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REPORT ON

AVIFAUNA BASELINE AND IMPACT ASSESSMENT REPORT FOR THE PROPOSED CONSTRUCTION OF PAULPUTS CSP PROJECT NEAR POFADDER, NORTHERN CAPE PROVINCE

Report Number: 2015/013/10/04

Submitted to:

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PURPOSE OF THIS DOCUMENT

Abengoa Solar (herein further referred to as Abengoa) is proposing to establish a new solar facility (Paulputs CSP Project) on Portion 4 of the Farm Scuitklip in the Northern Cape Province, South Africa. The study area is situated approximately 40km north-east of the town of Pofadder.

In order to obtain Environmental Authorisation for the proposed project, Abengoa is required to conduct an Environmental Impact Assessment (EIA) in terms of GN R. 982 of the National Environmental Management Act, 1998 (Act 107 of 1998) (as amended). New best practice guidelines, presently to be implemented by the Department of Environmental Affairs, require an avifauna study to be conducted independently of the ecological baseline and impact assessment.

The proposed Paulputs project will consist of a 200 MW concentrated solar power (CSP) tower facility. The CSP facility and its associated infrastructure are likely to cover an area of approximately 900ha. For the purposes of this study a survey of the entire 1600ha was conducted. The associated infrastructure to operate the solar development is also taken into account in this avifauna baseline and impact assessment report.

The purpose of this report is to describe the avian demography, and behaviour, of the avifauna populations in the receiving ecological environment, based on the avifauna data collected during the baseline avifauna assessment level study conducted during August 2015 and April 2016, with attention to the following:

Size and location of the study area;

Description of the policy and legislative context applicable to the proposed development;

Avifauna species diversity and abundance of the study area;

Avifauna species of concern in the study area;

Habitats associated with avifauna species of concern;

Potential issues identified during the baseline and impact assessment phase study; and

Possible mitigation measures for identified impacts.

SUMMARY OF THE CONTENTS OF THIS BASELINE AND IMPACT ASSESSMENT REPORT

The baseline and impact assessment of the EIA process is the second of the studies completed for the process (Figure 1) and contains:

- **Location of the proposed development;**
- **Description of the policy and legislative context applicable to the proposed development;**
- **Methodologies employed during the avifauna baseline and impact assessment study;**
- **Description of avifauna demography of the area; and**
- **Description of the potential issues identified during the baseline and impact assessment study.**

Figure 1: Process of the environmental impact assessment (EIA), the position of the impact assessment is indicated by the red outline

EXECUTIVE SUMMARY

In order to investigate possible impacts of the Paulputs CSP facility on avifauna, vantage point surveys were conducted in order to cover the entire study area. Initially six vantage point surveys were envisaged for the project. Due to the field conditions (e.g. homogeneity of the vegetation, topography and visibility), the number of vantage point surveys was reduced to four. The approximate visibility radius of each of the vantage point surveys was approximately 800m, although this varied according to topography. The central point of each vantage point was clearly visible from each of the adjacent vantage points. The use of high quality optics and sound recording equipment made it possible to identify bird species from one vantage point to approximately 50m to the adjacent vantage points. The number of species and individuals recorded during the surveys gives a high degree of confidence in the vantage point surveys conducted. Furthermore, transect surveys were conducted in the drainage lines or washes in order to determine the use of these areas as corridors by avifauna species. These surveys yielded results particularly pertinent to the project and there is high confidence in the understanding of the avifauna in the study area, the project and possible impacts of each on the other gained during the study.

The main pertinent observations made during the vantage point surveys can be summarised as follows:

Avifauna diversity - During the study a total of 29 species were recorded and a total of 1341 individual birds were recorded. Only one species of conservation importance was recorded during the study namely, the Maccoa Duck This species was recorded to the south of the study area flying towards the Kaxu evaporation ponds.

Avifauna behaviour – One of the main aspects of avifauna behaviour noted was that 78% of bird species, and 98% of individual birds, recorded during the study flew at an average height of 6m (rounded off to the closest meter) and were observed at an average minimum height of 0.5m and an average maximum height of 12m. When applied, to what was learned about the CSP facility, this means that most resident bird species usually fly below the height of the heliostats, this was confirmed during the vantage point surveys at another CSP facility, where most species were found to be active below the heliostats and very few species flew over them. Another noteworthy observation was the lack of activity in the open field areas between 11:00 and 16:00 every day, during this time most species were found to be active in the riparian or wash areas traversing the study area. As was expected, during the dry season survey, species activities were restricted to foraging and feeding or searching for food. No nesting or mating behaviour was observed. During the wet season survey no nesting was in progress, but recently used nests were abundant, especially in areas with larger trees and shrubs.

During the study Secretarybird (*Sagittarius serpentarius*), Sclater's Lark, (*Spizocorys sclateri*), Kori Bustard (*Ardeotis kori*) and Ludwig's Bustard (*Neotis ludwigii*) appeared absent from the study area, all these species are likely to be resident species and the fact that they were not recorded does strongly suggest that they are in fact not present within the study area.

In order to deter avian species from the proposed CSP facility the area needs to be as unsuitable for avian biological requirements as possible, as avifauna tend to avoid areas that are not suitable for their requirements (Hudson & Bouwman, 2008). Biological requirements of avian species can be summarised as follows:

- Food sources;
- Water sources;
- Nesting sites;
- Perching sites; and

- Reduced competition.

During the study the following factors which could provide these requirements for local avifauna were identified. These potential factors should therefore be mitigated in order to reduce the number of birds likely to occupy the CSP facility (i.e. deter birds from using the area by making it as unsuitable for meeting avian biological requirements as possible, and therefore less attractive to birds):

- Openings at either end of the proposed horizontal rotating cylinder – may potentially provide nesting sites;
- Flat surfaces at the base of the proposed tower – may provide possible nesting and perching sites for a large number of species; and
- Colour of the proposed tower – may attract insects, which are a food source for insectivorous avifauna.

Further potential issues at the proposed CSP facility identified for mitigation are:

- Proposed mirrors in cleaning position – very high risk for avian collisions; and
- Focusing the proposed heliostats above the tower during maintenance – may increase the possibility of incineration of birds as opposed to being defocussed or focussed on the central receiver

One of the factors most likely to reduce the risk of mortality in avifauna species is the low average flight height of birds in the area, as most bird species will fly under the proposed heliostats. The fact that many of the species of concern appear to be absent from the study area further reduces the likely impacts of the facility.

In order to mitigate any possible impacts it is recommended that the following measures are implemented:

- Openings at either end of the proposed horizontal rotating cylinder – The simplest way to mitigate this impact would be to seal the openings at each end of the proposed cylinder. This can be done by tack-welding appropriately sized discs onto either end;
- Proposed heliostats in the vertical position – the proposed heliostats should be limited to being in the vertical position for as short a time as possible. The trucks which clean the proposed heliostats should follow each other as close as possible and the proposed heliostats returned to a static (horizontal) or focussed position as soon as possible after cleaning;
- Flat surfaces at the base of the proposed tower – all ledges should be built or panelled so that they slope at an angle downwards to the outside to prevent nesting on these ledges;
- Colour of the proposed tower– a neutral brown, concrete colour or grey would prevent the reflection of UV light and thus mitigate the possible impact of the white tower; and
- Focusing the proposed heliostats above the tower during maintenance – ideally the heliostats should be in one of three positions: vertical (washing position – for as short a time as possible), static position; or focussed in order to prevent the undetectable "hotspot" above the tower.

Further recommendations for consideration prior to operation are:

- A detailed avifauna monitoring plan should be compiled prior to operation and implemented in order to constantly monitor the CSP facility and all associated infrastructure, including the power lines. Any and all avifauna mortalities should be investigated.
- The results of these investigations should then inform the management of the CSP facility and associated infrastructure, regarding the implementation, update and/or upgrade to any mitigation measures at the facility as necessary.

In conclusion, with implementable mitigation measures and a functional monitoring – management – implementation – monitoring feedback loop in order to monitor and mitigate impacts, all probable avifauna impacts can be managed to a low impact rating. Based on this and the fact that South Africa is experiencing a significant energy crisis, the risks and losses associated with this development can be seen as acceptable and defendable. Based on all these factors, and with the proviso that we assume that all information available is correct and up to date, no significant changes will be made to the proposed project, no unforeseeable impact synergies arise and all mitigations proposed will be implemented and adhered to, we are of the opinion that this project could be implemented without causing significant unsustainable damage to the natural environment of the region

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1 INTRODUCTION

Hudson Ecology (Pty) Ltd was commissioned by Savannah Environmental (Pty) Ltd to conduct an avifauna study for the proposed 200MW Paulputs concentrated solar power (CSP) tower facility.

The aim of this avifauna baseline and impact assessment level study was to provide a description of the avifaunal demography that may be impacted upon by the proposed project, and investigate the issues, identified in the scoping study, associated with the avifauna of the study area and surrounds.

The objectives in this study can be summarised as follows:

- Location of the proposed development;
- Description of the policy and legislative context applicable to the proposed development;
- Methodologies employed during the avifauna baseline and impact assessment study;
- Description of the receiving avifauna population;
- Description of issues identified during the baseline and impact assessment study; and
- Mitigations to reduce the impacts identified.

The proposed Paulputs project will consist of a CSP facility. The CSP facility and its associated infrastructure are likely to cover an area of approximately 900ha. For the purposes of this study a survey of the entire 1600ha was conducted. The associated infrastructure to operate the solar development is also taken into account in this Baseline and impact assessment Report.

The Paulputs CSP facility is to be located in the northern part of the Northern Cape Province, South Africa, approximately 40 km north-east of the town of Pofadder. The project will include a CSP facility. The total area to be developed is approximately 900ha.

2 LEGISLATIVE CONTEXT

This section provides a brief overview of both the national and international requirements that must be met by this report. It includes international conventions and agreements, as well as the IFC Standards and the Equator Principles.

2.1 National Environmental Management Act

This report has been prepared in terms the EIA Regulations 2014 (South Africa, 2014) promulgated under the National Environmental Management Act No. 107 of 1998 (NEMA) and is compliant with Regulation 982. Specialist reports and reports on specialised processes under the Act. Relevant clauses of the above regulation are quoted below and reflect the required information in the ―Control sheet for specialist report‖ given above.

Appointment of EAPs and specialists

12. (1) A proponent or applicant must appoint an EAP at own cost to manage the application.

(2) In addition to the appointment of an EAP, a specialist may be appointed, at the cost of the proponent or applicant, if the level of assessment is of a nature requiring the appointment of a specialist.

(3) The proponent or applicant must:

(a) take all reasonable steps to verify whether the EAP and specialist complies with regulation 13(1)(a) and (b); and

(b) provide the EAP and specialist with access to all information at the disposal of the proponent or applicant regarding the application, whether or not such information is favourable to the application.

General requirements for EAPs and specialists

13. (1) An EAP and a specialist, appointed in terms of regulation 12(1) or 12(2), must-

(a) be independent;

(b) have expertise in conducting environmental impact assessments or undertaking specialist work as required, including knowledge of the Act, these Regulations and any guidelines that have relevance to the proposed activity;

(c) ensure compliance with these Regulations;

(d) perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the application;

(e) take into account, to the extent possible, the matters referred to in regulation 18 when preparing the application and any report, plan or document relating to the application; and

(f) disclose to the proponent or applicant, registered interested and affected parties and the competent authority all material information in the possession of the EAP and, where applicable, the specialist, that reasonably has or may have the potential of influencing-

(i) any decision to be taken with respect to the application by the competent authority in terms of these Regulations; or

(ii) the objectivity of any report, plan or document to be prepared by the EAP or specialist, in terms of these Regulations for submission to the competent authority; unless access to that information is protected by law, in which case it must be indicated that such protected information exists and is only provided to the competent authority.

(2) In the event where the EAP or specialist does not comply with subregulation (1)(a), the proponent or applicant must, prior to conducting public participation as contemplated in chapter 5 of these Regulations, appoint another EAP or specialist to externally review all work undertaken by the EAP or specialist, at the applicant's cost.

(3) An EAP or specialist appointed to externally review the work of an EAP or specialist as contemplated in subregulation (2), must comply with subregulation (1).

In terms of Appendix 6 of the Regulations (South Africa, 2014) the specialist report must contain:

(a) details of-

(i) the specialist who prepared the report; and

(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;

(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;

(c) an indication of the scope of, and the purpose for which, the report was prepared;

(d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;

(e) a description of the methodology adopted in preparing the report or carrying out the specialised process;

(f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;

(g) an identification of any areas to be avoided, including buffers;

(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;

(i) a description of any assumptions made and any uncertainties or gaps in knowledge;

(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;

(k) any mitigation measures for inclusion in the EMPr;

(l) any conditions for inclusion in the environmental authorisation;

(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;

(n) a reasoned opinion-

(i) as to whether the proposed activity or portions thereof should be authorised; and

(ii) if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;

(o) a description of any consultation process that was undertaken during the course of preparing the specialist report;

(p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto.

2.2 Further South African legislation considered in the compilation of this report

2.2.1 National Environmental Management Act, Act No. 107 of 1998 (NEMA)

NEMA requires, inter alia, that:

- Development must be socially, environmentally, and economically sustainable;
- Disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied; and
- A risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions.

NEMA states that ―the environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people‘s common heritage.‖

2.3 International Conventions and Agreements

Relevant environmental and social international conventions and agreements to which South Africa is a party are presented in Table 1.

Table 1: Relevant international conventions to which South Africa is a party

Convention	Summary of objectives or relevant conditions	South AfricanStatus
CITES Convention (1 July 1975)	CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	Party to
Convention on Biological Diversity (29 December 1993)	Develop strategies, plans or programs for conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programs which shall	Party to.

Convention	Summary of objectives or relevant conditions	South AfricanStatus
	reflect, inter alia, the measures set out in this Convention.	
Convention on Wetlands of International Importance (Ramsar) (21 December 1975)	To stem the progressive encroachment and loss of wetlands now and in the future.	Party to.

3 AIMS AND OBJECTIVES

3.1 Aim

The aim of this baseline and impact assessment study was to provide a high level description of the avifauna occurring in the area, which may be impacted upon by the proposed project, and identify possible ecological issues and red flags associated with the avifauna of the study area and surrounds. Issues identified will make specific reference to species of concern and habitats and will recommend species and habitats to be investigated during the EIA ecological specialist study.

3.2 Objectives

The objectives in this study can be summarised as follows:

- Description of the location of the proposed development;
- Description of the policy and legislative context applicable to the proposed development;
- Methodologies employed during the avifauna baseline and impact assessment study;
- Description of the avifauna population;
- Potential issues identified during the baseline and impact assessment study; and
- Mitigations to reduce the impacts identified.

4 SCOPE OF WORK

4.1 Literature Review

Due to the fact that this type of solar project and its impact on avifauna is new, poorly researched and poorly understood in South Africa and the rest of the world, the literature review consisted of the review of existing reports for the current projects, as well as relevant literature for similar projects worldwide in order to obtain a better understanding of the project, as well as the impacts on similar projects in other parts of the world.

4.2 Fieldwork

The fieldwork consisted of a six day field study during the dry season (August 2015) and wet season (April 2016). During this period four vantage point surveys were conducted and transects were conducted in the washes (riparian zones).

4.3 Analysis of Data

Data, collected during the field surveys, were analysed in order to determine avian behaviour in the area. The data was analysed in order to determine the risks associated with the development with respect to avifauna species based on the nature of the development and avifauna behaviour in the area.

4.4 Reporting and Deliverables

Reporting took the form of a standalone avifauna baseline and impact assessment report, which follows the scoping avifauna report and provides the methodology, results, discussion and recommendations arising from both the scoping and impact assessment studies.

5 STUDY AREA

The proposed development area (study area) covers approximately 1600ha on portion 4 of the Farm Scuitklip 92. The area of interest which was considered is the northern half of the larger farm portion, and the remaining part of the farm which is not currently under construction, or where infrastructure is standing. The study area is situated along a minor road that connects the N14 and the R357, in the Khai-Ma Municipal District of the Northern Cape (Figure 2). The site falls within the quarter degree grid 2819DC. No alternative site is currently being considered for the proposed solar thermal facility and due to a number of considerations (discussed in the ecological impact assessment report) no suitable locations occur within a 30km radius of the site currently under investigation.

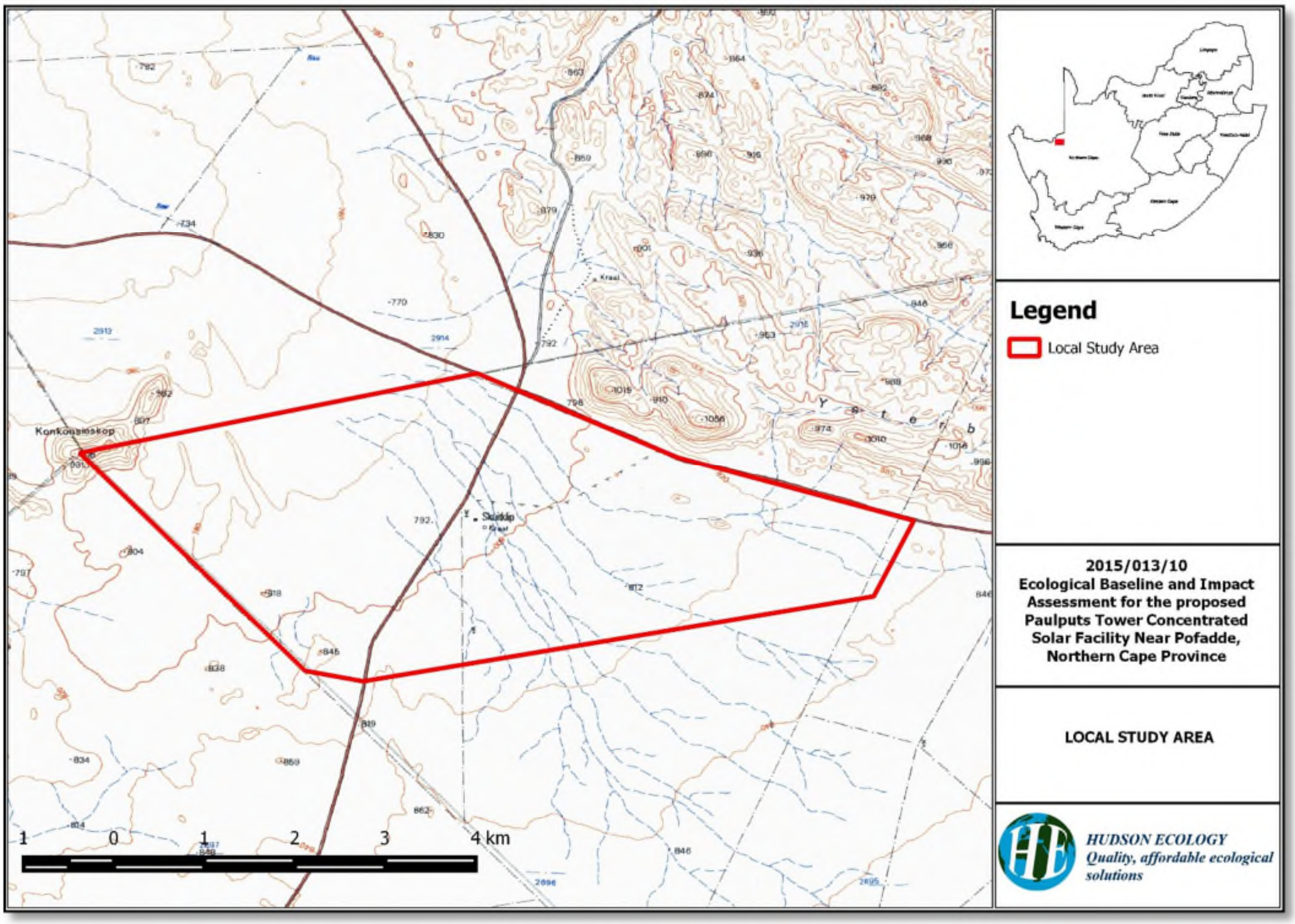

Figure 2: Locality of the study area

The study area is relatively isolated and is situated along a minor road that connects the N14 and the R357. The N14 connects Pofadder and Kakamas and the R358 connects Pofadder and Karasburg in Namibia. Although these are relatively minor roads, the site is easily accessible from Upington which is located approximately 180 km to the east on the N14.

