on average, generate no more than about 150 vehicle trips (two way trips) daily. The main percentage of the trips will be concentrated in the morning and evening peak periods. In general, the construction traffic will have a relatively minor effect on the noise climate alongside the main external roads in the area.

The nature of the noise impact from the road construction activities (internal roads, access roads) is likely to be as follows:

- The level and character of the construction noise will be highly variable as different activities with different plant/equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site.

- As no specific construction details or possible locations of major ancillary activity sites are available at this stage, the anticipated noise from various types of construction activities cannot be calculated accurately. In general at this stage, it can be said that the typical noise levels of construction equipment at a distance of 15 metres lie in the range of 75 decibels (dBA) to 100dBA. Based on data from similar "linear" construction sites, a one-hour equivalent noise level of between 75dBA and 78dBA at a point 50 metres from the construction would be typical for the earthmoving phase.

It should be noted that higher ambient noise levels than recommended in SANS 10103 are normally accepted as being reasonable during the construction period, provided that the very noisy construction activities are limited to the daytime and that the contractor takes reasonable measures to limit noise from the work site. Note that it has been assumed that construction will generally take place from 06h00 to

18h00 with no activities (or at least no noisy construction activities) at night. From the details presently available, it appears that the construction noise impact is not likely to be severe. Preliminary investigation showed that there are several noise sensitive receptors within the areas of impact of the construction (refer to **Appendix K** Figure 2 in the Noise Impact Assessment Report).

#### *7.11.3.3 Assessment of the Operational Phase*

The planned Solar Power Plant was evaluated on the following basis:

- Electrical substation to accommodate step-up transformers and switch gear connecting the plant to the electricity grid.
- Truck-mounted high-pressure washing system to clean the heliostats and PV panels (night-time).
- Noise impact from ancillary works (such as water purification works and waste water treatment plant).
- Solar Thermal Plant generated traffic.

The main noise sources at the CSP Plant will be the steam generating unit, the turbines, the cooling fans, and the pumps. The noise from the cooling fans will be the loudest and will predominate at areas outside the development property.

Two operational situations have been modelled, namely full operations during the daytime, and standby operations during the night and during cloudy conditions. In addition, for the daytime operations, various meteorological conditions have been modelled.

It is predicted that the noise from the CSP Plant could be of the order as shown in **Table 33** at the given offsets from the plant for various meteorological conditions. The equivalent continuous sound pressure level for one hour of operation (LAeq,1h) is indicated.

**Table 34** indicates the continuous sound pressure level for one hour of operation (LAeq,1h) during standby conditions. Inversion conditions (worst case scenario) have been modelled for the standby conditions.

For daytime operations, noise sensitive sites (in a rural setting) within 2 150 m from the CSP Plant and 600 m from the PV Plants could be significantly impacted. For night-time operations (standby) noise sensitive sites within 2 450 m of the Plant will be impacted. There are several noise sensitive receptors affected by noise from the development.

The noise levels given are the unmitigated values. A conservative approach has been taken in that a hard intervening ground condition has been modelled. There will be greater attenuation than shown with distance where there are houses, other buildings and terrain restraints in the intervening ground between the source and the receiver point. The sparse vegetation in the area will not assist the attenuation with distance.

With regard to the washing of the heliostats, there will be an intermittent noise generating operation undertaken at night. A truck mounted high pressure washing system will be used. While the trucks are spraying the heliostats, maximum noise levels are not expected to exceed 35dBA at 1 000 m.

The Solar Power Plant will only operate during the hours of daylight and, at best in mid-summer will operate from 08h00 to 18h00. This operation will generally be continuous during this period. Although the power generation will be limited to the hours of sunlight, the temperature of the heat transfer fluid has to be kept heated during the night-time and/or any other down-period. An auxiliary heating system for the heat transfer fluid will be installed. The heliostats and PV panels will be regularly cleaned by means of a truck mounted high-pressure washing system. This operation will presumably take place at night. It is predicted that the noise from the Plant could be of the following order (under atmospheric temperature inversion conditions) at the given offsets from the plant:

**Table 36: CSP plant noise levels from under inversion conditions (40 inverter/transformer units)**

| Noise Level (dBA) | Offset (m) |
|---|---|
| **35** | 1 500 |
| **40** | 1 000 |
| **45** | 600 |
| **50** | 300 |

Under daytime operating conditions impacts can be expected within 600 metres of the PV Plants (using rural residential standards). The noise levels given are the unmitigated values. A conservative approach has been taken in that a hard intervening ground condition has been modelled. There will be greater attenuation than shown with distance where there are houses, other buildings and terrain restraints in the intervening ground between the source and the receiver point. The sparse vegetation in the area will not assist the attenuation with distance.

A substation will be built to serve the Solar Power Plant. The noise profile of a typical medium-sized substation is as given in Table 37below. Preliminary investigation shows that there are some noise sensitive receptors in the vicinity of the substation site. It should, also be noted that transformers typically emit a predominant pure tone of 100Hz, which, although not loud in volume, has the potential to induce vibrations in nearby structures, such as the houses/lodges nearby and offices for the complex.

**Table 37:Noise profile of a typical substation**

| Offset Distance (m) | 250 | 500 | 1000 | 1500 | 2000 | 2500 | 3000 |
|---|---|---|---|---|---|---|---|
| Noise Level (dBA) | 39.7 | 33.6 | 27.6 | 24.1 | 21.6 | 19.7 | 18.1 |

These noise levels are very low and are likely to be masked by the noise generated by the CSP Plant (both daytime operational and night-time standby mode).

For a typical Ancillary Plant (Water Purification Works and Waste Water Treatment)installation that could be used the ambient noise level could be of the order of 40dBA at a 300 m offset.

There are no other sources of noise in the study area with which the Solar Power Plant will have significant cumulative effects.

The total volume of traffic generated by the Solar Power Plant will be very small in comparison to the total volume of traffic on the adjacent main roads. It is estimated that there could be of the order of 60 vehicle trips (two-way) per day generated by the development. These volumes are far too small to cause any significant noise impact on the main roads in the study area. Although there will be a relatively large increase in traffic volumes on the access road to the development site (the access road to Arriesfontein Station), the order of this increase will not have significant noise impact.

### 7.11.4 Sensitivity Rating

The following assessment of the potential noise impact of the Solar Power Plant is based on the methodology provided by Worley Parsons RSA (Pty) Ltd. The construction, operational and closure phases were analysed.

**Table 38**: Impact Significance

| POTENTIAL ENVIRONMENTAL | CRITERIA | | | | | S | SIGNIFICANCE | | |
|---|---|---|---|---|---|---|---|---|---|
| IMPACT | Nature | P | D | S | M | TOTAL | L | M | H |
| CONSTRUCTION | - | 3 | 2 | 2 | 4 | 24 | L | | |
| CONSTRUCTION MITIGATION | + | 3 | 2 | 2 | 4 | 24 | L | | |
| OPERATION | - | 3 | 4 | 2 | 4 | 30 | L | | |
| OPERATION MITIGATION | - | 3 | 4 | 2 | 4 | 30 | L | | |
| CLOSURE | + | 3 | 2 | 2 | 4 | 24 | L | | |
| CLOSURE MITIGATION | + | 3 | 2 | 2 | 4 | 24 | L | | |

### 7.11.5 **Conclusion**

The conclusions that can be drawn from the Noise Impact Evaluation indicates that the residual noise climate area of the Solar Power Plant development is typical of a rural environment. The residential areas of Daniëlskuil and Lime Acres have a typical suburban noise climate. These however will not be affected by the noise proposed by the Solar Power Plant. Areas close to the main roads and railway lines in the study area are furthermore degraded with respect to rural residential living. The Solar Power Plant will introduce an uncharacteristic loud noise source into the area.

For day time operation of the Solar Power Plant an area within a radius of 2 150 m of the plant (45dBA contour) could potentially be adversely affected by the noise from the plant. And examination of the area indicates that there are noise sensitive receptors within the noise area of influence from the development. There are measures that can be introduced to mitigate some of the impacts of the operational noise but in general the development will alter the noise profile and character of the area significantly. Adverse noise conditions can be expected especially at night.

To conclude the noise impact proposed Solar Power Plant will not be extensive but will be significant with relation to the nearest noise sensitive receptor.

### 7.11.6 **Mitigation Measures**

It is recommended that the National Noise Control Regulations and SANS 10103:2008 should be used as the main guidelines for addressing the potential noise impact on the project. All mitigation measures as listed in the remainder of this section needs to be considered. The power generation unit of the Solar Power Plant should be constructed at an offset as far as possible from the nearest noise sensitive receptors – depending on the intended period of operations. Additionally it is recommended that the proposed noise mitigation measures as listed below be designed and or signed off by an acoustical engineer in order to optimise the design parameters and ensure that the cost/benefit of the measure is optimised. Upon completion and finalisation of the layout components the actual noise profile of the Solar Power Plant needs to be derived and checked.

At the commissioning of the Solar Power Plant the noise footprint of each discrete element should be established by the measurement in accordance with the relevant standards i.e. SANS ISO 8297:1994 and SANS 10103. Noise character should be checked to ascertain if any nuisance factors arise during g operations. Lastly it is recommended that the integrity of access to the farms be maintained to the east of the development as these farms presently obtain access by means of the Arriesfontein Station access road which is routed across the site.

Potential noise mitigation measures for the project were identified.

### *7.11.6.1 Pre-construction Phase*

Local residents should be notified of any potentially noisy field survey works or other works during the planning and design phase and these activities should be undertaken at reasonable times of the day. These works should not take place at night or on weekends.During this phase, consideration must be given to the noise mitigation measures required during the construction phase and which should be included in the tender document specifications and the design.

### *7.11.6.2 Construction Phase*

The noise mitigation measures to be considered during the construction phase are as follows:

- Construction site yards, workshops, concrete batching plants, and other noisy fixed facilities should be located well away from noise sensitive areas.
- Use of low-noise generation construction machinery. Noise control measures on construction machinery must, however, be agreed with the manufacturer.
- Where possible, stationary noisy equipment (for example compressors, pumps, pneumatic breakers) should be encapsulated in acoustic covers, screens or sheds. Proper sound insulation can reduce noise by up to 20dBA. Portable acoustic shields should be used in the case where noisy equipment is not stationary (for example drills, angle grinders, chipping hammers, poker vibrators).
- Curtailing the uses of reverse-warning signals on site vehicles in certain areas and at certain times. Consideration of alternative safety measures may be necessary when taking such a measure.
- All construction vehicles, plant and equipment are to be kept in good repair, for example, cover sheets should not vibrate or rattle; wheels, rollers and pulleys should not squeak.
- Truck traffic should be routed away from noise sensitive areas, where possible.
- Noisy operations should be combined so that they occur where possible at the same time.
- Instruction of employees on low-noise work methods, for example, the handling of structural steel and the use radiotelephony rather than shouting for communication.
- Blasting operations (if required) are to be strictly controlled with regard to the size of explosive charge in order to minimise noise and air blast, and timings of explosions. The number of blasts

per day should be limited, blasting should be undertaken at the same times each day and no blasting should be allowed at night.

- Machines in intermittent use should be shut down in the intervening periods between work or throttled down to a minimum.

- Construction activities are to be contained to reasonable hours during the day and early evening. Night-time activities near noise sensitive areas should not be allowed. No construction should be allowed on weekends from 14h00 on Saturday afternoons to 06h00 the following Monday morning.

- With regard to unavoidable very noisy construction activities in the vicinity of noise sensitive areas, the contractor should liaise with local residents and owners on how best to minimise impact, and the local population should be kept informed of the nature and duration of intended activities.

- As construction workers operate in a very noisy environment, it must be ensured that their working conditions comply with the requirements of the Occupational Health and Safety Act (Act No 85 of 1993). Where necessary ear protection gear should be worn.

#### *7.11.6.3 Operational Phase*

The following noise mitigation measures, which will need to be considered where appropriate, are indicators of what needs to be done to reduce or control the noise generated by the operations at the Solar Power Plant:

- The design of all major plant for the development is to incorporate all the necessary acoustic design aspects required in order that the overall generated noise level from the new installation does not exceed a maximum equivalent continuous day/night rating level (LRdn), namely a noise level of 70dBA (just inside the property projection plane, namely the property boundary of the Solar Power Plant) as specified for industrial districts in SANS 10103. Notwithstanding this provision, the design is also to take into account the maximum allowable equivalent continuous day and night rating levels of the potentially impacted sites outside the Solar Power Plant property. Where the noise level at such an external site is presently lower than the maximum allowed, the maximum shall not be exceeded. Where the noise level at the external site is presently at or exceeds the maximum, the existing level shall not be increased by more than indicated as acceptable in SANS 10103.

- The latest technology incorporating maximum noise mitigation measures for components of the complex should be designed into the system. Ideally, plant and equipment should meet the following specification: the sound power level (LW) should be such that the sound pressure level (SPL – i.e. the noise level) measured at 1 m from the surface of the given plant/equipment should not exceed 85dBA. When ordering plant and machinery, manufacturers should be requested to provide details of the sound power level. Where possible, those with the lowest sound power level (most quiet) should be selected.

- The design process is to consider, inter alia, the following aspects:
- The position and orientation of buildings on the site. Ideally the power block should be located as far as possible from any of the Arriesfontein farm boundaries.
- The design of the buildings to minimise the transmission of noise from the inside to the outdoors.
- The insulation of particularly noisy plant and equipment.
- All plant, equipment and vehicles are to be kept in good repair.
- Where possible, very noisy activities should not take place at night (between the hours of 20h00 to 06h00). It must be ensured with the washing of the heliostats and PV panels at night that noise levels from the high-pressure hose system (compressor) on the trucks are minimised.

It should be noted that any mitigation measures taken at the Solar Power Plant will limit the impacts in the specific areas designed for, but will not necessarily contribute to improving the degraded noise climates in adjacent areas where there is already a problem.

## 7.12 VISUAL IMPACT ASSESSMENT

The study area for the visual assessment encompasses a geographical area of 61x67 km and includes a minimum 16 km buffer zone from the proposed development area. The Visual Impact Assessment is attached as **Appendix O**.

The project is located in a semi-arid region with sparse vegetation and exposed soil, which is mostly untransformed. Development that due occur in the area include mining and farming activities, with commercial farming limited to sheep, cattle and game farming. Hunting takes place on some farms in the region. A hunting enterprise, *Constantia Safaris*, abuts the proposed development site on its eastern boundary (Farm 268). Farmsteads are widely spread, with an associated low population density.

The towns in the study area are mostly associated with mining activity. Daniëlskuil, Hay and Lime Acres are located between 25 – 27 km west of the site. Koopmanshoop and Ulco are located at a distance of 24 and 40 km from the site respectively.

Infrastructure in the study area consist of a network of roads and overhead distribution powerlines, substations, and a railway line. The R385 is the closest road and situated roughly 5 km north of the site. Other roads include the R31 and R373, as well as a number of secondary roads and access roads to farms. A 132 kV transmission line and a railway line transect the proposed development site from west to east, running more or less parallel to each other.

The proposed development site is located on a large plateau with Ghaap Plateau Vaalbosveld the dominant vegetation type. This plateau is flanked by the Rooiberge / Asbesberge mountain range in the west, and a range of distinct ridges in the east. The plateau slopes gently eastward towards the Vaal river which is approximately 50 – 60 km south east of the site. Being a flat area, drainage lines are limited to a few east flowing non-perennial rivers. Dry pans are a general sight in the area.

The combination of thicket, bushland and bush clumps on a vast flat landscape, together with views of relative high mountains in the west, lend a coherent visual character to the area. Being largely undeveloped for at least 25 km around the site, views in this area are aesthetically pleasing. At night, especially moonless nights, the skies reveal rarely seen clear views of the stars, with particularly the milky way etched against a pitch black night sky.

The sense of place in this region is characterised by a quiet, undeveloped landscape with views of wide and open flats. Mountain ridges are visible in the far distance. Views of this unique landscape are found over most of the region, which as such is sensitive to land use change.

### 7.12.1 Terms of Reference

The scope of work for this study includes the determination of the potential visual impacts in terms of nature, extent, duration, magnitude, probability, and significance of the construction and operation of the proposed infrastructure.

In this regard specific issues relate to the visual impact to the affected environment. These have been established during the scoping phase and include the following:

- The visibility of primary infrastructure, especially the central receiver and heliostats of the CSP plant, and the solar panels of the PV plant;
- The exposure of the above mentioned infrastructure and potential visual impact in respect of sensitive receiving environments, including the following:
  - the neighbouring Farm 268, directly east of the development site, hosting Constantia Safaris, which is a hunting operation;
  - Other farms around the proposed CSP and PV Plant site;

  - Observers travelling along roads, i.e. the R385, R31 and R373;

- Potential impact of the facility on the visual character of the landscape and sense of place of the region;

- The potential visual impact of ancillary infrastructure (substation, access roads, other buildings) on observers in close proximity to the site;

- The potential visual impact of operational, safety and security lighting at night time on observers living in close proximity to the site;

- Potential cumulative impacts, taking into account the introduction of CSP and PV technology in a rural area;

- The visual absorption capacity of the natural vegetation (if applicable);

- Potential visual impacts associated with the construction phase; and

- The potential to mitigate visual impacts.

The above issues will each be assessed individually, and quantified where applicable according to specific assessment criteria.

## 7.12.2 **Impact Assessment and Identification**

### *7.12.2.1 Potential Visual Exposure*

The potential visual exposure analysis was undertaken from actual positions as set out in the layout for the CSP and PV plant. The heights of the central tower (approximately 200 m) and heliostats (approximately 14 m) were used to generate viewsheds (areas with a line of sight to the facility), as these represent the largest and potentially the most visibly and prominent infrastructure within the proposed facility. The potential visual exposure of the CSP panels and ancillary infrastructure is also accommodated within the heliostat field viewshed, as the footprint and height of these are smaller.

The visual exposure of the field of heliostats and that of the central tower are indicated on the map in Figure 25. The viewshed of the heliostat field is indicated in shadings of red (full exposure), changing to yellow, green and blue, thereby signifying declining visual exposure. Underneath, the viewshed of the central tower is indicated in shadings of brown, with dark brown representing full exposure and light brown indicating areas from which only parts or sections would be visible. The overwhelming red and dark brown colours are indicative of the large degree of visual exposure, meaning that the complete facility may be visible to large parts of the study area. It must be noted that the effect of distance is not incorporated in this analysis. Proximity is assessed as a separate parameter.

The viewshed analyses indicate that the heliostat field would primarily be exposed to areas north, east and south of the facility, extending to distances of beyond 16 km. Due to its extensive height, the central tower will be exposed to a much larger area, covering virtually the whole study area.

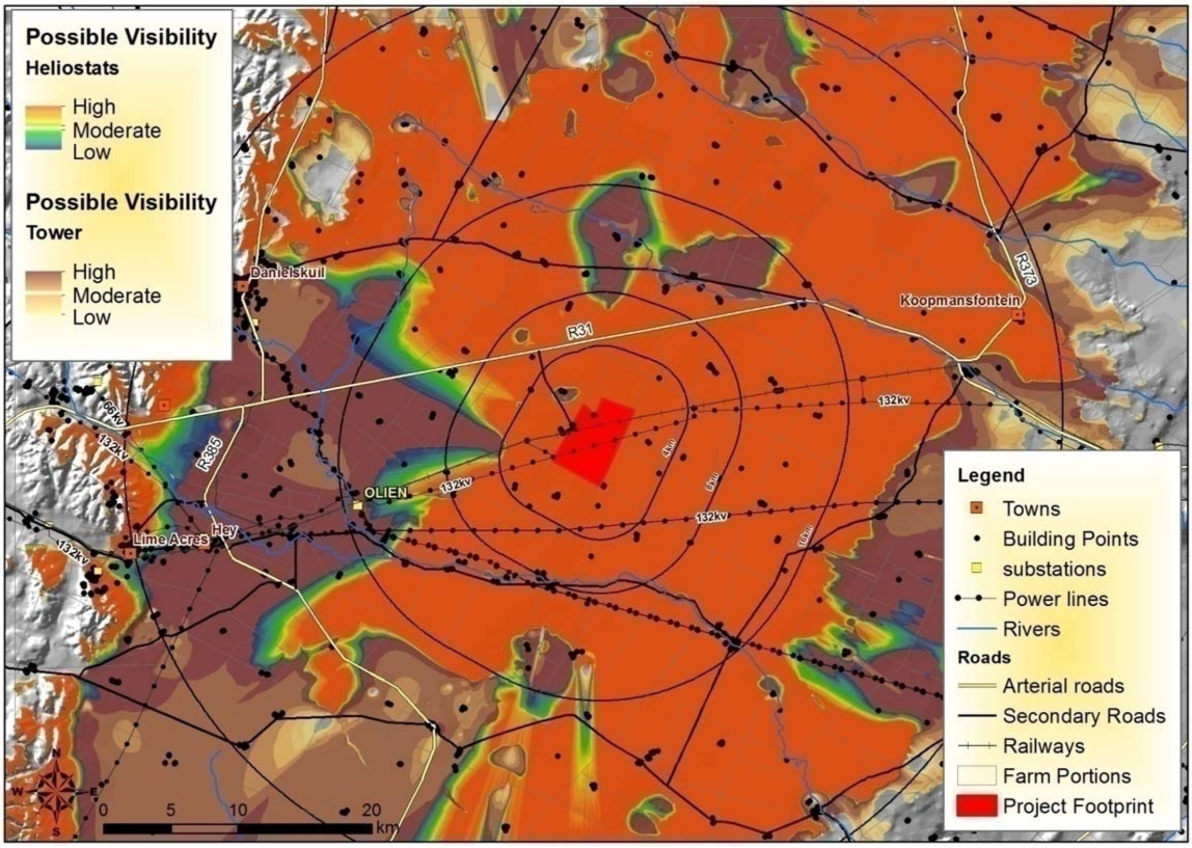


**Figure 25: Combined viewshed analysis of the Central Tower and Heliostats.**

Affected areas include the rural area surrounding the facility, and roads within close proximity (< 8 km). Although towns and settlements are implicated in the viewshed analyses, it is anticipated that they won't be affected significantly.

The proposed solar facility will be visible from Constantia Safaris, on the neighbouring Farm 268. It should be noted that this farm is primarily used for hunting purposes and that it does not attract large numbers of tourists. It is envisaged that the proposed facility would be easily and comfortably visible, especially within a 16 km radius of the site. The central tower in particular would constitute a high visual prominence, potentially resulting in a high visual impact. ***It should be noted, however that the nature of the impact is subjective.***

### *7.12.2.2 Visual Distance/Observer Proximity to the facility*

In addition to the visibility and exposure analyses as described above, a proximity analysis is required to incorporate the effect of reduced visibility over distance. The degree to which an object fills a person's central field of vision determines the visual impact it might cause.

The central field of vision for most people covers an angle of between 50° to 60°. Within this angle, both eyes observe an object simultaneously. This creates a central field of greater magnitude than that is possible by each eye separately. Within this field images are sharp, depth perception occurs and colour discrimination is possible (**Figure 26**).

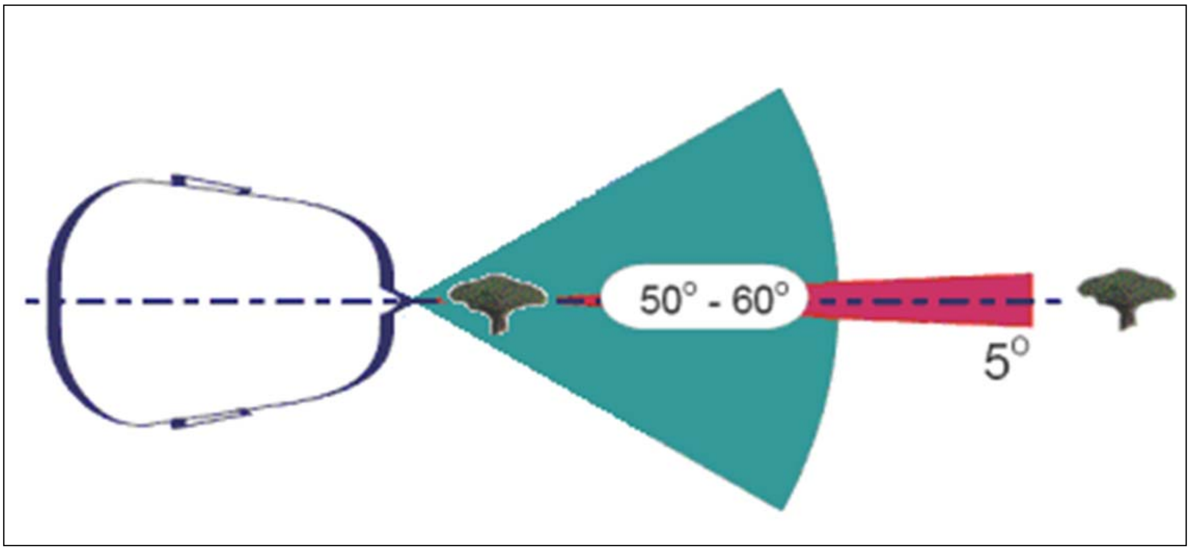


**Figure 26: Illustration of a person's central field of vision and the relation between distance from an object and visual impact.**

The visual impact of a development will vary according to the proportion in which an observed object impacts on the central field of vision. This in turn is determined by the distance from the object (e.g. a tree as illustrated in Figure 27). Objects which take up less that 5% of the central field of vision are usually insignificant in most landscapes (Berry and Martin, 2003).

The degree to which visual impact might be reduced over distance is illustrated by the graph in **Figure 27:** Reduced visibility over distance below. Expressed as a hyperbolic function, more than 50% of the degree of impact is reduced over a relative short distance from the immediate proximity of an object.

The interpretation of proximity as a parameter is conceptual, since the spatial dimensions of the object in view determine the degree of exposure within the central field of vision, which is difficult to quantify.

