SPECIALIST ECOLOGICAL SURVEY FOR PROPOSED 150MW CONCENTRATED SOLAR PARK (CSP); SAND DRAAI 391, NORTHERN CAPE PROVINCE

Compiled for: **Royal Haskoning*DHV***

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SUBMITTED: 20th NOVEMBER 2015

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ABBREVIATIONS

AOO	Area of Occupancy
CBA	Critical Biodiversity Area
DEAT	Department of Environmental Affairs and Tourism
Mamsl	Metres Above Mean Sea Level
NEMBA ToPS	National Environmental Management: Biodiversity Act Threatened or Protected Species (No. 10 of 2004)
NFA	National Forests Act (No. 30 of 1998)
PRECIS	National Herbarium Pretoria Computerised Information System
SANBI	South African National Biodiversity Institute

TERMINOLOGY

Biodiversity	The structural, functional and compositional attributes of an area, ranging from genes to landscapes.
Degraded	An ecosystem that is in a poor ecological state, usually through impacts such as invasion by alien plants, severe overgrazing, poor burning regimes, etc. These systems still contain a moderate proportion of indigenous flora.
Geophyte	Plants that produce their growth points from organs stored below the ground, an adaption to survive frost, drought and / or fire.
Rupicolous	Faunal species living on and amongst rocks (several lizard species).
Transformed	Transformed ecosystems are no longer natural and contain little or no indigenous flora. Examples include agricultural lands, plantations, urban areas, etc.

DETAILS OF SPECIALIST

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Appointment of specialist

Prof. L.R. Brown of Enviroguard Ecological Services cc. and Mr. C. L. Cook were appointed by Royal Haskoning*DHV* (RHDHV) to undertake a specialist ecological assessment for the proposed EIA for the 150 MW Concentrate Solar Plant (CSP) situated on the Farm Sand Draai 391 in the Northern Cape province of South Africa. Two alternative sites were proposed 150 MW CSP. Conclusions reached and recommendations made are based not only on occurrence of individual species, but more appropriately on habitats and ecosystem pattern and processes. Planning must therefore allow for the maintenance of species, habitats and ecosystem processes, even if Red Data or endemic plant species are absent.

Summary of expertise

Leslie Brown:

- Registered professional member of The South African Council for Natural Scientific Professions (Botanical and Ecological Science), registration number 4400075/98
- MGSSA (Professional member of the Grassland Society of Southern Africa).
- Specialist vegetation and Ecological consultant.
- Conducted over 400 specialist vegetation and ecological surveys.
- Conducts research on various vegetation ecological projects throughout SA, including Northern Cape.
- Author/co-author of more than 50 articles on vegetation descriptions and management in scientifically accredited and popular journals.
- Has presented more than 60 papers/posters at national and international conferences
- Project leader of more than 30 master's and doctorate projects on vegetation ecology.
- Research on the vegetation ecology of urban open spaces in Gauteng.
- The development of a tree appraisal model for the urban environment of South Africa
- Tested and developed techniques to rehabilitate of old crop lands at Suikerbosrand Nature Reserve
- The phytosociology of the Natural Vegetation occurring in the Cradle of Humankind, World Heritage Site; Gauteng, South Africa.
- Assessment of variable buffer zones for rocky ridge vegetation in Gauteng.
- Long-term research on vegetation in the Nama karoo at Mountain Zebra National Park
- Developed a new technique to assess tree volume

Clayton Cook:

- Registered professional member of The South African Council for Natural Scientific Professions (Zoological Science), registration number 400084/04.
- Faunal and Specialist Herpetological consultant since 1997.
- Conducted over 250 preliminary faunal surveys and 100 specialist faunal and herpetological surveys.
- Regional Organiser for Gauteng Province for the South African Frog Atlas Project 1999-2003.
- Published a scientific paper on *Pyxicephalus adspersus*, 8 scientific conference presentations, co-wrote the species accounts for the genus *Pyxicephalus* for the Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland South African Red as well as W.R.C Report No. 1258/1/06 on "A Biophysical framework for The Sustainable Management Of Wetlands In Limpopo Province With Nylsvley as a Reference Model".
- Attended 5 national and international herpetological congresses & 3 expert workshops, lectured zoology and botanical science at University of Limpopo (2001-2004).
- Lead researcher of a 3 year W.R.C. project on the status of frog species in the Kruger National Park as well as the impacts of water quality on tadpoles (2009-2012). Water Research Commission (WRC) report WRC PROJECT K5/1928: Assessment Of The Current Biodiveristy Of The Wetland Amphibians Associated With Major River Systems Of The Kruger National Park (And The Physical And Chemical Factors Affecting Their Distribution). VLOK, W[1], Fouche, P[2], Cook, C.L.[3] and Pieterson, I[4].

Declaration of Independence

We declare that we have been appointed as independent consulting ecologists with no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2010. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. Remuneration for our services by the proponent is not linked to approval by any decision-making authority responsible for authorising this development.

C.L.Cook *20th of November 2015*

L.R.Brown *20th of November 2015*

Indemnity and specific conditions relating to the report

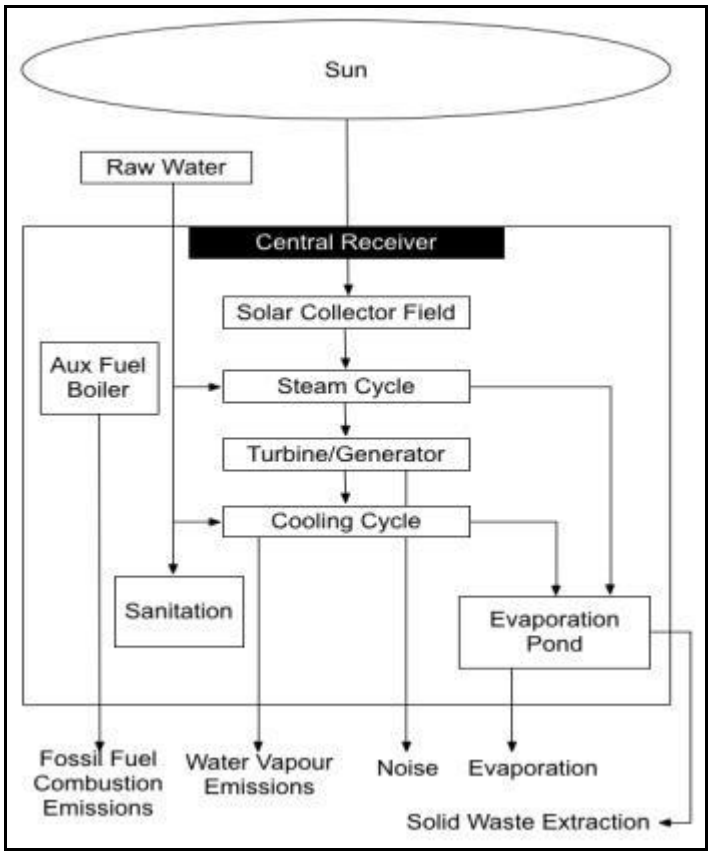
The findings and recommendations in this report are based on best scientific practices, available information, professional experience and judgement. Due diligence has been observed throughout the preparation of the document. Clayton Cook and Leslie Brown accept no liability for any claim, demand, cost or inconvenience arising from this report or its contents and by accepting this report recipients indemnify the authors, contributors and collaborators from any such liability. This report must not be altered or added to without the prior written consent of the authors. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

1. BACKGROUND INFORMATION

South Africa's Department of Energy released the Integrated Resource Plan for Electricity 2010-2030 ("IRP") in March 2011. The IRP indicated that renewable energy will make up a substantial 42% of all new electricity generation (totaling 17,800 MW) from 2010-2030. Under the IRP the South African Department of Energy committed to produce 1,200 MW of power from CSP through the REIPP Procurement Program. A draft update to the IRP was released for comment in November 2013. The updated IRP proposes an increased allocation for solar power for the 2010-2030 period, with a notable increase in CSP capacity to 3,300 MW. Under the REIPP Procurement Program, prospective project developers submit bids to South Africa's Department of Energy to construct and operate renewable energy projects and sell power to Eskom, South Africa's national electricity utility. The bidding process is organized into several bidding rounds, the first of which was completed in December 2011.

The REIPP Procurement Program includes the following technologies: onshore wind, small hydro, landfill gas, solid biomass, biogas, photovoltaic, and CSP. CSP is a renewable energy source suitable for South Africa. The technology is relatively new to South Africa, but five CSP projects have been approved during the first three rounds of the REIPP Procurement Program. CSP systems use mirrors or lenses to concentrate a large volume of sunlight onto a small receiving device. The concentrated light is converted to heat, which drives a heat engine (usually a steam turbine) connected to an electrical power generator. CSP power stations consist of two parts: one that collects solar energy and converts it to heat; and another that converts heat energy to electricity. These systems can include capacity for thermal energy storage (such as heat transfer fluid or molten salts); this stored energy can be utilized to generate power during evening hours.

Central Receiver: A circular array of heliostats (large mirrors with sun-tracking motion) concentrates sunlight on to a central receiver mounted at the top of a tower. A heat-transfer medium in this central receiver absorbs the highly concentrated radiation reflected by the heliostats and converts it into thermal energy, which is used to generate superheated steam for the turbine. To date, the heat transfer media demonstrated include water/steam, molten salt and air.



Process Flow Diagram

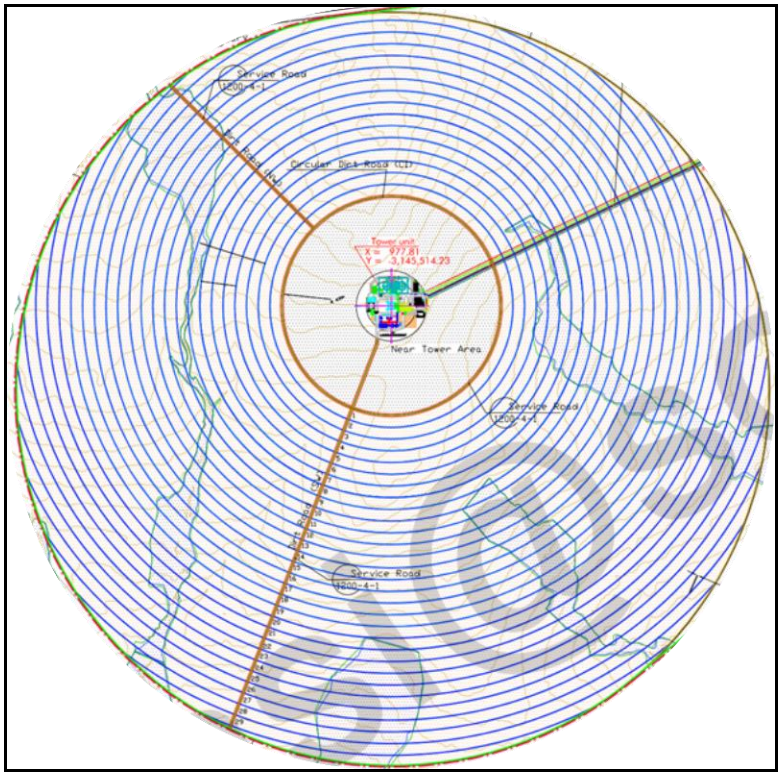
A CSP power tower system consists of:

- a tower and receiver;
- a heliostat field;
- a power block; and
- an optional thermal storage system.

The field of heliostats (flat, dual-axis tracking mirrors) focuses direct normal solar radiation onto a receiver located at the top of a tower at the center of the heliostat field. The receiver absorbs the concentrated radiation and transforms it into thermal energy in a working fluid, which is then pumped to the power block. The power block generates steam (from the heated fluid) to drive a conventional steam turbine generator to produce electricity.

The temperatures achievable with power tower systems are greater than those achievable through parabolic trough technology, and are in the range of 400-550°C. Temperatures of up to 1000°C (e.g. supercritical CO_2 cycle) are being proposed for future plants that can have much higher power cycle efficiency. Although CSP tower technology is commercially less mature than parabolic trough technology, a number of components and experimental systems were field tested as early as the 1980s and in early 1990s. The technology is now fully commercialized.

The principal components of power tower systems are described in further detail in the following sections.



Example of Layout

Tower/Receiver System

The solar receiver is mounted atop the tower, either directly on top or on one side, depending on the arrangement of the heliostat array. The tower design is specific to each supplier. Studies have been performed with regard to using a steel frame tower of several different configurations (uniform cross-section, tapered cross-section or a combination of the two) as well as concrete shell slip formed similar to a chimney. The height of the tower is primarily limited by cost. Each design needs to take wind, seismic and dead load considerations into account before determining which is best for the given location.

The tower structure will support the solar receiver and will typically include internal stairways and an elevator shaft or rack and pinion support. Additional plant equipment such as the de-aerator and feed-water heaters may also be included within the tower. This provides protection from the elements if the equipment can be placed within the tower. Any evaluation of the tower design should consider the material quantities, ease and speed of erection and layout considerations. In addition, key factors of the evaluation should include maximization of ground fabrication – enhancing safety during erection; ease of installing receiver commodities, equipment and support systems; the schedule from start of erection to completion; and facility maintenance. A drop zone for equipment movement within the tower may be desirable, but in many cases the drop zone will need to be located outside the tower footprint.

To minimize the work effort at elevations above the ground, assembly of as large a section as possible at grade is preferable. Then a crane will lift the section into its position. Stairs and elevator supports should also be preassembled at grade and lifted into place. Modularization of entire elevation sections of the tower, including pipe and cable trays, should be maximized to the crane limitations to reduce the erection job hours aloft.

Steel tower designs can utilize either pipe columns or wide flange beams. One additional design uses pipe columns filled with concrete. These composite columns increase the cross-sectional area of the member for compressive loads as well as increasing the resistance to buckling. The receiver, placed atop the tower, is located at the point where the reflected energy from the heliostats can be intercepted most efficiently. The receiver absorbs the energy and transfers it to the heat transfer fluid, be it water to steam or molten salt. There are two basic types of receivers – external and cavity type.

The external receiver normally consists of panels of vertical tubes welded side to side to form a cylinder. The bottoms and tops of the tubes are welded to headers that supply the fluid to the bottom and collect the heated fluids at the top. This is similar to a traditional boiler turned inside out. The surface of the tubes is generally coated with a black material to maximize the thermal absorption. The cavity type of receiver is a design meant to keep the convective heat losses to a minimum by allowing the reflected rays to enter the receiver through apertures in the sides of the receiver and strike internal surfaces within the unit.

Receiver, Heat Transfer Medium: The receiver transfers the concentrated solar energy reflected from the heliostats to the transfer medium. Dependent on the technology, the receiver can be a boiler or steam drum. This directly produces superheated steam at around 550°C and a pressure of 160 bar for supply to the steam turbine or steam storage tank (as in the case of the BrightSource technology). Alternatively, molten salt can be used as the heat transfer fluid and heat storage medium. The tower supports the receiver, which needs to be located at a certain height above the heliostats to avoid, or at least reduce, shading and blocking of the heliostats. Tower heights can vary from 50 meters to up to 200^{+} meters depending on the size of the plant and distance of the heliostats from the tower. Since the effectiveness of focusing irradiation on the receiver diminishes when the heliostats are at too great a distance from the receiver, large power projects may comprise of more than one power tower, each with its own heliostat field. Experimental projects, such as the 2 MW Eureka tower constructed by Abengoa Solar, are testing higher temperature technologies to achieve increased efficiency.

Gemasolar CSP Tower Plant with Molten Storage System

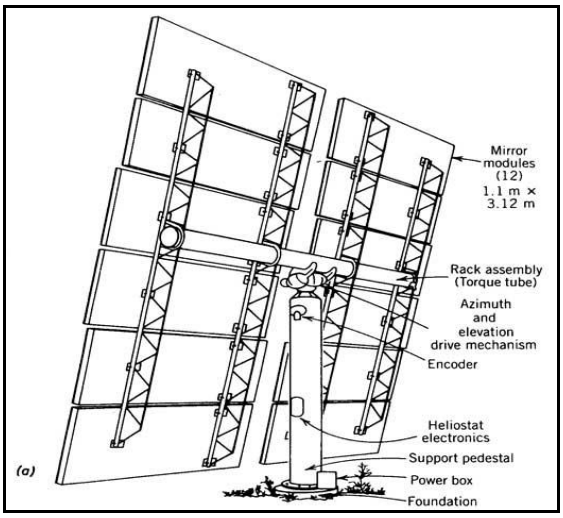
Receivers: As cited previously, an external receiver normally consists of panels of vertical tubes welded side to side to form a cylinder. The bottoms and tops of the tubes are welded to headers that supply the fluid to the bottom and collect the heated fluids at the top. It is the type of receivers that was used in Solar 1. With Solar 1, the unit had six panels used for preheating the water and eighteen panels for producing the steam. This is similar to a traditional boiler turned inside out. The surface of the tubes is generally coated with a black material to maximize the thermal absorption.

The external surface area is generally kept to a minimum to reduce radiant and convection heat losses. External receivers are directly exposed to ambient air and at high temperatures convection losses can be high. Temperature stratification will also occur inside the receiver back panel. With all of the heating being done solely on front end of the receiver panel, the internal temperature will vary depending on the distance away from the absorber surface. Consequently, the receiver efficiency will be reduced. The other drawback is effective absorption. For an external receiver, if any radiation is reflected from the surface, it is lost. However, this all can be calculated with reasonable accuracy during the design stage and a performance or effective collection efficiency can be predicted, as part of the vendor's offering.

Heliostat and the Tracking and Control Mechanisms

A heliostat consists of a mirror mounted on a structure which allows the mirror to rotate. This allows direct solar radiation to be steadily reflected in one direction, despite the movement of the sun. The heliostat should be positioned so that the reflected ray is consistently orientated towards the receiver.

Heliostat Design: Figure below shows a typical 12m x 12m heliostat structure. For recently completed Ivanpah Solar facility, BrightSource used 3.8m x 3.8m heliostats. Advantage of smaller heliostat is easier mounting, and smaller drive mechanism that can be powered by a small solar panel. Commercial heliostat sizes vary widely and aperture areas of up to 150 m^2 have been designed successfully.



Typical Heliostat Control and Support Arrangement

Each heliostat is composed of a flat reflective surface, a supporting structure and a solar tracking mechanism. Currently, the most commonly used reflective surface is glass mirror. Membrane technology is under development, which consists of a thin film reflective membrane stretched across a mounting structure. This technology is still in its infancy and is not yet commercially available. Problems observed with stretched membrane heliostats include the durability of the reflecting membrane and possible shape change of the heliostats surface due to wind effects.

Solar I plant used heliostats with a 40 m^2 reflective surface. For Solar II additional heliostats were 96 m^2 in size. For Gemasolar, the heliostat size was increased to 120 m^2. The drive for increasing the heliostat size was to reduce the number and costs of the gear boxes and controllers required for tracking. Furthermore the O&M costs of a field consisting of larger heliostats would be reduced. Heliostats from 100 m^2 to 200 m^2 have been developed and successfully tested at Sandia and NREL, from a technical point of view of their aiming characteristics and performance. The three commercial central receiver plants which were recently built by Abengoa and Sener in Spain have ~120 m^2 heliostats.

