Report on the ecological and wetland assessment for the proposed Harmony 1 Plant PV solar development situated in Welkom, Free State Province.

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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 Harmony 1 Plant PV solar development situated in Welkom, Free State Province.**		
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Executive Summary

The study area is situated approximately 2 km to the south and on the outskirts of the town of Welkom and to the west of the large Witpan waterbody (Appendix A: Map 1). The study area is fairly large but is dominated by grassland plains without prominent slopes and has an approximate extent of 300 hectares. The majority of this area has previously been transformed by urban development, mining operations and agricultural cropfields. Subsequently those portions of previous cultivation has now re-established grassland but which is of secondary establishment while portions of previous residential areas had also been rehabilitated but is evidently still quite degraded. Despite the largely transformed condition of the site, fairly large areas of remaining natural grassland are also still present and these areas clearly have a high conservation value.

From the description of the area it is clear that large portions of the area has been transformed by agriculture and mining operations (Appendix A: Map 1). The natural vegetation type in this area, Vaal-Vet Sandy Grassland is also currently under severe transformation pressure. Consequently, any remaining natural areas would therefore be regarded as having a very high conservation value. These natural areas have also been listed as Critical Biodiversity Area 1 (CBA 1) which confirms this (Appendix A: Map 2). These areas should therefore be avoided by the development. The borders of these natural areas have also been refined by the current site survey (Appendix A: Map 4).

Should development of the solar facility be able remain within transformed areas (southern and eastern portions), this will greatly decrease the anticipated impacts (Appendix A: Map 4). However, should the development encroach into areas of remaining natural grassland (northern and north western portions) this will entail a high impact (Appendix A: Map 4). Being a mining area, this results in transformation and degradation of large portions of land. The cumulative impact of development and mining in this area is therefore high. The proposed solar development should therefore first consider the development of areas considered as already transformed and of low sensitivity (Appendix A: Map 4). These include the secondary grassland (southern portion) and areas which previously consisted of buildings and structures (eastern portion). Only if no remaining options remain should the development consider encroaching into remaining natural areas. However, in this instance it will result in high impacts. Likewise the remaining natural wetland areas in the north eastern portion of the site will also have a high level of sensitivity and should be avoided by development but will be discussed in greater detail in the wetland assessment section of the report.

Signs and tracks of mammals are present on the site but notably less when compared to the natural condition. This is most likely a consequence of the fragmented condition of the area, the proximity of mining operations and urban areas and high levels of disturbance. Natural vegetation has a high carrying capacity for mammals which decreases significantly where agriculture and mining transforms this natural vegetation and in such areas the mammal population is normally represented by a generalist mammal population. The area proposed for development contains large areas being transformed from the natural condition while natural grassland does still occur it is also largely fragmented and isolated from surrounding extensive natural areas. The mammal population in the study area is therefore dominated by generalist species while being largely modified from the natural mammal population. 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. Such species may still occur in the portions of remaining natural grassland in the study area though due the fragmented and

isolated nature of these areas the likelihood is considered relatively low. Mammal species identified on the site indicate only a moderate species diversity of largely widespread and generalist species and is indicative of a modified natural mammal population.

The surface water features of the study area are dominated by two large pan wetland systems in the north western portion of the site (Appendix A: Map 3). The Witpan, an exceedingly large pan system is also located along the north eastern border of the site but does not form part of the study area (Appendix A: Map 3). A grid connection powerline situated adjacent to this pan may however still have some impact on it and this pan will also be included in this assessment, at least in overview. Two areas of surface disturbance (shallow excavations and dumps) also promote the accumulation of surface water and consequent formation of artificial wetland areas but since they are undoubtedly artificial and do not form part of the natural drainage pattern, they will not be assessed and only discussed in overview. The assessment will focus on the two pans forming part of the site while the Witpan will also be included in overview.

The pan wetlands were delineated by use of topography (land form and drainage pattern) and obligate wetland vegetation with limited soil sampling (Appendix C). The vegetation survey indicated that obligate wetland vegetation dominates the two pan system on the site, while the Witpan also contains obligate wetland vegetation but which is clearly quite heavily degraded. In all of these instances this was also confirmed by soil samples which indicated a seasonal zone of wetness within the two pan systems on the site while the Witpan is dominated by a perennial zone of wetness. These systems were therefore confirmed as wetland system in terms of topography, obligate wetland vegetation and soil wetness indicators (Appendix A: Map 3). The two pan systems on the site and Witpan to the east of the study area can be categorised as depressions wetlands (SANBI 2009).

The determination of the condition of the wetlands on the site will focus on the pan system in the north western portion of the site (Appendix A: Map 3). The aim is to provide an overall overview of the wetlands in the study area. This pan is the largest and most prominent wetland on the site and should therefore provide the most comprehensive indication of the overall wetland condition on the site. Therefore, a WET-Health determination will be done for this large pan system occurring on the site and should give a good overall indication of the condition of the wetlands on the site. The WET-Health will be taken as representative of the Present Ecological State (PES) of this system (Appendix D). The Witpan does not form a part of the site though there is a low likelihood that it may still be affected by the proposed grid connection powerline (Appendix A: Map 3). The condition of the Witpan will therefore only be assessed at a desktop level, using available resources in order to give a general indication of its condition and the probability that the grid connection powerline will further affect this system.

The pan wetland systems in the north western portion of the site is affected by several impacts which result in a significant level of modification. A WET-Health determination was undertaken for the depression wetland to determine its current condition given the impacts affecting it (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 modified catchment and impacts within the wetland. The EI&S of the pan wetland system has been rated as being Moderate.

From the desktop information of the Witpan it is clearly a heavily degraded system. A WET-Health: Level 1 desktop determination was undertaken for the Witpan to determine its current condition given the impacts affecting it (Appendix D). The results of the desktop assessment

indicated an overall Present Ecological State of Category E: Seriously Modified. This is considered relatively accurate given the severe impacts affecting it. The EI&S of the Witpan has been rated as being Moderate.

A Risk Assessment for the proposed solar facility which will affect the two pan systems in the north west of the site and the grid connection powerline which may affect the Witpan 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). Aspects of the development that may have an impact on the surface water features of the site include, construction of the solar facility in close proximity to the two pans in the north west of the site and construction of the grid connection powerline in close proximity to the Witpan to the north east of the site (Appendix A: Map 3).

The two pans situated in the north western portion of the site is imbedded within the remaining natural Vaal-Vet Sandy Grassland in the north western portion of the site which is an endangered ecosystem and also listed as CBA 1 (Appendix A: Map 1 - 4). This portion of the site should be excluded from development and if this remains the case, the development should also by default avoid this pan system and will then have no impact on it. Furthermore, according the National Water Act (1998) any activity which occurs within the regulated area of a wetland (500 meters from the edge of the wetland) should be assessed and the necessary authorisation obtained. Therefore, where the solar development footprint is retained further than 500 meters from the edge of these pans, it will not require any Water Use License Application (WULA). Where development occurs closer than 500 meters from the edge of either of these pans, there may be some residual impact but is still anticipated to be very low and a low risk is anticipated.

The Witpan does not form part of the site, however, the proposed grid connection powerline will be situated in close proximity to it (approximately 50 meters) along the eastern border of the site (Appendix A: Map 3). Given the severely degraded condition of this pan and the fact that the powerline will only be situated in close proximity to it, the anticipated risk is low. However, the powerline will still be situated within the regulated area of the pan and the necessary authorisation will still have to be obtained.

A large artificial wetland area has development adjacent to the south eastern corner of the site (Appendix A: Map 3). Historical images also confirm that this has developed in response to surrounding mining operations. The area is severely degraded but does contain significant surface inundation and saturated areas. Development within this artificial wetland area may therefore be difficult and will also affect the surface water of the area. The development footprint will largely avoid this artificial wetland area though since it will be situated in close proximity to it, it was also included within the risk assessment, though as can be expected the anticipated risk will remain low in view of the artificial nature of this wetland area.

The impact significance for the development has been determined and should development take place without mitigation it is anticipated that several moderate-high to high impacts will occur. The impact on remaining natural areas of grassland as well as the wetland systems in the north western portion of the site will especially be heavily affected. However, should adequate mitigation be implemented as described these can all be reduced to moderate and low-moderate impacts. This is however subject to the development footprint being retained within areas of low sensitivity and avoiding any areas of remaining natural grassland as well as the wetland systems on the site (Appendix A: Map 4).

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1. INTRODUCTION

1.1 Background

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 2 km to the south and on the outskirts of the town of Welkom and to the west of the large Witpan waterbody (Appendix A: Map 1). The study area is fairly large but is dominated by grassland plains without prominent slopes and has an

approximate extent of 300 hectares. The majority of this area has previously been transformed by urban development, mining operations and agricultural cropfields. Subsequently those portions of previous cultivation has now re-established grassland but which is of secondary establishment while portions of previous residential areas had also been rehabilitated but is evidently still quite degraded. Despite the largely transformed condition of the site, fairly large areas of remaining natural grassland are also still present and these areas clearly have a high conservation value. Two distinct pan wetlands are also present in the area and will be affected by the development.

A site visit was conducted on 14 June 2022. The entire footprint of the proposed development area, including terrestrial and riparian areas, was surveyed over the period of one day. The site survey was conducted during early winter and though vegetation was in the process of going dormant, late rains and light frost to date did allow for adequate vegetation identification and an active hydrological regime was present. This ensured accurate identification of watercourses and wetlands.