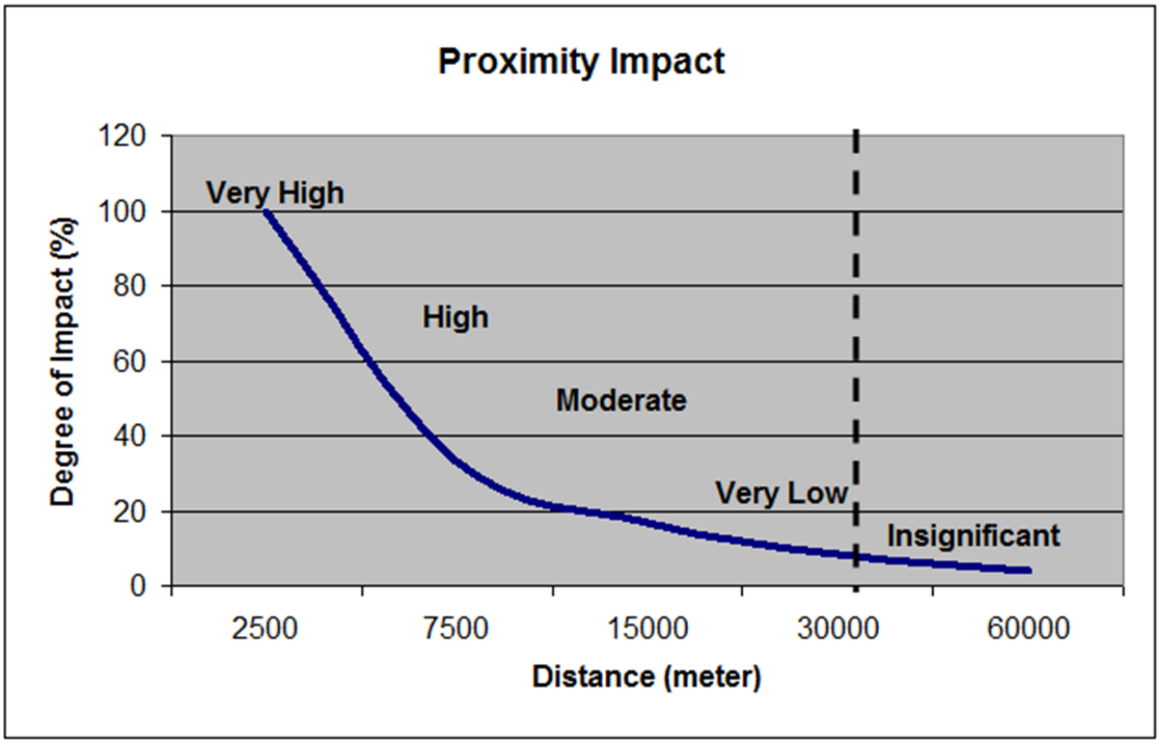


**Figure 27: Reduced visibility over distance**

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

The proximity radii (calculated from the boundary lines of the farm selected for the solar facility) are shown on the map in **Figure 28** and are as follows:

- 0 – 4 km - Short distance view where the solar facility would dominate the frame of vision and constitute a high to very high visual prominence.
- 4 – 8 km - Medium distance views where the solar facility would be easily and comfortably visible and constitute a high visual prominence.
- 8 - 16 km - Medium to longer distance view where the facility would become part of the visual environment, but would still be visible and recognisable, especially if the whole facility is exposed. This zone constitutes a high to medium visual prominence.
- Greater than 16 km - Long distance view of the facility where solar facility would still be visible though not as easily recognisable. This zone constitutes a medium to low visual prominence for the facility.

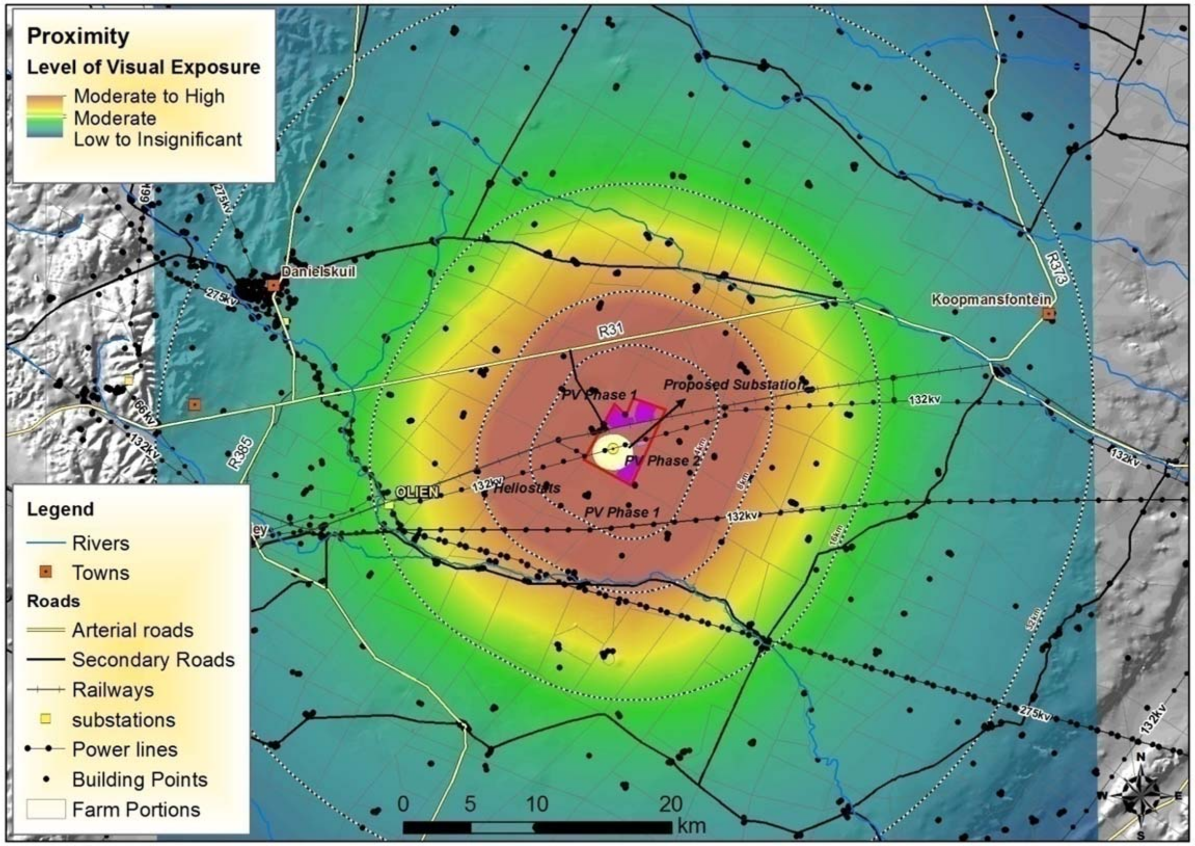


**Figure 28: Proximity analysis, showing diminishing significance of visual exposure with distance.**

### *7.12.2.3 Viewer Incidence & Viewer Perception*

The viewer incidence analysis is based on the identification of places of residence, commercial activity, leisure activity, sports, roads and tourists areas where a concentration of people normally occur. Information is extracted from the baseline data, and supplemented by inputs from other specialist studies, such as tourism.

This is integrated with data from the viewshed analyses where possible, for further interpretation. For the purpose of this study, four categories were identified as having differing observer incidences and/or perceptions.

- The first category of high viewer incidence and potential negative perception includes the built-up areas within the study area. These include Daniëlskuil, Lime Acres, Hey, Koopmansfontein and Ulco. These towns are further than 20 km from the proposed facility. Observers residing in these areas are accustomed to the wide natural expanses and vistas afforded by this rural region. Visual exposure to the solar facility will be limited to partial views of the PV plant, the heliostat field and the central tower. Viewed from these distances, the PV plant and heliostat field will only be visible by virtue of colour contrast, whereas the central tower may be visible as a vertical structure, emphasized by the bright glow of the central receiver against the backdrop of the topography.

- Residents on and visitors to farmsteads around the proposed facility, make up the second category. This area includes large tracts of sparsely populated land (thicket and bushland, shrubland and grassland used for agricultural purposes) with low observer incidence. No information with regard to the perception of these inhabitants (apart from the neighbour on Farm 268) is available, and it is expected that the perception of viewers would be neutral.

- The third category, that could potentially experience a negative visual impact due to land use conflict, is Constantia Safaris, situated on land adjacent to the proposed facility. According to the tourism study, the owner believes that the facility will have a huge visual impact on his business. He believes that this impact will be two-folded, with both the tourists and the animals on his farm being affected. This constitutes a negative viewer perception. Any visual impact resulting from the proposed facility is expected to be of very high significance.

- The fourth category comprises corridors along the main roads in the area. These areas include a 300 m buffer zone along the arterial and secondary roads (there is no national road within the study area). The arterial roads (R31, R385 and R373) are expected to carry a moderate frequency of observers, whereas the secondary roads are expected to carry a low frequency of observers. These roads represent the area with the highest potential sightings of the solar facility. Visual exposure and related visual impact will vary from high to low, depending on the distance between the observer and the solar facility, and the nature of the landscape surrounding the observer at a specific location.

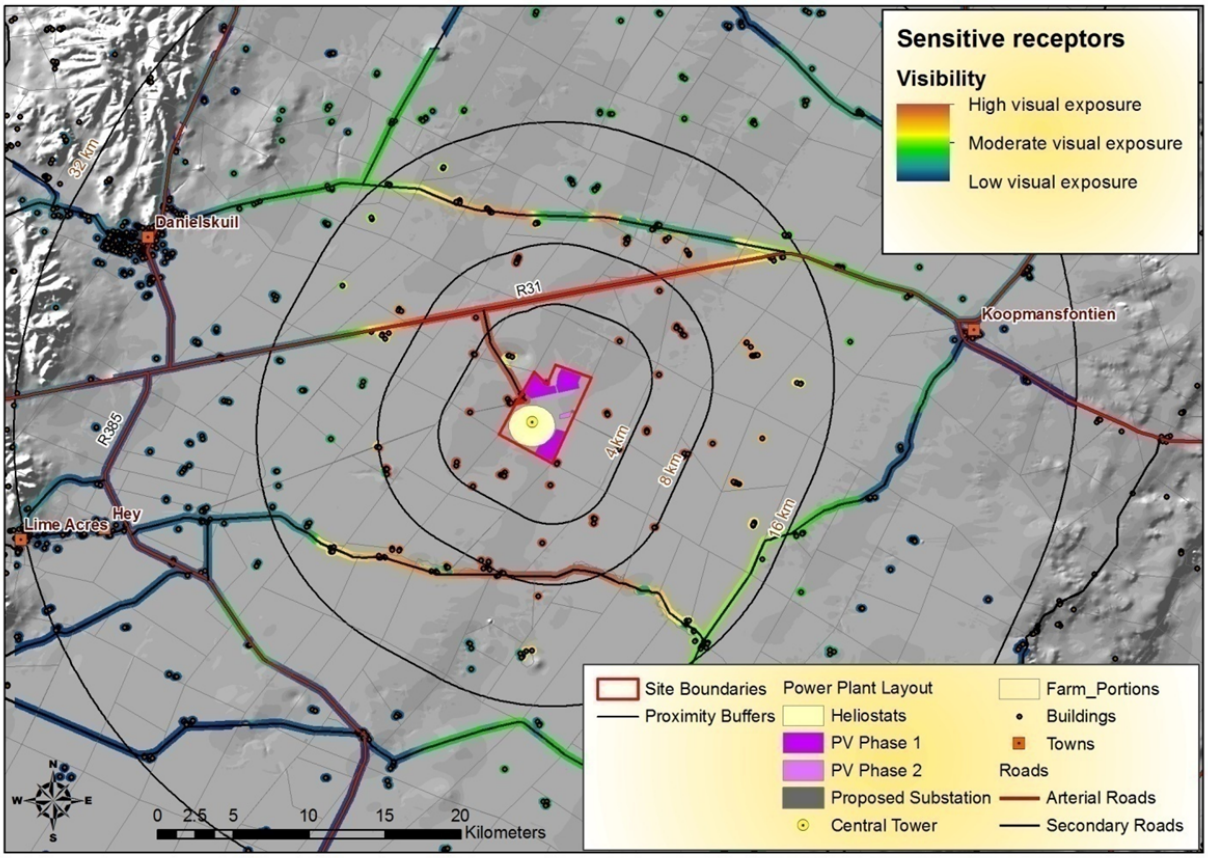


**Figure 29: Viewer incidence – roads, farmsteads and settlements.**

### *7.12.2.4 Visual Absorption Capacity of the natural vegetation*

The vegetation units present in the study area surrounding the solar facility (predominantly Ticket and Bushland and Shrubland) are on average only 2 m high. This, coupled with the sparse distribution of the plant species, the dimensions of the facility and height of structures, it was determined that the Visual Absorption Capacity (VAC) is low to negligible for virtually the entire study area.

#### *7.12.2.5 Visual impact index*

The combined results of the visual exposure, viewer incidence and proximity to the proposed solar facility are displayed on the map in **Figure 30**. Here the weighted impact and the likely areas of impact are indicated as a visual impact index. Values were assigned for each potential visual impact per data category and merged in order to calculate the visual impact index.

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

The visual impact index indicates a core area of high visual impact from the immediate vicinity to distances of 8 km from the boundaries of the site. Visual exposure becomes intermittent with varying degrees of exposure from 8 km and further. A Zone of moderate visual impact is discernible to the north, east and south for distances between 8 km and 20 km. In these zones possible sensitive visual receptors are located on farmsteads and on roads.

Settlements and towns are not expected to be affected significantly, due to distances of more than 20 km from the facility. Any possible exposure of the facility tower over such distances is expected to have a low visual impact as a result. It is anticipated that the other primary infrastructure or ancillary infrastructure will not be visible from this distance.

A few roads, particularly the R31, as well as farmsteads between 4 km and 16 km of the site will be exposed to views of the central tower, heliostats and PV plant, with moderate to high visual impacts, becoming low in places. It is again noted that Constantia Safaris, situated immediately east of the facility, will be highly affected by the proposed facility.

Beyond 16 km from the development, the potential visual impacts along all the roads and on farmsteads becomes low to very low or not visible, with mainly the central tower being visible. It is not anticipated that the other primary infrastructure or ancillary infrastructure will be visible from this distance.

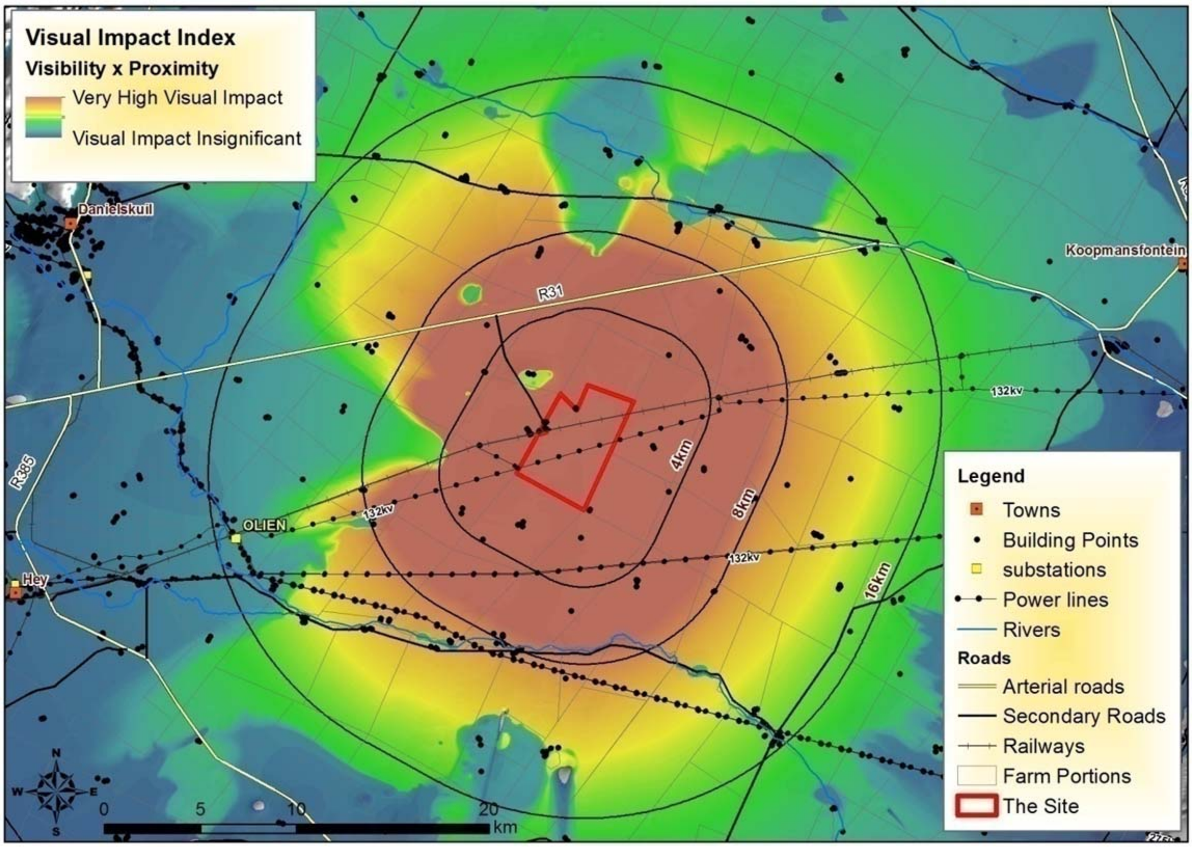


**Figure 30: Visual impact index: Integrated visual exposure and proximity analyses.**

### 7.12.3 **The potential to mitigate visual impacts**

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

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

- However, the visual impact of ancillary structures such as the pipe line can be successfully mitigated by placing the pipe underground, and rehabilitating the vegetation within the pipeline servitude. This has the further advantage of negating possible visual impacts associated with vegetation clearing and potential unsightly erosion scarring.
- The mitigation of secondary visual impacts caused by security and functional lighting, and construction activities may be mitigated through careful planning and management.
- A land use conflict exists with regard to Constantia Safaris, which is the only hunting farm in the area. This land use conflict is limited to Farm 268, as it is unlikely that the rest of the region will be developed as hunting farms (as indicated in the Tourism study). The visual impact represented by the solar facility may impose limitations on hunting operations at Constantia Safaris. This impact is not possible to mitigate.
- It should be noted, however that the farm is visited for hunting purposes primarily, and that very little, if any, leisure tourists visit the farm.
- The secondary visual impact associated with the access road is not possible to mitigate.
- Mitigation of lighting impacts includes the pro-active design, planning, and specification lighting for the facility. The correct specification and placement of lighting and light fixtures for the infrastructure will go far to contain rather than spread the light. Additional measures include the following:
  - Shielding the sources of light by physical barriers (walls, vegetation, or the structure itself);
  - Limiting mounting heights of lighting fixtures, or alternatively using foot-lights or bollard level lights;
  - Making use of downward directional fixtures;
  - Making use of minimum lumen or wattage in fixtures;
  - Making use of down-lighters, or shielded fixtures;
  - Making use of Low Pressure Sodium lighting or other types of low impact lighting;
  - Making use of motion detectors on security lighting. This will allow the site to remain in relative darkness, until lighting is required for security or maintenance purposes.

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

### 7.12.4 **Sensitivity Rating**

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

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

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

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

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

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

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

#### *7.12.4.1 The visibility of primary infrastructure of the CSP plant and PV plant.*

Visibility of the proposed facility extends for distances beyond 20 km. Visual exposure is high to areas in close proximity of the facility, at least for distances of less than 10 km. Distance is the only factor diminishing the level of exposure to the facility. This is contributed to the flat and open terrain with little to no visual absorption capacity in terms of topographical features and / or vegetation. The significance of visual impact in terms of visibility and exposure is therefore anticipated to be **high to very high**.

**Table 39: Impact table summarising the significance of the visibility of primary infrastructure, especially the central receiver and heliostats of the CSP plant, and the solar panels of the PV plant.**

| **Nature of Impact:** The visibility of primary infrastructure, especially the central receiver and heliostats of the CSP plant, and the solar panels of the PV plant | |
|---|---|
| **Extent** | Local **(4)** |
| **Duration** | Long term **(4)** |
| **Magnitude** | High **(8)** |

| | |
|---|---|
| **Probability** | High **(4)** |
| **Significance** | High **(64)** |
| **Status (positive or negative)** | Negative |
| **Reversibility** | Recoverable **(3)** |
| **Irreplaceable loss of resources?** | No |
| **Can impacts be mitigated during operational phase?** | No |
| **Mitigation:**<br>Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years. | |
| **Cumulative impacts:**<br>The development of the primary infrastructure over 2 to 3 years may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility). | |
| **Residual impacts:**<br>None.  The visual impact will be removed after decommissioning, should all structures be removed and the area rehabilitated. | |

### *7.12.4.2 Potential visual impact on the neighbouring Farm 268, directly east of the development site, hosting Constantia Safaris, which is a hunting operation.*

The visual impact of the proposed solar facility on Constantia Safaris is found to be high to very high, owing to its close proximity to Arriesfontein.  Full exposure of the central receiver tower, heliostats, PV plant and ancillary infrastructure will be experienced.  Lighting impacts during the night are also anticipated to be adverse, given the current undeveloped status of the region. No mitigation of the impact is possible.

The table below illustrates this impact assessment.

**Table 40: Impact table summarising the significance of visual impacts the neighbouring Farm 268.**

| **Nature of Impact:**<br>Potential visual impact on the neighbouring Farm 268,  directly east of the development site, hosting Constantia Safaris, which is a hunting operation. | |
|---|---|
| **Extent** | Local **(4)** |
| **Duration** | Long term **(4)** |
| **Magnitude** | Very High**(10)** |
| **Probability** | Definite**(5)** |
| **Significance** | High**(90)** |
| **Status (positive or negative)** | Negative |
| **Reversibility** | Recoverable **(3)** |

| | |
|---|---|
| **Irreplaceable loss of resources?** | Yes, in terms of night time experience of complete darkness currently experienced. |
| **Can impacts be mitigated during operational phase?** | No |
| **Mitigation:**<br>Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years. | |
| **Cumulative impacts:**<br>The development of the facility, consisting of various components covering virtually the whole of Farm 267 will create the impression of a cumulative visual impact on neighbouring observers. | |
| **Residual impacts:**<br>None. The visual impact will be removed after decommissioning and rehabilitation of the veld. | |

### *7.12.4.3 Potential visual impact of the proposed solar facility on observers travelling along roads, i.e. the R385, R31 and R373.*

The potential visual impact of the proposed solar facility on observers travelling along roads, i.e. the R385, R31 and R373 is expected to be moderate, depending on the distance from the facility. These roads are not known as tourist routes. The amount of traffic is relatively low with a moderate number of possible visual receptors. No mitigation measures are possible.

The table below illustrates this impact assessment.

**Table 41 Impact table summarising the significance of visual impacts on observers travelling along roads, i.e. the R385, R31 and R373.**

| **Nature of Impact:**<br>Potential visual impact of the proposed solar facility on observers travelling along roads, i.e. the R385, R31 and R373. | |
|---|---|
| **Extent** | regional **(3)** |
| **Duration** | Long term **(4)** |
| **Magnitude** | High**(8)** |
| **Probability** | Probable**(3)** |
| **Significance** | Moderate **(45)** |
| **Status (positive or negative)** | Negative |
| **Reversibility** | Recoverable **(3)** |
| **Irreplaceable loss of resources?** | No |
| **Can impacts be mitigated during operational phase?** | No |
| **Mitigation:**<br>Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years. | |

| |
|---|
| **Cumulative impacts:**<br>The development of the primary infrastructure over 2 to 3 years may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility). |
| **Residual impacts:**<br>None. The visual impact will be removed after decommissioning |

#### *7.12.4.4 Potential visual impact of the proposed solar facility on the visual character of the landscape and sense of place of the region.*

The sense of place is characterised by a quiet, undeveloped landscape with views of wide and open flats. Views of this unique landscape are found over most of the region, which as such is sensitive to land use change. Due to the large extend of visual exposure of the proposed facility; the significance of this impact on the sense of place is regarded as high. However, in view of the facility harvesting energy from a renewable source in an environmentally friendly manner, this change in the sense of place may be accepted by the wider community. No mitigation measures are possible.

The table below illustrates this impact assessment.

**Table 42 Impact table summarising the significance of visual impacts the visual character of the landscape and sense of place of the region**

| **Nature of Impact:**<br>Potential visual impact of the proposed solar facility on the visual character of the landscape and sense of place of the region. | |
|---|---|
| **Extent** | regional **(3)** |
| **Duration** | Long term **(4)** |
| **Magnitude** | High**(8)** |
| **Probability** | Definite**(5)** |
| **Significance** | High**(75)** |
| **Status (positive or negative)** | Negative |
| **Reversibility** | Recoverable **(3)** |
| **Irreplaceable loss of resources?** | No |
| **Can impacts be mitigated during operational phase?** | No |
| **Mitigation:**<br>Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years. | |
| **Cumulative impacts:**<br>The development of the primary infrastructure over 2 to 3 years may create the impression of a cumulative visual impact on uninformed observers (i.e. observers who are not aware of the total extent of the facility). | |

| |
|---|
| **Residual impacts:**<br>None. The visual impact will be removed after decommissioning |

### *7.12.4.5 Potential visual impact of ancillary infrastructure.*

Ancillary infrastructure (i.e. the generator building, the substation, storage reservoirs, the internal roads, the office and the workshop) will be located within the development footprint, and will generally be overshadowed by the much taller central tower as well as the heliostats and PV panels.

Although no dedicated viewshed has been generated for these ancillary infrastructure, it is expected that the area of potential visual exposure will lie within that of the primary infrastructure (i.e. specifically the central tower and heliostats). The significance of potential visual impact of this ancillary infrastructure is expected to be low.

The table below illustrates this impact assessment.

**Table 43 Impact table summarising the significance of visual impact of other ancillary infrastructure.**

| **Nature of Impact:**<br>Potential visual impact of other ancillary infrastructure | |
|---|---|
| **Extent** | Local **(4)** |
| **Duration** | Long term **(4)** |
| **Magnitude** | Moderate**(6)** |
| **Probability** | Low **(2)** |
| **Significance** | Low **(28)** |
| **Status (positive or negative)** | Negative |
| **Reversibility** | Recoverable **(3)** |
| **Irreplaceable loss of resources?** | No |
| **Can impacts be mitigated during operational phase?** | No |
| **Mitigation:**<br>Decommissioning: removal of the solar facility structures and ancillary infrastructure after 30 years | |
| **Cumulative impacts:**<br>None. | |
| **Residual impacts:**<br>None. The visual impact will be removed after decommissioning | |

#### *7.12.4.6 Secondary visual impacts: Lighting impacts*

Light impacts are expected to occur from the central tower glowing white hot during the day, and security lighting during the night. The glowing effect of the tower receiver will be low, but noticeable due to its height above ground, which is negligible in the context of daylight. At night time security lighting may cause glare and sky glow.

Although the area has a low population density, the light trespass and glare from the security and after-hours operational lighting will have some significance, especially with regard to the neighbouring hunting farm. Furthermore, the sense of place and cultural ambiance of the local area increases its sensitivity to such lighting intrusions.

A second source of light pollution stemming from the solar facility will be in the form of ‘glare light’, which is not as intense as flood lighting. The source of this lighting is the aircraft warning lights mounted on top of the central tower. These lights are less aggravating due to the toned-down red colour, but have the potential to be visible from a great distance. The Civil Aviation Authority (CAA) prescribes these warning lights and the potential to mitigate their visual impact is low. Only the central tower will require such lights, which means the impact of these should also be low. Authorisation for the proposed CSP project has been received from the CAA.

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

Although light pollution can be mitigated, the effects as described above will still be noticeable.

#### *7.12.4.7 Potential visual impacts associated with the construction phase*

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

### 7.12.5 **Conclusion**

The construction and operation of the proposed Arriesfontein Solar Power Plant (primarily the central receiver tower) will have a visual impact on the landscape, at least within a radius of 16 km from the facility. However, the author is of the opinion that the solar facility has an advantage over other more conventional central generating plants (e.g. coal-fired central stations). The facility utilises a renewable source of energy (considered as an international priority) to generate power and is therefore generally perceived in a positive light. It does not emit any harmful by-products or pollutants and is therefore not negatively associated with possible health risks to observers.

The facility further has a novel and futuristic design that invokes a curiosity factor not generally present with other conventional central generating plants. The advantage being that the solar facility can become an attraction or a landmark within the region that people would actually want to come and see. As it is impossible to hide the facility, the only option would be to promote it. This opinion should however not distract from the fact that the central tower would be visible for a large area that incorporates various sensitive visual receptors that should ideally not be exposed to industrial-type structures.

