Report on the ecological and wetland assessment for the proposed Kiara PV Solar development for Phase 2 situated on Portion 2 and the Remaining Extent of the Farm Hollaagte 8 near the town of Lichtenburg, North West Province.

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Prepared by:

Darius van Rensburg
Pr.Sci.Nat. 400284/13
T 083 410 0770
darius@dprecologists.co.za
P.O. Box 12726 | 61 Topsy Smith Street
Brandhof | Langenhovenpark
9324 | 9300

Prepared for:
Savannah Environmental (Pty) Ltd
P.O. Box 148
Sunninghill
Gauteng
2157

DECLARATION OF INDEPENDENCE

DPR Ecologists and Environmental Services is an independent company and has no financial, personal or other interest in the proposed project, apart from fair remuneration for work performed in the delivery of ecological services. There are no circumstances that compromise the objectivity of the study.

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Title	**Report on the ecological and wetland assessment for the proposed Kiara PV Solar development for Phase 2 situated on Portion 2 and the Remaining Extent of the Farm Hollaagte 8 near the town of Lichtenburg, North West Province.**		
Author	**DP van Rensburg (Pr.Sci.Nat)**		**Sept'22**

Executive Summary

The study area is situated approximately 15 km to the north east of the town of Lichtenburg in the North West Province (Appendix A: Map 1 – 4). The development will consist of seven separate phases but which all form part of the same study area. This report will be applicable to Phase 2 of the development. The study area is fairly large and is dominated by undulating grassland plains with gentle slopes that generally slopes toward a lower lying drainage area located centrally within the study area. The study area has an approximate extent of 1600 hectares while phase 2 covers 179 hectares of this. The majority of the study area is still dominated by natural vegetation although significant portions of it was affected by historical transformation for crop cultivation.

As previously indicated, the study area is still dominated by natural vegetation but which is fairly uniform and can be considered as a whole. The study area will therefore be discussed in its entirety with smaller specific elements indicated where these were noted to be of sufficient importance.

Lichtenburg, and the specific study area, is situated within the Grassland Biome and under natural conditions would be dominated by grasses with shrubs and trees being almost completely absent. However, this region is situated in a transitional area between the Grassland and Savannah Biomes and consequently a tree layer is present but sparse and represented by scattered trees. Where rocks, mostly dolomite, outcrop in the area this also promotes the establishment of trees. Since the area is still dominated by natural vegetation, the area is still dominated by open grassland but with scattered trees also present. However, patches and pockets of lower lying areas had previously been ploughed and cultivated. These are most probably areas containing deeper soils with a higher moisture regime. This is also relevant where the surrounding areas may be dominated by surface dolomite rock. Aerial images dating back several decades also confirm this. The vegetation composition of these areas have however been able to largely, re-establish itself to near natural conditions. Other areas where the vegetation composition and structure has been locally modified include farmsteads, stock watering points and a woodlot of invasive Bluegum (*Eucalyptus camaldulensis*). However, overall the vegetation composition and structure of the area would therefore seem to be largely intact.

From the description of the area it is clear that the majority of the site still consists of natural grassland which is still in a fairly good condition (Appendix A: Map 1). Some disturbance is present though in general these are localised or has been able re-establish a near natural grass layer. The surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase does not cover a large area, cumulatively the development will have a high impact. This will also be taken into account for the current proposed development which will therefore contribute toward a significant cumulative impact.

The description of the proposed development area indicates a relatively uniform habitat, with moderate species diversity and largely without any unique habitats or areas of high diversity. Furthermore, the vegetation consists of Carletonville Dolomite Grassland, which although it has a significant species diversity, is currently listed as being of Least Concern (LC) which also

does not contribute toward its conservation value (Appendix A: Map 1). Overall, the vegetation in the study area can therefore not be regarded as exceeding a Moderate level of sensitivity (Appendix A: Map 4). Areas of localised high conservation value may however still be present and which may require exclusion from development. Phase 2 of the development contains a large dolomite sinkhole which may require exclusion from development (Appendix A: Map 4). It is also located approximately 800 meters to the south of a drainage area but which will be discussed in greater detail in the wetland assessment section of the report (See Section 4.3) (Appendix A: Map 3).

Phase 2 of the development contains a large sinkhole which represents a unique habitat within the landscape and functions largely in terms of groundwater recharge. It therefore has a somewhat higher conservation value than the surrounding landscape and also provides higher value ecological functions (groundwater recharge and unique habitat) and as a result it is considered to have a High level of sensitivity as opposed to the Moderate sensitivity of surrounding areas. The development should therefore consider the exclusion of this sinkhole. Furthermore, the Marico Biosphere Reserve also border the study area to the north. The protected area should remain unaffected by the proposed development, but should still be consulted during the application process.

Signs and tracks of mammals are fairly abundant on the site and will be relatively close to the natural condition, both in terms of species composition and population size. Rare and endangered mammals are often reclusive and avoid areas in close proximity to human activities and are also dependant on habitat in pristine condition. The site would therefore have some impact on the likelihood of such rare and endangered species occurring in the area, though there will remain a significant likelihood of such a species occurring in the area. The most significant impact on mammals anticipated on the site itself is primarily concerned with the loss and fragmentation of available habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. Since it is inevitable that the development will involve the transformation of natural grassland this contributes significantly toward habitat loss which in turn will result in a high impact on the mammal population. The area is surrounded by extensive natural areas which will somewhat decrease the impact though the loss of habitat will still result in a decrease in the mammal population size which will essentially result in a reduction in the mammal population of the area.

The area is largely devoid of surface drainage lines, watercourses and wetlands, however, a large drainage area is situated in the central portion of the study area (Appendix A: Map 1 & 3). It does not form a defined watercourse though scattered wetland depressions become evident towards the eastern end of the study area and also confirms a shallow groundwater table along this drainage area. The drainage area is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). It will however still be included in the report in order to provide an overall description of the study area. This drainage area is also likely to play an important role in terms of groundwater recharge for this area. Especially so since it is regarded as part of the Bo-Molopo Karst Belt Strategic Water Source Area (SWSA) which perform important functions in terms of groundwater resources. The drainage area will be excluded from the development footprint and will therefore not be directly affected by it though the development may still have some indirect impacts on it.

The vegetation survey indicated that the drainage area is devoid of both wetland and riparian vegetation and is largely dominated by a combination of pioneer grasses, most likely a consequence of the historical ploughing. Toward the eastern end of the study area, obligate

wetland grasses, *Leptochloa fusca*, become prominent in depressions and here wetland conditions are confirmed. In these instances the soil samples also confirmed the presence of soil wetness indicators. However, for the majority of the drainage area, soils did not conclusively indicate the presence of saturated conditions. The drainage area does however still play an important role, especially in terms of groundwater resources and it is therefore regarded as important and sensitive. However, wetland systems would normally be regarded as having a Very High level of sensitivity but since the survey confirmed that wetland areas only become evident toward the eastern end of the study area, this drainage system is only regarded as having a High level of sensitivity (Appendix A: Map 4).

From the impacts affecting the system it should be clear that the depression wetland areas associated with the drainage area (and therefore also the drainage system as a whole) has resulted in a significant level of modification. A WET-Health determination was undertaken for the depression wetland area to determine its current condition and provide an indication of the overall condition of the drainage system (Appendix D). The results of the WET-Health indicated an overall Present Ecological State of Category C: Moderately Modified. This is considered relatively accurate given the impacts on the system. The EI&S of the wetland depression portion of the drainage system has been rated as being Low.

A Risk Assessment for the proposed solar facility which will affect the drainage system in the study area has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). The drainage system will be excluded from the development though development and is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). A risk matrix and subsequent water use therefore does not apply to this phase of the development.

Despite the drainage area being largely modification and large portion being devoid of riparian and wetland conditions, it should still be regarded as a no-go area and no construction or operational activities including stockpiling, clearing, laydown areas, vehicle movement or any other associated activities should occur within this drainage area.

The impact significance has been determined and indicates that the majority of impacts will remain moderate such as the impact on protected plant species, the drainage system, infestation by exotic weeds, erosion and habitat fragmentation. These impacts will all remain moderate and several can also be further decreased given adequate mitigation is implemented. However, since the area of development is fairly large and still consists of natural vegetation in a relatively good condition the impact on vegetation and diversity loss as well as the impact on the mammal population will remain high. These impacts can also not readily be mitigated since the development footprint is fixed.

List of Acronyms

CBA – Critical Biodiversity Area
ESA – Ecological Support Area
NFEPA – National Freshwater Ecosystem Priority Areas
PES – Present Ecological State
NBA – National Biodiversity Assessment
SWSA – Strategic Water Source Areas
TOPS – Threatened Or Protected Species
DWS – Department of Water and Sanitation
WRC – Water Research Commission
EIS – Ecological Importance and Sensitivity
EMC – Ecological Management Class
SAIIAE – South African Inventory of Inland Aquatic Ecosystems
CSIR – Council for Scientific and Industrial Research
SANBI – South African National Biodiversity Institute
BSR – Biodiversity Sensitivity Rating
AMSL – Above Mean Sea Level
POSA – Plants of South Africa
LC – Least Concern
DDD - Data Deficient - Insufficient Information
NT – Near Threatened
VU – Vulnerable
EN – Endangered
NWA – National Water Act
NWBSP – North West Biodiversity Sector Plan

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Ecological and wetland assessment.

1. INTRODUCTION

Natural vegetation is an important component of ecosystems. Some of the vegetation units in a region can be more sensitive than others, usually as a result of a variety of environmental factors and species composition. These units are often associated with water bodies, water transferring bodies or moisture sinks. These systems are always connected to each other through a complex pattern. Degradation of a link in this larger system, e.g. tributary, pan, wetland, usually leads to the degradation of the larger system. Therefore, degradation of such a water related system should be prevented.

Though vegetation may seem to be uniform and low in diversity it may still contain species that are rare and endangered. The occurrence of such a species may render the development unviable. Should such a species be encountered the development should be moved to another location or cease altogether.

South Africa has a large amount of endemic species and in terms of plant diversity ranks third in the world. This has the result that many of the species are rare, highly localised and consequently endangered. It is our duty to protect our diverse natural resources.

South Africa's water resources have become a major concern in recent times. As a water scarce country, we need to manage our water resources sustainably in order to maintain a viable resource for the community as well as to preserve the biodiversity of the system. Thus, it should be clear that we need to protect our water resources so that we may be able to utilise this renewable resource sustainably. Areas that are regarded as crucial to maintain healthy water resources include wetlands, streams as well as the overall catchment of a river system.

In order to better manage our water resources several guidelines and research sources have been developed. Amongst these are the National Freshwater Ecosystem Priority Areas for South Africa 2011 (NFEPA).

The human population has become a power-hungry system where non-renewable resources are being utilised at an alarming rate. These resources are nearing depletion and are often associated with some form of pollution (air-, water-, atmospheric pollution). The unlimited use of these non-renewable resources is not sustainable. In recent times people have become aware of this and are attempting to alleviate this by using renewable energy sources. This has become increasingly popular and are commonplace in many first world countries. Recently it has come to light that South Africa is optimally situated for solar power production. The use of solar power will alleviate the pressure experienced by Eskom, will reduce carbon emissions and will promote the use of renewable energies. The development of solar facilities should be encouraged. Solar parks do have their disadvantages. These include the use of fertile soil for power production rather than food supply and the disturbance and removal of natural vegetation.

The study area is situated approximately 15 km to the north east of the town of Lichtenburg in the North West Province (Appendix A: Map 1 – 4). The development will consist of seven separate phases but which all form part of the same study area. This report will be applicable to Phase 2 of the development. The study area is fairly large and is dominated by undulating grassland plains with gentle slopes that generally slopes toward a lower lying drainage area

located centrally within the study area. The study area has an approximate extent of 1600 hectares while phase 2 covers 179 hectares of this. The majority of the study area is still dominated by natural vegetation although significant portions of it was affected by historical transformation for crop cultivation.

A site visit was conducted on 21 to 23 June 2022. The entire footprint of the study area (1600 hectares), including terrestrial and riparian areas, was surveyed over the period of several days. The entire study area has been assessed as a whole, while including each phase as a separate report and indicating specific elements for each of these phases. The site survey was conducted during early winter and the majority of vegetation was already in a dormant phase. However, sufficient above ground material was still present to enable identification at least to generic level.

For the above reasons it is necessary to conduct an ecological and wetland assessment of an area proposed for development.

The report together with its recommendations and mitigation measures should be used to minimise the impact of the proposed solar development.

1.1 Background

The Applicant, Voltalia South Africa (Pty) Ltd, is proposing the construction of a photovoltaic (PV) solar energy facility (known as the **Kiara PV facility**) located on a site approximately 16km north east of the town of Lichtenburg in the North West Province. The solar PV facility will comprise several arrays of PV panels and associated infrastructure and will have a contracted capacity of up to **130MW**. The development area is situated within the Ditsobotla Local Municipality within the Ngaka Modiri Molema District Municipality. The site is accessible via an existing gravel road which provides access to the development area.

The development area for the PV facility and associated infrastructure will be located on Portion 2 and the Remaining Extent of the Farm Hollaagte No. 8

Seven PV facilities (Kiara PV 1, Kiara PV 2, Kiara PV 3, Kiara PV 4, Kiara PV 5, Kiara PV 6, Kiara PV 7) are concurrently being considered on the project site (within Portion 2 of the Farm Hollaagte 8 and the Remaining Extent of the Farm Hollaagte No. 8) and are assessed through separate Environmental Impact Assessment (EIA) processes.

A facility development area (approximately 1600ha) have been considered. The infrastructure associated with this PV facility includes:

- PV modules and mounting structures
- Inverters and transformers
- Battery Energy Storage System (BESS)
- Site and internal access roads (up to 8m wide)
- Site offices and maintenance buildings, including workshop areas for maintenance and storage.
- Temporary and permanent laydown area
- Grid connection solution will include:
    - Facility Substation
    - Eskom Switching Station

1.2 The value of biodiversity

The diversity of life forms and their interaction with each other and the environment has made Earth a uniquely habitable place for humans. Biodiversity sustains human livelihoods and life itself. Although our dependence on biodiversity has become less tangible and apparent, it remains critically important.

The balancing of atmospheric gases through photosynthesis and carbon sequestration is reliant on biodiversity, while an estimated 40% of the global economy is based on biological products and processes.

Biodiversity is the basis of innumerable environmental services that keep us and the natural environment alive. These services range from the provision of clean water and watershed services to the recycling of nutrients and pollution. These ecosystem services include:

- Soil formation and maintenance of soil fertility.
- Primary production through photosynthesis as the supportive foundation for all life.
- Provision of food, fuel and fibre.
- Provision of shelter and building materials.
- Regulation of water flows and the maintenance of water quality.
- Regulation and purification of atmospheric gases.
- Moderation of climate and weather.
- Detoxification and decomposition of wastes.
- Pollination of plants, including many crops.
- Control of pests and diseases.
- Maintenance of genetic resources.

1.3 Value of wetlands and watercourses

Freshwater ecosystems provide valuable natural resources, which contributes toward economic, aesthetic, spiritual, cultural and many recreational values. Yet the integrity of freshwater ecosystems in South Africa is rapidly declining in recent times. This crisis is largely a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (the need to utilise these recourses between different stakeholders, i.e. individuals, communities, corporate and industrial) and institutional (Implementing appropriate governance and management). Water affects every activity and aspiration of human society and sustains all ecosystems.

Freshwater ecosystems provide many of our fundamental needs, enable important regulating ecosystem services, supports functional faunal and floral communities:

- Water for drinking and irrigation
- Food such as fish and water plants.
- Building material such as clay and reeds.
- Preventing floods and easing the impacts of droughts.
- Remove excess nutrients and toxic substances from water
- Rivers, wetlands and groundwater systems maintain water supplies and buffer the effects of storms, reducing the loss of life and property to floods.

- Riverbanks help to trap sediments, stabilise
- river banks and break down pollutants draining from the surrounding land.

1.4 Details and expertise of specialist

DPR Ecologists and Environmental Services (Pty) Ltd.
Darius van Rensburg *Pr. Sci. Nat.*
61 Topsy Smith
Langenhoven Park
Bloemfontein
9300
Tel: 083 410 0770
darius@dprecologists.co.za

Professional registration:
South African Council for Natural Scientific Professions No. (400284/13) (Ecological Science).

Membership with relevant societies and associations:
- South African Society of Aquatic Scientists (SASAQS0091)
- South African Association of Botanists
- South African Wetlands Society (3SLY4IG4)

Expertise:

- Qualifications: B.Sc. (Hons) Botany (2008), M.Sc. in Vegetation Ecology (2012) with focus on ephemeral watercourses.
- Vegetation ecologist with over 10 years experience of conducting ecological assessments.
- Founded DPR Ecologists & Environmental Services (Pty) Ltd in 2016.
- Has conducted over 200 ecological and wetland assessments for various developments.
- Regularly attend conferences and courses in order to stay up to date with current methods and trends:

  2017: Kimberley Biodiversity Symposium.
  2018: South African Association of Botanists annual conference.
  2018: National Wetland Indaba Conference.
  2019: SASS5 Aquatic Biomonitoring Training.
  2019: Society for Ecological Restoration World Congress 2019.
  2019: Wetland rehabilitation: SER 2019 training course.
  2020: Tools For Wetlands (TFW) training course.

2. SCOPE AND LIMITATIONS

- To evaluate the present state of the vegetation and ecological functioning of the area proposed for the solar development.
- To identify possible negative impacts that could be caused by the proposed clearing of vegetation and establishment of solar development.
    - Severity relates to the nature of the event, aspect or impact to the environment and describes how severe the aspects impact on the ecosystem.
    - Duration refers to the amount of time that the environment will be affected by the event, risk or impact, if no intervention e.g. remedial action takes place.
    - Extent refers to the spatial influence of an impact.
    - Frequency refers to how often the specific activity, related to the event, aspect or impact, is undertaken.
    - Probability refers to how often the activity/event or aspect has an impact on the environment.
- To provide a description of watercourses, wetlands and riparian vegetation included within the study area.
- Identify watercourses including rivers, streams, pans and wetlands and determine the presence of wetland conditions within these systems.
- Where wetland conditions have been identified the classification of the wetland system will be given.
- To evaluate the present state of the wetlands and riparian vegetation in close proximity to the site. The importance of the ecological function and condition will also be assessed.
- Determine the Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS) for the watercourses in close proximity to operations.
- Conduct a risk assessment and determine the likelihood that watercourses and wetlands will be adversely affected by the development.

2.1 Vegetation

Aspects of the vegetation that will be assessed include:

- The vegetation types of the region with their relevance to the proposed site.
- The overall status of the vegetation on site.
- Species composition with the emphasis on dominant-, rare- and endangered species.

The amount of disturbance present on the site assessed according to:

- The amount of grazing impacts.
- Disturbance caused by human impacts.
- Other disturbances.

2.2 Fauna

Aspects of the fauna that will be assessed include:

- A basic survey of the fauna occurring in the region using visual observations of species as well as evidence of their occurrence in the region (burrows, excavations, animal tracks, etc.).

- The overall condition of the habitat.

2.3 Wetlands and watercourses

Aspects of the wetlands that will be assessed include:

- Identification and delineation of watercourses including rivers, streams, pans and wetlands.
- Determine the presence of wetland conditions and riparian vegetation using obligate wetland and riparian species.
- Describe watercourses and wetlands and importance relative to the larger system.
- Conduct habitat integrity assessment of perennial systems to inform the condition and status of watercourses.

2.4 Limitations

- Due to the season of the survey several bulbs, seasonal herbs and subterranean succulents may have been overlooked as leaves and flowers may be absent due to their seasonal or deciduous nature.
- Although a comprehensive survey of the site was done it is still likely that several species were overlooked.
- Smaller drainage lines may have been overlooked where a distinct channel or riparian vegetation is absent.
- Due to time constraints only limited surveys of wetlands were done.
- Some animal species may not have been observed as a result of their nocturnal and/or shy habits.

3. METHODOLOGY

3.1 Several literature works were used for additional information.

Background information of the region will be taken from:

- Morris, J.W. 1973. Automatic classification and ecological profiles of South-western Transvaal Highveld Grassland. D.Sc. dissertation. University of Natal, Durban.
- Morris, J.W. 1976. Automatic classification of the highveld grassland of Lichtcnburg. south-western Transvaal. Bothalia 12: 267-292.
- Bezuidenhout, H., Bredenkamp, G.J., Theron, G.K. & Morris, J.W. 1994. A Braun-Blanquet reclassification of the Bankenveld Grassland in the Lichtenburg area, south-western Transvaal. South African Journal Botany 60(6): 297-305.

Vegetation:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- NBA 2018: South African Inventory of Inland Aquatic Ecosystems (SAIIAE).
- NBA 2018 Technical Report: Inland Aquatic (Freshwater) Realm.
- NBA 2018 Technical Report Volume 1: Terrestrial Realm.
- National Freshwater Ecosystem Priority Areas 2011 (NFEPA).
- Strategic Water Source Areas 2018 (SWSA).
- SANBI (2011): List of threatened ecosystems.
- NEM:BA: List of threatened ecosystems and Threatened Or Protected Species (TOPS).
- North West Province Biodiversity Sector Plan (2015).