On the other hand heliostats of 7 m^2 have been successfully tested in a pilot plant in Israel by BrightSource and 15 m^2 heliostats are used at Ivanpah steam electric station. eSolar has used 1 m^2 heliostat at their Lancaster facility, but eSolar layout approach is totally different and not comparable to other tower receiver technology. Based on different approach taken by BrightSource vs. Abengoa, Sener and SolarReserve, it can be concluded that size of the heliostat can vary depending on the commercial offerings, and it may not have any standalone discerning impact on performance, annual field efficiencies or land area requirement. The study by Sandia indicates that there is some economy of scale as heliostat size is increased. However, with wireless technology and increased computer power to control multitude of heliostats, that cost advantage may not be there as indicated by BrightSource approach.

It should also be noted that size of the heliostat will also dictate foundation requirement, pylon design, and drive motor selection. The technology developer will have its internal cost/benefit criteria for selecting and optimizing these components. In order to function properly, the heliostats must be cleaned at regular intervals as dirty heliostats can greatly reduce the efficiency of the entire system. One difficulty encountered with the Abengoa Solar PS10 pilot plant (in Spain) was related to the wind conditions under which the heliostats could be utilized. In wind speeds greater than 10 m/s the heliostats must be stowed (secured in a horizontal position) in order to avoid structural damage of the components. Very high wind speeds could cause damage. A more sturdy frame system will reduce wind speed problems but will increase the capital costs.

Heliostat Field Arrangement: The heliostat field is normally arranged to surround the power tower. The most common layouts utilize a full circular field or a surrounding field in a north/south direction with more heliostats located in north field for a site in northern hemisphere (more heliostats south of the tower for site in southern hemisphere).

The early demonstration plants selected a north heliostat field with single aperture cavity receiver tower at the south end of the field. These plants – e.g., SSPS, CESA1, THEMIS, EURELIOS, etc. were in the 1 MW range. The 10 MW Solar I plant at Barstow USA selected a surrounded field with external cylindrical receiver placed on the tower in the middle of the heliostat field. The same field was used in Solar II with molten salt receiver and added additional heliostats to account for three hours of storage. In the mid 1980's the German- Spanish GAST project -20 MWe with pressurized air tube receiver- preferred the north field approach with cavity receiver. This was also applied to the commercial plants of PS10 and PS20 in Seville. The Gemasolar plant uses a surrounded field with external receiver similar to Solar II design.

A cavity receiver with multiple apertures can be placed in a surround field. But as number of apertures increase, the heat preservation advantage of cavity receiver is lost and its performance approaches external receiver. The tracking system comprises an elevation drive and an azimuth drive which facilitate the movement of the heliostat to track the path of the sun throughout the day. To activate the tracking, each heliostat has its own individual control system.

Heliostat control is critical to achieve maximum tower output potential; even slight misdirection of the radiation onto the receiver can create hot spots and result in damaging thermal stresses. Larger receiver designs require sophisticated heliostat aim control to maintain an even heat distribution at the receiver. If HTF pumping power fails, the heliostats must be able to rapidly turn to “off-sun” position or be repowered by a back-up energy source to protect the receiver and HTF from overheating. Heliostat controls are calibrated to prevent misdirection and ensure proper function.

The tower height is designed so all heliostats have a direct line-of-sight to the receiver requiring the tower and collector field design to be integrated. Some tower technology providers offer a pre-set tower and field size with varying output and storage capacities; others adjust their tower and field size according to desired output and storage capacities. For example, eSolar’s concept is to standardize a plant (from collector to steam generator), combining several modules having a 48.8 m (160 ft) tower/receiver with rectangular-shaped heliostat collector blocks located north and south of the tower. Sixteen modules are used to feed a central power block utilizing a conventional Rankine cycle, together forming a single 50 MW generation facility. Each facility roughly occupies a quarter section of land (0.65 km^2/ 160 acres). Multiple facilities can be built adjacent to one-another and connected to a common substation tie-in. The tracking algorithm takes into account various factors such as the distance from the heliostat to the receiver.

The receiver size will play an important role in determining the breakeven level for both concepts – receiver type and heliostat field arrangement. Unfortunately no real data from big cavity receivers with tilted aperture or for external receiver are available to make such as assessment. For external cylindrical receivers there is at least some information from the Solar I and Solar II plant, and the theoretical correlations for heat losses from a larger module exposed to ambient conditions are more accurate than those for the thermal losses in cavity receivers.

No detailed analysis have been published for receiver selection or field arrangements, but preliminary evaluation by Sandia National Lab, DLR – German Aero Space Center, and Plataforma Solar de Almería (PSA) of Spain indicate that for power plant smaller than 100 MWth (<50 MWe) and with no storage, a cavity receiver may have performance advantage and can be managed well in field construction. Also, a north field arrangement may offer advantage for such receiver. For larger plant with storage, external receiver and surround field would be a better option. This is due to its simpler design, ease of constructability, and flexibility of placing heliostat in surround field arrangement. Current development efforts by major receiver designers – ALSTOM, B&W, Riley Power, Foster-Wheeler, and others are for larger external receiver for plant size > 150 MWth (>50 MWe and with 3-6 hour of storage).

Solafrica Photovoltaic Energy (Proprietary) Limited ("Solafrica") proposes a 150 MW Concentrated Solar Plant (CSP), based on a technology to be selected after the technical assessment of a feasibility study, with options to add, under subsequent phases, an additional 150 MW parabolic trough CSP plant situated on the Farm Sand Draai 391 in the Northern Cape province of South Africa. Solafrica's intends to develop a CSP plant with significant amounts of thermal storage.

Solafrica appointed Royal HaskoningDHV formerly trading as SSI Engineers & Environmental Consultants (Pty) (Ltd) to undertake the environmental authorization (Basic Assessment and EIA) for the construction of a 150 MW CSP (henceforth called the Sand Draai CSP). Prof. L.R. Brown of Enviroguard Ecological Services cc. and Mr. C. L. Cook were appointed by Royal Haskoning*DHV* (RHDHV) to undertake a specialist ecological assessment for the proposed EIA for the 100 MW CSP situated on the Farm Sand Draai 391 in the Northern Cape province of South Africa. Two alternative sites were proposed 150 MW CSP plant.

The purpose of this document is to highlight potential impacts on the biodiversity of the project from two site visitation undertaken in March and November 2015 from a vegetation and faunal (mammals, reptiles and amphibian) perspective. A separate specialist avifaunal (bird) assessment is being conducted for the project.

1.1 Objectives of the Specialist Ecological Survey

- To provide a description of the vegetation as well as fauna with special emphasis of threatened plant or animal species occurring or likely to occur on the proposed Sand Draai CSP sites.
- To describe the available habitats on site including areas of important conservation value or areas most likely to form important habitat for remaining threatened plant and animal species on or around the proposed two alternative Sand Draai CSP sites.

1.2 Scope of study

- A specialist ecological survey with special emphasis on the current status of threatened plant and animal species (Red Listed/Data Species), within the proposed Sand Draai CSP sites based on two site visits as well as using historic as well as published literature and distribution records.
- An assessment of the ecological habitats, evaluating conservation importance and significance with special emphasis on the current status of threatened plant and animal species (Red Data/Listed Species), within the proposed two alternative Sand Draai CSP sites.
- To compile a sensitivity map for the proposed Sand Draai CSP sites.
- Documentation of the findings of the study in a report.

2. METHODOLOGY

2.1 Predictive methods

A 1:50 000 map of the study area was provided showing existing infrastructure and the proposed CSP site. This was used as far as possible in order to identify potential "hot-spots" along the corridors, e.g. Patches of undisturbed vegetation, Gariep (Orange) River, non-perennial drainage lines, seasonally inundated pans and rocky hills and inselbergs. Satellite imagery of the area was obtained from Google Earth ™ was studied in order to get a three dimensional impression of the topography and land use.

2.2 Literature Survey

A detailed literature search was undertaken to assess the current status of the vegetation as well as threatened plant species as well as fauna that have been historically known to occur in the Groblershoop study area (2822 CA, 2821 CD & 2821 DD) quarter degree grid cells, within which the proposed Sand Draai CSP site is located. The literature search was undertaken utilizing *The Vegetation of South Africa, Lesotho and Swaziland* (Mucina & Rutherford 2006) for the vegetation description as well as *National Red List of Threatened Plants of South Africa* (Raimondo *et al,* 2009) as well as the internet using the South African National Biodiversity Institutes (SANBI's), POSA (http://posa.sanbi.org) to produce a list of the most likely occurring species, which were searched for during fieldwork. Conservation-important plants include those listed as species of conservation concern by Raimondo *et al.*(2009) or protected species as listed under the National Forests Act (NFA) (No. 30 of 1998) or the National Environmental Management: Biodiversity Act Threatened or Protected Species (NEMBA ToPS) (No. 10 of 2004). Faunal literature survey included the use of *The Mammals of the Southern African Subregion* (Skinner & Chimimba 2005) and *The Red Data Book of the Mammals of South Africa: A Conservation Assessment* (Friedmann and Daly (editors) 2004) as well as ADU's MammalMAP http://vmus.adu.org.za/vm_sp_list.php accessed on the 14th of November 2015) for mammals. *A Complete Guide to the Frogs of Southern Africa* (du Preez & Carruthers 2009) and *The Atlas and Red Data Book of the frogs of South Africa, Lesotho and Swaziland* (Minter *et al.* 2004) for amphibians as well as SAFAP FrogMAP (http://vmus.adu.org.za). The *Field Guide to the Snakes and other Reptiles of Southern Africa* (Branch 2001) and *South African Red Data Book-Reptiles and Amphibians* (Branch 1988) as well as SARCA (http://sarca.adu.org.za accessed on the 14th of November for reptiles.

2.3 Fieldwork

Field work for the preliminary vegetation survey was conducted by Prof. LR Brown and the faunal survey by Mr. CL Cook during the period from the 20-24th of March and the 2nd -4th of November 2015. During the field surveys, selected natural areas were covered on foot and the majority of the rest of the site by vehicle. Faunal records were gathered using visual cues such as sightings, tracks and scats, active searching as well as auditory recognition for amphibians.

2.3 Assumptions, Limitations and Knowledge Gaps

2.3.1. Seasonality

The vegetation and faunal surveys were restricted to a single season during an El Nino drought cycle. The faunal and vegetations assessments were based on two 3 day field surveys in the late and early growing season, and only species of plants visible and / or flowering in late and mid-summer were detected. It is possible that plants which flower at other times of the year are under represented, especially geophytes which flower after adequate rainfall. Thus only those flowering plants that flowered at the time of the visit could be identified with high levels of confidence. Some of the more rare and cryptic species may have been overlooked due to their inconspicuous growth forms. Many of the rare and endangered succulent species can only be distinguished (in the field or veld) from their very similar relatives on the basis of their reproductive parts. These plants flower during different times of the year. Multiple visits to any site during the different seasons of the year could therefore increase the chances to record a larger portion of the total species complex associated with the area. The survey of the study site is however considered as successful with a correct identification of the different vegetation units.

2.3.2 Overlooked Species

Certain plant species, particularly geophytes, will only flower in seasons when conditions are optimal and may thus remain undetected, even over a survey that encompasses several seasons. Other plant species may be overlooked because of very small size and / or extreme rarity. Several faunal species are highly secretive and may remain undetected over extensive surveys conducted for extended periods.

2.3.2 Potential impacts of CSP

Despite the growing popularity of solar power, an extensive review of the available literature on the internet relating to faunal interactions at solar energy power plants revealed little information pertaining to mammals, reptiles and amphibians and focuses mainly on bird collisions as well as burning.

Possible reasons for this include the following:

- It may be that the impacts of concentrated solar power plants of this type on fauna are in fact minimal, therefore the lack of available literature on the subject. The impact is mainly on the avifauna or birds as well as bats which are attracted to the insects. See separate avifaunal report.

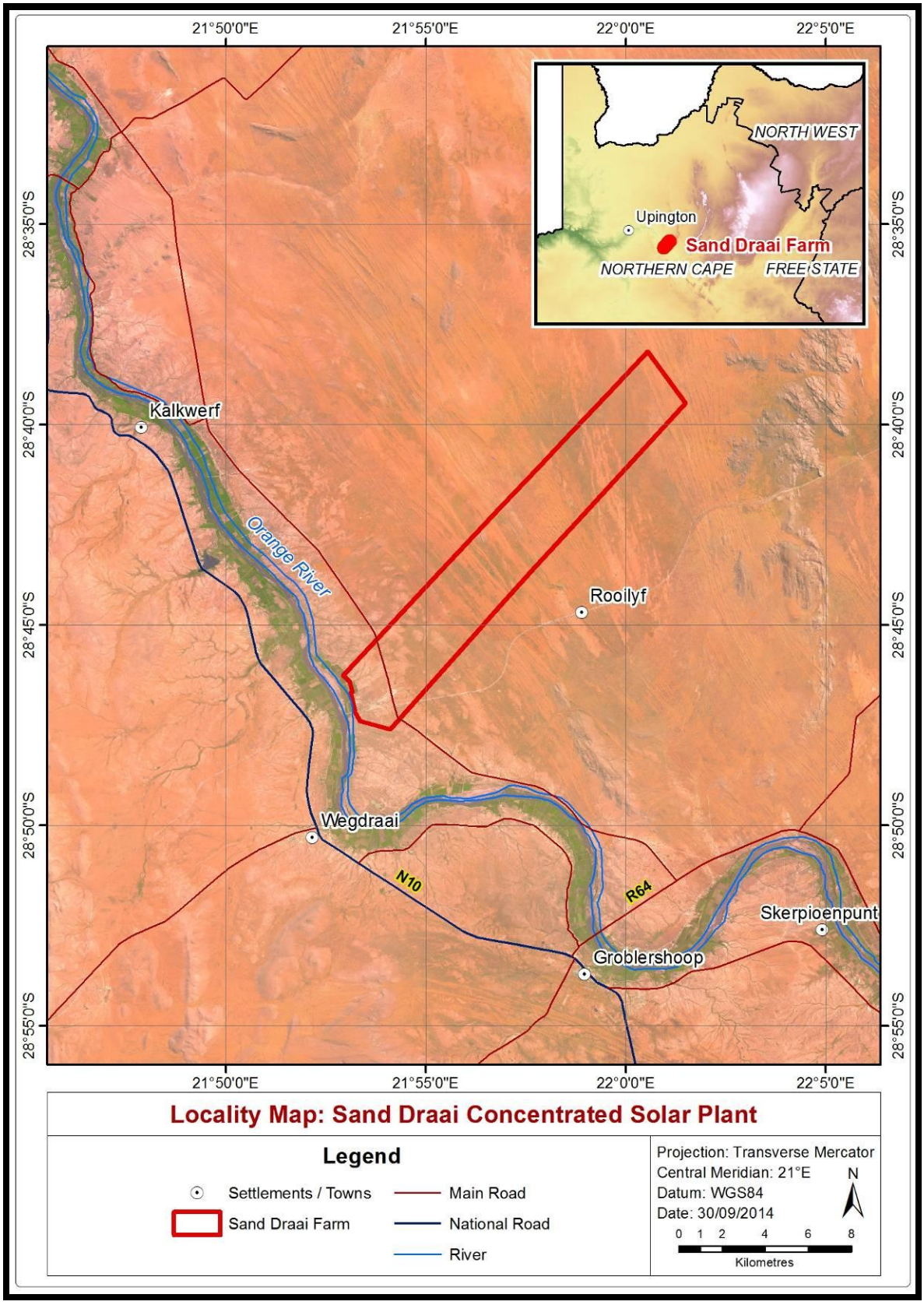


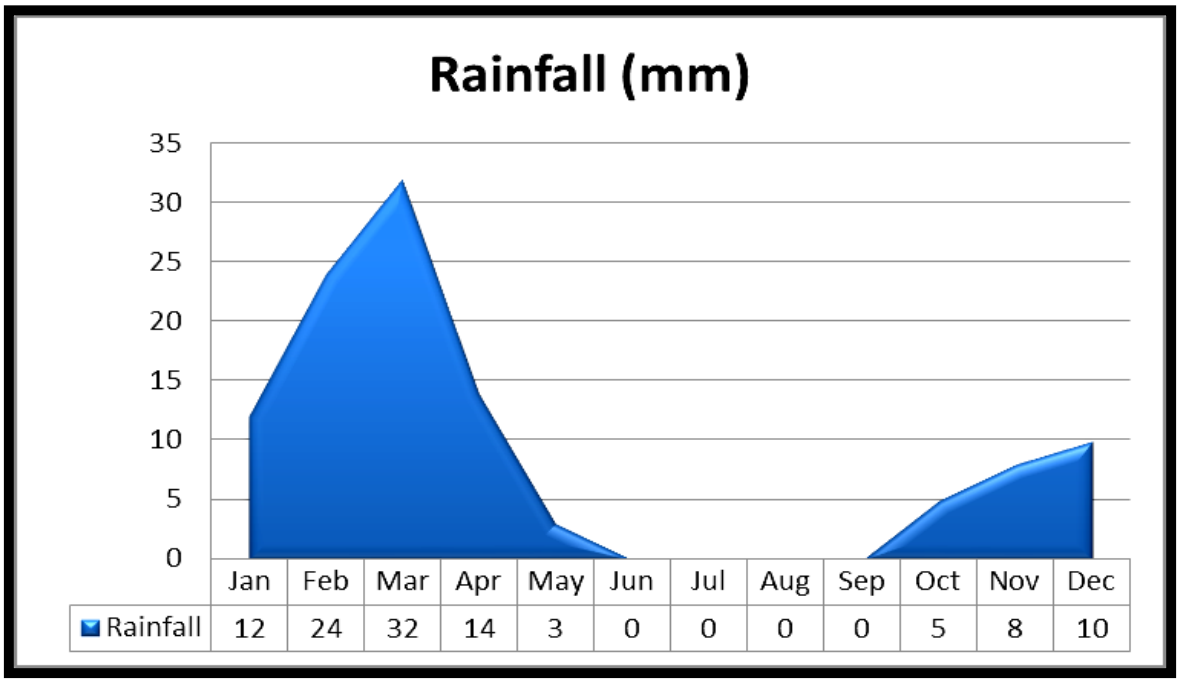
Figure1. Locality map of the proposed Sand Draai CSP sites.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Location

The project site is located on the north-east end of an existing farm (Sand Draai) near the town of Groblershoop in the Northern Cape Province of South Africa (see Figure 1 above). A provincial gravel road (MR874 Gariep Road) runs through the farm property connecting with the N8 (national road). The N8 is accessible from Kimberley or via the N10 (national road) running from Britstown to Upington where it interfaces with the N14. It is situated east the lower portion of the Gariep (Orange) River, approximately 70 km southeast of the town of Upington. In this section of the river, the channel becomes wider with a large number of agricultural activities (mostly planting of grapes) present along the floodplain areas of the Gariep River.

The study area is located within the arid region of South Africa and annually receives approximately 108 mm of rain (Figure 2). Most rainfall occurs during the months of February and March (end summer-autumn). During the winter months (June, July, August) and spring (September) the average annual rainfall is 0 mm with the highest (32mm) in March. The monthly distribution of average daily maximum temperatures indicates that the average midday temperatures in summer ranges from 5°C in October to 33°C in March. The area is the coldest during July when the mercury drops to 0°C on average during the night (http://www.saexplorer.co.za/south-africa/climate/groblersdal_climate.asp).