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.

1.2 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

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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 previous transformation and mining activities this may have altered soil layers and the morphology of drainage areas which would complicate the delineation of wetland and riparian areas.
- 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.

General ecology:

- 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).
- Biodiversity Plan Free State Province (2018).

Vegetation:

- Red Data List (Raymondo *et al.* 2009).
- Vegetation types (Mucina & Rutherford 2006).
- 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, Griffiths & Picker 2015, Manning 2009, Moffett 1997, Pooley 1998, 2003, Retief & Meyer 2017, Van Ginkel & Cilliers 2020, Van Ginkel *et al* 2011, Van Oudtshoorn 2004, Van Wyk & Malan 1998, Van Wyk & Van Wyk 1997, Venter & Joubert 1985).

Terrestrial fauna:

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

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.

According to Mucina & Rutherford (2006) the area consists of Vaal-Vet Sandy Grassland (Gh 10) This vegetation type is currently listed as Endangered (EN) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 1). Any remaining patches of natural grassland would therefore be regarded as being of very high conservation value. The vegetation type is currently heavily affected by extensive transformation by agriculture, urban expansion and mining operations.

The Free State Province Biodiversity Management Plan (2015) has been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The site in question is divided into portions being regarded as Degraded, Other and Critical Biodiversity Area 1 (CBA 1) (Appendix A: Map 2). The Degraded and Other portions are largely transformed from the natural condition and though indigenous grassland still dominate, it is of secondary nature, i.e. the natural, original grass layer was previously removed and a secondary grass layer has been able to re-establish but which is not representative of the natural vegetation type. These areas would therefore entail a fairly low conservation value. However, those areas identified as CBA 1 areas represent remnant patches of the threatened Vaal-Vet Sandy Grassland. These areas remain essential to maintaining the conservation targets for this vegetation type and they should all be regarded as having a very high conservation value. These areas regarded as CBA 1 should be excluded from the development and should be completely avoided by any associated activities.

The study area is situated approximately 2 km to the south and on the outskirts of the town of Welkom and to the west of the large Witpan waterbody (Appendix A: Map 1). The study area is fairly large but is dominated by grassland plains without prominent slopes and has an approximate extent of 300 hectares. The majority of this area has previously been transformed by urban development, mining operations and agricultural cropfields. Subsequently those portions of previous cultivation has now re-established grassland but which is of secondary establishment while portions of previous residential areas had also been rehabilitated but is evidently still quite degraded. Despite the largely transformed condition of the site, fairly large areas of remaining natural grassland are also still present and these areas clearly have a high conservation value. Two distinct pan wetlands are also present in the area and will be affected by the development.

As previously stated, the majority of the study area has already been transformed by agricultural land use and mining activities. This is also confirmed by the National Biodiversity Assessment (2018) (Appendix A: Map 1). A large portion of the east of the study area has previously been transformed by a range of buildings, residences and plantings of invasive Bluegum (*Eucalyptus camaldulensis*). In this portion the natural vegetation and surface topography has been transformed to a large degree and is certainly not representative of the

natural vegetation type. Some pioneer grasses and exotic herbs have become re-established though this area is clearly quite degraded.

Figure 1: The area which clearly consisted of built-up areas has been able to re-establish a pioneer grass layer but is evidently degraded and transformed. Note also extensive occurrence of invasive trees.

The north eastern portion of the site is centred around the mining operations and urban areas. As a result, disturbance is high in this portion though remnants of the natural grassland do still occur here. Due to the proximity of transformed areas and mining activities this does result in some disturbance of the natural grassland. However, intact Vaal-Vet Sandy Grassland is still present in these areas and since it is regarded as an Endangered ecosystem and is also listed as CBA 1 these areas would still have a high conservation value (Appendix A: Map 2). Therefore, despite containing significant disturbance, these areas will still have to be excluded from development.

Figure 2: The north eastern portion of the study area which is situated near the mining operations clearly still consist of natural grassland though disturbance is evident.

The north western portion of the study area consists of a fairly large area of remaining natural grassland. Some disturbance is also present here though in general this portion is a good representation of the natural grassland in this area, Vaal-Vet Sandy Grassland. This vegetation type is listed as Endangered (EN) and any remaining areas such as this, will be essential to meeting the conservation targets for it (Appendix A: Map 1 & 2). The conservation value of this area will be very high and should be excluded from development.

Figure 3: The remaining natural grassland in the north western portion of the site is fairly extensive and a good representation of the natural vegetation type.

The southern portion of the site consists of a fairly large area that contains a well-developed, dense grassland but which is clearly of secondary establishment (Appendix A: Map 1). Primary grassland is an area that consists of the natural grass vegetation type and which has not previously been cleared or transformed. Secondary grassland establishes in areas where the natural grassland has previously been cleared and the topsoil layer often also being disturbed. This results in a grass layer which is dominated by pioneer species and which is not representative of the natural vegetation type. Since the topsoil layer was also previously disturbed it is also highly unlikely that the natural vegetation type will ever be able to re-establish in any significant manner. This portion of the site can therefore be regarded as transformed from the natural vegetation type though still being dominated by an indigenous grass layer.

Figure 4: Although an indigenous grass layer is present in the south of the site, it is dominated by pioneer species and is not representative of the natural vegetation type.

The study area also contains several wetland areas which may be affected by the development. These are all pan systems that clearly contain saturated soil conditions on a seasonal basis and has developed wetland conditions (Appendix A: Map 1 & 3). The largest of these is the Witpan, a very large pan system to the east of the site. Though it located outside the study area and will not be affected by it, the grid connection powerline may occur in close proximity to it. Two other large pans are situated in the north western portion of the site and falls within the boundary of the study area. These are grassy pans which will become shallowly inundated during the rainy season. These areas will all be assessed in detail in the wetland assessment section of the report.

Figure 5: One of the large grassy pans in the north western portion of the site.

The main impacts affecting the area is associated with the mining operations here (Appendix A: Map 1). The plant itself covers a fairly large area which is completely transformed, associated with the mining plant is also a network of infrastructure which includes railways, roads, dirt tracks and pipelines which contributes toward transformation. To the south east of the plant is also residential areas associated with the mine and of these one is still present and this area is completely transformed while the other residential area has since been demolished and the area rehabilitated though it is also clearly still transformed from the natural condition. Associated with these residential built-up areas are also fairly large plantings of exotic and invasive trees. These also cause local transformation of the natural vegetation. In the west and south of the site there are also a few areas which no longer contain surface structures but was also clearly associated with mining activities. These areas now consist of rubble and spoil dumps, barren patches and degraded areas. In addition to these impacts, the area is also being utilised as communal grazing areas and since this does not follow a structured grazing regime or stocking levels it does contribute toward disturbance in the form of overgrazing and trampling by domestic livestock. From the described impacts it should be clear that large portions of the site has been completely transformed while significant disturbance is also present overall.

Figure 6: Impacts in the study area (red) are evident and include previously built areas (light blue), invasive tree plantings (pink), currently built areas (yellow), the mining plant (light green) and areas of mining disturbance (blue) (Google Earth 2022).

Where impacts have caused transformation of the natural vegetation as described in the previous paragraphs, this has resulted in a significant transformation of the natural surface topography. Previously built-up areas, mining operations and disturbances has resulted in infilling, shallow excavations and rubble dumps. This also affects the natural drainage patterns and causes the formation of ponding which leads to artificial wetland areas which were especially notable to the south of the site. The general topography is dominated by a fairly flat plain with a slight slope from west to east and toward the large Witpan waterbody.

The site and the surrounding area is situated in a region experiencing moderate rainfall, with cold, dry winters and warm summers. Climate for the site can be extrapolated from rainfall and evaporation data from the weather station C4E009 (Zeebrugge@Sand-Vet). The site is located in an area with a rainfall of between 500 mm and 600 mm per annum with an average of 508.7 mm per year. Rainfall occurs largely as summer rainfall with a mean annual evaporation of between 1600 and 1799 mm/annum. The surface water runoff in the area is therefore not significantly high which results in a relatively low runoff for the area of between 20 - 50 mm according to a study by the Water Research Commission.

The study area is situated on geology associated with the Adelaide Subgroup. The Adelaide Subgroup of the Beaufort Group in the vicinity of Virginia is dominated by underlying mudrock. However, the site and surroundings are dominated by quite fine sand and silt soils. This is also one of the main drivers of the vegetation composition of the area.

As previously indicated, the terrestrial component of the study area, can roughly be divided into four distinct areas, based on the degree of transformation. These are the previously built-up areas now having been rehabilitated, areas of natural grassland in close proximity to mining operations and therefore with significant disturbance, those portions of remaining natural grassland and which are fairly good representations of the natural grassland and that portion of grassland which has clearly been transformed from the natural condition. These will be

discussed separately in the below paragraphs and elements of conservation value indicated where these were observed.

Eastern previously built-up areas (Pioneer grass layer with invasive trees)

A significant portion in the east of the site was previously dominated by residential buildings and infrastructure which has subsequently been demolished and the materials removed and the area rehabilitated (Appendix A: Map 1). It is however clear that the surface is completely transformed and now forms an artificial habitat dominated by indigenous pioneer species and exotic weeds. Plantings of invasive trees are also common in this area.