6 METHODOLOGY

6.1 Literature Review

The literature review took into account 38 scientific publications on the following subjects:

- Avifauna behaviour in desert and semi-desert regions of southern Africa;
- Avian diversity in the study area;

- Avian endemism in the study area;
- Avian red data species in the study area;
- Ecological consequences of habitat fragmentation;
- The use of corridors by avifauna in arid and semi-arid regions;
- Land transformation effects on avian diversity and population structure;
- Collision effects of various obstacles on avifauna;
- Collision effects of solar power generation on avifauna;
- Avian impacts assessments of solar projects;
- Avifauna collision deterrence;
- Guidelines to minimise impact of solar facilities and infrastructure on avifauna; and
- Monitoring of avian mortalities associated with solar power plants.

6.2 Field Methodology

6.2.1 Study area

This section provides a discussion of the study area and context in which the proposed project will take place. Using a number of bird atlases and field guides (Harrison, et al., 1997; Sinclair, et al., 2002; Hockey, et al., 2005; Maclean, 1993; Hockey, et al., 2005) it was determined that avifauna diversity in the area is high with approximately 171 avifauna species (APPENDIX A) occurring in the region. Of these species 13 (9%) area listed as endemic and 11 (7%) are listed as being Red Data species.

6.2.1.1 Topography

The study area is located mostly on flat plains, gently sloping from the south-west to the north east (Figure 3). The western corner is characherised by a single hill (Konkonsieskop) and a range of four small outcrops to the south of the Ysterberg (Figure 4). Konkonsieskop, in the north-western corner of the study area, reaches a peak of 922 m above sea level, approximately 150 m above the surrounding plains over a distance of approximately 250 m.

A drainage line (wash) bisects the study area from east to west, gradually narrowing towards the North West boundary of the study area (Figure 3).

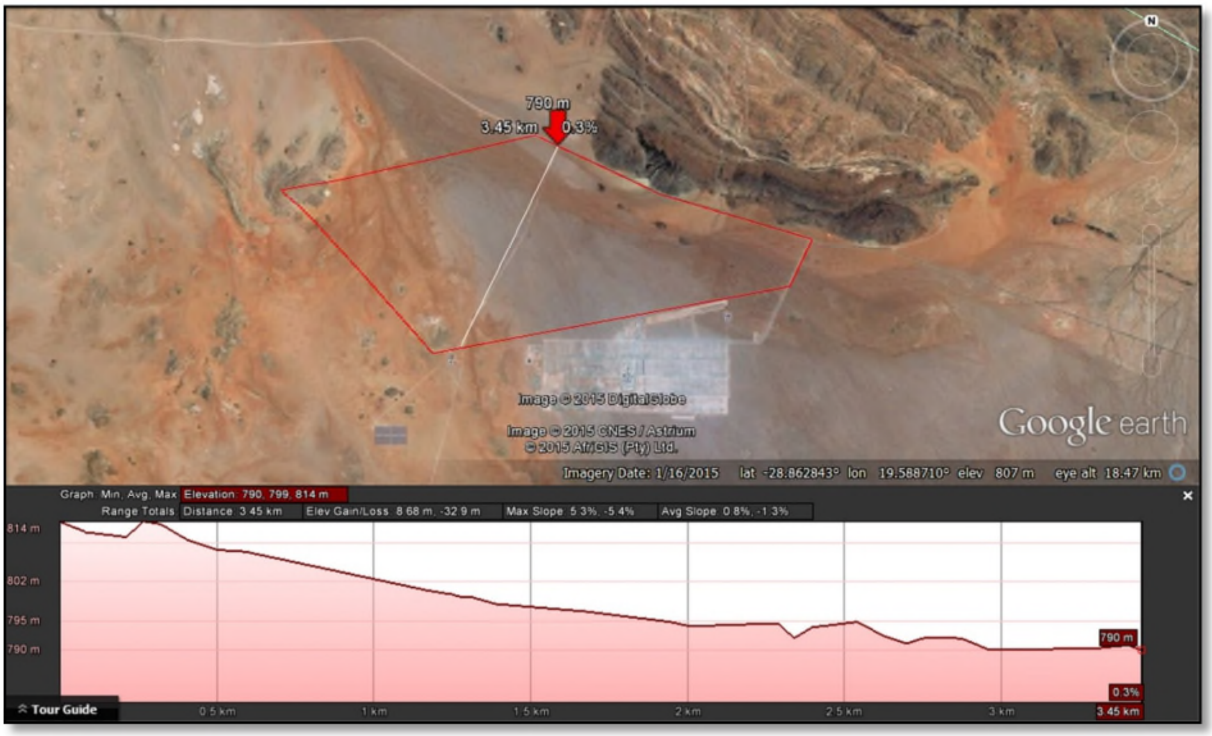

Figure 3: Gradient of the study area (reproduced from Google Earth)

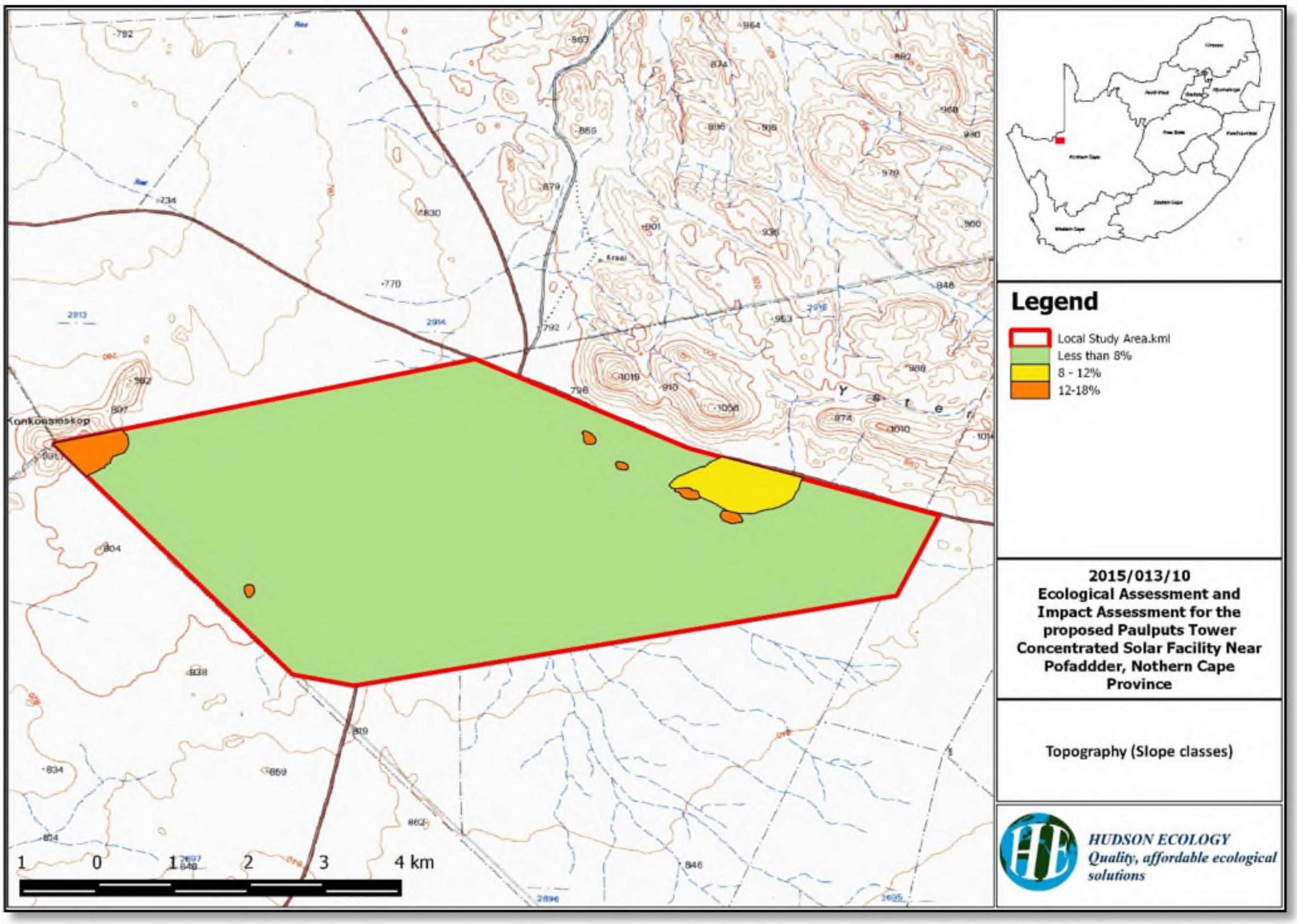

Figure 4: Topography of the study area

6.2.1.2 *Geology & Soils*

Most of the area is covered by recent (Quaternary) alluvium and calcrete. Gneisses and metasediments of Mokolian age outcrop in the area. The soils of most of the area are red-yellow apedal soils, freely drained, with a high base status and <300 mm deep, with about one fifth of the area deeper than 300 mm, typical of Ag and Ae land types. (Mucina & Rutherford, 2006)

6.2.1.3 *Climate*

Rainfall largely in late summer/early autumn (major peak) and very variable from year to year. MAP ranges from about 70 mm in the west to 200 mm in the east. Mean maximum and minimum monthly temperatures for Kenhardt are 40.6°C and –3.7°C for January and July respectively. Corresponding values for Pofadder are 38.3°C and –0.6°C. Frost incidence ranges from around 10 frost days per year in the northwest to about 35 days in the east. Whirl winds (dust devils) are common on hot summer days. See also climate diagram for NKb 3 Bushmanland Arid Grassland. (Mucina & Rutherford, 2006)

6.2.1.4 *Biome and Vegetation Types*

The study area falls within the Karoo Biome (Rutherford & Westfall 1986). The most recent and detailed description of the vegetation of this region is part of a national map (Mucina & Rutherford, 2006). This map shows two vegetation types occurring in the area. The vegetation types are Bushmanland Arid Grassland and Lower Gariep Broken Veld (Figure 5).

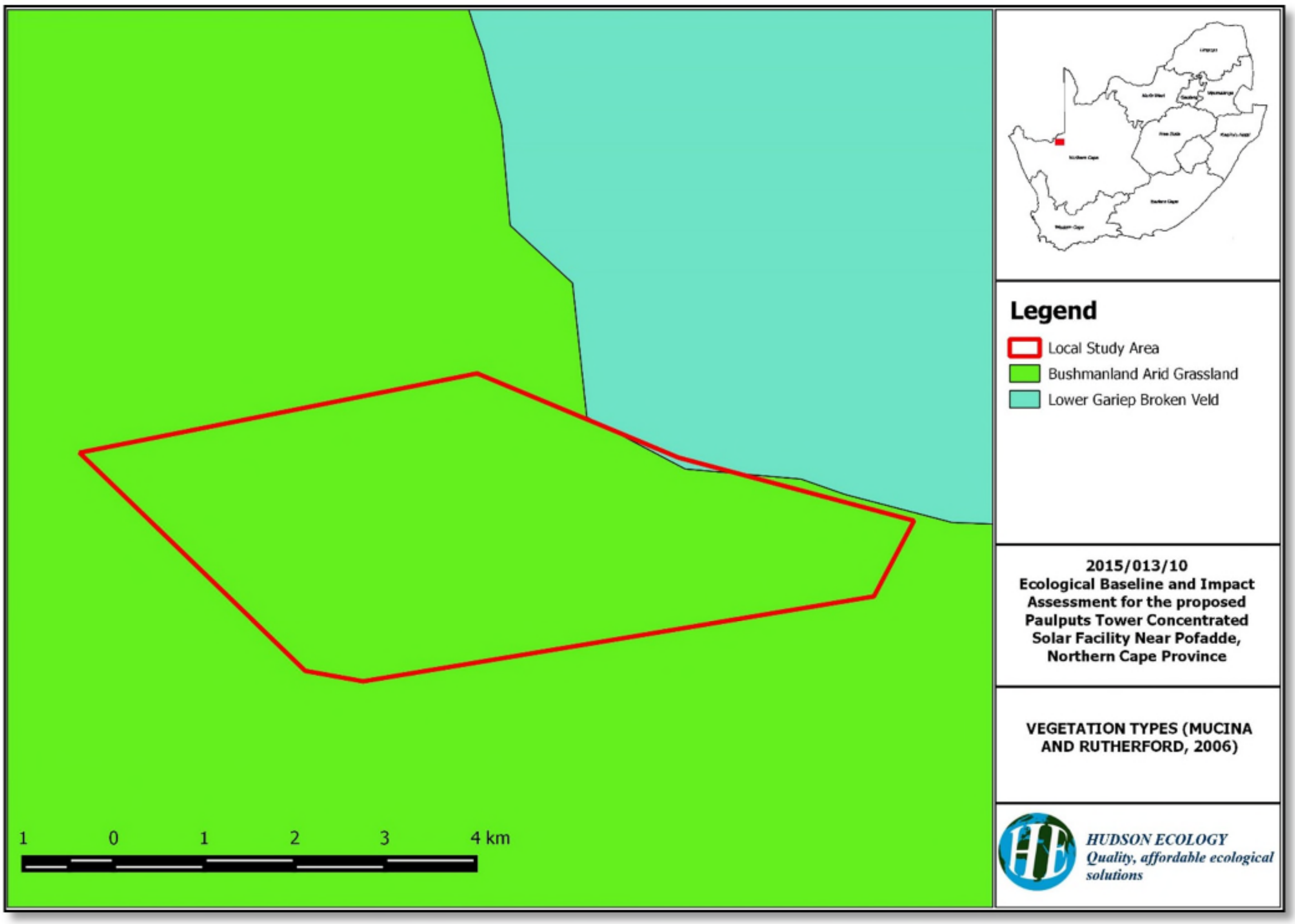

Figure 5: Vegetation types occurring in the study area (Mucina and Rutherford, 2006)

6.2.1.4.1 Bushmanland Arid Grassland

Synonyms: VT 29 Arid Karoo and Desert False Grassveld (36%), VT 32 Orange River Broken Veld (36%) (Acocks 1953). LR 51 Orange River Nama Karoo (51%) (Low & Rebelo 1996).

Distribution

Northern Cape Province: Spanning about one degree of latitude from around Aggeneys in the west to Prieska in the east. The southern border of the unit is formed by edges of the Bushmanland Basin while in the northwest this vegetation unit borders on desert vegetation (northwest of Aggeneys and Pofadder). The northern border (in the vicinity of Upington) and the eastern border (between Upington and Prieska) are formed with often intermingling units of Lower Gariep Broken Veld, Kalahari Karroid Shrubland and Gordonia Duneveld. Most of the western border is formed by the edge of the Namaqualand hills. Altitude varies mostly from 600–1 200 m (Mucina & Rutherford, 2006).

Vegetation & Landscape Features

Extensive to irregular plains on a slightly sloping plateau sparsely vegetated by grassland dominated by white grasses *(Stipagrostis* species) giving this vegetation type the character of semidesert 'steppe'. In places low shrubs of *Salsola* change the vegetation structure. In years of abundant rainfall rich displays of annual herbs can be expected (Mucina & Rutherford, 2006).

Important Taxa

Graminoids:

Aristida adscensionis (d), *A. congesta* (d), *Enneapogon desvauxii* (d), *Eragrostis nindensis* (d), *Schmidtia kalahariensis* (d), *Stipagrostis ciliata* (d), *S. obtusa* (d), *Cenchrus ciliaris, Enneapogon scaber, Sporobolus nervosus, Stipagrostis brevifolia, S. uniplumis* and *Tragus berteronianus* (Mucina & Rutherford, 2006).

Small Trees:

Acacia mellifera and *Boscia foetida subsp. foetida* (Mucina & Rutherford, 2006).

Tall Shrubs:

Lycium cinereum (d), *Rhigozum trichotomum* (d), *Cadaba aphylla* and *Parkinsonia africana* (Mucina & Rutherford, 2006).

Low Shrubs:

Aptosimum spinescens (d), *Hermannia spinosa* (d), *Pentzia spinescens* (d), *Aptosimum elongatum, Barleria rigida, Berkheya annectens, Blepharis mitrata, Eriocephalus ambiguus, E. spinescens, Limeum aethiopicum, Lophiocarpus polystachyus, Monechma incanum, M. spartioides, Pentzia pinnatisecta, Polygala seminuda, Pteronia leucoclada, P. mucronata, P. sordida, Rosenia humilis, Senecio niveus, Sericocoma avolans, Solanum capense, Tetragonia arbuscula* and *Zygophyllum microphyllum* (Mucina & Rutherford, 2006).

Succulent Shrubs:

Kleinia longiflora, Lycium bosciifolium, Salsola tuberculate and *S. glabrescens* (Mucina & Rutherford, 2006).

Herbs:

Acanthopsis hoffmannseggiana, Aizoon canariense, Amaranthus praetermissus, Chamaesyce inaequilatera, Dicoma capensis, Indigastrum argyraeum, Lotononis platycarpa, Sesamum capense, Tribulus pterophorus, T. terrestris and *Vahlia capensis* (Mucina & Rutherford, 2006).

Succulent Herbs:

Psilocaulon coriarium and *Trianthema parvifolia.*

Geophytic Herb:

Moraea venenata (Mucina & Rutherford, 2006).

Biogeographically Important Taxon (Bushmanland endemic)

Tridentea dwequensis (Mucina & Rutherford, 2006).

Endemic Taxa:

Dinteranthus pole-evansii, Larryleachia dinteri, L. marlothii, Ruschia kenhardtensis, Lotononis oligocephala and Nemesia *maxii*. (Mucina & Rutherford, 2006)

Conservation

Least threatened. Target 21%. Only small patches statutorily conserved in Augrabies Falls National Park and Goegab Nature Reserve. Very little of the area has been transformed. Erosion is very low (60%) and low (33%) (Mucina & Rutherford, 2006).

6.2.1.4.2 Lower Gariep Broken Veld

VT 32 Orange River Broken Veld (70%) (Acocks 1953). LR 51 Orange River Nama Karoo (95%) (Low & Rebelo 1996).

Distribution

Northern Cape Province: Hardeveld along the Orange River from Onseepkans in the west, including the canyon below the Augrabies Falls and parts of Riemvasmaak and adjacent areas to Keimoes resuming from the Boegoeberg to around Prieska in the east. A series of inselbergs and koppies occurring between Keimoes and around Kakamas, and the ridge running west of Groblershoop from Karos in the north to around Marydale in the south. The unit also occurs in neighbouring Namibia. Most of the area varies from 400–1 200 m in altitude (Mucina & Rutherford, 2006).

Vegetation & Landscape Features

Hills and low mountains, slightly irregular plains but with some rugged terrain (e.g. downstream of the Augrabies Falls) with sparse vegetation dominated by shrubs and dwarf shrubs, with annuals conspicuous, especially in spring, and perennial grasses and herbs. Groups of widely scattered low trees such as Aloe dichotoma var. dichotoma and Acacia mellifera subsp. detinens occur on slopes of koppies and on sandy soils of foot slopes respectively (Mucina & Rutherford, 2006).

Important Taxa

Succulent Trees: *Aloe dichotoma var. dichotoma* (Mucina & Rutherford, 2006).

Small Trees:

Acacia mellifera subsp. detinens (d), *Commiphora gracilifrondosa, Ficus cordata, Pappea capensis, Rhus populifolia* and *Ziziphus mucronata subsp. mucronata* (Mucina & Rutherford, 2006).

Tall Shrubs:

Rhigozum trichotomum (d), *Adenolobus garipensis, Antherothamnus pearsonii, Cadaba aphylla, Caesalpinia bracteata, Ehretia rigida subsp. rigida, Nymania capensis* and *Rhus burchellii* (Mucina & Rutherford, 2006).

Epiphytic Semiparasitic Shrub:

Tapinanthus oleifolius (Mucina & Rutherford, 2006).

Succulent Shrubs:

Ceraria namaquensis, Cryptolepis deciduaW, Euphorbia avasmontana, E. gregaria, Kleinia longiflora, Lycium bosciifolium and *Zygophyllum dregeanum* (Mucina & Rutherford, 2006).