There are not many recommendations as to the mitigation of the visual impact of the facility (including the primary and ancillary infrastructure), but especially the central tower. It is however recommended that all disturbed areas are properly rehabilitated, and that all infrastructure and the general surrounds are maintained in a neat and appealing way. Furthermore, the visual impact of ancillary structures such as the pipe line can be successfully mitigated by placing the pipe underground, and rehabilitating the vegetation within the pipeline servitude.

The construction phase of the facility should be sensitive to potential observers near the construction site. The placement of lay-down areas and temporary construction camps should be carefully considered in order to not negatively influence the future perception of the facility.

Secondary visual impacts associated with the construction phase, such as the sight of construction vehicles, dust and construction litter must be managed to reduce visual impacts. The use of dust-suppression techniques on the access roads (where required), timely removal of rubble and litter, and the erection of temporary screening will assist in doing this. The planning and proper placement of light fixtures will also reduce visual impacts associated with glare and light trespass.

The facility should be dismantled upon decommissioning and the site and surrounding area should be rehabilitated to its original (current) visual status. In light of the results and findings of the Visual Impact Assessment undertaken for the proposed Arriesfontein Solar Power Plant, it is acknowledged that the natural and relatively unspoiled rural views surrounding the site will be impacted upon, primarily by the central tower, for the entire operational lifespan (approximately 30 years) of the facility.

The potential visual impact on users of national, arterial and secondary roads in close proximity of the solar facility will be of high significance and the potential visual impact on residents of towns, settlements and homesteads in close proximity to the proposed solar facility and within the region, as well as on protected areas and eco-tourism will be of moderate significance. In terms of the ancillary infrastructure, the potential visual impact is low, and much of this will be overshadowed by the much taller central tower as well as the heliostats and PV panels. This anticipated visual impact is not, however, considered to be a fatal flaw from a visual perspective, considering the low incidence of visual receptors in the region and the contained area of potential visual exposure.

### 7.12.6 Mitigation Measures

The management plan tables aim to summarise the key findings of the visual impact report and to suggest possible management actions in order to mitigate the potential visual impacts. The management plan primarily focuses on the mitigation and management of potential secondary visual impacts, due to the fact that the primary visual impact (i.e. the central tower and heliostats) has very low or limited mitigation potential.

**Table 44: Management plan – Arriesfontein Solar Power Plant**

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

**Table 452: Management plan - Lighting impacts**

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

## 7.13 SOCIO ECONOMIC IMPACT

Study area delineation depends on the type of economic activity that is being analysed and the perceived spread of economic impacts that are expected to be generated from the project during both construction and operation. The municipal area where the site is located is likely to experience some direct, indirect and induced impacts resulting from the activities on site. The Socio Economic Report is attached as **Appendix M**.

However, it is highly unlikely that the local economy can be sufficiently diversified to supply all materials and services and support construction and operational activities from start to finish. Thus economic impacts tend to extend beyond the municipal boundaries and spread throughout the entire national economy.

For the purpose of this study the following study areas will be delineated:

– The primary study area: This refers to the locality where direct economic impacts of the proposed activity are to be concentrated. It is defined considering the actual location of the proposed project, proximity to skilled and unskilled labour, juxtaposition relative to suppliers, and availability of data The primary study area for the proposed Solar Park was chosen to be the Kgatelopele Local Municipality, as this is the smallest administrative unit for which most recent economic data can be supplied.

– The secondary and tertiary study areas: They are the areas where the majority of indirect and induced effects will be concentrated and where the former forms part of the latter. The proposed project is to be located about 160 kilometres away from Kimberley, which is a major urban centre of the Northern Cape Province. Thus it is safe to assume that some of the inputs required for the establishment and operations would be sourced from the Northern Cape, i.e. the same province where the project is located. The tertiary study are is chosen to be South Africa, as it will benefit from all domestic expenditure directly or indirectly related to the proposed project.

– Visually affected study area: The consultation with other specialists on the team revealed that the most significant environmental impact associated with the proposed activity is a visual impact. Thus, another area was delineated for this purpose and will be referred to as a visually affected study area.

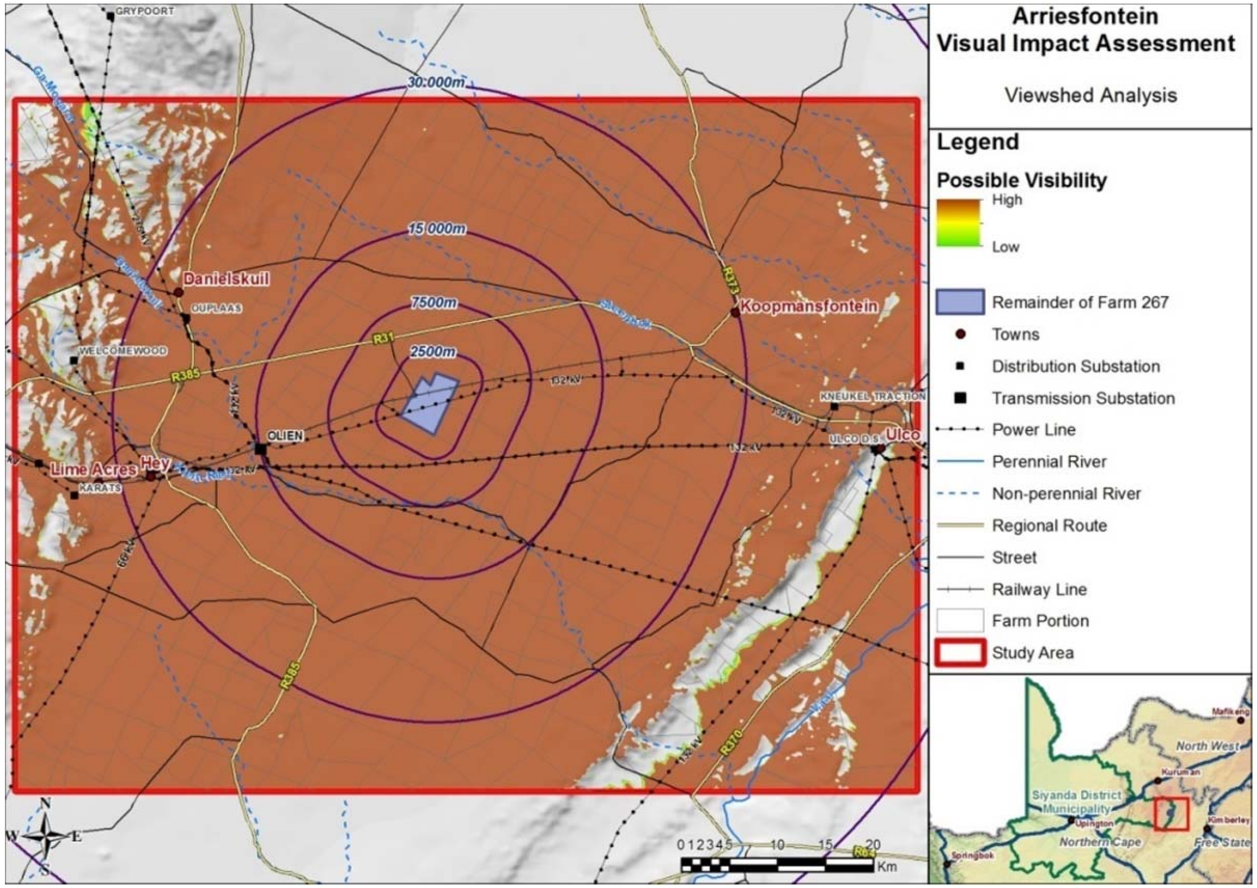


**Figure 31: Visual Impact Assessment**

### 7.13.1 **Terms of Reference**

The purpose of the Socio-Economic Impact Assessment is to determine the potential positive and negative effects of the proposed Solar Park, i.e. an impacting agent in the context of this study, on the local and regional economies and to compare their effects with the “no go” alternative to determine the net effect of the project. The “no go” alternative assumes that the proposed Solar Power Park is not established at the intended location, nor anywhere else in the country. The “no go” alternative represents the current status of the environment, including the socio-economic situation.

Socio-economic impacts generated by the impacting agent can be disaggregated in terms of the initial impacts, or direct impacts that are created. Such impacts trigger second and further flow-on rounds of impacts, thus creating a multiplier effect that can be either positive or negative. In pure economic terms these are expressed as indirect and induced effects, where:

- Indirect effects relate to the changes in economic indicators that are triggered along the upstream industries that supply goods and services to the impacting agent
- Induced effects refer to the changes in economic indicators that are stimulated by changes in consumption expenditure of households that were directly or indirectly affected by the impacting agent

In addition to the above, two (2) other types of socio-economic impacts can be distinguished in the context of the environmental impact assessment studies and thus need to be investigated. These include, inter alia:

- Secondary impacts that are caused by the impacting agent, but that are further removed in distance or take place later in time and are still reasonable foreseeable. Secondary impacts largely relate to changes in the land use pattern, economic vitality, changes to community’s character, and property values in the vicinity of the impacting agent’s location.
- Cumulative effects are the results of incremental consequences of the impacting agent’s activity when added with other past, present, and anticipated future interventions. They consider the manner in which the impacts of a project may affect or be affected by other projects. Such effects are generally difficult to identify as they require a complete knowledge of local conditions and developmental plans, and are sometimes even more difficult to quantify.

The specific objective aimed to be achieved by the socio-economic impact assessment study include, inter alia:

- Create profiles for the economies representing the study areas and the environmentally affected environment, which would then represent a “do nothing” alternative and would be used to assess the potential changes ensued from the proposed activity
- Identify positive and negative economic impacts that are expected to be stimulated by the proposed facility during both construction and operational phases
- Quantify socio-economic impacts, where possible, using an economic model developed on the basis of a Social Accounting Matrix
- Determine the significance of potential impacts using criteria determined by the environmental practitioner
- Compare various alternatives and advise on the most beneficial option
- Provide practical mitigation measures where possible and where necessary

### *7.13.1.1 Methodology*

The methodology employed in conducting the study comprised of six main steps. The following paragraphs briefly describe each of the steps.

### *Step 1: Data gathering*

Impact assessment requires the knowledge of the socio-economic environment that will be affected by the proposed project and expenditure during both the construction and operational phases. Gathering of the above-mentioned data followed the next approach:

- Status-quo data: In order to create a comprehensive understanding of the socio-economic environment that might be affected by the Solar Park, a socio-economic profile of the study areas and visually affected area needed to be created. The following information sources were used in gathering the data:
  - Quantec database (1995-2010)
  - StatsSA Labour Force Survey (LFS)
  - Siyanda DM: Integrated Development Plan (IDP) DP 2010-2011 and Integrated Economic Development Plan (IEDP) 2006

 - Personal interview with Gerrie Cloete, the owner of the Arriesfontein farm where the proposed facility to be located
 - Information collected by Grant Thornton, the tourism specialist on the team, during the initial communication with Constantia Safaris that is located next to the Arriesfontein farm; unfortunately, the owner refused to provide any data to the economic specialist
 - Constantia Safaris website: http://www.constantiasafaris.co.za accessed in January 2012
- Information on project's expenditure was sourced from SRSA These figures present estimates and could change in the future, however for the purpose of the study they were deemed to be sufficient.

*Step 2: Data analysis*

Data analysis involved the processing of information gathered during the previous step and presenting its results in terms of selected economic variables. Socio-economic data describing the study areas were analysed and presented as the baseline data. Information regarding the project and economic activities that will be affected by the project (i.e. economic activity on site in the visually affected area) was reviewed, collated and presented as input into modelling exercises.

*Step 3: Modelling*

In order to estimate the direct and follow-on effects of the proposed project expenditure, as well as the potential losses associated with the sterilisation of agricultural land and visual impacts, an economic modelling technique was utilised. The modelling exercise made use of two economic models developed on the basis of the South Africa's Social Accounting Matrix (SAM) and the Northern Cape Province's SAM updated to 2011 figures. The SAM is a comprehensive, economy-wide database that contains information about the flow of resources that takes place between the different economic agents in this case in the provincial economy.

The selection of two models to be used in the assessment was attributed to the expected spatial distribution of procurement during both the construction and operational phases. It is expected that most of the local inputs required for the project will be sourced from outside the Northern Cape Province, which justifies the use of the national SAM. Some expenditure during construction and most of the spending during operations, though, are assumed to be retained in the Northern Cape Province. Gross operating surplus to be earned during operation is expected to be counted outside the Northern Cape Province, i.e. where SolarReserve quarters are located. Thus, the calculation of impacts during the operational phase made use of both SAMs – for South Africa and the Northern Cape.

The following assumptions were used with respect to the economic model and the modelling exercise:

- No structural changes in the economy are experienced during the analysed period (between 2004 and 2011).
- The model was closed by households to determine the consumptions induced effects in addition to direct and production induced impacts.
- When calculating the exogenous inputs, Gross Operating Surplus was excluded from the consumption induced effects thus assuming that all earnings will be retained and not paid out as dividends. Capital formation and interest payments were excluded from modelling, too.
- The model assumes that the economy is in equilibrium.
- The supply of each good and service is assumed to be perfectly elastic and absent of any capacity constraints. This means that industries and sectors can produce any quantities of goods and services and would not experience technological, budgetary, and/or human resource constraints.
- Employment is estimated in full-time equivalent (FTE) person-years for one year. This, however, does not directly translate into new employment positions. In the short-term, an increase in FTE could be absorbed by currently employed through working overtime or it could translate into the support of currently employed people.

The results of the modelling exercise were provided in constant 2011 prices to ensure the compatibility of this data with the baseline data, which is also presented in 2011 figures where applicable.

### *Step 4: Interpretation*

The results of the modelling exercise were translated in terms of various socio-economic impacts and were interpreted against the current status of the analysed economies. The analysis of impacts was disaggregated between various phases of the project life cycle, i.e. construction, operation and closure. Where possible, impacts were separated in terms of direct, indirect, and induced effects; as well as secondary and cumulative impacts.

### *Step 5: Net effect assessment*

The proposed project is expected to stimulate both positive and negative impacts in terms of the same economic indicators, such as production, value added, employment, etc. Analysis of the same type of positive and negative impacts separately from each other could lead to distorted results. Thus prior the evaluation of socio-economic impacts, the net effect of the project was estimated. This was done for each socio-economic impact identified and involved the summation of all positive impacts and deduction of all negative impacts.

*Step 6: Impact rating*

Impact rating is done for each type of impact identified during all the stages of the project's life cycle that is being analysed (i.e. construction, operation, and closure). In determination of the impact rating, the net was considered, if applicable. The significance rating of impacts was determining using probability, duration, scale, and magnitude ranges as outlined in Table 46.

**Table 46: Impact Significance Ranking Scales**

| Probability: | Duration: | Scale: | Magnitude: |
|---|---|---|---|
| **5 - Definite/don't know**<br>**4 - Highly probable**<br>**3 - Medium probability**<br>**2 - Low probability**<br>**1 - Improbable**<br>**0 - None** | 5 - Permanent<br>4 - Long-term (impact ceases after the operational life of the activity)<br>3 - Medium-term (5-15 years)<br>2 - Short-term (0-5 years)<br>1 - Immediate | 5 - International<br>4 - National<br>3 - Regional<br>2 - Local<br>1 - Site only | 10 - Very high/don't know<br>8 - High<br>6 - Moderate<br>4 - Low<br>2 - Minor<br>0 - None |

Once the above factors had been ranked for each impact, the overall significance of each impact was assessed using the following formula:

**Potential Significance (PS) = (Magnitude + Duration + Scale) x Probability**

All impacts were then ranked in terms of low, moderate and high following the scale:

– PS ≥ 60 = High Environmental Significance (Adverse Impact. Mitigation, if possible, is often difficult, expensive and time consuming)

– 60 < PS ≥ 30 = Moderate Environmental Significance (Mitigation is both feasible and fairly easily possible)

– PS < 30 = Low Environmental Significance (Mitigation easily achieved or little is required)

### 7.13.2 Impact Assessment and Identification

This section aim at defining the impacts to be incurred as a result of the project's expenditure during construction, operation, and closure phases. Impact that are expected to take place as a result of land sterilisation, secondary, and cumulative effects are analysed later in the report.

#### *7.13.2.1 Construction phase assumption (impacts)*

The estimated cost of development of a CSP plant of the suggested size is R5 686 million. Of the total expenditure, approximately one-third (R 1 949 million) will be spent on materials, components, and services which cannot be sourced locally and will be imported, such as heliostats, salt and a receiver for the molten salt circuit, as well as a steam turbine generator. The nature and magnitude of the proposed development necessitates the use of some foreign labour with sufficient expertise and "know-how" in the construction and development of similar projects. The remaining two-thirds of the capital expenditure - R3 737 million - will be spent locally on all other goods and services required for the development of the solar power plant.

In total, the development of the proposed 325 MW solar Park will cost R11 026.8 million (CSP Development included) in 2011 prices. Of the total amount, the domestic expenditure used is estimated at R5 473.7 million whilst the remaining R5 555.1 million will be spent on imported goods and services. It is estimated that the CSP plant will be built over a period of 30 months, whilst the duration of construction of a single PV facility is between 12 months and 18 months. For impact estimation and projection purposes, the construction phase of a single PV block is assumed to be one complete year, i.e. 12 months per phase. Furthermore, it is assumed that construction of all phases will start at the same time.

**Table 47: Construction phase assumptions (R'ml, 2012 prices)**

| Item | Detail | | |
|---|---|---|---|
| | CSP | PV Phase 1, 2, and 3 | Total |
| Capital expenditure (R'ml) | R 5 685 | R1 780.6 | R11 026.8 |
| Local expenditure (R'ml) | R 3 737 | R 578.9 | R 5 473. 7 |
| Imports (R'ml) | R 1 949 | R1 201.7 | R 5 554.1 |
| Duration of construction (months) | 30 | 12 | - |

*Source: SolarReserve South Africa, 2011*

The construction of the complete CSP and PV facility will require approximately 1 396 full-time employees of varying skills. From this total, 15 people will be international experts, whilst the rest will be sub-divided into:

- 481 full-time employees to build the CSP plant (Phase 4)
- 300 full-time employees to build each phase of the PV component, i.e. a total of 900 full-time employees for PV component of the Solar Power Park.

The vast majority of the workforce required for the establishment of the CSP and PV systems is envisaged to be sourced from different parts of South Africa. Given the opportunities for unskilled and semi-skilled workers, a significant share of positions during construction could be occupied by people from the local communities. From a different perspective but equally in line with the approximated job opportunities, the project is estimated to create 2 102 employment person-years of which 1 202 and 900 will be created by the CSP plant and the complete PV system, respectively. The estimated salary and wage bill for the required domestic labour force will equate to R162.2 million for the CSP plant and R119.1 million for the complete PV component. Thus, the total salary and wage bill over the construction phase will equate to R281 million in 2011 prices.

**Table 48: Employment opportunities created for South Africa's labour force**

| Employment opportunities | CSP (Phase 4) | | | Three sets of PV (Phases 1,2, and 3) | | |
|---|---|---|---|---|---|---|
| | Jobs | Person-years | % | Jobs | Person-years | % |
| Highly skilled | 125 | 312 | 26.0% | 60 | 60 | 6.7% |
| Skilled | 214 | 535 | 44.5% | 90 | 90 | 10.0% |
| Unskilled | 142 | 355 | 29.5% | 750 | 750 | 83.3% |
| **TOTAL** | **481** | **1 202** | **100.0%** | **900** | **900** | **100%** |

### *7.13.2.2 Construction Phase Impacts*

The analysis of the expected impact from the construction phase of the development of the proposed project is presented in the following sections. The analysis covers a number of aspects such as the impact on the volume of production in the Province and the rest of the country, GDP, employment, household income, and government revenue.

Most of the materials and services required for the successful establishment of the proposed facility will be sourced outside of the Northern Cape Province, due to the specialised nature of some of the materials required and relatively undiversified provincial manufacturing sector. Therefore, when impacts during construction are analysed, it is assumed that they will be spill over the entire country depending on where materials and services are procured from.

### 1. Impact on the Balance of Payments:

The establishment of the Solar Power Park plant will require an investment of R11 026.8 million in 2011 prices, of which R5 555.1 million will be spent on imported goods and services. The required capital will be sourced within South Africa; therefore any expenditure on imported goods can be regarded as a leakage of money from the national economy, which has a negative impact on the trade balance. The impact of the project on the balance of payments will result in an increase in the deficit, i.e. project expenditure on imports will reflect as income payments worth R5 555.1 million.

The balance of payments for the entire 2011 year is not yet known, but in 2010 the current account had a deficit of R74.1 billion. Thus the need to import materials, equipment, and services required for the completion of the Solar Park would most likely increase the trade deficit in the country. However, since the trade deficit in 2010 was 2.8% of the national GDP, an increase in the trade deficit at this stage to the value mentioned above is not expected to have any impact on the monetary or fiscal policies of the country.

Moreover, a negative balance of payments in a developing economy such as South Africa is generally acceptable as the economy needs to borrow money to allow it to invest in infrastructure, people, and businesses that eventually propel growth in the years to come. Care though should be taken to ensure that the current account deficit does not grow beyond the means of the country to service its debt and that the economy is not forced into a default position, as happened recently with Greece.

## 2. Impact on Production:

Holistically, the development of the concentrated solar power plant and the photovoltaic system has a positive impact on the regional as well as the national economy. During the construction phase, the demand for necessary goods, services, and materials will induce production amongst the supporting industries and their supply value chains.

Total local expenditure during the development phase amounts to R5 473.7 million in 2011 prices which represents the direct impact of the proposed project on the economy. The direct impact is wholly absorbed by the construction sector throughout the period of development, i.e. 30 months for the CSP plant (Phase 4) and 12 months for the completion of each 75 MW PV facility (Phases 1, 2 and 3).

The total impact of the proposed project considering production and consumption induced effects is estimated at R17 442.3 million in 2011 prices. The CSP component (Phase 4) is expected to generate two thirds of this production, whilst each phase of PV is expected to contribute 11.3% to this total. To put the direct effect into perspective, every R1 spent locally on construction of the entire facility will generate an additional R2.2 in business sales throughout the country's economy.

**Table 49: Production effects during construction (R'ml, 2011 prices)**

| Project Item | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| PV Phase 1 | R 578.9 | R 775.3 | R 622.3 | R 1 976.5 |
| PV Phase 2 | R 578.9 | R 775.3 | R 622.3 | R 1 976.5 |
| PV Phase 3 | R 578.9 | R 775.3 | R 622.3 | R 1 976.5 |
| CSP Phase 4 | R 3 737.0 | R 4 311.1 | R 3 464.9 | R 11 512.7 |
| **Total** | **R 5 473.7** | **R 6 637.0** | **R 5 331.8** | **R 17 442.3** |

A significant portion of new business sales in the economy during construction is expected to be generated through production induced effects, i.e. indirect impacts. The total indirect impact is estimated at R6 637 million in 2011 prices. This impact will not only be experienced in the Northern Cape but in South Africa as a whole since the goods and services to be used are expected to be procured throughout the country. The majority of new business sales through indirect impacts will be generated in the manufacturing sector with specific reference to industries such as non-metallic mineral products, basic metal products, and structural metal products. Other economic sectors that will benefit to a great extent are the financial and business services sector, trade and accommodation, as well as the transport sector.

Further effects are created through increased household expenditure, which comes as a result of increased household income stimulated through direct and indirect effects of the project. Spending of this income on household goods and services will have a further stimulating effect in the economy in that producers and suppliers thereof will realise increased demand and will try to match it with respective business sales. Therefore, the induced impact of the project will be observed through growth in production volumes of businesses in the country to the value of R5 332 million. Sectors that are likely to benefit the most through the induced effect are namely manufacturing, financial services, trade and accommodation, and transport.

Overall, the project has a positive effect on the production in the economy; however it is of a temporary nature and will only last for the duration of the construction phase. During this time, the construction sector, followed by the manufacturing, business services and trade and accommodation will benefit the most.

## 3. Impact on GDP-R:

A positive relation between production volumes and Gross Domestic Product per Region (GDP-R) volumes exists such that the increased production levels in affected sectors will temporarily increase their value added and result in the overall growth of the national GDP-R, albeit for a short period of 30 months.

**Table 50: GDP-R effects during construction (R'ml, 2011 prices)**

| Project Item | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| PV Phase 1 | R 153.4 | R 309.2 | R 275.1 | R 737.8 |
| PV Phase 2 | R 153.4 | R 309.2 | R 275.1 | R 737.8 |
| PV Phase 3 | R 153.4 | R 309.2 | R 275.1 | R 737.8 |
| CSP Phase 4 | R 896.1 | R 1 573.6 | R 1 531.5 | R 4 001.3 |
| **Total** | **R 1 356.4** | **R 2 501.4** | **R 2 356.8** | **R 6 214.5** |

Table 50above indicates that the local expenditure of R5 473.7 million will subsequently generate R6 214.5 million of GDP-R throughout the economy. Of this, R1 356.3 million of GDP-R in South Africa will be generated directly by the project itself. The remaining expected increase in GDP-R can be attributed to indirect and induced effects, where the former is valued at R2 501.3 million and the latter amounts to R2 356.7 million of GDP-R in 2011 prices, respectively.

Similar to the impact on business sales in the economic sectors, the construction sector is expected to have the highest increase in GDP-R during the developmental phase. Approximately a quarter of the total impact on GDP-R is within the construction sector (24.7%) which is followed by the manufacturing sector (20.2%) and the business services sector (12.2%).

### 4. Impact on Employment:

The establishment of the Solar Park will directly create 2 102 full-time equivalent (FTE) person-years. It is not possible to state at this stage of the development where the workers will come from; however it can be expected that a relatively notable share will come from the immediate and surrounding areas, i.e. from within the Northern Cape Province. Besides the employment that will be temporarily created by the construction of the facility directly, an increase in labour demand as a result of production and consumption induced effects is also expected.

Given the local expenditure on materials and services required for construction, the production volumes of affected suppliers are expected to rise over this period. As a result, an additional 13 620 FTE person-years will be created indirectly whilst the induced effect of the project on employment is estimated at 11 277 FTE person-years. Overall, 26 999 FTE person-years is expected to be created during the construction of the proposed Solar Park.

**Table 51: Estimated FTE person-years to be created during the construction phase**

| Project Item | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| PV Phase 1 | 300 | 1 320 | 1 316 | 2 936 |
| PV Phase 2 | 300 | 1 320 | 1 316 | 2 936 |
| PV Phase 3 | 300 | 1 320 | 1 316 | 2 936 |
| CSP Phase 4 | 1 202 | 9 659 | 7 328 | 18 189 |
| **Total** | **2 102** | **13 620** | **11 277** | **26 999** |

From the total job opportunities slightly more than a third will come from the construction of the CSP plant (35%) which is due to hire about 481 people during the 30-month construction period (equivalent of 1 202 FTE person-years). Of these, 50 positions will be occupied by engineers and consultants, 75 positions will be taken up by supervisors and foremen, and the rest will be construction workers. \

This means that on average, 356 people will be working on site throughout the entire construction period. At least a third of these jobs will become available for the local communities, which means that the local employment situation in the municipality could improve, albeit temporarily.

Conversely, a single 75 MW PV facility (i.e. PV Phase 1,2, or 3) requires approximately 300 FTE person-years to construct it in the space of a year (as stated in the assumptions). This translates into 300 employment opportunities that will be directly created for building one phase of the PV component.