Terrestrial fauna:

- Field guides for species identification (Smithers 1983, Child *et al* 2016, Cillié 2018).

Vegetation:
Field guides used for species identification (Bromilow 1995, 2010, Coates-Palgrave 2002, Fish *et al* 2015, Gerber *et al* 2004, Gibbs-Russell *et al* 1990, Manning 2009, Van Ginkel *et al* 2011, Van Oudtshoorn 2004, Van Rooyen 2001, Van Rooyen & Van Rooyen 2019, Van Wyk & Malan 1998, Van Wyk & Van Wyk 1997).

Wetland methodology, delineation and identification:
Department of Water Affairs and Forestry 2004, 2005, 2008, Collins 2006, Duthie 1999, Kleynhans *et al* 2008, Marnewecke & Kotze 1999, Macfarlane, Ollis & Kotze 2020, Ollis *et al* 2013, Nel *et al* 2011, SANBI 2009.

3.2 Survey

The site was assessed by means of transects and sample plots. Observation w.r.t. the general ecology of the area includes:

- Noted species include rare and dominant species.
- The broad vegetation types present at the site were determined.
- The state of the environment was assessed in terms of condition, grazing impacts, disturbance by humans, erosion and presence of invader and exotic species.

- The state of the habitat was also assessed.

Ecological aspects surveyed and recorded includes:

- The overall ecology of an area including the diversity of species, uniformity or diversity of habitats and different vegetation communities.
- Identification and delineation of distinct vegetation communities ad habitats and the ecological drivers responsible for these distinct communities, i.e. soil, geology, topography, aspect, etc.
- A comprehensive plant species survey including the identification of protected, rare or threatened species.
- Any ecological process or function which is important to the ecosystem including ecological drivers such as fire, frost, grazing, browsing, etc. and any changes to these processes.

Animal species were also noted as well as the probability of other species occurring on or near the site according to their distribution areas and habitat requirements.
The state of the habitat was also assessed.

In order to provide a visually representative overview of the results obtained from the survey, site sensitivity mapping will also be done. This should indicate the relative importance of different ecological elements on the site as obtained from the survey. In general, these levels of sensitivity will include:

- Low Sensitivity – normally confined to areas that are completely transformed from the natural condition or degraded to such an extent that they are no longer representative of the natural ecosystem. Such areas will also no longer contain any ecological processes of importance relative to the surrounding areas, i.e. in some instances such as watercourses which are completely transformed but still provide important ecological functions, a low level of sensitivity will not apply.

- Moderate Sensitivity – normally applicable to areas that are still natural and therefore does still have some ecological importance but which do not contain elements of high conservation value and are not essential to the continued functioning of surrounding areas. Areas of Moderate Sensitivity usually require some mitigation but can be developed without resulting in high impacts.

- High Sensitivity – areas of high sensitivity contain one or more ecological elements which are considered of high conservation value. Such areas are normally preferred to be excluded from a development but where this is not possible, will require comprehensive mitigation and is also likely to result in high impacts.

- Very High Sensitivity – these areas are critical to the continued functioning of the ecosystem on and around the site. Development of such areas normally represent a fatal flaw and should be excluded from development. No manner of mitigation is able to decrease the anticipated impact in these areas.

All rivers, streams, pans and wetlands were identified and surveyed where they occurred in the study area. These systems were determined by use of topography (land form and drainage

pattern) and riparian vegetation with limited soil sampling (Appendix B & C). The following outlines the process applied during the on-site survey in order to obtain all required data:

- Perform desktop overview of the study area utilising available resources (Section 3.1). From the desktop overview identify the different landscape forms, possible wetland areas, watercourses and their relative flow patterns. Using this information, identify transects and sample plots for possible on-site survey. This should be both representative of the wetland or watercourse as a whole but should also include any prominent or significantly unique features.
- Possible sites identified during the desktop overview should be surveyed on-site. Where access is not possible or where desktop features are considered poor representatives of the wetland or watercourse the survey site or transect should be moved to another location, without compromising a comprehensive overview of the system.
- Where a lateral transect is taken of a watercourse this is done from the water's edge, across the marginal, lower and upper zones and extended across the floodplain until the edge of the riparian zone is reached.
- Where a transect is taken of a wetland system, this should preferably be taken across the entire wetland at its widest part or where it is most relevant to the proposed development, from the terrestrial surroundings, across the temporary, seasonal and perennial zones across the wetland.
- Soil samples are taken at 10 meter intervals along the survey transect, or where a distinct transition into a different zone is observed.
- A survey of the plant species within each distinct riparian or wetland zone is undertaken and includes the identification of obligate wetland species, riparian species, terrestrial species, exotic species and the general species composition and vegetation structure which allows for an accurate description of the watercourse or wetland.
- Visual survey of the general topography which substantiates the presence of riparian zones and wetland forms.
- Other general observations include any impacts observed, the overall ecosystem function, presence of fauna, surrounding land uses and the overall condition of the watercourse or wetland.
- Data is recorded by means of photographs with GPS coordinates taken at all relevant soil sampling sites and borders of riparian and wetland zones.

Data obtained during the on-site survey is utilised to provide the following information on the system:

- Desktop overview and assimilation of information on the likely impacts and functioning of the wetland system.
    - Review all available spatial data and resources in order to provide an estimate of the likely impacts and condition of the wetland or watercourse system.
- Confirm the presence of the wetland or watercourse system and provide an estimate of its borders.
    - The border of wetland conditions or the edge of the riparian zone will be confirmed by using soil sampling, obligate wetland vegetation and topography. This will also include the delineation of any temporary, seasonal or perennial zones of wetness along wetlands and the marginal, lower, upper and riparian zones along watercourses.

- Provide a description of the wetland or watercourse.
    - Provide the hydrogeomorphic setting of the wetland, a longitudinal profile which will aid in determining the erodibility of the wetland and provide an overall description of the wetland and impacts affecting it.
    - Provide a general description of the lateral zonation of the watercourse banks including the marginal, lower, upper and riparian zones and a description of the riparian vegetation along the banks of the watercourse. This will also include the description of any impacts or modification of the watercourse.
- Assess the current condition of the wetland or watercourse.
    - Utilising information obtained from the assessments listed above, determine the condition of this portion of the wetland by applying the WET-Health 2 tool.
    - Utilising information obtained from the assessments listed above, determine the condition of the relevant section of the watercourse by applying the Index of Habitat Integrity (IHI) tool.
- Utilising all of the information obtained from the assessment, provide recommendations to mitigate anticipated impacts that the development will have.

The following guidelines and frameworks were also used to determine the presence of the rivers, streams, pans and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

The following guidelines and frameworks were used to determine the sensitivity or importance of these identified watercourses or wetlands in the study area:

- Nel *et al.* (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

- Government of South Africa. 2008. National Protected Area Expansion Strategy for South Africa 2008: Priorities for expanding the protected area network for ecological sustainability and climate change adaptation. Government of South Africa, Pretoria.

- Duthie, A. 1999. Appendix W5: IER (floodplain and wetlands) determining the Ecological Importance and Sensitivity (EIS) and Ecological Management Class (EMC). In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

These guidelines provide the characteristics which can be utilised to determine if a wetland or watercourse is present and also aids in determining the boundary of these systems.

The following were utilised to inform the condition and status of watercourses:

- Kleynhans, C.J., Louw, M.D. & Graham, M. 2008. Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity. Joint

Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 377-08.

The following were utilised to inform the condition and status of wetlands:

- Macfarlane, D.M., Ollis, D.J. & Kotze, D.C. 2020. WET-Health (Version 2.0): a refined suite of tools for assessing the present ecological state of wetland ecosystems. WRC Report No. TT 820/20.

A Risk Assessment will be conducted for the proposed development in or near watercourses and wetlands in accordance with the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use.

3.3 Criteria used to assess sites

The following criteria is also applied during the site survey to further inform the general sensitivity and conservation value of the site or specific elements on the site. These criteria were used to assess the site and determine the overall status of the environment.

3.3.1 Vegetation characteristics

Characteristics of the vegetation in its current state. The diversity of species, sensitivity of habitats and importance of the ecology as a whole.

Habitat diversity and species richness: normally a function of locality, habitat diversity and climatic conditions.
Scoring: Wide variety of species occupying a variety of niches – 1, Variety of species occupying a single nich – 2, Single species dominance over a large area containing a low diversity of species – 3.

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely – 3.

Ecological function: All plant communities play a role in the ecosystem. The ecological importance of all areas though, can vary significantly e.g. wetlands, drainage lines, ecotones, etc.
Scoring: Ecological function critical for greater system – 1, Ecological function of medium importance – 2, No special ecological function (system will not fail if absent) – 3.

Degree of rarity/conservation value:
Scoring: Very rare and/or in pristine condition – 1, Fair to good condition and/or relatively rare – 2, Not rare, degraded and/or poorly conserved – 3.

3.3.2 Vegetation condition

The sites are compared to a benchmark site in a good to excellent condition. Vegetation management practises (e.g. grazing regime, fire, management, etc.) can have a marked impact on the condition of the vegetation.

Percentage ground cover: Ground cover is under normal and natural conditions a function of climate and biophysical characteristics. Under poor grazing management, ground cover is one of the first signs of vegetation degradation.
Scoring: Good to excellent – 1, Fair – 2, Poor – 3.

Vegetation structure: This is the ratio between tree, shrub, sub-shrubs and grass layers. The ratio could be affected by grazing and browsing by animals.
Scoring: All layers still intact and showing specimens of all age classes – 1, Sub-shrubs and/or grass layers highly grazed while tree layer still fairly intact (bush partly opened up) – 2, Mono-layered structure often dominated by a few unpalatable species (presence of barren patches notable) – 3.

Infestation with exotic weeds and invader plants or encroachers:
Scoring: No or very slight infestation levels by weeds and invaders – 1, Medium infestation by one or more species – 2, Several weed and invader species present and high occurrence of one or more species – 3.

Degree of grazing/browsing impact:
Scoring: No or very slight notable signs of browsing and/or grazing – 1, Some browse lines evident, shrubs shows signs of browsing, grass layer grazed though still intact – 2, Clear browse line on trees, shrubs heavily pruned and grass layer almost absent – 3.

Signs of erosion: The formation of erosion scars can often give an indication of the severity and/or duration of vegetation degradation.
Scoring: No or very little signs of soil erosion – 1, Small erosion gullies present and/or evidence of slight sheet erosion – 2, Gully erosion well developed (medium to large dongas) and/or sheet erosion removed the topsoil over large areas – 3.

3.3.3 Faunal characteristics

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species or very unique and sensitive habitats can potentially be a fatal flaw.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely.

3.4 Biodiversity sensitivity rating (BSR)

The total scores for the criteria discussed in section 3.3 were used to determine the biodiversity sensitivity ranking for the sites. On a scale of 0 – 30, five different classes are described to assess the biodiversity of the study area. The different classes are described in the Table 1:

Table 1: Biodiversity sensitivity ranking

BSR	BSR general floral description	Floral score equating to BSR class
Totally transformed (5)	Vegetation is totally transformed or in a highly degraded state, generally has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area has lost its inherent ecological function. The area has no conservation value and potential for successful rehabilitation is very low.	29 – 30
Advanced Degraded (4)	Vegetation is in an advanced state of degradation, has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area's ecological function is seriously hampered, has a very low conservation value and the potential for successful rehabilitation is low.	26 – 28
Degraded (3)	Vegetation is notably degraded, has a medium level of species diversity although no species of concern are present. Invasive plants are present but are still controllable. The area's ecological function is still intact but may be hampered by the current levels of degradation. Successful rehabilitation of the area is possible. The conservation value is regarded as low.	21 – 25
Good Condition (2)	The area is in a good condition although signs of disturbance are present. Species diversity is high and species of concern may be present. The ecological function is intact and very little rehabilitation is needed. The area is of medium conservation importance.	11 – 20
Sensitive/Pristine (1)	The vegetation is in a pristine or near pristine condition. Very little signs of disturbance other than those needed for successful management are present. The species diversity is very high with several species of concern known to be present. Ecological functioning is intact and the conservation importance is high.	0 - 10

4. ECOLOGICAL OVERVIEW OF THE SITE

For the purpose of this report the terrestrial ecology of the study area will first be discussed followed by a discussion of the watercourses and wetland systems.

4.1 Overview of ecology and vegetation types

Refer to the list of species encountered on the site in Appendix B.

The area has a fairly uniform topography as well as soils and geology and as a result contains only one main vegetation type. According to Mucina & Rutherford (2006), the study area consists exclusively of Carletonville Dolomite Grassland (Gh 15). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) this vegetation type is currently listed as being of Least Concern (LC) (Appendix A: Map 1). Although it is in some instances heavily affected by crop cultivation and mining this is not yet considered to be to such an extent as to warrant it being considered a Threatened Ecosystem. It will therefore, in general, have a moderate conservation value. The survey of the study area also confirmed that it corresponds well will this vegetation type as well as the topography and geology of the site. The vegetation type is adapted to a mosaic pattern of shallow soils over dolomite. It consists of a well-developed grass layer but with scattered trees and shrubs, especially where surface rock occurs.

The North West Biodiversity Sector Plan (2015) has been developed and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA), and other elements of high conservation importance. This includes both terrestrial and aquatic elements of importance. Most probably as a result of the uniform nature of this area and the general absence of elements of high conservation value the area is listed as an Ecological Support Area 1. However, the following CBA's and elements of high conservation value are still present and must be regarded as having a significant level of sensitivity (Appendix A: Map 2):

Terrestrial components:

- A large portion of the study area consists of an Ecological Support Area 1 (ESA) and functions as part of an ecological corridor. This function will most likely be affected by the development and will have to be taken into consideration.

Aquatic components:

- The region forms part of the Bo-Molopo Karst Belt Strategic Water Source Area (SWSA) which perform important functions in terms of groundwater resources. As a result, it is listed as an ESA 1. The development is unlikely to affect this functioning though it will still need to be taken into consideration by the development. This will also be especially relevant to drainage areas and sinkholes which mainly function in terms of ground water recharge.
- A central lower lying drainage area is listed as CBA 1 as it forms part of the local drainage network and contains scattered wetland conditions which is of high conservation value. This will be an important element which the development will have to avoid.

The study area is situated approximately 15 km to the north east of the town of Lichtenburg in the North West Province (Appendix A: Map 1 – 4). The development will consist of seven

separate phases but which all form part of the same study area. This report will be applicable to Phase 2 of the development. The study area is fairly large and is dominated by undulating grassland plains with gentle slopes that generally slopes toward a lower lying drainage area located centrally within the study area. The study area has an approximate extent of 1600 hectares while phase 2 covers 179 hectares of this. The majority of the study area is still dominated by natural vegetation although significant portions of it was affected by historical transformation for crop cultivation.

As previously indicated, the study area is still dominated by natural vegetation but which is fairly uniform and can be considered as a whole. The study area will therefore be discussed in its entirety with smaller specific elements indicated where these were noted to be of sufficient importance.

Lichtenburg, and the specific study area, is situated within the Grassland Biome and under natural conditions would be dominated by grasses with shrubs and trees being almost completely absent. However, this region is situated in a transitional area between the Grassland and Savannah Biomes and consequently a tree layer is present but sparse and represented by scattered trees. Where rocks, mostly dolomite, outcrop in the area this also promotes the establishment of trees. Since the area is still dominated by natural vegetation, the area is still dominated by open grassland but with scattered trees also present. However, patches and pockets of lower lying areas had previously been ploughed and cultivated. These are most pr+obably areas containing deeper soils with a higher moisture regime. This is also relevant where the surrounding areas may be dominated by surface dolomite rock. Aerial images dating back several decades also confirm this. The vegetation composition of these areas have however been able to largely, re-establish itself to near natural conditions. Other areas where the vegetation composition and structure has been locally modified include farmsteads, stock watering points and a woodlot of invasive Bluegum (*Eucalyptus camaldulensis*). However, overall the vegetation composition and structure of the area would therefore seem to be largely intact.

Figure 1: Natural grassland dominate the study area but which is clearly fairly uniform.

Figure 2: The study area is dominated by grassland with rocky outcrops also being fairly common throughout the area.

Figure 3: Though a well-developed grass layer dominated the area, scattered trees and shrubs are also characteristic of the vegetation type.

From the above paragraphs it is clear that the study area is still largely natural and dominated by dense grassland with scattered trees and shrubs. However, several localised areas have been affected by previous transformation and other current impacts. These are all associated with the farming activities in this area. Areas of notable transformation or impacts include:

- The area is largely used for grazing by domestic livestock and though the impact is not extensive, a moderate degree of overgrazing and trampling is evident but which will not have any significant impact on vegetation modification or degradation. It may however increase the establishment of exotic weeds in some areas.

- Aerial images of the area indicate previous ploughing for crop cultivation had occurred several decades ago (Appendix A: Map 1). This has mostly affected the lower lying drainage area though a patchwork of other small areas has also been affected all over the study area. These areas have now been able to re-establish a grass layer though it is evident that some level of disturbance remains in these areas. This is most evident in a higher proportion of pioneer grasses being present in these areas.

- A few stock watering areas and livestock enclosures also cause local transformation. These areas are notably degraded but fairly localised and small areas.

- Two historical farmsteads occur in the area and also cause localised transformation.

- A network of dirt roads and tracks occur on the site but will only result in limited, local disturbances.

- A fairly large woodlot of invasive Bluegum (*Eucalyptus camaldulensis*) occurs in the north east of the study area but will only be relevant to phase 4 of the development. This affects an area of approximately 5 hectares.

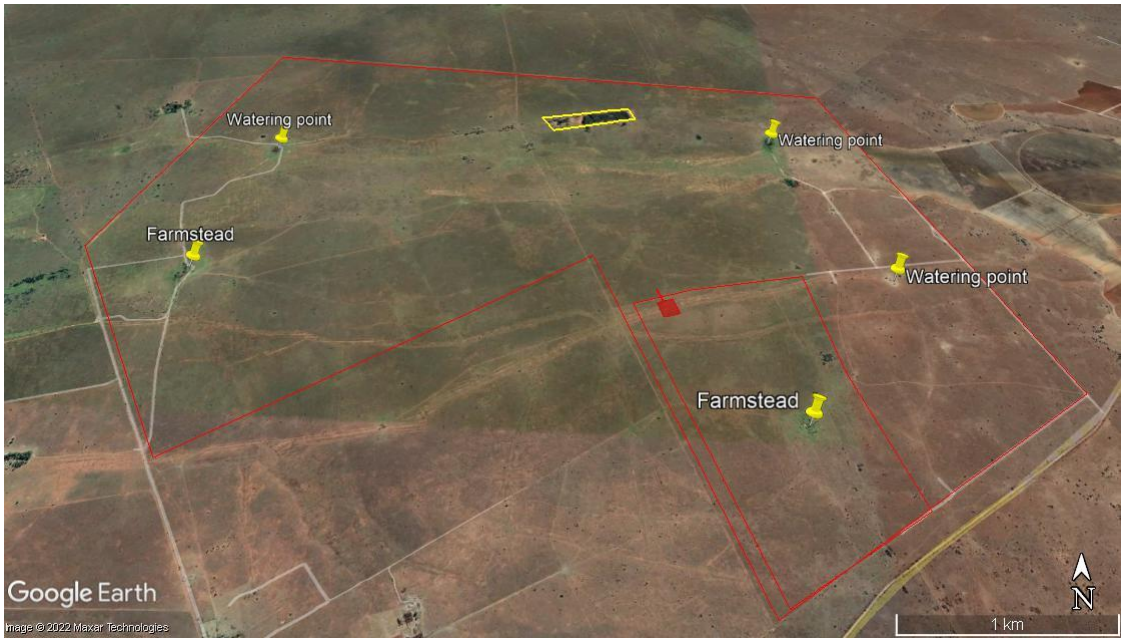

Figure 4: Relative areas of transformation and impacts in the study area (red) in relation to Phase 2 of the development include; farmsteads, stock watering points, dirt tracks and a woodlot of invasive Bluegum trees (yellow). Some of the disturbance caused by historical ploughing is visible in some areas though note that this is much more evident to the east where cultivation is still ongoing.