Woody Succulent Climber:

Sarcostemma viminale (Mucina & Rutherford, 2006).

Low Shrubs:

Blepharis mitrata (d), *Aizoon schellenbergii, Aptosimum albomarginatum, A. lineare, A. marlothii, Barleria rigida, Berkheya spinosissima subsp. namaensis, Dyerophytum africanum, Hermannia spinosa, H. vestita, Hibiscus elliottiae, Indigofera heterotricha, Limeum aethiopicum, Lophiocarpus polystachyus, Monechma spartioides, Phaeoptilum spinosum, Phyllanthus maderaspatensis, Polygala seminuda, Ptycholobium biflorum subsp. biflorum, Sericocoma avolans, Solanum capense, Stachys burchelliana, Talinum arnotii, Tetragonia arbuscula* and *Zygophyllum rigidum* (Mucina & Rutherford, 2006).

Semiparasitic Shrub:

Thesium lineatum (Mucina & Rutherford, 2006).

Graminoids:

Aristida adscensionis (d), *Enneapogon desvauxii* (d), *E. scaber* (d), *Eragrostis nindensis* (d), *Stipagrostis obtusa* (d), *S. uniplumis* (d), *Aristida congesta, A. engleri, Cenchrus ciliaris, Digitaria eriantha, Enneapogon cenchroides, Eragrostis annulata, E. lehmanniana, E. porosa, Schmidtia kalahariensis, Setaria verticillata, Sporobolus fimbriatusE, Stipagrostis anomala, S. ciliata, Tragus berteronianus, Triraphis ramosissima* (Mucina & Rutherford, 2006).

Herbs:

Forsskaolea candida (d), *Acanthopsis hoffmannseggiana, Barleria lichtensteiniana, Chamaesyce glanduligera, Chascanum garipense, Cleome angustifolia subsp. diandra, Codon royenii, Dicoma capensis, Rogeria longiflora, Sesamum capense, Tribulus zeyheri* and *Trichodesma africanum* (Mucina & Rutherford, 2006).

Succulent Herbs:

Orbea lutea subsp. lutea and *Stapelia flavopurpurea* (Mucina & Rutherford, 2006).

Endemic Taxom:

Ruschia pungens (Mucina & Rutherford, 2006).

Conservation:

Least threatened. Target 21%. Statutorily conserved in Augrabies Falls National Park (4%). Only a very small part transformed. Erosion is low (58%), very low (27%) and moderate (14%) (Mucina & Rutherford, 2006).

6.3 Field Surveys

The field surveys can be subdivided into three facets, namely:

- Vantage point surveys; and
- Drainage line transects.

The methodologies for each of these facets are outlined in sections 6.3.1 to 6.3.2, below.

6.3.1 Vantage point surveys

Initially 6 vantage point surveys were envisaged for the project. Due to the field conditions (e.g. homogeneity of the vegetation, topography and visibility), the number of vantage point surveys was reduced to four *(Figure 6).* The approximate radius of each of the vantage point surveys was approximately 800m, although this varied according to topography. The central point of each vantage point was clearly visible from each of the adjacent vantage points.

Equipment used at each of the vantage point surveys comprised of:

- Zeiss Conquest 15x56 binoculars;
- Sightmark SM21031K 6-100x100 Spotting Scope;
- Garmin Montana 600 GPS;
- Tascam DR-100MKII sound recorder with ME66/K6 Microphone;
- Samsung Galaxy 4 Tablet with preloaded field data sheets; and
- Waterproof notebook and pencil.

Each of the vantage points was surveyed for 12 hours, comprising an entire day, from 06:30 to 18:30 each day. Surveys were undertaken on the 9th, 10th, 11th and 12th August 2015 and 6th, 7th, 8th and 10th of April 2016. The following data were recorded at each site:

- Date of survey;
- Co-ordinates of vantage point;
- Species recorded, number of each species recorded;
- Species behaviour;
- Species flight direction; and
- Species flight height.

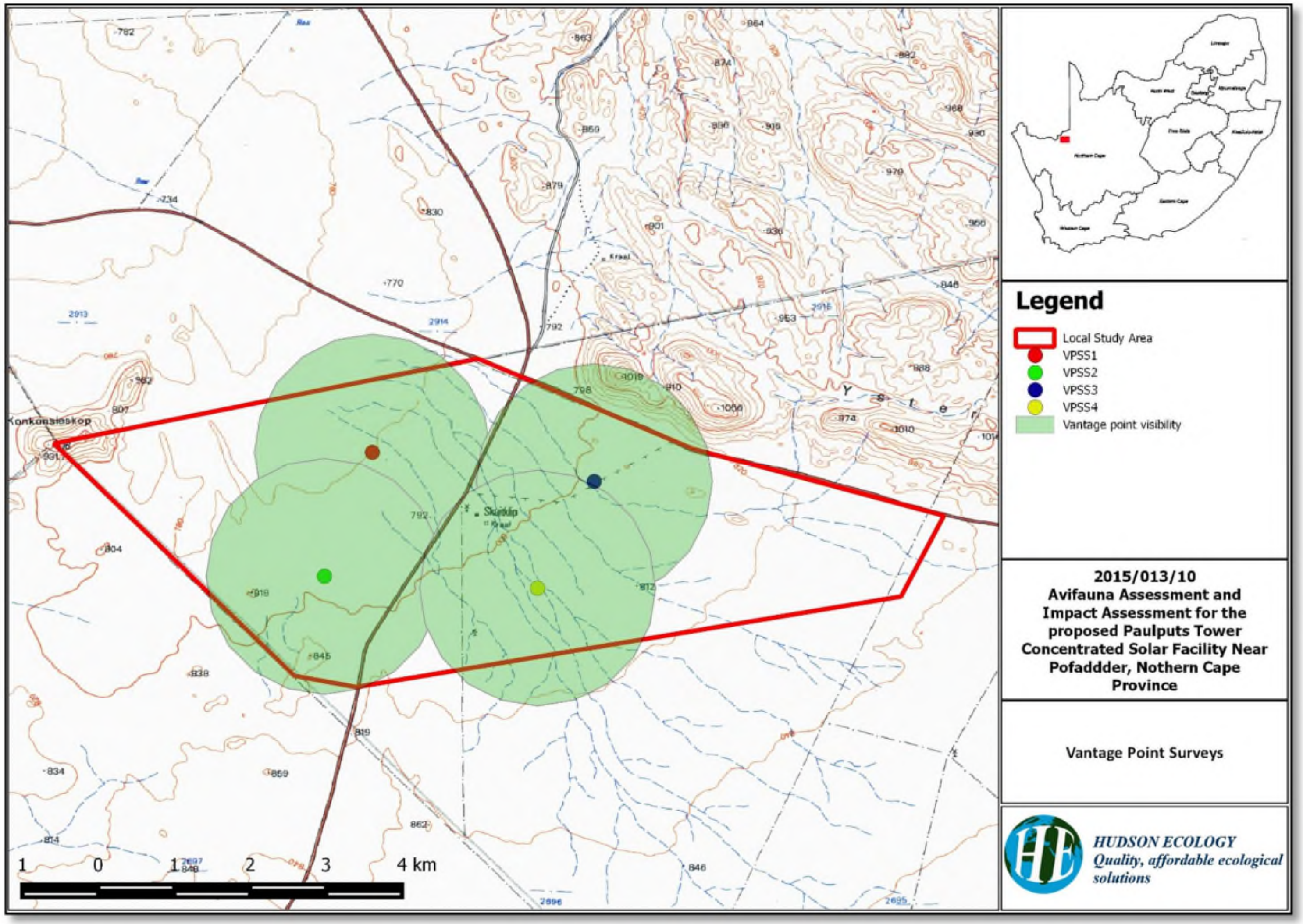

Figure 6: Locations of the vantage point surveys within the study area

6.3.2 Drainage line transects

Transects were conducted along some of the drainage lines occurring in the study area. Five transects surveys were randomly selected and conducted (Refer to Figure 6) in order to investigate these areas for avifauna activity.

- Equipment used at each of the transect surveys comprised of:
- Zeiss Conquest 15x56 binoculars;
- Garmin Montana 600 GPS;
- Samsung Galaxy 4 Tablet with preloaded field data sheets; and
- Waterproof notebook and pencil.

Each transect was surveyed on foot at a steady pace and the following data were recorded along each transect:

- Date of survey;
- Track log of each survey;
- Species recorded, number of each species recorded;
- Species behaviour; and
- Species flight direction

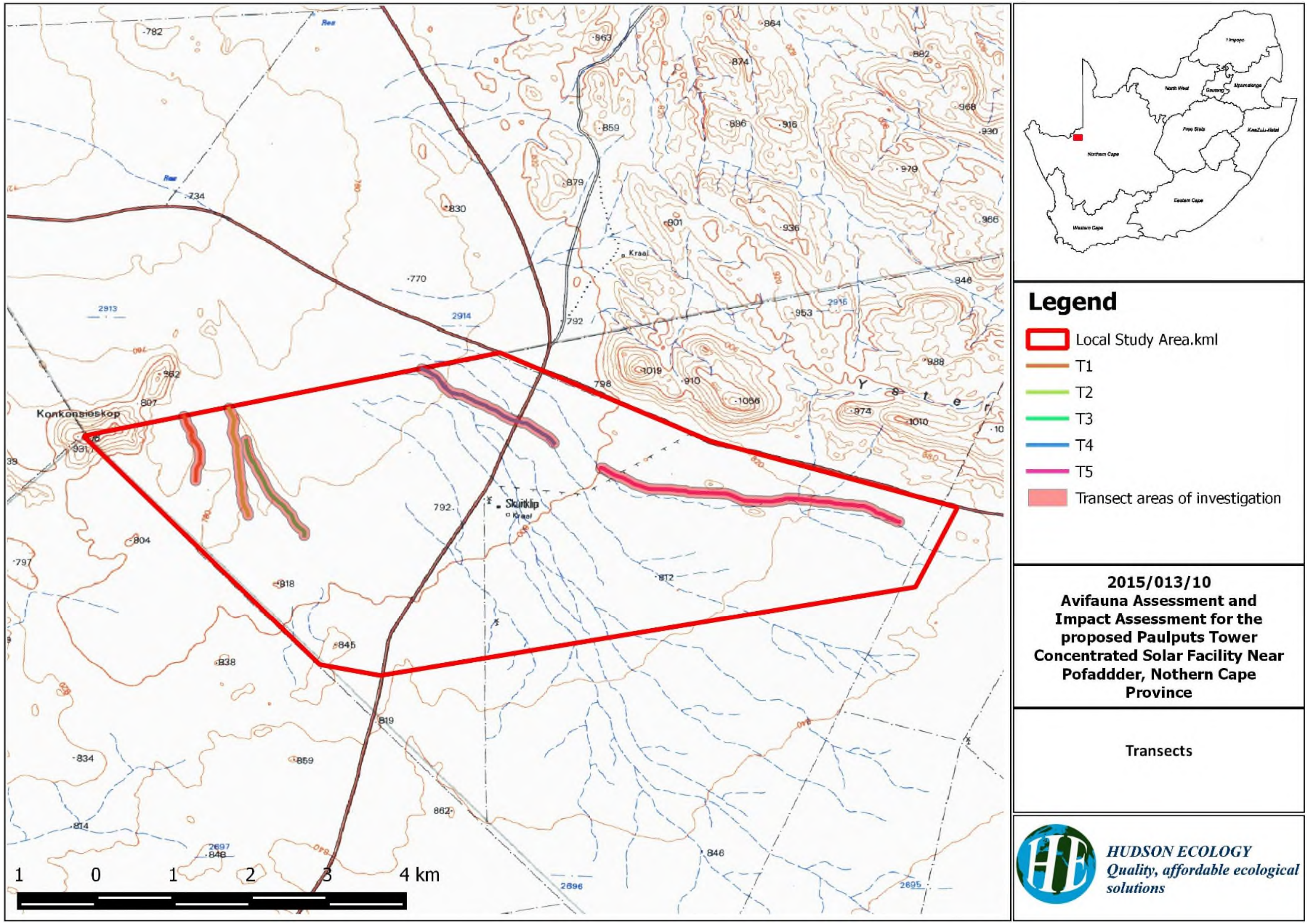

Figure 7: Transects conducted during the 2015 survey

6.4 Data Analysis

Avifauna data was analysed in order to determine:

- Average flight height per species (quantitative);
- Flight speed per species (qualitative); and
- Average flight distance per species (quantitative).

Data was further analysed in order to determine avifauna flight paths and corridors used.

Where possible results were presented graphically or diagrammatically.

These data were then used to determine the possible impacts the proposed infrastructure may have on the species recorded in the area.

6.5 Impact assessment

The Environmental Impact Assessment methodology that has been used in the evaluation of the overall effect of a proposed activity on the environment includes an assessment of the significant direct, indirect, and cumulative impacts. The significance of environmental impacts is to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

The nature of the impact refers to the causes of the effect, what will be affected and how it will be affected.

Extent (E) of impact

Local (site or surroundings) to Regional (provincial)

Rating = 1 (low) to 5 (high).

Duration (D) rating is awarded as follows:

Whether the life-time of the impact will be:

- Very short term – up to 1 year: Rating = 1
- Short term – >1 – 5 years: Rating = 2
- Moderate term - >5 – 15 years: Rating = 3
- Long term – >15 years: Rating = 4
  - The impact will occur during the operational life of the activity, and recovery may occur with mitigation (restoration and rehabilitation).
- Permanent: Rating = 5
  - The impact will destroy the ecosystem functioning and mitigation (restoration and rehabilitation) will not contribute in such a way or in such a time span that the impact can be considered transient.

Magnitude (M) (severity):

A rating is awarded to each impact as follows:

- Small impact – the ecosystem pattern, process and functioning are not affected
  Rating = 0
- Minor impact - a minor impact on the environment and processes will occur
  Rating = 2
- Low impact - slight impact on ecosystem pattern, process and functioning
  Rating = 4
- Moderate intensity – valued, important, sensitive or vulnerable systems or communities are negatively affected, but ecosystem pattern, process and functions can continue albeit in a slightly modified way

Rating = 6

- High intensity – environment affected to the extent that the ecosystem pattern, process and functions are altered and may even temporarily cease. Valued, important, sensitive or vulnerable systems or communities are substantially affected
  Rating = 8
- Very high intensity – environment affected to the extent that the ecosystem pattern, process and functions are completely destroyed and may permanently cease
  Rating = 10

Probability (P) (certainty) describes the probability or likelihood of the impact actually occurring, and is rated as follows:

- Very improbable – where the impact will not occur, either because of design or because of historic experience
  Rating = 1
- Improbable – where the impact is unlikely to occur (some possibility), either because of design or historic experience
  Rating = 2
- Probable - there is a distinct probability that the impact will occur (<50% chance of occurring)
  Rating = 3
- Highly probable - most likely that the impact will occur (50 – 90% chance of occurring)
  Rating = 4
- Definite – the impact will occur regardless of any prevention or mitigating measures (>90% chance of occurring).
  Rating = 5

Significance (S) - Rating of low, medium or high. Significance is determined through a synthesis of the characteristics described above where:

$$S = (E + D + M) \times P$$

The significance weighting should influence the development project as follows:

- Low significance (significance weighting: <30 points)
  If the negative impacts have little real effects, it should not have an influence on the decision to proceed with the project. In such circumstances, there is a significant capacity of the environmental resources in the area to respond to change and withstand stress and they will be able to return to their pre-impacted state within the short-term.
- Medium significance (significance weighting: 30 – 60 points)
  If the impact is negative, it implies that the impact is real and sufficiently important to require mitigation and management measures before the proposed project can be approved. In such circumstances, there is a reduction in the capacity of the environmental resources in the area to withstand stress and to return to their pre-impacted state within the medium to long-term.
- High significance (significance weighting: >60 points)
  The environmental resources will be destroyed in the area leading to the collapse of the ecosystem pattern, process and functioning. The impact strongly influences the decision whether or not to proceed with the project. If mitigation cannot be effectively implemented, the proposed activity should be terminated.

7 ASSUMPTIONS AND LIMITATIONS

- Accuracy of the maps, ecosystems, routes and desktop assessments were made using Google Earth and converting the .kml files to .shp files and are subject to the accuracy of Google Earth imagery with some loss of accuracy during the conversion process;
- GPS co-ordinates are accurate to within 10m and lines drawn on maps can only be assumed to be accurate to within a distance of 30m;
- Data obtained from published articles, reference books, field guides, official databases or any other official published or electronic sources are assumed to be correct and no review of such data was undertaken by Hudson Ecology Pty Ltd;
- Satellite imagery obtained was limited to imagery on Google Earth, thus the ability to accurately map vegetation communities was limited by the level of accuracy of google earth;
- Time and budget constraints do not allow for an intensive survey of the entire study area, and as with any survey of this kind, rare and cryptic species may be overlooked during the study;
- Every possible precaution was taken to reduce the effect of the above-mentioned limitations on the data collected for this study;
- The fact that a species or Red Data species is not recorded during a survey cannot support the assumption that the species in question does not occur in the area, it can only indicate a decreased probability of the species occurring in the area. This is particularly pertinent if the species has been recently or historically recorded in the area; and
- Ecological studies should be undertaken over at least two seasons in order to obtain significant data. Studies are usually conducted in this way in order to eliminate the effects of unusual climatic conditions or other unusual conditions prevailing at the study area during the time of study. The results of this report are based on a literature review and one dry and one wet season field surveys, conducted in early August 2015 and April 2016.

8 RESULTS

8.1 Literature Review

8.1.1 Avian diversity, endemism and red data species in the study area

Using a number of bird atlases and field guides (Harrison, et al., 1997; Sinclair, et al., 2002; Hockey, et al., 2005; Maclean, 1993; Hockey, et al., 2005) it was determined that avifauna diversity in the area is high with approximately 171 avifauna species (APPENDIX A) occurring in the region. Of these species 13 (9%) area listed as endemic and 11 (7%) are listed as being Red Data species. The number of species would certainly have been higher if the survey had been conducted during the summer months, especially after good rains. The only Red Data avifauna species recorded during the study were the Maccoa Duck, which are resident on the evaporation ponds of the operational XaXu CSP facility, and Lanner Falcon recorded just outside of the study area. Further Red Data species, which may occur in the study area, are discussed below. Only one exotic avifauna species is expected to occur in the study area, namely the House Sparrow (*Passer domesticus*).

Seven Species of Special Concern have been identified, based on distribution ranges and habitat requirements that are likely to occur within the study area. These species are listed in Table 2.

Table 2: Avifaunal Species of Special Concern that may occur within the study area

Common Name	Scientific Name	Conservation Status

Secretarybird	*Sagittarius serpentarius*	Near Threatened
Lanner Falcon	*Falco biarmicus*	Near Threatened
Sclater's Lark	*Spizocorys sclateri*	Near Threatened
Kori Bustard	*Ardeotis kori*	Vulnerable
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable
Martial Eagle	*Polemaetus bellicosus*	Vulnerable
Maccoa Duck	*Oxyura maccoa*	Near Threatened

Secretarybird (*Sagittarius serpentarius*) – Near Threatened

This species is uncommon to locally fairly common, favouring open grasslands with scattered trees and shrubs. Although considered resident, it is not sedentary, with highly nomadic movements across their large home range (up to 230km^2). Local populations are thought to have decreased in South Africa, with the species being highly susceptible to being injured or killed by collisions with overhead power lines and telephone wires. It is sensitive to habitat degradation due to overgrazing, bush encroachment, disturbance, and loss of habitat to afforestation and crop cultivation. Recent data has seen a constriction of its range and lower reporting rates which is cause for concern. This species has the potential to occur within or pass through the study area due to its nomadic movements and wide ranging foraging patterns.

Lanner Falcon (*Falco biarmicus*) – Near Threatened

This species has a fairly high tolerance regarding habitat requirements, being found across southern Africa in most habitat types excluding forest. The Lanner Falcon is generally a cliff nester and its distribution is closely associated with mountainous areas. However, and especially in the Karoo, the increasing number of power line towers has offered alternative nesting opportunities for this species.