The establishment of each 75 MW PV facility is expected to further create approximately 1 320 FTE person-years through production induced effects and 1 316 FTE person-years through consumption induced effects, thus creating in total about 2 936 FTE person-years. If all three phases are to be completed and this is to be done simultaneously, this impact will be tripled over the period of one year.

The greatest concentration of employment impacts will be in the manufacturing sector, as illustrated in **Figure 32**. Given that the majority of the suppliers for the construction inputs are in the manufacturing sector, it is fitting that slightly over a quarter of the jobs generated would fall within this sector. Other sectors that will experience the greater than average stimulus from the construction activities include; trade and accommodation, construction (through sub-contracting), and business services.

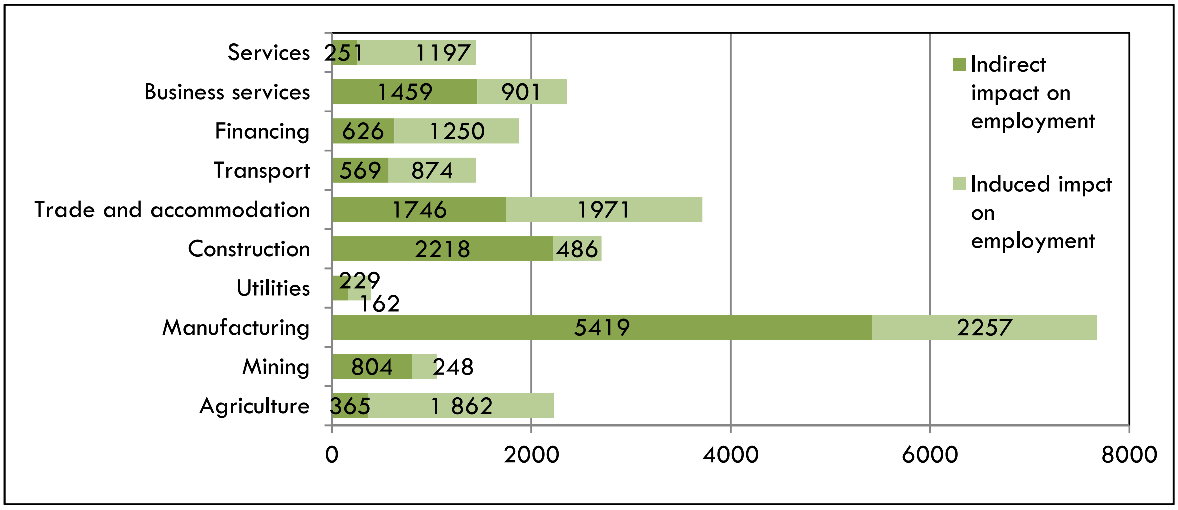


**Figure 32: Sectoral distribution of indirect and induced impact on employment during construction**

## 5. Impact on household income:

Given the temporary increase in production levels across the country as well as stimulus to the employment situation, a temporary growth in household income is in order. As indicated Table 52, the affected households (inclusive of the direct impact) will earn about R2 359.53 million in 2011 prices over the construction period. It is essential to keep in mind that this impact is of a temporary nature and it will not be sustained once the facility has been established.

More than half of the stimulus for household income increase will come from the establishment of the CSP component of the Solar Park, whilst each phase of the PV component will contribute about 11.3%.

**Table 52: Impact on household income during construction (R' ml, 2011 prices)**

| Item | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| PV Phase 1 | R 39.7 | R 104.2 | R 122.2 | R 266.1 |
| PV Phase 2 | R 39.7 | R 104.2 | R 122.2 | R 266.1 |
| PV Phase 3 | R 39.7 | R 104.2 | R 122.2 | R 266.1 |
| CSP Phase 4 | R 162.2 | R 718.6 | R 680.4 | R 1 561.2 |
| **Total** | **R 281.4** | **R 1 031.1** | **R 1 047.1** | **R 2 359.6** |

## 6. Impact on Government Revenue:

It is estimated that the construction of the Solar Power Park will increase the government revenue for the duration of that phase by an additional R254 million in 2011 prices. The majority of this revenue is expected to be collected by the national government. Thus, the benefit to the local and provincial government will be limited.

## 7. Impact on skills development:

Establishing of the Solar Power Park gives way to a host of skills transfer and development opportunities for people across the country. The impact is widespread seeing that two different types of solar power generation systems will be developed on site. At present there are no such projects in the country thus depending in the rollout of the build programme, specialised skills required to construct CSP and PV facilities will most likely be sourced abroad in the short to medium term.

Attraction of foreign experts on this particular project and the roll out of similar projects in the future could result in the development of the local expertise and knowledge in both the construction and manufacturing sectors. Furthermore, opportunities to develop skills on the R&D level will also be created, particularly if the projects of that kind become common in the country and stimulate the establishment of local manufacturing capabilities.

### *7.13.2.3 Operational Phase Impacts*

The expected impact of the proposed development throughout the operational phase is presented in the following sub-sections. An estimated project lifespan of 30 years for the CSP plant and 25 years for each PV facility, respectively, is expected; therefore, the impacts described in this section are of a long-term nature. All estimates, however, are provided for one operational year in 2011 prices and are assumed to be sustained throughout the lifespan of the facility (where applicable).

## 1. Impacts on Production:

Given that the proposed Solar Park operates at full capacity, it is expected to generate a combined turnover of approximately R2 314.7 million in 2011 prices per annum, of which almost half will be generated by the CSP component of the facility. Overall, a total of R2 745.7 million of new business sales in 2011 prices will be stimulated by the proposed project throughout the entire economy. Most of it will be attributed to the sale of electricity by the Solar Power Park itself.

This is due to the fact that operation expenditure of the facility is relatively small compared to the expenditure required to establish the facility, and significantly smaller than the expected turnover. As a result, the indirect and induced effects stimulated by spending on operations are not expected to be of a significant amount and thus will have limited spill over effects.

**Table 53: Estimated annual impact on business sales (R'ml, 2011 prices)**

| Item | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| PV Phase 1 | R 400.1 | R 20.0 | R 51.0 | R 455.6 |
| PV Phase 2 | R 400.1 | R 20.0 | R 51.0 | R 455.6 |
| PV Phase 3 | R 400.1 | R 20.0 | R 51.0 | R 455.6 |
| CSP Phase 4 | R 1 114.5 | R 163.0 | R 241.4 | R 1 379.1 |
| **Total** | **R 2 314.7** | **R 222.9** | **R 394.5** | **R 2 745.7** |

With regard to the sectoral breakdown of the impact, the utilities sector (as can be expected) will benefit the most. This is attributed to the relatively large turnover that is expected to be generated by the facility on an annual basis. Other than the utilities sector, the financial services and manufacturing sectors are expected to benefit considerably through indirect effects. With respect to induced effects, manufacturing will be the largest beneficiary of the increased household spending ensued by the project, which will be followed by the finance, trade, and transport sectors.

## 2. Impacts on GDP-R:

Given the expected annual turnover of the Solar Power Park, the facility is expected to directly create R1 840.4 million of value-added per annum (2011 prices) once it reaches full operational capacity. Though indirect and induced effects, the proposed project will generate another R106.1 million and R174.2 million of value-added in 2011 prices per annum. Thus, the total spill-over effects of the project during operations are estimated at R280.3 million per annum in 2011 prices. This translates into an additional R1.14 in value-added generated elsewhere in the economy per R1 spent on operations of the Solar Power Park.

Overall, he total annual contribution of the Solar Power Park towards the national economy will amount to R2 120.7 million in 2011 prices, which equates to about 0.08% of the size of the national economy and 4.2% of the size of the utilities sector in the country. In terms of the multiplier, this equates to R8.6 of value added generated in the entire national economy for every R1 spent on operations. Such a multiplier effect is considered to be high and is attributed to the fact that energy sources used to produce electricity by the proposed Solar Power Park comes free, unlike in conventional power stations where coal and transportation thereof comprise a significant portion of operating expenditure.

Similar to the impact on production, the utilities sector will be the sole benefactor of the direct value-added, which is expected to be accounted in the province where the headquarters of the Independent Power Producer are to be established. A certain portion of that value added (i.e. payment of salaries and wages, local and provincial taxes) will be accounted in the Northern Cape Province. As far as indirect and induced effects are concerned, the greater portion of these impacts will also be created outside the Province. Furthermore, most of the production and consumption induced impacts will be stimulated by operations of the CSP component, as outlined in Table 54.

**Table 54: Estimated annual impact on business sales (R'ml, 2011 prices)**

| Item | | Direct | Indirect | Induced | Total |
|---|---|---|---|---|---|
| **PV Phase 1** | National | R 358.1 | R 6.4 | R 18.6 | R 383.1 |
| | Provincial | R 11.0 | R 3.1 | R 3.9 | R 18.0 |
| | Total | R 369.1 | R 9.5 | R 22.5 | R 401.1 |
| **PV Phase 2** | National | R 358.1 | R 6.4 | R 18.6 | R 383.1 |
| | Provincial | R 11.0 | R 3.1 | R 3.9 | R 18.0 |
| | Total | R 369.1 | R 9.5 | R 22.5 | R 401.1 |
| **PV Phase 3** | National | R 358.1 | R 6.4 | R 18.6 | R 383.1 |
| | Provincial | R 11.0 | R 3.1 | R 3.9 | R 18.0 |
| | Total | R 369.1 | R 9.5 | R 22.5 | R 401.1 |
| **CSP Phase 4** | National | R 710.5 | R 65.0 | R 98.2 | R 873.8 |

| Item | | Direct | Indirect | Induced | Total |
|---|---|---|---|---|---|
| | Provincial | R 22.5 | R 12.4 | R 8.3 | R 43.2 |
| | Total | R 733.1 | R 77.4 | R 106.6 | R 917.0 |
| **Total** | **National** | **R 1 784.9** | **R 84.2** | **R 154.1** | **R 2 023.1** |
| | **Provincial** | **R 55.4** | **R 21.7** | **R 20.0** | **R 97.1** |
| | **Total** | **R 1 840.3** | **R 105.9** | **R 174.1** | **R 2 120.2** |

Overall, aside from the utilities sector itself, industries that that are expected to benefit the greatest in terms of GDP growth will be the same as those that experience growth in production volumes. Examples of these industries include the finance services, manufacturing, transport, as well as trade and accommodation sectors.

**Table 55: Impact on GDP during one year of full operational capacity (R' ml, 2011 prices)**

| Economic sector | Direct | Indirect | Induced | Total | % share |
|---|---|---|---|---|---|
| **Agriculture** | - | R 0.3 | R 6.9 | R 7.2 | 0.3% |
| **Mining** | - | R 7.1 | R 3.1 | R 10.2 | 0.5% |
| **Manufacturing** | - | R 9.0 | R 28.1 | R 37.1 | 1.7% |
| **Utilities** | R 1 840.3 | R 28.4 | R 6.3 | R 1 875.1 | 88.4% |
| **Construction** | - | R 2.7 | R 1.7 | R 4.4 | 0.2% |
| **Trade and accommodation** | - | R 5.9 | R 25.7 | R 31.6 | 1.5% |
| **Transport** | - | R 7.3 | R 26.1 | R 33.4 | 1.6% |
| **Financing** | - | R 35.0 | R 34.3 | R 69.3 | 3.3% |
| **Business services** | - | R 7.6 | R 18.9 | R 26.5 | 1.2% |
| **Community and government services** | - | R 2.8 | R 23.1 | R 25.9 | 1.2% |
| **TOTAL** | **R 1 840.3** | **R 106.1** | **R 174.2** | **R 2 120.7** | **100%** |

## 3. Impacts on Employment:

During the operational phase, 147 permanent job opportunities for South Africans will be created and retained at the proposed facility for a period of 25 to 30 years depending on the power generation system. Each PV component will employ 35 persons, 25 of which will be unskilled and semi-skilled workers. The CSP component will employ 42 people, most of which will be skilled and highly skilled workers and about 12 will be semi-skilled and unskilled workers. An additional five (5) experts will be involved in running of the CSP facility in the beginning, whilst a skills development programme is pursued to ensure that over time the workers at the Solar Power Park are completely local (i.e. South African).

The total impact of the proposed project on employment can be seen in Table 54. . It is clear that unlike the impact on production and GDP, the indirect and induced effects of the project on employment exceed the number of direct jobs to be created by the Solar Park during operations. Aside from the direct employment opportunities that will be supported by the project throughout its operations life, an additional 1 231 annual FTE positions will be created in the economy. Of these, 385 will be created through production induced effects and 846 FTE positions will be generated through consumption induced effects. Of the total jobs created, about 849 will be created as a result of the CSP facility's operations and 529 will be created due to the three sets of 75 MW PV facilities.

**Table 56: Annual FTE positions created for South Africans and their possible distribution**

| Item | | Direct | Indirect | Induced | Total |
|---|---|---|---|---|---|
| **PV Phase 1** | National | - | 24 | 89 | 113 |
| | Provincial | 35 | 7 | 21 | 64 |
| | Total | 35 | 31 | 110 | 176 |
| **PV Phase 2** | National | - | 24 | 89 | 113 |
| | Provincial | 35 | 7 | 21 | 64 |
| | Total | 35 | 31 | 110 | 176 |
| **PV Phase 3** | National | - | 24 | 89 | 113 |
| | Provincial | 35 | 7 | 21 | 64 |
| | Total | 35 | 31 | 110 | 176 |
| **CSP Phase 4** | National | - | 237 | 470 | 708 |
| | Provincial | 42 | 54 | 45 | 141 |
| | Total | 42 | 291 | 516 | 849 |
| **Total** | **National** | **-** | **308** | **737** | **1 046** |
| | **Provincial** | **147** | **76** | **109** | **332** |
| | **Total** | **147** | **385** | **846** | **1 378** |

All the direct jobs created at the solar Power Park will be created in the Kgatelopele LM, the Northern Cape Province. Since the PV facility requires a considerable number of unskilled and semi-skilled people to maintain it, most of these positions are expected to be filled by local residents. Training programmes planned to be provided by the Independent Power Producers are also expected to increase the chances of the local labour to be employed in skilled and possibly highly skilled positions.

Regarding FTE positions to be created through production and consumption induced impacts, about 185 of them will be created within the Northern Cape Province and the rest will be created elsewhere in the economy. With respect to the distribution of employment opportunities, most of indirect FTE positions will be created in the financing services sector, followed by the manufacturing sector. As for the induced effects, the industries with the greatest benefits include tertiary sectors such as trade, accommodation, transport, financial services, real estate, and community services.

## 4. Impacts on skills development:

Establishing and operating the plant will result in improved skills amongst the staff as the facility will include a training centre and a certain percentage of its operating expenditure will be allocated to training and development.

On-the-job training is a key element of the staff development many of the required skills during the operational phase will be taught to staff through day-to-day operations. It is also expected that the training programme implemented at the Solar Park will reduce the necessity to acquire foreign expertise in the future. Thus, potentially all employment positions created by the facility will be allocated to South Africa's residents.

## 5. Impacts on Government revenue:

The proposed project is due to have a positive impact on government revenue to the tune of R196.1 million per annum in 2011 prices. The revenue would be collected through direct and indirect rates and taxes, part of which could be used to secure better infrastructure in the region, as well as to provide basic services to people residing in the Local Municipality and the rest of the Province.

## 6. Impact on quality of life and household income:

Given the positive impact on employment realised by all affected households there will be an increase in income levels, which subsequently will improve the standard of living for these households. The operation of the facility will directly increase and secure the earnings of approximately 147 households to an estimated value of R38.6 million per annum in 2011 prices.

Through indirect and induced impacts, the Solar Park will increase household income to additional values of R44.1 million and R78.1million in 2011 prices, respectively. The overall effect of the project is summarised and presented in **Table 63.**

**Table 57: Estimated annual impact on household income (R' ml, 2011 prices)**

| Item | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| PV Phase 1 | R 8.4 | R 3.7 | R 10.1 | R 22.3 |
| PV Phase 2 | R 8.4 | R 3.7 | R 10.1 | R 22.3 |
| PV Phase 3 | R 8.4 | R 3.7 | R 10.1 | R 22.3 |

| | | | | |
|---|---|---|---|---|
| CSP Phase 4 | R 13.3 | R 33.0 | R 47.7 | R 94.0 |
| **Total** | **R 38.6** | **R 44.1** | **R 78.1** | **R 160.8** |

## 7. Local economic and social development:

Any renewable energy project approved by government will need to allocate a certain percentage of its revenue towards social development activities in the local communities.

The current threshold for solar energy project stands at 1.0% of the project's revenue. Given the expected revenue to be generated by each phase of the Solar Power Park, the potential benefits of the local communities on an annual basis could amount to the following in 2011 prices:

- From each PV phase – R4 million
- From CSP components – R11.1 million
- Total for the Solar Power Park – R23.1 million

Thus, up to R23.1 million per annum in 2011 prices could be spent on upliftment of local communities through and projects such as social infrastructure development, training, or other.

### *7.13.2.4 Impact expected during the closure phase*

Upon the expiry of the Solar Power Park's lifespan, the facility would be disbanded, and where necessary, ground will be rehabilitated in attempt to return it to the pre-project conditions. This means that all impacts that took place during the operational phase will cease to exist. At the same time, though, spending on the disassembly of the components and rehabilitation of land will increase the demand for construction services and other industries, thus stimulating economic activity in the local area and in the country albeit over a temporary period.

Socio-economic impacts stimulated by the expenditure during the closure phase are expected to be similar to those that take place during the construction phase. They will also be temporary; however they will most likely require a considerably smaller expenditure than that observed during the construction phase; thus in quantitative terms it will be a fraction of what was observed during operations.

It is expected that the following socio-economic impacts would ensue during the closure phase as a result of project spending:

- Temporary increase in production and value added of the construction sector and its supporting industries due to the demand for demolishing and rehabilitation services, as well as in industries providing goods and services to households due to the consumption induced effects stimulated by the closure expenditure
- Temporary increase in employment due to direct, indirect and induced effects stimulated by the closure of the project
- Temporary increase in income of households that benefit from the direct or indirect activities
- Temporary increase in government revenue through direct and indirect taxes that will need to be paid by the construction companies involved in the disassembly of the facility and rehabilitation

#### *7.13.2.5 Land Sterilisation, Visual Effects and other Secondary and Cumulative Impacts*

The purpose of this chapter is to describe potential socio-economic impacts that are expected to take place as a result of sterilisation of land on site, visual impacts, and present and future developments in the local area (i.e. cumulative effects). For this purpose, the current economic activity observed on the site where the Solar Park is proposed to be developed and economic activities that would be affected due to visual impacts are described and then assessed in terms of the risks and potential losses.

The proposed Solar Park is to be located in the Kgatelopele LM that from the land use perspective largely comprises of agricultural land. The Arriesfontein farm, which wasthe site chosen for the proposed Solar Power Park, is also a farm used for cattle grazing. The farm has a homestead; however, it is not occupied as the owner of the farm lives in the nearby Daniëlskuil. No other residencies are built on the farm and no other families live on it. The farm also has a railway passing through it. In the past, Arriesfontein station, which is also located on the farm, was used to transport cattle and dairy products.

The area surrounding Arriesfontein is also largely comprises of cattle farms, with an exception of the Constantia Safaris bordering the farm to the south-east. Based on the tourism study completed by Grant Thornton, Constantia Safaris is the only game lodge within the visually affected area. Access to Constantia Safaris, as well as the other two farms located south and southwest of the Arriesfontein farm is gained by means of driving through the Farm Arriesfontein.

Other land uses observed in the visually affected area include Lime Acres and Danielskuil towns, Lime Acres Limestone Quarry and Finsch Mine near Lime Acres, and IDWALA Lime located at Danielskuil.

**IDWALA Lime**

**Finsch Mine**

**Lime Acres Limestone Quarry**

The review of the project and communication with other specialists on the team suggests that the most significant environmental impacts that can ensue from the project and result in negative economic impacts include the sterilisation of agricultural land within the footprint of the facility and visual effects. Based on the existing knowledge of land uses, it appears that the most sensitive economic activities within the visually affected area include:

- the agricultural activity on site itself, as the proposed project will sterilise the agricultural land
- Constantia Safaris as the revenue derived by the game lodge is dependent on the area appearing to be pristine from industrial activities

Revenues of other activities such as mines and quarries, as well as business activities located in town are not expected to be negatively affected by visual impacts of footprint of the project.

### *7.13.2.6 Economic losses and impacts due to sterilisation of agricultural land*

The farm Arriesfontein is currently being utilised for cattle farming, therefore, the establishment of the proposed Solar Power Park will sterilise the portion of this farm from agricultural potential and will thus lead to the economic losses. The following paragraphs describe the current agricultural activity taking place on site, which represents a “no go” alternative and provide estimates of the potential losses.

As mentioned earlier, the farm Arriesfontein is used for cattle farming primarily toproduce“weaners”, which is also the most frequent form of cattle farming in South Africa (Department of Agriculture, Forestry, and Fisheries, 2012). The assumptions used to estimate the current revenue of the farm were gathered from the Department of Agriculture, Forestry, and Fisheries (DAFF) (2011, 2012) and discussion with the farm owner. These assumptions were:

- The size of the property is 1 836ha

- Total number of Animal Units (AUs) on the farm is 150 (12ha/AU)
- Bulls to cow ratio – 1 to 20
- Weaners' production rate – 80%
- Weaners are sold to abattoirs when they reach 250kg at R24.3/kg

Based on the above assumptions, it is thus estimated that the average annual revenue of the farm is R692 550 in 2011 prices. The farm does not employ permanent workers, thus it is further assumed that two workers are hired on temporary basis and work for a total of four months per year.

The proposed project, if established, will effectively reduce the output of the farm on which it is to be located. It is estimated that about 950 ha of agricultural land that is presently used for cattle farming will be lost to the new development. Given that the current productivity of the farm is estimated at R377/ha, the sterilisation of the agricultural land will mean the loss of R358 300 per annum. The size of the farm will be reduced by halve; however, it is assumed that the remaining portion of the farm will continue to be used for cattle farming in the future either through a lease agreement or farming by the owner depending on the agreements made between the farm owner and the IPP.

site presents the direct, indirect, induced effects as well as the total loss in the provincial economy due to the sterilisation of agricultural land. Overall, it is estimated that the loss in the national economy will amount to R0.86 million in 2011 prices per annum, which translates into R0.41 million of GDP-R. Since the farm is currently employing two (2) people on a temporary basis, it is expected that the same people will be used to assist with the herd on the remaining portion of the farm.

Thus, the Solar Power Park is not expected to result in negative direct impacts on employment and income. Some income could potentially be lost through indirect and induced impacts as the reduced operating expenditure of the farm will lower demand for respective goods and services. About one FTE person-year will also be lost due to indirect effects; however, such person-years will be spread amongst various sectors and will not translate into the loss of employment in the economy.

**Table 58: Expected losses due to sterilisation of agricultural land on site**

| Impact | Direct | Indirect | Induced | TOTAL |
|---|---|---|---|---|
| Impact on production | - R 0.41 | - R 0.32 | - R 0.13 | - R 0.86 |
| Impact on GDP | - R 0.21 | - R 0.13 | - R 0.06 | - R 0.41 |
| Impact on employment | 0 | 1 | 0 | 1 |
| Impact on income | - R 0.00 | - R 0.06 | - R 0.03 | - R 0.09 |
| Fiscal impact | - R 0.04 | - | - | - |

#### *7.13.2.7 Economic losses due to visual effects*

The Solar Power Park is expected to create a visual disturbance in the area, which would have a negative effect on revenue generation potential of economic activities that are reliant on the scenic beauty of the surrounding environment. Based on the knowledge of existing economic activities that are taking place within the visually affected area, the industry that is expected to be negatively affected due to visual effects exerted by the Solar Power Park includes hunting, photographic, and leisure safaris. The following paragraphs provide assumptions and estimations of the potential economic losses that could be expected to take place in the local safari industry due to the establishment of the proposed facility.

Within the visually affected study area the safari industry is represented by Constantia Safaris private nature game reserve, which borders the farm Arriesfontein inthe south-east. Unfortunately, no data could be collected from the owner of the business concerning the revenues, employment, and other aspects of the business that could be useful in determining the scale of the current economic activity and its potential losses. Therefore, a combination of different data sources was used to estimate the figures required for the impact assessment. These data sources included:

- Constantia Safaris website (http://www.constantiasafaris.co.za), where information on the size of the game farm was sourced
- Information gathered by Grant Thornton during the initial interview with the owner at the end of 2011 that offered estimates of the average number of tourists hosted by the facility over a year
- Review of similar businesses in the country and derivation of trends regarding hunting packages offered, prices, duration, etc.
- Review of prices of taxidermy services provided on various internet websites and derivation of average figures
- Discussions with industry players to acquire outstanding data and to confirm selected assumptions

Using the above-mentioned sources, the following key assumptions regarding the composition and magnitude of safari industry in the visually affected study area were developed:

- The safari industry is represented by a 5 000 ha private nature game reserve
- The revenue sources of the industry include trophy hunting, biltong hunting, photographic safaris, sale of meat of animals hunted for trophies, and sale of animals
- Number of tourists: an average of 200 tourists visit the game reserve on an annual basis

- Tourist split:
  - 180 people (90%) are international tourists
  - 20 people (10%) are domestic tourists
- Purpose of visit:
  - 85% of international tourists (153 people) come to the game reserve for trophy hunting, whilst the rest (27) either accompany the hunters or come for photographic safaris;
  - all 20 domestic tourists to the game reserve come for biltong hunting and occasional trophy hunting, but such tourists are either part of corporate groups or domestic tourists that choose more luxurious facilities.
- Duration of stay:
  - international trophy hunters stay at the reserve seven days at a time on average, i.e. purchasing a seven-day hunting package; the same applied to other international tourists;
  - domestic tourists stay on average three days at a time.
- Spending pattern:
  - International tourists purchase seven-day packages that are assumed to cost US$4 500 and include all costs such as trophy fees, guide fees, license, meals, accommodation, drinks, land transportation, services of tracker and skinners, care of trophies, licences and permit fees;
  - The seven-day package for international tourists accompanying hunters or coming for photographic safaris is US$1 050;
  - Biltong hunters are assumed to pay R1 200 per person per night for accommodation, catering and other services offered, and an average of R835 per animal hunted.

The following table estimates the total revenue of the safari industry in the visually affected area. An exchange rate of R8/US$1 was used to estimate Rand values where assumptions included prices in US$. It shows that the estimated average annual revenue of the facility is about R6.8 million.

**Table 59: Safari and taxidermy industry average annual revenue (R'ml, 2011 prices)**

| Revenue sources | Annual average (R, 2011) |
|---|---|
| Revenue from trophy hunters | R5 508 000 |
| Revenue from photographic safaris | R226 800 |
| Revenue from biltong hunters | R138 000 |
| Revenue from sale of meat | R780 300 |
| Revenue from sale of animals | R104 375 |
| **Total annual average revenue of the local safari industry** | **R6 765 575** |
| **Other revenue streams - taxidermist** | **R2 759 508** |

As far as employment data is concerned, it is assumed that 15 people are permanently employed by the local safari industry, comprising of trackers, the cooking crew, cleaning ladies, administrative staff, and skinners. For the purpose of the economic modelling exercise, it is further assumed that 50.5% of the annual revenue is spent on intermediate goods, another 6.5% on labour costs, and the rest represents gross operating surplus.