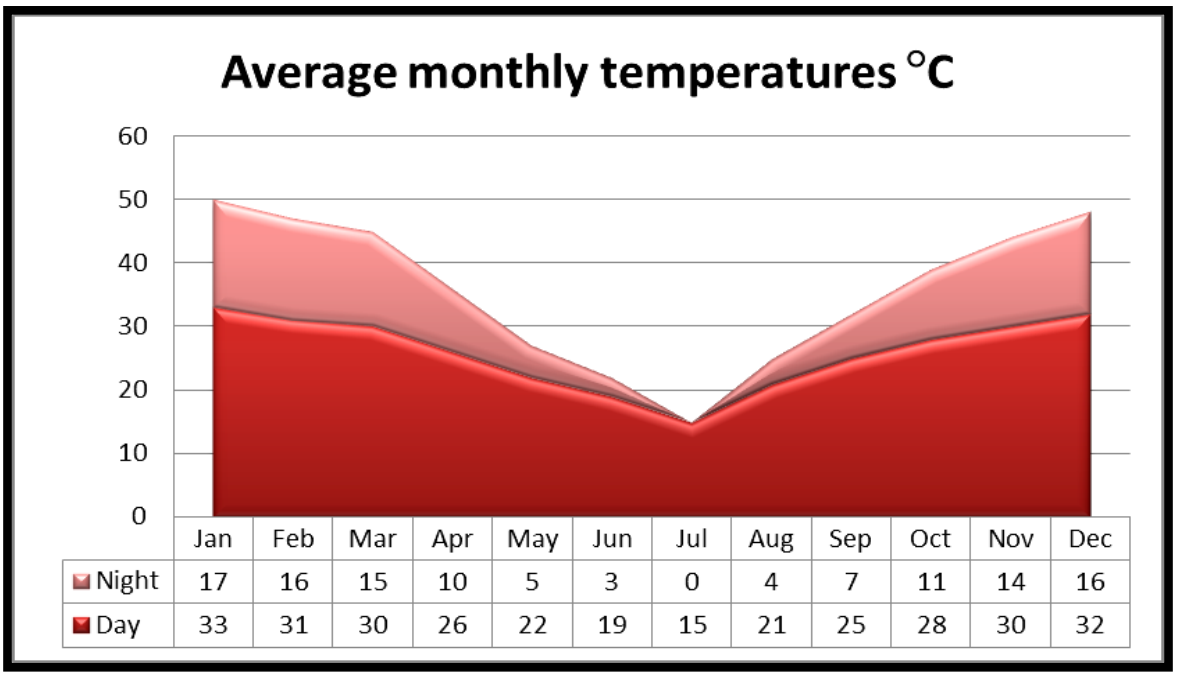


Figure2. Average monthly rainfall and temperatures for the study area.

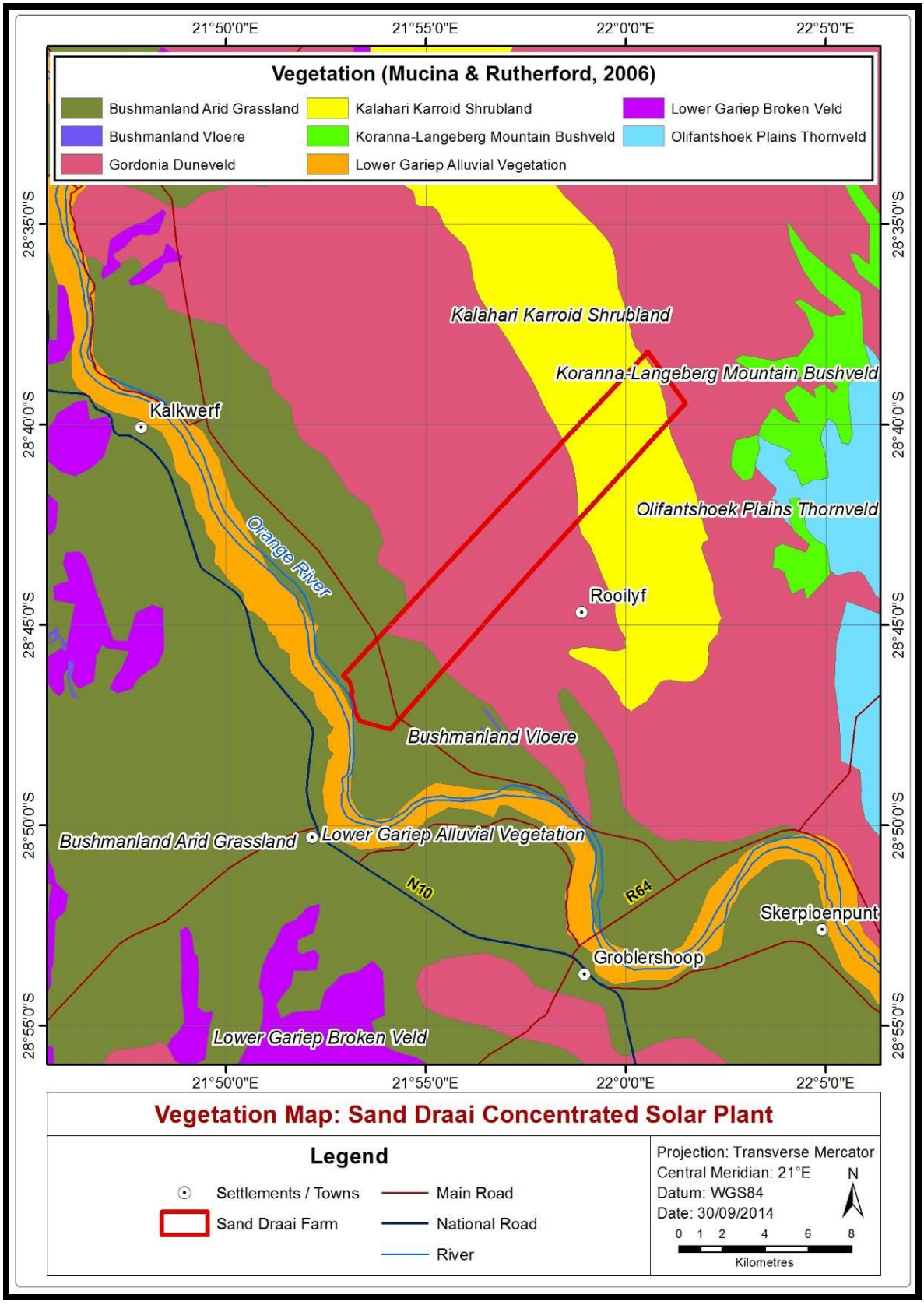


Figure3. Vegetation map of the Sand Draai site.

3.2 Vegetation

The proposed site is mainly located within the Savanna Biome, with a small northern portion situated within the Nama Karoo Biome. The Savanna Biome is known to support more than 5,700 plant species, exceeded only by the Fynbos Ecoregion in species richness. The study sites are located within the Kalahari variation of the Savanna Biome, which although referred to as a desert, is not a true desert as it does not approximate the extreme aridity of a true desert. This area is covered by sparse grass layer and scattered shrubs and trees.

The Nama Karoo Biome, the second largest biome in Southern Africa, is characterised by plains of dwarf shrubs and grasses, dotted with characteristic koppies. It is essentially a grassy, dwarf shrubland; the ration of grasses to shrubs increase progressively, until the Nama Karoo merges with the Grassland Biome. The species richness of this region is not particularly rich; only 2 147 species, of which 386 (18%) are endemic and 67 are threatened.

The SANBI database indicates the presence of approximately 5 315 plant species within the Northern Cape Province, with only 91 species within the ¼ degree grids in which the study sites are located (2821DB, 2821 DD, 2822CA). This low diversity reflects the poor floristic knowledge of the region. The species diversity comprises a diversity of growth forms, dominated by herbs (32 species, 35.2%), dwarf shrubs (24 species, 26.4%) and grasses (18 species, 19.8%). Trees and tall shrubs comprise a relatively low part of the total, reflecting on the open savanna / shrubland physiognomy of the region.

The Sand Draai farm is located within four vegetation types as defined by Mucina & Rutherford (2006) namely the **Bushmanland Arid Grassland (NKb3)**, **Gordonia Duneveld (SVkd1**), **Kalahari Karroid Shrubland (NKb5)**, and the **Lower Gariep Alluvial vegetation (AZa3)** situated within the floodplain of the Gariep River (Figure 3 above). The proposed CSP plant or central receiver 1 is situated on the north-eastern portions of the site and falls mainly within the **Kalahari Karroid Shrubland (NKb5)** and the alternative site or central receiver 2 is situated within **Gordonia Duneveld (SVkd1**) within the central portions of the Sand Draai site**.** The shared infrastructure between the proposed CSP, parabolic troughs as well as Photovoltaic Plant (PV) comprising pipelines, powerlines and access roads fall within the **Kalahari Karroid Shrubland (NKb5), Gordonia Duneveld (SVkd1**) as well as **Bushmanland Arid Grassland (NKb3)** on the south-western portions of the site

Table1. Vegetation status of different vegetation types (Mucina & Rutherford 2006).

VEGETATION TYPE	NATIONAL STATUS	REMAINING	CONSERVATION TARGET	FORMALLY CONSERVED
Bushmanland Arid Grassland (NKb3)	Least Threatened	99%	20%	0.1%
Gordonia Duneveld (SVkd 1)	Least Threatened	99.8%	16%	14.2%
Kalahari Karroid Shrubland (NKb 5)	Least Threatened	99.2%	21%	0.1%
Lower Gariep Alluvial vegetation (AZa3)	Endangered	50%	31%	6%

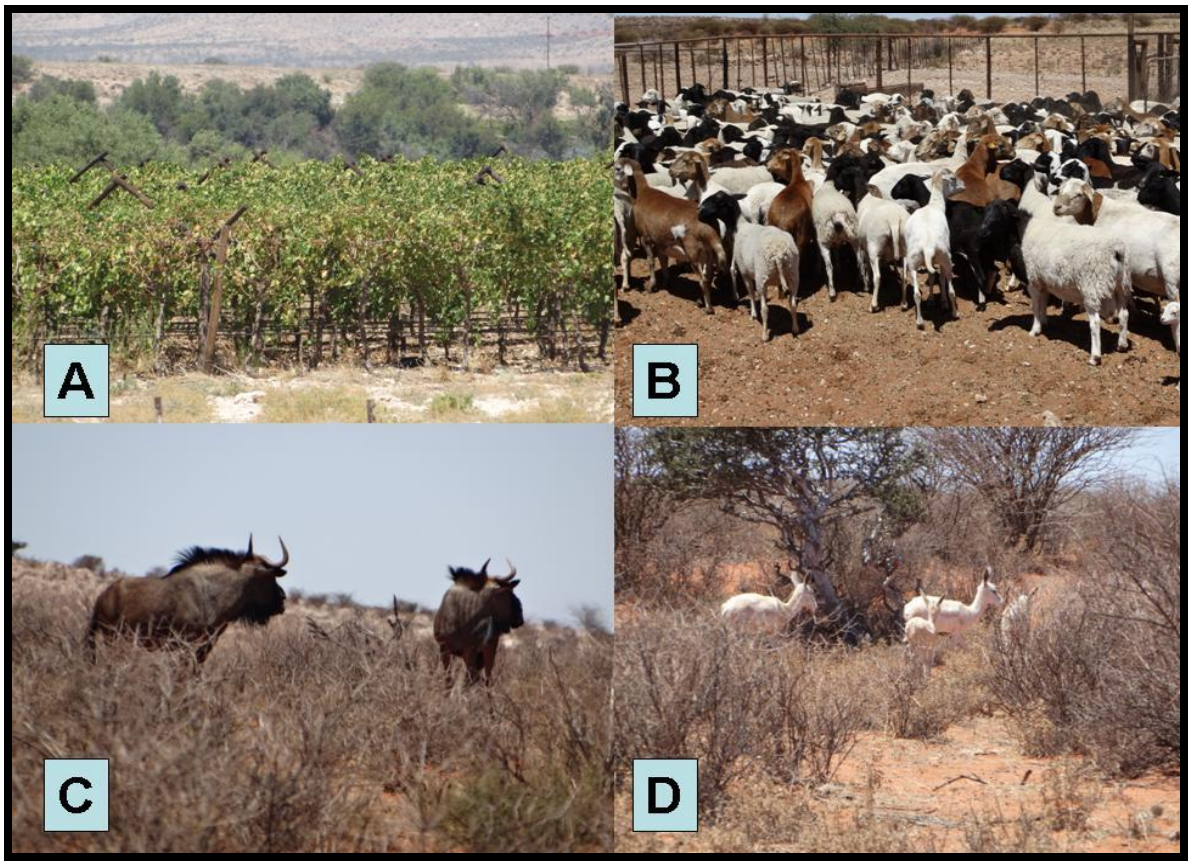


Figure4. A collage of photographs displaying the major land-usage for the Sand Draai Farm. A: The southern portion of the site situated adjacent to the Gariep River is utilised for grape vineyards as well as cultivation of livestock feed (Lucerne). **B:** The majority of the Sand Draai Farm is used for livestock grazing activities mainly by sheep, cattle and horses. **C & D:** The site is also utilised for game production which are used mainly for low-impact hunting activities.

4. VEGETATION ASPECT

The vegetation of the proposed two alternative CSP sites were surveyed and data analysed. Prior to the field survey, available literature, and database information pertaining to the vegetation and threatened species of the study area was obtained and reviewed. The literature review included scientific and popular publications on related aspects for the area. Internet searches for ecological issues in the area and red data plant and animal species were done. The Google search engine was used for information pertaining to Red Data flora and fauna and their habitat preferences.

During the two separate field trips the proposed two alternative CSP sites were covered using both a vehicle as well as selected areas covered on foot to survey the vegetation in the field.

The Braun-Blanquet survey technique to describe plant communities as ecological units was used for this study (Brown *et al.* 2013; Kent & Coker 1992; Mueller-Dombois & Ellenberg 1974). It allows for the mapping of vegetation and the comparison of the data with similar studies in the area. The vegetation survey was conducted by Prof. LR Brown.

By using aerial photographs, the study area was stratified into physiognomic - physiographic units. Sample plots were placed on a randomly stratified manner to represent each vegetation unit identified. Plot sizes were fixed at approximately 400 m^2 according to Brown (1997).

In spite of a relative homogenous appearance to much of the regional habitat, with the exception of extensive mountain ranges to the north and south of the Sand Draai site, a relatively obvious physiognomic variability is noted in the study area with plains alternating with parallel dunes occurring within the central and northern portions of the site. It is highly likely that various smaller phytosociological differences are present within each of the identified habitat types, but for the purpose of this assessment, the observed ecological units are considered similar in major phytosociological, physiognomic and biophysical attributes. Many plant species occur across all of the habitat types, but many of the differences between units are ascribed purely on the basis of terrain morphology, soil characteristics or changes in the dominance and structure of the plant species. Surface water and rainfall in this part of the Kalahari is scarce and, together with substrate, is a major driving force of vegetation composition and succession**.**

Data recorded included:

Data pertaining to the vegetation physiognomy and floristic composition (species richness and canopy cover of each species) was collected in the field. A list of all plant species present, including trees, shrubs, grasses, forbs, geophytes and succulents were made.

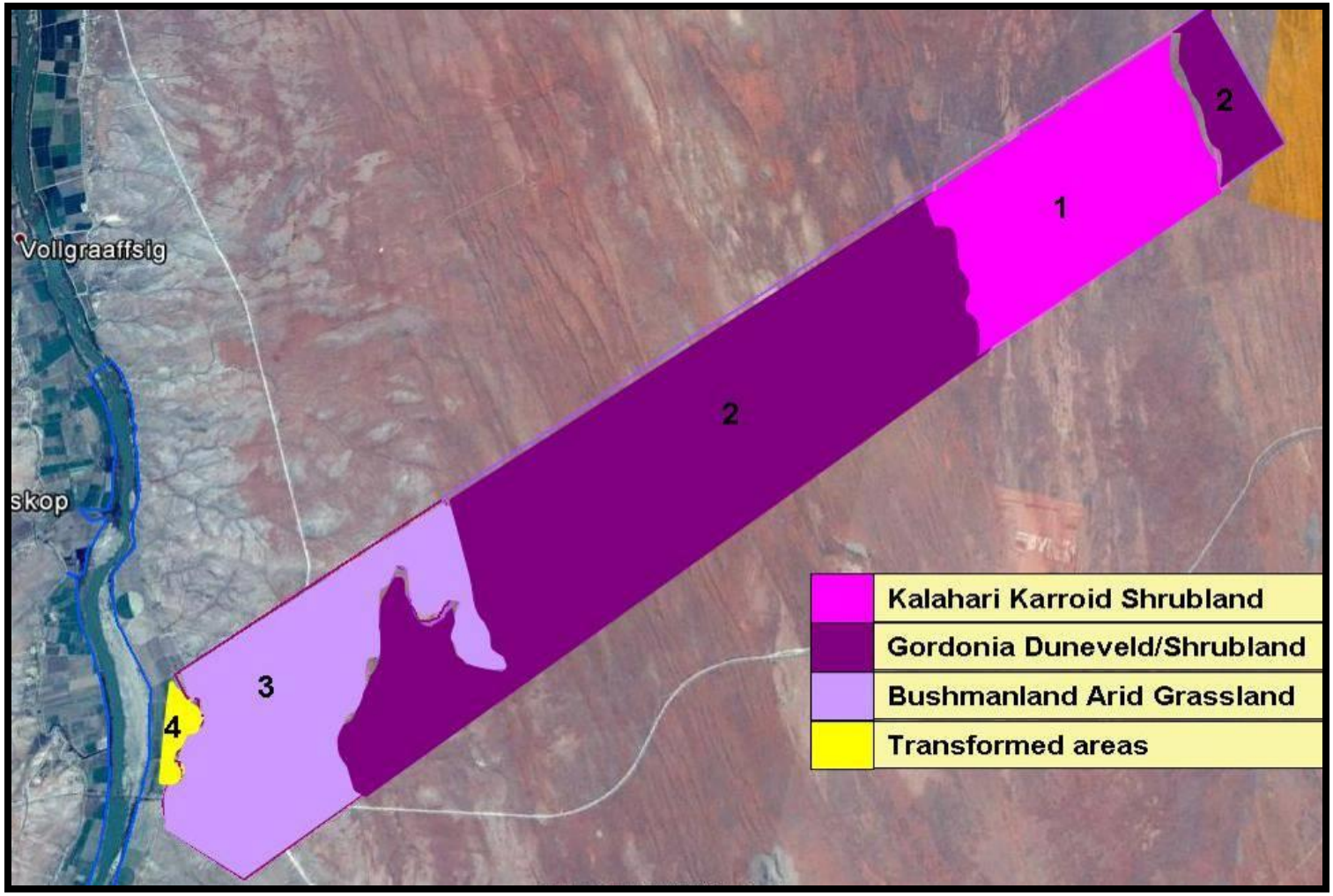


Figure5. Vegetation units observed within the proposed Sand Draai sites.