The natural grassland has been completely transformed and though an indigenous grass layer has been able to re-establish in many areas, it is dominated by only a few pioneer grasses, also confirming the transformed condition of this area. These pioneer grasses include *Cynodon dactylon, Aristida congesta, Eragrostis lehmanniana* and *Chloris virgata*. Many other pioneer herbs and dwarf shrubs are also abundant and include *Chenopodium album, Chrysocoma ciliata, Moraea pallida, Lycium horridum, Solanum incanum, Felicia muricata* and *Salvia verbenaca*. Because of the high level of disturbance in this portion and the degree of transformation, exotic weeds are also abundant and include *Cestrum laevigatum, Verbena bonariensis, Bidens bipinnata, Tagetes minuta, Datura stramonium, Schkuhria pinata, Flaveria bidentis* and *Sphaeralcea bonariensis*. As previously mentioned, this area also contains plantings of several exotic and invasive trees which include *Melia azedarach, Prosopis glandulosa, Eucalyptus camaldulensis, Schinus molle* and *Cupressus sp.* Several of these are also considered serious invaders and may spread into surrounding areas.

From the vegetation description of these areas which previously consisted of buildings and structures the area is completely transformed and heavily degraded (Appendix A: Map 1). It was also notable that weeds and invasive species are common and this will also require clearing and adequate disposal during construction. The proposed development will also have to implement a comprehensive monitoring and eradication programme. This eastern portion of the site is however completely transformed, is regarded as having a low conservation value and would be ideal for the proposed development (Appendix A: Map 4).

Figure 7: The eastern portion of the site is dominated by a pioneer grass layer with extensive plantings of exotic and invasive trees.

Figure 8: Invasive trees can be quite abundant in some areas and is also spreading into surrounding areas.

Figure 9: Because of high levels of degradation, exotic weeds and invasive trees can be quite abundant in this portion of the site.

North eastern natural grassland (natural grassland with disturbance)

The area still consists of natural grassland but which is situated within and surrounded by residential areas and the mining plant, with infrastructure also transecting it including several roads, powerlines and railway lines (Appendix A: Map 1). This portion is therefore somewhat isolated and because development is situated in close proximity, this also causes significant disturbance within the natural grassland. This is also a consequence of the edge-effect, i.e. transformed areas will also cause disturbance along their borders with natural areas. The vegetation composition is still representative of the Vaal-Vet Sandy Grassland though diversity may be somewhat lower and with exotic weeds also being present.

The grass layer is dominated by climax grasses though pioneer species may also be abundant. This is indicative of a natural grass layer but with some disturbance also being evident. The grass layer is dominated by climax grasses such as *Themeda triandra, Eragrostis superba, Cymbopogon pospischillii, Sporobolus fimbriatus* and *Triraphis andropogonoides* while pioneer grasses such as *Eragrostis echinichloidea, Eragrostis lehmanniana, Cynodon dactylon* and

Aristida congesta are also abundant. A natural herbaceous component is still present and includes *Barleria macrostegia, Indigofera sessilifolia* and *Lotononis listii*. The natural vegetation, containing a sandy topsoil, normally also contains a prominent component of geophytic species and this portion of the site also contains several geophytic species though somewhat lower in diversity. These species include *Colchicum longipes, Oxalis depressa* and *Bulbine abyssinica*. Dwarf karroid shrubs are also naturally present within this vegetation type though at low abundances and where they increase in abundance this indicates disturbance, as is the case for this portion of the site. These dwarf karroid shrubs include *Felicia muricata, Nolletia cilliaris, Ruschia hamata* and *Chysocoma ciliata*. The pioneer herb, *Nidorella reseidoflia* is also abundant and is also an indicator of disturbance. As a result of the higher level of disturbance in this portion, exotic weeds are also present and include *Bidens bipinnata, Conyza bonariensis* and *Alternanthera pungens.* No protected or endangered species could be identified in these areas though it remains possible that some may be present.

This portion of natural grassland is still representative of Vaal-Vet Sandy Grassland though also contains notable levels of disturbance due to the proximity of development and transformed areas. However, this vegetation type is under severe development pressure and almost all remaining portions are regarded as essential for reaching conservation targets. This remaining portion, though somewhat disturbed, is therefore also listed as Critical Biodiversity Area 1 (CBA 1) (Appendix A: Map 2). The portion still has a very high conservation value and should be retained in its current condition (Appendix A: Map 4). This portion of the site should therefore be avoided by the development.

Figure 10: The north eastern portion of the site contains grassland still representative of the natural vegetation type though the proximity of urban areas do cause significant disturbance.

Figure 11: Due to higher levels of disturbance, exotic weeds may also be present in some areas of this portion.

North western natural grassland (natural grassland with low disturbance)

A large portion of the north west of the site consists of natural grassland and though some disturbance is evident it is still considered as a good representation of the Vaal-Vet Sandy Grassland (Appendix A: Map 1). Disturbance can mostly be attributed to overgrazing by domestic livestock as this portion is utilised for communal grazing. The grassland is however still in a fairly good condition, with climax grasses dominating and with a significant level of species diversity present.

The grass layer is dominated by climax species while pioneer grasses are largely absent. These grass species include *Themeda triandra, Eragrostis superba, Eragrostis gummiflua, Pogonarthria squarrosa* and *Cymbopogon pospischillii*. A natural herbaceous component is also evident and includes species such as *Stachys spathulata, Dicoma macrocephala, Selago densiflora, Hermannia depressa, Vigna sp., Hibiscus pusillus* and *Helichrysum caespititum*. A few dwarf karroid shrubs such as *Pentzia incana* is also present, but since disturbance is lower, they are not abundant in this portion. The Vaal-Vet Sandy Grassland is also characterised by a sandy topsoil layer which is one of the main ecological drivers for this vegetation type. This sandy topsoil also promotes the establishment of geophytic species (plants with an underground storage organ). Within this portion, geophytic species are also abundant and include *Oxalis depressa, Drimia elata, Eriospermum cooperi, Colchicum burkei, Lapeirousia plicata* subsp. *foliosa, Babiana bainesii, Scilla nervosus* and *Massonia jasminiflora*. Of these, *L. plicata* and *B. bainesii* are also protected species with a significant conservation value. Should this portion be excluded from development, these protected species should by default also remain intact.

This portion of natural grassland is still representative of Vaal-Vet Sandy Grassland and though some disturbance is present, it is still a good representative area for this vegetation type. The vegetation type is also under severe development pressure and almost all remaining portions are regarded as essential for reaching conservation targets. This remaining portion, though somewhat disturbed, is therefore also listed as Critical Biodiversity Area 1 (CBA 1) (Appendix A: Map 2). The portion still has a very high conservation value and should be retained in its current condition (Appendix A: Map 4). This portion of the site should therefore be avoided by the development.

Figure 12: The north western portion of the site is dominated by a large area of natural grassland which is representative of the natural vegetation type.

Southern transformed grassland (indigenous but secondary grassland)

The southern portion of the site consists of grassland which is dominated by indigenous species but which is clearly no longer representative of the natural vegetation type (Appendix A: Map 1). The natural Vaal-Vet Sandy Grassland layer that had originally occurred in this portion, was previously cleared and ploughed and the subsequent grass layer that has since become established is no longer representative of the natural vegetation type. This is also largely confirmed by the National Biodiversity Assessment (2018) as well as the Free State Biodiversity Management Plan (2016) (Appendix A: Map 1 & 2). Secondary grassland establishes in areas where the natural grassland has previously been cleared and the topsoil layer often also being disturbed. This results in a grass layer which is dominated by pioneer species and which is not representative of the natural vegetation type. Since the topsoil layer was also previously disturbed it is also highly unlikely that the natural vegetation type will ever be able to re-establish in any significant manner. This portion of the site can therefore be regarded as transformed from the natural vegetation type though still being dominated by an indigenous grass layer.

The grass layer is dominated by a variety of pioneer and sub-climax grasses which are not characteristic of the natural vegetation type. These include *Aristida congesta, Stipagrostis uniplumis, Trichoneura grandiglumis, Cynodon dactylon* and *Eragrostis lehmanniana*. A low species diversity is notable with a few herbaceous species including *Gazania krebsiana, Selago densiflora* and *Anthospermum rigidum*. Geophytic species are present in low

abundance and include *Hypoxis hemerocallidae* and *Trachyandra laxa* with the latter also being an indicator of disturbance in the grass layer. Where more recent mining disturbance has occurred, the invasive shrub, *Tamarix chinensis* is also prominent. No protected or endangered species were noted and given the largely transformed condition of this portion, is considered unlikely to occur.

From the vegetation description of this previously cleared portion, it is clearly transformed from the natural vegetation type and can no longer be regarded as representative of the Vaal-Vet Sandy Grassland vegetation type (Appendix A: Map 1). The area is also utilised as communal grazing and is affected by fairly high levels of overgrazing by livestock. Given that the soil profile had also been transformed by previous ploughing it is highly unlikely that they would ever be able to re-attain a similar composition to the natural vegetation type. The portion is consequently regarded as having a low conservation value and would be ideal for the proposed development (Appendix A: Map 4).

Figure 13: The southern portion of the site consists of a dense grassland but which is no longer representative of the natural vegetation type.

Figure 14: Though the southern still consists of indigenous grassland it is dominated by pioneer species which is not representative of Vaal-Vet Sandy Grassland.