Besides the revenue derived by the local safari industry, taxidermy services are also dependent on the number of trophy hunters coming into the area. Although, such services could be located beyond the visually affected area, they will experience a decline in the demand for their services if the number of tourist were to diminish and thus are also included in the assessment. For the purpose of this study, it is assumed that the direct income derived by local taxidermists from the safari industry located within the visually affected area is about R2.8 million per annum.

It is estimated that the local safari industry in the visually affected area is largely dependent on the international trophy hunters. This segment of the market and revenue stream is assumed to contribute 85% of the total annual revenue of the local industry. Interviews with 27 international tourists that come to South Africa for trophy hunting (through e-mails) and local professional hunters (through telephonic discussions) conducted in January 2012 revealed that trophy hunters in general are sensitive to the visual disturbances. The effects of various visual impacts on the decision of trophy hunters to return to the same farm to hunt are dependent on the type of the facility in question and the proximity thereof towards the farm. This implies that a power line running through a property, for example, would have a lesser negative effect on a decision of the trophy hunter to return to the game reserve as a coal-powered power station located in its vicinity. It also appears that a solar energy facility, for example, would be more tolerable than a coal-powered station.

Given the information collected through interviews with various groups of tourists (i.e. game viewers, domestic hunters, international trophy hunters), a number of assumptions regarding changes in future behaviour of visitors to the local safari were made. These assumptions are presented in the following table and illustrate the percentage of tourists that are expected to change their decision with respect to the return visit to the same game farm if visual disturbance such as a solar energy facility were to be introduced into the area.

The same percentages were assumed to represent the share of tourists that will be lost, which in turn can be translated in to the losses of industry's revenue from related revenue streams.

**Table 60: Expected direct losses of the local safari industry due to visual impacts**

| Revenue stream | % of tourists lost | % of revenue loss | Revenue loss (R) |
|---|---|---|---|
| Revenue from trophy hunters | 63.8% | 63.8% | - R3 514 104 |
| Revenue from photographic safaris | 60.0% | 60.0% | - R136 080 |
| Revenue from biltong hunters | 62.5% | 62.5% | - R91 313 |
| Revenue from sale of meat | - | 63.8% | - R497 831 |
| Revenue from sale of animals | - | - | - |
| **Total for safaris industry** | - | **62.7%** | **- R4 239 328** |
| **Total for taxidermy** | - | **63.8%** | **- R1 756 566** |
| **Total losses of the local safari and taxidermy industries** | | | **- R5 999 894** |

The potential revenue losses of the local safari industry as a result of the establishment of the proposed facility are estimated to be about R4.2 million per annum, in current prices. This represents 62.7% of the annual revenue derived by the industry at the moment, or in the case of the "no go" alternative. In addition to these losses, the decline in the number of trophy hunters in the area will also lead to the decline in the demand for the local taxidermy services. Thus, an additional R1.8 million will be lost by the taxidermy industry, making the total losses to be R6 million per annum.

Since the safari industry and taxidermy services also support other business activities, most of which are probably located in the local municipality and the Province, the estimation of the total losses to the economy is done by employing the provincial economic model used in estimating the impacts of proposed project's expenditure. The summary of the total losses in the economy due to the reduced turnover of the local safari and taxidermy industries is provided inTable 61**.**

**Table 61: Expected losses due to visual impact on local safari industry (2011 prices)**

| Impact | Direct | Indirect | Induced | TOTAL |
|---|---|---|---|---|
| **Impact on production (R'ml)** | - R 6.0 | - R 5.0 | - R 2.2 | - R 13.2 |
| **Impact on GDP (R'ml)** | - R 2.6 | - R 2.1 | - R 1.0 | - R 5.6 |
| **Impact on employment (FTE person years)** | - 13 | - 15 | - 5 | - 33 |

| Impact | Direct | Indirect | Induced | TOTAL |
|---|---|---|---|---|
| **Impact on income (R'ml)** | - R 2.2 | - R 1.1 | - R 0.5 | - R 3.8 |
| **Fiscal impact (R'ml)** | - R 0.6 | - | - | - |

Assuming that most of the production and consumption induced effects are concentrated in the Northern Cape Province, it is estimated that the visual effects associated with the proposed Solar Power Park will reduce the production in the provincial economy to the value of R13.2 million and result in the loss of about 33 FTE employment positions. Households would lose about R3.8 million in annual earnings, of which the biggest portion would be the losses, experienced by the owners of the owners of the safari and taxidermy businesses. Government revenue will be reduced by about R0.6 million per annum.

With respect to the start and the duration of the losses, the following is assumed:

- The negative impact on the local safari industry and as a result on the related and supported sectors will be introduced in the first year of operations. The game farm in question is accessed through the farm Arriesfontein, which means that all potential tourists would most probably be greeted with the construction activities taking place on the site, unless the road is re-routed through another farm.
- It is expected that the negative impact will reach its peak in the second year and will remain as such for the rest of the construction, operating, and closure periods, i.e. for about 34 years. Thereafter, the disassembly of the facility and rehabilitation of land could reduce the visual impact to being negligible, which could return the local safari industry to the pre-project situation. This of course is subject to a number of conditions, including substantial investment in marketing.

### *7.13.2.8 Other secondary and cumulative socio-economic impacts*

Aside from the negative impacts discussed in this chapter and positive impacts outlined in the previous chapter, the proposed Solar Power Park is expected to be associated with a number of other secondary and cumulative socio-economic impacts that are more difficult to quantify than impacts analysed to this stage. These impacts are described in the following sections.

### 1. Increased levels of crime and other social conflicts due to influx of job seekers and workers from other areas (construction and closure phases)

The local economy is not sufficiently diversified to supply the entire work force for the construction of the facility. Therefore, it is expected that a significant portion of the construction workers will be coming from outside the area. In addition, an influx of job seekers to the area could also be expected. This migration of people to the area could result in social conflicts between the local population and the migrants, and could leave to increased levels of crime, prostitution, and possibly deterioration of health amongst the local communities due to the spread of sexually transmitted diseases.

The issue of construction workers and job seekers that decide to stay in the area after the project's establishment is also a great concern, as left without income these individuals could resolve to crime and contribute to the increase in the levels of poverty in the local communities.

Aside from the broader community issues, the presence of the workforce on site could lead to negative impacts in the surrounding area such as poaching of cattle and game in the nearby farms, burglaries, trespassing, development of informal trading, and littering.

## 2. Increased pressure on economic and social infrastructure in the area (during construction)

The proposed development will create 2 102 FTE person-years, the greatest share of which will be created in the first year of the two and a half year construction period, assuming that all phases are being built simultaneously. This means that up to 1 381 persons will be involved in the project in the first year, of which the majority will be construction workers. Housing of these construction workers, many of which are expected to be migrants could pose a problem in the area as the supply of rental housing and accommodation in the area is limited.

The developments in the nearby municipalities around Postmasburg and Kathu have put extreme pressure on accommodation and rental housing market. Thus, the proposed project is expected to aggravate the problem in this respect.

Regardless of the options chosen to pursue to accommodate the temporary workforce (on-site or off-site), it will put an additional pressure on the local service delivery as the local municipality comprises of just over 21 000 people and depending on the number of people employed from the local community, the temporary increase in the local population could range between a couple of hundred to a thousand people.

This would increase the demand for local social services, such as health facilities, as well as the demand for water and electricity, which would translate in greater running costs of such infrastructure. Thus, the entire service delivery in the local municipality would be under significant strain during the first year of operations when all four (4) phase are assumed to be pursued, as well as under pressure albeit at a lower level for another year and a half during which the establishment of the CSP facility will be completed.

The effects of the project on road infrastructure should also be noted, as the development will most likely increase the local traffic in the area which could lead to significant deterioration of local road conditions. This in turn could lead to greater accidents in the area and will require greater expenses to maintain the road.

## 3. Increased pressure on housing and services during operations

The proposed facility is expected to create 147 additional new jobs, of which 142 will be created for South African citizens. As mentioned earlier, about 25 jobs at each phase of the PV component and 12 jobs at the CSP component will require semi-skilled and unskilled workers. Given the current unemployment rate in the municipality, it can be safely estimated that these positions could be filled by locals. The rest, though, might require attraction of workers from other parts of the Province and most likely the country.

With every new household brought to the area, the demand for affordable rental and permanent housing options will grow. The housing market in the District is strained due to expansion and establishment of new mining operations; therefore, the attraction of new households to the area will aggravate a problem further. If the demand is satisfied, this will put further pressure on service delivery of the local municipalities, i.e. provision of access to water, electricity, and sanitation.

## 4. Impact on property values in the visually affected area

The establishment of the proposed facility is expected to have a significant negative visual impact, particularly within the four (4) kilometre radius from the farm Arriesfontein and to a lesser extent within the entire visually affected area. Such a visual disturbance, as was indicated earlier, is not expected to reduce the revenue of cattle farms that are dominated in the area, but is expected to reduce the revenue of the nearby Constantia Safaris.

Revenue derived by a real estate is one (1) of the factors of property value. The most common valuation approaches of real estate such as income cap or direct capitalisation and discounted cash flows make use of income or revenue streams to determine the property value. This means that if the revenue changes, the property value is also expected to change.

In the case of Constantia Safaris, the annual average revenue estimated to be derived from the facility is expected to drop by about 62.7%. Alternative agricultural uses of the property would not be able to generate the same turnovers as its current uses, thus the revenue loss would be permanent. Such a significant decline in revenue is expected to have a major impact on the value of that property for the purposes of game hunting and photographic safaris, which will ultimately result on lower returns on investment of the property's owner.

## 5. Stimulation of the local manufacturing industry to support the development of solar projects

With reference to the objectives of the New Growth Path (2010), the Green Economy Accord (2011) and IPAP2 (2011-2014) to support the green economy and renewable energy sources, the establishment of the solar power park is pivotal. It will not only create direct positive economic impacts, but will also aid in the establishment of the specialised manufacturing industries.

The Green Jobs (Maia et al, 2011) report estimated that 608 and 8 463 sustainable jobs could be created in the country in the long-term in manufacturing industries directly supporting the CSP and PV projects, respectively. The realisation of these opportunities is largely reliant on the economies of scale created within the economy, which requires the CSP and PV facilities to be established over a long-term period and at a steady growth trajectory.

Government has already approved the licensing of solar energy projects to a capacity of 200 MW of CSP and 1 450 MW of PV. It is also known that a number of similar projects are being proposed to be established in the Northern Cape, including the Siyanda DM where the proposed Solar Power Park is to be located. Over the next 20 years, 1 000 MW of CSP and 8 400 MW of PV facilities are planned to be allocated creating a long-term demand for inputs to these projects.

Without doubt, the development of these projects offers notable opportunities to the national and local economies not only in terms of primary or direct impacts, but importantly in terms of opportunities for establishing local manufacturing and service industries. However, realisation of economies of scale is only possible if the demand created is for the same type of inputs, materials, and equipment. Given that the CSP and PV technologies are proprietary and differ from one developer to another, realisation of local manufacturing opportunities could be constrained by either the desire or technological needs to retain a supply chain independent on the competitors. Thus, it could lead to a situation that only a fraction of potential localisation opportunities are being realised. Such a situation could change drastically if the developers are assigned a greater share of projects and thus see it feasible to invest in establishing local capabilities, which will bring knowledge and skills to the national economy and aid in the development of the entire industry.

The Arriesfontein Solar Power Facility proposed to be established by SRSA, is one of a few solar energy projects that the above-mentioned developer applies for the license. Other projects are all located in the Northern Cape and include inter alia:

- Arriesfontein CSP-Tower (100 MW) facility about 32 kilometres east from Daniëlskuil
- Rooipunt Solar Park outside Upington (100 MW CSP and 225 MW PV)
- Farm 198 Solar Park outside Windsorton (75 MW of PV)

Based on the above, it shows that if projects applied by the developer are approved it would create sufficient incentive for the developer to invest in local capabilities and develop its local supply value chain that would support the construction of CSP and PV facilities using proprietary technology of SRSA, as well as businesses providing necessary spare parts and materials for maintenance of these facilities.

### 7.13.3 Sensitivity Rating

The purpose of this chapter is to evaluate the socio-economic impacts of the Solar Power Park on the regional and local economies. Since the proposed project would have both positive and negative economic impacts in terms of a number of indicators, a net effect for these impacts is firstly calculated. It is then followed by the evaluation as per the method described in the first chapter of the report. Impact evaluation is done for all types of effects identified earlier in the report and are grouped per the stage of the project's lifecycle, i.e. during construction, operations, and closure phases.

#### *7.13.3.1 Rating of impacts taking place during construction*

The net impact of the proposed project on the aforementioned indicators and economic variables is presented in the following sub-sections. Recall that the bulk of the capital expenditure will be spent on local goods and services therefore in comparison to the onsite agricultural activity, the net impact of the CSP plant on the regional economy is expected to be considerably large during this stage. However, as mentioned in previous chapters, the impact from the construction phase is not sustainable as the duration of this phase is capped at 30 months.

### 1. Evaluation of the impact on balance of payment

The construction of the proposed Solar Power Park will negatively impact the balance of payments as the required capital to finance the project will be sourced from within South Africa and about R5 555.1 million in 2011 prices will be spent on imported goods. This amount represents about 7.5% of the trade deficit observed in 2010; however, on its own it is not expected to create the need for fiscal and monetary policy changes.

**Table 62: Evaluation of impact on balance of payment**

| Impact: | Increase in imports and possible increase of the trade deficit during construction | | | Negative |
|---|---|---|---|---|
| **Before mitigations** | | | | |
| Probability | Highly probable (4) | Scale | National (4) | |
| Duration | Short-term (2) | Magnitude | Low (4) | |
| Significance | **Moderate (40)** | | | |
| **After mitigations** | | | | |

| | |
|---|---|
| Mitigations | None at this stage – requires development of the local manufacturing capabilities |

## 2. Evaluation of the impact on production

As indicated in Table 48 the net impact of the proposed project on new business sales or production during construction is R17 407.2 million in 2011 prices. This is taking into account not only the loses of the agricultural revenue that can be derived from the cattle farm for the entire duration of the construction period (2.5 years), but also the potential losses of the local tourism industry over the same period. It is clear that the negative impacts on production are considered to be minute compared to the total new business sales that are expected to be stimulated by the investment in four phases of the project.

**Table 63: Net impact on production during construction (R'ml, 2012 prices)**

| Impact | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Impact of proposed project | R 5 473.7 | R 6 637.0 | R 5 331.8 | R 17 442.3 |
| Loss of the current activity | R -1.0 | R -0.8 | R -0.3 | R -2.2 |
| Loss due to visual impact | R -15.0 | R -12.5 | R -5.5 | R -33.0 |
| **Net impact** | **R 5 457.7** | **R 6 623.7** | **R 5 326.0** | **R 17 407.2** |

The evaluation of the impact is tabulated below. As indicated the impact is expected to be of moderate significance, which is downscaled due to its short-term duration.

**Table 64:Evaluation of net impact on production during construction**

| Impact: | Temporary increase in production in the countryduring construction | | Positive |
|---|---|---|---|
| **Before mitigations** | | | |
| Probability | Highly probable (4) | Scale | National (4) |
| Duration | Short-term (2) | Magnitude | High (8) |
| Significance | **Moderate (56)** | | |
| **After mitigations** | | | |
| Mitigations | In order to optimise the stimulation of the economy through direct, indirect and induced effects, the following should be applied where possible:<br>• Engagement with the district and local municipalities and local business forums or chambers to investigate the possibility of procurement of construction materials, goods, and products from local suppliers where feasible<br>• Employ local contractors where possible<br>The proposed measures are not going to affect the rating of that impact. | | |
| Probability | Highly probable (4) | Scale | National (4) |
| Duration | Short-term (2) | Magnitude | High (8) |

| | |
|---|---|
| Significance | **Moderate (56)** |

## 3. Evaluation of the impact on GDP-R

Over the construction period a total of R15 million of GDP-R (2011 prices) is expected to be lost in the economy due to the loss of the agricultural land and visual impacts of the project. On the other hand, the investment in the Solar Power Park will generate over R6 214.5 million in 2011 prices. Thus the net effect on the national GDP-R by the project will be about R6 199.5 million, whilst the net direct contribution of the project towards the stimulation of the national economy will amount to R1 349.4 million in 2011 prices over the two and a half year  (2.5) period (Table 65).

**Table 65: Net impact on GDP-R during construction (R'ml, 2012 prices)**

| Impact | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Impact of proposed project | R 1 356.4 | R 2 501.4 | R 2 356.8 | R 6 214.5 |
| Loss of the current activity | R -0.5 | R -0.3 | R -0.2 | R -1.0 |
| Loss due to visual impact | R -6.5 | R -5.3 | R -2.5 | R -14.0 |
| **Net impact** | **R 1 349.4** | **R 2 495.8** | **R 2 354.2** | **R 6 199.5** |

The evaluation of the net impact on GDP-R during construction is presented in Table 66. Similar to the net impact on production, the impact on GDP-R is of moderate significance irrespective of the enhancement measures put in place.

**Table 66: Evaluation of net impact on GDP-Rduring construction**

| Impact: | Temporary increase in GDP-R during construction | | Positive |
|---|---|---|---|
| **Before mitigations** | | | |
| Probability | Highly probable (4) | Scale | National (4) |
| Duration | Short-term (2) | Magnitude | High  (8) |
| Significance | **Moderate (56)** | | |
| **After mitigations** | | | |
| Mitigations | The facility should be encouraged to procure materials, goods, services and products required for the operation of their businesses from local suppliers to increase the impact on local and regional economies, without jeopardising its own efficiency and competitiveness. However, this might have an impact on the local economy and will not affect the estimate of the total value-added to be generated by the project. Thus, it will not change the score. | | |
| Probability | Highly probable (4) | Scale | National (4) |
| Duration | Short-term (2) | Magnitude | High  (8) |
| Significance | **Moderate (56)** | | |

## 4. Evaluation of the impact on employment

The net effect on employment during the construction period will be positive and will be significantly greater than the potential losses. As indicated in Table 53, up to 86 FTE positions could be lost in the economy due to sterilisation of agricultural land and visual impacts, whilst almost 27 thousand FTE positions could be created through the expenditure on the project.

When considering local impacts only, the net effect is also positive and the created local opportunities are expected to be bigger by a factor. These opportunities though will last only for the duration of the construction period.

**Table 67:** Net impact on employment during construction

| Impact | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Impact of proposed project | 2 102 | 13 620 | 11 277 | 26 999 |
| Loss of the current activity | - | 3 | - | 3 |
| Loss due to visual impact | -33 | -38 | -13 | -83 |
| **Net impact** | **2 070** | **13 585** | **11 265** | **26 919** |

**Table 68**: **Evaluation of net impact on employment during construction**

| Impact: | Creation of employment opportunities during construction | | Positive |
|---|---|---|---|
| **Before mitigations** | | | |
| Probability | Highly probable (4) | Scale | National (4) |
| Duration | Short-term (2) | Magnitude | High (8) |
| Significance | **Moderate (56)** | | |
| **After mitigations** | | | |
| Mitigations | The following is recommended to enhance the benefits of the created employment in the local area where feasible:<br>• Consider employing labourers who would lose their jobs in the local safari industry due to the visual impact<br>• Consider organising local community meetings to advise them on the project that is planned to be established and the jobs that can potentially be applied for by the local labour<br>• Establish a local skills desk to determine the potential skills that could be sourced locally<br>• Recruit local labour where supply and demand of skills match<br>• Employ labour-intensive methods in construction where feasible | | |

| | | | |
|---|---|---|---|
| | • Sub-contract to local construction companies where possible<br>• Utilise local suppliers where possible<br>The proposed enhancement measures would increase the opportunities for local businesses and labour force, but would not change the total net impact. Thus the rating of the impact after enhancement measures remains the same. | | |
| Probability | Highly probable (4) | Scale | National (4) |
| Duration | Short-term (2) | Magnitude | High (8) |
| Significance | **Moderate (56)** | | |

## 5. Evaluation of the net impact on household income

The potential household income losses by the agricultural activity currently in place and local safari industry is comparatively negligible to that of the income to be generated during the construction period of the Solar Power Park. It is estimated that the loss of R5.5 million over the two and a half year period experienced by the directly affected households in the local area will be substituted by the creation of an additional R281.4 million in 2011 prices over the same period.

A significant portion of this income will be paid to the constructing workers, who are either living in the area or will be moving to the area, which means that they will be spending that income in the local area stimulating the economy of Kgatelopele LM and its surrounding municipalities.

**Table 69: Net impact on household income during construction (R'ml, 2011 prices)**

| Impact | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Impact of proposed project | R 281.4 | R 1 031.1 | R 1 047.1 | R 2 359.6 |
| Loss of the current activity | R 0.0 | R -0.2 | R -0.1 | R -0.2 |
| Loss due to visual impact | R -5.5 | R -2.7 | R -1.1 | R -9.4 |
| **Net impact** | **R 281.4** | **R 1 031.3** | **R 1 047.2** | **R 2 359.8** |

The evaluation of the impact on household income is similar to that of the impact on employment as the two are indivisibly related. The results are presented in Table 69.

**Table 70: Evaluation of net impact on household income during construction**

| | | | |
|---|---|---|---|
| Impact: | Increase in household income during construction | | Positive |
| **Before mitigations** | | | |
| Probability | Highly probable (4) | Scale | National (4) |
| Duration | Short-term (2) | Magnitude | High (8) |

| | | | |
|---|---|---|---|
| Significance | **Moderate (56)** | | |
| | **After mitigations** | | |
| Mitigations | Considerations of the potential loss of the Arriesfontein farm owners' profit and businesses directly affected by the visual impact (i.e. local safari industry) during construction should be taken into account and the affected parties should be adequately reimbursed for this. Such reimbursement should be fair and should be satisfactory for all affected parties. | | |
| Probability | Highly probable (4) | Scale | National (4) |
| Duration | Short-term (2) | Magnitude | High (8) |
| Significance | **Moderate (56)** | | |

## 6. Evaluation of the net impact on government revenue

The local capital expenditure of R 5 473.7 million is expected to increase government revenue to the value of approximately R 254.0 million in 2011 prices. The potential losses in value added by the agricultural and visually affected businesses will at the same time reduce government revenue, but at a fraction of the volume that is expected to be created (i.e. R1.6 million in 2011 prices over the construction period).

Irrespective of the specific government objective achieved through this income, the net increase in government revenue of R252.4 million will be beneficial, although in the context of the current government's spending is very small. The evaluation of the net impact on government revenue is provided in Table 71.

**Table 71: Net impact on government revenue during construction (R' ml, 2011 prices)**

| Impact: | Increase in government revenue during construction | | Positive |
|---|---|---|---|
| | **Before mitigations** | | |
| Probability | Highly probable (4) | Scale | National (4) |
| Duration | Short-term (2) | Magnitude | Low (4) |
| Significance | **Moderate (40)** | | |
| | **After mitigations** | | |
| Mitigations | None | | |

## 7. Impact on skills development

The development of the CSP and PV components as part of the Solar Power Park will benefit the South African workforce in terms of knowledge transfer amongst the project management and engineering professions involved in the construction, skills development amongst employees along the supply value chains (particularly manufacturing), and importantly skills development amongst the construction workers.

**Table 72: Impact on skills development during construction**

| Impact: | Skills development of people involved in construction, project management, engineering and manufacturing | | Positive |
|---|---|---|---|
| **Before mitigations** | | | |
| Probability | Medium probability (3) | Scale | National (4) |
| Duration | Permanent(5) | Magnitude | Low (4) |
| Significance | **Moderate (39)** | | |
| **After mitigations** | | | |
| Mitigations | • Facilitate knowledge and skills transfer between the foreign experts and South African professionals<br>• Set up apprenticeship programmes to build onto existing or develop new skills of construction workers, especially those coming from the local communities | | |
| Probability | Medium probability (3) | Scale | National (4) |
| Duration | Permanent(5) | Magnitude | Moderate (6) |
| Significance | **Moderate (45)** | | |

## 8. Increased levels of crime and social conflicts impacts evaluation

The influx of job seekers and migrant construction workers is expected to create social disturbances and conflicts in the local economy, amongst which include crime around the site (poaching of game and cattle) and elsewhere in the community (burglaries, assaults, etc.), adverse health impacts, and others. The significance of such impacts is dependent to a certain extent on the proportion of workers that are brought from outside the area.

The greater the number of migrant workers used in the construction, the greater social disturbances will be created. The influx of job seekers is difficult to mitigate; however, appropriate awareness campaigns and strict adherence to the recruiting practices could potentially reduce the adverse effects. In any case, addressing the challenges related to potential social impacts is best to be done in partnership with the adjacent property owners, local communities, councils, and municipal authorities that would promote transparency, information sharing, and build good relationships between the parties.

**Table 73: Evaluation of impact on crime situation and social conflicts in the local area**

| | | | |
|---|---|---|---|
| Impact: | Possible increase in crime and other social conflicts due to influx of job seekers and migrant construction workers | | Negative |
| **Before mitigations** | | | |
| Probability | Probable (3) | Scale | Local (2) |
| Duration | Short-term (2) | Magnitude | Moderate (6) |
| Significance | **Moderate (30)** | | |
| **After mitigations** | | | |
| Mitigations | The following mitigation measures are proposed to reduce the adverse effects associated with the influx of job seekers and migrant construction workers:<br>• Employ locals as far as feasible (though the creation of the local skills base and recruitment of suitable candidates)<br>• Control the movement of workers between the site and areas of residence to minimise loitering around the Arriesfontein farm and communities by providing scheduled transportation services<br>• Engage communities with respect to their possible involvement during construction in providing supporting services such as catering, temporary housing of workers, transportation, etc.<br>• Formalise trading and service provision around the site, by providing a dedicate area for such services and signing contracts with service providers<br>• Set up a recruitment office in the nearby town (i.e. Danielskuil) and adhere to strict labour recruitment practices that would reduce the desire of potential job seekers to loiter around the properties in hope to find temporary employment<br>• Establish a proper fencing around the property to reduce the desire of workers to trespass between the construction site and adjacent properties<br>• Set up a gate and controlled access system to monitor the movement of people to and from the property, as well as to reduce the influx of job seekers to the site itself | | |
| Probability | Probable (3) | Scale | Local (2) |
| Duration | Short-term (2) | Magnitude | Low (4) |
| Significance | **Low (24)** | | |

## 9. Evaluation of the impact on economic and social infrastructure

The construction of the proposed Solar Power Park that could require up to 1 381 people be on site during the first year and about 481 in the second year and less than that in the third years is expected to have a notable impact on the economic and social infrastructure, particularly given the fact that many of the workforce involved in the development would be coming from outside the municipality.

Thus, the housing and accommodation situation, basic service provision, health facilities, and road infrastructural are expected to be under strain during the construction period. Unless proper measures are put in place, these infrastructural elements could deteriorate leading to a reduced standard of living of the entire community. Most of these impacts are possible to mitigate to a certain extent, but will require the developer to engage with the local authorities prior the construction to commence to find the most practical and least harmful solution.