4.1 Open Shrub Plains or Kalahari Karroid Shrubland (NKb5)

Soil	Coarse medium to deep red sand
Topography	Undulating with small dunes
Land use	Game and livestock farming

Conservation value	**medium**	**Ecosystem functioning**	**medium**

The Kalahari Karroid Shrubland is dominated by low karroid shrubland on flat, gravel plains situated on the northern portions of the Farm Sand Draai. The alternative 1 CSP site is situated within large sections of this vegetation unit. The vegetation is characterised by low karroid shrubs and is indicative of a transition zone between the deep Kalahari sand and the Karoo shrublands. The geology is characterised by Cenozoic Kalahari Group sands and small patches of calcrete outcrops and screes on scarps of intermittent rivers (mekgacha). In places Dwyka tillites outcrop. The soils are deep (>300mm), red-yellow, apedal, freely drained with a high base status (Mucina & Rutherford 2006). This habitat type is representative of the regional vegetation type Kalahari Karroid Shrubland (Mucina & Rutherford, 2006), which typically forms bands alternating with bands of Gordonia Duneveld.

Biophysical attributes include open plains (flat or slightly undulating) with shrubs and scattered trees on deep sandy, red soils or gravel plains and a well-developed herbaceous layer. Prominent tall woody species in this undulating landscape are *Vachellia erioloba*, *Senegalia mellifera*, *Parkinsonia africana*, *Grewia flava* and *Boscia albitrunca*. Low shrubs include *Lebeckia linearifolia*, *Lycium bosciifolium*, *Rhigozum trichotomum* and *Salsola etoshensis*. Conspicuous grass species include *Schmidtia kalahariensis*, *Eragrostis lehmanniana, Enneapogon desvauxii, Stipagrostis amabilis* and *Stipagrostis ciliata*. Prominent forb species include *Monechma genistifolium* subsp. *genistifolium* and *Indigofera* species.

Important taxa (Mucina & Rutherford 2006):

Grasses	*Dinebra retroflexa*

Alien species within this vegetation type:

Prosopis glandulosa; Opuntia inbricata.

Protected Tree Species

Two protected tree species were recorded including scattered Shepherd's Trees (*Boscia albitrunca*) as well as Camel Thorn Vachellia erioloba.

Red data species

One protected and red data species the tree *Vachellia erioloba* was found within this shrubland.

Conservation status: The broad vegetation type is considered as 'Least threatened' with a conservation target of 21%. Least threatened with a conservation target of 21%. Very little is statutorily conserved in the Augrabies Falls National Park. Although only a small area has been transformed many of the belts of this vegetation type were preferred routes for early roads, thus promoting the introduction of alien plants, especially *Prosopsis* spp. Erosion is very low (Mucina & Rutherford 2006). The Kalahari Karroid Shrubland is fairly natural with no signs of overgrazing present and is considered to have **medium conservation potential** and ecosystem functioning and has been utilised for sheep grazing activities as well as for game species.

4.2 *Open Shrubland or Gordonia Duneveld (SVkd1)*

Soil	Coarse deep red sand
Topography	Undulating with dunes up to 8m tall
Land use	Game and livestock farming

Conservation value	**medium**	**Ecosystem functioning**	**medium**

The Gordonia Duneveld (SVkd1) consists of parallel dunes on deep Aeolian sand underlain by superficial silicretes and Calcretes of the Cenzoic Kalahari Group with flat areas between the dunes, the latter between 3-8m above the plains. The alternative 1 northern section is situated as well as the entire alternative 2 CSP within open plain shrubland and dune shrubland. Biophysical attributes include open plains (flat or slightly undulating) with shrubs and scattered trees on deep sandy, red soil dunes and a well-developed grass layer. Prominent tall woody species in this undulating landscape are *Vachellia erioloba*, *Senegalia mellifera*, *Parkinsonia africana*, *Grewia flava* and *Boscia albitrunca*. The vegetation is dominated by open shrub-land with ridges of grassland dominated by *Stipagrostis amabilis* on the dune crests and *Vachellia haematoxylon* on the dune slopes, also with the bush encroacher *Senegalia mellifera* subsp. *detinens* on the lower slopes and *Rhigozum trichotomum* in the interdune straaten. Grass species observed include *Schmidtia kalahariensis, Brachiara glomerata, Eragrostis lehmanniana, Stipagrostis amabilis*, *Stipagrostis ciliate* and *Stipagrostis unimplumis*.

Important taxa-Kalahari Endemics (Mucina & Rutherford 2006):

Small trees/shrubs	*Vachellia haematoxylon*

Grasses	*Stipagrostis amabilis; Anthephora argentea; Megaloprotachnes albescens*

Forbs	*Helichrysum arenicola; Kohautia ramosissima; Neuradopsis austro-africana*

Alien species within this vegetation type:

Prosopis glandulosa; Atriplex nummularia, Argemone ochroleuca

Indigenous bush encroacher:

Vachellia melifera subsp. detinens

Protected Tree species

Two protected tree species were recorded including several Shepherds Trees (*Boscia albitrunca*) as well as Camel Thorn (*Vachellia erioloba*).

Red data species

One red data species namely the Camel Thorn (*Vachellia erioloba*) was found scattered as single medium-sized individuals within this open dune shrubland.

Conservation status: Least threatened with a target of 16% conserved. Some 14% statutorily conserved in the Kgalagadi Transfrontier Park. Very little is transformed and erosion is generally low, but some areas with spectacular destabilization of normally vegetated dunes through local overstocking. The Gordonia Duneveld (SVkd1) is considered to be mostly natural with little signs of degradation and has a **medium conservation potential** and **ecosystem functioning**. The are has been utilised for sheep grazing activities as well as for game species.

4.3 Bushmanland Arid Grassland (NKb3)

Soil	Sandy loam & calcrete with a high base status
Topography	Undulating to level terrain
Land use	Livestock farming & Game

Conservation value	**medium**	**Ecosystem functioning**	**medium**

The Bushmanland Arid Grassland is characterised by extensive to irregular plains on slightly sloping plateau vegetated grassland dominated by white grasses (*Stipagrostis* spp.) giving the vegetation type the character of semi-desert 'steppe'. In places low shrubs of *Salsola sp.* change the vegetation structure. In years of abundant rainfall rich displays of annual herbs can be expected. The geology of the vegetation unit comprises recent (Quarternary) alluvium and calcrete. Superficial deposits of the Kalahari Group are present in the east. The extensive Paleozoic diamictities of the Dwyka Group also outcrop in the area as do gneisses and meta-sediments of the Mokolian Age. This vegetation type occurs on freely drained, red-yellow apedal soil, with a high base status and <300mm deep and is sparsely vegetated and consists of irregular and slightly sloping plateau and plains grasslands. Very little of this vegetation type has been transformed and the area is mostly used for grazing by domestic livestock and game.

Biophysical attributes include open plains (flat or slightly undulating) with shrubs and scattered trees on calcrete soils. Low-lying quartzite rocky hills occur within the vegetation unit. Prominent tall woody species in this flat to gently undulating landscape are *Vachellia erioloba*, *Senegalia mellifera*, *Parkinsonia africana*, *Grewia flava* and *Boscia albitrunca*. The dominance of the tall shrubs *Lycium cinereum, Rhigozum trichotomum*, the dwarf shrub *Aptosimum spinescens*, the grasses *Stipagrostis uniplumis, Enneapogon desvauxii, Cenchrus ciliaris* and *Aristida congesta*. The forb *Pentzia incana* is prominent while*, Salsola rabiena* and *Salsola geniculata* are also present.

Important taxa (Mucina & Rutherford 2006):

Tridentea dwequensis; Dinteranthus pole-evansii; Larryleachia dinteri; L marlothii; Ruschia kenhardtensis; Lotononis oligocephala; Nemesia maxii

Alien and invasive species within this vegetation type:

Prosopis glandulosa, Opuntia spp

Indigenous bush encroacher:

Senegalia melifera subsp. detinens

Protected Tree species

Two protected tree species were recorded including several Shepherds Trees (*Boscia albitrunca*) as well as Camel Thorn (*Vachellia erioloba*).

Red data species

One red data species namely the Camel Thorn (*Vachellia erioloba*) was found scattered within this open dune shrubland.

Conservation status: Least threatened vegetation type with a conservation target of 21%. Only small patches statutorily conserved in Augrabies Falls National Park and Goegab. Nature Reserve Very little of this area has been transformed and erosion is low to very low (Mucina & Rutherford 2006. The Bushmanland Arid Grassland is considered to be fairly natural with a **medium conservation potential** and **ecosystem functioning** and has been utilised for sheep grazing activities as well as for game species.

4.4 Lower Gariep Alluvial vegetation (AZa3)

Soil	Soil deeper than 1.2 m with clay content 15 to 35%.
Topography	River
Land use	Irrigation, agriculture, livestock and free moving game

Conservation value	**High**	**Ecosystem functioning**	**High**

The vegetation of the Lower Gariep Alluvial vegetation (AZa3) type comprises alluvial terraces and small riverine "islands" with riparian thickets mostly dominated by *Ziziphus mucronata, Vachellia karroo, Salix mucronata, Euclea pseudebenus* and *Phragmites australis*. Grasslands occurring on the flat alluvial are periodically flooded and also forms part of this complex vegetation type. These grasslands are mostly dominated by *Cynodon dactylon, Setaria verticillata* and *Cenchrus cilliaris*. Due to the unpredictable flooding events the riparian areas have a high disturbance regime and soil movement. Grass cover varies both spatially and temporally. A number of alien plants occur along these riparian embankments. Recent alluvial deposits of the Orange River supporting soil forms such as Dundee and Oakleaf. The Orange River cuts through a great variety of Pre-cambian metamorphic rocks. The Orange River is subjected to floods, especially in summer, as a result of high precipitation on the highveld. The soil of these areas (mainly from the Ia land type) are very fertile resulting in various grapes and other crops being planted along the Gariep (Orange) River (Mucina & Rutherford 2006).

Alien species observed within this vegetation type:

Salix babylonica; Prosopis glandulosa, Argemone ochroleuca.

Conservation status: This vegetation type is classified as 'Endangered' with a conservation target of 31% with only 6% statutorily conserved in the Richtersveld and Augrabies Falls National Parks. Riverine ecosystems are considered to have high conservation value and ecosystem functioning. Close to 50% of these systems are transformed for (vegetables and grapes) or alluvial diamond mining. *Prosopis* spp., *Nicotiana glauca* and *Argemone ochroleuca* can invade the alluvia in disturbed places (Mucina & Rutherford 2006). A proposed pipeline for water abstraction is proposed within the riparian zone of the Gariep or Orange River. The alternative 2 is preferred as it will result in less destruction of the sensitive riparian zone. The pipeline should avoid the destruction of any large indigenous riparian tree species and vegetation clearance should be restricted to the alien invaded *Prosopsis glandulosa* sections.

4.5 Transformed areas

Soil	Variable
Topography	Level to slightly undulating
Land use	Irrigation, agriculture, livestock

Conservation value	**Low**	**Ecosystem functioning**	**Low**

Situated on the southern boundary of the site are transformed areas including existing residential homesteads, workshops as well as grape vineyards. No development except for the water extraction pipeline alternative 2 is proposed within these transformed area which have **low conservation potential** as well as **low ecosystem functioning**. Several alien invasive *Prosopis glandulosa* were observed around the homesteads.

4.6 Protected Species

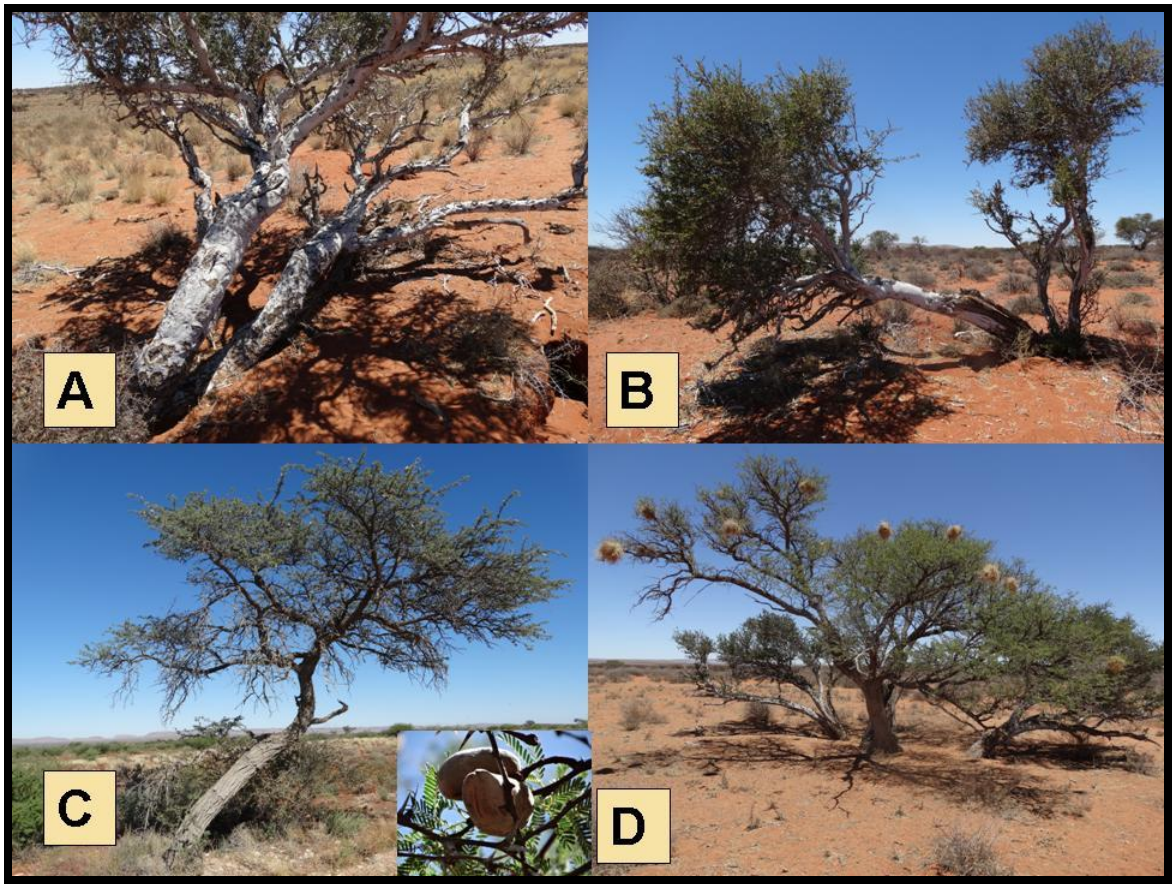


Figure6. A collage of photographs displaying the protected tree species observed within the Sand Draai site. A & B: Several protected Shepherd's Trees *Boscia albitrunca* were observed scattered throughout the Sand Draai site. **C:** The red listed 'Declining' and protected Camel Thorn *Vachellia erioloba* was observed scattered throughout the Sand Draai site. **D:** The Grey Camel Thorn *Vachellia haaematoxylon* was observed on and between the dune systems on the Sand Draai site.

Table2. Protected tree species recorded within the Sand Draai site.

Species name	Common Name	Recorded in study area
Vachellia (*Acacia*) *erioloba*	Camel thorn	✓
Vachellia haematoxylon	Grey camel thorn	✓
Boscia albitrunca	Shepherd's tree	✓

In terms of the National Forests Act 1998 (Act No 84 of 1998) the Camel Thorn (*Vachellia erioloba*), Grey Camel Thorn (*Vachellia haematoxylon*) and Shepherd's Tree (*Boscia albitrunca*) have been identified and declared as protected. The Department of Water Affairs and Forestry (now Department of Forestry and Fisheries) developed a list of protected tree species. In terms of Section 15(1) of the National Forests Act, 1998, no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree or any forest product derived from a protected tree, except under a license or exemption granted by the Minister to an applicant and subject to such period and conditions as may be stipulated. Trees are protected for a variety of reasons, and some species require strict protection while others require control over harvesting and utilization. The Department of Agriculture, Forestry and Fisheries (DAFF) will have to be approached to obtain the required permits for the removal of any protected tree species.

4.7 Red Data Species

A list of red data and endemic species for the Northern Cape Province is included in the Appendix (see Table 8) while a list of possible red data species for the study area is included as Table 3 below. One red listed species was recorded during the current field survey namely the “Declining” Camel Thorn (*Vachellia erioloba*). A species is listed as ‘Declining’ when it does not meet or nearly meet any of the five IUCN criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing continuing decline of the species.

Table3. List of possible red data and endemic species for the Sand Draai-Groblershoop area (red=confirmed during current survey).

Genus	Species	Family	Endemism	National Status	Assessment Rationale
Acacia	erioloba	FABACEAE	NOT	Declining	Concerns have been raised over the large volumes of A. erioloba wood being removed for commercial sale of firewood. Many trees are also killed as a result of bush encroachment control through pesticides. A study conducted in the Northern Cape indicated that at present only dead trees are being harvested for firewood and only a very small percentage of the study area (less than2%) was affected by clearing of A. erioloba.
Anacampseros	scopata	PORTULACACEAE	SA	Rare	A habitat specialist, this species is not threatened due the inaccessibility of its habitat.
Cleome	conrathii	CAPPARACEAE	SA	NT	Known from 8 locations and potentially threatened by urbanisation, invasive alien plants, incorrect fire regimes, overgrazing and trampling, erosion and incorrect fire regimes.
Gethyllis	namaquensis	AMARYLLIDACEAE	FSA	VU	This is a Northern Namaqualand and Southern Namibian endemic, suspected to occur in less than 100 locations. subpopulations are small (typically less than 20 plants). There are a few large subpopulations but these are never larger than 1000 individuals. We suspect that there are fewer than 10 000 plants in total. There is an ongoing decline as a result of harvesting for food and horticultural purposes.
Dinteranthus	pole-evansii	MESEMBRYANTHEMACEAE	SA	VU	A restricted range species (EOO 10 km²), known from only two locations from fewer than 1000 mature individuals and potentially threatened by livestock overgrazing.
Dinteranthus	wilmotianus	MESEMBRYANTHEMACEAE	FSA	NT	EOO less than 10 000 km², suspected to occur at between 10 and 20 locations this species is experiencing ongoing decline due to crop farming and livestock overgrazing and trampling.
Felicia	deserti	ASTERACEAE	SA	DD	Known only from 2 old (pre 1925) highly disjunct collections, one from Keimos in the Upington dist the other from the Khamiesberg. No habitat information known.

4.8 Medicinal species

Three medicinal plant species, have been identified within the study area. These plants occur throughout the southern African region on various soil types and areas none are threatened species.

Plant name	Medicinal use
Gomphocarpus fruticosus	Treatment of headaches, stomach pain and tuberculosis
Vachellia karroo	Diarrhoea & dysentery Gum: colds, oral thrush & haemorrhage.
Ziziphus mucronata	Cough & chest problems; diarrhea; pain relief

4.9 Land Degradation

The study area is located within an area where soil erosion is regarded as insignificant with low to medium veld degradation. Most of these areas are flat while deep sand occurs on the duneveld areas. As a result little erosion is present. The smaller drainage channels or non-perennial drainage lines that occur scattered throughout the south-western portions of the site contribute somewhat to erosion especially during (infrequent) flash floods. The areas are mostly utilised for grazing by game and domestic animals including sheep and goats, thus in some areas signs of overgrazing are evident, though not large areas. The riverine areas belonging to the Lower Gariep Alluvial vegetation (AZa3) are the areas that are mostly affected by agricultural activities with close to 50% of the area transformed. The Lower Gariep Alluvial vegetation (AZa3) unit falls within an “Endangered” ecosystem.