Conclusions

From the description of the area given above it is clear that large portions of the area has been transformed by agriculture and mining operations (Appendix A: Map 1). The natural vegetation type in this area, Vaal-Vet Sandy Grassland is also currently under severe transformation pressure. Consequently, any remaining natural areas would therefore be regarded as having a very high conservation value. These natural areas have also been listed as Critical Biodiversity Area 1 (CBA 1) which confirms this (Appendix A: Map 2). These areas should therefore be avoided by the development. The borders of these natural areas have also been refined by the current site survey (Appendix A: Map 4). From aerial imagery it is also evident how the area has progressively been transformed.

Figure 15: The area is clearly heavily affected by all manners of transformation. The differing portion of the site is also indicated: Eastern portion (light green), North eastern portion (blue), North western portion (yellow) and Southern portion (red).

Should development of the solar facility be able to remain within transformed areas (southern and eastern portions), this will greatly decrease the anticipated impacts (Appendix A: Map 4). However, should the development encroach into areas of remaining natural grassland (northern and north western portions) this will entail a high impact (Appendix A: Map 4). Being a mining area, this results in transformation and degradation of large portions of land. The cumulative impact of development and mining in this area is therefore high. The proposed solar development should therefore first consider the development of areas considered as already transformed and of low sensitivity (Appendix A: Map 4). These include the secondary grassland (southern portion) and areas which previously consisted of buildings and structures (eastern portion). Only if no remaining options remain should the development consider encroaching into remaining natural areas. However, in this instance it will result in high impacts. Likewise the remaining natural wetland areas in the north eastern portion of the site will also have a high level of sensitivity and should be avoided by development but will be discussed in greater detail in the wetland assessment section of the report.

The portions of remaining natural grassland do still contain several protected plant species with significant conservation value (Appendix B). Should areas of natural grassland be excluded

from development, these protected species should however also be preserved by default and the impact on them will be negligible. The area also contain quite a substantial infestation of invasive trees 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 fauna (actual & possible)

Signs and tracks of mammals are present on the site but notably less when compared to the natural condition. This is most likely a consequence of the fragmented condition of the area, the proximity of mining operations and urban areas and high levels of disturbance. Natural vegetation has a high carrying capacity for mammals which decreases significantly where agriculture and mining transforms this natural vegetation and in such areas the mammal population is normally represented by a generalist mammal population. The area proposed for development contains large areas being transformed from the natural condition while natural grassland does still occur it is also largely fragmented and isolated from surrounding extensive natural areas (Appendix A: Map 1). The mammal population in the study area is therefore dominated by generalist species while being largely modified from the natural mammal population. 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. Such species may still occur in the portions of remaining natural grassland in the study area though due the fragmented and isolated nature of these areas the likelihood is considered relatively low.

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 will also be the case for the natural pan wetlands in the north western portion of the site. Though these areas are also disturbed to some extent and coupled with the close proximity of human activities, these wetlands will still be able to sustain a higher bio-load which in turn supports a larger mammal population. This also substantiates the need to avoid these wetland areas and exclude them from development.

The mammal survey of the site was conducted by means of active searching 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.

- Extensive colonies of Ground Squirrel (*Xerus inauris*) and Yellow Mongoose (*Cynictis penicillata*) occur in the study area. These are companion species which are widespread and common and found in most natural or disturbed habitats.

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

- Spoor of Steenbok (*Raphicerus campestris*) or Common Duiker (*Sylvicapra grimmia*) were also observed. These species are both widespread but confined to fairly natural or agricultural areas and generally avoid urban areas.

These species identified on the site indicate only a moderate species diversity of largely widespread and generalist species and is indicative of a modified natural mammal population. A similar mammal population should also be able to re-establish in the solar development footprint after construction has taken place.

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. Large portions of the study area has already been largely transformed and consequently the current mammal population is already modified from the natural condition and will consequently decrease the anticipated impact of the development significantly. In addition, should those portions of Endangered Vaal-Vet Sandy Grassland and CBA 1 areas be excluded from development, it will further decrease the impact on the natural mammal population.

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.

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 2: Red Listed mammals occurring or likely to occur in the study area (Child *et al* 2016).

Scientific name	Common name	Status
Mystromys albicaudatus	African White-tailed Rat	**Vulnerable (VU)**
Damaliscus lunatus lunatus	(Southern African) Tsessebe	**Vulnerable (VU)**
Hippotragus equinus	Roan Antelope	**Endangered (EN)**
Hippotragus niger niger	Sable Antelope	**Vulnerable (VU)**
Kobus leche	Lechwe	**Near Threatened (NT)**
Pelea capreolus	Vaal Rhebok	**Near Threatened (NT)**
Felis nigripes	Black-footed Cat	**Vulnerable (VU)**
Hyaena brunnea	Brown Hyena	**Near Threatened (NT)**

The survey has indicated that though the mammal population will consist largely of widespread, generalist species, there remains a low likelihood that some of these Red Listed species may occur in the area.

Table 3: Likely mammal species in the region.

Family	Scientific name	Common name	Status
Bathyergidae	Cryptomys hottentotus	Southern African Mole-rat	Least Concern
Bovidae	Aepyceros melampus	Impala	Least Concern

	Alcelaphus buselaphus	Hartebeest	Least Concern
	Antidorcas marsupialis	Springbok	Least Concern
	Connochaetes gnou	Black Wildebeest	Least Concern
	Connochaetes taurinus taurinus		Least Concern
	Damaliscus lunatus lunatus	(Southern African) Tsessebe	Vulnerable (VU)
	Damaliscus pygargus phillipsi	Blesbok	Least Concern
	Hippotragus equinus	Roan Antelope	Endangered (EN)
	Hippotragus niger niger	Sable Antelope	Vulnerable (VU)
	Kobus ellipsiprymnus ellipsiprymnus	Wwaterbuck	Least Concern
	Kobus leche	Lechwe	Near Threatened (NT)
	Oryx gazella	Gemsbok	Least Concern
	Pelea capreolus	Vaal Rhebok	Near Threatened (NT)
	Raphicerus campestris	Steenbok	Least Concern
	Redunca arundinum	Southern Reedbuck	Least Concern
	Redunca fulvorufula	Mountain Reedbuck	Least Concern
	Sylvicapra grimmia	Bush Duiker	Least Concern
	Syncerus caffer	African Buffalo	Least Concern
	Taurotragus oryx	Common Eland	Least Concern
	Tragelaphus angasii	Nyala	Least Concern
	Tragelaphus scriptus	Bushbuck	Least Concern
	Tragelaphus strepsiceros	Greater Kudu	Least Concern
Canidae	Canis mesomelas	Black-backed Jackal	Least Concern
	Vulpes chama	Cape Fox	Least Concern
Cercopithecidae	Chlorocebus pygerythrus	Vervet Monkey	Least Concern
Equidae	Equus quagga	Plains Zebra	Least Concern
Felidae	Felis nigripes	Black-footed Cat	Vulnerable (VU)
Giraffidae	Giraffa giraffa giraffa	South African Giraffe	Least Concern
Herpestidae	Cynictis penicillata	Yellow Mongoose	Least Concern
	Herpestes sanguineus	Slender Mongoose	Least Concern
	Suricata suricatta	Meerkat	Least Concern
Hippopotamidae	Hippopotamus amphibius	Common Hippopotamus	Least Concern
Hyaenidae	Hyaena brunnea	Brown Hyena	Near Threatened (NT)
	Proteles cristata	Aardwolf	Least Concern
Hystricidae	Hystrix	Cape Porcupine	Least Concern

	africaeaustralis		
Leporidae	Lepus capensis	Cape Hare	Least Concern
	Lepus saxatilis	Scrub Hare	Least Concern
Muridae	Aethomys namaquensis	Namaqua Rock Mouse	Least Concern
	Gerbilliscus brantsii	Highveld Gerbil	Least Concern
	Mastomys coucha	Southern African Mastomys	Least Concern
	Rhabdomys dilectus	Mesic Four-striped Grass Rat	Least Concern
	Rhabdomys pumilio	Xeric Four-striped Grass Rat	Least Concern
Mustelidae	Ictonyx striatus	Striped Polecat	Least Concern
Nesomyidae	Mystromys albicaudatus	African White-tailed Rat	Vulnerable (VU)
Sciuridae	Xerus inauris	South African Ground Squirrel	Least Concern
Suidae	Phacochoerus africanus	Common Warthog	Least Concern
Thryonomyidae	Thryonomys swinderianus	Greater Cane Rat	Least Concern
Viverridae	Genetta genetta	Common Genet	Least Concern

From historical records (Table 3) it is evident that the area contains a large amount of mammals and numerous Red Listed mammals. Of these the larger antelope are however historical records and would only be found within conservation areas, they are not of consequence to the development. The smaller Red Listed mammal species may still occur in the area, including the Black-footed Cat (*Felis nigripes*), Brown Hyena (*Hyaena brunnea*), and African White-tailed Rat (*Mystromys albicaudatus*). These would however only make use of portions of remaining natural grassland. If development therefore excludes these areas, the anticipated impact on these endangered mammals would also be negligible.

A note should also be made of the Sungazer Lizard (*Smaug giganteus*). This is a highly endangered reptile known to occur in the sandy grassland habitats of this region. The survey also specifically targeted this species but was found to be absent from the area. It may however still be present in those portions of natural grassland in the northern and north western portions of the site. However, as long as these areas are excluded from development any likely impact would be negligible.