**Table 74: Evaluation of impact on economic and social infrastructure**

| | | | |
|---|---|---|---|
| Impact: | Strained and possible deteriorated economic and social infrastructure | | Negative |
| **Before mitigations** | | | |
| Probability | Highly probable (4) | Scale | Local (2) |
| Duration | Short-term (2) | Magnitude | Moderate (6) |
| Significance | **Moderate (40)** | | |
| **After mitigations** | | | |
| Mitigations | • Engage local authorities prior the construction period and discuss with them the demands for various services such as water, electricity, etc. that are expected to ensure during the development<br>• Identify in consultation with local authorities the infrastructural services that will be affected the most and would be put under significant strain depending on the supply and capacity thereof at the time of construction and created demand by the proposed project<br>• Devise the plan to assist the municipality in addressing the challenges and thus reducing the pressure of the proposed development on the supply of such services and ensuring its uninterrupted supply to the site and other affected parties | | |
| Probability | Highly probable (4) | Scale | Local (2) |
| Duration | Short-term (2) | Magnitude | Minor (4) |
| Significance | **Low (24)** | | |

### *7.13.3.2 Rating of impacts taking place during operations*

The evaluation of the net impact of the proposed project during its operational phase is presented in the following sub-sections. The information under analysis is the average impact that can be expected on an annual basis during the operational life of the facility.

## 1. Evaluation of the impact on production

The proposed project is expected to generate, on average, a turnover of R2 314.7 million per annum given that it is operating at full capacity. This turnover translates into the direct impact of the plant operations on regional business sales which, through economic spin-offs, generates a total impact of R2 745.7 million in 2011 prices.

At the same time, due to the sterilisation of land and visual impacts, the economy is expected to lose R14.1 million in 2011 prices per annum. Thus the net effect will equate to R2 731.7 million per annum in 2011 price, which shows that the proposed facility's benefits for the national economy's production by far outweigh the potential losses in production stimulated by the facility's negative effects.

**Table 75: Net impact on production during the operational phase (R' ml, 2011 prices)**

| Impact | Direct | Indirect | Induced | TOTAL |
|---|---|---|---|---|
| Impact of proposed project | R 2 314.7 | R 222.9 | R 394.5 | R 2 745.7 |
| Loss of the current activity | R -0.4 | R -0.3 | R -0.1 | R -0.9 |
| Loss due to visual impact | R -6.0 | R -5.0 | R -2.2 | R -13.2 |
| **Net impact** | **R 2 308.3** | **R 217.6** | **R 392.2** | **R 2 731.7** |

**Table 76: Evaluation of the net impact on production over one year of full operational capacity**

| Impact: | Increase in production during operation | | | Positive |
|---|---|---|---|---|
| **Before mitigations** | | | | |
| Probability | Highly probable (4) | Scale | Local (4) | |
| Duration | Long-term (4) | Magnitude | High (8) | |
| Significance | **High (64)** | | | |
| **After mitigations** | | | | |
| Mitigations | The Solar Park should be encouraged to procure materials, goods and products required for the operation of their businesses from local suppliers to increase the positive impact in the local economy as far as possible. In general terms, however, this will not change the total impact and will only change the distribution of the impact; as a result, the weighting for the impact will not change after mitigations. | | | |
| Probability | Highly probable (4) | Scale | Local (4) | |
| Duration | Long-term (4) | Magnitude | High (8) | |
| Significance | **High (64)** | | | |

As opposed to the construction phase, the net impact of the project during the operational phase with regard to production is of high significance. This is mainly attributed to the magnitude and duration of the impact.

## 2. Evaluation of the impact on GDP-R during the operational phase

The net direct impact of the project on GDP is R1 840.5 million per annum, which will increase the size of the local economy making it less dependent on the mining sector. Furthermore, the project is expected to boosts the value added in the tertiary services industries and manufacturing sectors both in the Province and nationally.

The total value added loss due to the sterilisation of land and the visual impact is expected to be about R6 million per annum, which is a fraction of what will be generated by the Solar Park. In total, the net impact of the project is estimated at R2 114.2 million in 2011 prices.

**Table 77: Net impact on GDP-R during the operational phase (R' ml, 2011 prices)**

| Impact | Direct | Indirect | Induced | TOTAL |
|---|---|---|---|---|
| Impact of proposed project | R 1 840.3 | R 105.9 | R 174.1 | R 2 120.2 |
| Loss of the current activity | R -0.2 | R -0.1 | R -0.1 | R -0.4 |
| Loss due to visual impact | R -2.6 | R -2.1 | R -1.0 | R -5.6 |
| **Net impact** | **R 1 837.5** | **R 103.7** | **R 173.0** | **R 2 114.2** |

**Table 78: Evaluation of net impact on the GDP-R (operational phase)**

| Impact: | Increase in GDP-R during operation | | | Positive |
|---|---|---|---|---|
| **Before mitigations** | | | | |
| Probability | Highly probable (4) | Scale | Local (4) | |
| Duration | Long-term (4) | Magnitude | High (8) | |
| Significance | **High (64)** | | | |
| **After mitigations** | | | | |
| Mitigations | The facility should be encouraged to procure materials, goods, services and products required for the operation of their businesses from local suppliers to increase the impact on local and regional economies, without jeopardising its own efficiency and competitiveness. | | | |
| Probability | Highly probable (4) | Scale | Local (4) | |
| Duration | Long-term (4) | Magnitude | High (8) | |
| Significance | **High (64)** | | | |

## 3. Evaluation of the net impact on employment creation during the operational phase

During the operational phase about 147 people, excluding foreign labour, will be employed at the plant to oversee daily operations. Through indirect and induced effects, over 900 additional employment opportunities will be created in the economy. The sterilisation of the agricultural land on the Arriesfontein farm will result in about one FTE position lost through indirect impacts, whilst the impact on the safari industry will result in the loss of about 33 FTE positions throughout the economy.

Thus, the benefits of the Solar Power Park in terms of employment considerably exceed the job losses associated with the secondary impacts ensued as a result of it. Importantly, the benefit to the local employment in Kgatelopele will be at least ten times greater than the local job losses; nevertheless, in the context of the national economy and in light of the job creation targets set for the next ten years this number is low. Since the employment though is long-term, the significance of the impact is moderate.

**Table 79: Net impact on SA employment over one year of full operational capacity**

| Impact | Direct | Indirect | Induced | TOTAL |
|---|---|---|---|---|
| Impact of proposed project | 147 | 385 | 846 | 1 378 |
| Loss of the current activity | 0 | 1 | 0 | 1 |
| Loss due to visual impact | -13 | -15 | -5 | -33 |
| **Net impact** | **134** | **371** | **841** | **1 346** |

**Table 80: Evaluation of the impact on employment during operations**

| Impact: | Creation of sustainable employment opportunities | | | Positive |
|---|---|---|---|---|
| **Before mitigations** | | | | |
| Probability | Highly probable (4) | Scale | National (4) | |
| Duration | Long-term (4) | Magnitude | Low (4) | |
| Significance | **Moderate (48)** | | | |
| **After mitigations** | | | | |
| Mitigations | Where possible, the local labour should be considered for employment to increase the positive impact on the local economy, i.e. Kgatelopele LM. However, this will not impact on the total employment opportunities created by the Solar Power Park and will therefore not change the weights of the impact. | | | |
| Probability | Highly probable (4) | Scale | National (4) | |
| Duration | Long-term (4) | Magnitude | Low (4) | |
| Significance | **Moderate (48)** | | | |

## 4. Evaluation of household income during the operational phase

Households are expected to experience a net positive effect as a result of the net increase in employment. The project will support R38.6 million per annum in 2011 prices of direct income, whilst the potential direct household losses due to secondary impacts are expected to be around R2.2 million per annum. Thus, the net direct effect on household income will be R36.4 million per annum.

Taking into account the spill over effects, the total project's net impact on household earnings in the country will be R156.9 million per annum. This is significantly greater than the income generated as a result of the "no go" option, but still small considering the size and numbers of households in the country.

**Table 81: Net impact on the household income during operational phase (R'ml, 2011 prices)**

| Impact | Direct | Indirect | Induced | TOTAL |
|---|---|---|---|---|
| Impact of proposed project | R 38.6 | R 44.1 | R 78.1 | R 160.8 |
| Loss of the current activity | R 0.0 | R -0.1 | R -0.0 | R -0.1 |
| Loss due to visual impact | R -2.2 | R -1.1 | R -0.5 | R -3.8 |
| **Net impact** | **R 36.4** | **R 42.9** | **R 77.6** | **R 156.9** |

**Table 82: Evaluation of the impact on household income during operations**

| Impact: | Increase in household earningsduring operations | | | Positive |
|---|---|---|---|---|
| **Before mitigations** | | | | |
| Probability | Highly probable (4) | Scale | National (4) | |
| Duration | Long-term (4) | Magnitude | Low (4) | |
| Significance | **Moderate (48)** | | | |
| **After mitigations** | | | | |
| Mitigations | In order to increase the income retention in the local economy, local SMMEs should be employed to provide selected services, such as cleaning, security, transportation, etc. | | | |
| Probability | Highly probable (4) | Scale | National (4) | |
| Duration | Long-term (4) | Magnitude | Low (4) | |
| Significance | **Moderate (48)** | | | |

## 5. Evaluation on the net impact on government revenue

The Solar Park plant, if established, would generate R196.1 million per annum of government revenue. On the other hand, the direct losses of the agricultural sector and safari industry would reduce government earnings by R0.64 million per annum. Nevertheless, the net effect on government reverence will still be positive and significantly greater than the losses. Considering the total budget of government though, this amount is minute.

**Table 83: Evaluation of the impact on government revenue (operational phase)**

| | | | | |
|---|---|---|---|---|
| Impact: | Increase of government revenue during operation | | | Positive |
| **Before mitigations** | | | | |
| Probability | Highly probable (4) | Scale | National (4) | |
| Duration | Long-term (4) | Magnitude | Low (4) | |
| Significance | **Moderate (48)** | | | |
| **After mitigations** | | | | |
| Mitigations | No mitigations measures | | | |

## 6. Evaluation of the impact on housing and services in the local area

The need to provide housing and in particularly services during the operational phase is likely to have a lower negative impact on the economy than during construction, since the number of employees in need thereof decrease substantially between the construction and operational phases. About 150 people will be employed between the CSP and PV plants during operations of which some will come from the immediate local area.

With respect to the rest, various accommodation forms will be required varying in terms of cost, convenience, and luxury. Given that the current housing situation in the nearby town suffers from shortage of appropriate accommodation, new households' arriving to the area will increase the pressure on housing and services provision. Such a pressure would though be temporal and would be released once housing and service delivery issues are addressed.

**Table 84: Evaluation of the impact on housing and basic services during the operational phase**

| | | | | |
|---|---|---|---|---|
| Impact: | Increase in demand for housing and basic services during operations | | | Negative |
| **Before mitigations** | | | | |
| Probability | Medium probability (3) | Scale | Local (2) | |

| | | | |
|---|---|---|---|
| Duration | Short-term (2) | Magnitude | Low (4) |
| Significance | **Low (24)** | | |
| **After mitigations** | | | |
| Mitigations | • The developer should consider providing assistance to its workers with respect to finding suitable rental housing and permanent housing in the area.<br>• The developer should also inform the municipality of the demand for housing and social services (health facilities, schools, crèches, water and electricity services, etc.), so that the municipality can plan accordingly. | | |
| Probability | Medium probability (3) | Scale | Local (2) |
| Duration | Short-term (2) | Magnitude | Minor (2) |
| Significance | **Low (18)** | | |

## 7. Social benefits derived by local communities during operations

The proposed Solar Park will contribute about R23.1 million on an annual basis towards social development projects. This is considered to be a significant investment in the context of the local economy, production of which is valued at R3 797 million in 2011.

The allocated towards social projects could be directed at the upgrade and development of infrastructure that is of the highest priority for the local municipality, which will improve the service provision and standards of living of the local community. It could also be used for skills development and training, in the form of sponsored apprenticeships, bursaries, etc. The evaluation of the impact in the context of the local economy is presented in the next table.

**Table 85: Evaluation of social benefits derived from the project's local investment**

| Impact: | Social benefits derived from the project by local communities | | Positive |
|---|---|---|---|
| **Before mitigations** | | | |
| Probability | Highly probable (4) | Scale | Local (2) |
| Duration | Long-term (4) | Magnitude | High (8) |
| Significance | **Moderate (56)** | | |
| **After mitigations** | | | |
| Mitigations | • A three-year social development programmes should be devised by the developer throughout the project's lifespan<br>• The plan should be developed through consultation with local authorities and local communities to identify community projects that would result in the greatest social benefits<br>• A plan should be reviewed on an annual basis and where necessary updated | | |
| Probability | Highly probable (4) | Scale | Local (2) |

| Duration | Long-term (4) | Magnitude | High (8) |
|---|---|---|---|
| Significance | **Moderate (56)** | | |

#### *7.13.3.3 Rating of impacts taking place during closure*

The types of impacts expected to take place during the closure phase would largely mirror those that are expected to occur during construction. However, since information about the costs and construction crew that would be required to disassemble the facility and costs involved in rehabilitation of land thereafter are not known, the quantification of these impacts were not possible.

Nevertheless, it is expected that for the duration of the closure phase their positive economic effects would outweigh the economic impacts currently sustained by the agricultural activity on site and the safari industry. The following table outlines the evaluation of the socio-economic impacts expected to take place during the closure phase.

Since these types of impacts are similar to those occurring during construction, the same mitigation measures would be applied to these impacts as those proposed for the construction phase. It is however, foreseen that given the minor magnitude expected with the majority of these impacts and that complete elimination of negative impacts is not possible, the significance ratings will remain the same for the after mitigation situation.

**Table 86: Evaluation of impacts during closure - same before and after mitigations**

| Impact during closure | Nature | P | D | S | M | Total | Rating |
|---|---|---|---|---|---|---|---|
| Impact on production | Positive | 3 | 2 | 4 | 4 | 30 | Moderate |
| Impact on GDP | Positive | 3 | 2 | 4 | 4 | 30 | Moderate |
| Impact on employment | Positive | 3 | 2 | 4 | 2 | 24 | Low |
| Impact on income | Positive | 3 | 2 | 4 | 2 | 24 | Low |
| Skills development impacts | Positive | 3 | 5 | 4 | 2 | 33 | Moderate |
| Government revenue impact | Positive | 3 | 2 | 4 | 2 | 24 | Low |
| Impacts on crime and social conflicts | Negative | 3 | 2 | 2 | 2 | 18 | Low |
| Impacts on social and economic infrastructure | Negative | 3 | 2 | 2 | 2 | 18 | Low |

#### *7.13.3.4 Rating of other impacts*

The following section presents the evaluation of two distinct impacts. One is being the impact on property values and the other being the potential of developing the local manufacturing industry in the country.

## 1. Evaluation of the impact on property values

As indicated earlier in the report, certain properties in the visually affected area are expected to drop in value due to the combination of the current activity that is taking place on these properties and the negative visual effect of the Solar Power Park that will take place during construction, operations, and closure.

An assessment of the rating of the impact on property values in the visually affected area with the proposed mitigation measures is presented in Table 87. It should be noted that a minor magnitude for the impact was given due to the fact that considering the extent of the visual impact, the share of properties that will be affected is small.

The proposed mitigation measure is aimed at retaining the property value considering the sensitivity of the current activity to visual disturbances, but rather focuses on the facilitation of the acceptance of the project by the affected owner/s.

**Table 87: Evaluation of the impact on property values**

| Impact: | Declined values of selected properties in the visually affected area | | Negative |
|---|---|---|---|
| **Before mitigations** | | | |
| Probability | Definite54) | Scale | Local (4) |
| Duration | Long-term (4) | Magnitude | Minor (2) |
| Significance | **Moderate (40)** | | |
| **After mitigations** | | | |
| Mitigations | • Negotiate with the property owners whose property values will be negative affected due to the proposed project to find the solution plausible for both parties | | |
| Probability | Definite54) | Scale | Local (4) |
| Duration | Long-term (4) | Magnitude | None (0) |
| Significance | **Moderate (30)** | | |

## 2. Potential to develop local solar energy manufacturing industry - cumulative effect

As indicated earlier in the report, the number of similar projects proposed to be built by the developer and the nameplate capacity of facilities that government is planning to approve in the next couple of years offers opportunity for the development of the local industry. If conditions are favourable and incentives for the developers to procure local content are in place, the growth of the existing businesses and establishment of new manufacturing enterprises could boost the economy and assist in reducing the unemployment levels in the country.

Due to the a number of prerequisites for this to happen such as the need for sufficient demand to achieve economies of scale and others, the current probability of this to take place is not so high, thus the current significance is undervalued. However, if conditions are met, the significance would increase.

**Table 88: Evaluation of the impact on local manufacturing industry development**

| Impact: | Development of the local solar energy manufacturing industry | | | Positive |
|---|---|---|---|---|
| **Before mitigations** | | | | |
| Probability | Low (2) | Scale | National (4) | |
| Duration | Permanent (5) | Magnitude | High (8) | |
| Significance | **Moderate (34)** | | | |
| **After mitigations** | | | | |
| Mitigations | • From government perspective:<br>o Approval of as many developers project as possible to increase its demand for the same types of inputs and materials and thus incentivise to invest in local capabilities<br>• From the developer's perspective:<br>o Commit to investment in the local capabilities and capacities if required thresholds for total capacity necessary are achieved/approved<br>o Where possible engage in negotiations with other developers to co-invest in development of local capabilities with the purpose fo reducing total costs of the project | | | |
| Probability | Low (4) | Scale | National (4) | |
| Duration | Permanent (5) | Magnitude | High (8) | |
| Significance | **High (68)** | | | |

### 7.13.4 Conclusion

The proposed Arriesfontein Solar Thermal Energy Power Park is proposed to be established in the Kgatelopele Local Municipality, the Northern Cape Province. The economy of the municipality is relatively small and largely comprising of the mining activities and tertiary industries that provide the necessary services to the local communities. A vast area of the municipality is used for agricultural purposes, primarily livestock farming. Although the situation in the municipality in terms of employment and income levels was better than in the Province or nationally, the local economy has been growing at a lower rate than the Northern Cape or South Africa's economies.

This is due to the high dependency of the economy on the performance of the mining sector, which was hard hit after the 2008 global financial crisis. Thus the need for diversification of the local economy to reduce the risks and improve its stability is very prominent.

The location of the municipality and its endowments do not provide for many opportunities to diversify the local economy. The proposed Solar Park, though, would do exactly this. This means that the establishment of the Solar Park would not only contribute to the growth of the economy, but would also contribute to the reduction of its volatile nature. Besides this, the positive spill over effects will spread throughout the entire nation. It is estimated that the construction of the entire Solar Park will generate R6 214.5 million in value added (2011 prices) and create 26 999 FTE person-years in the country. Its operations will increase the national economy by R2 120.2 million in 2011 prices and will support 1 378 FTE positions for the entire operating period.

The local economy alone will see the creation of a minimum of 147 new employment opportunities during that period. Moreover, the project will allocate about R23.1 million per annum towards social development projects in the local area, which could significantly improve the local communities' standard of living. The establishment of the facility, though, will not be without negative impacts. The loss of agricultural land on site and economic losses due to visual impacts will take place, albeit at a minute scale when compared to the positive effects. In addition, crime, social conflicts, pressure on social and economic infrastructure, aggravation of the housing situation in the municipality, decline in value of selected properties are also expected.

Most of these impacts can be mitigated. However, even without mitigations the positive socio-economic benefits that are expected to ensue from the development of all phases or one phase only will outweigh the negative impacts that can take place during the life of the project. Thus, from the socio-economic perspective the proposed project is highly recommended. The developer should take the proposed measures to enhance the positive impacts and reduce the negative impacts into account though.

The summary of significance of all impacts identified before and after mitigations is provided below.

**Table 89: Summary of impact evaluation**

| Impacts | | Nature | P | D | S | M | S Total | Interpretation Low | Med | High |
|---|---|---|---|---|---|---|---|---|---|---|
| **Impact during construction** | | | | | | | | | | |
| Impact on balance of | Before | Negative | 4 | 2 | 4 | 4 | 40 | | M | |

| Impacts | | Nature | P | D | S | M | S Total | Interpretation Low | Med | High |
|---|---|---|---|---|---|---|---|---|---|---|
| payment | | | | | | | | | | |
| Impact on production | Before | Positive | 4 | 2 | 4 | 8 | 56 | | M | |
| | After | | 4 | 2 | 4 | 8 | 56 | | M | |
| Impact on GDP | Before | Positive | 4 | 2 | 4 | 8 | 56 | | M | |
| | After | | 4 | 2 | 4 | 8 | 56 | | M | |
| Impact on employment | Before | Positive | 4 | 2 | 4 | 4 | 40 | | M | |
| | After | | 4 | 2 | 4 | 8 | 56 | | M | |
| Impact on income | Before | Positive | 4 | 2 | 4 | 4 | 40 | | M | |
| | After | | 4 | 2 | 4 | 8 | 56 | | M | |
| Skills development impacts | Before | Positive | 3 | 5 | 4 | 4 | 39 | | M | |
| | After | | 3 | 5 | 4 | 6 | 45 | | M | |
| Government revenue impact | Before | Positive | 4 | 2 | 4 | 4 | 40 | | M | |
| Increased levels of crime and social conflicts | Before | Negative | 3 | 2 | 2 | 6 | 30 | | M | |
| | After | | 3 | 2 | 2 | 4 | 24 | L | | |
| Impact on economic and social infrastructure | Before | Negative | 4 | 2 | 2 | 6 | 40 | | M | |
| | After | | 4 | 2 | 2 | 2 | 24 | L | | |
| **Impacts during operations** | | | | | | | | | | |
| Impact on production | Before | Positive | 4 | 4 | 4 | 8 | 64 | | | H |
| | After | | 4 | 4 | 4 | 8 | 64 | | | H |
| Impact on GDP | Before | Positive | 4 | 4 | 4 | 8 | 64 | | | H |
| | After | | 4 | 4 | 4 | 8 | 64 | | | H |
| Impact on employment | Before | Positive | 4 | 4 | 4 | 4 | 48 | | M | |
| | After | | 4 | 4 | 4 | 4 | 48 | | M | |
| Impact on income | Before | Positive | 4 | 4 | 4 | 4 | 48 | | M | |
| | After | | 4 | 4 | 4 | 4 | 48 | | M | |
| Skills development impacts | Before | Positive | 4 | 4 | 4 | 4 | 48 | | M | |
| | After | | 4 | 4 | 4 | 4 | 48 | | M | |
| Government revenue impact | Before | Positive | 4 | 4 | 4 | 4 | 48 | | M | |
| Impact on housing and services provision | Before | Negative | 3 | 2 | 2 | 4 | 24 | L | | |
| | After | | 3 | 2 | 2 | 2 | 18 | L | | |
| Social benefits to local communities | Before | Negative | 4 | 4 | 2 | 8 | 56 | | M | |
| | After | | 4 | 4 | 2 | 8 | 56 | | M | |
| **Impacts during closure** | | | | | | | | | | |
| Impact on production | Before | Positive | 3 | 2 | 4 | 4 | 30 | | M | |
| | After | | 3 | 2 | 4 | 4 | 30 | | M | |
| Impact on GDP | Before | Positive | 3 | 2 | 4 | 4 | 30 | | M | |
| | After | | 3 | 2 | 4 | 4 | 30 | | M | |
| Impact on employment | Before | Positive | 3 | 2 | 4 | 2 | 24 | L | | |
| | After | | 3 | 2 | 4 | 2 | 24 | L | | |
| Impact on income | Before | Positive | 3 | 2 | 4 | 2 | 24 | L | | |
| | After | | 3 | 2 | 4 | 2 | 24 | L | | |
| Skills development impacts | Before | Positive | 3 | 5 | 4 | 2 | 33 | | M | |

| Impacts | | Nature | P | D | S | M | S | Interpretation | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Total | Low | Med | High |
| | After | | 3 | 5 | 4 | 2 | 33 | | M | |
| Government revenue impact | Before | Positive | 3 | 2 | 4 | 2 | 24 | L | | |
| Increased levels of crime and social conflicts | Before | Negative | 3 | 2 | 2 | 2 | 18 | L | | |
| | After | | 3 | 2 | 2 | 2 | 18 | L | | |
| Impact on economic and social infrastructure | Before | Negative | 3 | 2 | 2 | 2 | 18 | L | | |
| | After | | 3 | 2 | 2 | 2 | 18 | L | | |
| **Other impacts** | | | | | | | | | | |
| Impact on property values | Before | Negative | 5 | 4 | 2 | 2 | 40 | | M | |
| | After | | 5 | 4 | 2 | 0 | 30 | | M | |
| Stimulation of new manufacturing industry | Before | Positive | 2 | 5 | 4 | 8 | 34 | | M | |
| | After | | 4 | 5 | 4 | 8 | 68 | | | H |

## 7.14 TOURISM IMPACTS

### 7.14.1 Terms of Reference

Future room night demand in a specific market segment, for a given area, can be projected based on levels of current room night demand and forecasts of future demand growth, taking into account past and present growth trends. A comparison of future supply and demand levels yields a projection of average occupancies for the relevant market as a whole. Where the projected occupancy levels exceed expected reasonable annual average room occupancies for accommodation establishments, the extent of excess demand can be used to indicate the total number of additional rooms that the projected demand could support.

In order to determine net impact of the project from the perspective of tourism products, the number of additional rooms that could be developed taken into account the project, should be compared to the number of additional rooms that could be developed in the absence of the project. In other words, tourism demand will grow in the absence of the project and we need to subtract this growth to isolate the growth in demand due to the project. The Tourism Report is attached as **Appendix N**.

#### *7.14.1.1 Assumptions*

**1. Multipliers**

The determination of the overall economic benefit of the project requires reference to the income multiplier. The multiplier expresses the relationship between initial spend and changes in total local income.

Direct demand refers to the first round of expenditure, indirect demand to the second and subsequent rounds of expenditure, while induced demand reflects consumers' expenditure of earnings derived from the various rounds of expenditure constituting a particular economic activity. For example, the expenditure by a guest in a restaurant (direct) results in expenditure by the restaurant on food, (indirect) and expenditure by the restaurant's employees in local shops (induced).

The magnitude of a multiplier depends almost entirely on the nature of the local economy. In general, the larger and more diverse the economy of an area, the more linkages there will be between business firms in the area, and therefore the higher the multiplier will be.

Grant Thornton uses national section multipliers purchased fromConningarth Economists which are based on their latest social accounting matrix ("SAM") for the South African economy. We adapt these national multipliers to the specific province and local area in which the project is based. This adaptation is based on a subjective estimation of the extent of economic benefit lost in a specific geographic economy in constructing and operation a specific project. The following multipliers were used in estimating impact on income and employment at the Northern Cape provincial and local Daniëlskuil level.

## 2. Employment skills levels

The following profile was assumed in respect of employment skills levels i.e. in terms of all jobs created / sustained through the project:

- 11% high level occupations
- 32% mid-level occupations
- 57% semi-skilled and unskilled occupations

We have estimated a breakdown of the labour market by skills level using Department of Labour statistics and our knowledge of, and experience in, the trade and catering industries.

## 3. Average Salary per month

We applied the average minimum wages for employers with more than 10employees for the hospitality sector according to FEDHASA. In 2011, this was R2 318 per month.

## 4. Taxation assumptions

In calculating the projected tax that will be generated by the Arriesfontein development, we have made the following assumptions:

- 80% of indirect spend is subject to VAT;
- 10% of total direct and indirect spending will become taxable corporate profits and the average corporate tax rate will be 28%;
- the 2011 average monthly salary per direct or indirect employee is R4 330 and the average employee's personal tax rate applied was 19% for high level occupations;
- the rate of VAT is 14%.

### 7.14.2 **Impact Assessment and Identification**

Figure 33illustrates the possible impacted tourism facilities located within the tourism assessment area. Currently there is only one tourism facility located within the 20 km radius from the site. The enterprises highlighted in green are the mines located in the vicinity of the proposed site.