Sclater's Lark (*Spizocorys sclateri*) – Near Threatened

This species is endemic to South Africa and Southern Namibia, where its distribution is confined to the Nama Karoo biome - concentrated in the Northern Cape, slightly to the south of the study area. Although this species has been reported to move substantially, it appears to move within in its core Bushmanland distribution. This species was not detected during the site visits, but is notoriously nomadic responding to rainfall events. Its preferred habitat is sparsely vegetated quartz gravel or stony plains, sometimes with some scattered grass tufts or scrubby bushes, on shales or clay. It is therefore not expected that this species occurs within the study area.

Kori Bustard (*Ardeotis kori*) - Vulnerable

This species is considered uncommon to locally common, favouring open savannah woodland, dwarf shrubland and occasionally grassland. Although a sedentary resident, this species is locally nomadic in response to rainfall and the subsequent flush of small invertebrates. The species has declined in South Africa due to habitat loss through transformation, collision with overhead power lines and poisoning. This species has the potential to occur within or pass through the study area due to the availability of suitable foraging habitat and the species' nomadic movements.

Ludwig's Bustard (*Neotis ludwigii*) – Vulnerable

This species is a sparse to locally common near endemic nomad, favouring semi-arid dwarf shrubland, arid woodland and the arid western edge of the grassland biome. This species is highly susceptible to collisions with overhead power lines and telephone wires, with this single human-induced mortality factor considered the most important threat to this species. A study of 150 km of power line transects across the country revealed approximately 600 carcasses comprising mainly of this species (± 45% of carcasses). This species has the potential to occur within or pass through the study area due to the availability of suitable foraging habitat and the species highly nomadic movements.

Martial Eagle (*Polemaetus bellicosus*) - Vulnerable

This species is widespread, although generally uncommon in South Africa, tolerating a wide range of habitat types, including open grassland, scrub and woodland. This species requires exceptionally large home ranges (in excess of 130 km^2), making use of large trees and electricity pylons to provide nest sites – which are often a limiting factor concerning this species. Population declines are largely the result of direct persecution due to the perceived threat posed to livestock, poisoning, electrocutions on electricity pylons and the reduction of its prey base as a result of habitat transformation. SABAP2 data shows records of this species in the vicinity of the study site. One individual was recorded to the north-east of the study area. Although not recorded in the study area, this species has the potential to occur within or pass through the study area due to the availability of suitable foraging habitats.

Maccoa Duck *Oxyura maccoa* – Near Threatened

Maccoa Duck's breeding habitat is shallow fresh waters, and it is also found in brackish and saline lakes in winter. Rarer than previously believed, it was uplisted from a species of Least Concern to Near Threatened status in the 2007 IUCN Red List.

8.1.2 Factors influencing avifauna presence and behaviour

Birds, like all other living organisms, need certain resources and conditions to survive and propagate. The needs of birds, as well as the availability of resources and conditions to fulfil these needs, determine the distribution of these birds. The fact that humans alter the environment for a variety of needs causes changes in the factors determining birds' ability to utilize those areas, and can (and usually does) cause a change in bird species composition in those areas (Hockey, 2003).

Effects of human intervention can have a negative effect on species diversity and numbers, deforestation, land degradation, invasion of exotics and other habitat destruction, caused by human activities, may cause areas to become unsuitable for species. For example, destruction of forest habitats will cause a decline or total disappearance of forest specialists. In the same way, draining wetlands to build residential areas will make the area unsuitable for wetland birds (e.g. aquatic birds and waders) and make the area more suitable for generalist species (e.g. starlings) and human commensals such as sparrows (Hockey, 2003).

Human intervention in the environment does not always have a negative impact on bird species. Human movement westwards in southern Africa has caused an increase in man-made structures that form suitable breeding places for birds, for example, the South African Cliff Swallow (*Hirundo spilodera*) and human commensals such as the Southern Grey-headed Sparrow (*Passer diffuses*). Furthermore, the Southern Grey-headed Sparrow's (*Passer diffuses*) movements appear to be closely tracked by its nest parasite, the Lesser Honeyguide (Hockey, 2003). The construction of dams and mini wetlands by humans, for irrigation and stock watering, has also increased the ranges of water-dependent bird species, for example, the Burchell's Sandgrouse (*Pterocles burchelli*) and Sclater's Lark (*Spizocorys sclateri*) (Hockey, 2003).

Although factors influencing bird diversity are well documented, there is still an ongoing debate as to which of the factors influencing bird diversity are more important in determining the presence or absence of bird species in a specific area. In a USDAF paper (DeGraaf, et al., 1991) on forest and rangeland birds, food, water and shelter were named as most important factors with nest sites, song posts and perch sites as secondary considerations. The paper does go on to mention that proximate factors such as vegetation structure give indications of ultimate factors such as food availability. Lack (1933) suggested that birds are "programmed" to select habitats by identifying features and patterns that are not immediately required for survival. Lack (1933) also proposed that different species are limited in their ranges by one of three factors more than the other two. The factors taken into consideration during the study were: suitable climatic conditions, sufficient food supply and a safe nesting place. Lack (1933) suggested that birds do not adapt to a specific area, but choose the area because of their ability to recognise potentially satisfactory ultimate factors by means of the visible proximate factors.

8.1.2.1 Food

Studies have been done to examine the possibility that food availability influences the distribution of birds. A study by Johnson & Sherry (Johnson & Sherry, 2001) indicated that food availability does influence the distribution of birds; this study did, however, not take vegetation structure into account during the site selection process. If food availability is not a limiting factor, or if birds are unable to track variations in food availability between habitats, then food availability will not be a determining factor in the distribution of avian species.

Dewalt et al. (2003) did show a correlation between frugivorous birds and the availability of food in tropical forest areas. Insectivore distributions may also be affected by food availability, although the effect may not be as profound, due to the wide distributions of insects. In the same way food availability may not be definitive indicator of distribution of granivorous birds in savanna or grasslands, due to the abundance of seed-bearing grasses in these areas (De Walt, et al., 2003).

Large and small raptor species are, to a much greater extent, restricted in their distribution by food availability (Casey & Hein, 1994) and tend to be greater specialists than birds of other guilds. Raptors also need perches from which to hunt, as well as open areas in which to hunt (Casey & Hein, 1994) although for example, some owl species, as well as eagle species such as the Crowned Eagle (*Stephanoaetus coronatus*) do hunt in forest areas.

8.1.2.2 Water availability

Birds vary in their needs for water. Granivorous birds, birds such as Sclater's Lark (*Spizocorys sclateri*) and the sandgrouse species are restricted in their distribution by their dependency on a daily supply of water (Hockey, 2003). Many of the birds occurring in the drier area of southern Africa are, however, not dependent on a regular supply of water (Maclean, 1993).

8.1.2.3 Nesting sites

Bird species, particularly specialist species, require specific nesting sites. Some birds, for example Pinkbilled Lark (*Spizocorys conirostris*), Larklike Bunting (*Emberiza impetuans*] and Kori Bustard (*Ardeotis kori*) are ground nesting (Maclean, 1993). Others, for instance Jackal Buzzards (*Buteo rufofuscus*), Peregrine Falcons (Falco peregrinus) and Cliff Swallows (*Hirundo spilodera*), require cliffs, rocky ledges or sometimes man-made structures in areas where cliffs do not occur. Species that only nest in trees also exist, for instance Fork-tailed Drongo (*Dicrurus adsirnilis*), Pied Babblers (*Turdoides bicolor*) and Bateleurs (Terathopius ecaudatus) (Maclean, 1993). Many species like the Pririt Batis (*Batis pririt*), Longbilled Crombec (*Sylvietta rufescens*) and Yellow-bellied Eremomelas (*Eremomela icteropygialis*) nest only in the habitat shrub layer (Maclean, 1993). The last section of birds that can be grouped according to breeding habits are birds such as the Desert Cisticola (*Cisticola aridulus*), White-winged Widowbird (*Euplectes albonotatus*) and Kalahari Robin (*Cercotrichas paena*) that nest in grass just above the ground (Maclean, 1993).

The importance of nesting sites cannot be marginalised; Ricklefs (1969) found that nest predation is the major cause of reproductive failure in birds.

8.1.2.4 Competition

Competition is the process by which species or individuals within species compete for resources. Subsequently, certain species or individuals become deprived of those resources due to the inability to compete with more efficient or aggressive competitors (Begon, et al., 1996).

Competition can be direct, whereby individuals actually interact in order to gain access to a resource (birds jostling for song perches), or indirect, whereby an individual's use of a resource leads to the inability of other individuals to utilize that resource (effective predatory birds hunting out prey so that there is less prey for less effective predatory birds) (Begon, et al., 1996).

Interspecific competition can be defined as competition between different species (Begon et al, 1996). In the case of birds this can be competition for food, nesting sites, song perches and hunting perches. The result of interspecific competition is the reduction in fecundity, survivorship and growth as a result of the interference by individuals of another species (Begon, et al., 1996). Interspecific competition is most pronounced in bird species that belong to the same guild or that in some way or another utilizes the same resources, be it for feeding breeding or nesting. This competition leads to the regulation of the numbers of individuals of species occurring in a system. In areas where resources competed over are in limited supply, competition is more pronounced and can ultimately lead to the complete exclusion of one or more of the weaker competing species.

Intraspecific competition is defined in Begon et al (1996) as competition between individuals of the same species. Competition between birds of the same species does not lead to the exclusion of the species from an area, but does have a profound effect on the numbers of individuals of the species in a system (Begon, et al., 1996).

In the case of birds, competition has a much more profound effect on specialist species when compared with generalist species. Generalists are more resilient to environmental pressures due to the fact that they are more adaptable than specialists who, as their name would indicate, are much specialised in their choice of food type, methods of feeding, nesting areas or breeding (Maesetas, et al., 2003).

8.1.2.5 Predation

Predation is defined as the killing and consumption of one organism (prey) by another organism (predator) (Begon, et al., 1996). Besides the obvious effects of predation namely: reduction of prey population size, "weeding out of older and weaker individuals and reducing intraspecific competition within the prey population, predation can have other effects on a prey populations, depending on the conditions under which the predation takes place. In theory, prey populations will not be totally depleted by predators due to reduction in predator numbers when prey populations are decreased in number (Begon, et al., 1996).

However, due to human interference in system processes, prey populations can decrease below the critical level required by that population to regenerate itself; this can lead to local extinctions of those species. Human factors that can increase the intensity or effect of predation are: fragmentation of habitat (Keyser, 2002), introduction of predators, domestic or wild, (Maesetas, et al., 2003) and (in birds) destruction of suitable nesting habitat (Maesetas, et al., 2003).

8.1.2.6 Vegetation structure

De Walt et al. (2003) states that, although the roles of vegetation structure in shaping faunal communities is not clear, vegetation can provide important resources for nesting, foraging and protection for a variety of taxa. MacArthur & MacArthur (1961) showed a definite positive correlation between vertical height diversity of vegetation and number of bird species in North American forest areas.

Furthermore, studies in forest areas (Willson, 1974) and desert scrub (Tomoff, 1974) showed no positive correlation between foliage height diversity and bird species diversity. Dean (2000) also indicated that an increase in taller, woody vegetation shows an increase in avian species richness, when compared to the surrounding shrubland in the Karoo semi-desert areas of South Africa.

Willson (1974) also found no positive correlation between spatial heterogeneity and bird species diversity. These findings appear to indicate that bird species diversity is either more dependent on other factors than spatial heterogeneity or that the findings of these studies were affected by variables that were not taken into account by the researchers.

Flather et al. (1992) found that vertical habitat structure alone could not account for species diversity, and concluded that in order to predict avian species diversity effectively, spatial heterogeneity needed to be taken into account.

Whitford (Whitford, 1997) indicates that bird species diversity actually increased with an increasing degree of desertification (desertification usually indicates less floral species diversity).

A study of avian demography in afforested grasslands in Illinois, USA showed that the planting of trees in grasslands caused a rapid decline in not only grassland species, but in the total number of species in the afforested area (Naddra & Nyberg, 2001). This appears to oppose the school of thought that avian diversity is enhanced by vertical structural diversity.

Hudson and Bouwman (2007) found a distinct correlation between an increase in vegetation structural diversity and avian species diversity in arid savanna regions.

8.1.3 Use of corridors by avifauna in arid and semi-arid regions

Seymore and Simmons (2008) found that birds often exhibit distinct species assemblages associated with habitat and that degradation or removal of riparian habitat, particularly in arid environments, may threaten bird diversity. The importance of riparian zones as corridors for avian species was also noted by Dean et al. (2002).

8.1.4 Effects of solar power generation on avifauna

Due to the similarity in vegetation and type of development at Solar One CSP in the Mojave Desert in the United States, it could be seen as a good surrogate for expected activity at the Paulputs facility. Between May and June 1982, the avian mortalities at Solar One were studied by McCrary et al. (1986). The study was conducted over a period of 40 weeks and 57 collision fatalities and 13 burning fatalities were recorded (McCrary, et al., 1986). Aerial foragers (swallows and swifts) were found to be more susceptible to being burned due to their foraging behaviour. It must be noted as well that the burned birds were burned while flying through the standby focal point, and not while the heliostats were focused on the tower (McCrary, et al., 1986).

McCrary et al. (1986) found that most of the collision incidences were recorded at the reflective surfaces of the heliostats and not against the heliostat stands or the tower. Considering the avian fatalities during the study the impact of the facility on avifauna was determined to be minimal with a mortality of 1.9 to 2.2 birds per week and with the recorded abundance only 0.6 to 0.7% of the local population (McCrary, et al., 1986).

It must be taken into account that the magnitude of the CSP facility at Solar One is considerably smaller than modern facilities and that the impacts may be nonlinear for modern facilities. However, it can also be noted that the impacts and mitigations noted in the Solar One study are relevant to modern facilities.

Infrastructure at other tower CSP facilities were investigated in order to determine the possible impacts on avifauna. The current infrastructure was investigated keeping in mind the findings of the Solar One study by McCrary et al. (1986) as well as the avian species and behaviour recorded during the vantage point surveys conducted. In order to reduce the possible impacts of the development on avian species the infrastructure of the development should be made as unattractive as possible for avian species. The factors that would make the infrastructure attractive for avian species are factors which could:

- Provide food sources;
- Provide water sources;
- Provide nesting sites;
- Provide perching sites;
- Provide areas of reduced competition;
- Provide areas of reduced predation or areas which aid predatory birds;
- Provide increased vegetation structural diversity.

The aspects of the infrastructure, noted as needing mitigation in order to reduce impacts on avifauna in the area, are discussed in sections 8.1.4.1 to **Error! Reference source not found.**. It should be noted that the impacts and mitigation measures are based on similar infrastructure at other tower solar facilities, taking into account the previous study by McCrary et al. (1986) and avifauna survey data, but would be equally relevant to the proposed Paulputs Tower plant, and can be readily considered in the construction of the facility.

8.1.4.1 Openings at either end of the horizontal rotating cylinder

The first aspect of the facility that should be addressed are the openings at either end of the horizontal rotating cylinder of the heliostats. These openings would be ideal nesting sites for sparrow species, as well as any other structure nesting species. This may not necessarily be a negative impact, but certain factors need to be taken into account. In order to make the development as unattractive for avifauna species, possible nesting sites need to be limited to as few as possible, with two openings in each heliostat, these openings could provide more than 3400 nesting sites, with two birds per nest this can cause an influx of 6800 birds to the area. Species most likely to be attracted to these nesting sites are sparrows and doves which, in turn, act as prey species for larger raptors, thus being likely to attract more of these species to the area as well.

Furthermore, if nests are built in these openings, the eggs or chicks could roll out of the nests as the cylinder rotates. In the long term this could lead to a lower local fecundity of species using these openings as breeding sites.

8.1.4.2 Mirrors in cleaning position

The heliostats themselves, when in a static position (horizontal to the grade) or focused position (at an angle to the grade) are very visible and thus unlikely to cause avifauna collisions. Mirrors placed in the cleaning position (perpendicular to the ground), give the illusion of a continuation of the heliostat field and are very likely to cause collisions, due to birds trying to continue to fly through the heliostat field which appears to be continuing in the mirrors.

8.1.4.3 Flat surfaces at the base of the tower

Any elevated flat surfaces are seen by many avian species as potential nesting sites, including smaller and larger raptor species, pigeons and doves. The tower itself has many flat surfaces including ledges near the base of the tower. These ledges may attract many species of birds which will use them as nesting places, but these birds may in turn attract raptor species which prey on the species using the ledges as nesting sites.

8.1.4.4 Colour of the tower

Towers are sometimes painted white. Because white light reflects ultraviolet light it is likely that the white areas will attract insects, which in turn will attract aerial insectivores such as swallows, swifts and martins (the same species which were found to be most susceptible to being burned to death during the Solar One study (McCrary, et al., 1986).

8.1.4.5 Focusing the heliostats above the tower during maintenance

Information about the operation of the CSP indicated that, during maintenance, the heliostats may be focused above the tower in order to allow for maintenance. This practice may produce a sudden, invisible “hotspot” above the tower which will not give any warning to birds, such as a gradual increase in temperature around the central reciever, due to reflection of some of the heat, may allow during operation. This undetectable sudden “hotspot’ may increase the possibility of birds being burned, as was proposed by McCrary, et al. (1986).

8.2 Field Survey Results

8.2.1 Avifauna Surveys

8.2.1.1 Vantage point surveys

During the surveys a total of 29 species were recorded and a total of 1341 individual birds were recorded. The species recorded are given in Table 3. Only one species of conservation importance was recorded during the study namely, the Maccoa Duck (*Oxyura maccoa*). The Maccoa Duck was recorded to the south of the study area, flying towards the evaporation ponds at the Kaxu facility.

Table 3: Species and abundances of avifauna recorded during the study

Species	Species Biological Name	Total number of individuals recorded
South African Shelduck	*Tadorna cana*	35
Maccoa Duck	*Oxyura maccoa*	5
Lanner Falcon	*Falco biarmicus*	4
Namaqua Sandgrouse	*Pterocles namaqua*	54
Rock Dove	*Columba livia*	33
Speckled Pigeon	*Columba guinea*	25

Species	Species Biological Name	Total number of individuals recorded
Cape Turtle Dove	*Streptopelia capicola*	17
Laughing Dove	*Streptopelia senegalensis*	25
Namaqua Dove	*Oena capensis*	14
Red-faced Mousebird	*Urocolius indicus*	78
Red-capped Lark	*Calandrella cinerea*	21
Sabota Lark	*Calendulauda sabota*	16
Spike-heeled Lark	*Chersomanes albofasciata*	149
Pied crow	*Corvus albus*	40
Familiar Chat	*Cercomela familiaris*	27
Ant-eating Chat	*Myrmecocichla formicivora*	19
Karoo Scrub Robin	*Erythropygia coryphoeus*	10
Chestnut-vented Tit-Babbler	*Sylvia subcaerulea*	5
Zitting Cisticola	*Cisticola juncidis*	12
African Pied Wagtail	*Motacilla aguimp*	27
Bokmakierie	*Telophorus zeylonus*	9
Cape Sparrow	*Passer melanurus*	187
Southern Grey-headed Sparrow	*Passer diffusus*	142
White-browed Sparrow-Weaver	*Plocepasser mahali*	121
Sociable Weaver	*Philetairus socius*	221
Yellow Canary	*Crithagra flaviventris*	31
Barn Swallow	*Hirundo rustica*	14

8.3 Data Analysis Results

During the avifauna surveys, data was collected on the number of species and abundance at each of the vantage point surveys. Due to the homogeneity of the vegetation throughout the study area there was no significant difference in the species richness or species diversity at any of the vantage points. Information pertinent to the study was also recorded, namely flight height, flight direction and behaviour.

8.3.1 Avifauna flight height

The average flight height data rounded to the nearest whole number collected during the surveys are represented graphically in Figure 8. It can be noticed that most of the species recorded in the area fly at an average height of 7m, while the average minimum height is 0.5m and the average maximum height is 12.1m. What is noticeable is that the vast majority of species show and average flight height (based on the actual flying height excluding the ground level data) of below 10m. This is likely due to the vegetation being low shrubs and grass with few or no trees, all feeding, nesting and protection against predation thus occurs at very low altitudes.