Figure 16: Tracks and signs of mammals on the site include from top to bottom; soil mound of the Common molerat (*Cryptomys hottentotus*), Ground squirrels (*Xerus inauris*), Burrow of an unidentified small rodent and Spoor of either a Steenbok (*Raphicerus campestris*) or Common Duiker (*Sylvicapra grimmia*).

4.3 Wetland Assessment

4.3.1 Introduction

The surface water features of the study area are dominated by two large pan wetland systems in the north western portion of the site (Appendix A: Map 3). The Witpan, an exceedingly large pan system is also located along the north eastern border of the site but does not form part of the study area (Appendix A: Map 3). A grid connection powerline situated adjacent to this pan may however still have some impact on it and this pan will also be included in this assessment, at least in overview. Two areas of surface disturbance (shallow excavations and dumps) also promote the accumulation of surface water and consequent formation of artificial wetland areas but since they are undoubtedly artificial and do not form part of the natural drainage pattern, they will not be assessed and only discussed in overview (Appendix A: Map 3). The assessment will focus on the two pans forming part of the site while the Witpan will also be included in overview.

As indicated, the north western portion of the site contains two large pan systems which forms part of the site and may therefore be directly affected by it (Appendix A: Map 3). These are seasonal, grassy pans which is dominated by a dense grass and sedge vegetation layer and contain very shallow surface water during the rainy season. The catchment of these pans are limited to the immediate surrounding plains. These pans are still largely natural but affected to

some degree by trampling and overgrazing by domestic livestock. The pans are considered important ecosystems which will contribute toward bioremediation, groundwater recharge and wetland habitat.

The Witpan is an exceedingly large pan system with diameter of approximately 2.5 km and situated immediately to the east of the site (Appendix A: Map 3). The pan contains surface water year-round mostly as a result of discharge of effluent from Waste Water Treatment Works (WWTW) and dewatering of mining areas which also has a detrimental impact on this system. It does not form a part of the site and will therefore not be directly affected by it. However, the grid connection powerline will be situated approximately 50 meters from the edge of the pan and there is still a low likelihood of it affecting the pan system. The pan is heavily degraded by surrounding land use, mostly associated with the WWTW and gold mine operations, but still forms an important surface water feature in the area and the grid connection powerline should not contribute to any further impacts on it.

A few areas occur that are clearly not natural watercourses or wetlands but may have formed artificial wetland conditions due to the accumulation of surface runoff. Such areas include a shallow excavation in the eastern portion of the site an area of dumps and general surface disturbance in the southern portion of the site. The southern wetland area may have been associated with remnants of a natural wetland system to the south though investigation of historical images confirms that itself is completely artificial and a manifestation of the local disturbance (Appendix A: Map 3). These artificial areas will be noted in the report but will not form part of the discussions.

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.

The classification of stream orders from 1 to 3 can be illustrated by means of the Strahler 1952 classification:

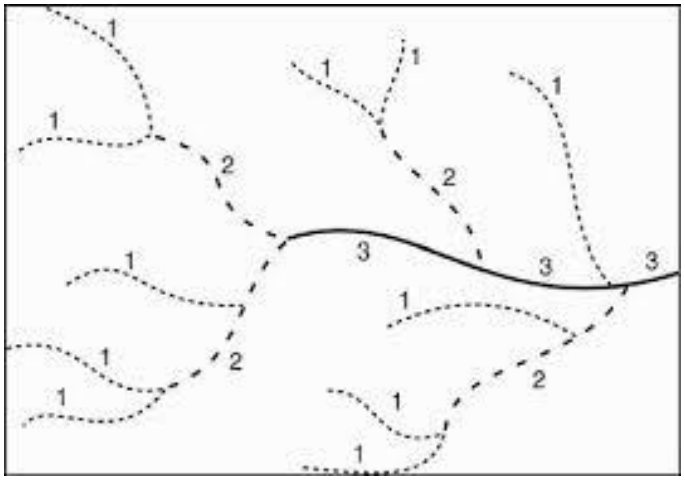

Figure 17: The classification of stream orders from 1 to 3 (Strahler 1952).

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 pan wetlands were 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 at sample sites within each of the identified wetland systems 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 within sample points within the two pan systems on the site, the Witpan to the east of the site and the two artificial wetland areas. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils (Appendix C).

The vegetation survey indicated that obligate wetland vegetation dominates the two pan systems on the site, while the Witpan also contains obligate wetland vegetation but which is clearly quite heavily degraded. In all of these instances this was also confirmed by soil samples which indicated a seasonal zone of wetness within the two pan systems on the site while the Witpan is dominated by a perennial zone of wetness. These systems were therefore confirmed as wetland system in terms of topography, obligate wetland vegetation and soil wetness indicators (Appendix A: Map 3). Because the topography is fairly flat in this region, coupled with a moderate rainfall and shallow soils, pan and wetland systems are abundant in this area. These wetland systems on the site are also a consequence of this. Due to extensive mining activities in this area the surface drainage patterns has been heavily modified. This also affects

wetlands in the area, especially the Witpan system, and any remaining wetlands will therefore also be regarded as having a high conservation value and will also increase their value in terms of the surface water drainage of the area.

4.3.3 Classification of wetland systems

The wetland conditions identified within the two pan systems located on the site as well as the Witpan can be classified into a specific wetland type.

The two pan systems on the site and Witpan to the east of the study area can be categorised as depressions 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 pans and their functioning. They are all circular, forming a shallow but discernible depression in the landscape (Appendix A: Map 3). These pans are all endorheic (without outflow).

4.2.4 Description of watercourses and wetlands

The study area contains the two pan systems in the north west of the site, the Witpan adjacent and to the east of the site and two artificial wetlands areas (Appendix A: Map 3). A short description of each of these 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 4: 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 Pan wetland – One of two large pans situated in the north west of the site.	S 28.025540°, E 26.745063°	Seasonal

Description of watercourse:

The north eastern portion of the site contains two fairly large pans or depression wetlands of which this is the most northern of the two. It is also the most prominent, with more pronounced wetland conditions being present. This pan is fairly large, with a diameter of approximately 220 meters. The pan has an elongated shape but clearly forms a circular depression in the landscape. It also contains no defined in- or outflow. Inflow into the pan is primarily multidirectional from the immediately surrounding catchment but may also in part occur from groundwater. This pan is imbedded within the remaining natural Vaal-Vet Sandy Grassland in the north western portion of the site which is an endangered ecosystem and also listed as CBA 1. This portion of the site should be excluded from development and if this remains the case, the development should also by default avoid this pan system and will then have no impact on it. The pan is clearly a natural system and though it is still largely intact, it is affected by high levels of trampling and overgrazing caused by domestic livestock. The catchment of the wetland is also completely transformed and this will undoubtedly also have an impact on the pan. The condition of the pan would therefore seem to be at least moderately modified.

The pan forms a very shallow, but definite depression in the landscape and the topography therefore clearly promotes the formation of a wetland. Vegetation within the pan is dominated by a variety of obligate wetland grasses and sedges which also confirm the presence of saturated soils. Soil samples also reliably confirm the presence of wetland conditions which indicate a seasonal zone of wetness within the wetland.

Dominant plant species:

Diplachne fusca (OW), *Marsilea sp.* (OW), *Schoenoplectus corymbosus* (OW).

Protected plant species:

None observed.

Soil sample:

The pan system is clearly differentiated within the landscape.

Dense wetland vegetation and saturated soils clearly indicate the presence of wetland conditions. Note also high levels of trampling by domestic livestock.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#2 Pan wetland – One of two large pans situated in the north west of the site.	S 28.025960°, E 26.747499°	Seasonal

Description of watercourse:

The north eastern portion of the site contains two fairly large pans or depression wetlands of which this is the south easterly situated pan. It is somewhat less prominent than the pan situated to the north west and while wetland conditions are less prominent it was still confirmed with a high level of certainty. This pan is also fairly large, with a diameter of approximately 180 meters. The pan has an elongated shape but clearly forms a circular depression in the landscape. It also contains no defined in- or outflow. Inflow into the pan is primarily multidirectional from the immediately surrounding catchment but may also in part occur from groundwater. This pan is imbedded within the remaining natural Vaal-Vet Sandy Grassland in the north western portion of the site which is an endangered ecosystem and also listed as CBA 1. This portion of the site should be excluded from development and if this remains the case, the development should also by default avoid this pan system and will then have no impact on it. The pan is clearly a natural system and though it is still largely intact, it is affected by high levels of trampling and overgrazing caused by domestic livestock. The catchment of the pan is still fairly natural though mining disturbances to the south west will have significant impacts on it. The condition of the pan would therefore seem to be at least moderately modified.

The pan forms a very shallow, but definite depression in the landscape and the topography therefore clearly promotes the formation of a wetland. Vegetation within the pan is dominated by a variety of obligate wetland grasses and sedges which also confirm the presence of saturated soils. Soil samples also reliably confirm the presence of wetland conditions which indicate a seasonal zone of wetness within the wetland.

Dominant plant species:
Diplachne fusca (OW), *Cyperus difformis* (OW), *Schoenoplectus corymbosus* (OW).

Protected plant species:
None observed.