4.10 Discussion

The vegetation of the study area is associated with the arid section of the rainfall gradient and occurs on sandy soil while alluvial soil is present in the riparian zone. The topography varies from low-lying plateau areas, flat plains to deep red sandy dunes between 3-9m tall. The area is regarded by some scientists as a transitional area between the Kalahari and the Nama-karoo. The vegetation comprises small trees/tall shrubs with the grass layer the most prominent; especially during wet seasons. The dune areas have scattered small to medium-sized trees. The Bushmanland Arid Grassland (NKb3), Gordonia Duneveld (SVkd 1) and Kalahari Karroid Shrubland (NKb 5) vegetation types are all three regarded as being “**least threatened**” in terms of the conservation of these vegetation types. The presence of protected tree species *Acacia erioloba*, *Acacia haematoxylon* and *Boscia albitrunca* have been confirmed on the site within these vegetation types. The destruction of these species will therefore require a permit for DAFF for the removal. These areas are regarded as having a moderate floristic status. The Lower Gariep Alluvial vegetation (AZa3) is structurally complex comprising dense riverine vegetation, short open grassland on floodplains, bare rocks in the riverbed and dense reed beds in some areas. This vegetation type is subject to large scale degradation and is as a result regarded as “**endangered”** and therefore has a **high conservation** status.

This region is economically important in terms of the production of grapes, meat and wool production. Tourism potential is regarded as medium to low. Very little research has been undertaken in the region that is regarded as species rich with more than 7000 plant species recorded. All four vegetation types present are poorly protected although large sections are still natural.

4.11 Conclusion

The largest part of the vegetation of the study area is not threatened from a conservation point of view. Sections within these different vegetation types are degraded due to human influences, while alien invasive species are present in other parts where they have displaced the natural vegetation. Suitable habitat does however exist for some red data plant species and have been recorded in the vicinity of the study area. No red data plant species were observed and it is doubted that these species would occur on the study site with only marginal habitat present in some localities. The presence of three protected species has also been confirmed during the site visits to the area during current survey. From a vegetation perspective either of the two sites are suitable for the proposed CSP development. The vegetation is relatively homogenous throughout the study area as well as the presence of protected tree species. A proposed pipeline for water abstraction is proposed within the riparian zone of the Gariep or Orange River. The alternative 2 is preferred as it will result in less destruction of the sensitive riparian zone. The pipeline should avoid the destruction of any large indigenous riparian tree species and vegetation clearance should be restricted to the alien invaded *Prosopsis glandulosa* sections. As a precautionary measure a suitably qualified botanist should undertake a walk-through for the preferred CSP site during the wet summer months in order to identify any protected or threatened plant species which may have been overlooked during the current survey. A rescue and recovery programme should be implemented with the relocation of any remaining geophytes or Aloes away from the proposed development area.

5. SPECIALIST FAUNAL HABITAT ASSESSMENT

The Nama-Karoo and Succulent Karoo, now almost devoid of large wild ungulates, holds some 10 million Sheep (*Ovis aries*) and Goats (*Capra hircus*). The once plentiful and diverse set of nomadic herbivores has been replaced by large encamped herds of small livestock with specialist feeding habits. Nearly 200 years of this treatment has had a devastating effect on the Karoo soils and vegetation. Prolonged heavy grazing is considered to suppress shoot/root formation and flowering in the Nama-Karoo and Succulent-Karoo flora, which leads to compositional changes and depletion and thinning out of the vegetation, particularly those components that the sheep find palatable (Milton *et al.* 1994). Changes in the structure and composition of the vegetation affect the associated fauna. Thinning of the already sparse vegetation layer has greatly accelerated rates of soil erosion. Although conditions have improved since the 1950's, vegetation changes in the Nama-Karoo and Succulent-Karoo are now difficult or even impossible to reverse. The changed herbivore community and the resultant impacts on the vegetation has led to lower productivity of karroid vegetation. This, in turn, is thought to have affected the food chain and ultimately reduced the density of tertiary predators, particularly mammals as well as large eagles. High livestock densities also pose considerable threat to wildlife, since high numbers of domesticated animals generally cause a displacement of game, as there is less suitable habitat available. Furthermore, wild predators and scavengers such as the Black-backed Jackal, Caracal, Leopard and the Cape vulture have been eradicated by livestock farmers who see these animals as a threat to their livelihoods. Poisoned carcasses are often used for this purpose; this method is indiscriminate and therefore poses considerable threat to all predators and scavengers; especially the threatened White-backed and Lappet-faced Vultures. Poaching and illegal hunting (dogs) are further reducing the remnant faunal populations.

The faunal habitat assessment was bases on two site visitations conducted during March and November of 2015. The faunal habitat assessment was heavily supplemented by previous surveys conducted in the Northern Cape (2007-2015), virtual museums as well as published literature.

5.1 Mammals

The area is currently utilised for pastoral livestock grazing activities (mainly sheep, cattle and horses) as well as extensive agricultural activities adjacent to the Gariep (Orange) River. The baiting and non-selective killing of predators has a negative impact on remaining populations. The use of wire snares as well as hunting dogs for high intensity poaching activities will significantly affect remaining mammal species such as rabbits and mongooses. The baiting of problem animals such as Black-backed Jackal and Caracal will have an impact on populations as well as non-target species. The spraying of insecticides for locusts can have a negative impact by secondary poisoning on Aardwolf populations. Smaller mammal species are extremely vulnerable to snares and poaching activities as well as feral cats and dogs. Furthermore, sheep and cattle grazing observed within the study area influences the existence of small mammals in the area. According to Bergstrom (2004), the presence of livestock has a negative effect on both small mammal species richness and abundance. Primary and secondary access roads and vehicles increase the risk of road fatalities of smaller mammal species such as the Slender Mongoose (*Galerella sanguinea*), Small Grey Mongoose (*Galerella pulverulenta*), Yellow mongoose (*Cynictis penicillata*), Scrub Hares (*Lepus saxatilis*) and Cape Hare (*Lepus capensis*). A road fatality of a Bat-eared Fox was observed along the primary Gariep access road which bisects the site. Several larger mammal species occur on the site, (mainly introduced for hunting purposes) including Gemsbok (*Oryx gazella*), Blue Wildebees (*Connochaetes taurinus*), Red Hartebees (*Alcelaphus buselaphus*), Springbok (*Antidorcas marsupialis*) including leucistic white form. Smaller antelope species observed included several Steenbok (*Raphicerus campestris*) and Common or Grey Duiker (*Sylvicarpa grimmia*). Burrowing mammal species observed included several active and abandoned Aardvark (*Orycteropus afer*) burrows as well as foraging activities with several recently scraped termite mounds. Porcupines (*Hysterix africaeaustralis*) and Bat-eared Fox (*Octocyon megalotis*), Springhare (*Pedetes capensis*) and South African Ground Squirrels (*Xerus inauris*) and the endemic Brant's Whistling Rat (*Parotomys brantsii*) were observed in the red dune sands.

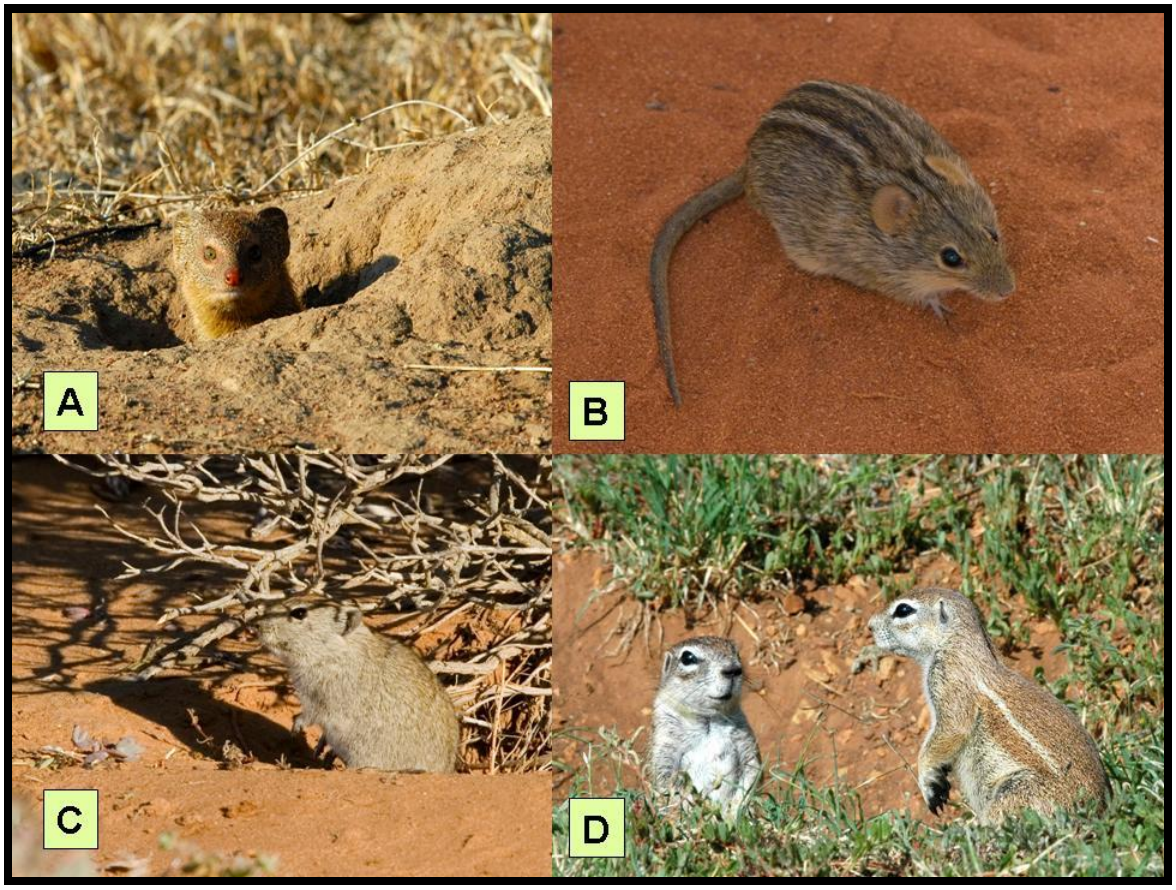


Figure7. Small mammal species observed on the site included: **A:** Yellow Mongoose (*Cynictis penicillata*); **B:** Xeric Four-striped Grass Mouse (*Rhabdomys pumilio*); **C:** Brant's Whistling Rat (*Parotomys brantsii*) and **D:** South African Ground Squirrel (*Xerus inauris*). Photographs courtesy of Prof. G.D. Engelbrecht University of Limpopo.

Various mammal species are likely to occur within the study area. A probable mammal species list of mammals that are likely to occur in study area according to Skinner & (Chimimba 2006) with the assigned level of threat facing each particular species is included in Table 4 below. A map was used to correlate the occurrence of the Red Data species with their approximate occurrence within the study area. According to Friedman & Daly (2004) and Skinner & Chimimba (2006), the majority of species within the study area are common and widespread and listed as species of least concern.

Table4. Mammal species recorded from the study area according to MammalMAP as well as published distribution records (Skinner & Chimimba 2006). Species highlighted in yellow were observed during the two site visits between March and November 2015.

Family	Genus	Species	Subspecies	Common name	Red list category
Bathyergidae	*Cryptomys*	*hottentotus*		Southern African Mole-rat	Not listed
Bovidae	*Alcelaphus*	*caama*		Red Hartebeest	Not listed
Bovidae	*Antidorcas*	*marsupialis*		Springbok	Not listed
Bovidae	*Connochaetes*	*taurinus*	*taurinus*	Blue Wildebeest	Not listed
Bovidae	*Damaliscus*	*pygargus*	*phillipsi*	Blesbok	Not listed
Bovidae	*Kobus*	*ellipsiprymnus*	*ellipsiprymnus*	Waterbuck	Not listed
Bovidae	*Oryx*	*gazella*		Gemsbok	Not listed
Bovidae	*Raphicerus*	*campestris*		Steenbok	Not listed
Bovidae	*Taurotragus*	*oryx*		Common Eland	Not listed
Canidae	*Otocyon*	*megalotis*		Bat-eared Fox	Not listed
Canidae	Vulpes	*chama*		Cape Fox	Not listed
Canidae	Canis	*mesomelas*		Black-backed Jackal	Not Listed
Felidae	Felis	*caracal*		Caracal	Not Listed
Herpestidae	*Suricata*	*suricatta*		Suricate	Not Listed
Herpestidae	*Galerella*	*sanguinea*		Slender Mongoose	Not Listed
Herpestidae	*Cynictis*	*penicillata*		Yellow Mongoose	Not listed
Herpestidae	*Galerella*	*pulverulenta*		Small Grey Mongoose	Not Listed
Leporidae	*Lepus*	*capensis*		Cape Hare	Not Listed
Leporidae	*Lepus*	*sextalis*		Scrub Hare	Not Listed
Manidae	***Manis***	***temminckii***		**Ground Pangolin**	**Near-Threatened**
Macroscelididae	*Macroscelides*	*proboscideus*		Round-Eared Elephant Shrew	Not Listed
Mellivorinae	***Mellivora***	***capensis***		**Honey Badger**	**Near-Threatened**
Muridae	*Aethomys*	*namaquensis*		Namaqua Rock Mouse	Least Concern
Muridae	*Desmodillus*	*auricularis*		Cape Short-tailed Gerbil	Not listed
Muridae	*Gerbillurus*	*paeba*		Paeba Hairy-footed Gerbil	Not listed
Muridae	*Gerbillurus*	*vallinus*		Brush-tailed Hairy-footed Gerbil	Not listed
Muridae	*Mastomys*	*coucha*		Southern African Mastomys	Not listed

Muridae	*Rhabdomys*	*pumilio*		Xeric Four-striped Grass Rat	Not listed
Muridae	***Tatera***	***leucogaster***		**Bushveld Gerbil**	**Data deficient**
Mustelidae	*Ictonyx*	*striatus*		Striped Polecat	Not listed
Nesomyidae	*Malacothrix*	*typica*		Large-eared African Desert Mouse	Not listed
Orycteropodidae	*Orycteropus*	*afer*		Aardvark	Not listed
Sciuridae	*Xerus*	*inauris*		Ground Squirrel	Not listed
Soricidae	*Crocidura*	*cyanea*		Reddish-gray Musk Shrew	Not listed
Soricidae	*Crocidura*	*hirta*		Lesser Red Musk Shrew	Not listed

Table5. Mammal species of conservation importance (Friedman & Daly, 2004) possibly occurring on the proposed site (using habitat availability observed during brief field surveys and distribution as an indicator of presence).

Family	Genus	Species	Subspecies	Common name	Red list category	Likelihood of Occurrence
Erinaceidae	*Atelerix*	*frontalis*		South African Hedgehog	Near Threatened	Medium-High
Felidae	*Felis*	*nigripes*		Small Spotted Cat		Medium-High
Hyaenidae	*Hyaena*	*brunnea*		Brown Hyaena	Near Threatened	Low
Macroscelididae	*Elephantulus*	*intufi*		Bushveld Elephant-shrew	Data Deficient	High
Manidae	*Manis*	*temminckii*		Ground Pangolin	Vulnerable	Medium
Mustelidae	*Mellivora*	*capensis*		Honey Badger	Near Threatened	High
Petromuridae	*Petromus*	*typicus*		Dassie Rat	Near Threatened	Low
Rhinolophidae	*Rhinolophus*	*darlingi*		Dent's Horseshoe Bat	Near Threatened	Low
Vespertilionidae	*Miniopterus*	*schreibersii*		Darlings Horeshoe Bat	Data Deficient	Low

Figure8. A collage of photographs[*] displaying the threatened mammal species likely to occur on and around the Sand Draai CSP site. A: South African Hedgehog (*Aterix frontalis*); **B:** Ground Pangolin (*Manis temminckii*); **C:** Honey Badger (*Mellivora capensis*) and **D:** Black-footed or Small Spotted Cat (*Felis nigripes*[δ]). Species has been downgraded to Least Concern

Several mammal species have been downgraded since the conservation assessment undertaken by Friedman & Daly, (2004). Species downgraded to Least Concern included African Wildcat (*Felis silvestris*), Small Spotted Cat (*Felis nigripes*), Dassie Rat (*Petromus typicus*), Honey Badger (*Mellivora capensis*), Geoffrey's Horeshoe Bat (*Rhinolophus clivosus*) and the Littledale's Whistling Rat (*Parotomys littledalei*) which were previously listed as 'Near Threatened'.

[*] Photographs courtesy of Prof G.D. Engelbrecht U.L.

[δ] Photograph taken by Beryl Wilson in the Benfontein Nature Reserve near Kimberley

No evidence of any of the above-mentioned threatened mammal species were observed during the two site visitations. Honey Badgers have been recorded from the neighbouring Farm Bokpoort to the south of the site (Bathusi Environmental 2010). The destruction of vegetation within the CSP site will not have a significant impact on the larger mammal species which will be able to move away from the area and establish new territories. The clearing of the vegetation as well as soil disturbances will have a high impact the smaller mammal species which occur in the area. As a precautionary mitigation measure it is recommended that the developer and construction contractor as well as an independent environmental control officer should be made aware of the possible presence of certain threatened animal species (South African Hedgehog, Honey Badger, Pangolin) prior to the commencement of construction activities. In the event that any of the above-mentioned species are discovered relevant conservation authorities should be informed and activities surrounding the site suspended until further investigations have been conducted. If any South African Hedgehogs are observed within the CSP site they should be collected and relocated in suitable habitat away from the site.

No specific recommendations are made for the protection of burrowing red data mammals. Consideration could be given to rescuing the animals where there burrows are found in advance of construction. This is not recommended as a general prescription since the chances of digging out live Aardwolf or Antbear (Aardvark) are small. Aardwolf as well as Aardvark/Antbear are likely to vacate their burrows in the face of the advancing construction. There is also a risk associated with capturing animals dug out of burrows, and holding them in captivity. All animals should be allowed to move away freely from the vegetation clearing activities. No hunting or poaching activities should be allowed on the site. The site should be adequately fence preventing larger mammal species entering the 'high-risk' area of the proposed CSP plant and possible damage to mirrors or burning on pipes. Bats have been reported to be killed while foraging on insects which are attracted to the CSP site. No information is available for the impact of CSP plants on bat mortality in South Africa. To reduce potential impacts on bats; exclusionary measures should be implemented to prevent bats from roosting on the site.

More intensive surveys conducted over extended periods are required in order to ascertain the current conservation status of the above-mentioned threatened mammal species on the site. The majority are extremely secretive and elusive species which may not be observed over extended field as well as camera-trapping surveys. It is highly unlikely that the proposed CSP site forms critical habitat for any of the above-mentioned threatened mammal species and will most likely result in a medium, short to long term negative impact on the remaining mammal species occurring within the area.