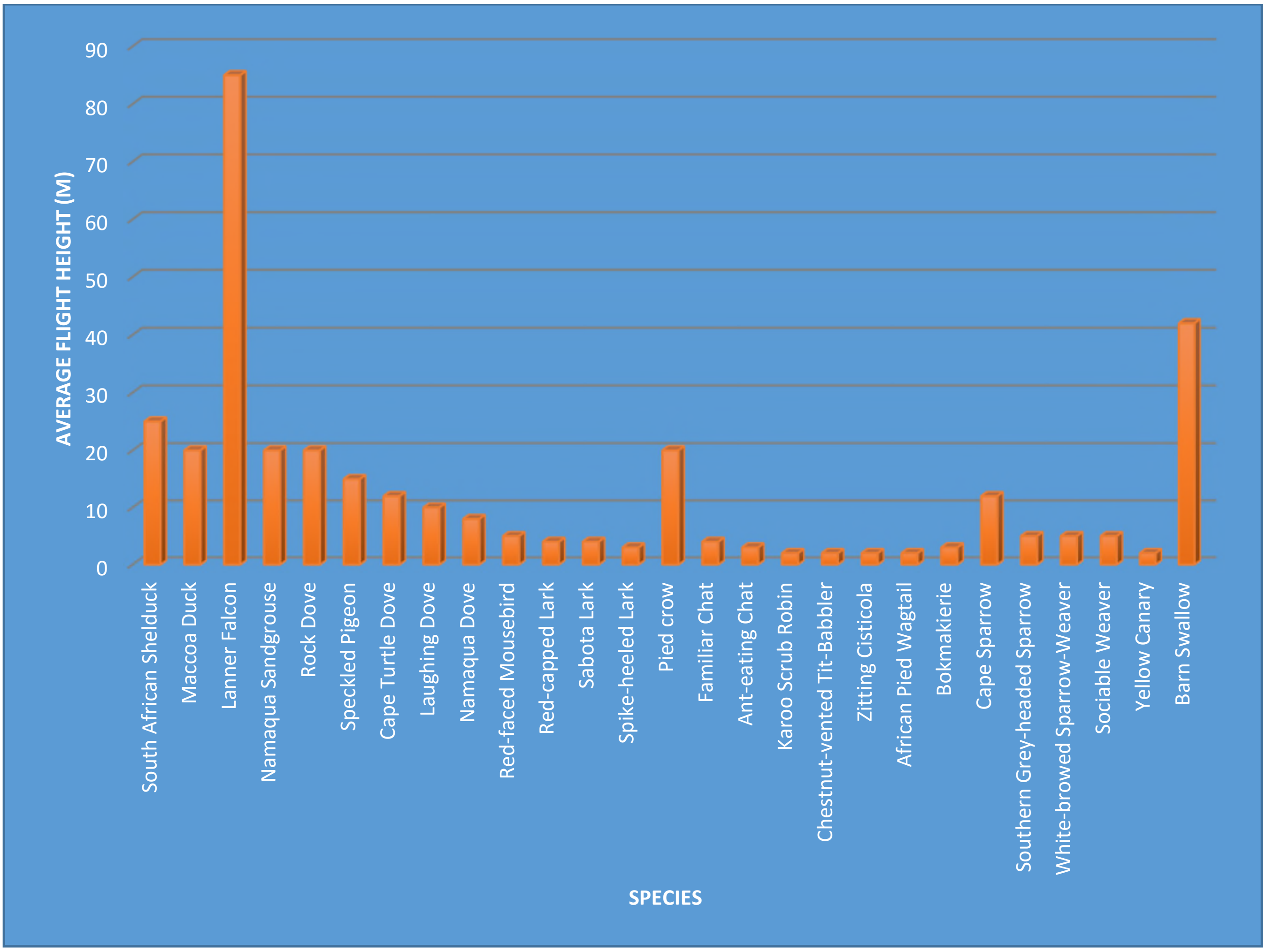

Figure 8: Average flight heights per species according to data collected during the winter and summer vantage point surveys

Avifauna flight direction

Flight direction data was recorded for each bird recorded during the vantage point surveys. The direction was taken as the closest main direction (e.g. east north east would be recorded as east, north north west would be recorded as north etc.) and these data were then presented graphically (Figure 9).

From the data recorded (Figure 9) there does not appear to be any preferred or prevalent direction in which birds tend to fly. This may be due to the fact that most of the birds recorded are locally resident and do not migrate. Furthermore the vegetation surrounding the study area is also relatively homogenous and no areas exist that would attract birds in large numbers, such as rivers, wetlands etc.

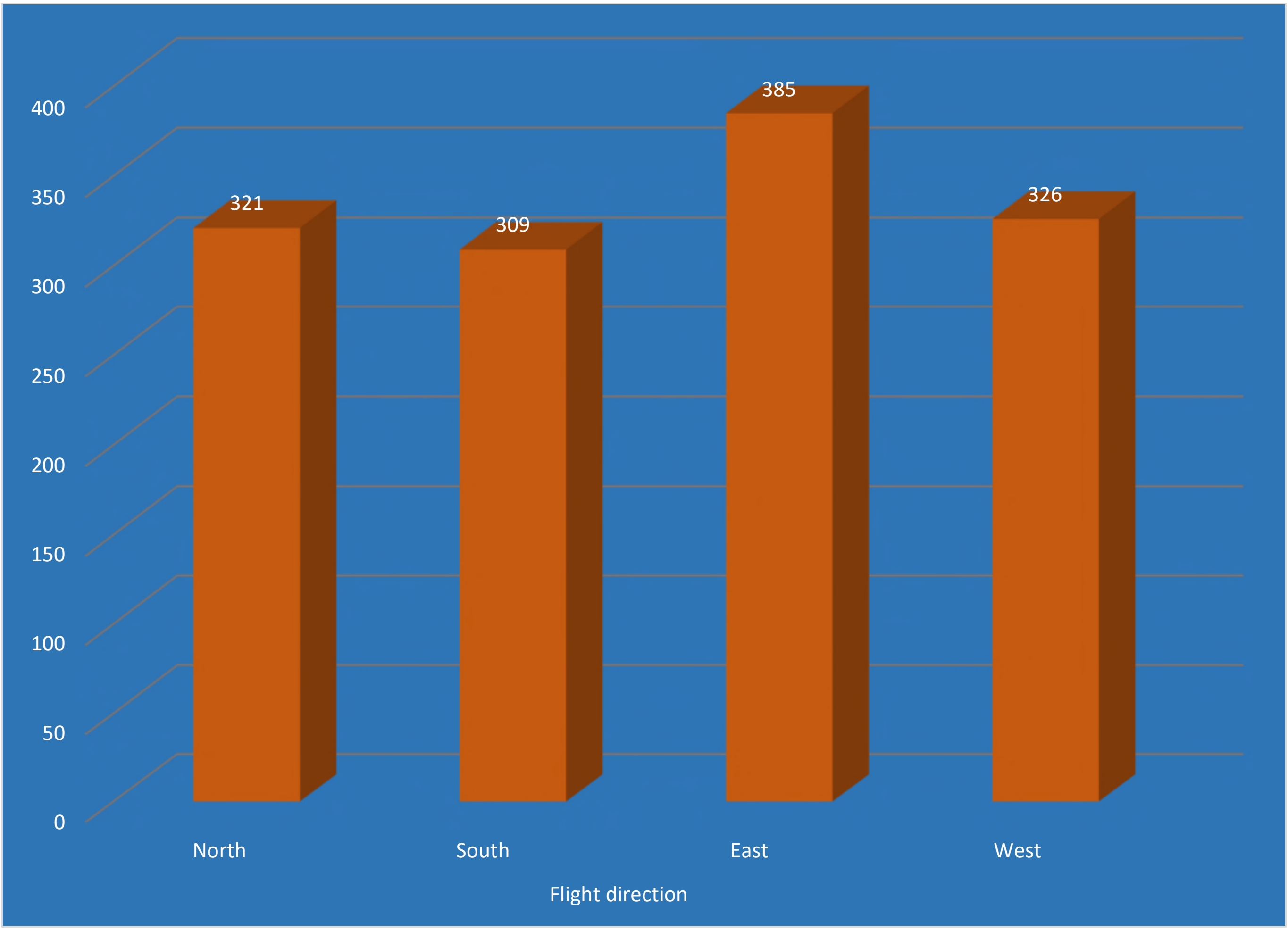

Figure 9: Recorded directions of flight recorded during both wet and dry season surveys

Avifauna behaviour

Bird activity was restricted to flying, feeding, perching and soaring in search of food (for the predatory birds). Unfortunately the nesting season had already ended prior to when the surveys commenced although there was evidence of nesting in the area, particularly in larger shrubs or small trees in the area. Due to the small tree size in the area Sociable weavers mainly nest on telephone or electricity transmission poles along the roads in the area.

9 IMPORTANT BIRD AREAS

The Matheus-Gat IBA borders on the southern border of the proposed development site. This IBA is approximately 66 670ha in size and stretches from north east of Pofadder to south of the study area (Figure 10).

The Mattheus-Gat IBA is one of a few sites protecting both the Red Lark (*Certhilauda burra*; globally Vulnerable) and Sclater's Lark (*Spizocorys sclateri*; near-threatened). Both are endemic species with restricted ranges. Red Lark inhabits red sand dunes and sandy plains with a mixed grassy dwarf shrub cover while Sclater's Lark occurs erratically on gravel plains. The area around the IBA has been poorly atlassed, but the IBA potentially supports 16 of the 23 Namib-Karoo biome-restricted assemblage species and a host of other arid-zone birds. It is seasonally important for nomadic larks, such as Stark's Lark, and sparrow-larks, which are abundant after good rains.

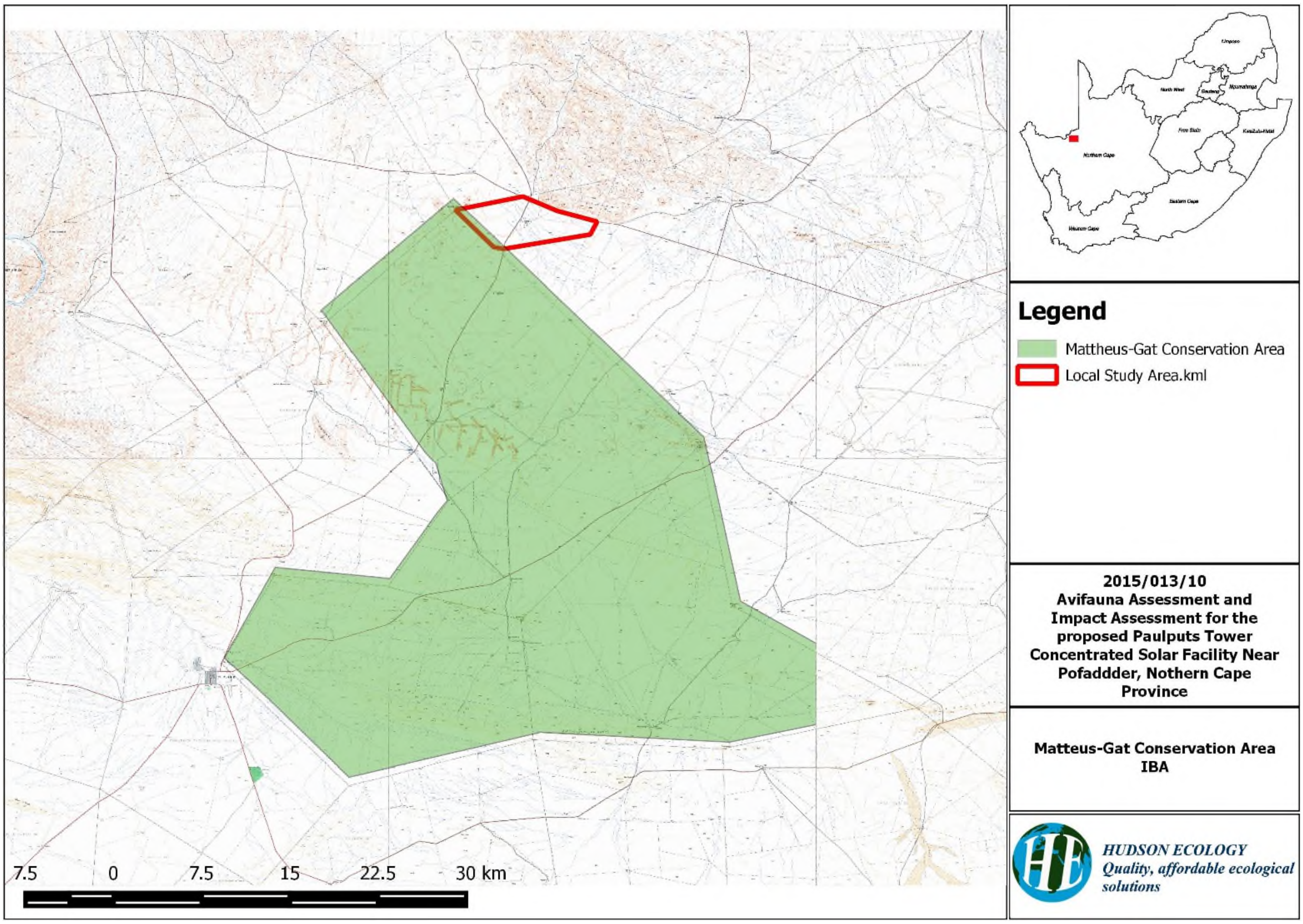

Figure 10: Mattheus-Gat Conservation Area in relation to the study area

IBA trigger species include globally threatened Red Lark, Sclater's Lark, Kori Bustard *Ardeotis kori*, Ludwig's Bustard *Neotis ludwigii* and Black Harrier *Circus maurus,* and regionally threatened Karoo Korhaan *Eupodotis vigorsii*. Biome-restricted species include Stark's Lark, Karoo Long-billed Lark *Certhilauda subcoronata*, Black-eared Sparrow-lark *Eremopterix australis*, Tractrac Chat *Cercomela tractrac*, Sickle-winged Chat *C. sinuata*, Karoo Chat *C. schlegelii*, Layard's Tit-Babbler *Sylvia layardi,* Karoo Eremomela, *Eremomela gregalis*, Cinnamon-breasted Warbler *Euryptila subcinnamomea,* Namaqua Warbler *Phragmacia substriata*, Sociable Weaver *Philetairus socius,* Pale-winged Starling *Onychognathus nabouroup* and Black-headed Canary *Serinus alario*. Additional priority species in the IBA include Martial Eagle *Polemaetus bellicosus*, Secretarybird *Sagittarius serpentarius*, Verreauxs' Eagle3*Aquila verreauxii*, Booted Eagle *Hieraaetus pennatus*, Black-chested Snake Eagle *Circaetus pectoralis*, Cape Eagle-Owl *Bubo capensis*, and Spotted Eagle-Owl *B. africanus*.

It must be noted that none of these species were recorded during the extensive avifauna surveys that were conducted on site. It must also be noted that the vegetation to the south of the study area is far more accommodating to avifauna than the vegetation on site.

10 COMMENTS FROM INTERESTED AND AFFECTED PARTIES

Comments from Samantha Ralston at Birdlife SA were received on the 3rd of December 2015. These comments will be discussed below:

BLSA: Worldwide there has been little rigorous monitoring of the effects of CSP on birds, and where monitoring has been done, the data are rarely made publically available. What is understood, is that potential impacts could be significant.

I am afraid that most of the "literature" currently being published on the topic are sensational colloquial articles involving no peer review and mainly written to create sensation. The numbers being given in these publications seem incongruent with the study by McCrary et al (1986). In order to keep with the scientific nature of the process of impact assessments I would prefer that peer reviewed articles take precedence over colloquial articles. In Birdlife SA's comments they mention that approximately 215 birds were killed annually after they adjusted the 70 species in 40 weeks found by McCrary et al. (1986) to account for the proportion of the area searched, searcher efficiency and scavenger removal. The entire 32ha of facility as well as ponds and other infrastructure were surveyed by McCrary et al. (1986), thus no "adjustment" is necessary in this regard. Furthermore the data utilised to determine the searcher efficiency and scavenger removal were not indicated in Birdlife SA's comments. Birdlife SA fails to mention the fact that by their calculations McCrary et al. (1986) found that only 0.6 – 0.7% of the local population at any given time was affected by the facility. With scavenger bias etc. McCrary et al. (1986) actually found that the mortality rate is 1.9 to 2.2 bird per week giving a total of 98.8 to 114.4 bird per annum.

Regardless of the exact number, we need to put these numbers into perspective compared to other sources of bird deaths. Power lines alone may kill up to 175 million birds a year (Richardson, 2014), according to a US Fish and Wildlife Service document. Up to 3.7 billion are killed by cats per year (Richardson, 2014). Furthermore, according to the Audubon Society, more than one million birds died due to the Deepwater Horizon oil spill (Canfield, 2015). The oil industry contributes far more to bird deaths each year than this one solar power plant. In a review Trail (2006) noted that every year an estimated 500,000 to 1 million birds are killed in oilfield production skim pits, reserve pits, and in oilfield wastewater disposal facilities. The New York State Energy Research and Development Authority has confirmed that based on the comparative amounts of SO2, NOx, CO2, and mercury emissions generated from coal, oil, natural gas, and hydro and the associated effects of acidic deposition, climate change, and mercury bioaccumulation, coal as an electricity generation source is by far the largest contributor to risks to wildlife found in the NY/NE region.

BLSA: In light of the risks associated with CSP projects, particularly power towers, and the uncertainly in predicting impacts, BirdLife South Africa cannot support the development of further CSP projects in, or close to IBAs.

We understand the importance of the Matteus-Gat Conservation Area as an important bird area (IBA) but do not understand how a facility outside the IBA would create such a significant impact on the IBA that it would need to be opposed. It must also be noted that none of the species of concern mentioned as trigger species for the IBA were found to occur in the study area. The proposed facility will not be in any way encroaching on the IBA. Consistency is also an issue here, three solar facilities have already been developed within the boundries of the IBA. To oppose this development on the basis of its proximity will cannot be seen as procedurally fair. This right to fair administrative action has been constitutionalised by the Constitution of the Republic of South Africa 1996 and fleshed out (given content and meaning) in the Promotion of Administrative Justice Act 3 of 2000 (Brynard, 2010).

BLSA: A pair of Verreaux's Eagles was observed on two consecutive days in that area when BirdLife South Africa visited the IBA in early 2014.

This sighting may have been a case of mistaken identity or a pair of vagrants passing through the area. After spending a total of approximately a month on site this species has not been recorded during the studies. During questioning none of the staff on site, or local farmers, have spotted this species in the area. This is a very noticeable species and if a pair are resident, they would surely have been spotted.

11 IMPACT ASSESSMENT

Commercial-scale solar technologies are relatively new, with a limited number of significant developments worldwide. Some studies have been conducted on the effects of CSP facilities on avifauna, most notably The Solar One plant in the Mojave Desert in the United States (McCrary, et al., 1986).

Although there may be considerable impact due to the clearing of vegetation and the large footprint required for commercial-scale energy production, which would refer to the habitat loss and disturbance created during the construction phase of the facility, birds are the most mobile of vertebrate species and there is a considerable amount of the same vegetation in adjacent areas to which avifauna will move. Furthermore, in this case, the vegetation of the area is very low and revegetation the area of the heliostat field can result inrecovering some of the lost vegetation. Secondary impacts relate to the operation of the facility and include avian mortality due to direct interactions with the facilities and their associated infrastructure.

Based on the information gathered, several impacts have been identified and will be quantified in sections below:

- Impact on local bird community due to habitat loss;
- Impact on local bird community due to disturbance;
- Impact on birds attracted to solar thermal plant infrastructure;
- Birds may be singed or killed flying into the focal point;
- Collision of birds with infrastructure associated with the CSP facilities;
- Collision of birds with the associated power line; and
- Electrocution of birds on associated power line tower structures.

These impacts were quantified using the data collected during the site visit and according to criteria set out by Savannah Environmental.

11.1 Construction Phase

11.1.1 Impact on local bird community due to habitat loss

Nature: In order for solar energy facilities to be commercially viable, they require large tracts of land, in this case ±900ha. It can therefore be assumed that habitat will be lost during the establishment of the facility and its associated infrastructure (including clearing for access roads and power lines). Habitat loss reduces the carrying capacity of a habitat, often resulting in localised population declines. Such habitat loss can impact on local as well as, to a lesser degree, migratory species. The general nature of the study area (already relatively disturbed, and extremely uniform throughout the wider area) means that this is not likely to impact significantly on the avifauna of the area.