Soil sample:

The wetland is somewhat less prominent in terms of wetland conditions, though is still clearly discernible within the landscape.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#3 Witpan wetland – An exceedingly large wetland to the east of the site.	S 28.017310°, E 26.753505° S 28.017143°, E 26.753716°	Perennial

Description of watercourse:
The Witpan is a very large pan system which is situated immediately to the east of the site but does not form part of the development footprint. It is a very prominent area that contains surface water year-round and consequently wetland conditions are quite prominent. As

indicated, this is a very large pan system with an approximate diameter of 2.3 km. It is a clearly circular system which forms a prominent depression in the landscape. The pan does not contain any prominent streams or watercourses flowing in or out of it. Inflow into the pan is primarily multidirectional from the immediately surrounding catchment but may also in part occur from groundwater. As indicated, this pan does not form part of the development footprint. However, the grid connection powerline for the development will be situated approximately 50 meters from the edge of the pan and there is still a low likelihood of it affecting the pan system. This pan system is highly degraded and in a very poor condition. This is a result of many decades of impacts. Some of the largest impacts on the pan include the discharge of raw sewage into the pan. The Waste Water Treatment Works (WWTW) discharging into the pan is notoriously unreliable and this results in the frequent discharge of raw sewage into the pan and causes severe degradation of its condition. Discharge of mine water, including acid mine drainage, is also a well known impact on the pan and will also contribute large impacts on it. The heavily degraded condition of the pan is therefore quite evident and the proposed grid connection powerline is unlikely to have a high impact on it.

The pan forms a clear depression in the landscape and the topography therefore clearly promotes the formation of a wetland. Although the pan is permanently inundated, the shores are dominated by obligate wetland vegetation such as Bulrush and reeds which also confirm the presence of saturated soils. Soil samples also reliably confirm the presence of wetland conditions which indicate a permanent zone of wetness. Current resources including the NBA 2018: South African Inventory of Inland Aquatic Ecosystems (SAIIAE) and National Freshwater Ecosystem Priority Areas 2011 (NFEPA) do not confirm the presence of this pan system or indicate it to be artificial. However, historical imagery reliably confirm it to be a natural pan system.

Dominant plant species:
**Cyperus eragrostis* (OW), *Typha capensis* (OW), *Phragmites australis* (OW), **Tamarix chinensis, *Cirsium vulgare, Cynodon dactylon*.

Protected plant species:
None observed.

Soil sample:

The Witpan is a large waterbody but which is clearly heavily modified from the natural condition.

Modifications and sever degradation is evident along the shores of the Witpan.

Approximate location of the grid connection powerline in relation to the Witpan. It should be clear that the anticipated impact on the wetland will be limited.

Historical imagery (National Geospatial Database 1944) reliably confirm that the Witpan is a natural wetland system and also clearly indicate the extensive modification it has undergone through the decades.

Watercourse name:	**Coordinates of sampling:**	**Flow regime:**
#4 Artificial wetland areas	S 28.024294°, E 26.757266° S 28.034761°, E 26.756994°	Artificial

Description of watercourse:

The following two areas have been identified as being formed by artificial, human induced modifications in the landscape and are not regarded as forming either natural watercourses or wetlands. Due to surface modifications, they may contain surface water for some periods which may form artificial wetland conditions. These artificial wetland areas consist of the following:

- An elongated and shallow excavation forms a depression in the landscape and collects surface water runoff. As a consequence, artificial wetland areas has formed. They are not considered to play any role in the surface drainage pattern of the site and are therefore not considered to be of consequence to the development. They are however simply listed here to confirm that they have been surveyed and confirmed to be of low sensitivity in terms of the development.

- A large circular area containing dumps and general surface disturbance occurs in the southern portion of the site. Saturated soils with a high salt concentration cause the formation of wetland conditions. Historical imagery indicate that this area has formed as a result human induced disturbance and is not a natural occurring wetland area.

A shallow excavation which accumulates surface water and now forms artificial wetland conditions.

Artificial wetland area in southern portion of the site.

Historical imagery (National Geospatial Database 1975) also confirms that wetland conditions

in the southern portion of the site were not naturally present in previous decades and are therefore a consequence of human induced disturbance.

4.3.5 Condition and importance of the affected wetland

The determination of the condition of the wetlands on the site will focus on the pan system in the north western portion of the site (Appendix A: Map 3). The aim is to provide an overall overview of the wetlands in the study area. This pan is the largest and most prominent wetland on the site and should therefore provide the most comprehensive indication of the overall wetland condition on the site. Therefore, a WET-Health determination will be done for this large pan system occurring on the site and should give a good overall indication of the condition of the wetlands on the site. The WET-Health will be taken as representative of the Present Ecological State (PES) of this system (Appendix D).

The Witpan does not form a part of the site though there is a low likelihood that it may still be affected by the proposed grid connection powerline (Appendix A: Map 3). The condition of the Witpan will therefore only be assessed at a desktop level, using available resources in order to give a general indication of its condition and the probability that the grid connection powerline will further affect this system.

Table 5 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 6 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 5: 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 6: Ecological importance and sensitivity categories.

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

According to previous desktop assessments (Kleynhans 2000, Van Deventer *et al* 2018) the pan system in the north western portion of the site is considered to have a PES varying from Category C: Moderately Modified to Category D/E/F: Largely to Extremely Modified. This does indicate the desktop uncertainty with regards to the pan wetlands on the site. The current assessment has however confirmed a condition of Category C: Moderately Modified which does seem to be an accurate determination when seen in context of the impacts in the catchment of the pan. Despite this modified condition, the wetland remains a sensitive system and any additional impacts on it should be prevented. This pan is imbedded within the remaining natural Vaal-Vet Sandy Grassland in the north western portion of the site which is an endangered ecosystem and also listed as CBA 1 (Appendix A: Map 1 - 4). This portion of the site should be excluded from development and if this remains the case, the development should also by default avoid this pan system and will then have no impact on it.

As indicated above, the pan wetland has been at least moderately modified by several significant impacts. A summary of the impacts will be provided in the following paragraphs.

The catchment of the pan is dominated by natural grassland though ecological assessment has indicated that this grassland does still contain some disturbance, mainly caused by trampling and overgrazing by domestic livestock. A portion of the catchment also consists of old ploughed fields and these areas have a lower percentage vegetation cover which increases runoff and consequently erosion. One of the more significant impacts occurs as a result of several surface structures which includes a tarred road, dirt tracks, a railway and general

surface disturbance all of which act as surface flow barriers and diverts a portion of runoff away from the wetland and alters the surface flow patterns. A small percentage of the catchment also consists of paved areas and mining activities which will also have some impact on the site. The combination of these impacts will have a significant impact on the pan and its functioning.

The pan itself is largely intact though is also affected to a significant extent by high level of overgrazing and trampling by domestic livestock. This results in elevated nutrient levels caused by manure. Trampling and overgrazing also decreases the percentage vegetation cover while also causing disturbance of the soil surface. This all leads to some modification of the wetland hydrology and vegetation cover.

Figure 18: Various structures and infrastructure in the catchment of the pan act as obstructions to surface flow and impact on the hydrology of the pan.

Figure 19: Trampling by domestic livestock within the pan is quite high and visibly contributes toward a decrease in vegetation cover, an increase in soil disturbance and modification of the surface roughness of the wetland.

From the above described impacts it should be clear that the pan wetland system is affected by several impacts which result in a significant level of modification. A WET-Health determination was undertaken for the depression wetland to determine its current condition given the impacts affecting it (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 modified catchment and impacts within the wetland.

The EI&S of the pan wetland system has been rated as being 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. This is mostly a result of the already modified condition of the wetland, though since it is a large system still providing several important functions the EI&S remains Moderate.

As previously indicated, the Witpan adjacent to the site is unlikely to be affected to any significant extent by the proposed grid connection powerline and its condition was therefore only assessed at desktop level. This system is well known for being heavily degraded and is primarily affected by mining discharge and untreated sewage flowing into the pan. Mining activities, and to some extent industrial operations, will undoubtedly also contribute to poor water quality within the pan. Soil sampling analysis around the pan also confirm high levels of contamination which includes heavy metals, high alkalinity, high acid values and very high nutrient levels (Steenekamp & Nell 2000). This is most likely a consequence of mining and industry. The WWTW of Welkom which also discharges into the pan is well known for its poor management and raw sewage often discharges into the pan. Recent reports of blood and organic pollutants from an abattoir discharging into the pan will also contribute to high impacts on the system. These are but a few of the detrimental impacts which affect the pan and it should be clear that it is in a heavily degraded state.