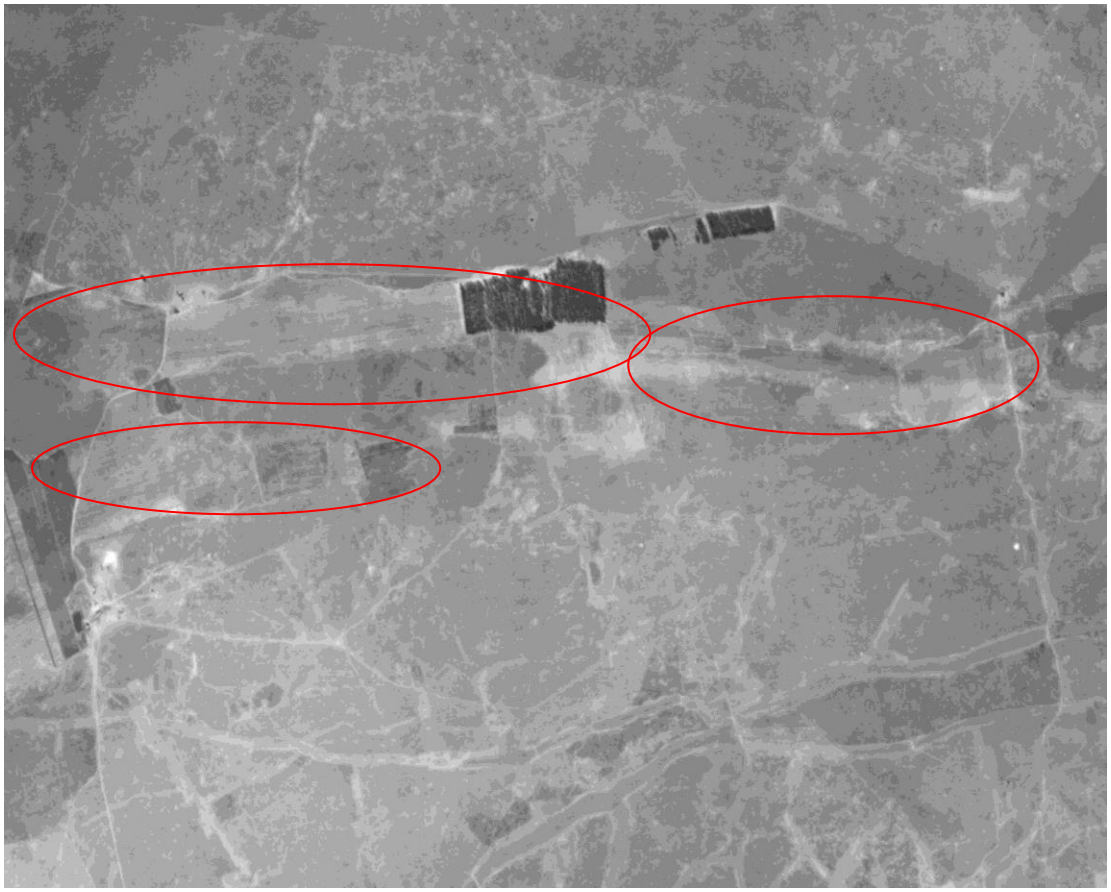

Figure 5: Historical image of the study area (National Geospatial 1975) which more clearly indicates the remnants of cultivation in the area.

Figure 6: Farmsteads cause localised transformation.

Figure 7: A network of dirt tracks also contribute toward localised disturbance.

Figure 8: A woodlot of invasive Bluegum also transform an area of approximately 5 hectares.

Protected Areas

Formally and informally protected areas function in the preservation of natural areas and these areas are normally regarded as having a very high conservation value. The National Environmental Management Protected Areas Act (NEMPAA of 2003) allows for the proclamation of an area as a protected area. The following conservation areas have been identified in this area (Appendix A: Map 1):

- Marico Biosphere Reserve – This protected area borders the study area to the north. A biosphere reserve is large parcel of land within which the land use is determined by the local society. The protected area should remain unaffected by the proposed development. However, the biosphere reserve should still be consulted during the application process.

Topography

The study area has a fairly large extent and as a result contains a moderate surface variety though in general it is a fairly flat area. The area is dominated by plains with a relatively flat gradient though the slope does increase slightly toward the lower lying drainage situated centrally in the study area. The area does not contain any hills and ridges, however, given that the area consists of Carletonville Dolomite Grassland, surface outcrops are common in the

area. Where these dolomite outcrops occur they also provide a more specialised habitat and in these areas a higher diversity of plant species have become established. As indicated, a lower lying drainage area is situated in the central portion of the study area though the survey has indicated that wetland conditions are largely absent, while becoming evident only toward the eastern border of the study area (Appendix A: Map 1 & 3). The drainage area will however still play an important role in terms of surface runoff but especially also in terms of groundwater recharge. This is also relevant in light of the area being regarded as part of the Bo-Molopo Karst Belt Strategic Water Source Area (SWSA) which perform important functions in terms of groundwater resources. The altitude of the study area varies from 1520 m AMSL on the slightly higher lying areas to 1511 m AMSL in the lower lying drainage area. This represents a difference of 8 m which indicates and confirms a fairly flat area.

Climate

Lichtenburg is situated in a region experiencing moderate rainfall, with cold, dry winters and warm summers. The average annual maximum temperature is 28 °C in January and 18 °C in July but in extreme cases temperatures may rise to 37 °C and 25 °C, respectively. Average daily minimums range from about 15 °C in January to 2 °C in July, whereas extremes may drop to 6 °C and -10 °C, respectively. The period during which frost is likely to occur lasts, on average, for 106 days from May to September, during which period frost occurs on about 26 days. Sunshine duration in summer is about 60 percent and in winter 80 percent of the possible. Climate for the site can be relatively accurately represented by rainfall and evaporation data from the weather station C2E016 (Elandskuil). The area receives an average of 600.4 mm per year. Precipitation occurs mainly during summer, with most rainfall received during December to March. This is considered a moderate rainfall though the area is still considered to form part of a semi-arid region of South Africa. The mean annual evaporation is 1864 mm. Evaporation is highest during summer. As a result, surface runoff in the area is only moderate, occurs mostly during summer and results in an estimated mean annual runoff for the area between 20 – 50 mm according to a study by the Water Research Commission (WRC REPORT NO. TT 685/16, 2016).

Geology and soils

According to Morris (1976) the area is covered by dolomite and to the north of Lichtenburg, is very flat, being relieved by occasional chert ridges, shallow depressions, dry watercourses and, more frequently, by sink-holes. This is also largely the case for this area proposed for development. The geology of the area consists of Dolomite, subordinate chert, minor carbonaceous shale, limestone and quartzite of the Malmani Subgroup of the Chuniespoort Group of the Transvaal Supergroup (Council for Geoscience 2016). Dolomites are, for the most part, covered by more recent deposits, particularly of gravel and surface limestone. In many places dolomite has been weathered chemically and numerous sink-holes are found as a result. Within the study area, sinkholes were found to be largely absent or not visible though one large sinkhole was noted in the southern portion of the study area. The site in question is coupled with red and yellowish Kalahari sand, consisting in the main of slightly rounded grains of quartz, less than one mm in diameter.

As previously indicated, the terrestrial component of the study area, is relatively uniform, without any prominently different habitats and the area will therefore be discussed as a whole (Appendix A: Map 1). Where areas occur that are sufficiently different or contain elements of

significant conservation value these will be indicated separately for each relevant development phase.

Grass dominated plains (Carletonville Dolomite Grassland) (Appendix A: Map 1)

The study area is relatively uniform and dominated by grassy, undulating plains. However, because there is some variation in soil depth, slope and the degree of surface rock the study area does exhibit a habitat mosaic of plant diversity and species composition. Those areas which are considered sufficiently different or containing unique features or species of conservation value will be indicated in the following discussion.

The vegetation is largely natural with only local modifications and is overall in a fairly good condition. Some local disturbances are present, especially where historical ploughing had taken place and this will also be indicated in the discussion (Appendix A: Map 1). It is however evident that very few exotic weeds and invasive species occur in the study area, also confirming the relatively good condition of the ecosystem (Appendix B). Even those areas previously ploughed are also largely devoid of exotic weeds and also indicated that though disturbed, they have again become largely natural and stable.

As indicated, the study area is dominated by undulating grassy plains and which contain a significant diversity of grass species. These include *Cymbopogon pospischillii, Themeda triandra, Heteropogon contortus, Eragrostis curvula, Hyparrhenia hirta, Loudetia simplex, Eragrostis superba, Triraphis andropognoides, Anthephora pubescens, Eragrostis gummiflua, Aristida congesta, Trachypogon spicatus, Urelytrum agropyroides, Trichoneura grandiglumis, Sporobolus fimbriatus* and *Elionurus muticus*. This is notably quite a high grass diversity, which is also a characteristic of this vegetation type and also a consequence of the variety in soil depth and degree of rocky outcrop. The majority of these are climax species indicating a fairly good condition though some pioneer grasses were also noted where disturbance was higher. Imbedded within this dense grass layer is also a prominent herbaceous component which includes species such as *Dicoma macrocephala, Helichrysum caespititum, Anthospermum rigidum, Senecio latifolius, Blepharis angusta, Helichrysum callicomum, Polygala hottentotta, Gerbera piloselloides, Hermannia depressa, Monsonia angustifolia, Hermannia tomento* and *Barleria macrostegia*. This is considered a natural component of the vegetation type. Where disturbance is evident such as along dirt tracks, stock watering points and other localised areas of general disturbance, a few pioneer herbs are also evident. These include *Sesamum triphyllum, Hypocharis radicata, Helichrysum argyrosphaerum, Nidorella hottentottica, Acrotome inflata* and *Gazania krebsiana*. This is however also a natural occurrence in the vegetation type though is more pronounced in areas of disturbance. It therefore still indicates natural vegetation in fairly good condition. The study area also contained a prominent element of geophytic species, i.e. plants with an underground storage organ. These include plants such as *Oxalis depressa, Boophone distichia, Babiana bainesii, Ledebouria revoluta, Eriospermum porphyrium, Hypoxis hemerocalidae, Schizocarpus nervosus, Trachyandra laxa, Moraea pallida, Colchicum burkei, Hypoxis rigidula* and *Gladiolus cf. elliottii*. Though these are all generally widespread, *B. bainesii* and *G. cf. elliottii* are protected species and it remains possible that other protected species may also still be present in the area. As previously indicated, the vegetation type in the area also contains scattered, but a characteristic tree and shrub component which also includes *Searsia lancea, Searsia pyroides, Celtis africana, Gymnosporia buxiifolia, Ziziphus mucronata, Grewia flava, Ehretia rigida, Vachellia tortillis, Vachellia karroo, Senegalia caffra, Vachellia erioloba* and *Diospyros lycioides*. Of these, *V. erioloba* (Camel Thorn) is also listed as a protected tree but is only represented by a few

scattered specimens which therefore have a limited conservation value. This tree/shrub component also provides opportunity for a few climbers to establish underneath them and includes species such as *Clematic brachiata, Clematis villosa* subsp. *stanleyi* and *Pergularia daemia*. Another vegetation element which was evident in the vegetation layer included a few suffrutices (plants with an extensive belowground stem network) and include *Parinari capensis* and *Ziziphus zeyheriana*.

Figure 9: Panorama of the study area which illustrates a fairly uniform grass layer with scattered trees and shrubs.

Figure 10: Panorama of the study area indicating a grass dominated landscape and without a diversity of different habitats.

As previously indicated a patchwork of historical ploughing is also present in the study area and still visible on aerial photos as lines and patches in the landscape (Appendix A: Map 1). These have now become re-integrated into the surrounding grassland and are no longer as clearly visible while the species composition here is also now quite similar to the surroundings. Some areas do however still indicate significant disturbance where pioneer species are abundant and the vegetation cover is somewhat lower than the surroundings. In these areas, pioneer grasses are also more abundant including *Melinis nerviglumis* and *Aristida congesta* while exotic weeds may also be more prominent such as *Datura ferox* and *Schkuhria pinata* (Appendix B).

Figure 11: Areas where historical ploughing had taken place are not readily distinguishable from the surroundings though a somewhat lower vegetation cover (red) is still present in these areas and rock piles (yellow) also indicate where areas were cleared for cultivation.

As previously indicated, there are also a few farmsteads and livestock enclosures where disturbance and transformation is present and it is prominent that several exotic and invasive plant species are the remnants of this transformation. These include invasive succulent plants such as *Cereus jamacaru* and *Cyllindropuntia imbricata* as well as a few invasive tree species such as *Eucalyptus camaldulensis, Melia azedarach* and *Gleditsia triacanthos.* A variety of weeds are also present around these areas which include *Alternanthera pungens, Bidens bipinnata* and *Xanthium spinosum*. These areas are clearly transformed but only occur in small, localised areas of the study area.

Figure 12: Invasive succulents and trees are present around the old farmsteads on the site.

The study area contains a significant species diversity though only a few of these are listed as being protected species (Appendix B). These include *Babiana bainesii* and *Gladiolus cf. elliottii*. It will therefore still be necessary to undertake a walkthrough of the site prior to construction, to obtain the necessary permits and to transplant affected plants to adjacent areas where they will remain unaffected. *Vachellia erioloba* (Camel Thorn), a protected tree but is also represented by a few scattered specimens. Where any of the protected Camel Thorn tree specimens will be affected by the development, permits will have to be obtained for their removal.

Figure 13: Protected species observed on the site include *Babiana bainesii* (Left), *Gladiolus cf. elliottii* (Middle) and *Vachellia erioloba* (Right).

From the above description of the vegetation composition in the study area it would seem to be largely intact and in a fairly good condition (Appendix A: Map 1). Some signs of disturbance are present and where historical ploughing occurred the vegetation composition is visibly more disturbed. Some diversity of habitat is present though overall the study area is fairly uniform and largely without any unique habitats or areas of high diversity. Furthermore, the vegetation consists of Carlteonville Dolomite Grassland, which although it has a significant species diversity, is currently listed as being of Least Concern (LC) which also does not contribute toward its conservation value. Overall, the vegetation in the study area can therefore not be regarded as exceeding a Moderate level of sensitivity (Appendix A: Map 4).

Rocky habitats

As indicated, rocky areas are quite common over the study and was also evident in the phase 2 development area. These rocky areas do provide additional habitat which is more specialised and as a result does contribute toward an increased species diversity. This also presents a more arid habitat which provides for the establishment of more specialised succulent plants and other growth forms. A prominent succulent component therefore includes species such as *Aloe greatheadii, Anacampseros filamentosa* subsp. *filamentosa, Crassula lanceolata* subsp. *transvaalensis, Crassula capitella* and *Othonna oxyriifolius*. Other specialised growth forms also include the terestrial fern, *Pellaea calomelanos,* lithophilic (rock-loving) herbs such as *Senecio coronatus, Justicia anagalloides, Striga elegans, Pelargonium dolomiticum, Blepharis angusta* and *Triumfetta sonderi* and other lithophilic grass species such as *Sporobolus discosporus* and *Oropetium capense*. The sedge, *Bulbostylis burchellii* is also quite characteristic of these rocky areas. These rocky areas may also contain protected species and which will then require suitable mitigation which will involve either removing or transplanting of affected plants.

These rocky areas occur throughout the study area, including the footprint of phase 2 of the development. They also clearly contribute toward a higher species diversity and may in some areas also contain species of conservation value and areas of high species diversity which is itself also regarded as having a high conservation value. Such areas were however only noted in the northern portion of the study and were not present in the footprint of the phase 2 of the development. It is therefore not relevant for this portion of the development area which therefore still retains a moderate level of sensitivity.

Figure 14: Areas of exposed rocky terrain represent a more specialised habitat which increases the species diversity of these areas.

Dolomite Sinkhole

A large dolomitic sinkhole is also situated in phase 2 of the development. This sinkhole has an approximate diameter of 60 meters and a depth of up to 3 meters. The sinkhole forms a distinctively different habitat in the landscape and is dominated by woodland vegetation with tree dominating. This also represents a unique habitat which provides a more specialised environment with differing ecological and results in a somewhat higher species diversity and an ecosystem differing from the surrounding landscape. The woodland component of the vegetation within this sinkhole is dominated by several large specimens of *Celtis africana* trees, while shrubs such as *Grewia flava* and *Asparagus larcinus* are also common. The understorey and grass layer indicates a somewhat higher moisture regime and includes *Eleusine coracana* though the sinkhole is devoid of any riparian or wetland conditions.

The sinkhole represents a unique habitat within the landscape and functions largely in terms of groundwater recharge. It therefore has a somewhat higher conservation value than the surrounding landscape and also provides higher value ecological functions (groundwater recharge and unique habitat) and as a result it is considered to have a High level of sensitivity as opposed to the Moderate sensitivity of surrounding areas. The development should therefore consider the exclusion of this sinkhole.

Figure 15: View of the sinkhole in phase 2 of the development. It clearly forms a fairly deep depression in the landscape, is associated with a unique woodland vegetation composition and will play a role in groundwater recharge.

Conclusions

From the description of the area given above it is clear that the majority of the site still consists of natural grassland which is still in a fairly good condition (Appendix A: Map 1). Some disturbance is present though in general these are localised or has been able re-establish a near natural grass layer. The surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase will not cover a large area, cumulatively the development will have a high impact. This will also be taken into account for the current proposed development which will therefore contribute toward a significant cumulative impact.

The description of the proposed development area indicates a relatively uniform habitat, with moderate species diversity and largely without any unique habitats or areas of high diversity (Appendix A: Map 4). Furthermore, the vegetation consists of Carletonville Dolomite Grassland, which although it has a significant species diversity, is currently listed as being of Least Concern (LC) which also does not contribute toward its conservation value (Appendix A: Map 1). Overall, the vegetation in the study area can therefore not be regarded as exceeding a Moderate level of sensitivity (Appendix A: Map 4). Areas of localised high conservation value may however still be present and which may require exclusion from development. Phase 2 of the development contains a large dolomite sinkhole which may require exclusion from development (Appendix A: Map 4). It is also located approximately 800 meters to the south of a drainage area but which will be discussed in greater detail in the wetland assessment section of the report (See Section 4.3) (Appendix A: Map 3).

Phase 2 of the development contains a large sinkhole which represents a unique habitat within the landscape and functions largely in terms of groundwater recharge. It therefore has a somewhat higher conservation value than the surrounding landscape and also provides higher value ecological functions (groundwater recharge and unique habitat) and as a result it is considered to have a High level of sensitivity as opposed to the Moderate sensitivity of surrounding areas. The development should therefore consider the exclusion of this sinkhole. Furthermore, the Marico Biosphere Reserve also border the study area to the north. The protected area should remain unaffected by the proposed development, but should still be consulted during the application process.

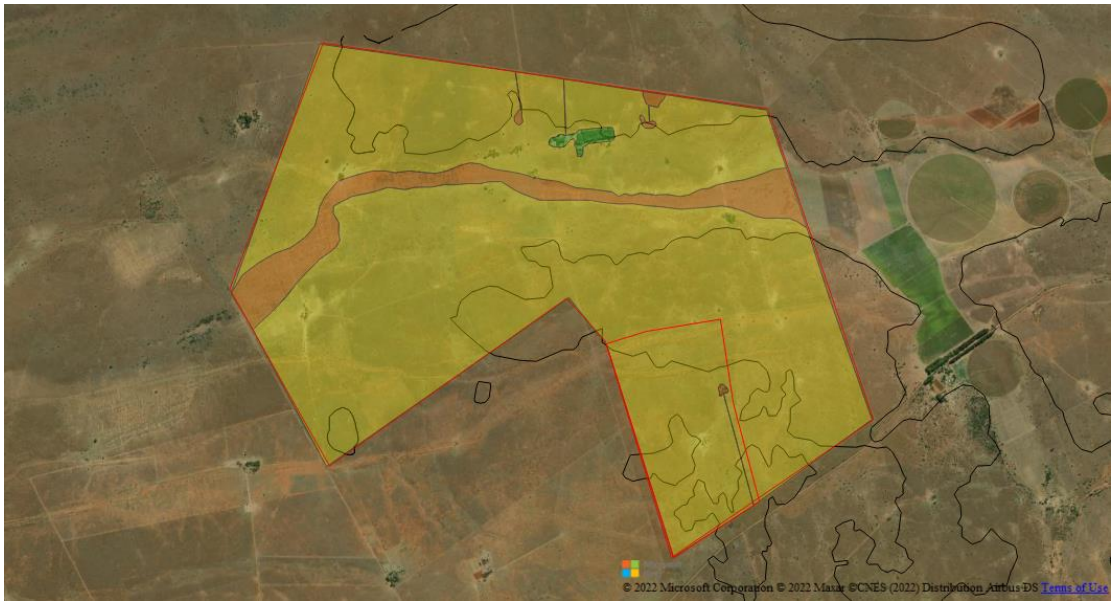

Figure 16: Areas of relative sensitivity for the study area with the phase 2 portion indicated (red). Note that the area is generally considered to have a moderate level of sensitivity given the fairly uniform habitat present. The lower lying drainage area (orange) adjacent to the site is indicated. Note the location of a large sinkhole.

The area has been indicated to contain a few protected plant species which will have to be taken into consideration by the development (Appendix B). These include the protected succulent and geophytic species, *Babiana bainesii, Gladiolus cf. elliottii* and *Pellaea calomelanos*. Where development will affect these species, the necessary permits should be obtained and a significant proportion of these transplanted to adjacent areas where they will remain unaffected. *Vachellia erioloba* (Camel Thorn), a protected tree but is also represented

by a few scattered specimens. Where any of the protected Camel Thorn tree specimens will be affected by the development, permits will have to be obtained for their removal.