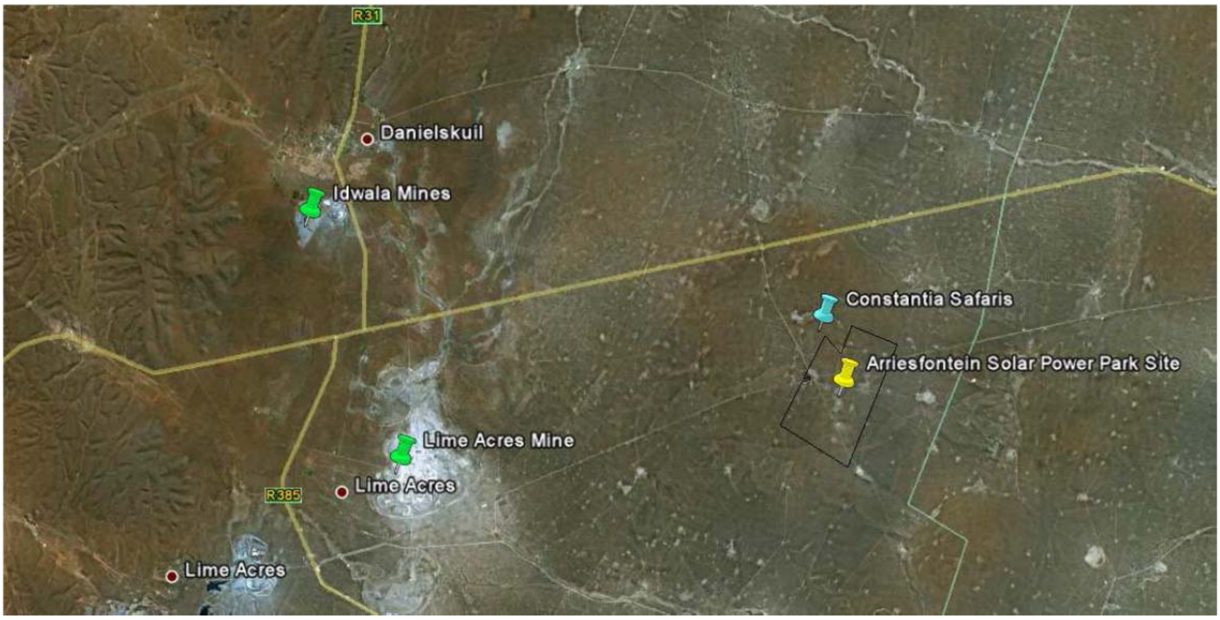


**Figure 33: Potential Tourism Impacted Facilities**

*Constantia Safaris*

Constantia Safaris offer guests hunting, leisure and photographic safaris and is located on a 5000 ha private game reserve right next to the proposed Arriesfontein Solar Power Plant site. Constantia Safaris can accommodate a maximum of 20 guests at atime and facilities include 10 luxury chalets, the Trophy Room lounge, a dining room, a swimming pool and an open-air entertainment area with a bar and braai facilities. Constantia Safaris offer guests 17 game species on their property.

Based on an interview with the product owner, Constantia Safaris receives approximately 200 guests a year and these are majority hunting parties. Hunting packages range from 7-days,10 –days or 14-daypackages and prices depend on what the guests are coming to hunt and how many meals they would like included in their package. According to the owner, Constantia Safaris receives approximately 50% foreign and50% domestic guests, with the majority of the foreign guests originating from Europe. The owner believes that the proposed ArriesfonteinSolar Power Plant will have a huge visual impact on his business. He believes that this impact will be two-folded, with both the tourists and the animals being affected.

From the tourists perspective, he believes that the guests enjoy the peace, tranquillity and beauty offered by the Northern Cape landscape and that the proposed Arriesfontein Power Plant will deter from this experience. From a hunting point of view, the presence of the Arriesfontein Power Plant and the increase in human activity that this Plant will bring to the area, especially during the construction phase, will definitely have an impact of the movements of the animals and would make them more difficult to trace and hunt.

Furthermore there is no direct access to the private game reserve on which Constantia Safaris is located and the guests need to travel through the proposed Arriesfontein site to reach the access gate to Constantia Safaris. The area on which the proposed Arriesfontein Power Plant is to be developed is located only 300 m from this access gate into Constantia Safaris. The owner is certain that this development will have a huge impact on his guests and is adamant that a new access road is developed from the R31 directly into his property as to minimize the impact of the proposed Solar Power Plant on his guests.

### *Greater Daniëlskuil Area*

Business tourism is the main driver of tourism bed nights spent in Daniëlskuil. Based on information received, the Solar Power Plant is expected to create in the range of 600-1000 jobs during the construction period (this figure will depend on the construction period and the final design of the Solar Power Plant). However, not all these contract employees will qualify as business tourist as they will either be employed from within the local area or these employees will be accommodated within the envisioned temporary construction camp that will be located within the proposed Arriesfontein Solar Plant site. Only avery small amount of contract employees will be travelling to and from the construction site and would then require accommodation within the Daniëlskuil area (approximately 200 people, depending on the construction phase timelines and roll out plan).

Once the Solar Power Plant is operational between 50 to 100 people could be employed at the site, depending on the final plant design. However, once again most of these employees will not qualify as business tourists as they will be employed from within the local area or if not, will been encouraged to relocate to the area. It is expected that once the Solar Power Plant is operational, only SRSA employees will visit the site and is expected to travel in groups of 2-10 people.

These predicted employment levels is expected to have a positive impact on the surrounding tourism industry as the Arriesfontein Solar Plant site is located in close proximity to the Daniëlskuil area. Currently, there is already a few accommodation facilities (2 bed and breakfasts, 1 hotel and 2 guesthouses) available in Daniëlskuil (of which only the hotel, 1 bed and breakfast establishment and 1 guesthouse are listed by the tourism bureau) and based on the interviews conducted with the tourism product owners in the area, itis expected that the presence of the Plant would have a positive impact on the surrounding accommodation sector by increasing the average occupancies in the area.

#### *7.14.2.1 Potential Impact on the Future Development of the Tourism Industry in and around Daniëlskuil*

The closest sites with tourism potential in the area are the farms neighbouring the proposed site. However, from our research and site visit, it is clear that all of this land, with the exception of the private game reserve on which Constantia Safaris is located, is only used for agricultural purposes, with the main activity being cattle farming. According to our research, the other farmers in the area are not considering developing their farms into tourist attractions.

However, if additional farmers do decide in the future to develop tourism facilities, it is our belief that the proposed Solar Plant could have a visual impact on their tourism potential. The envisioned employment levels expected to be created by the Solar Power Plant is expected to have a positive impact on the current accommodation sector in and around Daniëlskuil.

The fact that there are currently only 1 tourism facility available within the 20 km radius of the site means that there is huge potential for the plant to contribute to the development of new accommodation facilities in the area.

#### *7.14.2.2 Analysis of Impact on Tourism Demand in the Study Area*

### 1. Growth in Tourism Numbers

In Annexure A, we estimated that the Daniëlskuil area received around3 712 tourists in 2011.During our research, we did not find any planned developments within the municipal area which will have a significant impact on tourism growth figures, thus we projected a stable growth of 3,5% and

2,0%respectively for business and leisure (transit) tourists for the area without the inclusion of the Arriesfontein project.

**Table 90: Illustrates our estimated growth rates in tourists numbers (by purpose of visit), assuming both the absence and inclusion of the Arriesfontein development.**

| | Purpose of Visit | 2012 | Phased Construction | | | | Projects Operation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2013 | 2014 | 2015 | 2016 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Without Arriesfontein | Busines s | 3.5% | 3.5% | 3.5% | 3.5% | 3.5% (Jan-Dec) | | 3.5% | 3.5% | 3.5% | 3.5% | 3.5% |
| | Transit (Leisure) | 2.0% | 2.0 % | 2.0% | 2.0% | 2.0% (Jan-Dec) | | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% |
| | | | | | | | | | | | | |
| With Arriesfontein | Busines s | 3.5% | 5.0% | 6.0% | 6.0% | 4.0% (Jan-Aug) | 1.3% (Sep-Dec) | 3.8% | 3.8% | 3.8% | 3.8% | 3.8% |
| | Transit (Leisure) | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% (Jan-Dec) | | 2.0% | 2.0% | 2.0% | 2.0% | 2.0% |

In 2012, the forecasted percentage growth remains the same for both business and leisure tourists, because construction of the Arriesfontein plant is assumed to only start in August 2013. The forecasted growth in business tourists increased in 2013- August 2016 because there is expected to be an increase in employees who will need accommodation in the Daniëlskuil area during the construction of the Arriesfontein Power Plant. For the purpose of our analysis, we assumed that the PV and CSP will be built at the same time, resulting in the combined three (3)year construction period. However, not all of the employees will require formalised accommodation during the construction period as the bulk of people will be construction workers who will be housed in construction camps on or near the site.

Based on the information received from SRSA, around 200management staff and experts will require formalised housing during the construction period. Once the construction is completed, the influx of people to the Daniëlskuil area is expected to decrease again. The Arriesfontein Solar Power plant is expected to operate with about 100 permanent staff members, who will live in the area permanently, and it is expected that the plant will receive approximately 10 visitors every two (2) months, who will stay for a night or two.

Taking these assumptions into consideration, the projected growth in business tourists decreases again in September 2016 (the start of the operation phase) from 4,0% to 1,3%. From 2017, this forecasted growth increases again to 3,8% as the plant goes into full operational years. We did not inflate the projected 2,0% growth in leisure (transit) tourists, as the development of the project is not expected to have an impact on the very limited leisure tourism in the Daniëlskuil area. Based on the projected growth rates illustrated in Table 91, we estimated the annual tourist numbers to the Daniëlskuil area, both with and without taking the Arriesfontein development into consideration.

**Table 91: Tourism Impacts of Development**

| | Purpose of Visit | 2012 | Phased Construction | | | | Projects Operation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2013 | 2014 | 2015 | 2016 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Without Arriesfontein | Business | 3 292 | 3 407 | 3 527 | 3 650 | 3 778 (Jan-Dec) | | 3 910 | 4 047 | 4 188 | 4 335 | 4 487 |
| | Transit (Leisure) | 420 | 429 | 437 | 446 | 455 (Jan-Dec) | | 464 | 473 | 483 | 493 | 502 |
| | **Total** | **3 712** | **3 836** | **3 964** | **4 096** | **4 233 (Jan-Dec)** | | **4 374** | **4 520** | **4 671** | **4 828** | **4 989** |
| | | | | | | | | | | | | |
| With Arriesfontein | Busines s | 3292 | 3 407 | 3 578 | 3 792 | 4 235 (Jan-Dec) | | 4 396 | 4 563 | 4 736 | 4 916 | 5 103 |
| | Transit (Leisure ) | 420 | 429 | 437 | 446 | 464 (Jan-Dec) | | 464 | 473 | 483 | 493 | 502 |
| | **Total** | **3 712** | **3 918** | **4 136** | **4 367** | **4 699 (Jan-Dec)** | | **4 689** | **4 858** | **5 035** | **5 217** | **5 407** |
| Without-With Arriesfontein | **Busine ss** | 0 | 0 | 51 | 142 | 242 (Jan – Dec) | | 325 | 349 | 375 | 401 | 430 |
| | **Leisure** | 0 | 0 | 0 | 0 | 0 (Jan-Dec) | | 0 | 0 | 0 | 0 | 0 |
| | **Total** | **0** | **0** | **51** | **142** | **242 (Jan-Dec)** | | **325** | **349** | **375** | **401** | **430** |

## 2. Possible changes in Tourism Product Supply

***<u>Without the Arriesfontein Development</u>***

In Annexure A, we projected the annual room-night demand in the Daniëlskuil area without taking the Arriesfontein development into consideration. Table 78, illustrates this annual room-night demand based on the annual tourists numbers shown in Table 92, and our assumptions of an average length of stay of 3 nights and an average double occupancy percentage (i.e. the extent to which rooms/units are occupied by more than one person) of 6%.

**Table 92: Room-night Occupancy**

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Annual Room-nights | 10 732 | 11 089 | 11 459 | 11 841 | 12 236 | 12 645 | 13 067 | 13 504 | 13 956 | 14 423 | 14 906 |

Based on the annual room-night demand for the area and the current daily room supply of 50 rooms/units, we estimated the annual average occupancy of the market to be 59% in 2011.Without taking the Arriesfontein development into consideration, we determined the additional rooms/units the market could potentially develop in the future. These projected numbers of additional rooms/ units are shown in Table 93.

**Table 93: Additional Rooms**

| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Additional rooms/units** | 0 | 0 | 0 | **10** | 0 | 0 | 0 | 0 | 0 | **10** |

As can be seen in Table 94, we have projected low levels of development within the study area, with only an additional 20 rooms/units being added over the 10 year period. This is because we assume that future tourism demand will first be taken up by existing facilities (who operated at 59% occupancy levels in 2011) before new facilities will be developed. Following these calculations, we could determine the following annual occupancies for the accommodation market in the study area (Table 78).

**Table 94: Occupancy**

| | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Annual Occupancies** | 61% | 63% | 65% | 56% | 58% | 60% | 62% | 64% | 66% | 58% |

***Including the Arriesfontein Development***

When projecting the possible additional rooms which could be developed into the market, we developed two scenarios for taking the Arriesfontein development into consideration:

- Scenario 1 considers that all the 200 management staff will require paid tourist accommodation (e.g. guest houses, B&B rooms, self-catering units etc.) during the 3-year construction phase.
- Scenario 2 considers that only 20% of the management staff will require paid tourist accommodation (e.g. guest houses, B&B rooms, self-catering units etc.) during the 3-year construction phase, while the remaining 80% of the staff will be housed in rented permanent accommodation (such as houses or apartments).

Both scenarios make provision for 10 additional tourists travelling to the Arriesfontein Power Plant during the operational phase. It is assumed that these business tourists will stay an average of 2 nights and visit the plant every 2 months (i.e. 6 times a year).

**Table 95: New Annual Room-night**

| | 2012 | Phase Construction | | | | Projects Operations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 2015 | 2016 (Jan – Aug) | 2016 (Sept – Dec) | 2017 | 2018 | 2019 | 2020 | 2021 |
| Scenario 1 | 11 089 | 42 059 | 84 841 | 85 236 | 57 030 | 4 255 | 13 187 | 13 624 | 14 076 | 14 543 | 15 026 |
| **Scenario 2** | **11 089** | **17 579** | **26 441** | **26 836** | **18 150** | **4 255** | **13 187** | **13 624** | **14 076** | **14 543** | **15 026** |

*Source: Grant Thornton Analysis*

Based on the annual room-night demand and the current room/unit supply in the study area, we then determined the additional unit/rooms which should be added to the market. In Scenario 1, 200 rooms/units come into the market at the start of the construction period (2013), to accommodation the 200 management staff that will require tourist accommodation. This results in the market running at 93% occupancy levels for the 3-yearconstruction period.

However, once the construction phase comes to an end, the annual room-night demand decreases again as there will be a vast over supply in the market, resulting in very low operating occupancy levels We believe that this is not the most optimal scenario as it is high unlikely that all 200 management staff would utilise tourist accommodation. The resulting development scenario would also require a large expansion and then contraction in the room supply. In Scenario 2 (where only 20% of the management staff will require tourist accommodation during the construction phase), only 25 additional rooms/units are brought on to the market in 2013 and another 25 rooms/units in 2014, resulting in occupancy levels of between 70% and 75% during the construction phase.

Again, when the construction phase ends, the room-night demand contracts, however, this is much less than in Scenario 1. We also expect to see some of the less formal forms of tourist accommodation (such as single room establishments etc.) to close down once the construction phase is completed, resulting in an expected 25 room contraction in the room supply towards the end of 2016. As a result we expect the annual market occupancy percentage to level out at around 55% by the end of 2021, which is in line with the long term trend in market occupancies for the study area.

As a result, we feel that Scenario 2 is a more true reflection of the possible impact the Arriesfontein development could have on the tourism product supply in the study area. Table 96, summaries the projected additional room/ unit developments expected in the study area, taking consideration of both with and without the Arriesfontein Development Table 97, summaries the projected market occupancy levels.

**Table 96: Projected Additional Rooms**

| | 2012 | Phased Construction | | | | Projects Operation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 2015 | 2016(Jan-Aug) | 2016(Sep-Dec) | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Without Arriesfontein** | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 10 | 0 |
| **Scenario 2** | 0 | 25 | 25 | 0 | 0 | -25 | 0 | 0 | 0 | 0 | 0 |

**Table 974: Projected Market Occupancy Levels**

| | 2012 | Phased Construction | | | | Projects Operation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 2015 | 2016(Jan-Aug) | 2016(Sep-Dec) | 2017 | 2018 | 2019 | 2020 | 2021 |
| **Without Arriesfontein** | 61% | 63% | 65% | 56% | 58% (Jan-Dec 2016) | | 60% | 62% | 64% | 66% | 58% |
| **Scenario 2** | 61% | 64% | 72% | 74% | 75% | 47% | 48% | 50% | 51% | 53% | 55% |

Without Arriesfontein, there is a total growth in the market supply of 20 rooms and the market achieves an average annual occupancy percentage of 61% over the 10 year period. When the Arriesfontein development is considered, there is a total growth in the market supply of 25 rooms, but the market achieves a lower annual occupancy percentage of 58% over the 10 year period.

As is clearly visible for this analysis, the largest impact of the Arriesfontein development on the tourism market in the Daniëlskuil area will happen during the construction phase. Because the impact of the Arriesfontein development is more of a change in tourist products and not so much a clear cut growth, it is important to determine impact of the Arriesfontein development not only from a demand perspective, but also determine the economic impacts of such a development on the tourism industry in the Daniëlskuil area.

## 3. Results of Economic Impact Assessment

The expected economic impact that the Arriesfontein development will have on employment and GDP can be summarised as follows:

These job opportunities listed in Table 84 are expected to be mainly concentrated in semi-skilled and unskilled categories (57%) and the balance in mid-level (32%) and high-level (11%) occupations.

**Table 985: Job Opportunities**

| | | Project Construction | | | Projects Operation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Employment | NC | 97 | 146 | 148 | 123 | 72 | 74 | 77 | 79 | 81 |
| | Danielskuil | 78 | 117 | 118 | 98 | 58 | 59 | 61 | 63 | 65 |
| GDP Contribution | NC | 19 384 | 30 905 | 33 281 | 29 313 | 18 116 | 19 652 | 21 319 | 23 127 | 25 090 |
| | Danielskuil | 15 507 | 24 724 | 26 625 | 23 451 | 14 493 | 15 722 | 17 055 | 18 502 | 20 072 |

When looking at the expected number of indirect jobs to be created by the Arriesfontein development, it is important to remember that these employment figures are affected by the expected impact on income in the area and does not necessarily represent new full time employment. For example, someone who might only have worked 20 hours a week, could now be employed for a full 40-hour week as a result of the Arriesfontein development, thus increasing the employment opportunities without having created an actual extra employment position. Furthermore, these employment opportunities will not only be limited to the tourism industry, as the auxiliary services, which support the tourism industry, will also have to increase their workforce as more tourists make use of their services, e.g. a grocery store might employ more staff to be able to cater to the needs of more tourists being in town and to the greater number of tourist facilities expected to develop over time looking for fresh produce.

The Arriesfontein development is expected to pay a total of R5 million in taxes in 2013, decreasing to R4,2 million by 2021.The economic impact of the Arriesfontein development can be summarised as an increase in the tourist direct spend in the area (and thus the GDP contribution) and an increase in employment opportunities.

Based on the findings of our scoping phase as well as the tourism demand and economic impact assessments completed above, we identified the following possible impacts of the Arriesfontein Solar Power Plant development on the surrounding tourism industry of Daniëlskuil.

– Increase growth in tourist numbers to the study area

  Our study shows that the project will definitely result in stronger growth in overnight tourists to the Arriesfontein area, but this increase in growth will be limited to the short-term (5 years or less) as growth rates return to only slightly higher than standard growth levels after the construction phase of the project . Based on our primary research, our experience in the tourism industry and the assumptions provided as to the number of additional workers that would be involved in the construction and operation of the plant, we are certain that the increased growth in overnight tourists will definitely occur and that it will be beneficial (to the study area in light of economic development and job creation (thus the scale is a local impact).

The magnitude of the impact is Moderate, as the increase in growth in overnight tourists to the area will only result in short- to medium term effects. We don't believe any mitigation measures such as tourism promotion, is available to increase the magnitude of the impact to HIGH, as it is not the responsibility of the Arriesfontein development to promote the Daniëlskuil area as a tourist destination.

- Changes in growth of the accommodation product supply in the area

  Because the growth in tourist numbers are mostly limited to the construction phase of the project (with tourism growth expectations reducing too close to normal growth levels during the operation phase), we believe that there will be a change in the accommodation products supply over the projected 10 year period. We expect that accommodation supply will increase with 50 rooms/units during the construction phase and will then decrease again with 25 rooms/units as the expected business tourist numbers decrease again after the construction phase has been completed.

  Thus there will be an overall growth in the tourist accommodation supply of the area of 25rooms/units over the projected 10 year period. Because of this, we believe the overall growth in tourism products will be effected on the medium term. As with the increase in the growth in overnight tourists, we are certain that this impact will definitely occur and that it will be beneficial to the study area (on a local scale).

  The significance of the changes in the growth in tourism products is moderate, as the greatest impact will occur during the construction phase and even though there is an overall growth in the tourism supply, there will be a contraction in units/rooms at the start of the operational phase.

- Increase in tourism spend

  We believe that the development of the Arriesfontein Solar Power Plant will definitely have an impact on the tourism spend; both in the study area and the greater Northern Cape area (i.e. the impact will be on a regional scale).

  We believe that the this positive impact will be over the long term, as the levels of business tourists will continue to increase as long as the Arriesfontein Plant is operational. We believe the

Arriesfontein development will have a moderate impact on the economy and GDP contribution of the tourism industry in the study area and the greater Northern Cape.

- Increase in employment opportunities

  We believe that the development of the Arriesfontein Solar Power Plant will definitely have a positive impact on the job opportunities; both in the study area and the greater Northern Cape area (i.e. the impact will be on a regional scale).

  We believe that the this positive impact will be over the long term, as the levels of business tourists will continue to increase as long as the Arriesfontein Plant is operational. We believe the Arriesfontein development will have a moderate impact on the job opportunities, and thus the economy and GDP contribution of the tourism industry in the study area and the greater Northern Cape.

- Impact on the tourism revenue of Constantia Safaris

  The only identified tourism enterprise on which the proposed Arriesfontein development could have a negative impact is Constantia Safaris. However, we believe that there is a medium probability of the development having a significant impact on Constantia Safaris' revenue stream (i.e. moderate magnitude), as any impact will mostly be limited to the construction phase of the project (i.e. over the short term), as the expected increase in movement around the site could possibly make it more difficult for the hunters to track the animals and the owner of the establishment believes that the noise and visual impact of construction will have a negative impact on his tourists' experience.

  However, we believe that there is an opportunity to mitigate the possible impact, by reaching an arrangement between the Arriesfontein management and the owner of Constantia Safaris that a portion of the 200management staff could be housed at Constantia Safaris for the duration of the 3-year construction period (thus securing a constant revenue stream for the establishment).

  Furthermore, it is possible that the two parties could sign a preferred supplier agreement, meaning that the expected 10business tourists who will visit the Arriesfontein Solar Plant every two months during the operational phase of the project, could stay at Constantia Safaris, thus again securing a constant flow of revenue for the tourism enterprise. By implementing possible mitigation strategies as the ones mentioned here, the probability of the Arriesfontein development having an impact on the revenue of Constantia Safaris will decrease to low and the magnitude of the possible negative impact could be reduced the low as well.

- Increase tourism traffic along the R31

We believe that there will be definite increase in tourism traffic along theR31, especially during the construction phase of the project, as more business tourists will be travelling from Daniëlskuil to the development site. We believe that magnitude of this impact is moderate, as the significant increases in tourism traffic (we are only referring to the business tourists travelling and not the construction vehicles) is only expected during the construction phase of the project (i.e. short term).

However, with mitigation measures such as accommodating the bulk of the construction workers on the actual site or very close to the site, the magnitude of the impact could be reduced to low. Based on the PS rating of each factor, the potential environmental Impact was calculated and depicted in Table 99 below:

**Table 99: Potential Environmental Impacts**

| Potential Impact Factor | Criteria | | | | | PS | Significance | | |
|---|---|---|---|---|---|---|---|---|---|
| | Nature | P | D | S | M | | L | M | H |
| Increase in the tourist numbers | Positive | 5 | 2 | 2 | 6 | 50 | | Moderately Positive | |
| Changes in the accommodation supply | Positive | 5 | 3 | 2 | 6 | 55 | | Moderately Positive | |
| Increase in tourism spend | Positive | 5 | 4 | 3 | 6 | 65 | | | Highly Positive |
| Increase in employment opportunities | Positive | 5 | 4 | 3 | 6 | 65 | | | Highly Positive |
| Impact on the tourism revenue of Constantia Safaris (without mitigate) | Negative | 3 | 2 | 1 | 6 | 27 | Low Negative | | |
| Impact on the tourism revenue of Constantia Safaris (with mitigate) | Negative | 2 | 2 | 1 | 4 | 14 | Low Negative | | |
| Increased tourism traffic along the R31 (without mitigation) | Negative | 5 | 2 | 6 | 2 | 50 | | Moderate Negative | |
| Increased tourism traffic along the R31 (with mitigation) | Negative | 5 | 2 | 4 | 2 | 40 | | Moderate Negative | |

### 7.14.3 **Conclusion**

This section provides an overview and our final conclusions for the Tourism Impact Assessment of the Arriesfontein Solar Power Plant site.

#### *7.14.3.1 Tourism Industry in the Northern Cape*

*Summary of the Foreign Tourism Market in the Northern Cape*

- The Northern Cape is the least visited Province in South Africa.
- In 2010, the Northern Cape only received 1,2% of the total foreign tourists to South Africa and only 0,8% of all the foreign bed-nights were spent in the Province.
- The Northern Cape receives a lot of tourists from Namibia, who are en-route to the Western Cape, thus Africa and Middle East is the Province's major foreign tourist source market.
- Foreign tourists to the Northern Cape tend to be repeat leisure tourists, who travel in small groups or as couples, making use of their own transport.

*Summary of the Domestic Tourism Market in the Northern Cape*

- The Northern Cape also receives the lowest share of domestic arrivals and revenues across all the provinces.
- In 2010, only 0,7% of all domestic trips were undertaken to the Northern Cape and only 1.1% of the total domestic spend was recorded in the Province.
- Kimberley and Upington are the two most visited cities in the Province.
- Most of the domestic visitors to the Northern Cape originate from within the Province, while no visitors from Limpopo visited the Province in 2010.
- Mpumalanga and the Western Cape are also important source markets.
- Domestic visitors to the Northern Cape tend to stay an average of 4 nights per trip.