5.2 Reptiles

Reptile lists require intensive surveys conducted for several years. Reptiles are extremely secretive and difficult to observe even during intensive field surveys conducted over several seasons. The majority reptile species are sensitive to severe habitat alteration and fragmentation. Due to current agricultural activities in the area coupled with increased habitat degradation (overgrazing, soil erosion) and disturbances are all causal factors in the alteration of reptile species occurring in these areas. A few scattered low-lying rocky hills dominated by quartzite fragments occur on the proposed Sand Draai site and provide favourable refuges for certain snake and lizard species (rupicolous species). Reptile species observed within the low-lying quartzite and calcrete rocky hills included Variegated Skink (*Trachylepis variegata*), Western Three-striped Skink (*Trachylepis occidentalis*), Western Rock Skink (*Trachylepis sulcata sulcata*), Southern Rock Agama (*Agama atra*) and Ancheita's Agama (*Agama anchietae*). Suitable habitat occurs for the Karoo Girdled Lizard (*Karusasaurus polyzonus*) in the rocky hills, inhabiting fissures between rocks and under loosely embedded rocks

Trees such as the protected large Camel Thorns (*Vachellia erioloba*) and Grey Camel Thorn (*Vachellia haematoxylon*) offer suitable habitat for arboreal reptile species, such as the Karasburg Tree Skink (*Trachylepis sparsa*). Moribund (old abandoned or dead mounds) termite mounds offer important refuges for numerous frog, lizard and snake species. Large number of species of mammal, birds, reptiles and amphibians feed on the emerging alates (winged termites). These mass emergences coincide with the first heavy summer rains and the emergence of the majority of herpetofauna. Termite mounds also provide nesting site for numerous snakes, lizards (varanids) and frogs.

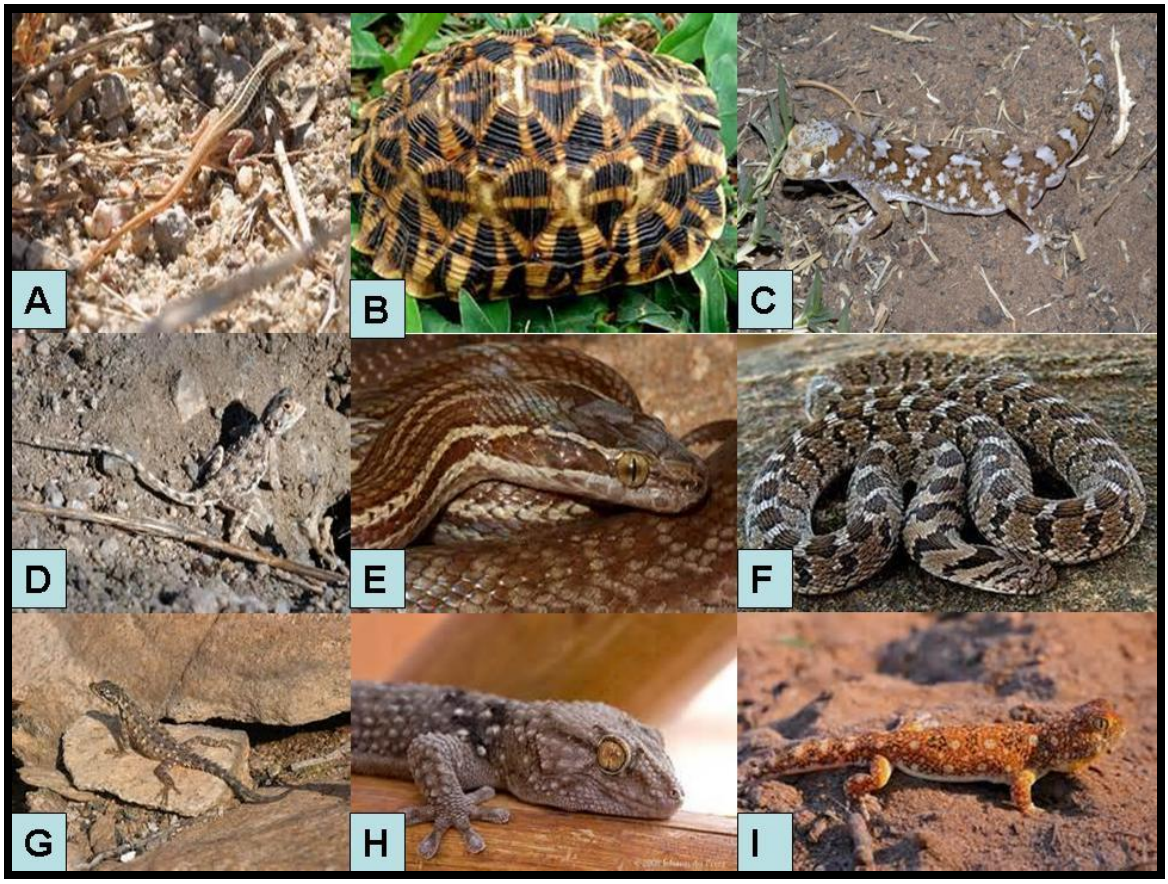


Figure9. A conglomerate of photographs displaying the reptile species recorded from the Sand Draai study area. A: Bushveld Lizard (*Heliobolus lugubris*); **B:** Serrated Tent Tortoise (*Psammobates oculifer*); C: Quartz Gecko (Pachydactylus latirostis); **D:** Ground Agama (*Agama aculeata aculeata*); **E:** Brown House Snake (*Boaedon capensis*); **F:** Rhombic Egg-eater (*Dasypeltis scabra*); **G:** Karoo Girdled Lizard (*Karusasaurus polyzonus*); **H:** Bribron's Gecko (*Chondrodactylus bibronii*) and **I:** Spotted Barking Gecko (*Ptenopus garrulous maculatus*).

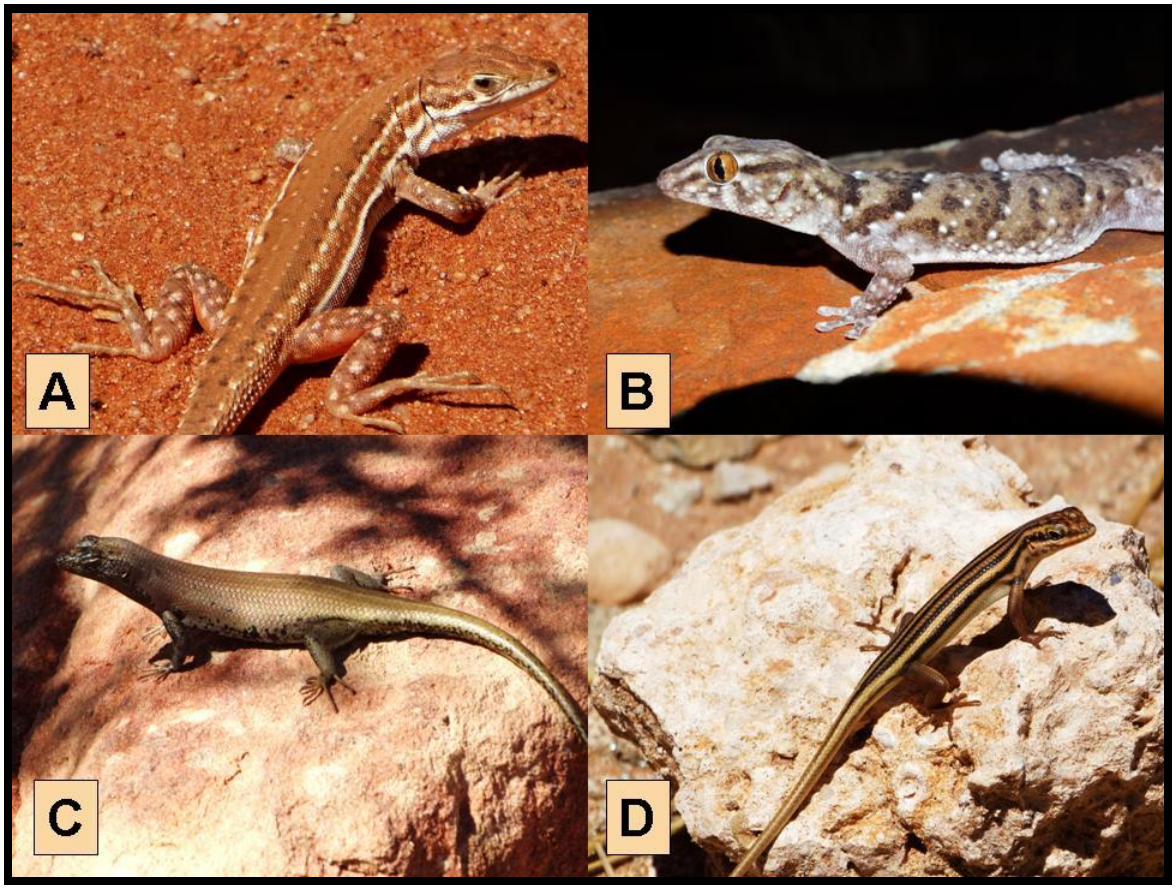


Figure10. A conglomerate of photographs displaying the reptile species recorded from the Sand Draai study area. A: Spotted Sandveld Lizard (*Pedioplanis lineocellata*); **B:** Turner's Thick-toed Gecko (*Pachydactylus turneri*); **C:** Male Western Striped Skink (*Trachylepis sulcata sulcata*); **D:** Female Western Striped Skink (*Trachylepis sulcata sulcata*).

Favourable habitat exists throughout most of the study area for various snake species. Indiscriminate killing of all snake species is likely to have resulted in the disappearance of the larger and the more sluggish snake species within the study area. Several terrestrial or ground-living lizards species were observed including Spotted Sandveld Lizard (*Pedioplanis lineocellata*) were observed darting between small shrubs within red sand dunes and Western Striped Skink (*Trachylepis sulcata sulcata*) within the low-lying quartzite and clacrete hills.

Table6. A list of reptile species recorded from the 2822CA, 2821CD, 2821DD QDGC's according to ReptiMAP/SARCA. Species in yellow have been recorded from the actual site as well as adjacent farm to the west of the site.

Family	Genus	Species	Subspecies	Common name	Red list category	Atlas region endemic
Agamidae	*Agama*	*aculeata*	*aculeata*	Common Ground Agama	Least Concern (SARCA 2014)	Yes
Agamidae	*Agama*	*atra*		Southern Rock Agama	Least Concern (SARCA 2014)	
Amphisbaenidae	*Dalophia*	*pistillum*		Blunt-tailed Worm Lizard	Least Concern (SARCA 2014)	
Amphisbaenidae	*Monopeltis*	*mauricei*		Maurice's Worm Lizard	Least Concern (SARCA 2014)	Yes
Colubridae	*Boaedon*	*capensis*		Brown House Snake	Least Concern (SARCA 2014)	
Colubridae	*Dasypeltis*	*scabra*		Rhombic Egg-eater	Least Concern (SARCA 2014)	
Colubridae	*Psammophis*	*notostictus*		Karoo Sand Snake	Least Concern (SARCA 2014)	
Cordylidae	*Karusasaurus*	*polyzonus*		Karoo Girdled Lizard	Least Concern (SARCA 2014)	Near Endemic
Elapidae	*Naja*	*nivea*		Cape Cobra	Least Concern (SARCA 2014)	
Gekkonidae	*Chondrodactylus*	*angulifer*	*angulifer*	Common Giant Ground Gecko	Least Concern (SARCA 2014)	
Gekkonidae	*Chondrodactylus*	*turneri*		Turner's Gecko	Least Concern (SARCA 2014)	
Gekkonidae	*Chondrodactylus*	*bibronii*		Bibron's Gecko	Least Concern (SARCA 2014)	
Gekkonidae	*Pachydactylus*	*capensis*		Cape Gecko	Least Concern (SARCA 2014)	
Gekkonidae	*Pachydactylus*	*latirostris*		Quartz Gecko	Least Concern (SARCA 2014)	
Gekkonidae	*Ptenopus*	*garrulus*	*maculatus*	Spotted Barking Gecko	Least Concern (SARCA 2014)	Yes
Lacertidae	*Pedioplanis*	*lineoocellata*	*lineoocellata*	Spotted Sand	Least Concern	

				Lizard	(SARCA 2014)	
Lacertidae	*Heliobolus*	*lugubris*		Bushveld Lizard	Least Concern (SARCA 2014)	
Scincidae	*Trachylepis*	*sparsa*		Karasburg Tree Skink	Least Concern (SARCA 2014)	
Scincidae	*Trachylepis*	*sulcata*	*sulcata*	Western Rock Skink	Least Concern (SARCA 2014)	Yes
Scincidae	*Trachylepis*	*variegata*		Variegated Skink	Least Concern (SARCA 2014)	
Testudinidae	*Psammobates*	*oculifer*		Serrated Tent Tortoise	Least Concern (SARCA 2014)	Yes
Viperidae	*Bitis*	*arietans*	*arietans*	Puff Adder	Least Concern (SARCA 2014)	
Viperidae	*Bitis*	*caudalis*		Horned Adder	Least Concern (SARCA 2014)	

Threatened species

According to the outdated Branch (1988b) Red Data Book as well as the updated South African Reptile Conservation Assessment (SARCA 2014) virtual museum; no threatened species of reptile occurs within the study area. The destruction of approximately 350 ha for the CSP plant will have a medium; short to long term impact on the reptile species occurring within the shrub plains and dunes. No development is proposed for the low-lying quartzite and calcrete rocky hills.

Several venomous snake species could occur within the Sand Draai site including Southern or Bibron's Burrowing Asp (*Atractaspis bibronii*), Cape Cobra (*Naja nivea*), Horned Adder (*Bitis caudalis*) and Puff Adder (*Bitis arietans*). General avoidance of snakes if the best policy if encountered. Snakes should not be harmed or killed and allowed free movement away from the area. Safety precaution measure must be implemented especially during the vegetation clearance phase which could result in encounters with several venomous snake species. Appropriate foot wear (sturdy leather boots) should be worn in the field. Educational programmes for the contractor's staff must be implemented to ensure that project workers are alerted to the possibility of snakes being found during vegetation clearance. The construction team must be briefed about the management of snakes in such instances. Ideally the independent ECO should undergo an accredited venomous snake handling course and any snakes or reptiles encountered should be captured and relocated away from the site. Certain structures within the CSP site could be used by certain urban exploiter reptile species such as the Western Striped Skink (*Trachylepis sulcata sulcata*).

5.3 AMPHIBIANS

Amphibians are an important component of South Africa's exceptional biodiversity (Siegfried 1989) and are such worthy of both research and conservation effort. This is made additionally relevant by international concern over globally declining amphibian populations, a phenomenon currently undergoing intensive investigation but as yet is poorly understood (Wyman 1990; Wake 1991). Amphibians have declined dramatically in many areas of the world. These declines seem to have worsened over the past 25 years and amphibians are now more threatened than either mammals or birds, though comparisons with other taxa are confounded by a shortage of reliable data.

Most frogs have a biphasic life cycle, where eggs laid in water develop into tadpoles and these live in the water until they metamorphose into juvenile fogs living on the land. This fact, coupled with being covered by a semi-permeable skin makes frogs particularly vulnerable to pollutants and other environmental stresses. Consequently frogs are useful environmental bio-monitors (bio-indicators) and may acts as an early warning system for the quality of the environment

Breeding in African frogs is strongly dependent on rain, especially in the drier parts of the country where surface water only remains for a short duration. The majority of frog species in the Northern Cape Province can be classified as explosive breeders. Explosive breeding frogs utilise ephemeral or seasonally inundated grassy pans for their short duration reproductive cycles. The amphibians of the area belong to the Kalahari assemblage whose boundaries conform closely to those of the Kalahari savannas of the Northern Cape and North-West provinces. The Kalahari is distinguished especially by its deep sandy substrates, and this feature has a marked effect on the availability of surface water. This is likely to be the key factor in the biogeography of amphibians. It is significant that the sole listed indicator species is a terrestrial breeder namely the Bushveld Rain Frog (*Breviceps adspersus*). The Kalahari assemblage has low species richness, with total species accounts not exceeding 10 species per grid cell anywhere in the assemblage. Only one endemic species, the Karroo Toad *Vandijkophrynus* (*Bufo*) *gariepinus*, enters the assemblage peripherally, and no range restricted species present (Alexander *et al.*, 2004).

Extremely limited historic data for frog species occurring within the 2822CA, 2821CD, 2821DD Quarter Degree Grid Squares (http://sarca.adu.org.za.) Only two frog species namely Guttural Toad (*Amietophrynus gutturalis*) and Bubbling Kassina (*Kassina senegalensis*) were recorded during the previous South African Frog Atlas Project. Both these species are common and have a wide distribution range. Four frog species were recorded during the current survey. Approximately 40mm of rainfall was recorded during a downpour which resulted in the emergence of several Guttural Toads (Amietophrynus gutturalis) as well as Western Olive Toad (Amietophrynus poweri). Several Bushveld Rain Frogs (Breviceps adspersus) were observed calling from burrows situated within the red sand plains as well as dunes. A Queckett's River Frog (*Amietia quecketti*) was flushed from the edge of an irrigation dam adjacent to the Orange River. No seasonal pans were observed on the site during the brief field survey. A probable amphibian species list is presented in Table 7 below.

Figure11. A collage of frog species likely to occur on and around the Sand Draai CSP site. **A:** Bushveld Rain Frog (*Breviceps adspersus*); **B:** Western Olive Toad (*Amietophrynus poweri*); **C:** Tremelo Sand Frog (*Tomopterna cryptotis*); **D:** Queckett's River Frog (*Amietia quecketti*); **E:** Guttural Toad (*Amietophrynus gutturalis*) and **F:** Bubbling Kassina (*Kassina senegalensis*).

Table7. Frog species likely to occur on the Sand Draai CSP site and adjacent areas. Species in yellow were recorded during the March and November 2015 field surveys.

Family	Genus	Species	Common name	Red list category	Atlas region endemic
Brevicepitidae	*Breviceps*	*adspersus*	Bushveld Rain Frog	Least Concern	0
Bufonidae	*Amietophrynus*	*gutturalis*	Guttural Toad	Least Concern	0
Bufonidae	*Amietophrynus*	*poweri*	Western Olive Toad	Least Concern	0
Hyperoliidae	*Kassina*	*senegalensis*	Bubbling Kassina	Least Concern	0
Pyxicephalidae	*Amietia*	*queckettii*	Queckett's River Frog	Least Concern	0
Pyxicephalidae	*Tomopterna*	*cryptotis*	Tremelo Sand Frog	Least Concern	0

HABITAT AVAILABLE FOR SENSITIVE OR ENDANGERED SPECIES

Figure12. The Giant Bullfrog has been recorded from adjacent grid squares to the south- east of the Sand Draai site breeding in seasonally inundated pans or depressions.