In addition, the area also contains a few invasive succulent and tree species (around farmsteads and areas of high disturbance), and this will pose a risk of spreading into surrounding natural areas, especially as construction of the solar development will increase disturbance in the area (Appendix B). The proposed development will also have to implement a comprehensive monitoring and eradication programme to ensure that invasive plant species are removed from the area and prevented from re-establishing.

4.2 Overview of terrestrial mammals (actual & possible)

Signs and tracks of mammals are fairly abundant on the site and will be relatively close to the natural condition, both in terms of species composition and population size. Natural vegetation has a high carrying capacity for mammals which has been confirmed to still be the case for this area. However, a few impacts associated with the land use in the area may still have some effect on the mammals in the area. Livestock normally has a low magnitude impact in that it decreases the grazing capacity available for the natural mammal population though this impact largely affects larger antelope and will not have a high impact on smaller mammals. Associated with this land use may also be the impact of any herding dogs kept by personnel on the site and any hunting and trapping which is also likely to occur in the area. Rare and endangered mammals are often reclusive and avoid areas in close proximity to human activities and are also dependant on habitat in pristine condition. The site would therefore have some impact on the likelihood of such rare and endangered species occurring in the area, though there will remain a significant likelihood of such a species occurring in the area.

Wetland and riparian habitats also generally provide a higher abundance of resources and subsequently are also able to sustain a diverse and large mammal population (Appendix A: Map 3). This may also be relevant for the lower lying drainage area in the study area. Although it has been affected by historical ploughing, it will still be able to sustain a higher bio-load which in turn supports a larger mammal population and it is likely that the mammal population along the drainage system will be substantial. This drainage system will however be excluded from development which should decrease the anticipated impact substantially.

The mammal survey of the site was conducted by means of active searching, camera traps and recording any tracks or signs of mammals and actual observations of mammals. From the survey the following actual observations of mammals were recorded:

- Soil mounds of the Common Molerat (*Cryptomys hottentotus*) were common in most areas of the study area. This is a widespread species which has even become adapted to urban areas. It is a generalist species anticipated to occur in this area.

- Scat of a small carnivore, which given the white colouration (bone) and hair is most likely that of a Black Backed Jackal (*Canis mesomelas*). Also a widespread species but which indicate a sufficient prey base for larger carnivores to occur.

- Quills of Porcupines (*Hystrix africaeaustralis*) were noted in several areas. This is also a generalist species, widespread and common in almost all natural areas.

- Several burrows of small mammals were noted which could not be identified but do indicate a significant mammal population in the area.

- Several burrows and excavation of Aardvark (*Oryteropus afer*) occur in the study area. This is also a fairly widespread and common species but is highly reclusive and is also listed as a protected species and is therefore of significant conservation value.

- Several observations of Steenbok (*Raphicerus campestris*) and Common Duiker (*Sylvicapra grimmia*) were also made. These species are both widespread but confined to fairly natural or agricultural areas and generally avoid urban areas. Of these, the Steenbok is also listed as a protected species and is therefore of higher conservation value.

- Springhare (*Pedetes capensis*) is also common in the area and also indicate a significant prey base for larger carnivores. This species is widespread but confined to natural areas with deeper sandy soils.

- A colony of Suricate or Meerkat (*Suricata suricatta*) was also noted. This is a widespread species but less common and confined to extensive natural areas.

- Several observations of Aardwolf (*Proteles cristatus*) were also made. This is also a fairly widespread and common species but is highly reclusive and is also listed as a protected species and is therefore of significant conservation value.

These species identified on the site indicate a significant diversity, which although dominated by widespread and generalist species, also contain species of higher conservation value. This also indicates that although the mammal population will be somewhat modified, it remains likely that other species of high conservation value will still be present.

The most significant impact on mammals anticipated on the site itself is primarily concerned with the loss and fragmentation of available habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. Since it is inevitable that the development will involve the transformation of natural grassland this contributes significantly toward habitat loss which in turn will result in a high impact on the mammal population. The area is surrounded by extensive natural areas which will somewhat decrease the impact though the loss of habitat will still result in a decrease in the mammal population size which will essentially result in a reduction in the mammal population of the area.

It is also considered likely that several mammal species were overlooked during the survey and it may also be likely that other rare and endangered species may be present on the site. The survey has indicated that though the mammal population will consist largely of widespread, generalist species, it remains possible that some of these Red Listed species may occur in the area.

Construction itself may also affect the mammal population and care should therefore be taken to ensure none of the faunal species on site is harmed. The hunting, capturing or harming in any way of mammals on the site should not be allowed. Voids and excavations may also act as pitfall traps to fauna and these should continuously be monitored and any trapped fauna removed and released in adjacent natural areas.

Mammals species likely to occur on the site has been determined by means of FitzPatrick Institute of African Ornithology (2022).

Table 3: Red Listed mammals likely to occur in the study area (Child *et al* 2016).

Scientific name	Common name	Status
Damaliscus lunatus lunatus	(Southern African) Tsessebe	Vulnerable
Damaliscus pygargus pygargus	Bontebok	Vulnerable
Hippotragus equinus	Roan Antelope	Endangered
Hippotragus niger niger	Sable Antelope	Vulnerable
Pelea capreolus	Vaal Rhebok	Near Threatened
Atelerix frontalis	Southern African Hedgehog	Near Threatened
Felis nigripes	Black-footed Cat	Vulnerable
Leptailurus serval	Serval	Near Threatened
Hyaena brunnea	Brown Hyena	Near Threatened
Otomys auratus	Southern African Vlei Rat (Grassland type)	Near Threatened
Aonyx capensis	African Clawless Otter	Near Threatened
Mystromys albicaudatus	African White-tailed Rat	Vulnerable
Crocidura mariquensis	Swamp Musk Shrew	Near Threatened

It is clear that the area may contain numerous species of conservation importance (Table 3). However, many of these, especially the larger antelope will only be present in conservation or game breeding areas and will not be relevant for the development. These include Tsessebe, Bontebok, Roan Antelope and Sable Antelope. The remaining smaller species are however quite likely to still occur in this area including the Black-footed Cat (*Felis nigripes*), Serval (*Leptailurus serval*), Southern African Vlei Rat (*Otomys auratus*), Hedgehog (*Atelerix frontalis*), Swamp Musk Shrew (*Crocidura ariquensis*), Brown Hyena (*Hyaena brunnea*) and African White-tailed Rat (*Mystromys albicaudatus*).

Table 4: Likely faunal species in the region.

Family	Scientific name	Common name
Bathyergidae	*Cryptomys hottentotus*	Southern African Mole-rat
Bovidae	*Aepyceros melampus*	Impala
	Alcelaphus buselaphus caama	Red Hartebeest
	Antidorcas marsupialis	Springbok
	Connochaetes gnou	Black Wildebeest
	Connochaetes taurinus	Blue Wildebeest
	Damaliscus lunatus lunatus	(Southern African) Tsessebe
	Damaliscus pygargus phillipsi	Blesbok
	Damaliscus pygargus pygargus	Bontebok
	Hippotragus equinus	Roan Antelope
	Hippotragus niger niger	Sable Antelope
	Kobus ellipsiprymnus	Waterbuck
	Oryx gazella	Gemsbok
	Pelea capreolus	Vaal Rhebok
	Raphicerus campestris	Steenbok
	Redunca arundinum	Southern Reedbuck
	Redunca fulvorufula	Mountain Reedbuck

	Sylvicapra grimmia	Bush Duiker
	Syncerus caffer	African Buffalo
	Taurotragus oryx	Common Eland
	Tragelaphus angasii	Nyala
	Tragelaphus scriptus	Bushbuck
	Tragelaphus strepsiceros	Greater Kudu
Camelidae	*Camelus dromedarius*	One-humped Camel
Canidae	*Canis mesomelas*	Black-backed Jackal
	Otocyon megalotis	Bat-eared Fox
	Vulpes chama	Cape Fox
Cercopithecidae	*Chlorocebus pygerythrus pygerythrus*	Vervet Monkey (subspecies pygerythrus)
	Papio ursinus	Chacma Baboon
Cervidae	*Dama dama*	Fallow Deer
	Elaphurus davidianus	Père David's Deer
Equidae	*Equus quagga*	Plains Zebra
Erinaceidae	*Atelerix frontalis*	Southern African Hedgehog
Felidae	*Caracal caracal*	Caracal
	Felis catus	Domestic Cat
	Felis nigripes	Black-footed Cat
	Leptailurus serval	Serval
	Panthera leo	Lion
Giraffidae	*Giraffa giraffa giraffa*	South African Giraffe
Gliridae	*Graphiurus (Graphiurus) platyops*	Flat-headed African Dormouse
Herpestidae	*Atilax paludinosus*	Marsh Mongoose
	Cynictis penicillata	Yellow Mongoose
	Herpestes sanguineus	Slender Mongoose
	Ichneumia albicauda	White-tailed Mongoose
	Suricata suricatta	Meerkat
Hyaenidae	*Hyaena brunnea*	Brown Hyena
	Proteles cristata	Aardwolf
Hystricidae	*Hystrix africaeaustralis*	Cape Porcupine
Leporidae	*Lepus capensis*	Cape Hare
	Lepus saxatilis	Scrub Hare
	Pronolagus randensis	Jameson's Red Rock Hare
Macroscelididae	*Elephantulus myurus*	Eastern Rock Elephant Shrew
Molossidae	*Chaerephon pumilus*	Little Free-tailed Bat
	Tadarida aegyptiaca	Egyptian Free-tailed Bat
Muridae	*Aethomys ineptus*	Tete Veld Aethomys
	Aethomys namaquensis	Namaqua Rock Mouse
	Gerbilliscus brantsii	Highveld Gerbil
	Gerbilliscus leucogaster	Bushveld Gerbil
	Mastomys coucha	Southern African Mastomys
	Mastomys natalensis	Natal Mastomys
	Mus (Nannomys) indutus	Desert Pygmy Mouse
	Mus (Nannomys) minutoides	Southern African Pygmy Mouse

	Otomys auratus	Southern African Vlei Rat (Grassland type)
	Rhabdomys pumilio	Xeric Four-striped Grass Rat
Mustelidae	*Aonyx capensis*	African Clawless Otter
	Ictonyx striatus	Striped Polecat
	Mellivora capensis	Honey Badger
Nesomyidae	*Dendromus melanotis*	Gray African Climbing Mouse
	Mystromys albicaudatus	African White-tailed Rat
	Saccostomus campestris	Southern African Pouched Mouse
Orycteropodidae	*Orycteropus afer*	Aardvark
Pedetidae	*Pedetes capensis*	South African Spring Hare
Procaviidae	*Procavia capensis*	Cape Rock Hyrax
Rhinolophidae	*Rhinolophus clivosus*	Geoffroy's Horseshoe Bat
Sciuridae	*Paraxerus cepapi*	Smith's Bush Squirrel
	Xerus inauris	South African Ground Squirrel
Soricidae	*Crocidura mariquensis*	Swamp Musk Shrew
	Myosorex varius	Forest Shrew
	Suncus varilla	Lesser Dwarf Shrew
Suidae	*Phacochoerus africanus*	Common Warthog
	Potamochoerus larvatus koiropotamus	Bush-pig (subspecies koiropotamus)
	Potamochoerus porcus	Red River Hog
Thryonomyidae	*Thryonomys swinderianus*	Greater Cane Rat
Vespertilionidae	*Miniopterus natalensis*	Natal Long-fingered Bat
	Myotis tricolor	Temminck's Myotis
	Neoromicia capensis	Cape Serotine
Viveridae	*Genetta maculata*	Common Large-spotted Genet
	Genetta genetta	Common Genet
	Genetta tigrina	Cape Genet (Cape Large-spotted Genet)

Figure 17: Tracks and signs of mammals on the site include clockwise from top left; a soil mound of the Common molerat (*Cryptomys hottentotus*) quill of a Porcupine (*Hystrix africaeaustralis*), Burrow of an Aardvark (*Orycteropus afer*) and scat of a Black Backed Jackal (*Canis mesomelas*).

Figure 18: The following mammals had been recorded by means of camera traps, from top to bottom; Steenbok (*Raphicerus campestris*), Springhare (*Pedetes capensis*), Common Duiker (*Raphicerus campestris*), Suricates (*Suricata suricatta*), Aardwolf (*Proteles cristatus*).

4.3 Wetland Assessment

4.3.1 Introduction

The area is largely devoid of surface drainage lines, watercourses and wetlands, however, a large drainage area is situated in the central portion of the study area (Appendix A: Map 1 & 3). The drainage area is the main, and only, surface water feature in the study area. It does not

form a defined watercourse though scattered wetland depressions become evident towards the eastern end of the study area and also confirms a shallow groundwater table along this drainage area. Downstream of the site it is also utilised for crop production (indicating deeper soils) while centre-pivot irrigation is also common (confirming it is an important groundwater resource). The section of the drainage area situated on the site had also historically been ploughed for crop production though has not been used for many decades. Consequently, the transformation caused by the ploughing is still evident though somewhat obscured by the re-establishment of vegetation.

The drainage area is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). It will however still be included in the report in order to provide an overall description of the study area. The drainage area is strictly ephemeral and will only contain surface water during years of exceptional rainfall. It is unlikely that it will ever contain any surface flow but may contain periodic surface water. It also does not fit the definition of a watercourse, does not contain a channel and is also devoid of any distinctive riparian vegetation. However, toward the eastern end of the study area, some small depressions do become evident, indicating shallow groundwater table and confirming that the drainage area does form a surface water feature. The condition of the drainage area will be determined from this wetland depression portion and inferred from this for the surrounding section of the drainage area. This drainage area is also likely to play an important role in terms of groundwater recharge for this area. Especially so since it is regarded as part of the Bo-Molopo Karst Belt Strategic Water Source Area (SWSA) which perform important functions in terms of groundwater resources.

The term watercourse refers to a river, stream, wetland or pan. The National Water Act (NWA, 1998) includes rivers, streams, pans and wetlands in the definition of the term watercourse. This definition follows:

Watercourse means:

- A river or spring.
- A natural channel in which water flows regularly or intermittently.
- A wetland, lake or dam into which water flows.
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

From the above definition, the drainage area in its entirety may not be regarded as a watercourse, however, the presence of a wetland pan does confirm the presence of some wetland conditions which in turn fits the definition of a watercourse.

4.3.2 Wetland indicators

Riparian habitat is an accepted indicator of watercourses used to delineate the extent of wetlands, rivers, streams and pans (Department of Water Affairs and Forestry 2005). The drainage area on the site was delineated by use of topography (land form and drainage pattern) and obligate wetland vegetation with limited soil sampling (Appendix C). Due to time constraints and the extent of the study area soil samples were only taken along a few transects of the drainage area to confirm the presence of wetland conditions. The following guidelines and frameworks were used to determine and delineate the watercourses and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

Obligate wetland vegetation was utilised to determine the presence and border of wetland conditions (Appendix B). Due to time constraints soil samples were only taken along several lateral transects of the drainage area to confirm the presence or absence of wetland conditions. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils (Appendix C).

The vegetation survey indicated that the drainage area is devoid of both wetland and riparian vegetation and is largely dominated by a combination of pioneer grasses, most likely a consequence of the historical ploughing. Toward the eastern end of the study area, obligate wetland grasses, *Leptochloa fusca*, become prominent in depressions and here wetland conditions are confirmed. In these instances the soil samples also confirmed the presence of soil wetness indicators. However, for the majority of the drainage area, soils did not conclusively indicate the presence of saturated conditions. The drainage area does however still play an important role, especially in terms of groundwater resources and it is therefore regarded as important and sensitive. However, wetland systems would normally be regarded as having a Very High level of sensitivity but since the survey confirmed that wetland areas only become evident toward the eastern end of the study area, this drainage system is only regarded as having a High level of sensitivity (Appendix A: Map 4).

4.3.3 Classification of wetland systems

The survey has confirmed that the drainage area is largely devoid of wetland conditions. However, toward the eastern end where wetland conditions become evident within a few depressions this can be classified into a specific wetland type.

The wetland conditions occurring within the small depressions toward the eastern portion of the drainage area within the study area can be categorised as depression wetlands (SANBI 2009):

"A depression wetland is a basin shaped area with a closed elevation contour with an increase in depth from the perimeter to the central areas that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent. Dominant water sources are precipitation, ground water discharge, interflow and (diffuse or concentrated) overland flow. For 'depressions with channeled inflow', concentrated overland flow is typically a major source of water for the wetland, whereas this is not the case for 'depressions without channeled inflow'. Dominant hydrodynamics are (primarily seasonal) vertical fluctuations. Depressions may be flatbottomed (in which case they are often referred to as 'pans') or round-bottomed (in which case they are often referred to as 'basins') and may have any combination of inlets and outlets or lack them completely. For 'exorheic depressions', water exits as concentrated surface flow while, for 'endorheic depressions', water exits by means of evaporation and infiltration."

This is an accurate description of these small depression areas and their functioning. They are all circular forming a very shallow but discernible depression within the drainage area (Appendix A: Map 3). Given the dolomitic geology of the area it is also likely that they are connected to the local groundwater aquifer.

4.2.4 Description of watercourses and wetlands

The study area contains only the drainage area which is the only surface water feature in the study area (Appendix A: Map 3). A short description of this system will be provided below.

Obligate wetland vegetation was also used to determine the presence of wetland conditions. Obligate wetland species are confined to wetlands and are only able to occur in wetlands. They are therefore reliable indicators of wetland conditions. Field observations over time as well as the following sources were used to determine FW and OW species:

- Marnewecke, G. & Kotze, D. 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

- DWAF. 2008. Updated manual for the identification and delineation of wetlands and riparian areas, prepared by M.Rountree, A.L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

- Van Ginkel, C.E. & Cilliers, C.J. 2020. Aquatic and wetland plants of Southern Africa. Briza Publications, Pretoria.

Table 2: Description of the individual watercourses and wetlands which forms part of the study area (Appendix A: Map 3) (FW – Facultative wetland species, OW – Obligate wetland species, * - Exotic species).

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#1 Lower lying drainage system – Main surface water feature in the study area	S 26.015670°, E 26.243323° S 26.010959°, E 26.256496° S 26.012639°, E 26.281909°	Ephemeral
Description of watercourse: The drainage area situated centrally within the study area is the most significant and only surface water feature in the area. It is a large, but poorly defined system which originates about 15 km to the east of the study area and follows a poorly defined flow pattern toward the west where it forms part of the drainage system of the Harts River. Due to the flat topography of this region it rarely contains well defined watercourses while such poorly defined drainage systems dominate. The drainage system therefore transects the study area from east to west though it is highly unlikely that surface water flow will ever occur. It is much more likely that groundwater movement will be a much more prominent element of this system. Furthermore, given the dolomitic geology of the area, a groundwater connection is also likely present between the drainage area and the local aquifer. This drainage area is clearly without a channel but does form a prominent low lying area within the landscape. The width of this drainage area is quite extensive and varies from around 150 meters to as much as 500 meters. The drainage area is likely fed by surrounding runoff but is also quite likely the groundwater will also play an		

important role in its functioning.

As a result, although this drainage area is poorly defined and is largely devoid of wetland conditions, it will still play an important role in terms of the surface water drainage of the area. In addition, it also forms part of the Bo-Molopo Karst Belt Strategic Water Source Area (SWSA) which perform important functions in terms of groundwater resources. The development will however exclude this area from development and should therefore not entail any direct impacts on it. Given that the solar development also implements a comprehensive storm water management system, this will also further limit any anticipated impacts on this drainage system.

This drainage area has also been heavily modified by historical impacts. It was ploughed for crop cultivation several decades ago though the impact is still visible as feint surface furrows and a vegetation layer dominated by pioneer grasses. This would undoubtedly also have influenced the functioning of the hydrology of this system. To the east of the study area this drainage system is also currently still affected by dryland crop cultivation but also by extensive centre-pivot irrigation. This will also have a high impact on the hydrology of this system and will likely contribute to lowering the groundwater level of it.

The drainage area is clearly situated in a low lying shallow valley and in terms of topography clearly supports the formation of a surface water feature. However, the vegetation within it is largely terrestrial and devoid of obligate wetland plants, except for the small depression areas in the eastern portion of the study area. Soil samples also largely indicate the absence of saturated soils, with seasonal saturation only being evident in the eastern portion of it. The drainage system can therefore not be regarded as a defined wetland system and neither does it comfortably fit within the definition of a watercourse. It does however contain patchy wetland areas in the east and clearly functions as a surface water feature and especially regarding groundwater functions and it therefore still important and should be avoided by the development.