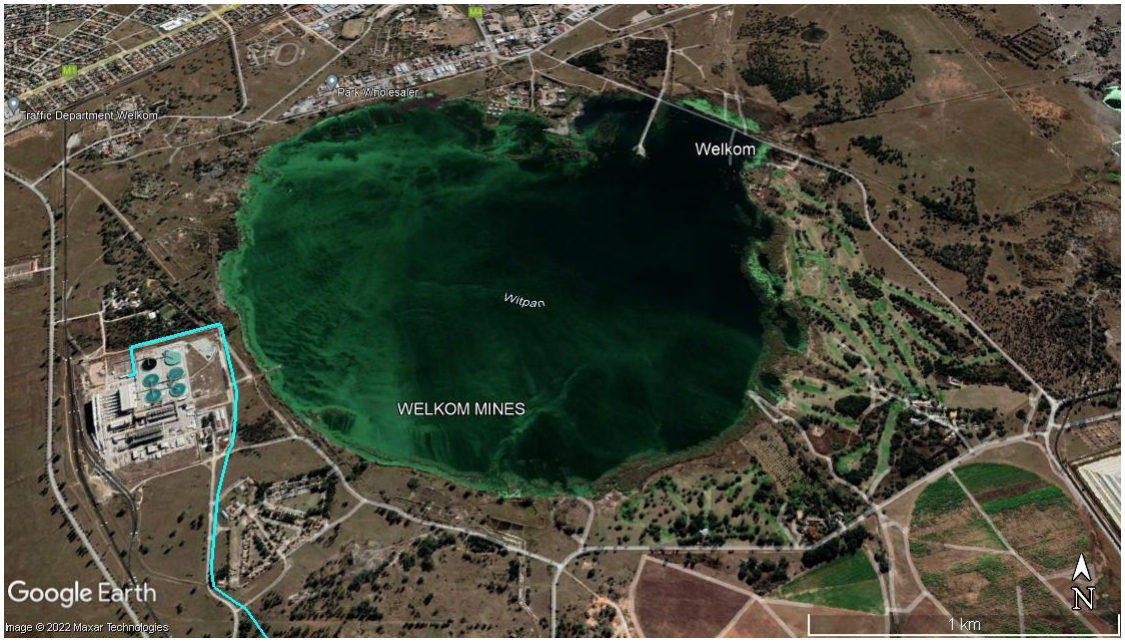

Figure 20: View of the Witpan as well as the grid connection powerline situated in close proximity to it (Light blue) (Google Earth 2022). Surrounding impacts are clearly visible. Note also the green colouration of the pan which is a consequence of an algal bloom which is caused by poor water quality and high nutrient levels.

From the desktop information of the Witpan it is clearly a heavily degraded system. A WET-Health: Level 1 desktop determination was undertaken for the Witpan to determine its current condition given the impacts affecting it (Appendix D). The results of the desktop assessment indicated an overall Present Ecological State of Category E: Seriously Modified. This is considered relatively accurate given the severe impacts affecting it.

The EI&S of the Witpan has been rated as being 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. This is mostly due to the heavily degraded condition of the pan, though since it is a large system still providing several important functions the EI&S remains Moderate.

4.3.6 Risk Assessment

A Risk Assessment for the proposed solar facility which will affect the two pan systems in the north west of the site and the grid connection powerline which may affect the Witpan 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). Aspects of the development that may have an impact on the surface water features of the site include, construction of the solar facility in close proximity to the two pans in the north west of the site and construction of the grid connection powerline in close proximity to the Witpan to the north east of the site.

The two pans situated in the north western portion of the site is imbedded within the remaining natural Vaal-Vet Sandy Grassland in the north western portion of the site which is an endangered ecosystem and also listed as CBA 1 (Appendix A: Map 1 - 4). This portion of the site should be excluded from development and if this remains the case, the development should also by default avoid these pan systems and will then have no impact on them. Furthermore, according the National Water Act (1998) any activity which occurs within the regulated area of a wetland (500 meters from the edge of the wetland) should be assessed and the necessary authorisation obtained. Therefore, where the solar development footprint is retained further than 500 meters from the edge of these pans, it will not require any Water Use License Application (WULA). Where development occurs closer than 500 meters from the edge of either of these pans, there may be some residual impact but is still anticipated to be very low and a low risk is anticipated. The development should however still 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 Witpan does not form part of the site, however, the proposed grid connection powerline will be situated in close proximity to it (approximately 50 meters) along the eastern border of the site (Appendix A: Map 3). Given the severely degraded condition of this pan and the fact that the powerline will only be situated in close proximity to it, the anticipated risk is low. However, the powerline will still be situated within the regulated area of the pan and the necessary authorisation will still have to be obtained.

A large artificial wetland area has development adjacent to the south eastern corner of the site (Appendix A: Map 3). Historical images also confirm that this has developed in response to surrounding mining operations. The area is severely degraded but does contain significant surface inundation and saturated areas. Development within this artificial wetland area may therefore be difficult and will also affect the surface water of the area. The development footprint will largely avoid this artificial wetland area though since it will be situated in close proximity to it, it was also included within the risk assessment, though as can be expected the anticipated risk will remain low in view of the artificial nature of this wetland area.

Low Risks: Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.

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 wetland systems in the area.

For the complete risk assessment please refer to Appendix E.

No.	Phases	Activity	Aspect	Impact	Risk Rating	Confidence level	Control measures
1	Mostly Construction Phase but also during operation	Construction of a solar facility	Two pan systems are situated in the north western portion of the site and where development may occur within 500 meters of these wetlands, it will require the necessary authorisation.	The construction of the facility may encroach into the regulated area of these wetlands in which case it may then impact on the catchment of these wetlands which will then have an indirect impact on them.	**L**	**80**	These pan wetlands are imbedded within endangered grassland which is likely to be excluded by development and which case it is highly unlikely that the development will have any significant impact on these pans. It will however still be important to implement a comprehensive storm water management system.
	Mostly Operational Phase but also during construction	Construction of a solar facility	A large artificial wetland area occurs in the south eastern corner of the site and development will occur in close proximity to it.	Given that this is an artificial wetland area there are no significant impacts anticipated though the development may still affect the surface water in this area.	**L**	**80**	Given the artificial condition of this wetland area the development is unlikely to have any significant impacts on it. It will however still be important to implement a comprehensive storm water management system.
	Mostly Operational Phase but also during construction	Construction of a grid connection powerline	Construction of a grid connection powerline in close proximity to the Witpan along the eastern border of the site.	Construction of the powerline in close proximity to the pan may cause local disturbance which then also affect the pan system in terms of increased sediment and weed establishment.	**L**	**80**	Given the already heavily degraded condition of the pan, it is highly unlikely that the proposed powerline will contribute any additional significant impacts on it. Rehabilitation and monitoring should still be implemented and should aim to establish an indigenous vegetation layer.

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 pan wetland systems 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, large portions of it has already been transformed and is no longer representative of the natural grassland in this area (Appendix A: Map 1). However, significant portions of the site still consist of natural grassland and which has also been confirmed as being representative of the original Vaal-Vet Sandy Grassland in this area. This vegetation type is also as Endangered (EN) and will therefore have a very high conservation value. This is also confirmed by the Free State Province Biodiversity Management Plan (2015) which regards the majority of these remaining natural areas as Critical Biodiversity Area 1 (CBA 1) and which is consequently of very high sensitivity (Appendix A: Map 2). Development of these remaining natural grassland areas will therefore entail a very high impact. However, as indicated, large areas of transformed grassland are present and which will be ideal for development and as long as the development footprint is retained within these areas of low sensitivity and remaining natural grassland areas avoided, the anticipated impact should remain fairly low (Appendix A: Map 4).

Large portions of the site has been transformed while remaining natural grassland areas also contain a degree of disturbance. However, the portions of remaining natural grassland do still contain several protected plant species with significant conservation value (Appendix B). Development within these areas will entail the loss of protected species which will result in a fairly high impact. However, should areas of natural grassland be excluded from development, these protected species should then also be preserved by default and the impact on them will be negligible (Appendix A: Map 4).

The survey of the site has identified two pan wetland systems in the north western portion of the site while the Witpan is also situated along the north eastern border of the site (Appendix A: Map 3). Development within any of these wetland areas will result in a high impact. However, this impact should be easily avoided. The two pans in the north west of the site can be completely avoided as long as this portion of natural grassland is also avoided by the development and the impact on these should then be negligible. The proposed grid connection powerline is still likely to have some impact on the Witpan though this is also anticipated to be a

fairly low impact. The solar development may still have some impact on the catchment of these wetland areas in terms of the rain shadow caused by the panels and the coupled runoff and infiltration patterns, erosion caused by these runoff patterns and disruption of surface watercourses. Implementation of a storm water management system should however adequately mitigate any impacts on runoff and erosion. Development within 500 meters of these wetland areas will require authorisation from DWS. Refer to the risk assessment (Section 4.3.6) for a more detailed discussion on the likely risks and impacts that the development will have on these wetland areas.

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. Though the wetlands on the site is likely to be excluded from development there is still some likelihood that runoff from the development may have some affect on these wetlands. In order to further mitigate 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 area, and especially the surroundings, are extensively transformed by various land uses and is therefore greatly affected by habitat fragmentation and the disruption of ecosystem processes (Appendix A: Map 1). Therefore, should the development encroach into any remaining natural areas this will have significant additional impacts in terms of habitat fragmentation. However, as indicated, large portions of the site is already transformed and should the development be able to avoid remaining natural grassland areas the impact on habitat fragmentation and the loss of ecosystem processes would remain low (Appendix A: Map 4).

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. Large portions of the study area has already been largely transformed and consequently the current mammal population is already modified from the natural condition and will consequently decrease the anticipated impact of the development significantly. In addition, should those portions of Endangered Vaal-Vet Sandy Grassland and CBA 1 areas be excluded from development, it will further decrease the impact on the natural mammal population (Appendix A: Map 4). 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 area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had is extensive (Appendix A: Map 1). Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area (Appendix A: Map 4).

The impact significance has been determined and should development take place without mitigation it is anticipated that several moderate-high to high impacts will occur. The impact on remaining natural areas of grassland as well as the wetland systems in the north western portion of the site will especially be heavily affected. However, should adequate mitigation be implemented as described these can all be reduced to moderate and low-moderate impacts. This is however subject to the development footprint being retained within areas of low sensitivity and avoiding any areas of remaining natural grassland as well as the wetland systems on the site (Appendix A: Map 4).