Extent: The western portion of the site would be the area within the broader site that would be disturbed by the proposed facility. This area is largely composed of unproductive plains, where bird density and diversity is low. Numerous small drainage lines make up a large wash within the area, although their influence on bird density and diversity was negligible. The impact of habitat loss would therefore be local.

Duration: The loss of habitat will have a permanent impact for the life of the project. Rehabilitation of the habitat is possible, however due to the long term nature of this project, it is unlikely that the habitat lost through the construction of the facility will be restored in the near future. Based on this, the loss of habitat and the subsequent impact on local bird communities will be long term.

Magnitude: The magnitude of this type of impact could be low to high, depending on the species concerned, the proportion of the study site affected and the current status of the habitat on site (i.e. degraded or intact). For instance, if Species of Special Concern were adversely affected by the habitat loss on site, then the impact would be high. No Species of Special Concern other than the Maccoa Duck resident on the Xaxu evaporation ponds were detected on site and the density and diversity of bird species was fairly low. The amount of habitat that would be lost (±700ha) would not be significant. For this reason, the magnitude is minor.

Probability: Habitat will be lost if the construction of the facility takes place and therefore, regardless of any prevention or mitigation measures that are put in place, an impact will occur. The impact will be definite.

Mitigation measures: The following mitigation measures are recommended:

- Minimise vegetation clearing;
- Avoid clearing vegetation in drainage channels or washes, where bird density and diversity has the potential to be higher;
- If possible, the servitude of the power line exiting the site should follow existing roads and not cut across habitat; and
- All construction and maintenance activities relevant to the power line must be undertaken in accordance with Eskom Transmission’s Environmental Best Practise Standards. All construction activities and access roads should be restricted as much as possible.

Table 4: Summary of impact significance table for habitat loss

1. Activity: Vegetation clearing for the CSP facility, access roads and powerlines				
Avifaunal Aspect: Impact on local bird community due to habitat loss from the construction of the CSP plant and associated infrastructure including power lines.				
	Overall impact of the proposed project considered in isolation		**With Mitigation**	
Extent (E)	1	Site Only	1	Site Only
Duration (D)	4	>15 years	3	5 - 15 years
Magnitude (M)	2	Minor	2	Minor
Probability (P)	4	Highly Probable	4	Highly Probable
Significance (S = [E+D+M]xP)	28	Low	24	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Low		Moderate	
Irreplaceable loss of resources	Yes		Yes	
Mitigability	Yes		Yes	
Mitigation measures:				
Where possible, avoid clearing vegetation in drainage channels or washes, where bird density and diversity has the potential to be higher (although this higher diversity was not recorded during the site visit). If possible, the servitude of the power line exiting the site should follow existing roads and not cut across habitat. All construction and maintenance activities must be undertaken in accordance with Eskom's Environmental Best Practise Standards. The construction footprint and access roads should be restricted to within the development footprint.				
Residual impacts:				
Localised displacement of avifauna species.				

11.1.2 Impact on local bird communities due to disturbance

Nature: Disturbance from human activity, during the construction and operation phases, has the potential to modify bird behaviour on site. For shy and sensitive species, this may result in displacement or exclusion.

Construction and maintenance activities associated with the power facility as well as the power line impact on birds through disturbance, particularly during the breeding season.

Certain bird species could also choose to nest on the towers of the proposed power line. In this arid and largely treeless landscape any form of available nesting substrate will probably be utilised by medium sized raptors, crows and the Sociable Weaver. The proposed power line is likely to be built on a monopole structure, which does not present the most conducive structure for nesting.

Extent: It is assumed that all new construction and subsequent operational activities will be limited mainly to the ±900ha area demarcated in the north east of the property. Based on this, the impact will be local.

Duration: Disturbance will mainly occur during the construction phase of the development, and to a lesser extent, during operation. Over time, bird species are able to adapt to and co-exist with certain disturbances. The duration of the impact will be of a short duration.

Magnitude: The magnitude of the impact is measured by the potential outcome should certain individuals in the bird community present on site be unduly disturbed and affected by the construction and operation of the facility.

No Species of Special Concern, other than the Maccoa Ducks resident on the Xaxu evaporation ponds, were detected during the site visit. In addition, none of the species detected on site are unduly shy or secretive species and particularly sensitive to disturbance. The magnitude of the impact will therefore be minor.

Probability: There is a distinct possibility of this impact occurring.

Mitigation: The additional disturbance will be minimal and it not expected to have a particularly significant impact on the local bird community. However:

- Contractors need to minimise the amount of disturbance during the construction phase of the facility, by staying within the demarcated ±900ha construction area
- If the nest of a protected species is detected within the vicinity of the area to be disturbed, then the Northern Cape Department needs to be notified and all attempts made to minimise the amount of disturbance near it.

Table 5: Summary of impact significance table for disturbance

2. Activity: Disturbance				
Avifaunal Aspect: Nature: Impact on local bird community due to disturbance on site and in surrounding area. Sensitive and threatened species are of most concern and particularly while breeding				
	Overall impact of the proposed project considered in isolation		**With Mitigation**	
Extent (E)	1	Site Only	1	Site Only
Duration (D)	2	2 - 5 years	3	5 - 15 years
Magnitude (M)	2	Minor	2	Minor
Probability (P)	3	Probable	2	Improbable
Significance (S = [E+D+M]xP)	15	Low	12	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Low		Moderate	
Irreplaceable loss of resources	Yes		Yes	
Mitigability	Yes		Yes	
Mitigation measures:				
Contractors need to minimise the amount of disturbance during the construction phase of the facility, by staying within the demarcated ±900ha construction area. If the nest of a large species is detected within the vicinity of the area to be disturbed, then the Northern Cape Department needs to be notified and all attempts made to minimise the amount of disturbance near it.				
Residual impacts:				
Localised loss or displacement of avifauna species.				

11.2 Operation Phase

11.2.1 Impact on birds attracted to the solar thermal infrastructure

Nature: The facility will cover an area of ±900ha and will include a series of heliostats/mirrors which will reflect sunlight. Infrastructure at the Khi Solar One site was previously investigated in order to determine the possible impacts on avifauna. The current infrastructure was investigated keeping in mind the findings of the Solar One study by McCrary et al. (1986) as well as the avian species and behaviour recorded during the vantage point surveys conducted. It was concluded that in order to reduce the possible impacts of the development on avian species the infrastructure of the development should be made as unattractive as possible for avian species.

Openings at either end of the horizontal rotating cylinder - The first aspect of the development that should be addressed are the openings at either end of the horizontal rotating cylinder of the heliostats. These openings would be ideal nesting sites for sparrow species, as well as any other structure nesting species. This may not necessarily be a negative impact, but certain factors need to be taken into account. In order to make the development as unattractive for avifauna species, possible nesting sites need to be limited to as few as possible, with two opening in each heliostats these openings could provide more than 3400 nesting sites, with two birds per nest this can cause an influx of 6800 birds to the area. Species most likely to be attracted to these nesting sites are sparrows and doves which, in turn, act as prey species for larger raptors, thus being likely to attract more of these species to the area as well. Furthermore, if nests are built in these openings, the eggs or chicks could roll out of the nests as the cylinder rotates. In the long term this could lead to a lower local fecundity of species using these openings as breeding sites.

Heliostats in the vertical position - The heliostats themselves, when in a static position (horizontal to the grade) or focused position (at an angle to the grade are visible very visible and thus unlikely to cause avifauna collisions. Mirrors placed in the cleaning position (perpendicular to the ground), give the illusion of a continuation of the heliostat field and are very likely to cause collisions, due to birds trying to continue to fly through the heliostat field which appears to be continuing in the mirrors. Collisions with heliostats were found to be the impact with the greatest probable magnitude related to the CSP facility in the study by McCrary et al (1986).

Flat surfaces at the base of the tower - Any elevated flat surfaces are seen by many avian species as potential nesting sites, including smaller and larger raptor species, pigeons and doves. The tower itself has many flat surfaces including ledges near the base of the tower. These ledges may attract many species of birds which will use them as nesting places, but these birds may in turn attract raptor species which prey on the species using the ledges as nesting sites.

Opening at the top of the tower - Not only will the opening at the top of the tower will allow structure nesting species access into the tower to build nests in what appears to be suitable nesting area for them, but to some species the visual similarity of the tower to a grain silo may be a distal factor that may attract them to the tower. The opening at the top of the tower may cause them to approach the tower in order to investigate the contents of the tower.

Colour of the tower - Because white light reflects ultraviolet light it is likely that any white areas will attract insects, which in turn will attract aerial insectivores such as swallows, swifts and martins (the same species which were found to be most susceptible to being burned to death during the Solar One study (McCrary, et al., 1986).

Focusing the heliostats above the tower during maintenance - Information about the operation of the CSP indicated that, during maintenance, the heliostats may be focused above the tower in order to allow for maintenance. This practice may produce a sudden, invisible “hotspot” above the tower which will not give any warning to birds, such as a gradual increase in temperature around the central receiver, due to reflection of some of the heat, may allow during operation. This undetectable sudden “hotspot’ may increase the possibility of birds being burned, as was proposed by McCrary, et al. (1986). The radiation from the central receiver will cause a gradually increasing “heat bubble” around the receiver which will be sensed by most birds before it is potentially fatal allowing birds to take evasive action. This radiating heat bubble will be a lot less distinct when the focal point is above the tower and this focal point may be perceived as a more sudden, potentially fatal, hotspot, thus not allowing birds to take evasive action in time.

Extent: This would be limited to the immediate area of the facility containing the heliostats. The extent of the impact would therefore be local.

Duration: The impact would exist for the life of the facility and would therefore be long term.

Magnitude: In order to measure the magnitude of this impact, one has to measure what impact the facility may have on birds attracted to the facility. It is uncertain as to whether birds will be attracted to the facility and if so, to what extent they would interact with the facility. While this phenomenon cannot be ruled out, evidence to date from other installed facilities have shown that the magnitude is low due to the type of birds resident in the area.

Probability: The probability of this occurring is relatively probable before mitigation.

Mitigation:

Openings at either end of the horizontal rotating cylinder – The simplest way to mitigate this impact would be to seal the openings at each end of the cylinder. This can be done by tack-welding appropriately sized discs onto either end.

Heliostats in the vertical position – the heliostats should be limited to being in the vertical position for as short a time as possible. The trucks which clean the heliostats should follow each other as close as possible and the heliostats returned to a static (horizontal) or focussed position as soon as possible after cleaning.

Flat surfaces at the base of the tower – all ledges should be built or panelled so that they slope at an angle downwards to the outside to prevent nesting on these ledges.

Colour of the tower– a neutral brown, concrete colour or grey would prevent the reflection of UV light and thus mitigate the possible impact of the white tower.

Focusing the heliostats above the tower during maintenance – ideally the heliostats should be in one of three positions vertical (washing position – for as short a time as possible), static position or focussed in order to prevent the undetectable "hotspot" above the tower.

Table 6: Impacts and mitigations of the operation of the CSP

1. Activity: Operation of the CSP				
Avifaunal Aspect: Openings at either end of the horizontal rotating cylinder - would be ideal nesting sites, but may lead to a local reduction of fecundity of species due to the rotation of the cylinder causing eggs or chick to fall out of the nests. Heliostats in the vertical position - very likely to cause collisions due to the fact that, in this position, the mirrors give an illusion of an extension of the heliostat field behind the observer. Flat surfaces at the base of the tower - Any elevated flat surfaces are seen by many avian species as potential nesting sites. Colour of the tower - white light reflects ultraviolet light it is likely that the white areas will attract insects and consequently aerial insectivores. Focusing the heliostats above the tower during maintenance –may increase the likelihood of singeing or death of birds. When focussed on the central receiver there will be a "heat bubble caused by radiation of heat from the central receiver. The radiation from the central reciever will cause a gradually increasing "heat bubble" around the receiver which will be sensed by most birds before it is potentially fatal allowing birds to take evasive action. This radiating heat bubble will be a lot less distinct when the focal point is above the tower and this focal point may be perceived as a more sudden, potentially fatal, hotspot, thus not allowing birds to take evasive action in time.				
	Overall impact of the proposed project considered in isolation		**With Mitigation**	
Extent (E)	1	Site Only	1	Site Only
Duration (D)	5	Permanent	5	Permanent
Magnitude (M)	2	Minor	2	Minor
Probability (P)	2	Improbable	1	Very Improbable
Significance (S = [E+D+M]xP)	16	Low	8	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Low		Moderate	
Irreplaceable loss of resources	Yes		Yes	
Mitigability	Yes		Yes	
Mitigation measures:				
Openings at either end of the horizontal rotating cylinder – The simplest way to mitigate this impact would be to seal the openings at each end of the cylinder. This can be done by tack-welding appropriately sized discs onto either end.				

Heliostats in the vertical position – the heliostats should be limited to being in the vertical position for as short a time as possible. The trucks which clean the heliostats should follow each other as close as possible and the heliostats returned to a static (horizontal) or focussed position as soon as possible after cleaning. Flat surfaces at the base of the tower – all ledges should be built or panelled so that they slope at an angle downwards to the outside to prevent nesting on these ledges. Colour of the tower– a neutral brown, concrete colour or grey would prevent the reflection of UV light and thus mitigate the possible impact of the white tower. Focusing the heliostats above the tower during maintenance – ideally the heliostats should be in one of three positions vertical (washing position – for as short a time as possible), static position or focussed in order to prevent the undetectable "hotspot" above the tower.
Residual impacts:
Localised loss or displacement of avifauna species.

11.2.2 Collision of birds with infrastructure associated with the development

Nature: Collisions are one of the biggest single threat posed by overhead power lines to birds in southern Africa. In South Africa, bird collisions with power lines are a major form of unnatural mortality, affecting several threatened species as well as other species. The majority of species that are susceptible to collisions tend to be long-lived, slow reproducing species such as bustards, cranes, korhaans and various water bird species who are not the most agile flyers. Due to the slow reproductive nature of many of the susceptible species, long-term mortalities caused by collisions may result in future population's abilities to sustain themselves. Birds usually avoid the highly visible bundled conductors, but often fail to see the thin earth wires, with typical injuries resulting from collisions including broken necks and legs. Threatened species that have the potential to occur in the study area and that may be involved in collision events include:

- Secretarybirds *Sagittarius serpentarius* – Near Threatened
- Kori Bustard *Ardeotis kori* – Vulnerable
- Ludwig's Bustard *Neotis ludwigii* – Vulnerable
- Maccoa Duck *Oxyura maccoa* Near Threatened

While the aforementioned species only include endangered species, all korhaan and bustard populations are currently under pressure. Birdlife SA lists the collision of large terrestrial birds with power lines as one of the highest mortality factors for these particular birds in South Africa – with this single mortality factor leading to the decline of Ludwig's Bustard *Neotis ludwigii*. For larger ground dwelling avifauna species collision mortalities would probably not have a hugely significant impact on their regional populations. Ongoing mortalities on a large-scale may however result in long term effects on these species and as such, an effort should be made to minimise the impacts upon these populations.

Susceptible species to collisions with power lines utilise waterways as flyways and the proximity of the Gariep (Orange) River accentuates the likelihood of interactions with power lines.

Duration: The impact would cover the lifespan of the facility and will be long-term.

Extent: The extent will be confined to the study area (i.e. the demarcated site for the facility as well as the extent of the power line). The extent is therefore local.

Magnitude: The magnitude of this impact will be moderate to high due to the conservation status of the species which have the potential to be involved in collision events. Ludwig's Bustard is of particular concern based on its biology and known incidences of collision events. This species may therefore be susceptible to collisions with the proposed power line, the consequences of which would be significant.

Probability: Bird species susceptible to collisions with power lines occur in the area such as South African Shelduck and Maccoa Duck, both of which are large, heavy bodied, low flying species, susceptible to collisions. There is therefore a high possibility of collision events and subsequent impacts on local bird populations. The probability of events can be minimised through the implementation of mitigation measures.

Significance: The significance of this impact will be moderate to high (due to the conservation status of the species involved in possible collision events). The significance of this impact can however be reduced through mitigation measures.

Mitigation: The incidences of birds interacting with the solar facility itself and subsequent mortalities are minimal. It is however recommended that appropriate bird deterrents are placed at power line locations around the facility to reduce this impact. Mitigation measures regarding the power line include:

- Install anti bird collision line marking devices on high risk sections of power line;
- Conduct avifaunal walk through to identify these high risk areas;
- The line should be kept as low as possible taking into account engineering and legal requirements;
- The span lengths should be kept as short as possible;
- Placement of bird flappers as markers on the earth wire, which will increase the visibility of the power line;
- Markers should be placed with sufficient regularity (at least every 5-10m). Eagle eye devices may be used, if feasible to deter birds from the CSP plant area/ solar field; and
- Regular monitoring and assessment and improvement of mitigation factors.

Table 7: Summary of impacts of collision of birds with infrastructure

2. Activity: Impact on local bird communities due to the power line due to collision by the overhead power lines				
Avifaunal Aspect: Collisions of birds with overhead powerlines				
	Overall impact of the proposed project considered in isolation		**With Mitigation**	
Extent (E)	1	Site Only	1	Site Only
Duration (D)	4	>15 years	4	>15 years
Magnitude (M)	8	High	4	Low
Probability (P)	4	Highly Probable	2	Improbable
Significance (S = [E+D+M]xP)	52	Moderate	18	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Low		Moderate	
Irreplaceable loss of resources	Yes		Yes	
Mitigability	Yes		Yes	
Mitigation measures:				
The line should be kept as low as possible taking into account engineering and legal requirements. The span lengths should be kept as short as is reasonable. Placement of bird flappers as markers on the earth wire, which will increase the visibility of the power line. Markers should be placed with sufficient regularity (at least every 5-10m). Eagle eye devices may be used, if feasible to deter birds from the CSP plant area/ solar field.				
Residual impacts:				
Death or injury of avifauna species.				

11.2.3 Electrocution of birds on associated power line tower structures

Nature: The design has allowed for an overhead power line, feeding into the Eskom network at the Paulputs Substation (a distance of approximately 2.5km). Power lines have a range of bird related impacts, one of which is electrocution events, which occur when a bird perches on an electrical structure and causes an electrical short circuit by bridging the gap between live components and/or live and earthed components. The larger transmission lines (220kV to 765kV) are not a threat to large raptors and other birds which are vulnerable to electrocutions – often proving to be beneficial by providing roosting and nesting sites. The smaller distribution lines, such as the 132kV proposed for the development, can however be dangerous to birds. Birds that are typically at risk are those with large wingspans which can bridge the gaps between lines, such as raptors, bustards and storks. Threatened species that have the potential to occur in the study area and that may be involved in electrocution events include:

- Secretarybird *Sagittarius serpentarius* – Near Threatened
- Kori Bustard *Ardeotis kori* – Vulnerable
- Ludwig's Bustard *Neotis ludwigii* – Vulnerable
- Martial Eagle *Polemaetus bellicosus* - Vulnerable
- Maccoa Duck *Oxyura maccoa* Near Threatened

In flat landscapes, typical of the study area, large raptors will instinctively look for the highest vantage point on which to perch. Given that the power line towers will be the highest structures in the area, there is a high probability that raptors will be landing on the structures and using them to survey the surrounding habitat or to nest on.

Electrocution is possible on lines such as those proposed, depending on the exact pole structure used. Since the developer have not yet committed to a tower structure, this impact cannot be fully assessed. The minimum phase – phase and phase – earth clearance of 2000mm should be adhered to for whichever structure is used, in order to mitigate for electrocution.

Extent: The impact will be confined to the length of the power line. It will however, potentially, have a regional impact on bird populations.

Duration: The impact will cover the lifespan of the facility and will be long term.

Magnitude: The magnitude of this impact will be moderate to high due to the conservation status of the species which may be involved in electrocution events.

Probability: There is a distinct possibility of electrocution events and subsequent impacts on local bird communities, including endangered species. The probability of such events can be minimised through mitigation measures.

Mitigation: It has been indicated that mono pole bird friendly tower structures will be utilised in the development. This will significantly minimise the number of electrocutions.