Dominant plant species:
Drainage area: *Berkheya onopordifolia, Eragrostis lehmanniana, Cymbopogon pospischillii, Aristida congesta, Lippia scaberrima, Hermannia geniculata, Stoene plumosus, Themeda triandra, Solanum incanum, Senecio coronatus, Asparagus larcinus, Heteropogon contortus, Helichrysum nudifolium, Helichrysum rugulosum, Pogonarthria squarrosa, Cynodon dactylon, Eragrostis curvula, Conyza podocephala.*

Depression areas: *Leptochloa fusca* (OW).

Protected plant species:
None observed.

Soil sample:

Drainage area – devoid of wetland conditions.

Depression areas – clear wetland conditions.

The drainage area is clearly discernible as a flat, low lying area but which is dominated by terrestrial grasses and without clear riparian and wetland conditions.

From the surroundings the drainage area is clearly a depression in the landscape and therefore substantiates the presence of a surface water feature despite riparian and wetland conditions being largely absent.

Toward the east of the study area, the drainage area does become more prominent and soil saturation also is more pronounced, indicating a much higher moisture regime.

At the eastern portion of the study area, the drainage area also develops small depressions where wetland conditions have become clearly present and some surface water was also present. This also substantiates that this drainage area forms part of a surface water feature.

4.3.5 Condition and importance of the affected wetland

The low lying drainage area in the study area forms the main and only surface water feature in the area and a determination of its condition will therefore be undertaken (Appendix A: Map 3). The drainage area is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). It will however still be included in the report in order to provide an overall description of the study area. The drainage area is strictly ephemeral and will only contain surface water during years of exceptional rainfall. However, it clearly does function in terms of the surface water of the area and is considered especially important in terms of groundwater recharge and any impact that the development will have on it will therefore be important to determine. Given the lack of a clear channel and also the absence

of distinctive riparian condition, there are no suitable indices to apply in order to determine its current condition. However, toward the eastern end of the study area, some small depressions do become evident, indicating shallow groundwater table and confirming that the drainage area does form a surface water feature. The condition of the drainage area will be determined from this wetland depression portion and inferred from this for the surrounding section of the drainage area. It will also be possible to apply the WET-Health indices for these wetland depressions and should give an accurate indication of the current condition of the system and its vulnerability to impacts of the development as well as the general condition of the drainage system as a whole. The WET-Health will be taken as representative of the Present Ecological State (PES) of this system (Appendix D).

Table 4 refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition. The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw 2007).

Table 5 refers to the Ecological Importance and Sensitivity (EIS) of wetlands. "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC).

Table 4: Ecological categories for Present Ecological Status (PES).

Ecological Category	Description
A	Unmodified, natural
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominately unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem function has occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

Table 5: Ecological importance and sensitivity categories.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very High		A

Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

In terms of previous wetland spatial resources (Kleynhans 2000, Van Deventer *et al* 2018) only portions of this drainage system had been identified. According to wetland probability maps (Van Deventer *et al* 2018) the system is indicated as having a high probability of forming a valley bottom system, while Kleynhans (2000) only recognises the presence of a few small depressions upstream of the site (much the same as those depressions occurring in the eastern portion of the study area). According to these resources the condition of these identified depression areas also range from a Category A/B: Largely Natural to Category C: Moderately Modified and also indicates the uncertainty of these desktop assessments. The current survey has undertaken a more detailed determination of the condition of the system which indicates that a moderate level of modification is more accurate for this system. It is affected by upstream abstraction for centre-pivots which is likely to affect the groundwater level of the system and historical ploughing of the area would also still have some remaining impacts, mostly in terms of the soil profile and vegetation composition. Despite these modifications on the system, it remains important in terms of the surface water functioning but also in terms of the groundwater and groundwater recharge. The drainage area is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). It will however still be included in the report in order to provide an overall description of the study area. Furthermore, as long as a comprehensive storm water management system is implemented the impact on this system should remain quite low.

As indicated above, the drainage system and the depression wetland area in particular has been modified by significant impacts. A summary of the impacts will be provided in the following paragraphs.

The drainage system has been affected by historical ploughing for dryland crop cultivation (Appendix A: Map 1). This drainage system contains deeper soils and it is notable that the moisture regime is much higher here. Consequently, it was ploughed and planted with crops. According to local inhabitants, this was first done during 1966 when flooding of the system occurred. It has since been left uncultivated and vegetation has become re-established. However, feint furrows are still visible and the vegetation composition is also dominated by pioneer grasses. This ploughing would also have modified the soil profile and it is possible that

this also affected the hydrology of the system, i.e. allowed for higher groundwater infiltration which would have affected the moisture regime of the system.

The study area is being used as grazing for domestic livestock and it was notable that trampling was quite high, especially in the small wetland depression areas in the eastern portion of the study area.

To the east of the study area, this drainage system is still being used for crop cultivation and has a large impact on the functioning of the system. These areas has removed the natural vegetation which promotes runoff while decreasing infiltration and in so doing increases surface erosion. This will also have a large influence on the hydrology of the system. Coupled with the crop cultivation will also be fertiliser, pesticide and herbicide runoff. The catchment also contains a network of small dirt roads and tracks and these would also have a significant impact on the wetland. These act as obstructions to flow and will affect the hydrology of the wetland.

It is also notable that several centre-pivot irrigation systems are located to the east of the study area and within this drainage system. This also confirms that this drainage system is associated with a prominent groundwater aquifer which may also contain an elevated groundwater table. This irrigation will abstract water from the drainage system which will then be lost to the system and is likely to result in a drawdown of the groundwater table which may then also have a substantial impact on the hydrology of the drainage system, at least those areas exhibiting wetland depression areas.

Figure 19: A recent aerial image of the drainage area (red) within the study area which also indicates the prominent impacts to the east which includes cropfields and centre-pivots (Google Earth 2022).

Figure 20: View of the drainage area to the east of the site where it has been ploughed for crop cultivation.

Figure 21: Historical ploughing of the drainage area has significantly decreased the percentage grass cover and has also altered its species composition.

Figure 22: Trampling of the wetland depression areas in the eastern portion of the drainage area is visibly quite high.

From the above described impacts it should be clear that the depression wetland areas associated with the drainage area (and therefore also the drainage system as a whole) has resulted in a significant level of modification. A WET-Health determination was undertaken for the depression wetland area to determine its current condition and provide an indication of the overall condition of the drainage system (Appendix D). The results of the WET-Health indicated an overall Present Ecological State of Category C: Moderately Modified. This is considered relatively accurate given the impacts on the system.

The EI&S of the wetland depression portion of the drainage system has been rated as being Low: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. This is a consequence of the small size of the depression wetland areas in relation to the overall drainage system, the lack of riparian and wetland conditions over the majority of the drainage area and currently modified condition of the system.

4.3.7 Risk Assessment

A Risk Assessment for the proposed solar facility which will affect the drainage system in the study area has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). The drainage system will be excluded from the development though development and is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). A risk matrix and subsequent water use therefore does not apply to this phase of the development.

Despite the drainage area being largely modification and large portion being devoid of riparian and wetland conditions, it should still be regarded as a no-go area and no construction or operational activities including stockpiling, clearing, laydown areas, vehicle movement or any other associated activities should occur within this drainage area.

Mitigation as recommended as well as any additional mitigation recommended by other specialist studies should be implemented in order to alleviate the risks on the drainage system.

5. ANTICIPATED IMPACTS

Anticipated impacts that the development will have is primarily concerned with the loss of habitat and species diversity but will also include impacts on the drainage system forming part of the study area (Appendix A: Map 1 - 4).

The following impacts on the ecosystem, ecology and biodiversity will be assessed:

- Loss of vegetation and consequently habitat and species diversity as a result.
- Loss of protected, rare or threatened plant species.
- Impacts on watercourses, wetlands or the general catchment.
- The impact that the development will have on exotic weeds and invasive species, both current and anticipated conditions.
- Any increased erosion that the development may cause.
- Fragmentation of habitat, disruption of ecological connectivity and -functioning in terms of the surrounding areas.
- Impacts that will result on the mammal population on and around the site.
- Any significant cumulative impacts that the development will contribute towards.

Solar PV developments usually entail the removal of surface vegetation and may also involve modification of the surface topography. This therefore has a large impact in terms of the loss of vegetation, vegetation type and consequently habitat. As indicated from the discussion of the study area, the majority of the area still consists of natural grassland in a fairly good condition (Appendix A: Map 1). Where these areas of natural grassland will be affected by the development it will therefore result in significant impacts. These areas do however not have a high conservation value, which will decrease the anticipated impact to some degree. The vegetation type in the study area, Carletonville Dolomite Grassland is not currently regarded as rare or endangered and still covers large areas of the region (Appendix A: Map 1). This will therefore not contribute toward their conservation value (Appendix A: Map 4). Furthermore, the North West Biodiversity Sector Plan (2015) regards the site as being of Ecological Support Area (ESA) 1 and do not contain Critical Biodiversity Areas (CBA) which would be of high conservation value (Appendix A: Map 2). Given the fairly low conservation value of remaining natural areas on the site, this will decrease the impact that development will have on the loss of habitat and species diversity. However, from previous solar development it is also clear that it causes significant impacts and result in the transformation of natural areas. By the nature of such developments, i.e. removal of the vegetation and modification of the soil surface, it results in the irreversible transformation of the ecosystem. There are no significant mitigation which can be recommended to decrease the impact of vegetation and diversity loss and consequently this will still result in a significant impact.

No Red Listed plant species could be identified on the site and the area is also not known to contain many such species though a few are still present in this region and a likelihood therefore remains that such a species may also be present on the site. However, given the large extent of the study area, it has been found to contain several protected plant species (Appendix B). These include the protected succulent and geophytic species, *Babiana bainesii, Gladiolus cf. elliottii* and *Pellaea calomelanos*. Where development will affect these species, the necessary permits should be obtained and a significant proportion of these transplanted to adjacent areas where they will remain unaffected. *Vachellia erioloba* (Camel Thorn), a protected tree but is also represented by a few scattered specimens. Where any of the protected Camel Thorn tree specimens will be affected by the development, permits will have

to be obtained for their removal. Provided that this mitigation is successfully implemented, the anticipated impact should remain moderate to low.

A large drainage area occurs in the central portion of the study area (Appendix A: Map 3). The drainage area is the main, and only, surface water feature in the study area. It does not form a defined watercourse though scattered wetland depressions become evident towards the eastern end of the study area and also confirms a shallow groundwater table along this drainage area. The drainage system will be excluded from the development and is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). This drainage area is also likely to play an important role in terms of groundwater recharge for this area. Especially so since it is regarded as part of the Bo-Molopo Karst Belt Strategic Water Source Area (SWSA) which perform important functions in terms of groundwater resources Despite the drainage area being largely modification and large portion being devoid of riparian and wetland conditions, it should still be regarded as a no-go area and no construction or operational activities including stockpiling, clearing, laydown areas, vehicle movement or any other associated activities should occur within this drainage area.

As was observed during the survey of the study area it contains several exotic weed and invader species (Appendix B). In addition, development (especially construction) will increase disturbance and exacerbate conditions susceptible to the establishment of exotic weeds and invaders. Without mitigation this will significantly increase the establishment of exotics and is likely to spread into the surrounding areas. It is therefore recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the development area. Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.

As indicated, because solar PV developments result in the removal of vegetation, this reduces infiltration and promotes runoff. Coupled with the rain shadow caused by panels and the resulting dripline, this increases runoff and erosion. This may also have an impact on the drainage system in the study area. In order to reduce this impact, the development should implement a comprehensive storm water management system which should ensure that the surface runoff patterns are retained as is, especially pertaining to solar panels, and that the development does not contribute toward increased surface flow, erosion and any impacts on downslope areas.

The region around the study area, especially to the north of it, is still dominated by extensive natural areas and consequently ecosystem functions, habitat fragmentation and the disruption of ecosystem processes is still fairly low. However, the proposed development will also require the transformation of fairly large areas consisting of natural grassland in fairly good condition and will therefore result in significant habitat loss and fragmentation. This will however be limited to the study area since the surroundings are still dominated by natural vegetation. However, a portion of the study area consists of an Ecological Support Area 1 (ESA) and functions as part of an ecological corridor (Appendix A: Map 1). The development will therefore also impact on this functioning. Mitigation can however be implemented in order to provide some manner of continued corridor. In order to mitigate the loss of a portion of this corridor, the development can also consider implementing measures to allow for fauna to still use the area as a corridor. Solar developments are often surrounded by extensive fences but this development should also consider implementing measures to allow for small mammals to cross

between these fences, i.e. wildlife permeable fencing or wildlife passages. Should mitigation be possible and given the largely natural surroundings the anticipated impact on habitat fragmentation is anticipated to remain largely moderate.

The most significant impact on mammals anticipated on the site itself is primarily concerned with the loss and fragmentation of available habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. Since it is inevitable that the development will involve the transformation of natural grassland this contributes significantly toward habitat loss which in turn will result in a high impact on the mammal population. The area is surrounded by extensive natural areas which will somewhat decrease the impact though the loss of habitat will still result in a decrease in the mammal population size which will essentially result in a reduction in the mammal population of the area. Construction itself may also affect the mammal population and care should therefore be taken to ensure none of the faunal species on site is harmed. The hunting, capturing or harming in any way of mammals on the site should not be allowed. Voids and excavations may also act as pitfall traps to fauna and these should continuously be monitored and any trapped fauna removed and released in adjacent natural areas.

As previously indicated, the surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase does not cover a large area, cumulatively the development will have a high impact. This will also be taken into account for the current proposed development which will therefore contribute toward a significant cumulative impact.

The impact significance has been determined and indicates that the majority of impacts will remain moderate such as the impact on protected plant species, the drainage system, infestation by exotic weeds, erosion and habitat fragmentation. These impacts will all remain moderate and several can also be further decreased given adequate mitigation is implemented. However, since the area of development is fairly large and still consists of natural vegetation in a relatively good condition the impact on vegetation and diversity loss as well as the impact on the mammal population will remain high. These impacts can also not readily be mitigated since the development footprint is fixed.

Please refer to Appendix F for the impact methodology.

Nature: **Loss of vegetation and consequently habitat and species diversity as a result.**
Impact description: Solar PV developments usually entail the removal of surface vegetation and may also involve modification of the surface topography. This therefore has a large impact in terms of the loss of vegetation, vegetation type and consequently habitat. As indicated from the discussion of the study area, the majority of the area still consists of natural grassland in a fairly good condition (Appendix A: Map 1). Where these areas of natural grassland will be affected by the development it will therefore result in significant impacts. These areas do however not have a high conservation value, which will decrease the anticipated impact to some degree. The vegetation type in the study area, Carletonville Dolomite Grassland is not currently regarded as rare or endangered and still covers large areas of the region (Appendix A: Map 1). This will therefore not contribute toward their conservation value (Appendix A: Map

4). Furthermore, the North West Biodiversity Sector Plan (2015) regards the site as being of Ecological Support Area (ESA) 1 and do not contain Critical Biodiversity Areas (CBA) which would be of high conservation value (Appendix A: Map 2). Given the fairly low conservation value of remaining natural areas on the site, this will decrease the impact that development will have on the loss of habitat and species diversity. However, from previous solar development it is also clear that it causes significant impacts and result in the transformation of natural areas. By the nature of such developments, i.e. removal of the vegetation and modification of the soil surface, it results in the irreversible transformation of the ecosystem.

	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent transformation of vegetation	**High Negative (70)**
Extent	3	Large development footprint	
Magnitude	6	Moderate conservation value of natural areas	
Probability	5	Impact is unavoidable	
Mitigation/Enhancement Measures			
Mitigation: There are no significant mitigation which can be recommended to decrease the impact of vegetation and diversity loss and consequently this will still result in a significant impact.			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent transformation of vegetation	**High Negative (70)**
Extent	3	Large development footprint	
Magnitude	6	Moderate conservation value of natural areas	
Probability	5	Impact is unavoidable	

Cumulative impacts:
The surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase does not cover a large area, cumulatively the development will have a high impact.

Residual Risks:
The solar development will involve the clearance of a fairly large area and lead to irreversible transformation of the natural grassland and residual impacts will remain high.

Nature:
Loss of protected, rare or threatened plant species.

Impact description: No Red Listed plant species could be identified on the site and the area is also not known to contain many such species though a few are still present in this region and a likelihood therefore remains that such a species may also be present on the site. However, given the large extent of the study area, it has been found to contain several protected plant species (Appendix B). These include the protected succulent and geophytic species, *Babiana bainesii, Gladiolus cf. elliottii* and *Pellaea calomelanos*. Where development will affect these species, the necessary permits should be obtained and a significant proportion of these transplanted to adjacent areas where they will remain unaffected. *Vachellia erioloba* (Camel

Thorn), a protected tree but is also represented by a few scattered specimens. Where any of the protected Camel Thorn tree specimens will be affected by the development, permits will have to be obtained for their removal. Provided that this mitigation is successfully implemented, the anticipated impact should remain moderate to low.

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	5	Permanent loss of protected species	**Moderate Negative (51)**
Extent	3	Large development footprint	
Magnitude	9	High likelihood for the loss of protected species	
Probability	3	Only a few protected species known to occur on the site and therefore probability is moderate	
Mitigation/Enhancement Measures			
Mitigation: Where development will affect these species, the necessary permits should be obtained and a significant proportion of these transplanted to adjacent areas where they will remain unaffected. Where any of the protected Camel Thorn tree specimens will be affected by the development, permits will have to be obtained for their removal. Provided that this mitigation is successfully implemented, the anticipated impact should remain moderate to low.			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent loss of protected species	**Moderate Negative (39)**
Extent	3	Large development footprint	
Magnitude	5	Loss of fewer protected species, provided mitigation is successfully implemented	
Probability	3	Probable that at least some protected species will be lost	
Cumulative impacts: The surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase does not cover a large area, cumulatively the development will have a high impact. Therefore, the cumulative loss of protected species will also be significant.			
Residual Risks: Despite comprehensive mitigation (dependant on this mitigation being successfully implemented) a residual loss of some protected species is still unavoidable. This also includes the loss of protected *Vachellia erioloba* (Camel Thorn) trees.			

Nature: **Impacts on watercourses, wetlands or the general catchment.**
Impact description: A large drainage area occurs in the central portion of the study area (Appendix A: Map 3). The drainage area is the main, and only, surface water feature in the study area. It does not form a defined watercourse though scattered wetland depressions

become evident towards the eastern end of the study area and also confirms a shallow groundwater table along this drainage area. The drainage system will be excluded from the development and is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). This drainage area is also likely to play an important role in terms of groundwater recharge for this area. Especially so since it is regarded as part of the Bo-Molopo Karst Belt Strategic Water Source Area (SWSA) which perform important functions in terms of groundwater resources Despite the drainage area being largely modification and large portion being devoid of riparian and wetland conditions, it should still be regarded as a no-go area and no construction or operational activities including stockpiling, clearing, laydown areas, vehicle movement or any other associated activities should occur within this drainage area.

	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent impact on surface water features	**Low Negative (8)**
Extent	2	Development area does not occur in close proximity to any surface water features	
Magnitude	1	Development area does not occur in close proximity to any surface water features	
Probability	1	Development area does not occur in close proximity to any surface water features	
Mitigation/Enhancement Measures			
Mitigation: Despite the drainage area being largely modification and large portion being devoid of riparian and wetland conditions, it should still be regarded as a no-go area and no construction or operational activities including stockpiling, clearing, laydown areas, vehicle movement or any other associated activities should occur within this drainage area.			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent impact on surface water features	**Low Negative (8)**
Extent	2	Development area does not occur in close proximity to any surface water features	
Magnitude	1	Development area does not occur in close proximity to any surface water features	
Probability	1	Development area does not occur in close proximity to any surface water features	
Cumulative impacts: The surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase does not cover a large area, cumulatively the			

development will have a high impact. The impact on the surface water features of the area would likewise also be extensive and the cumulative impact will remain significant.
Residual Risks: Should the drainage area be regarded as a no-go area and measures as indicated implemented the anticipated impact will be low though it remains likely that some increased erosion and sedimentation will remain and there will therefore remain a low residual impact.

Nature: **The impact that the development will have on exotic weeds and invasive species, both current and anticipated conditions.**			
Impact description: As was observed during the survey of the study area it contains several exotic weed and invader species (Appendix B). In addition, development (especially construction) will increase disturbance and exacerbate conditions susceptible to the establishment of exotic weeds and invaders. Without mitigation this will significantly increase the establishment of exotics and is likely to spread into the surrounding areas. It is therefore recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the development area. Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	4	Long-term infestation	**Moderate Negative (56)**
Extent	4	Spreading of infestation into neighbouring areas	
Magnitude	6	Infestation of surrounding natural areas	
Probability	4	Impact is highly likely	
Mitigation/Enhancement Measures			
Mitigation: It is recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the development area. Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.			
Post Mitigation/Enhancement Measures			
Duration	3	Limited duration if monitoring and eradication is maintained	**Moderate Negative (30)**
Extent	3	Limiting extent through monitoring and eradication	
Magnitude	4	Limiting infestation to the transformed footprint	
Probability	3	Moderate probability remains	
Cumulative impacts: The surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The			

proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase does not cover a large area, cumulatively the development will have a high impact. The cumulative impact of infestation by exotics would therefore also remain significant.