Giant Bullfrog (*Pyxicephalus adspersus*)

The Giant Bullfrog is currently assigned as a near-threatened species (IUCN Red List category) (Minter et al. 2004). Giant Bullfrogs have been recorded to the south (Brandvlei) as well as to the north of Augrabies National Park during previous surveys as well as during the South African Frog Atlas Project (SAFAP). Specimens recorded were of road fatalities, migrating adult males as well as a breeding locality in the Prieska area. Bullfrog density commonly varies within certain habitats (open grassland/karroid habitat). High densities are often associated with specific microhabitats or patches (hygrophytic or aquatic ephemerophytic grass and sedge dominated pans) that can be identified and randomly sampled. No natural seasonal or ephemeral pans or depressions were observed within the proposed Sand Draai site during the current field survey. Smaller seasonally inundated pools could possibly occur within certain lower-lying areas; especially along the non-perennial drainage lines. No Giant Bullfrogs were observed on the site as well as along the N-10 after heavy downpours in March 2015. If any Giant Bullfrogs are unearthed or discovered on the site they should be captured and relocated in suitable habitat adjacent to the site. If any dormant Giant Bullfrogs (within 'cocoon') are unearthed during earth-moving activities they should be stored in a cool place within a cooler box filled with moist potting soil and released after sufficient summer rainfall. More intensive surveys focusing on the neighbouring seasonal pans; conducted after sufficient rainfall are required to determine the presence of Giant Bullfrogs and other frogs species on the site. It is highly unlikely that the proposed 350 ha site provides critical habitat for any Giant Bullfrogs. The proposed CSP plant will most likely have a medium-low, short-long term impact on the remaining frog species likely to occur within the study area.

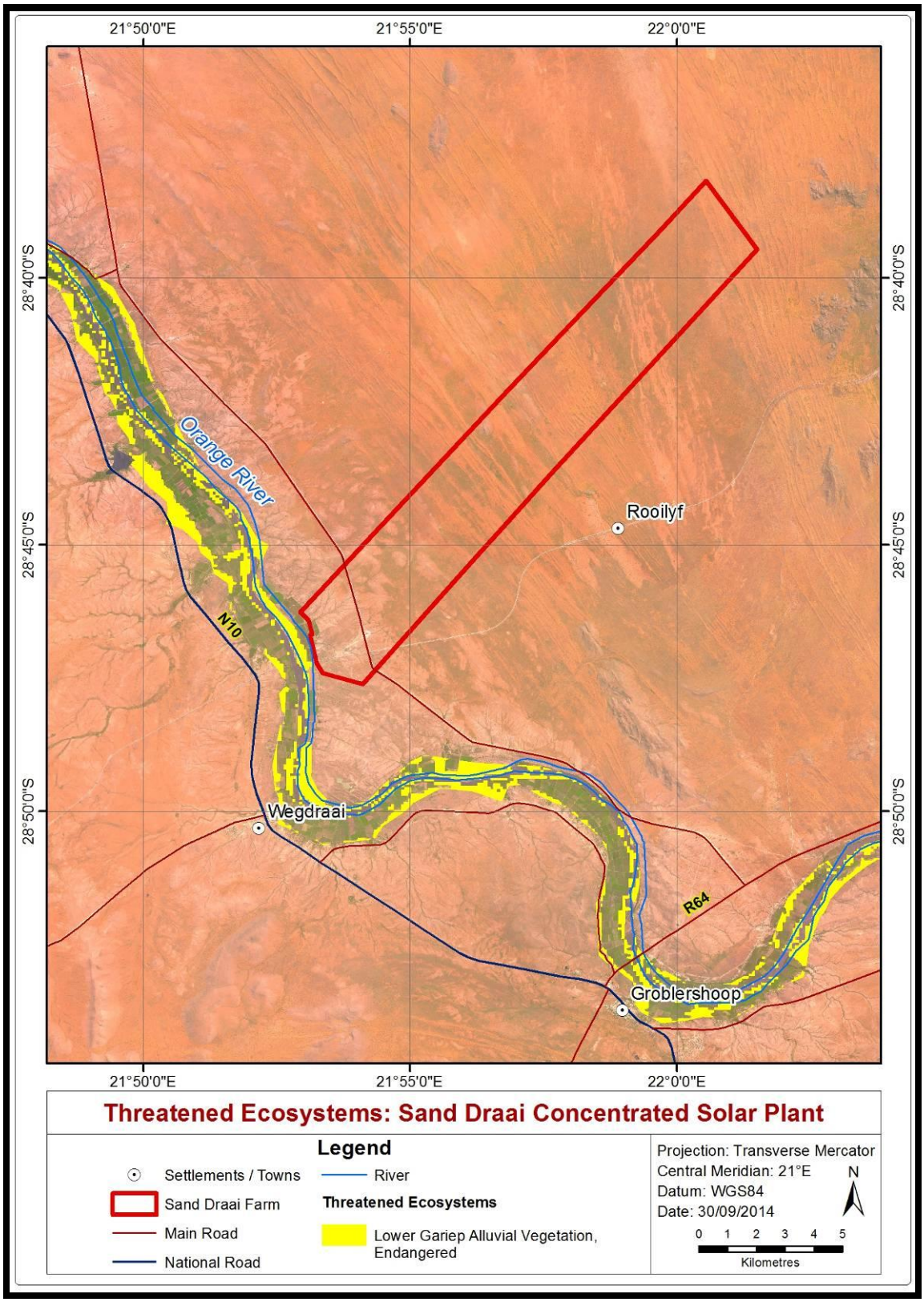


Figure13. Sand Draai site in relation to any threatened ecosystems (SANBI GIS layer).

6. SENSITIVE HABITATS

6.1 The Gariep (Orange) River and Riparian Zone and Non-Perennial Drainage Lines

Rivers and streams/drainage lines are longitudinal systems with impacts affecting both upstream and downstream habitat. The entire seasonally inundated or non-perennial drainage lines and their associated indigenous dominated riparian vegetation must be considered as sensitive habitats. Any impact on the riverine area within the study area is therefore also likely to impact on upstream and downstream areas. Riparian zones have the capacity to act as biological corridors connecting areas of suitable habitat in birds (Whitaker & Metevecchi, 1997), mammals (Cockle & Richardson 2003) reptiles and amphibians (Maritz & Alexander 2007). Riparian zones may act as potential refugia for certain fauna and could allow for possible re-colonisation of rehabilitated habitats. The riparian vegetation plays a vital role in the re-colonisation of aquatic macro-invertebrates as well as reptiles and amphibians (Maritz & Alexander 2007).

The riparian vegetation provides vital refuge, foraging and migratory passages for species migrating to and away from the rivers. The riparian zone comprises plant communities contiguous to and affected by surface and subsurface hydrological features of perennial or intermittent water bodies (rivers and streams). The riparian vegetation is dependant on the river for a number of functions including growth, temperature control, seed dispersal, germination and nutrient enrichment. Riparian vegetation comprises a distinct composition of species, often different from that of the surrounding terrestrial vegetation. Tree species are positioned according to their dependence or affinity for water, with the more mesic species (water-loving) being located closest to the river channel, often with their roots in the water, and the less water-loving terrestrial species further away from the river.

The riparian zone, of which vegetation is a major component, has a number of important functions including:

- enhancing water quality in the river by the interception and breakdown of pollutants;
- interception and deposition of nutrients and sediments;
- stabilisation of riverbanks and macro-channel floor;
- flood attenuation;
- provision of habitat and migration routes for fauna and flora;
- provision of fuels, building materials and medicines for communities (if done on a sustainable basis); and
- recreational areas (fishing - rod and line not shade or gill nets; bird watching; picnic areas etc.).

All rivers including the Gariep (Orange) River as well as several smaller non-perennial drainage lines must be considered as a **High sensitive habitats** due to ecological functioning as well as providing suitable habitat as well as biological or dispersal corridors for remaining faunal species. The Gariep (Orange) River and Lower Gariep Alluvial vegetation (AZa3) type comprises alluvial terraces and small riverine “islands” with riparian thickets mostly dominated by *Ziziphus mucronata, Vachellia karroo, Salix mucronata, Euclea pseudebenus* and *Phragmites australis*. Grasslands occurring on the flat alluvial are periodically flooded and also forms part of this complex vegetation type. These grasslands are mostly dominated by *Cynodon dactylon, Setaria verticillata* and *Cenchrus cilliaris*. The entire riparian zone has been classified as an ‘Endangered’ vegetation type (see Figure above). Activities within the Gariep (Orange) River’s riparian zone must be restricted to the proposed water abstraction pipeline servitude. Vegetation clearance must be restricted to the alien invaded sections dominated by *Prosopis glandulosa* and no indigenous riparian species must be removed. The pipeline servitude must be adjusted and follow existing cleared sections or alien invaded sections only to minimise the potential impacts on the highly sensitive riparian zone. The alternative 2 pipeline alignment is preferred as it bisects a narrower section of the riparian zone as well as running adjacent to transformed agricultural lands. The pipeline servitude within the Orange River’s riparian zone must be appropriately rehabilitated using indigenous (to the area) vegetation.

6.2 Low-lying Quartzite and Calcrete Rocky Hills

The low-lying quartzite and calcrete rocky hills must be considered as **medium sensitive** habitats which provides important habitat for birds and rupicolous reptile and mammal species. For example, a wide variety of bird groups utilize ridges, koppies and hills for feeding, roosting and breeding. These groups include some owls, falcons, nightjars, swifts, swallows, martins, larks, chats, thrushes, cisticolas, pipits, shrikes, starlings, sunbirds, firefinches, waxbills, buntings, canaries, bustards and eagles. The proposed road and pipeline alternative 1 bisects the low-lying rocky hills on the northern site boundary. They alternative 2 road and pipeline alternative is preferred. No developments are proposed within the low-lying rocky hills on the Sand Draai site.

From the initial site visitations as well as desktop study using inter alia aerial photographs and Google Earth ™ imagery the following four sensitivity categories of areas were identified:

High: Areas with high species richness and habitat diversity comprising natural indigenous plant species. These areas are ecologically valuable and important for ecosystem functioning. These areas should be avoided wherever possible.

Medium: An area with a relatively natural species composition; not a threatened or unique ecosystem; moderate species and habitat diversity. Development could be considered with limited impact on the vegetation / ecosystem.

Low-medium: Areas with relatively natural vegetation, though a common vegetation type. Could be developed with mitigation and expected low impact on ecosystem

Low: A totally degraded and transformed area with a low habitat diversity and ecosystem functioning; no viable populations of natural plants. Development could be supported with little to no impact on the natural vegetation / ecosystem.

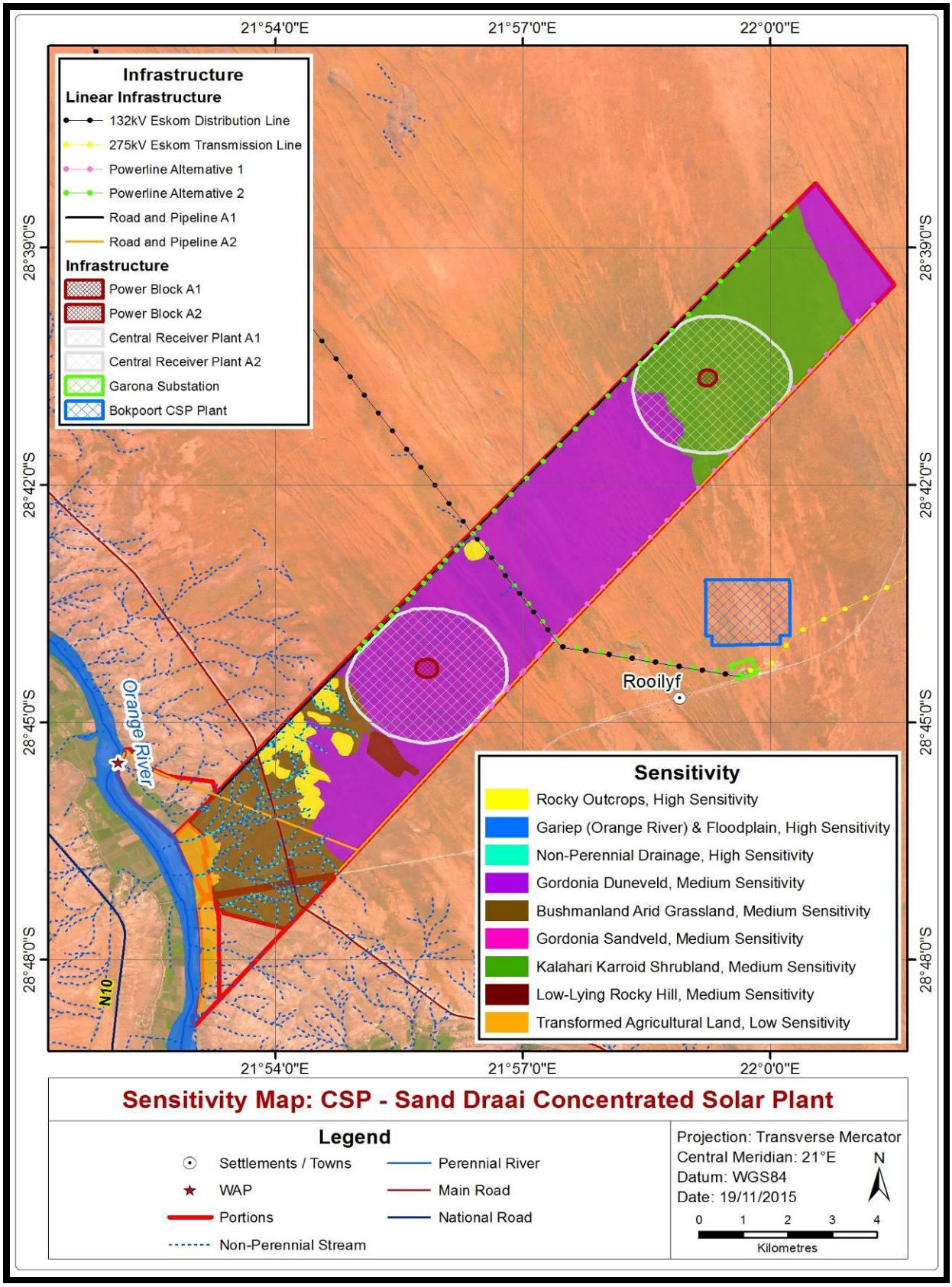


Figure14. Ecological sensitivity map for the proposed Sand Draai CSP.

7. Impact rating of the proposed Sand Draai CSP

Table8. The impact rating criteria used for determining potential impacts of the CSP.

Descriptive criteria		
Nature	**Include a descriptive sentence**	
Probability	**Categories 1 – 5**	
	1	Improbable (less than 24% chance of occurring)
	2	Probable (25 – 49%)
	3	Likely (50 – 69%)
	4	Very likely (70 – 89%)
	5	Definite (90 – 100%)
Frequency	Categories 1 – 5	
	1	Very rare to remote (once or twice a decade)
	2	Unusual to occasional (once or twice every 5 years)
	3	Frequent (a few times a month)
	4	Very frequent (a few times a week, to daily)
	5	Continuous (daily to a significant percentage of every day)
Extent	Categories 1 – 5	
	1	Footprint / site
	2	Local
	3	Regional
	4	National
	5	International (trans-boundary)
Duration	Categories 1 – 5	
	1	Short (few days to a few months, less than a phase)
	2	Short (few months, or less than a phase in total)
	3	Medium (a few years, significant part of a phase)
	4	Long (lifespan of development (i.e. all of operation)
	5	Permanent
Intensity	Categories 1 – 5	
	1	Very low – natural processes not affected
	2	Low – natural processes slightly affected
	3	Medium – natural processes continue but in a modified manner
	4	Medium-high – natural processes are modified significantly
	5	High – natural processes disturbed significantly so that they cease to occur (temporarily / permanently)
Significance	**Significance = P + F + E + D + I** Minimum value of 5, maximum of 25 Status determines if positive / negative	
	Any positive value	No impact High to low consequence, probability not an issue as positive, **no mitigation required**
	– 5	Low-Low consequence, probably, **minimal mitigation may be required**
	– 6 to 10	Medium-Medium consequence, probably, **mitigation is advised / preferred**
	– 11 to 15	Medium-High consequence, probably to very probable, **mitigation is necessary**
	– 16 to 20	High-High consequence, probably / definite, **mitigation is essential**
	– 21 to 25	Extreme-Very high consequence, definite, **Fatal flaw!**

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Table9. Summary table of the potential impacts and ratings for the CSP project.

Nature of Impact	Probability	Frequency	Extent	Duration	Intensity	Significance
Habitat destruction with transformation of natural vegetation and habitats within the proposed CSP Site.	Definite (90-100%)	During Construction Phase	Local Footprint / site	Permanent	Medium – natural processes continue but in a modified manner	High-High consequence, probably / definite, **mitigation is essential**
Destruction of suitable habitat for red listed plants and animals.	Definite (90-100%)	During Construction Phase	Local Footprint / site	Permanent	Medium – natural processes continue but in a modified manner	High-High consequence, probably / definite, **mitigation is essential**
Increased levels of road fatalities of dispersing animals.	Very likely (70 – 89%)	Very frequent (a few times a week, to daily)	Local Footprint / site	Long (lifespan of development (i.e. all of operation))	Low – natural processes slightly affected	High-High consequence, probably / definite, **mitigation is essential**
Erosion and sediment control from the cleared site.	Improbable (less than 24% chance of occurring)	Very rare to remote (once or twice a decade)	Local Footprint / site, but eroded soil could be washed onto other ecosystems	Long (lifespan of development (i.e. all of operation)	Low – natural processes slightly affected	Medium-Medium consequence, probably, **mitigation is advised / preferred**
Collisions with structures and possible burning on receiver tubes	Improbable (less than 24% chance of occurring)	Unusual to occasional (once or twice every 5 years).	Local	Long (lifespan of development (i.e. all of operation))	Very low – natural processes not affected	Medium to high-Medium-Medium consequence, probably, **mitigation is advised / preferred**

Table10. Summary table of the potential impacts for the shared linear infrastructure (road, pipeline and powerlines) for the CSP plant.

Nature of Impact	Probability	Frequency	Extent	Duration	Intensity	Significance
Habitat destruction with transformation of natural vegetation and habitats within the proposed alignments.	Definite (90-100%)	During Construction Phase	Local Footprint / site	Permanent	Medium – natural processes continue but in a modified manner	High-High consequence, probably / definite, **mitigation is essential**
Destruction of suitable habitat for red listed plants and animals.	Definite (90-100%)	During Construction Phase	Local Footprint / site	Permanent	Medium – natural processes continue but in a modified manner	High-High consequence, probably / definite, **mitigation is essential**
Increased levels of road fatalities of dispersing animals.	Very likely (70 – 89%)	Very frequent (a few times a week, to daily)	Local Footprint / site	Long (lifespan of development (i.e. all of operation))	Low – natural processes slightly affected	High-High consequence, probably / definite, **mitigation is essential**
Erosion and sediment control from the cleared site.	Improbable (less than 24% chance of occurring)	Very rare to remote (once or twice a decade	Local Footprint / site, but eroded soil could be washed onto other ecosystems	Long (lifespan of development (i.e. all of operation)	Low – natural processes slightly affected	Medium-Medium consequence, probably, **mitigation is advised / preferred**

8. POTENTIAL IMPACTS OF PROPOSED CSP PLANT ON ASSOCIATED VEGETATION AND FAUNA AS WELL AS PROPOSED MITIGATORY MEASURES

Any development will have a negative effect on the natural ecosystem in particular the vegetation thereof. The vegetation of areas where the CSP development and building of structures will take place will destroy all vegetation present on the specific area where the CSP structures are planned to be erected. Due to the effect of soil tillage and the complete removal of indigenous vegetation these areas will be totally transformed or destroyed. The effect on the ecosystem and surrounding areas will depend on the planned development activity.