Table 8: Summary of the electrocution impacts associated with the development

3. Activity: Impact on local bird communities due to the power lines due to electrocution				
Avifaunal Aspect: Power lines have a range of bird related impacts, one of which is electrocution events, which occur when a bird perches on an electrical structure and causes an electrical short circuit by bridging the gap between live components and/or live and earthed components.				
	Overall impact of the proposed project considered in isolation		**With Mitigation**	
Extent (E)	1	Site Only	1	Site Only
Duration (D)	4	>15 years	4	>15 years

Magnitude (M)	6	Moderate	2	Minor
Probability (P)	4	Highly Probable	2	Improbable
Significance (S = [E+D+M]xP)	44	Moderate	14	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Low		Moderate	
Irreplaceable loss of resources	Yes		Yes	
Mitigability	Yes		Yes	
Mitigation measures:				
Mono pole bird friendly tower structures will be utilised in the development. This will significantly minimise the number of electrocutions				
Residual impacts:				
Death or injury of avifauna species.				

11.3 Cumulative impacts

Due to the fact that there are already three existing solar facilities in the area, as well as the fact there are more planned, the cumulative impacts are likely to be of a higher order of magnitude than the significance ratings given in the impact assessment section. It must however be noted that none of the other solar facilities are tower facilities and therefore impacts unique to tower facilities are unlikely to have a higher cumulative impact. We cannot comment on the impacts, mitigation plans and their effectiveness, of other projects, therefore we cannot determine what the mitigated impacts would be and thus the cumulative impacts given here are based on all other projects' unmitigated impacts cumulated with this project's mitigated impacts.

Cumulative impacts are given in the impact assessment tables below:

11.3.1 Construction Phase

1. Activity: Vegetation clearing for the CSP facility, access roads and powerlines				
Avifaunal Aspect: Impact on local bird community due to habitat loss from the construction of the CSP plant and associated infrastructure including power lines. There are a number of solar projects proposed in the region. All of these are likely to involve clearing of vegetation therefore the cumulative impact of this impact will be significant.				
	Overall impact of the proposed project considered in isolation		**Cumulative Impact of the project and other projects in the area**	
Extent (E)	1	Site Only	3	Regional
Duration (D)	4	>15 years	3	5 - 15 years
Magnitude (M)	2	Minor	2	Minor
Probability (P)	4	Highly Probable	4	Highly Probable
Significance (S = [E+D+M]xP)	28	Low	32	Moderate
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Moderate		Low	
Irreplaceable loss of resources	Yes		Yes	

Mitigability	Yes		Yes	
Confidence in findings: High				
Mitigation: Provided that all similar projects are held to the same standards of mitigation this impact can be further mitigated in its entirety across all projects. This could reduce the overall probability and magnitude of this impact in the region				

2. Activity: Disturbance				
Avifaunal Aspect: Nature: Impact on local bird community due to disturbance on site and in surrounding area. Sensitive and threatened species are of most concern and particularly while breeding				
	Overall impact of the proposed project considered in isolation		**Cumulative Impact of the project and other projects in the area**	
Extent (E)	1	Site Only	3	Regional
Duration (D)	2	2 - 5 years	2	2 - 5 years
Magnitude (M)	2	Minor	2	Minor
Probability (P)	3	Probable	3	Probable
Significance (S = [E+D+M]xP)	15	Low	21	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Moderate		Low	
Irreplaceable loss of resources	Yes		Yes	
Mitigability	Yes		Yes	
Confidence in findings: High				
Mitigation: Provided that all similar projects are held to the same standards of mitigation this impact can be further mitigated in its entirety across all projects. This could reduce the overall probability and magnitude of this impact in the region				

11.4 Operation Phase

Avifaunal Aspect: Operation of the tower CSP facility				
Avifaunal Aspect: Due to the fact that this facility will be the only tower facility in the area, cumulative impacts will be no higher than the impacts of the proposed project.				
	Overall impact of the proposed project considered in isolation		**Cumulative Impact of the project and other projects in the area**	
Extent (E)	1	Site Only	1	Site Only

Duration (D)	5	Permanent	5	Permanent
Magnitude (M)	2	Minor	2	Minor
Probability (P)	2	Improbable	2	Improbable
Significance (S = [E+D+M]xP)	16	Low	16	Low
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Moderate		Low	
Irreplaceable loss of resources	Yes		Yes	
Mitigability	Yes		Yes	
Confidence in findings: High				

Mitigation: Openings at either end of the horizontal rotating cylinder – The simplest way to mitigate this impact would be to seal the openings at each end of the cylinder. This can be done by tack-welding appropriately sized discs onto either end.
Heliostats in the vertical position – the heliostats should be limited to being in the vertical position for as short a time as possible. The trucks which clean the heliostats should follow each other as close as possible and the heliostats returned to a static (horizontal) or focussed position as soon as possible after cleaning.
Flat surfaces at the base of the tower – all ledges should be built or panelled so that they slope at an angle downwards to the outside to prevent nesting on these ledges.
Colour of the tower– a neutral brown, concrete colour or grey would prevent the reflection of UV light and thus mitigate the possible impact of the white tower.
Focusing the heliostats above the tower during maintenance – ideally the heliostats should be in one of three positions vertical (washing position – for as short a time as possible), static position or focussed in order to prevent the undetectable "hotspot" above the tower.

Activity : Impact on local bird communities due to the power line due to collision by the overhead power lines

Avifaunal Aspect: Collisions of birds with overhead powerlines. There are a number of power lines in the vicinity as well as throughout the Northern Cape. Power lines that cross remote areas should be fitted with bird diverters (diurnal and nocturnal) to reduce the high incidence of collisions. As the number of power lines increase so the number of deaths of bustards and other birds will increase. With mitigation, it is considered unlikely that the addition of the proposed length of power line will significantly add to the cumulative impact of collision events in the region.

	Overall impact of the proposed project considered in isolation		**Cumulative Impact of the project and other projects in the area**	
Extent (E)	1	Site Only	3	Regional
Duration (D)	5	Permanent	5	Permanent
Magnitude (M)	2	Minor	6	Moderate
Probability (P)	2	Improbable	3	Probable
Significance (S = [E+D+M]xP)	16	Low	42	Moderate
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Moderate		Low	
Irreplaceable loss of resources	Yes		Yes	
Mitigability	Yes		Yes	
Confidence in findings: High				

Mitigation: All projects in the area should adhere to the following mitigation measures: The line should be kept as low as possible taking into account engineering and legal requirements.
The span lengths should be kept as short as is reasonable.
Placement of bird flappers as markers on the earth wire, which will increase the visibility of the power line.

Markers should be placed with sufficient regularity (at least every 5-10m). Eagle eye devices may be used, if feasible to deter birds from the CSP plant area/ solar field.

Impact: Impact on local bird communities due to the power lines due to electrocution				
Avifaunal Aspect: Power lines have a range of bird related impacts, one of which is electrocution events, which occur when a bird perches on an electrical structure and causes an electrical short circuit by bridging the gap between live components and/or live and earthed components. There are a number of power lines in the vicinity as well as throughout the Northern Cape. Power lines that cross remote areas should be fitted with bird guards to reduce the incidence of perching on towers. With mitigation, it is considered unlikely that the addition of the proposed length of power line will significantly add to the cumulative impact of electrocution events in the region.				
	Overall impact of the proposed project considered in isolation		**Cumulative Impact of the project and other projects in the area**	
Extent (E)	1	Site Only	3	Regional
Duration (D)	4	>15 years	4	>15 years
Magnitude (M)	2	Minor	6	Moderate
Probability (P)	2	Improbable	3	Probable
Significance (S = [E+D+M]xP)	14	Low	39	Moderate
Status (Positive, negative or neutral)	Negative		Negative	
Reversibility	Moderate		Low	
Irreplaceable loss of resources	Yes		Yes	
Mitigability	Yes		Yes	
Confidence in findings: High				
Mitigation: All projects in the area should adhere to the following mitigation measures: Mono pole bird friendly tower structures will be utilised in the development. This will significantly minimise the number of electrocutions				

12 DISCUSSION

12.1 Study confidence

In order to investigate possible impacts of the Paulputs CSP facility on avifauna, vantage point surveys were conducted in order to cover the entire study area. Initially six vantage point surveys were envisaged for the project. Due to the field conditions (e.g. homogeneity of the vegetation, topography and visibility), the number of vantage point surveys was reduced to four. The approximate visibility radius of each of the vantage point surveys was approximately 800m, although this varied according to topography. The central point of each vantage point was clearly visible from each of the adjacent vantage points. The use of high quality optics and sound recording equipment made it possible to identify bird species from one vantage point to quite close to the adjacent vantage points. The number of species and individuals recorded during the surveys gives a high degree of confidence in the vantage point surveys conducted. Furthermore, transect surveys were conducted in the drainage lines or washes in order to determine the use of these areas as corridors by avifauna species. These surveys yielded results particularly pertinent to the project and there is high confidence in the understanding of the avifauna in the study area, the project and possible impacts upon each other gained during the study.

12.2 Main pertinent observations

The main pertinent observations made during the vantage point surveys can be summarised as follows:

Avifauna diversity - During the study a total of 29 species were recorded and a total of 1341 individual birds were recorded. Only one species of conservation importance was recorded during the study namely, the Maccoa Duck This species was recorded to the south of the study flying towards the Kaxu evaporation ponds.

Avifauna behaviour – One of the main aspects of avifauna behaviour noted was that 78% of bird species, and 98% of individual birds, recorded during the study flew at an average height of 6m (rounded off to the closest meter) and were observed at an average minimum height of 0.5m and an average maximum height of 12m. When applied, to what was learned about the CSP facility, this means that most resident bird species usually fly below the height of the heliostats, this was confirmed during the vantage point surveys at another CSP facility, where most species were found to be active below the heliostats and very few species flew over them. Another noteworthy observation was the lack of activity in the open field areas between 11:00 and 16:00 every day, during this time most species were found to be active in the riparian or wash areas traversing the study area. As was expected, at this time of the year, species activities were restricted to foraging and feeding or searching for food. No nesting or mating behaviour was observed.

During the study Secretarybird (*Sagittarius serpentarius*), Sclater's Lark, (*Spizocorys sclateri*), Kori Bustard (*Ardeotis kori*) and Ludwig's Bustard (*Neotis ludwigii*) appeared absent from the study area, all these species are likely to be resident species and the fact that they were not recorded does strongly suggest that they are in fact not present within the study area.

In order to deter avian species from the proposed CSP facility the CSP facility needs to be as unsuitable for avian biological requirements as possible, as avifauna tend to avoid areas that are not suitable for their requirements (Hudson & Bouwman, 2008). Biological requirements of avian species can be summarised as follows:

- Food sources;
- Water sources;
- Nesting sites;
- Perching sites; and
- Reduced competition.

During the study the following factors could provide these requirements for local avifauna and it is needed that these potential factors be mitigated in order to reduce the number of birds likely to occupy the CSP facility (i.e. deter birds from using the area by making it as unsuitable for meeting avian biological requirements as possible, and therefore less attractive to birds):

- Openings at either end of the proposed horizontal rotating cylinder – may potentially provide nesting sites;
- Flat surfaces at the base of the proposed tower – may provide possible nesting and perching sites for a large number of species; and
- Colour of the proposed tower– may attract insects, which are a food source for insectivorous avifauna

Further potential issues at the proposed CSP facility identified for mitigation are:

- Proposed mirrors in cleaning position – very high risk for avian collisions; and
- Focusing the proposed heliostats above the tower during maintenance – may increase the possibility of incineration of birds as opposed to being defocussed or focussed on the central receiver.

13 CONCLUSIONS AND RECOMMENDATIONS

One of the factors most likely to reduce the risk of mortality in avifauna species is the low average flight height of birds in the area, as most bird species will fly under the proposed heliostats. The fact that many of the species of concern appear to be absent from the study area further reduces the likely impacts of the facility.

In order to mitigate any possible impacts we suggest that the following measures are implemented:

- Openings at either end of the proposed horizontal rotating cylinder – The simplest way to mitigate this impact would be to seal the openings at each end of the proposed cylinder. This can be done by tack-welding appropriately sized discs onto either end;
- Proposed heliostats in the vertical position – the proposed heliostats should be limited to being in the vertical position for as short a time as possible. The trucks which clean the proposed heliostats should follow each other as close as possible and the proposed heliostats returned to a static (horizontal) or focussed position as soon as possible after cleaning;
- Flat surfaces at the base of the proposed tower – all ledges should be built or panelled so that they slope at an angle downwards to the outside to prevent nesting on these ledges;
- Colour of the proposed tower– a neutral brown, concrete colour or grey would prevent the reflection of UV light and thus mitigate the possible impact of the white tower; and
- Focusing the proposed heliostats above the tower during maintenance – ideally the heliostats should be in one of three positions: vertical (washing position – for as short a time as possible), static position; or focussed in order to prevent the undetectable "hotspot" above the tower.

Further recommendations for consideration prior to operation are:

- A detailed avifauna monitoring plan should be compiled prior to operation and implemented in order to constantly monitor the CSP facility and all associated infrastructure, including the power lines. Any and all avifauna mortalities should be investigated. This should be undertaken for a 1-year period after which the results should be reviewed in order to inform the requirement for further monitoring and/or mitigation.
- The results of these investigations should then inform the management of the CSP facility and associated infrastructure, regarding the implementation, update and/or upgrade to any mitigation measures at the facility as necessary.

In conclusion, with implementable mitigation measures and a functional monitoring – management – implementation – monitoring feedback loop in order to monitor and mitigate impacts, all probable avifauna impacts can be managed to a low impact rating. Based on this and the fact that South Africa is experiencing a significant energy crisis, the risks and losses associated with this development can be seen as acceptable and defendable. Based on all these factors, and with the proviso that we assume that all information available is correct and up to date, no changes will be made to the proposed project, no unforeseeable impact synergies arise and all mitigations proposed will be implemented and adhered to, we are of the opinion that this project could be implemented without causing significant unsustainable damage to the natural environment of the region.

14 INPUTS FOR THE ENVIRONMENTAL MANAGEMENT PLAN

OBJECTIVE 1: Reduce the impact of avifauna by vegetation clearing

Project component/s	Ground clearing for tower, power block, heliostat field, evaporation ponds, road realignment, critical staff quarters, heliostat area and laydown area.

Potential Impact	Loss of avifauna species within the cleared area, destruction of nests and killing of nestlings and/or destruction of eggs. Permanent exclusion of avifauna species from the cleared area.
Activity/risk source	Ground clearing beginning before the objective is complete. Unqualified personnel utilised for the activity
Mitigation: Target/Objective	No destruction of eggs or killing of nestlings during the ground clearing process. Revegetation of the area to allow for recolonization by avifauna

Mitigation: Action/control	**Responsibility**	**Timeframe**
• Investigation of nests before ground clearing to determine whether avifauna are still nesting. • Conduct ground clearing during the winter to prevent impacts on nesting species • Monitoring during ground clearing to assess conservation of species and relocation of any individuals that may have been overlooked • Ground clearing should be kept to a minimum • Topsoil should be collected during ground clearing and kept for revegetation purposes.	Abengoa Environmental Manager Ornithology Consultants	Investigation to be completed before ground clearing starts. Monitoring to occur continuously until ground clearing is completed.

Performance Indicator	Number of species collected during ground clearing minimal. No avifauna killed or eggs destroyed during ground clearing. 75% of existing species recolonise the rehabilitated area within five years of ground clearing
Monitoring	Report including the locations of all nesting bird species to be completed before ground clearing starts Number of species relocated, killed or destroyed to be recorded on a daily basis and cross checked with initial report Final clearing avifauna report to be compiled and submitted to the relevant authorities

OBJECTIVE 1: Reduce impacts on avifauna species due to disturbance

Project component/s	Disturbance from human activity, during the construction and operational phase, has the potential to modify bird behaviour on site. For shy and sensitive species, this may result in displacement or exclusion.
Potential Impact	For shy and sensitive species, this may result in displacement or exclusion. Construction and maintenance activities associated with the power facility as well as the power line impact on birds through disturbance, particularly during the breeding season. Vibration and noise will have a significant

	effect mainly on fauna species in the immediate vicinity of the development, due to the heavy machinery utilised. Vibration can affect a number of subterranean fauna taxa, such as burrowing mammals, reptiles and arthropods. Vibration affects these animals by causing the collapsing of burrows, and causing these animals to leave the area due to the vibration. Noise will also affect a wide range of taxa including avifauna, mammals, reptiles, amphibians and arthropods. Avifauna, especially songbirds, and amphibians may find it difficult to find mates in areas of increased noise, mammals, reptiles and arthropods may find increased noise disturbing and therefore move away from the area
Activity/risk source	Excessive disturbance during the construction phase will exclude avifauna species from the area.
Mitigation: Target/Objective	Unnecessary disturbance should be kept to a minimum. Vibration and noise from heavy machinery can be kept to a minimum, especially during periods when indigenous species are active.

Mitigation: Action/control	Responsibility	Timeframe
• Contractors need to minimise the amount of disturbance during the construction phase of the facility, by staying within the demarcated ±900ha construction area • If the nest of a large species is detected within the vicinity of the area to be disturbed, then the Northern Cape Department needs to be notified and all attempts made to minimise the amount of disturbance near it. • Monitoring during ground clearing to assess whether species are being disturbed and or excluded from the area • Vibration and noise from heavy machinery can be kept to a minimum by reducing the movement of heavy vehicles to a minimum necessary for operations. • Placing the vehicle yard as close to the construction area as possible will also reduce the spatial scale of impact of vibration. • Changing the rerouting of the M73 to the east of the infrastructure instead of through areas of greater biodiversity importance to the west of the infrastructure will reduce this impact. • Unnecessary disturbance should be kept to a minimum	Abengoa Environmental Manager Ecological Consultant	The vibration and noise reduction measures should be in place before any construction begins and the management plan should be continuous throughout the life of the project

Performance Indicator	No avifauna will be excluded or disturbed outside of the area of ground clearing. Vibration and noise should be kept to a minimum and limited to diurnal periods and also minimised in higher biodiversity areas outside of the construction area.
Monitoring	Measures and success of measures implemented in order to reduce vibrations and noise need to be reported on monthly. Any incidents of contravention of the measures resulting in excessive noise, noise during the wrong time of the day or noise in the wrong areas need to be recorded and reported on monthly.

14.1 Operation phase

OBJECTIVE 1: Reduce impacts on avifauna species due to the operation of the tower CSP facility

Project component/s	Tower, heliostat field, power block and power lines
Potential Impact	Openings at either end of the horizontal rotating cylinder - would be ideal nesting sites, but may lead to a local reduction of fecundity of species due to the rotation of the cylinder causing eggs or chick to fall out of the nests. Heliostats in the vertical position - very likely to cause collisions due to the fact that, in this position, the mirrors give an illusion of an extension of the heliostat field behind the observer. Flat surfaces at the base of the tower - Any elevated flat surfaces are seen by many avian species as potential nesting sites. Colour of the tower - white light reflects ultraviolet light it is likely that the white areas will attract insects and consequently aerial insectivores. Focusing the heliostats above the tower during maintenance –may increase the likelihood of singeing or death of birds. When focussed on the central receiver there will be a “heat bubble caused by radiation of heat from the receiver. The radiation from the central receiver will cause a gradually increasing “heat bubble” around the receiver which will be sensed by most birds before it is potentially fatal allowing birds to take evasive action. This radiating heat bubble will be a lot less distinct when the focal point is above the tower and this focal point may be perceived as a more sudden, potentially fatal, hotspot, thus not allowing birds to take evasive action in time.
Activity/risk source	Operation of the facility may cause the injury or death of birds due to collisions, solar flux or nesting disturbances.
Mitigation: Target/Objective	Prevent injury or death of bird species due to the operation of the tower CSP facility.