Residual Risks:
Without mitigation this will significantly increase the establishment of exotics and is likely to spread into the surrounding areas.

Nature:
Any increased erosion that the development may cause.

Impact description: As indicated, because solar PV developments result in the removal of vegetation, this reduces infiltration and promotes runoff. Coupled with the rain shadow caused by panels and the resulting dripline, this increases runoff and erosion. This may also have an impact on the drainage system in the study area. In order to reduce this impact, the development should implement a comprehensive storm water management system which should ensure that the surface runoff patterns are retained as is, especially pertaining to solar panels, and that the development does not contribute toward increased surface flow, erosion and any impacts on downslope areas.

	Rating	Motivation	Significance
Prior to Mitigation			
Duration	4	Permanent modification of surface topography	**Moderate Negative (56)**
Extent	4	Spreading of erosion into neighbouring areas	
Magnitude	6	Limited magnitude due to the flat topography	
Probability	4	Highly likely to take place	
Mitigation/Enhancement Measures			
Mitigation: In order to reduce this impact, the development should implement a comprehensive storm water management system which should ensure that the surface runoff patterns are retained as is, especially pertaining to solar panels, and that the development does not contribute toward increased surface flow, erosion and any impacts on downslope areas.			
Post Mitigation/Enhancement Measures			
Duration	4	Permanent modification of surface topography	**Moderate Negative (33)**
Extent	3	Limiting extent through storm water management	
Magnitude	4	Limited magnitude due to the flat topography	
Probability	3	Unlikely to occur as long as storm water management is maintained	

Cumulative impacts:
The surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase does not cover a large area, cumulatively the

development will have a high impact. Therefore the cumulative impact of increased erosion would also remain significant.
Residual Risks: Erosion may still have a significant impact on the drainage system in the study area.

Nature: **Fragmentation of habitat, disruption of ecological connectivity and -functioning in terms of the surrounding areas.**			
Impact description: The region around the study area, especially to the north of it, is still dominated by extensive natural areas and consequently ecosystem functions, habitat fragmentation and the disruption of ecosystem processes is still fairly low. However, the proposed development will also require the transformation of fairly large areas consisting of natural grassland in fairly good condition and will therefore result in significant habitat loss and fragmentation. This will however be limited to the study area since the surroundings are still dominated by natural vegetation. However, a portion of the study area consists of an Ecological Support Area 1 (ESA) and functions as part of an ecological corridor (Appendix A: Map 1). The development will therefore also impact on this functioning. Mitigation can however be implemented in order to provide some manner of continued corridor. In order to mitigate the loss of a portion of this corridor, the development can also consider implementing measures to allow for fauna to still use the area as a corridor. Solar developments are often surrounded by extensive fences but this development should also consider implementing measures to allow for small mammals to cross between these fences, i.e. wildlife permeable fencing or wildlife passages. Should mitigation be possible and given the largely natural surroundings the anticipated impact on habitat fragmentation is anticipated to remain largely moderate.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent loss and fragmentation of habitat	**Moderate Negative (56)**
Extent	4	Large development footprint	
Magnitude	5	Moderate magnitude due to extensive natural surroundings	
Probability	4	Highly likely to take place	
Mitigation/Enhancement Measures			
Mitigation: a portion of the study area consists of an Ecological Support Area 1 (ESA) and functions as part of an ecological corridor (Appendix A: Map 1). The development will therefore also impact on this functioning. Mitigation can however be implemented in order to provide some manner of continued corridor. In order to mitigate the loss of a portion of this corridor, the development can also consider implementing measures to allow for fauna to still use the area as a corridor. Solar developments are often surrounded by extensive fences but this development should also consider implementing measures to allow for small mammals to cross between these fences, i.e. wildlife permeable fencing or wildlife passages.			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent loss and fragmentation of habitat	**Moderate Negative (52)**
Extent	3	Ensure movement of fauna remains possible	
Magnitude	5	Moderate magnitude due to extensive natural surroundings	

Probability	4	Highly likely to take place	
Cumulative impacts: The surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase does not cover a large area, cumulatively the development will have a high impact. As a result the cumulative fragmentation of habitat will remain significant.			
Residual Risks: The area is largely still dominated by natural grassland in fairly good condition and it is unavoidable that the development will result in transformation of a significant portion of natural grassland and consequently the residual impact on habitat fragmentation and the loss of ecosystem processes would remain significant.			

Nature: **Impacts that will result on the mammal population on and around the site.**			
Impact description: The most significant impact on mammals anticipated on the site itself is primarily concerned with the loss and fragmentation of available habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. Since it is inevitable that the development will involve the transformation of natural grassland this contributes significantly toward habitat loss which in turn will result in a high impact on the mammal population. The area is surrounded by extensive natural areas which will somewhat decrease the impact though the loss of habitat will still result in a decrease in the mammal population size which will essentially result in a reduction in the mammal population of the area.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Given the largely natural development footprint and permanent loss of habitat the duration will be permanent	**High Negative (64)**
Extent	4	Extensive loss of natural areas	
Magnitude	7	High given the largely natural mammal population	
Probability	4	High given the largely natural mammal population and loss of habitat	
Mitigation/Enhancement Measures			
Mitigation: Construction itself may also affect the mammal population and care should therefore be taken to ensure none of the faunal species on site is harmed. The hunting, capturing or harming in any way of mammals on the site should not be allowed. Voids and excavations may also act as pitfall traps to fauna and these should continuously be monitored and any trapped fauna removed and released in adjacent natural areas.			
Post Mitigation/Enhancement Measures			
Duration	5	Given the largely natural development footprint and permanent loss of habitat the	**High Negative (64)**

		duration will be permanent	
Extent	4	Extensive loss of natural areas	
Magnitude	7	High given the largely natural mammal population	
Probability	4	High given the largely natural mammal population and loss of habitat	

Cumulative impacts:
The surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase does not cover a large area, cumulatively the development will have a high impact. As a result the cumulative impact on the mammal population will remain significant.

Residual Risks:
Transformation of the indigenous vegetation on the site will result in a decrease in the mammal population size as available habitat decreases and consequently the residual impact will remain high.

Cumulative impact:

As previously indicated, the surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase does not cover a large area, cumulatively the development will have a high impact. This will also be taken into account for the current proposed development which will therefore contribute toward a significant cumulative impact.

	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	3	4
Duration	5	5
Magnitude	6	6
Probability	5	4
Significance	**High (70)**	**High (60)**
Status (positive or negative)	Negative	Negative
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Yes – but limited	Yes – but limited

Confidence in findings: High

Mitigation:
The cumulative impact is unlikely to be easily mitigated. Decreasing the total development footprint should allow for a decrease in the cumulative impact though is unlikely and the cumulative impact is therefore anticipated to remain significant.

6. BIODIVERSITY SENSITIVITY RATING (BSR)

Habitat diversity and species richness:
The majority of the area is still dominated by natural vegetation though the habitat is fairly uniform and without a high diversity of habitats (Appendix A: Map 1). The study area consists of an undulating landscape dominated by grassland and scattered trees with areas of exposed rocky terrain also present. This does however only represent a moderate habitat diversity. As a consequence species diversity is also still relatively moderate.

Presence of rare and endangered species:
No Red Listed plant species could be identified on the site and the area is also not known to contain many such species though a few are still present in this region and a likelihood therefore remains that such a species may also be present on the site. However, given the large extent of the study area, it has been found to contain several protected plant species (Appendix B). These include the protected succulent and geophytic species, *Babiana bainesii, Gladiolus cf. elliottii* and *Pellaea calomelanos*.

Ecological function:
The ecological function of the site is still relatively intact though some modification is still evident. The site functions as habitat for a variety of fauna, supports specific vegetation types and the drainage area also functions as a surface water feature with its functioning in terms of groundwater recharge being especially important. The majority of the area is still dominated by natural vegetation and therefore still retains the natural Carletonville Dolomite Grassland vegetation type (Appendix A: Map 1). As a result of this largely natural vegetation, the area also clearly still sustains a diverse mammal population. Historical ploughing has resulted in some modification of the area and farming activities has also contributed toward some modification of the ecological functioning. In general the ecological function is however still regarded as moderately intact

Degree of rarity/conservation value:
The majority of the area still consists of natural grassland in a fairly good condition (Appendix A: Map 1). These areas do however not have a high conservation value, which will decrease the anticipated impact to some degree. The vegetation type in the study area, Carletonville Dolomite Grassland is not currently regarded as rare or endangered and still covers large areas of the region (Appendix A: Map 1). This will therefore not contribute toward their conservation value (Appendix A: Map 4). Furthermore, the North West Biodiversity Sector Plan (2015) regards the site as being of Ecological Support Area (ESA) 1 and do not contain Critical Biodiversity Areas (CBA) which would be of high conservation value (Appendix A: Map 2). This contributes toward a moderate conservation value.

The drainage system occurring in the study area does not form a defined watercourse though scattered wetland depressions become evident towards the eastern end of the study area and also confirms a shallow groundwater table along this drainage area (Appendix A: Map 3). This drainage area is also likely to play an important role in terms of groundwater recharge for this area. Especially so since it is regarded as part of the Bo-Molopo Karst Belt Strategic Water Source Area (SWSA) which perform important functions in terms of groundwater resources. This system therefore also retains at least a moderate conservation value.

Percentage ground cover:
The area contains a dense grass layer with scattered trees and shrubs also present. There is however some decrease in this natural vegetation cover where historical ploughing has occurred and as a result the percentage vegetation cover is considered to be moderately modified.

Vegetation structure:
The area forms part of the Grassland Biome and should naturally therefore contain a well-developed grass layer and should also contained scattered trees and shrubs which are characteristic of the Carletonville Dolomite Grassland. This is also still the case for the and overall there has not been any significant modification of this vegetation structure and it is considered to still be intact.

Infestation with exotic weeds and invader plants:
In general, the natural areas in the study area are largely devoid of exotic weeds. However, where disturbance is present as well as those areas where transformation has occurred, exotic weeds and invasive trees have become established (Appendix B). These include *Datura ferox, Schkuhria pinata, Cereus jamacaru, Cyllindropuntia imbricata, Eucalyptus camaldulensis, Melia azedarach, Gleditsia triacanthos, Alternanthera pungens, Bidens bipinnata* and *Xanthium spinosum.* Several of these are considered serious invasive species and it is important that a comprehensive eradication and monitoring programme be implemented.

Degree of grazing/browsing impact:
The study area is being utilised for natural grazing for domestic livestock but which follows a structure grazing regime and overgrazing and trampling is therefore still regarded as only moderate.

Signs of erosion:
Due to the flat topography and the still natural vegetation cover the area is not affected by any pronounced erosion.

Terrestrial animals:
Signs and tracks of mammals are fairly abundant on the site and will be relatively close to the natural condition, both in terms of species composition and population size. Natural vegetation has a high carrying capacity for mammals which has been confirmed to still be the case for this area. However, a few impacts associated with the land use in the area may still have some effect on the mammals in the area. Livestock normally has a low magnitude impact in that it decreases the grazing capacity available for the natural mammal population though this impact largely affects larger antelope and will not have a high impact on smaller mammals. Associated with this land use may also be the impact of any herding dogs kept by personnel on the site and any hunting and trapping which is also likely to occur in the area. Rare and endangered mammals are often reclusive and avoid areas in close proximity to human activities and are also dependant on habitat in pristine condition. The site would therefore have some impact on the likelihood of such rare and endangered species occurring in the area, though there will remain a significant likelihood of such a species occurring in the area.

Table 6: Biodiversity Sensitivity Rating for the proposed solar development.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness		2	
Presence of rare and endangered species		2	
Ecological function		2	
Uniqueness/conservation value		2	
Vegetation condition			
Percentage ground cover		2	
Vegetation structure			1
Infestation with exotic weeds and invader plants or encroachers		2	
Degree of grazing/browsing impact		2	
Signs of erosion			1
Terrestrial animal characteristics			
Presence of rare and endangered species		2	
Sub total	0	16	2
Total		16	

7. BIODIVERSITY SENSITIVITY RATING (BSR) INTERPRETATION

Table 7: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Kiara PV Solar	18	Good condition	2

8. DISCUSSION AND CONCLUSION (Appendix A: Map 1 - 4)

The site proposed for PV solar development has been rated as being in a Good Condition. This is a result of the area still being dominated by natural grassland in a fairly good condition. The area has however been found to be fairly uniform in terms of habitat and species diversity and does not contain elements of high conservation value (Appendix A: Map 4). However given the large extent of the development, it will still result in several significant impacts.

The study area is situated approximately 15 km to the north east of the town of Lichtenburg in the North West Province (Appendix A: Map 1 – 4). The development will consist of seven separate phases but which all form part of the same study area. This report will be applicable to Phase 2 of the development. The study area is fairly large and is dominated by undulating grassland plains with gentle slopes that generally slopes toward a lower lying drainage area located centrally within the study area. The study area has an approximate extent of 1600 hectares while phase 2 covers 169 hectares of this. The majority of the study area is still dominated by natural vegetation although significant portions of it was affected by historical transformation for crop cultivation.

The area has a fairly uniform topography as well as soils and geology and as a result contains only one main vegetation type. According to Mucina & Rutherford (2006), the study area consists exclusively of Carletonville Dolomite Grassland (Gh 15). According to the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) this vegetation type is currently listed as being of Least Concern (LC) (Appendix A: Map 1). Although it is in some instances heavily affected by crop cultivation and mining this is not yet considered to be to such an extent as to warrant it being considered a Threatened Ecosystem. It will therefore, in general, have a moderate conservation value. The survey of the study area also confirmed that it corresponds well will this vegetation type as well as the topography and geology of the site. The vegetation type is adapted to a mosaic pattern of shallow soils over dolomite. It consists of a well-developed grass layer but with scattered trees and shrubs, especially where surface rock occurs.

The North West Biodiversity Sector Plan (2015) has been developed and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas (CBA), and other elements of high conservation importance. This includes both terrestrial and aquatic elements of importance. Most probably as a result of the uniform nature of this area and the general absence of elements of high conservation value the area is listed as an Ecological Support Area 1. However, the following CBA's and elements of high conservation value are still present and must be regarded as having a significant level of sensitivity (Appendix A: Map 2):

Terrestrial components:

- A large portion of the study area consists of an Ecological Support Area 1 (ESA) and functions as part of an ecological corridor. This function will most likely be affected by the development and will have to be taken into consideration.

Aquatic components:

- The region forms part of the Bo-Molopo Karst Belt Strategic Water Source Area (SWSA) which perform important functions in terms of groundwater resources. As a result, it is listed as an ESA 1. The development is unlikely to affect this functioning though it will still need to be taken into consideration by the development. This will also

be especially relevant to drainage areas and sinkholes which mainly function in terms of ground water recharge.

- A central lower lying drainage area is listed as CBA 1 as it forms part of the local drainage network and contains scattered wetland conditions which is of high conservation value. This will be an important element which the development will have to avoid.

As previously indicated, the study area is still dominated by natural vegetation but which is fairly uniform and can be considered as a whole. The study area will therefore be discussed in its entirety with smaller specific elements indicated where these were noted to be of sufficient importance.

Lichtenburg, and the specific study area, is situated within the Grassland Biome and under natural conditions would be dominated by grasses with shrubs and trees being almost completely absent. However, this region is situated in a transitional area between the Grassland and Savannah Biomes and consequently a tree layer is present but sparse and represented by scattered trees. Where rocks, mostly dolomite, outcrop in the area this also promotes the establishment of trees. Since the area is still dominated by natural vegetation, the area is still dominated by open grassland but with scattered trees also present. However, patches and pockets of lower lying areas had previously been ploughed and cultivated. These are most probably areas containing deeper soils with a higher moisture regime. This is also relevant where the surrounding areas may be dominated by surface dolomite rock. Aerial images dating back several decades also confirm this. The vegetation composition of these areas have however been able to largely, re-establish itself to near natural conditions. Other areas where the vegetation composition and structure has been locally modified include farmsteads, stock watering points and a woodlot of invasive Bluegum (*Eucalyptus camaldulensis*). However, overall the vegetation composition and structure of the area would therefore seem to be largely intact.

From the description of the area given above it is clear that the majority of the site still consists of natural grassland which is still in a fairly good condition (Appendix A: Map 1). Some disturbance is present though in general these are localised or has been able re-establish a near natural grass layer. The surrounding areas are also largely still natural and the area is therefore not affected to a large extent by cumulative transformation pressures. However, it is well known that the area has been increasingly subjected to applications for solar energy developments and the cumulative impact that this transformation will have will steadily increase over time. The proposed development will also entail an extensive total extent of approximately 1600 hectares and though each development phase does not cover a large area, cumulatively the development will have a high impact. This will also be taken into account for the current proposed development which will therefore contribute toward a significant cumulative impact.

The description of the proposed development area indicates a relatively uniform habitat, with moderate species diversity and largely without any unique habitats or areas of high diversity (Appendix A: Map 4). Furthermore, the vegetation consists of Carletonville Dolomite Grassland, which although it has a significant species diversity, is currently listed as being of Least Concern (LC) which also does not contribute toward its conservation value (Appendix A: Map 1). Overall, the vegetation in the study area can therefore not be regarded as exceeding a Moderate level of sensitivity (Appendix A: Map 4). Areas of localised high conservation value may however still be present and which may require exclusion from development. Phase 2 of the development contains a large dolomite sinkhole which may require exclusion from

development (Appendix A: Map 4). It is also located approximately 800 meters to the south of a drainage area but which will be discussed in greater detail in the wetland assessment section of the report (See Section 4.3) (Appendix A: Map 3).

Phase 2 of the development contains a large sinkhole which represents a unique habitat within the landscape and functions largely in terms of groundwater recharge. It therefore has a somewhat higher conservation value than the surrounding landscape and also provides higher value ecological functions (groundwater recharge and unique habitat) and as a result it is considered to have a High level of sensitivity as opposed to the Moderate sensitivity of surrounding areas. The development should therefore consider the exclusion of this sinkhole. Furthermore, the Marico Biosphere Reserve also border the study area to the north. The protected area should remain unaffected by the proposed development, but should still be consulted during the application process.

The area has been indicated to contain a few protected plant species which will have to be taken into consideration by the development (Appendix B). These include the protected succulent and geophytic species, *Babiana bainesii, Gladiolus cf. elliottii* and *Pellaea calomelanos*. Where development will affect these species, the necessary permits should be obtained and a significant proportion of these transplanted to adjacent areas where they will remain unaffected. *Vachellia erioloba* (Camel Thorn), a protected tree but is also represented by a few scattered specimens. Where any of the protected Camel Thorn tree specimens will be affected by the development, permits will have to be obtained for their removal.

In addition, the area also contains a few invasive succulent and tree species (around farmsteads and areas of high disturbance), and this will pose a risk of spreading into surrounding natural areas, especially as construction of the solar development will increase disturbance in the area (Appendix B). The proposed development will also have to implement a comprehensive monitoring and eradication programme to ensure that invasive plant species are removed from the area and prevented from re-establishing.

Signs and tracks of mammals are fairly abundant on the site and will be relatively close to the natural condition, both in terms of species composition and population size. Natural vegetation has a high carrying capacity for mammals which has been confirmed to still be the case for this area. However, a few impacts associated with the land use in the area may still have some effect on the mammals in the area. Livestock normally has a low magnitude impact in that it decreases the grazing capacity available for the natural mammal population though this impact largely affects larger antelope and will not have a high impact on smaller mammals. Associated with this land use may also be the impact of any herding dogs kept by personnel on the site and any hunting and trapping which is also likely to occur in the area. Rare and endangered mammals are often reclusive and avoid areas in close proximity to human activities and are also dependant on habitat in pristine condition. The site would therefore have some impact on the likelihood of such rare and endangered species occurring in the area, though there will remain a significant likelihood of such a species occurring in the area.

The most significant impact on mammals anticipated on the site itself is primarily concerned with the loss and fragmentation of available habitat. Transformation of the natural vegetation on the site will result in a decrease in the population size as available habitat decreases. Since it is inevitable that the development will involve the transformation of natural grassland this contributes significantly toward habitat loss which in turn will result in a high impact on the mammal population. The area is surrounded by extensive natural areas which will somewhat

decrease the impact though the loss of habitat will still result in a decrease in the mammal population size which will essentially result in a reduction in the mammal population of the area.

The area is largely devoid of surface drainage lines, watercourses and wetlands, however, a large drainage area is situated in the central portion of the study area (Appendix A: Map 1 & 3). The drainage area is the main, and only, surface water feature in the study area. It does not form a defined watercourse though scattered wetland depressions become evident towards the eastern end of the study area and also confirms a shallow groundwater table along this drainage area. Downstream of the site it is also utilised for crop production (indicating deeper soils) while centre-pivot irrigation is also common (confirming it is an important groundwater resource). The section of the drainage area situated on the site had also historically been ploughed for crop production though has not been used for many decades. Consequently, the transformation caused by the ploughing is still evident though somewhat obscured by the re-establishment of vegetation.