*Summary of the Tourism Profile in Danieslkuil*

- Majority of visitors to Daniëlskuil (between 90%-95%) stay in the area for business purposes.
- The majority of business visitors are contract workers or experts working with the many mines in the area, but there is also a lot of training done in the area for private businesses and Government employees (such as the police force or teachers) for which experts are brought in from across the country.
- Business travellers tend to stay between 3-5 nights, but it is also common to have business tourists who stay for 3 months.
- A much smaller percentage of guests (between 5%-10%) are in the area for leisure purposes.
- Of the leisure guests, VFR and transit is the main reason why they visit the area and these guests tend to be domestic South African visitors who stay on average only for 1-3 nights.
- There is no real leisure holiday market in the Daniëlskuil area. Because of the high levels of domestic business and VFR guests, the tourism industry in Daniëlskuil is mostly made up of 60% domestic travellers and 40% foreign guests.
- Foreign tourists tend to be experts coming to work on the mines and tend to come from Europe and the UK.
- Domestic travellers tend to originate mostly from within the Northern Cape, Gauteng or Mpumalanga.
- Because of the high level of business tourism in the area, the tourism industry in Daniëlskuil tend to be busier during the week than the weekends and have seasonality slumps during the school holidays
- However, the slump period have been decreasing in recent years as the mines in the area have been expanding.

### *7.14.3.2 Summary of the Tourism Impact Assessment of the Arriesfontein Solar Power Pant*

The final identified possible impacting factors of the Arriesfontein Solar Power Plant can be summarised as follows:

- Increase growth in tourist numbers to the study area-Highly positive impacting factor
- Changes in growth of the accommodation product supply in the area- PS of 55- Highly positive impacting factor

- Increase in tourism spend –Highly positive impacting factor
- Increase in employment opportunities- Highly positive impacting factor
- Impact on the tourism revenue of Constantia Safaris –Low impacting factor
- Increase tourism traffic along the R31- Moderate impacting factor

From the final tourism impact assessment, it is clearly visible that the proposed Arriesfontein development will have more positive than negative impacts on the tourism industry in the Daniëlskuil area, with the negative impacts being of low significance and easily mitigated.

## 7.15 SENSITIVITY MAPPING

A sensitivity map, Figure 36 below,  was compiled by Metrogis(Pty) Ltd based on the inputs received from the various specialists with specific emphasis on wetlands and wetlands buffers, biodiversity, heritage sites and linear infrastructure datasets. The wetland and biodiversity area's site values were multiplied by two (2) to emphasize their sensitivity and visibility.

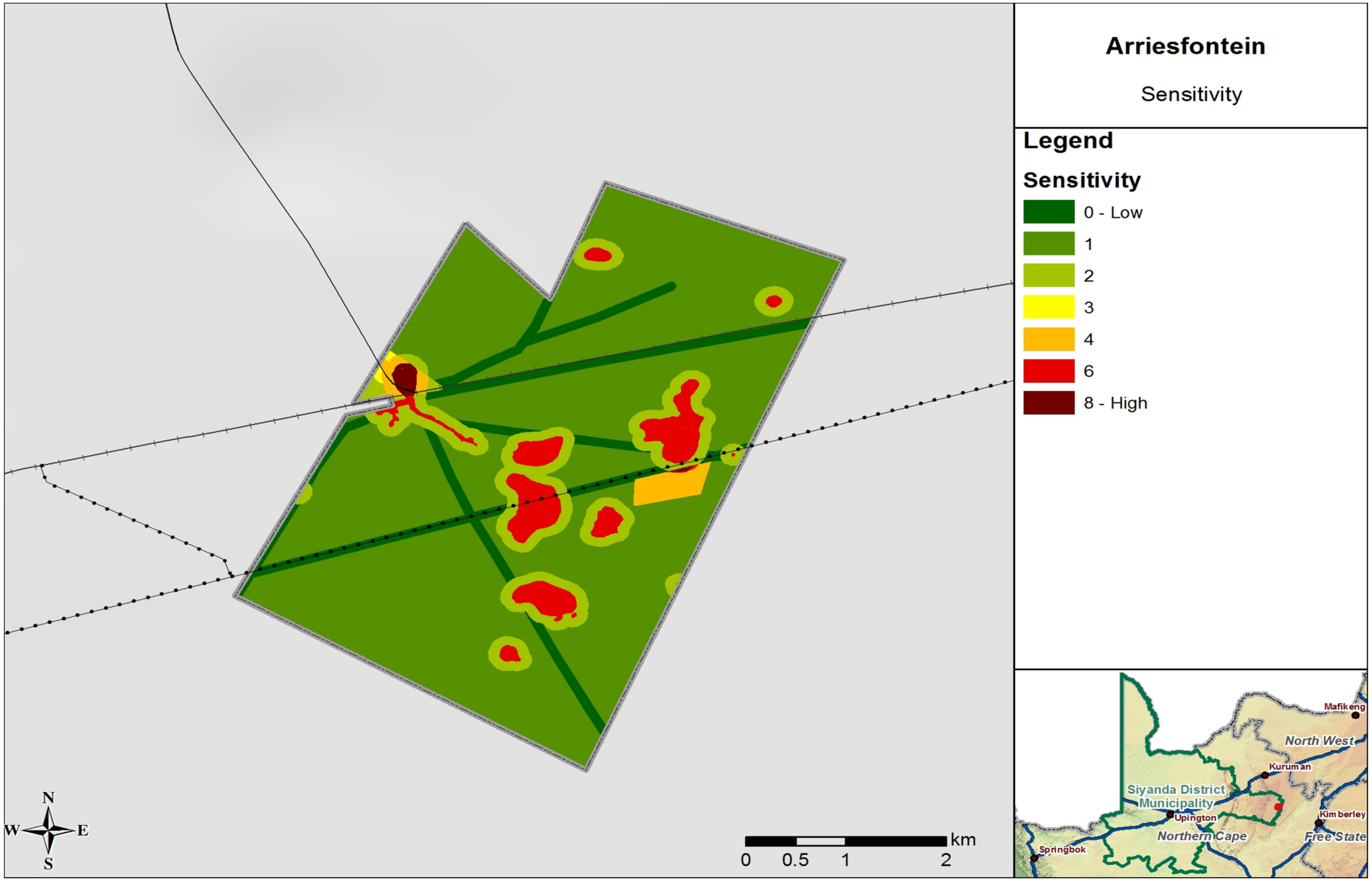


**Figure 34: On Site Sensitivity Map**

# 8. CUMULATIVE IMPACTS

As a result of an increase in interest and the number of EIAs for renewable energy developments (solar and other renewable energy technologies) it is important to follow a precautionary approach in accordance with the NEMA to ensure that cumulative impacts are addressed or avoided. The following aspects have been identified as potentially significant cumulative impacts that may result from the proposed development. These anticipated impacts were assessed by the specialists during the EIA Phase to get a handle on their cumulative effect. The impacts that were assessed included:

## 8.1 VISUAL INTRUSION

Cumulative landscape and visual effects (impacts) result from additional changes to the landscape or visual amenity caused by the proposed development in conjunction with other developments (associated with or separate to it), or actions that occurred in the past, present or are likely to occur in the foreseeable future. They may also affect the way in which the landscape is experienced. Cumulative effects may be positive or negative. Where they comprise a range of benefits, they may be considered to form part of the mitigation measures.

Cumulative effects can also arise from the inter-visibility (visibility) of a range of developments and /or the combined effects of individual components of the proposed development occurring in different locations or over a period of time. The separate effects of such individual components or developments may not be significant, but together they may create an unacceptable degree of adverse effect on visual receptors within their combined visual envelopes. Inter-visibility depends upon general topography, aspect, tree cover or other visual obstruction, elevation and distance, as this affects visual acuity, which is also influenced by weather and light conditions (Institute of Environmental Assessment and The landscape Institute (1996)).

The addition of other similar project to the Arriesfontein CSP would ultimately cause an increase in the footprint of the site but in terms of cumulative visual impact it is anticipated that there will be no major increase in impacts as assessed for the CSP Plant. The following impacts, similar to the impacts associated with the CSP were anticipated:

- The proposed CSP project is located in a landscape of moderate value partially tolerant of change;
- The construction and operational activities are visible from less than half the zone of potential influence,
- Views from the R31, nearby farmsteads, the Danielskuil community and dirt road transecting are the most sensitive. Some project activities will be visible from these areas and has been raised as a concern.

- Construction activities will cause a major change in landscape characteristics over localized area resulting in major changes in key views in the short term and have a high negative effect on the visual quality of the area.

These mitigations include:

- The minimum amount of existing vegetation and topsoil should be removed from construction areas. Ensure, wherever possible, all existing natural vegetation is retained and incorporated into the site design. Eradication of vegetation should be done in 'natural manner', avoiding harsh straight lines.
- Dust suppression techniques should be in place at all times during the construction and operational phases.
- Install light fixtures that provide precisely directed illumination to reduce light "spillage" beyond the immediate surrounds of the of the concentrator plant, refrigeration plant, the incline and vent shafts but which still illuminate the buildings/roads.
- Avoid high pole top flood and security lighting in these areas.
- Good housekeeping and encourage people to visit the Visitors Centre.
- Encourage vegetation (tree) growth along the boundary of the activity.

With the implementation of these mitigation measures it is anticipated in all likelihood that the cumulative visual impact of the two projects would not increase above that of the impacts of the CSP in isolation.

## 8.2 ECOLOGICAL IMPACTS

From a biodiversity perspective there are cumulative impacts which were assessed by the biodiversity specialist. These impacts are:

### 8.2.1 Impacts on SA's Conservation Obligations & Targets

This impact is regarded a cumulative impact since it affects the status of conservation strategies and targets on a local as well as national level and is viewed in conjunction with other types of local and regional impacts that affects conservation areas. The importance of regional habitat types is based on the conservation status ascribed to vegetation types. The loss of any area of natural habitat, however insignificant, implies that the conservation status of this vegetation type can be further affected. It is therefore imperative to ensure that the conservation of pristine grassland habitat be prioritised. The likelihood that this impact will occur is high and will be of moderate significance.

Impacts that are likely to result from the proposed activities are described briefly below. This list was compiled from a generic list of possible impacts derived from previous projects of this nature and from a literature review of the potential impacts of this type of development on the floristic environment. The most significant impact will result from loss of habitat, which may have direct or indirect impacts on individual organisms or communities.

### 8.2.2 **Loss or Degradation of Natural Vegetation/ Sensitive or Protected Habitat**

The loss or degradation of natural vegetation or habitat that are regarded sensitive as a result of restricted presence in the larger region (atypical habitat) represents a potential loss of habitat and biodiversity on a local and regional scale. Sensitive habitat types might include mountains, ridges, koppies, wetlands, rivers, streams, pans and localised habitat types of significant physiognomic variation and unique species composition. These areas represent centres of atypical habitat and contain biological attributes that are not frequently encountered in the greater surrounds. A high conservation value is generally ascribed to floristic communities and faunal assemblages that occupy these areas as they contribute significantly to the biodiversity of a region.

The endorheic pans present in the study area are included in this category, but the floristic status was found to be sub-optimal because of constant grazing pressure.

### 8.2.3 **Impacts on Surrounding Habitat/ Species & Ecosystem Functioning**

Surrounding areas and species present in the direct vicinity of the study area could potentially be affected by indirect impacts resulting from construction and operational activities. This indirect impact also includes adverse effects on any processes or factors that maintain ecosystem health and character, including the following:

- Disruption of nutrient-flow dynamics;
- Introduction of chemicals into the ground- and surface water through leaching;
- Impedance of movement of material or water;
- Habitat fragmentation;
- Changes to abiotic environmental conditions;

- Changes to disturbance regimes, e.g. increased or decreased incidence of fire;
- Changes to successional processes;
- Effects on pollinators; and
- Increased invasion by plants and animals not endemic to the area.

Changes to factors such as these may lead to a reduction in the resilience of ecological communities and ecosystems or loss or changes in ecosystem function. Furthermore, regional ecological processes, particularly aquatic processes that is dependent on the status and proper functioning of the drainage line, is regarded important.

It is well known that the status of a catchment is largely determined by the status of the upper reaches of the rivers. Small drainage lines, such as the one on this property, might be insignificant on a regional scale, but the combined status of numerous such small drainage lines will determine the quality of larger rivers further downstream.

### 8.2.4 Increase in Local & Regional Fragmentation/ Isolation of Habitat

Uninterrupted habitat is a precious commodity for biological attributes in modern times, particularly in areas that are characterised by moderate and high levels of transformation. The loss of natural habitat, even small areas, implies that biological attributes have permanently lost that ability of occupying that space, effectively meaning that a higher premium is placed on available food, water and habitat resources in the immediate surrounds. This, in some instances, might imply that the viable population of plants in a region will decrease proportionally with the loss of habitat, eventually decreasing beyond a viable population size.

The danger in this type of cumulative impact is that effects are not known or is not visible with immediate effect and normally when these effects become visible, they are usually beyond repair. Impacts on linear areas of natural habitat affect the migratory success of animals in particular.

The general region is characterised by low levels of transformation and habitat fragmentation. However, it is known that other similar developments are planned in the region. The level of fragmentation and habitat isolation is therefore likely to increase to some extent within the next few years.

### 8.2.5 Increase in Environmental Degradation, Pollution (soils, surface water)

Cumulative impacts associated with this type of development could lead to initial, incremental or augmentation of existing types of environmental degradation, including impacts on the air, soil and water present within available habitat. Pollution of these elements might not always be immediately visible or readily quantifiable, but incremental or fractional increases might rise to levels where biological attributes could be affected adversely on a local or regional scale. In most cases, these effects are not bound and is dispersed, or diluted over an area that is much larger than the actual footprint of the causal factor. Similarly, developments in untransformed and pristine areas are usually not characterised by visibly significant environmental degradation and these impacts are usually most prevalent in areas where continuous and long-term impacts have been experienced.

The nature of the development is such that pollution and degradation of the surrounding areas are expected to some extent.

## 8.3 GEOLOGICAL AND HYDROLOGICAL IMPACTS

It is highly unlikely there will be cumulative losses or gains that result from the project operations and the project could be considered to be hydrologically neutral from a surface water point of view. There will be neither a net loss nor gain to surface water in the surrounding area of Arriesfontein 267 and nearby or adjacent properties. There will be a net economic gain to Sedibeng Water through purchase of water supplied from the Vaal-Gamagara pipeline to support CSP or PV operations and generation of electricity. There may be a regional hydrological effect through the supply of water to the CSP and PV from the Vaal-Gamagara pipeline, in that it will increase competition for water from that source.

# 9. RECOMMENDATION

SRSA proposed the construction and operation of a CSP Plant on the Farm 267 i.e. 100MW Arriesfontein CSP Plant.

An extensive and rigorous EIA process was undertaken for the proposed Arriesfontein CSP Plant. The EIA was conducted within the context of the broader South African environmental legislative framework and particularly in line with the NEMA: EIA Regulations. The process undertaken during the EIA Phase included the continuation of the extensive PPP initiated during the Scoping Phase, the independent specialist assessment of anticipated impacts and proposal of mitigation measures, conducting of a sensitivity analysis and the compilation of a detailed EMP.

The multiple PPP during the EIA Phase provides stakeholders and I&APs the opportunity to review whether their issues and concerns raised during the Scoping Phase has been sufficiently addressed, mitigated and to highlight additional issues that requires attention.

SRSA made a conscious decision based on the recommendations and guidelines by the DEA to undertake 14 independent specialist assessments in order to assess both significant and less significant environmental impacts proposed by the development.

The detailed assessment of the anticipated impacts were undertaken with the purpose of highlighting any areas of concern regarding the proposed project during its construction and operation and proposes necessary mitigation measures of the significant impacts.

The proper procedures were conducted in the performing of the public participation process. All commenting authorities, stakeholders and registered I&AP's were involved throughout the PPP – their inputs, issues and concerns were considered by the EAP and addressed adequately as reflected in the CRR contained in **Appendix D.**

During the public meeting issues such as visual intrusion, light pollution, safety and water availability came to the fore.

### 9.1.1 **EAP Recommendation**

The impacts identified and assessed by the independent specialist impact assessments and the sensitivity analysis conducted, allowed for the development of effective mitigation measures (EMP).

The result of the independent specialist impact assessments and the subsequent sensitivity analysis proved that there is no residual impact that will prevail after the implementation of proposed mitigation measures identified during the EIA Process.

Although the landscape will be altered it is foreseen that all of the identified impacts can be properly mitigated. Although the aquifer underlying the site is regarded as highly vulnerable, proper lining during the construction of the evaporation ponds will prevent leakage into the underlying aquifer. The social impact of the proposed plant will have both negative and positive impacts. It will impact negatively on the surrounding landowners, especially from a visual perspective but will contribute significantly to the positive influx into the local economy.

Overall, the development of an alternative source of electricity will be a significant positive impact not only for the Northern Cape but for South Africa as well. Weighing up the potential negative impacts it can be seen that the overall positive impact will outweigh the negative impacts.

It is therefore the recommendation of the EAP that the proposed Arriesfontein Solar Power Plant receives an Environmental Authorisation of approval from the competent authority.

## 10. REFERENCES

ALMOND, J.E. 2008a. Fossil record of the Loeriesfontein sheet area (1: 250 000 geological sheet 3018). Unpublished report for the Council for Geoscience, Pretoria, 32 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2008b. Palaeozoic fossil record of the Clanwilliam sheet area (1: 250 000 geological sheet 3218). Unpublished report for the Council for Gesocience, Pretoria, 49 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. 2009. Contributions to the palaeontology and stratigraphy of the Alexander Bay sheet area (1: 250 000 geological sheet 2816), 117 pp. Unpublished report for the Council for Geoscience. Natura Viva cc, Cape Town.

ALMOND, J.E. 2011. Proposed Mainstream solar park near Keimoes, Gordinia District, Northern Cape Province. Preliminary desktop screening assessment, 12 pp. Natura Viva cc, Cape Town.

ALMOND, J.E. &PETHER, J. 2008. Palaeontological heritage of the Northern Cape. Interim SAHRA technical report, 124 pp. Natura Viva cc, Cape Town.

ARC-ISCW, 2004. Overview of the status of the agricultural natural resources of South Africa (First Edition). ARC-Institute for Soil, Climate and Water, Pretoria

BARNS, K.N. (ed.) 1998. The Important Bird Areas of southern Africa. BirdLife South Africa: Johannesburg.

BARNS, K.N. (ed.) 2000. The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland. BirdLife South Africa, Johannesburg.

BEAR, Jacob (1979). Hydraulics of Groundwater. McGraw-Hill Company.

BEAUMONT, P.B., SMITH, A.B., AND VOGEL, J.C. 1995. Before the Einiqua: the archaeology of the frontier zone. A. B. Smith (ed.). Einiqualand: studies of the Gariep River frontier p236-264. Cape Town: UCT Press.

CORNELL, D.H. et al. 2006. The Namaqua-Natal Province. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp 325-379. Geological Society of South Africa, Johannesburg & Council for Geoscience, Pretoria.

Council for Geoscience. 1 : 250,000 Geological map 2820 Upington.

DAVENPORT, T.R.H. 1963. The South African Rebellion, 1914. The English Historical Review 78(306): 73-94.

DEACON, J. 1997. 'My heart stands in the hill': rock engravings in the Northern Cape. Kronos 24: 18-29.

DEDARING, T. 2000. The Ferreira Raid of 1906: Boers, Britons and Germans in Southern Africa in the Aftermath of the South African War. Journal of Southern African Studies 26(1): 43-60

Department of Environmental Affairs and Tourism (2006). List of Activities and Competent Authorities Identified in Terms of Sections 24 and 24D of the National Environmental Management Act, 1998 – EIA Regulations 2006, made under section 24(5) of the Act. Published in Government Notice no. R 385 of 2006.

Development Bank of Southern Africa (DBSA), November 2007, Handbook on Environmental Assessment Legislation in the SADC Region

DINGLE, R.V., SIESSER, W.G. & NEWTON, A.R. 1983. Mesozoic and Tertiary geology of southern Africa. viii + 375 pp. Balkema, Rotterdam.

DOWSON, T.N. 1992. The rock engravings of southern Africa. Johannesburg: Witwatersrand University Press.

DU TOIT, A. 1954. The geology of South Africa. xii + 611pp, 41 pls. Oliver & Boyd, Edinburgh.

DWAF, (1997): Minimum Standards and Guidelines for Groundwater Resource Development for the Community Water Supply and Sanitation Programme. Department of Water Affairs & Forestry, Pretoria.

DWAF, (2003). 1 : 500,000 Hydrogeological Map Series Sheet 2722 Kuruman.

DWAF, (2004): Revision of General Authorisations in Terms of Section 39 of the National Water Act, 1998. Government Gazette no. 26187, Government Notice No. 399, 26 March 2004.DWAF, (2004).

DWAF, (2005). Groundwater Resource Assessment Phase 2. Reports 2C and 3E. Pretoria.

ELOFF, J.F., BENNIE, A.T.P., DIETRICHSEN, J.A.V. &Geers, B.C., 1983. Land types of the map 2820 Upington. Field information. Mem. Nat. Agric. Res. S. Afr. No. 3. ARC-Institute for Soil, Climate and Water, Pretoria.

Geological Survey, 1988. 1:250 000 scale geological map 2820 Upington. Department of Mineral and Energy Affairs, Pretoria.

GERINGER, G.J. (1990). Colston Granite. First Edition.

Google Earth, 2011

HADDON, I.G. 2000. Kalahari Group sediments. In: Partridge, T.C. & Maud, R.R. (Eds.) The Cenozoic of southern Africa, pp. 173-181. Oxford University Press, Oxford.

HARRISON, J.A., ALLAN, D.G., UNDERHILLI, L.G., HERREMANS, M., Tree, A.J., Parker, V & Brown, C.J. (eds). 1997. The atlas of southern African birds. Vol. 1&2. BirdLife South Africa, Johannesburg.

HENDEY, Q.B. 1984. Southern African late Tertiary vertebrates. In: Klein, R.G. (Ed.) Southern African prehistory and paleoenvironments, pp 81-106. Balkema, Rotterdam.

HOCKY, P.A.R., DEAN, W.R.J., RYAN, P.G. (Eds) 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

KOCH, F.G.L. &KOTZE, A.V., 1986. Climate data. In: Land types of the maps SE27/20 Witdraai, 2720 Noenieput, 2722 Kuruman, 2724 Christiana, 2820 Upington, 2822 Postmasburg. Mem. Agric. nat. Res. S. Afr. No. 3. Department of Agriculture and Water Supply, Pretoria.

LEGASSICK, M. 1996. The will of Abraham and Elizabeth September and the struggle for land in Gordonia. Journal of African History 37(3): 371-418.

Low, A.B. &Robelo, A.G. (eds). 1996. Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs and Tourism: Pretoria.

MACVICAR, C.N., de VILLIERS, J.M., LOXTON, R.F, VERSTER, E., LAMBRECHTS, J.J.N., MERRYWEATHER, F.R., le ROUX, J., van ROOYEN, T.H. &HARMSE, H.J. von M., 1977. Soil classification. A binomial system for South Africa. ARC-Institute for Soil, Climate & Water, Pretoria.

McCRARY, M.D., McKEMAN, R.L., SCHRIEBER, R.W., WAGNER, W.D. &SCIARROTTA, T.C. 1986. Avian mortality at a solar energy power plant. Journal of Field Ornithology Vol 57 (2) pp 135-141.

MOEN, H.F.G. 2007. The geology of the Upington area. Explanation to 1: 250 000 geology Sheet 2820 Upington, 160 pp. Council for Geoscience, Pretoria.

MORRIS, A.G. 1995. The Einiqua: an analysis of the Kakamas burials. A. B. Smith (ed.). Einiqualand: studies of the Gariep River frontier p110-164. Cape Town: UCT Press.

MORRIS, D. 1988. Engraved in place and time: a review of variability in the rock art of the Northern Cape and Karoo. South African Archaeological Bulletin 43: 109-121.

MUCINA, L, RUTHERFORD, C. 2006. The Vegetation of South Africa, Lesotho and Swaziland, South African National Biodiversity Institute, Pretoria.

Municipal Demarcation Board, 2011. www.demarcation.org.za

Northern Cape Growth and Development Strategy

PARTRIDGE, T.C., BOTHA, G.A. & HADDON, I.G. 2006. Cenozoic deposits of the interior. In: Johnson, M.R., Anhaeusser, C.R. & Thomas, R.J. (Eds.) The geology of South Africa, pp. 585-604. Geological Society of South Africa, Marshalltown.

PENN, N. 2005. The Forgotten Frontier: Colonist and Khoisan on the Cape's Northern Frontier in the 18th Century. Cape Town: Double Storey Books.

Quantec database, 2011

Revision of General Authorisations in Terms of Section 39 of the National Water Act, 1998. Government Gazette no. 26187, Government Notice No. 399, 26 March 2004.

ROBILE, J., 2011. South African SOLAR PARK PROJECT – UPDATE. Proceedings from the Energex Africa 2011 Conference.

SABS (2006). South African National Standard for Drinking Water. SANS 241:2006, Edition 6.1, ISBN 0-626-18876-8.

SCHNEIDER, G. & MARAIS, C. 2004. Passage through time – the fossils of Namibia. 159 pp. Gamsberg MacMillan, Windhoek.

SERFONTEIN, D. 1972. Ek is maar ene. Cape Town and Pretoria: Human & Rousseau.

Siyanda DM: IDP 2010-2011 and IEDP 2006

SMITH, A.B. 1995. Archaeological observations along the Gariep River and its hinterland. A. B. Smith (ed.). Einiqualand: studies of the Gariep River Frontier p263-300. Cape Town: UCT Press.

SMITH, B.W.S. and Ouzman, S. 2004. Taking stock: identifying Khoekhoen herder rock art in southern Africa. Current Anthropology 45(4): 499-526.

Soil Classification Working Group, 1991. Soil classification. A taxonomic system for South Africa. ARC-Institute for Soil, Climate and Water, Pretoria.

South African Committee for Stratigraphy (SACS), (1980). Stratigraphy of South Africa. Part 1. Litostratigraphy of the Replublic of South Africa, South West Africa/Namibia, and the Republics of Bophuthatswana, Transkei and Venda: Handb. geol. Surv. S. Afr., 8.

StatsSA Labour Force Survey, 2009

STRAUSS, T. 1979. War along the Gariep. UCT: Centre for African Studies, Communications 1.

THOMAS, D.S.G. & SHAW, P.A. 1991. The Kalahari environment, 284 pp. Cambridge University Press, Cambridge.

THOMAS, M.J. 1981. The geology of the Kalahari in the Northern Cape Province (Areas 2620 and 2720). Unpublished MSc thesis, University of the Gariep Free State, Bloemfontein, 138 pp.

Water Research Commission: South African Rain Atlas: http://134.76.173.220/rainfall/

Water Resources of South Africa 1990, Volume III Appendices; WRC, 1994

Water Resources of South Africa, 2005 Study; WRC, 2008; WRC Report # TT 382/08

Weather Data from http://weather.news24.com/Forecasts.aspx?loc=SA&cityId=77257

Weather Data from http://www.dwa.gov.za/gariep/low_gariep/upington.htm

WILCOX, A.R. 1986. Great River: The Story of the Gariep River. Winterton: DrakensbergPublications.

Wind data from http://www.worldclimateguide.co.uk/climateguides/southafrica/upington.php

WorleyParsons, 2011. Background Information document (BID): Proposed Arriesfontein Solar Power Park near Upington, Northern Cape Province, October 2011

YOUNG, D.J., HARRISON, J.A., NAVARRO, R.A., ANDERSON, M.D., &COLHAN, B.D. (Eds). 2003. Big Birds on Farms: Mazda CAR report 1993-2001. Avian Demography Unit, Cape Town.