Mitigation: Action/control	Responsibility	Timeframe
• An avifauna monitoring plan needs to be put in place before operation begins in order to	Abengoa Environmental Manager	The monitoring and mitigation measures should be

monitor, investigate and mitigate any avifauna deaths the details of the monitoring plan should be incorporated in the monitoring plan before the advent of the project. • Openings at either end of the horizontal rotating cylinder – The simplest way to mitigate this impact would be to seal the openings at each end of the cylinder. This can be done by tack-welding appropriately sized discs onto either end. • Heliostats in the vertical position – the heliostats should be limited to being in the vertical position for as short a time as possible. The trucks which clean the heliostats should follow each other as close as possible and the heliostats returned to a static (horizontal) or focussed position as soon as possible after cleaning. • Flat surfaces at the base of the tower – all ledges should be built or panelled so that they slope at an angle downwards to the outside to prevent nesting on these ledges. • Colour of the tower– a neutral brown, concrete colour or grey would prevent the reflection of UV light and thus mitigate the possible impact of the white tower. • Focusing the heliostats above the tower during maintenance – ideally the heliostats should be in one of three positions vertical (washing position – for as short a time as possible), static position or focussed in order to prevent the undetectable “hotspot” above the tower.	Ornithology Consultant	in place before operation begins and the management plan should be continuous throughout the life of the project

Performance Indicator	No avifauna will be killed or injured due to the operation of the CSP facility.
Monitoring	An intensive avifauna monitoring programme will need to be in place before operation commences.

OBJECTIVE 2: Reduce impacts on avifauna species due to collision by the overhead power lines

Project component/s	Power lines

Potential Impact	The collision of large terrestrial birds with power lines is one of the highest mortality factors for these particular birds in South Africa. For larger ground dwelling avifauna species collision mortalities would probably not have a hugely significant impact on their regional populations. Ongoing mortalities on a large-scale may however result in long term effects on these species and as such, an effort should be made to minimise the impacts upon these populations.
Activity/risk source	Collisions with power lines may cause death of avifauna species.
Mitigation: Target/Objective	Prevent all injury or death of bird species due to the collisions with overhead power lines.

Mitigation: Action/control	**Responsibility**	**Timeframe**
• The line should be kept as low as possible taking into account engineering and legal requirements. • The span lengths should be kept as short as is reasonable. • Placement of bird flappers as markers on the earth wire, which will increase the visibility of the power line. • Markers should be placed with sufficient regularity (at least every 5-10m). • Eagle eye devices may be used, if feasible to deter birds from the CSP plant area/ solar field. • An avifauna monitoring plan needs to be put in place before operation begins in order to monitor, investigate and mitigate any avifauna deaths.	Abengoa Environmental Manager Ornithology Consultant	The monitoring and mitigation measures should be in place before operation begins and the management plan should be continuous throughout the life of the project

Performance Indicator	No avifauna will be killed or injured due collisions with power lines.
Monitoring	An intensive avifauna monitoring programme will need to be in place before operation commences.

OBJECTIVE 3: Reduce impacts on avifauna species due to electrocution by the overhead power lines

Project component/s	Power lines
Potential Impact	The design has allowed for an overhead power line, feeding into the Eskom network at the Paulputs Substation (a distance of approximately 4km).

	Power lines have a range of bird related impacts, one of which is electrocution events, which occur when a bird perches on an electrical structure and causes an electrical short circuit by bridging the gap between live components and/or live and earthed components. The larger transmission lines (220kV to 765kV) are not a threat to large raptors and other birds which are vulnerable to electrocutions – often proving to be beneficial by providing roosting and nesting sites. The smaller distribution lines, such as the 132kV proposed for the development, can however be dangerous to birds. Birds that are typically at risk are those with large wingspans which can bridge the gaps between lines, such as raptors, bustards and storks. In flat landscapes, typical of the study area, large raptors will instinctively look for the highest vantage point on which to perch. Given that the towers will be the highest structures in the area, there is a high probability that raptors will be landing on the structures and using them to survey the surrounding habitat or to nest on. Electrocution is possible on lines such as those proposed, depending on the exact pole structure used. Since the developer have not yet committed to a tower structure, this impact cannot be fully assessed. The minimum phase – phase and phase – earth clearance of 2000mm should be adhered to for whichever structure is used, in order to mitigate for electrocution.
Activity/risk source	Electrocution by power lines may cause death of avifauna species.
Mitigation: Target/Objective	Prevent all injury or death of bird species due to electrocution by overhead power lines.

Mitigation: Action/control	**Responsibility**	**Timeframe**
• It has been indicated that mono pole bird friendly tower structures will be utilised in the development. This will significantly minimise the number of electrocutions. • The span lengths should be kept as short as is reasonable. • Placement of bird flappers as markers on the earth wire, which will increase the visibility of the power line. • Markers should be placed with sufficient regularity (at least every 5-10m). • Eagle eye devices may be used, if feasible to deter birds from the CSP plant area/ solar field. • An avifauna monitoring plan needs to be put in place before operation begins in order to monitor, investigate and mitigate any avifauna deaths.	Abengoa Environmental Manager Ornithology Consultant	The monitoring and mitigation measures should be in place before operation begins and the management plan should be continuous throughout the life of the project

Performance Indicator	No avifauna will be killed or injured due electrocution by power lines.
Monitoring	An intensive avifauna monitoring programme will need to be in place before operation commences.

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Adrian Hudson (Senior Ecologist)

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APPENDIX A

Avifauna species occurring in the region of the study area

Full Name	*Scientific Name*	RD (Regional, Global)	S	E
Little Grebe	*Tachybaptus ruficollis*			
Black-headed Heron	*Ardea melanocephala*			
Goliath Heron	*Ardea goliath*			
Grey Heron	*Ardea cinerea*			
Little Egret	*Egretta garzetta*			
Black Stork	*Ciconia nigra*	VU, LC		
White Stork	*Ciconia ciconia*			
Hamerkop	*Scopus umbretta*			
Egyptian Goose	*Alopochen aegyptiaca*			
Spur-winged Goose	*Plectropterus gambensis*			
South African Shelduck	*Tadorna cana*			
Maccoa Duck	*Oxyura maccoa*	NT, NT		
White-backed Duck	*Thalassornis leuconotus*			
Southern Pochard	*Netta erythrophthalma*			
African Black Duck	*Anas sparsa*			
Yellow-billed Duck	*Anas undulata*			
Cape Shoveler	*Anas smithii*			
Cape Teal	*Anas capensis*			
Red-billed Teal	*Anas erythrorhyncha*			
Black-chested Snake Eagle	*Circaetus pectoralis*			
Martial Eagle	*Polemaetus bellicosus*	EN, VU		
Verreauxs' Eagle	*Aquila verreauxii*	VU, LC		

Full Name	*Scientific Name*	RD (Regional, Global)	S	E
Booted Eagle	*Hieraaetus pennatus*			
European Honey Buzzard	*Pernis apivorus*			
Jackal Buzzard	*Buteo rufofuscus*			(*)
Common (Steppe) Buzzard	*Buteo buteo*			
Pale Chanting Goshawk	*Melierax canorus*			
Black-shouldered Kite	*Elanus caeruleus*			
Yellow-billed Kite	*Milvus aegyptius*			
Gabar Goshawk	*Melierax gabar*			
Lanner Falcon	*Falco biarmicus*	VU, LC		
Peregrine Falcon	*Falco peregrinus*			
Red-necked Falcon	*Falco chicquera*			
Greater Kestrel	*Falco rupicoloides*			
Rock Kestrel	*Falco rupicolus*			
Helmeted Guineafowl	*Numida meleagris*			
Common Ostrich	*Struthio camelus*			
Common Quail	*Coturnix coturnix*			
Red-knobbed coot	*Fulica cristata*			
Secretarybird	*Sagittarius serpentarius*	VU, VU		
Kori Bustard	*Ardeotis kori*	NT, NT		
Ludwig's Bustard	*Neotis ludwigii*	EN, EN		
Karoo Korhaan	*Eupodotis vigorsii*	NT, LC		
Northern Black Korhaan	*Afrotis afraoides*			

Full Name	*Scientific Name*	RD (Regional, Global)	S	E
Red-crested Korhaan	*Lophotis ruficrista*			
Southern Black Korhaan	*Afrotis afra*	VU, VU		*
Pied Avocet	*Recurvirostra avosetta*			
Black-winged Stilt	*Himantopus himantopus*			
Common Ringed Plover	*Charadrius hiaticula*			
Kittlitz’s Plover	*Charadrius pecuarius*			
Three-banded Plover	*Charadrius tricollaris*			
Crowned Lapwing	*Vanellus coronatus*			
Blacksmith Lapwing	*Vanellus armatus*			
Ruff	*Philomachus pugnax*			
Curlew Sandpiper	*Calidris ferruginea*			
Little Stint	*Calidris minuta*			
Common Sandpiper	*Actitis hypoleucos*			
Wood Sandpiper	*Tringa glareola*			
Common Greenshank	*Tringa nebularia*			
Marsh Sandpiper	*Tringa stagnatilis*			
Burchell's Courser	*Cursorius rufus*	VU, LC		
Double-banded Courser	*Rhinoptilus africanus*			
Spotted Thick-knee	*Burhinus capensis*			
White-winged Tern	*Chlidonias leucopterus*			
Double-banded Sandgrouse	*Pterocles bicinctus*			
Namaqua Sandgrouse	*Pterocles namaqua*			

Full Name	*Scientific Name*	RD (Regional, Global)	S	E
Rock Dove	*Columba livia*			
Speckled Pigeon	*Columba guinea*			
Cape Turtle Dove	*Streptopelia capicola*			
Laughing Dove	*Streptopelia senegalensis*			
Namaqua Dove	*Oena capensis*			
Rosy-faced Lovebird	*Agapornis roseicollis*			
Diederik Cuckoo	*Chrysococcyx caprius*			
Spotted Eagle-Owl	*Bubo africanus*			
Western Barn Owl	*Tyto alba*			
Rufous-cheeked Nightjar	*Caprimulgus rufigena*			
Alpine Swift	*Tachymarptis melba*			
Common Swift	*Apus apus*			
Böhm's Spinetail	*Neafrapus boehmi*			
African Palm Swift	*Cypsiurus parvus*			
Little Swift	*Apus affinis*			
Red-faced Mousebird	*Urocolius indicus*			
White-backed Mousebird	*Colius colius*			
European Bee-eater	*Merops apiaster*			
Swallow-tailed Bee-eater	*Merops hirundineus*			
African Hoopoe	*Upupa africana*			
Common Scimitarbill	*Rhinopomastus cyanomelas*			
Cardinal Woodpecker	*Dendropicos fuscescens*			

Full Name	*Scientific Name*	RD (Regional, Global)	S	E
Golden-tailed Woodpecker	*Campethera abingoni*			
Fawn-coloured Lark	*Calendulauda africanoides*			
Large-billed Lark	*Galerida magnirostris*			(*)
Red-capped Lark	*Calandrella cinerea*			
Sabota Lark	*Calendulauda sabota*			
Karoo Long-billed Lark	*Certhilauda subcoronata*			
Sclater's Lark	*Spizocorys sclateri*	NT, NT		(*)
Stark's Lark	*Spizocorys starki*			
Black-eared Sparrow-lark	*Eremopterix australis*			(*)
Chestnut-backed Sparrow-lark	*Eremopterix leucotis*			
Grey-backed Sparrow-lark	*Eremopterix verticalis*			
Spike-heeled Lark	*Chersomanes albofasciata*			
Barn Swallow	*Hirundo rustica*			
White-throated Swallow	*Hirundo albigularis*			
Brown-throated Martin	*Riparia paludicola*			
Rock Martin	*Hirundo fuligula*			
Fork-tailed Drongo	*Dicrurus adsimilis*			
Cape Crow	*Corvus capensis*			
Pied crow	*Corvus albus*			
Ashy Tit	*Parus cinerascens*			
African Red-eyed Bulbul	*Pycnonotus nigricans*			
Karoo Thrush	*Turdus smithi*			(*)

Full Name	*Scientific Name*	RD (Regional, Global)	S	E
Short-toed Rock Thrush	*Monticola brevipes*			
Familiar Chat	*Cercomela familiaris*			
Karoo Chat	*Cercomela schlegelii*			
Sickle-winged Chat	*Cercomela sinuata*			(*)
Tractrac Chat	*Cercomela tractrac*			
Mountain Wheatear	*Oenanthe monticola*			
Capped Wheatear	*Oenanthe pileata*			
Ant-eating Chat	*Myrmecocichla formicivora*			
Karoo Scrub Robin	*Erythropygia coryphoeus*			
Willow Warbler	*Phylloscopus trochilus*			
Burnt-necked Eremomela	*Eremomela usticollis*			
Green-capped Eremomela	*Eremomela scotops*			
Karoo Eremomela	*Eremomela gregalis*			(*)
Yellow-bellied Eremomela	*Eremomela icteropygialis*			
Cape Penduline-Tit	*Anthoscopus minutus*			
Long-billed crombec	*Sylvietta rufescens*			
Fairy Flycatcher	*Stenostira scita*			(*)
Chestnut-vented Tit-Babbler	*Sylvia subcaerulea*			
Layard’s Tit-Babbler	*Sylvia layardi*			(*)
Zitting Cisticola	*Cisticola juncidis*			
Grey-backed Cisticola	*Cisticola subruficapilla*			
Black-chested Prinia	*Prinia flavicans*			

Full Name	*Scientific Name*	RD (Regional, Global)	S	E
Namaqua Warbler	*Phragmacia substriata*			(*)
Rufous-eared Warbler	*Malcorus pectoralis*			
Spotted flycatcher	*Muscicapa striata*			
Chat Flycatcher	*Bradornis infuscatus*			
Cape White-eye	*Zosterops virens*			(*)
Orange River White-eye	*Zosterops pallidus*			
Pririt Batis	*Batis pririt*			
African Pied Wagtail	*Motacilla aguimp*			
Cape Wagtail	*Motacilla capensis*			
Long-billed Pipit	*Anthus similis*			
African Pipit	*Anthus cinnamomeus*			
Southern (Common) Fiscal	*Lanius collaris*			
Lesser Grey Shrike	*Lanius minor*			
Red-backed Shrike	*Lanius collurio*			
Bokmakierie	*Telophorus zeylonus*			
Brubru	*Nilaus afer*			
Pale-winged Starling	*Onychognathus nabouroup*			
Wattled Starling	*Creatophora cinerea*			
Dusky Sunbird	*Cinnyris fuscus*			
Southern Double-collared Sunbird	*Cinnyris chalybeus*			(*)
Cape Sparrow	*Passer melanurus*			
House Sparrow	*Passer domesticus*		I	

Full Name	*Scientific Name*	RD (Regional, Global)	S	E
Southern Grey-headed Sparrow	*Passer diffusus*			
White-browed Sparrow-Weaver	*Plocepasser mahali*			
Sociable Weaver	*Philetairus socius*			
Southern Masked Weaver	*Ploceus velatus*			
Southern Red Bishop	*Euplectes orix*			
Red-billed Quelea	*Quelea quelea*			
Pin-tailed Whydah	*Vidua macroura*			
Red-billed Firefinch	*Lagonosticta senegala*			
Grey Waxbill	*Estrilda perreini*			
Red-headed Finch	*Amadina erythrocephala*			
Scaly-feathered Finch	*Sporopipes squamifrons*			
Black-throated Canary	*Crithagra atrogularis*			
Yellow Canary	*Crithagra flaviventris*			
Black-headed Canary	*Serinus alario*			(*)
Cape Bunting	*Emberiza capensis*			
Lark-like Bunting	*Emberiza impetuani*			
White-throated Canary	*Crithagra albogularis*			

Red Data (RD); Regional*, Global

CR = Critically Endangered

EN = Endangered

VU = Vulnerable

NT = Near Threatened

LC = Least Concern

Status in South Africa (S)

V = vagrant

I = introduced

Endemism in south Africa (E)

Endemism in South Africa (E) (not southern Africa as in field guides)

* = endemic

SLS = endemic to South Africa, Lesotho and Swaziland

Full Name	*Scientific Name*	RD (Regional, Global)	S	E

EX = Extinct (regionally)

(*) = near endemic (i.e. ~70% or more of population in RSA)

DD= Data Deficient

B* = breeding endemic

NR= Not Recognised by BirdLife International

BSLS = breeding South Africa, Lesotho and Swaziland endemic

NA = Not Assessed

§ = Refer to footnote

W* = winter endemic

APPENDIX B

Details of Specialist

Appointment of specialist

Hudson Ecology Pty Ltd was commissioned by Savannah Environmental (Pty) Ltd to provide specialist consulting services for the Environmental Impact Assessment for the proposed Solar Thermal Plant near Pofadder in the Northern Cape. The consulting services comprise an assessment of potential impacts on the flora, fauna, vegetation and ecology in the study area by the proposed project.

Details of specialist

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Summary of expertise

Adrian Hudson is the owner, director and senior ecologist Hudson Ecology Pty Ltd. In this role, he provides assessments which encompass all aspects of terrestrial and wetland ecological studies including (but not limited to) baseline ecological assessments, ecological impact assessments and biodiversity management plans. He also has considerable experience in conservation, and conducted studies in veld management, stocking rates (wildlife and domestic) for a number of companies and organisations. Projects, unless otherwise requested by the client, are conducted according to the IFC Performance standard 6 criteria and Adrian Hudson is, therefore, au fait with the requirements and criteria of the Standard. Adrian has reviewed a number of projects throughout Africa for IFC Performance Standard 6 compliance, including Hassai Gold Mine in Sudan and Konkola North Copper mine in Zambia.

Adrian Hudson is a qualified ecologist and ornithologist who holds a Master's of Science degree in Ecology from the North West University and is currently completing his PhD in Ecology at the same institution. Adrian is currently still closely associated with the university as a supervisor for Honours and Master's degree students, lecturing of short courses at the university and co-authoring of scientific articles with faculty members of the university. Adrian is a member of the Zoological Society of Southern Africa and the International Society of Conservation Biology. Adrian is also a member of the Department of Environmental Affairs and Tourism (South African Government Department) roster of experts on ecology and desertification and a reviewer for a number of internationally accredited scientific journals. He is also accredited with authorship of a number of articles published in scientific journals.

Before founding Hudson Ecology Pty Ltd. in September 2014, Adrian worked for 18 years for a diverse range of organizations, including Natal Parks Board, North West University, United Nations Environmental Program /Global Environment Facility, ECOSUN cc and Golder Associates Africa Pty Ltd. In these roles, Adrian was responsible for anti- poaching, lecturing, research and consulting respectively. Thus far Adrian has worked as a consulting ecologist on more than 90 projects in 20 countries, including projects in Angola, South Africa, Lesotho, Swaziland, Namibia, Botswana, Mozambique, Zambia, Tanzania, Central African Republic, Democratic Republic of Congo, Sudan, Guinea, Guinea-Bissau, Uzbekistan and Liberia.

Independence

Hudson Ecology Pty Ltd and its Directors have no connection with Abengoa. Hudson Ecology Pty Ltd is not a subsidiary, legally or financially, of the proponent. Remuneration for services by the proponent in relation to this project is not linked to approval by decision-making authorities responsible for authorising this proposed project and the consultancy has no interest in secondary or downstream developments as a result of the authorisation of this project. Adrian Hudson is an independent consultant to Savannah Environmental (Pty) Ltd and has no business, financial, personal or other interest in the activity, application or appeal in respect of which he was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of this specialist performing such work. The percentage work received directly or indirectly from the proponent in the last twelve months is approximately 0% of turnover.

Scope and purpose of report

The scope and purpose of the report are reflected in the Terms of reference section of this report

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APPENDIX C

CONTROL SHEET FOR SPECIALIST REPORT

The table below lists the specific requirements for specialist studies, according to the 2014 EIA Regulations (South Africa, 2014)

Activity	Yes	No	Comment
Details of: i the person who prepared the report; and ii the expertise of that person to carry out the specialist study or specialised process	√		
	√		
	√		
ii. the expertise of that person to carry out the specialist study or specialised process	√		
A declaration that the person is independent in a form as may be specified by the competent authority	√		
An indication of the scope of, and the purpose for which, the report was prepared	√		
A description of the methodology adopted in preparing the report or carrying out the specialised process	√		
A description of any assumptions made and any uncertainties or gaps in knowledge	√		
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	√		
Recommendations in respect of any mitigation measures that should be considered by the applicant and the competent authority	√		
A description of any consultation process that was undertaken during the course of carrying out the study	√		
A summary and copies of any comments that were received during any consultation process	√		
Any other information requested by the competent authority	√		

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