The drainage area is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). It will however still be included in the report in order to provide an overall description of the study area. The drainage area is strictly ephemeral and will only contain surface water during years of exceptional rainfall. It is unlikely that it will ever contain any surface flow but may contain periodic surface water. It also does not fit the definition of a watercourse, does not contain a channel and is also devoid of any distinctive riparian vegetation. However, toward the eastern end of the study area, some small depressions do become evident, indicating shallow groundwater table and confirming that the drainage does form a surface water feature. The condition of the drainage area will be determined from this wetland depression portion and inferred from this for the surrounding section of the drainage area. This drainage area is also likely to play an important role in terms of groundwater recharge for this area. Especially so since it is regarded as part of the Bo-Molopo Karst Belt Strategic Water Source Area (SWSA) which perform important functions in terms of groundwater resources. The drainage area will be excluded from the development footprint and will therefore not be directly affected by it though the development may still have some indirect impacts on it.

The vegetation survey indicated that the drainage area is devoid of both wetland and riparian vegetation and is largely dominated by a combination of pioneer grasses, most likely a consequence of the historical ploughing. Toward the eastern end of the study area, obligate wetland grasses, *Leptochloa fusca*, become prominent in depressions and here wetland conditions are confirmed. In these instances the soil samples also confirmed the presence of soil wetness indicators. However, for the majority of the drainage area, soils did not conclusively indicate the presence of saturated conditions. The drainage area does however still play an important role, especially in terms of groundwater resources and it is therefore regarded as important and sensitive. However, wetland systems would normally be regarded as having a Very High level of sensitivity but since the survey confirmed that wetland areas only become evident toward the eastern end of the study area, this drainage system is only regarded as having a High level of sensitivity (Appendix A: Map 4).

The low lying drainage area in the study area forms the main and only surface water feature in the area and a determination of its condition will therefore be undertaken (Appendix A: Map 3). The drainage area is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). It will however still be included in the report in order to provide an overall description of the study area. Given the lack of a clear

channel and also the absence of distinctive riparian condition, there are no suitable indices to apply in order to determine its current condition. However, toward the eastern end of the study area, some small depressions do become evident, indicating shallow groundwater table and confirming that the drainage area does form a surface water feature. The condition of the drainage area will be determined from this wetland depression portion and inferred from this for the surrounding section of the drainage area. It will also be possible to apply the WET-Health indices for these wetland depressions and should give an accurate indication of the current condition of the system and its vulnerability to impacts of the development as well as the general condition of the drainage system as a whole. The WET-Health will be taken as representative of the Present Ecological State (PES) of this system (Appendix D).

From the described impacts affecting the system it should be clear that the depression wetland areas associated with the drainage area (and therefore also the drainage system as a whole) has resulted in a significant level of modification. A WET-Health determination was undertaken for the depression wetland area to determine its current condition and provide an indication of the overall condition of the drainage system (Appendix D). The results of the WET-Health indicated an overall Present Ecological State of Category C: Moderately Modified. This is considered relatively accurate given the impacts on the system. The EI&S of the wetland depression portion of the drainage system has been rated as being Low.

A Risk Assessment for the proposed solar facility which will affect the drainage system in the study area has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix E). The drainage system will be excluded from the development and is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). A risk matrix and subsequent water use therefore does not apply to this phase of the development.

Despite the drainage area being largely modification and large portion being devoid of riparian and wetland conditions, it should still be regarded as a no-go area and no construction or operational activities including stockpiling, clearing, laydown areas, vehicle movement or any other associated activities should occur within this drainage area.

The impact significance has been determined and indicates that the majority of impacts will remain moderate such as the impact on protected plant species, the drainage system, infestation by exotic weeds, erosion and habitat fragmentation. These impacts will all remain moderate and several can also be further decreased given adequate mitigation is implemented. However, since the area of development is fairly large and still consists of natural vegetation in a relatively good condition the impact on vegetation and diversity loss as well as the impact on the mammal population will remain high. These impacts can also not readily be mitigated since the development footprint is fixed.

9. RECOMMENDATIONS

- Phase 2 of the development contains a large sinkhole which represents a unique habitat within the landscape and functions largely in terms of groundwater recharge. The development should consider the exclusion of this sinkhole.

- The Marico Biosphere Reserve also border the study area to the north (Appendix A: Map 1). The protected area should remain unaffected by the proposed development, but should still be consulted during the application process.

- The following recommendations and mitigation measures should be implemented in order to manage impacts on the drainage system situated in the study area (Appendix A: Map 3):

    - The drainage system as delineated should be completely excluded from the development footprint in order to ensure no impacts on it occurs (Appendix A: Map 3).
    - The drainage area should be regarded as no-go area and no construction or operational activities including stockpiling, clearing, laydown areas, vehicle movement or any other associated activities should occur in or near this surface water feature.
    - The development should design and implement a comprehensive storm water management system in order to manage runoff and prevent erosion which will affect the drainage system.
    - All structures and mitigation measures should be maintained throughout the lifetime of the development in order to ensure they do not progressively increase the impact over time.
    - The drainage system will be excluded from the development and is situated approximately 800 meters to the north of phase 2 and is therefore unlikely to be affected by it (Appendix A: Map 3). A risk matrix and subsequent water use therefore does not apply to this phase of the development.

- As discussed in the report, the study area contains several protected species (Appendix B). These consist of a fern, succulents and geophytes. The following recommendations should be followed for protected species:

    - Where protected succulent/geophytic species will be affected by development, permits should be obtained and these transplanted to adjacent areas where they will remain unaffected.
    - These species are cryptic and inconspicuous and it is recommended that a walkthrough survey be conducted prior to an area being cleared. This should include identification and marking of all protected plants in such an area and should be performed by an ecologist or botanist.
    - The transplanting of these species should be overseen by an ecologist, botanist or other suitably qualified person.
    - Monitoring of the success of establishment should also be undertaken.

- The study area consists of an Ecological Support Area 1 (ESA) and functions as part of an ecological corridor (Appendix A: Map 1). In order to mitigate the loss of a portion of this corridor, the development can also consider implementing measures to allow for

fauna to still use the area as a corridor. Solar developments are often surrounded by extensive fences but this development should also consider implementing measures to allow for small mammals to cross between these fences, i.e. wildlife permeable fencing or wildlife passages.

- Construction may affect the mammal population and care should therefore be taken to ensure none of the faunal species on site is harmed. The hunting, capturing or harming in any way of mammals on the site should not be allowed.

- Voids and excavations may also act as pitfall traps to fauna and these should continuously be monitored and any trapped fauna removed and released in adjacent natural areas. This should include mammals, reptiles and amphibians.

- In the event of poisonous snakes or other dangerous animals encountered on the site an experienced and certified snake handler or zoologist must remove these animals from the site and re-locate them to a suitable area.

- Due to the susceptibility of disturbed areas, it is recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the development area and should be extended into the operational phase.

- Adequate monitoring of weed establishment and their continued eradication must be maintained (Appendix B). Where category 1 and 2 weeds occur, they require removal by the property owner according to the Conservation of Agricultural Resources Act, No. 43 of 1983 and National Environmental Management: Biodiversity Act, No. 10 of 2004.

- No littering must be allowed and all litter must be removed from the site.

- Construction should be confined to the site footprint and should not encroach into adjacent areas.

- After construction has ceased all construction waste should be removed from the area.

- Monitoring of construction including weed establishment and erosion should take place.

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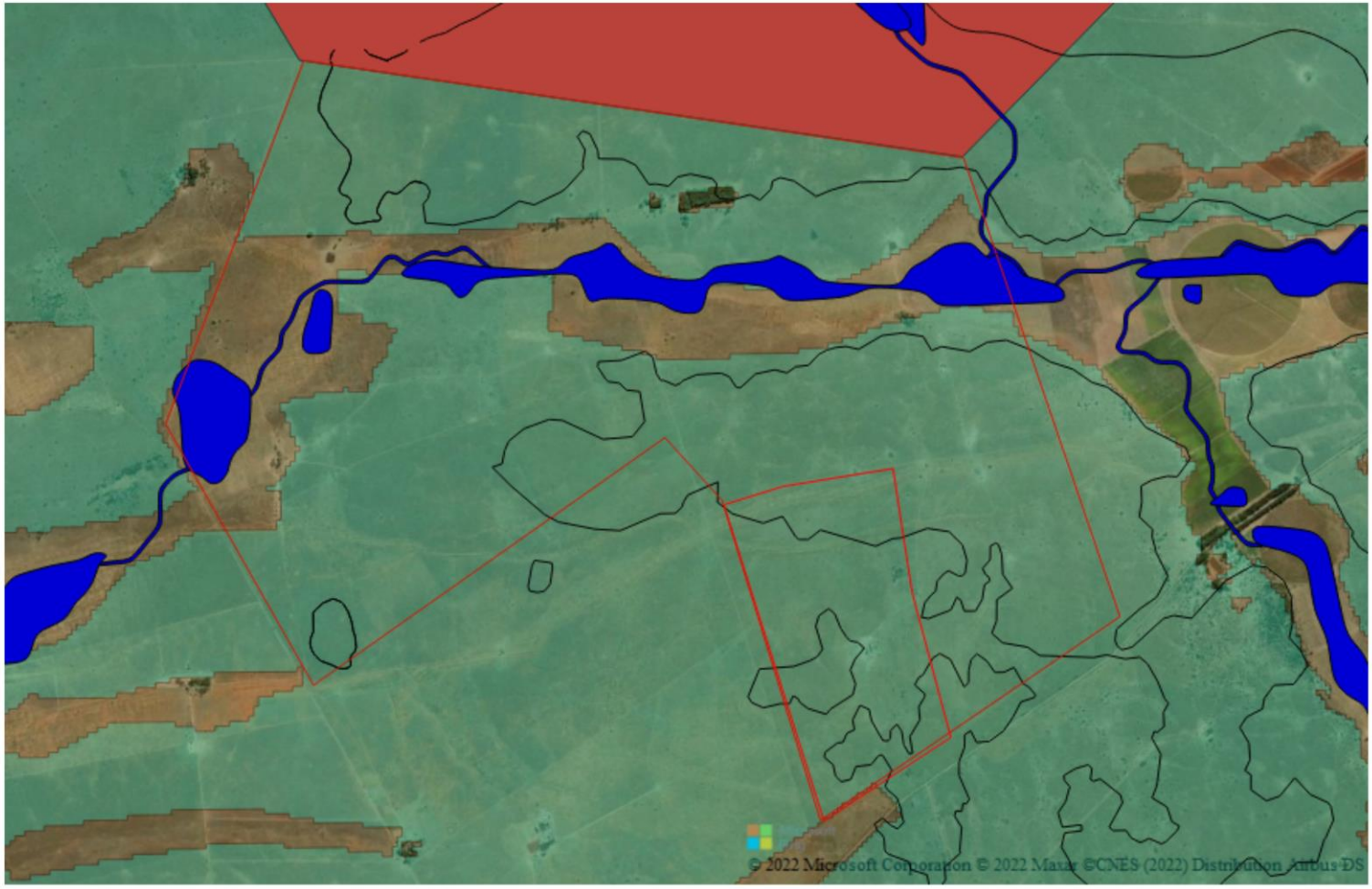
Annexure A: Maps

Locality map for the proposed Kiara PV solar development (Phase 2) situated on Portion 2 and the Remaining Extent of the Farm Hollaagte 8 near the town of Lichtenburg, North West Province.



Map 1: Locality map of the proposed Kiara PV solar development (Phase 2) on the Farm Hollaagte 8 near the town of Lichtenburg. Areas still consisting of the local vegetation type, Carletonville Dolomite Grassland is indicated. Note that the majority of the study area still consists of natural vegetation. Areas which were historically ploughed are indicated as transformed. The probability for the occurrence of wetlands and watercourses is also indicated. Note the drainage area indicated within the central portion of the study area. The delineation of this drainage area was also improved by accurate on-site delineation (Map 3). The Marico Biosphere Reserve also borders the site to the north.

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Sunninghill
2157

Legend:

- Relief Lines
- Study area and powerline
- Watercourses
- Wetlands and impoundments
- Carletonville Dolomite Grass
- Formal Protected Areas

Map Information

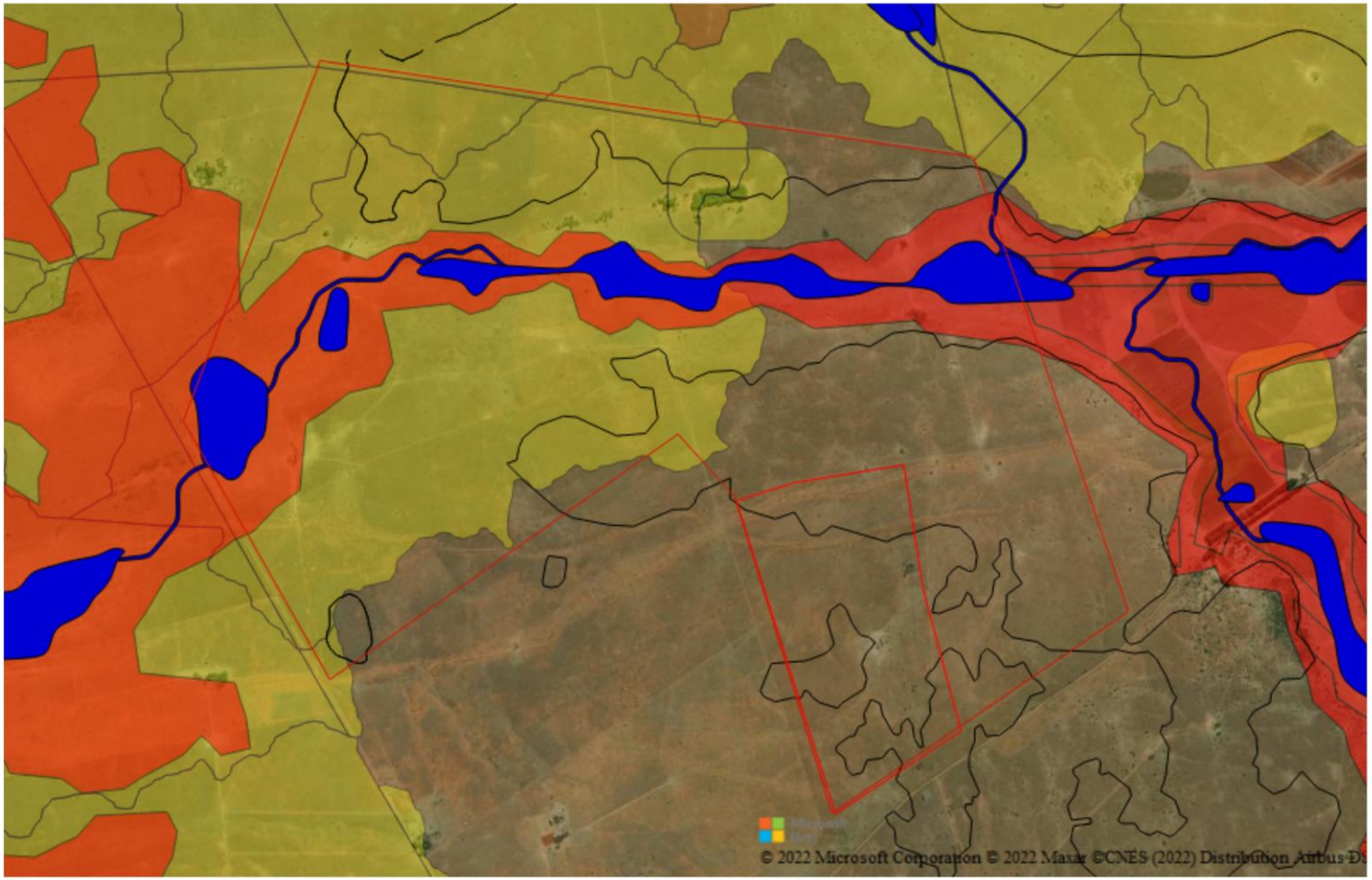
Spheroid: WGS 84

Quantum GIS

Scale: 1:40 000

DPR Ecologists
Contact Darius van Rensburg at:
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
Tel: 083 410 0770

North West Biodiversity Sector Plan map for the proposed Kiara PV solar development (Phase 2) situated on Portion 2 and the Remaining Extent of the Farm Hollaagte 8 near the town of Lichtenburg, North West Province.



Map 2: North West Biodiversity Sector Plan map of the proposed Kiara PV solar development (Phase 2) on the Farm Hollaagte 8 near the town of Lichtenburg. A large portion of the study area is regarded as an Ecological Support Area 1 and functions in support of an ecological corridor. The drainage area situated on the site is also regarded as a Critical Biodiversity Area 1 in terms of the aquatic component and indicates the importance of the system as a surface water feature as well as its importance with regard to groundwater recharge.

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Legend:

- Relief Lines
- Study area and powerline
- Watercourses
- Wetlands and impoundments
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- Ecological Support Area 1
- Ecological Support Area 2

Map Information

Spheroid: WGS 84

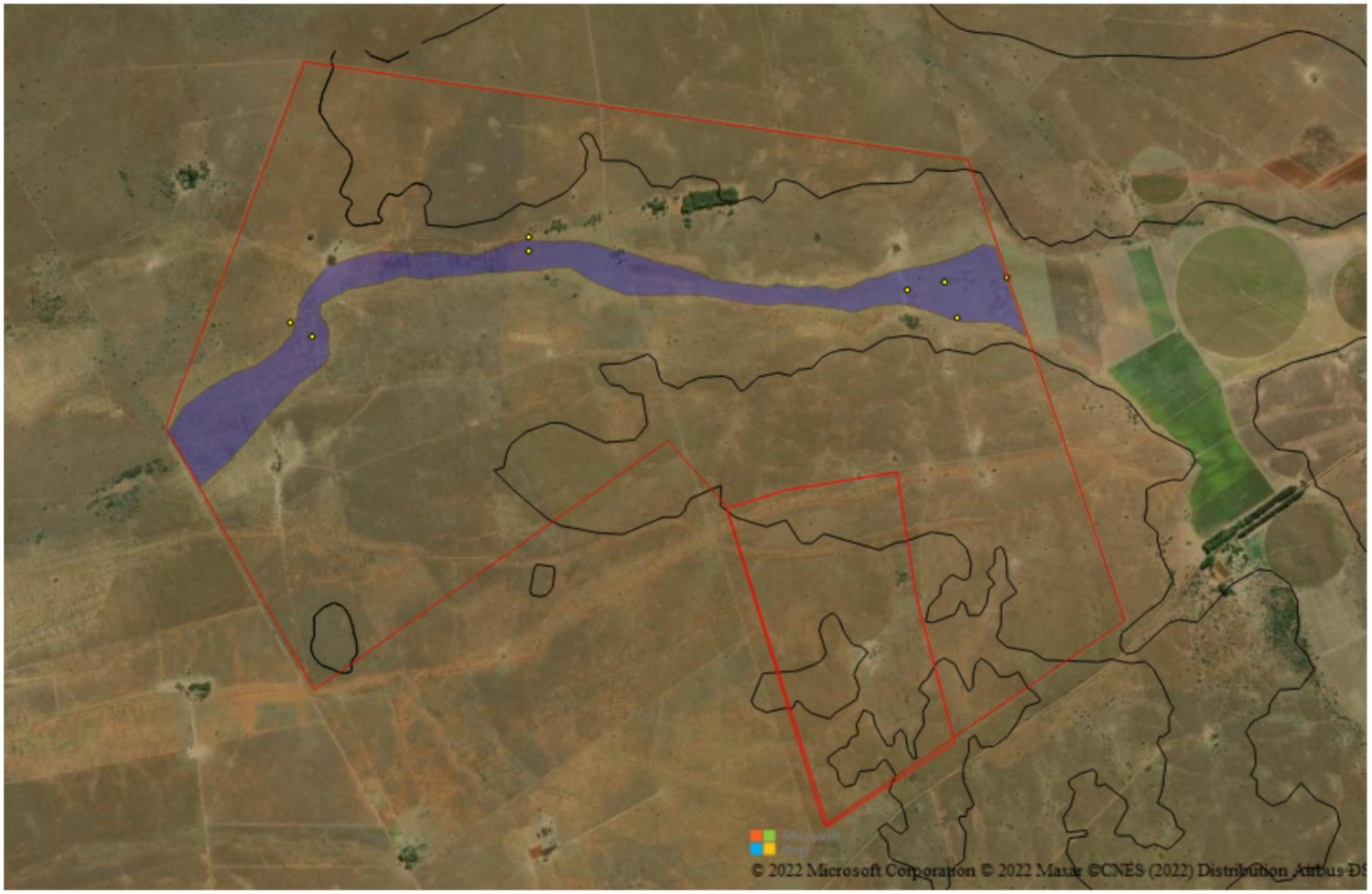
Quantum GIS

Scale: 1:40 000

DPR Ecologists
Contact Darius van Rensburg at:
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
Tel: 083 410 0770

DPR Ecologists & Environmental Services

Surface water delineation map for the proposed Kiara PV solar development (Phase 2) situated on Portion 2 and the Remaining Extent of the Farm Hollaagte 8 near the town of Lichtenburg, North West Province.