The purpose of any ecological assessment is to determine areas of high sensitivity and to provide guidelines to ensure that the proposed development is ecologically sensitive and to prevent unnecessary destruction of natural ecosystems. It is mostly unavoidable to prevent all development especially the linear developments such as power lines, roads and pipelines to bisect sensitive areas. It is therefore important that all possibilities for such linear infrastructures are investigated in order to provide ecologically sound recommendations on routes to be followed.

The proposed linear infrastructure alignments are located within four different vegetation types. Three of the vegetation types namely the Bushmanland Arid Grassland (NKb3), Gordonia Duneveld (SVkd1), Kalahari Karroid Shrubland (NKb5) that are not regarded as being threatened. The **Lower Gariep Alluvial vegetation (AZa3)** situated within the floodplain of the Gariep River is classified as an “Endangered” vegetation type. No major developments are proposed within this sensitive habitat except for the proposed water abstraction pipeline. It is imperative that construction activities are restricted to the piplein servitude within the riparian zone of the Gariep River. Vegetation clearance should be restricted to alien invasive sections preventing the removal of any indigenous riparian tree species. The landscape is mostly low flat to undulating areas with sandy plains, dunes and low-lying rocky hills present in some areas.

Large portions of the Sand Draai site are used for grazing by domestic stock (sheep) and game. Although representative of the natural vegetation, none of the units are regarded as very sensitive with large patches of these vegetation types available in other parts of the Northern Cape region. One does however have to ensure that no unnecessary disturbance of the adjacent natural vegetation occurs so as to eliminate an edge effect of the CSP. None of the impacts assessed for the different vegetation units will have a high negative effect on the adjacent environment

The red data 'declining' tree *Vachellia erioloba* is present in all of the vegetation units. It plays an important role in the ecosystem by providing food, shelter and shade to various animal and bird species. Protected tree species recorded on the site included Camel Thorn (*Vachellia erioloba*), Grey Camel Thorn (*Vachellia haematoxylon*) and Shepherd's Tree (*Boscia albitrunca*). It is imperative that these trees are not unnecessarily removed from the ecosystem. If single individuals of these species have to be removed, a permit from the Department of Agriculture, Fisheries and Forestry (Forestry Branch) and Nature Conservation will have to be obtained for this purpose. It is recommended that once the final linear infrastructure and CSP site have been decided on and pegged that a walk down by a qualified plant ecologist is done to determine how many of these protected species must be removed.

The proposed CSP plant and associated linear infrastructure including pipelines, powerlines and access roads and associated increased vehicular traffic may impact on the terrestrial fauna in various ways. The major impacts occurring during the construction phase involve the loss and fragmentation of habitats, with a consequent loss of biodiversity, some ecosystem functioning and possibly loss of remnant faunal species or of plant species of conservation concern. This may result from direct land clearance, or occur indirectly via loss or changes in habitats due to consequent changes in drainage patterns, increased fire risk, or secondary impacts associated with socio-economic factors resulting from changes in surrounding land use. During the operational life of the CSP plant and access road, small accumulative impacts would also occur, including ongoing road mortalities, increased disturbance (noise and light), dust generation, air pollution, chemical contamination from petroleum and rubber products, increased litter, changes in the incidence of fire (more frequent), and the introduction of a corridor for alien vegetation. All of these factors may impact the surrounding fauna and ecological processes in different ways. The potential impact of fauna colliding with the infrastructure as well as possible burning by the central receiver is not know and would be restricted mainly to birds (see separate Avifaunal assessment) as well as bats foraging on insects. No information is available for the impact of CSP plants on bat mortality in South Africa. To reduce potential impacts on bats; exclusionary measures should be implemented to prevent bats from roosting on the site.

8.1 EVALUATION OF THE ALTERNATIVE CSP SITES AND LINEAR ALIGNMENTS

As mentioned previously, two alternative sites have been for the new CSP plant. Factors considered in evaluating and determining the order of preference of the site and linear infrastructure (access road, pipeline and powerline) corridors in terms of vegetation and faunal impacts are listed and discussed below:

CSP Central Receiver Site Alternatives:
The CSP alternative site 1 is situated within the northern portions of the site mainly within Open Shrub Plains or Kalahari Karroid Shrubland (NKb5) with a small section of Gordonia Duneveld (SVkd1),. There is no preference from a vegetation perspective as the vegetation within both site are relatively homogenous with protected tree species occurring in both sites and both vegetation units been listed as 'Least-threatened'. The vegetation units are both classified as medium conservation status. Both the CSP sites offers suitable habitat for certain red listed faunal species. The alternative CSP site 1 however is situated within the northern portions of the site so additional access roads, pipelines as well as powerlines will be required. For this reason alternative site 2 is preferred due to shorter distances for the linear infrastructure on the site as well as proposed powerlines to the adjacent Garona substation. Additional roads will result in further increased road fatalities and powerlines (bird collisions).

Road and Pipeline alternatives:
The alternative 1 runs along the northern boundary and bisects Gordonia Duneveld with low-lying rocky outcrops. The alternative 2 bisects the site including non-perennial drainage lines and runs adjacent to the southern boundary of the site. Both the alternatives are preferred with a slight preference for alternative 2 as it does not bisect the low-lying rocky areas on the northern boundary and is situated adjacent to existing access roads and railway line to the south.

Water abstraction pipeline alignments
The alternative 1 water abstraction pipeline alignment bisects natural arid shrubland as well as non-perennial drainage lines. The alternative 2 water abstraction pipeline alignment is preferred as it bisects a narrower section of the riparian zone as well as running adjacent to transformed agricultural lands.

Powerline alternatives
Powerline 1 alternative runs on the southern boundary of the site. Alternative 2 runs of the northern boundary as well as bisecting Gordonia Duneveld towards the Garona substation. The alternative 1 is preferred as it is shorter and situated adjacent to existing access roads and railway line to the south. The alternative also runs parallel to the preferred road and pipeline alignments.

In order to rank these alternatives a table was compiled and the two CSP sites and linear infrastructure corridors or alignments were given a rating on a scale of 1 to 5, with 1 being the least preferred and 5 being the most highly preferred option.

Table11: Preference rating for the CSP site alternatives and linear infrastructure alignments.

CSP SITE	**PREFERENCE RATING**
1	3
2	2
Road & Pipeline Alternatives	**Preference Rating**
1	2.5
2	2
Water abstraction pipeline alternatives	**Preference Rating**
1	2
2	1.5
Powerline	**Preference Rating**
1	2
2	2.5

As can be seen from the discussions and table above, CSP site alternative 2 is slightly preferred over alternative 1. Road and pipeline alternative 2 is slightly preferred over alternative 1. The water abstraction pipeline alternative 2 is preferred over the alternative 1.The powerline alternative 1 is slightly preferred over alternative 2.

9. HABITAT DESTRUCTION AND ASSOCIATED DISTURBANCES TO REMAINING FAUNAL SPECIES

During the construction phase of the proposed CSP plant, habitat destruction and alteration inevitably takes place. This happens with the construction of access roads, and the clearing of the vegetation on the site for the CSP plant. These activities will have an impact on the associated vegetation and fauna; especially ground living and fossorial species occurring within and in close proximity of the CSP site, both through modification of habitat and disturbance caused by human activity. The proposed impact will be of a **definite medium; short-long term negative impact** on remaining natural vegetation and associated faunal species within the CSP site and immediate adjacent areas.

MITIGATION AND RECOMMENDATIONS

The following recommendations are made to minimize the impacts of proposed CSP plant and linear infrastructure (road, pipeline and powerline) on the immediate environment and remaining fauna:

- Close site supervision must be maintained during construction. A suitably qualified (minimum BSC. Hons.) Environmental Control Officer (ECO) must be appointed for the project.
- During the **CONSTRUCTION** phase workers must be limited to areas under construction within the CSP site and access to the undeveloped areas, especially the surrounding low-lying rocky hills, non-perennial drainage lines and Gariep River and riparian zone must be strictly regulated ("no-go" areas during construction as well as operational activities).
- Provision of adequate toilet facilities must be implemented to prevent the possible contamination of ground (borehole) water in the area. Mobile toilets must be provided in order to minimize un-authorised traffic of construction workers outside of the designated areas.
- All alien invasive plant should be removed from the proposed pipeline and road servitude to prevent further invasion.
- Firearms or any other hunting weapons must be prohibited on site.
- Contract employees must be educated about the value of wild animals and plants and the importance of their conservation.
- Severe contractual fines must be imposed and immediate dismissal on any contract employee who is found attempting to snare or otherwise harm remaining faunal species.
- No animals should be intentionally killed or destroyed and poaching and hunting should not be permitted on the site.

SCORPIONS AND SPIDERS

- Several poisonous spiders occur around the site including the Black Button Spider (*Lactrodectus indistincus*). One of the most dangerous spiders in Southern Africa with a neurotoxic venom.
- Several species of scorpions are recorded from the area including *Pseudolychas pegleri*, *Uroplected triangulifer*, *Uroplectes formosus, Opistacanthus vallidus, Opistothalmus macer, Opistothalmus karrooensis, Opistothalmus capensis, Opistothalmus pictus*.
- These scorpions construct burrows or scrapes under rocks as well as found under loose bark, wood piles and other surface debris.
- The majority of these scorpions possess a painful sting they are not of medical importance except *Parubuthus granulatus* which is South Africa's most venomous scorpion species.
- Care should be taken when removing stumps, logs or rock material.
- Any scorpions encountered on the site should be left alone and allowed free access away from the activity or safely removed from the area.
- No scorpions should be intentionally killed. Standard precautions or safety measures includes wearing sturdy leather boots and gloves in the field and close inspection of sleeping areas and bedding, clothes, shoes etc. for any scorpions.
- Stings from mildly venomous scorpions cause localised pain and swelling, with little systematic reaction. The affected limb should be immobilized and an ice pack should be applied, if possible, to the site of the sting. The site of the sting should be cleaned and never cut open.
- Venom sprayed in the eyes (certain *Parabuthus* species are able to spray venom) produces an intense burning sensation and may result in temporary blindness if the eyes are not washed out thoroughly with clean water or some other neutral liquid such as milk

SNAKES

- Educational programmes for the contractor's staff must be implemented to ensure that project workers are alerted to the possibility of snakes being found during vegetation clearance. The construction team must be briefed about the management of snakes in such instances.
- Several venomous snake species occur within the Sand Draai site including Southern or Bibron's Burrowing Asp (*Atractaspis bibronii*), Cape Cobra (*Naja nivea*), Horned Adder (*Bitis caudalis*) and Puff Adder (*Bitis arietans*).
- Safety precaution measure must be implemented especially during the vegetation clearance phase which could result in encounters with several venomous snake species.
- Appropriate foot wear (sturdy leather boots) should be worn in the field.

8.2 VEGETATION

All indigenous trees and plants occurring outside the proposed road, pipeline and powerline servitude shall be left undisturbed and permits will be required for the removal of the protected tree species Camel Thorn (*Vachellia erioloba*), Grey Camel Thorn (*Vachellia haematoxylon*) and Shepherd's Tree (*Boscia albitrunca*) have been identified and declared as protected. In terms of the National Forests Act 1998 (Act No 84 of 1998) certain tree species can be identified and declared as protected. The Department of Water Affairs and Forestry (now Department of Forestry and Fisheries) developed a list of protected tree species. In terms of Section 15 (1) of the National Forests Act, 1998, no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree or any forest product derived from a protected tree, except under a license or exemption granted by the Minister to an applicant and subject to such period and conditions as may be stipulated. Trees are protected for a variety of reasons, and some species require strict protection while others require control over harvesting and utilization. The Department of Agriculture, Forestry and Fisheries (DAFF) will have to be approached to obtain the required permits for the removal of any protected tree species.

Management objective

- Minimal disturbance to vegetation where such vegetation does not interfere with the CSP plant and the linear infrastructure servitudes (road, pipeline and powerline)
- No unnecessary destruction to surrounding vegetation especially in the adjacent natural areas situated in close proximity to the CSP site and linear infrastructure servitudes.

Measurable targets

- Adequate protection of adjacent indigenous plant or tree species, especially protected trees including Camel Thorn (*Vachellia erioloba*), Grey Camel Thorn (*Vachellia haematoxylon*) and Shepherd's Tree (*Boscia albitrunca*).
- Permits are obtained from DAFF prior to the removal of any protected tree or plant species.
- No litigation due to removal of vegetation (protected plant and tree species) without the necessary permits

MITIGATION AND RECOMMENDATIONS

- As a precautionary measure as suitably qualified botanist should undertake a walk-through of the CSP site as well as linear developments servitudes and undertake a rescue and recovery programme. All remaining geophytes and Aloes should be removed and relocated away from the development.

- Regular inspections should be performed on the translocated plants in order to gauge the success of the exercise. This information should be relayed to the Northern Cape conservation authorities.

- Where herbicides are used to clear vegetation, selective and biodegradable herbicides registered for the specific species should be applied to individual plants only. General spraying and the use of non-selective herbicides (e.g. Roundup, Mamba etc.) should be prohibited at all times.

- All alien vegetation should be eradicated within the linear infrastructure servitudes over a five-year period. Invasive species (*Prosopis gladulosa* var. *tooreyana, Opuntia sp., Argemone ochroleuca)* should be given the highest priority. No dumping of any materials in undeveloped open areas and neighbouring properties. Activities in the surrounding open undeveloped areas must be strictly regulated and managed. It is imperative that the construction and operational activities are restricted to the CSP plant and associated linear infrastructure. This impact is anticipated to be **localised, of a long-term nature and of low significance**, provided that appropriate mitigation measures are implemented (e.g. the limitation of vegetation or tree clearance adjacent to the linear infrastructure).

8.3 VEGETATION CLEARANCE

Management objective

- Minimise damage to surrounding vegetation
- Minimise damage to topsoil
- Successful rehabilitation of barren areas

Measurable targets

- No damage to indigenous vegetation outside the road servitude
- No loss of topsoil
- No visible erosion three months after completion of the contract
- All disturbed areas successfully rehabilitated three months after completion of the contract

MITIGATION AND RECOMMENDATIONS

- Vegetation clearing of the CSP plant must be kept to the site. Vegetation clearance for the shared linear infrastructure should be restricted to the servitudes. Several protected tree species occur within and adjacent to the proposed alignments. Any trees with large root systems shall be cut manually and removed, as the use of a bulldozer will cause major damage to the soil when the root systems are removed. Stumps shall be treated with herbicide. Smaller vegetation can be flattened with a machine, but the blade should be kept above ground level to prevent scalping. Any vegetation cleared shall be removed or flattened and not be pushed to form an embankment.

- Disturbed areas of natural vegetation must be rehabilitated immediately to prevent soil erosion. This is especially relevant to the water abstraction pipeline within the alluvial riparian vegetation of the Gariep River. The use of herbicides shall only be allowed after a proper investigation into the necessity, the type to be used, the long-term effects and the effectiveness of the agent. Application shall be under the direct supervision of a qualified technician. All surplus herbicide shall be disposed of in accordance with the supplier's specifications.

- All alien vegetation in the linear infrastructure servitudes and densifiers creating a fire hazard shall be cleared and treated with herbicides. Exotic and invasive plant species were categorised according to the framework laid out by The Conservation of Agricultural Resources Act (CARA) (Act 43 of 1983). CARA defines weeds as alien plants, with no known useful economic purpose that should be eradicated. Invader plants, also considered by the Act, can also be of alien origin but may serve useful purposes as ornamentals, as sources of timber, or may have other benefits (Henderson, 2001). These plants need to be managed and prevented from spreading.

Alien and invasive plant species can be grouped three categories:

- Category 1 plants are weeds that serve no useful economic purpose and possess characteristics that are harmful to humans, animals or the environment. These plants need to be eradicated using the control methods stipulated in Regulation 15.D of the CARA.
- Category 2 plants are plants that are useful for commercial plant production purposes but are proven plant invaders under uncontrolled conditions outside demarcated areas.
- Category 3 plants are mainly used for ornamental purposes in demarcated areas but are proven plant invaders under uncontrolled conditions outside demarcated areas.

The dominant alien invasive vegetation observed mainly within the transformed areas adjacent to existing homesteads on the south-western boundary included the Category 2 *Prosopis gladulosa* var. *tooreyana,* Category 1 *Opuntia sp.* and Category 1 Weed *Argemone ochroleuca.*

It is recommended that a contractor for the vegetation clearing of the CSP site as well as linear infrastructure should comply with the following parameters:

- The contractor must have the necessary knowledge to be able to identify indigenous and protected tree species including Camel Thorn (*Vachellia erioloba*), Grey Camel Thorn (*Vachellia haematoxylon*) and Shepherd's Tree (*Boscia albitrunca*) as well as indigenous species not interfering with the pipeline, road and powerline towers/servitudes.
- The contractor must also be able to identify declared weeds and alien species that must be totally eradicated according to the Conservation of Agricultural Resources Act (Act 43 of 1983).
- The contractor must be in possession of or appoint a person with a valid herbicide applicators license.

8.4 INCREASED ROAD FATALITIES

The proposed access roads to the CSP plant will most-likely result in a **medium-high, short-long duration negative impact** due to increase in numbers of road fatalities of dispersing faunal species. The alternative 1 road alignment which bisects the low-lying rocky hills on the northern boundary could potentially result in increased fatalities of faunal species moving towards and away from these areas.

MITIGATION AND RECOMMENDATIONS

- The alternative 2 road and pipeline alignment is preferred as they don't bisect any low-lying rock hills.
- Speed limits should be imposed on the proposed access roads.
- Fences should be erected adjacent to the access road preventing animals entering onto the road.

8.5 EROSION AND SEDIMENT CONTROL

The deep red sands within the CSP site have a **low** erodibility and **low** risk of erosion**.** No specific mitigatory measures for controlling erosion and sedimentation are expected from the CSP site as well as access roads due to the flat topography and well-drained, deep red sandy soils.

8.6 FIRE FREQUENCY

The possibility occurs for fires and burning of the vegetation will have a high impact on remaining vegetation and associated faunal species. Fires during the winter months will severely impact on the hibernating species, which are extremely sluggish. Fires during the early summer months destroy the emerging reptiles as well as refuge areas increasing predation risks.

Management objective

- Minimise risk of veld fires
- Minimise damage to grazing
- Prevent runaway fires

Measurable targets

- No veld fires started by the Contractor's work force
- No claims from Landowners for damages due to veld fires
- No litigation

MITIGATION AND RECOMMENDATIONS

- **No open fires shall be allowed on site** under any circumstance. The Contractor shall have fire-fighting equipment available on all vehicles working on site, especially during the winter months.
- Precautionary signs should be erected indicating no open fires.
- During the operational phase of the CSP plant firebreaks should be maintained between the CSP site and adjacent natural vegetation.

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