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Legend:

- Relief Lines
- Study area and powerline
- Surface water features
- Sampling points

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:40 000

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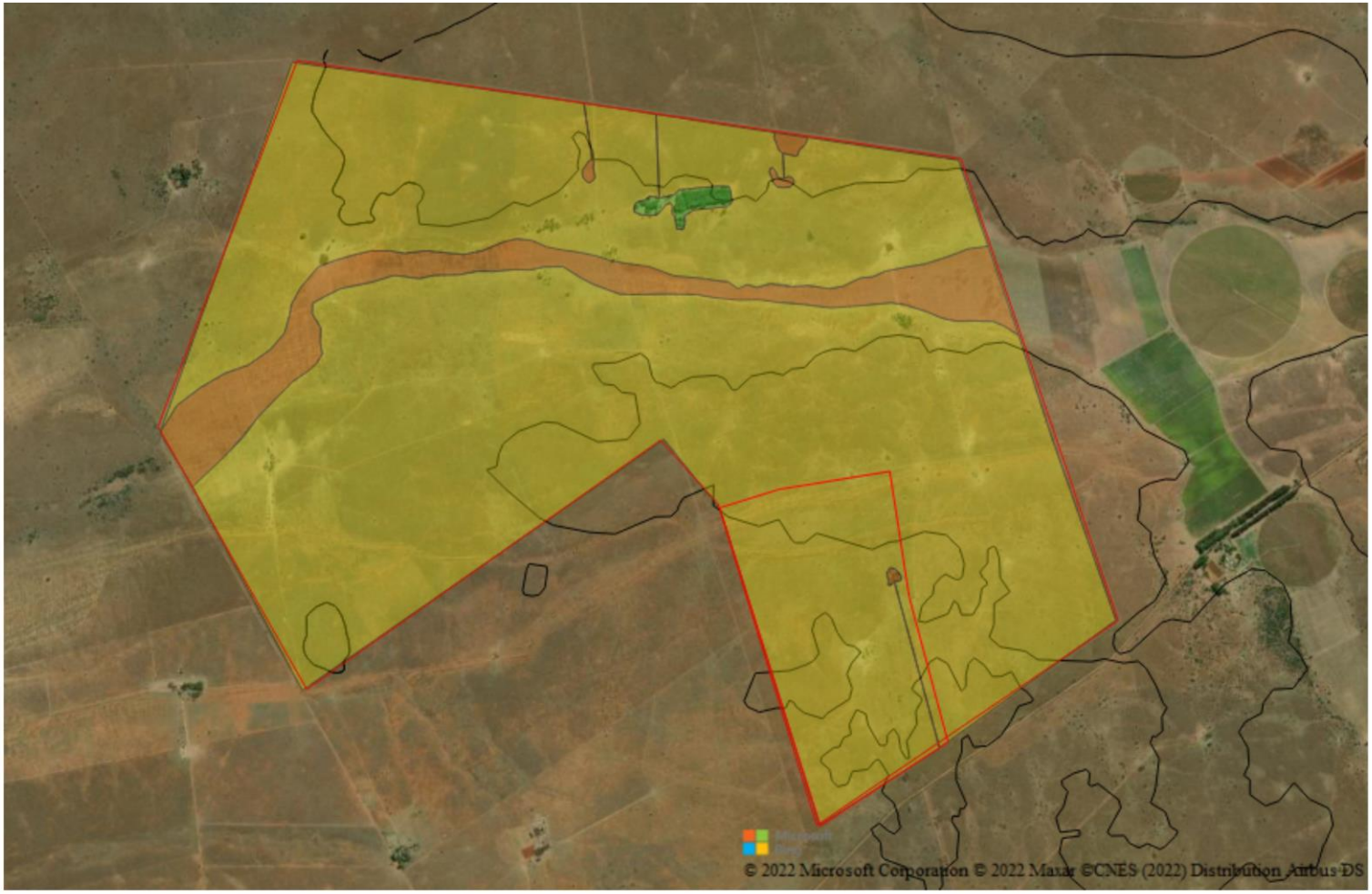
Contact Darius van Rensburg at:
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
Tel: 083 410 0770

Map 3: Surface water delineation map of the proposed Kiara PV solar development (Phase 2) on the Farm Hollaagte 8 near the town of Lichtenburg. A large central drainage area occurs in the study area. The system is largely devoid of riparian and wetland conditions with a few depression wetland areas only forming toward the eastern portion of the study area. This will decrease the sensitivity of the system. However, it does still function as a surface water system and wetland areas in the eastern portion confirm a shallow groundwater table. It will also play an important in terms of the local groundwater resources, especially so since it forms part of the Bo-Molopo Karst Belt Strategic Water Source Area (SWSA). This drainage area will be excluded from development and should therefore remain unaffected by the development.

Sensitivity map for the proposed Kiara PV solar development (Phase 2) situated on Portion 2 and the Remaining Extent of the Farm Hollaagte 8 near the town of Lichtenburg, North West Province.



Map 4: Sensitivity map of the proposed Kiara PV solar development (Phase 2) on the Farm Hollaagte 8 near the town of Lichtenburg. The area is fairly uniform with only a moderate habitat and species diversity while the natural vegetation in this area is also listed as being of Least Concern. As a result, the study area is largely regarded as being of Moderate Sensitivity. However, since the vegetation is still natural and in a fairly good condition, the sensitivity cannot be regarded as Low which is only applicable to areas of transformation such a an area occupied by a woodlot of invasive Bluegum trees. The drainage area in the study area is largely devoid of riparian and wetland conditions and is therefore only afforded a High level of sensitivity but since it will be excluded from development, should remain unaffected. Note also the location of a large sinkhole (High Sensitivity) in phase 2 of the development.

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Legend:

- Relief Lines
- Study area and powerline
- Very High Sensitivity
- High Sensitivity
- Moderate Sensitivity
- Low Sensitivity

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:40 000

DPR Ecologists
Contact Darius van Rensburg at:
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
Tel: 083 410 0770

Appendix B: Species list

Species indicated with an * are exotic.

Protected species are coloured orange and Red Listed species red.

Species	Growth form
**Alternanthera pungens*	Herb
**Bidens bipinnata*	Herb
**Cereus jamacaru*	Succulent
**Cyllindropuntia imbricata*	Succulent
**Datura ferox*	Herb
**Gleditsia triacanthos*	Tree
**Melia azedarach*	Tree
**Schkuhria pinata*	Herb
**Solanum nigrum*	Herb
**Xanthium spinosum*	Herb
Acrotome inflata	Herb
Aloe greatheadii	Succulent
Anancampseros filamentosa subsp. *filamentosa*	Succulent
Anthephora pubescens	Grass
Anthospermum rigidum	Herb
Aristida congesta	Grass
Asparagus larcinus	Shrub
Babiana bainesii	Geophyte
Barleria macrostegia	Herb
Berkheya onopordifolia	Herb
Blepharis angusta	Herb
Boophone distichia	Geophyte
Bulbine abyssinica	Geophyte
Bulbostylis burchellii	Sedge
Celtis africana	Tree
Chascanum pinnatifidum	Herb
Clematis brachiata	Climber
Clematis villosa subsp. *stanleyi*	Climber
Colchicum burkei	Geophyte
Commellina sp.	Herb
Conyza podocephala	Herb
Crassula capitella	Succulent
Crassula lanceolata subsp. *transvaalensis*	Succulent
Cucumis myriocarpus	Creeper
Cymbopogon pospischillii	Grass
Cynodon dactylon	Grass
Dicoma macrocephala	Herb
Diospyros lycioides	Shrub

Ehretia rigida	Shrub
Eleusine coracana	Grass
Elionurus muticus	Grass
Eragrostis curvula	Grass
Eragrostis gummiflua	Grass
Eragrostis lehmanniana	Grass
Eragrostis superba	Grass
Eriospermum porphyrium	Geophyte
Euphorbia davyi	Succulent
Euphorbia inaequilatera	Herb
Gaxania krebsiana	Herb
Gerbera piloselloides	Herb
Gladiolus cf. elliottii	Geophyte
Gomphocarpus fruticosus	Herb
Grewia flava	Shrub
Gymnosporia buxiifolia	Shrub
Helichrysum rugulosum	Herb
Helichrysum argyrosphaerum	Herb
Helichrysum caespititum	Herb
Helichrysum callicomum	Herb
Helichrysum nudifolium	Herb
Hermannia coccocarpa	Herb
Hermannia depressa	Herb
Hermannia geniculata	Herb
Hermannia tomentosa	Herb
Heteropogon contortus	Grass
Hilliardiella oligocarphela	Herb
Hyparrhenia hirta	Grass
Hypochaeris radicata	Herb
Hypoxis hemerocallidae	Geophyte
Hypoxis rigidula	Geophyte
Justicia anagalloides	Herb
Ledebouria revoluta	Geophyte
Leptochloa fusca	Grass
Lippia scaberrima	Herb
Lotononis sp.	Herb
Loudetia simplex	Grass
Melinis nerviglumis	Grass
Monsonia angustifolia	Herb
Moraea pallida	Geophyte
Nidorella hottentottica	Herb
Nolletia sp.	Dwarf shrub
Ophioglossum sp.	Fern
Orbea lutea subsp. *lutea*	Succulent
Oropetium capense	Grass
Othonna oxyriifolius	Geophyte

Oxalis depressa	Geophyte
Parinari capensis	Suffrutex
Pelargonium dolomiticum	Geophyte
Pellaea calomelanos	Fern
Pergularia daemia	Climber
Pogonarthria squarrosa	Grass
Polygala hottentotta	Herb
Portulaca quadrifida	Herb
Schizocarpus nervosus	Geophyte
Searsia lancea	Tree
Searsia magalismontanum	Shrub
Searsia pyroides	Shrub
Sebaea exigua	Herb
Senecio coronatus	Herb
Senecio latifolius	Herb
Senecio sp.	Herb
Senegalia caffra	Tree
Sesamum triphyllum	Herb
Solanum incanum	Herb
Solanum supinum	Herb
Sporobolus discosporus	Grass
Sporobolus fimbriatus	Grass
Stoebe plumosus	Dwarf shrub
Striga elegans	Herb
Themeda triandra	Grass
Trachyandra laxa	Geophyte
Tragypogon spicatus	Grass
Trichoneura grandiglumis	Grass
Triraphis andropogonoides	Grass
Triumfetta sonderi	Herb
Urelytrium agropyroides	Grass
Ursinia nana	Herb
Vachellia erioloba	Tree
Vachellia karroo	Tree
Vachellia tortilis	Tree
Vigna sp.	Herb
Ziziphus mucronata	Tree
Ziziphus zeyheriana	Suffrutex

Appendix C: Soil Samples

Obligate wetland vegetation was utilised to determine the presence and border of wetlands. Soil samples were used to confirm the wetland conditions in the study area. Soil samples were taken at approximately 10 meter intervals. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

Within wetlands the hydrological regime differs due to the topography and landscape. For instance; a valley bottom wetland would have a main channel that is below the water table and consequently permanently saturated, i.e. permanent zone of wetness. As you move away from the main channel the wetland would become dependent on flooding in order to be saturated. As a result along this hydrological regime areas of permanent saturation, seasonal and temporary saturation would occur. At some point along this gradient the saturation of the soil would be insufficient to develop reduced soil conditions and therefore will not be considered as wetland.

Within wetland soils the pores between soil particles are filled with water instead of atmosphere. As a result available oxygen is consumed by microbes and plantroots and due to the slow rate of oxygen diffusion oxygen is depleted and biological activity continues in anaerobic conditions and this causes the soil to become reduced.

Reduction of wetland soils is a result of bacteria decomposing organic material. As bacteria in saturated soils deplete the dissolved oxygen they start to produce organic chemicals that reduce metals. In oxidised soils the metals in the soil give it a red, brown, yellow or orange colour. When these soils are saturated and metals reduced the soil attains a grey matrix characteristic of wetland soils.

Within this reduction taking place in the wetland soils there may be reduced matrix, redox depletions and redox concentrations. The reduced matrix is characterised by a low chroma and therefore a grey soil matrix. Redox depletions result in the grey bodies within the soil where metals have been stripped out. Redox concentrations result in mottles within the grey matrix with variable shape and are recognised as blotches or spots, red and yellow in colour.

Soil wetness indicator is used as the primary indicator of wetlands. The colour of various soil components are often the most diagnostic indicator of hydromorphic soils. Colours of these components are strongly influenced by the frequency and duration of soil saturation. Generally, the higher the duration and frequency of saturation in a soil profile, the more prominent grey colours become in the soil matrix.

Coloured mottles, another feature of hydromorphic soils, are usually absent in permanently saturated soils and are at their most prominent in seasonally saturated soils, becoming less abundant in temporarily saturated soils until they disappear altogether in dry soils (Collins 2005).

The following soil wetness indicators can be used to determine the permanent, seasonal and temporary wetness zones. The boundary of the wetland is defined as the outer edge of the temporary zone of wetness and is characterised by a minimal grey matrix (<10%), few high chroma mottles and short periods of saturation (less than three months per year). The seasonal zone of wetness is characterised by a grey matrix (>10%), many low chroma mottles and significant periods of wetness (at least three months per year). The permanent zone of wetness

is characterised by a prominent grey matrix, few to high chroma mottles, wetness all year round and sulphuric odour (rotten egg smell).

According to convention hydromorphic soil must display signs of wetness within 50 cm of the soil surface (DWAF 2005).

Appendix D: Index of Habitat Integrity (IHI)/WET-Health Summary

For the complete WET-Health please contact the author of this report.

Wetland Attributes	
The information in this sheet must be captured before continuing with any other aspects of the assessment. Not capturing all the information required will lead to errors in the spreadsheet calculations, which will prevent a final outcome being obtained.	
Wetland Name	Kiara Drainage System
Assessment Unit Name / No.	1
Assessor	D van Rensburg
Date of Assessment	21/06/2022
HGM Type (Basic)	Depression
	DEP
HGM Type (Refined)	Depression without flushing
	DEP-endo
Conceptual model	Water and sediment inputs from the topographically defined catchment are assumed to emanate largely from lateral inputs, with limited inputs from the catchment upstream of the wetland. For the the purposes of geomorphic and water quality assesments, a weighting of 80% is therefore allocated to impacts associated with lateral inputs whilst impacts associated with the upstream catchment only contribute 20% to final catchment impact scores. For the hydrological assessment, weightings are based on the relative extent of contributing areas rather than default weightings.
Wetland size (Ha)	0.5
Upslope catchment size (Ha)	232
Quaternary Catchment[1]	C31A
MAR (Mm3)	12.4
MAR per unit area (m3/Ha)	71.0
MAP (mm)	553
PET (mm)	1900
MAP:PET ratio	0.3
Vulnerability Factor	1.0
Hydrogeological Type Setting[2]	Karst landscape
Connectivity of wetland to a regional aquifer	Connected to both the regional aquifer and other sources, but neither appear to be dominant
Change in groundwater levels in the regional aquifer	Moderate lowering of the water table in the regional aquifer which moderately reduces its contact with the rooting zone in the wetland
Water quality of regional aquifer	Unknown
Channel characteristics (if present)	
Natural wetness regimes	Mix of seasonal and temporarily saturated soils
Broad vegetation attributes	Dominated by obligate wetland grasses within the depression while surrounding drainage areas are dominated by terrestrial grasses.
Number of dams in the catchment	0
Average surface area of dams (m2)	0
Perimeter of wetland (m)	263
Perimeter-to-area ratio (m/ha)	526.0
Down-slope length of wetland (m)	60
Elevation change over length (m)	0
Longitudinal Slope (%)	0.0%
Propensity to erode (Category)[3]	Very low
Propensity to erode (Score)	1.0
Dominant sediment accumulation process	Clastic

WET-Health Level 2 assessment: PES Summary

This worksheet provides an overall summary of the WET-Health Assessment that can be used for reporting purposes

	Wetland PES Summary
Wetland name	**Kiara Drainage System**
Assessment Unit	**1**
HGM type	Depression without flushing
Areal extent (Ha)	0.5 Ha

Unadjusted (modelled) Scores

PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	3.1	1.5	2.0	6.0
PES Score (%)	69%	85%	80%	40%
Ecological Category	**C**	**B**	**C**	**E**
Combined Impact Score	3.1			
Combined PES Score (%)	69%			
Combined Ecological Category	**C**			
Hectare Equivalents	0.3 Ha			
Confidence (modelled results)	nal aquifer but missing information on the degree of connectitivity, the lowering of			

Final (adjusted) Scores

PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	3.1	1.5	2.0	6.0
PES Score (%)	69%	85%	80%	40%
Ecological Category	**C**	**B**	**C**	**E**
Trajectory of change				
Confidence (revised results)	Not rated	Not rated	Not rated	Not rated
Combined Impact Score	3.1			
Combined PES Score (%)	69%			
Combined Ecological Category	**C**			
Hectare Equivalents	0.3 Ha			

Appendix E: Risk Assessment Matrix

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP REGISTERED PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE

					Severity																	
No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
1	Mostly Construction Phase but also during operation	Construction of a solar facility	A large drainage system with patchy wetland depression areas may be affected by the proposed development	The construction of the facility will occur in close proximity to the drainage area as well as those patches having been identified as containing wetland conditions and there will be an impact on the catchment of the drainage system which will then have an indirect impact on it.	1	1	1	1	1	2	1	4	2	3	5	3	13	52	L	80	Provided that recommendations are implemented and that the drainage system is excluded from the development and is treated as no-go areas, the anticipated risk should remain low. As the development may still occur in relatively close proximity to it, it will also be important to implement a comprehensive storm water management system.

Appendix F: Impact methodology

Direct, indirect and cumulative impacts associated with the projects must be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;
- The **magnitude**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:

S=(E+D+M)P

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

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

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),

» 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
» > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

Assessment of impacts must be summarised in the following table format. The rating values as per the above criteria must also be included. Complete a table and associated ratings for **each** impact identified during the assessment.

<u>Example</u> of Impact table summarising the significance of impacts (with and without mitigation)

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**			
Impact description: The impact will occur due to added pressure on the availability of housing located in the local community. This may contribute to increased levels of competition in the temporary housing market.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	Short-term (1)	The construction period will last for less than one year	**Low Negative (18)**
Extent	Local (1)	Pressure will only be added on the local municipality to provide housing for outsourced construction workers	
Magnitude	Low (4)	The increase in demand for affordable accommodation should not be extensive as workers will primarily be sourced from the local communities.	
Probability	Probable (3)	The possibility of the impact on the provision of affordable accommodation is very low	
Mitigation/Enhancement Measures			
Mitigation: "Mitigation", means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible. • Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind.			
Post Mitigation/Enhancement Measures			
Duration	Short-term (1)	Pressure will only be added on the local municipality to provide housing for outsourced construction workers.	**Low Positive (8)**
Extent	Local (1)	The increase in demand for affordable accommodation should be mitigated if external construction crews are provided with onsite accommodation.	
Magnitude	Minor (2)	The possibility of the impact on the	

		provision of affordable accommodation is very low.	
Probability	Improbable (2)	A reduced amount of pressure will be added on the local municipality to provide housing for outsourced construction workers.	
Cumulative impacts: "Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities.			
Residual Risks: "Residual Risk", means the risk that will remain after all the recommended measures have been undertaken to mitigate the impact associated with the activity (Green Leaves III, 2014).			

Assessment of Cumulative Impacts

As per requirements of the EIA Regulations, specialists are required to assess the cumulative impacts. In this regard, please refer to the methodology below that will need to be used for the assessment of Cumulative Impacts.

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities[1].

The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section should address whether the construction of the proposed development will result in:

» Unacceptable risk
» Unacceptable loss
» Complete or whole-scale changes to the environment or sense of place
» Unacceptable increase in impact

The specialist is required to conclude if the proposed development will result in any unacceptable loss or impact considering all the projects proposed in the area.

Example of a cumulative impact table:
Nature: Complete or whole-scale changes to the environment or sense of place (example)

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**		
	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**

[1] Unless otherwise stated, all definitions are from the 2014 EIA Regulations, as amended, GNR 326

Extent	Low (1)	Low (1)
Duration	Medium-term (3)	Long-term (4)
Magnitude	Minor (2)	Low (4)
Probability	Improbable (2)	Probable (3)
Significance	**Low (12)**	**Low (27)**
Status (positive or negative)	Negative	Negative
Reversibility	High	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes
Confidence in findings: High.		
Mitigation: "Mitigation", means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible. Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind.		