Please refer to Appendix G 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, large portions of it has already been transformed and is no longer representative of the natural grassland in this area (Appendix A: Map 1). However, significant portions of the site still consist of natural grassland and which has also been confirmed as being representative of the original Vaal-Vet Sandy Grassland in this area. This vegetation type is also as Endangered (EN) and will therefore have a very high conservation value. This is also confirmed by the Free State Province Biodiversity Management Plan (2015) which regards the majority of these remaining natural areas as Critical Biodiversity Area 1 (CBA 1) and which is consequently of very high sensitivity (Appendix A: Map 2). Development of these remaining natural grassland areas will therefore entail a very high impact. However, as indicated, large areas of transformed grassland are present and which will be ideal for development and as long as the development footprint is retained within these areas of low sensitivity and remaining natural grassland areas avoided, the anticipated impact should remain fairly low (Appendix A: Map 4).			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent transformation of vegetation	**High Negative (90)**
Extent	3	Significant development footprint	
Magnitude	10	Loss of a Threatened Ecosystem	
Probability	5	Impact is unavoidable	
Mitigation/Enhancement Measures			
Mitigation: As indicated, large areas of transformed grassland are present and which will be ideal for			

development and as long as the development footprint is retained within these areas of low sensitivity and remaining natural grassland areas avoided, the anticipated impact should remain fairly low (Appendix A: Map 4).			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent transformation of vegetation	**Low Negative (18)**
Extent	2	Decreased development extent maintained within transformed areas	
Magnitude	2	Development limited to areas of transformation	
Probability	2	Impact probability is low since development is limited to already transformed areas	
Cumulative impacts: The area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had is extensive (Appendix A: Map 1). Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area (Appendix A: Map 4).			
Residual Risks: As long as the development footprint is retained within areas of low sensitivity and these areas of remaining natural grassland are avoided, the anticipated impact should remain fairly low (Appendix A: Map 4).			

Nature: **Loss of protected, rare or threatened plant species.**			
Impact description: Large portions of the site has been transformed while remaining natural grassland areas also contain a degree of disturbance. However, the portions of remaining natural grassland do still contain several protected plant species with significant conservation value (Appendix B). Development within these areas will entail the loss of protected species which will result in a fairly high impact. However, should areas of natural grassland be excluded from development, these protected species should then also be preserved by default and the impact on them will be negligible (Appendix A: Map 4).			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent loss of protected species	**High Negative (64)**
Extent	3	Significant development footprint	
Magnitude	8	Protected species confirmed in areas of remaining natural grassland	
Probability	4	Protected species confirmed in the study area and probability therefore high	
Mitigation/Enhancement Measures			
Mitigation:			

Should areas of natural grassland be excluded from development, these protected species should then also be preserved by default and the impact on them will be negligible (Appendix A: Map 4).			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent loss of protected species	**Low Negative (9)**
Extent	2	Decreased development extent maintained within transformed areas	
Magnitude	2	Unlikely loss of protected species as long as natural grassland is avoided	
Probability	1	Loss of protected of protected species unlikely as long as natural grassland areas are avoided	
Cumulative impacts: The area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had is extensive (Appendix A: Map 1). Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact including any impact on protected species. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area including any cumulative impacts on protected species (Appendix A: Map 4).			
Residual Risks: As long as areas of remaining natural grassland area avoided any residual impact on the loss of protected or endangered plant species should remain fairly low (Appendix A: Map 4).			

Nature: **Impacts on watercourses, wetlands or the general catchment.**			
Impact description: The survey of the site has identified two pan wetland systems in the north western portion of the site while the Witpan is also situated along the north eastern border of the site (Appendix A: Map 3). Development within any of these wetland areas will result in a high impact. However, this impact should be easily avoided. The two pans in the north west of the site can be completely avoided as long as this portion of natural grassland is also avoided by the development and the impact on these should then be negligible. The proposed grid connection powerline is still likely to have some impact on the Witpan though this is also anticipated to be a fairly low impact. The solar development may still have some impact on the catchment of these wetland areas in terms of the rain shadow caused by the panels and the coupled runoff and infiltration patterns, erosion caused by these runoff patterns and disruption of surface watercourses. Implementation of a storm water management system should however adequately mitigate any impacts on runoff and erosion. Development within 500 meters of these wetland areas will require authorisation from DWS. Refer to the risk assessment (Section 4.3.6) for a more detailed discussion on the likely risks and impacts that the development will have on these wetland areas.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent transformation of wetland areas	**High Negative (90)**

Extent	3	Spill over of impacts into downstream areas	
Magnitude	10	Direct wetland loss	
Probability	5	Impact is unavoidable	
Mitigation/Enhancement Measures			
Mitigation: Should these wetland areas be excluded from the development and measures as indicated implemented the anticipate impact should remain low. Refer to the risk assessment (Section 4.3.6) for a more detailed discussion on the likely risks and impacts that the development will have on these wetland areas.			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent transformation of wetland areas	**Low Negative (18)**
Extent	1	Wetlands excluded from development footprint	
Magnitude	3	Impacts on wetland should remain low as long as areas of natural grassland are avoided by the development	
Probability	2	Impact probability is low	
Cumulative impacts: The area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had is extensive, including the impacts on wetlands in the area. Therefore, should the proposed development further encroach into natural areas (including wetlands) it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas and exclude wetland areas, it should therefore not contribute significantly toward the cumulative impacts in this area (including wetlands) (Appendix A: Map 4).			
Residual Risks: Should areas of natural grassland (and by default wetland areas) be excluded from the development and measures as indicated implemented the anticipated impact should remain low.			

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	**High Negative (80)**
Extent	4	Spreading of infestation into neighbouring areas	
Magnitude	8	Infestation of a Threatened Ecosystem	
Probability	5	Impact is unavoidable	
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 (33)**
Extent	2	Limiting extent through monitoring and eradication	
Magnitude	6	Limited but unavoidable infestation	
Probability	3	Moderate probability remains	
Cumulative impacts: The area has a long history of transformation by mining, agriculture and urban expansion which increases the cumulative impact of increased infestation by exotics (Appendix A: Map 1). Therefore, should the proposed development further encroach into natural areas and contribute to increased infestation it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts associated with increased exotic vegetation infestation (Appendix A: Map 4).			
Residual Risks: Without mitigation this will significantly increase the establishment of exotics and is likely to spread into the surrounding natural 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. Though the wetlands on the site is likely to be excluded from development there is still some likelihood that runoff from the development may have some affect on these wetlands. In order to further mitigate 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	5	Permanent modification of surface topography	**Moderate Negative (56)**
Extent	3	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	5	Permanent modification of surface topography	**Low Negative (20)**
Extent	1	Limiting extent through storm water management	
Magnitude	4	Limited magnitude due to the flat topography	
Probability	2	Unlikely to occur as long as storm water management is maintained	
Cumulative impacts: The area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact (including surface erosion) that this has had is extensive. Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact (including surface erosion). However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas and successfully implement a storm water management system it should not contribute significantly toward the cumulative erosion in this area (Appendix A: Map 4).			
Residual Risks: Erosion may also have a significant impact on the wetland systems adjacent to the site.			

Nature: **Fragmentation of habitat, disruption of ecological connectivity and -functioning in terms of the surrounding areas.**			
Impact description: The area, and especially the surroundings, are extensively transformed by various land uses and is therefore greatly affected by habitat fragmentation and the disruption of ecosystem processes (Appendix A: Map 1). Therefore, should the development encroach into any remaining natural areas this will have significant additional impacts in terms of habitat fragmentation. However, as indicated, large portions of the site is already transformed and should the development be able to avoid remaining natural grassland areas the impact on habitat fragmentation and the loss of ecosystem processes would remain low.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	5	Permanent loss and fragmentation of habitat	**High Negative (64)**
Extent	3	Significant loss of natural areas	
Magnitude	8	High impact due to fragmentation of a Threatened Ecosystem	
Probability	4	Highly likely to take place	

Mitigation/Enhancement Measures			
Mitigation: Large portions of the site is already transformed and should the development be able to avoid remaining natural grassland areas the impact on habitat fragmentation and the loss of ecosystem processes would remain low (Appendix A: Map 4).			
Post Mitigation/Enhancement Measures			
Duration	5	Permanent loss and fragmentation of habitat	**Low Negative (18)**
Extent	2	Limiting extent by excluding remaining natural areas	
Magnitude	2	Limited magnitude due to limiting development to already transformed areas	
Probability	2	Low probability as long as development is limited to already transformed areas	
Cumulative impacts: As previously indicated, the area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had is extensive (Appendix A: Map 1). Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area (Appendix A: Map 4).			
Residual Risks: The area is largely transformed and should the development be able to avoid remaining natural grassland areas the impact on habitat fragmentation and the loss of ecosystem processes would remain low.			

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. Large portions of the study area has already been largely transformed and consequently the current mammal population is already modified from the natural condition and will consequently decrease the anticipated impact of the development significantly. In addition, should those portions of Endangered Vaal-Vet Sandy Grassland and CBA 1 areas be excluded from development, it will further decrease the impact on the natural mammal population (Appendix A: Map 4). 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.			
	Rating	**Motivation**	**Significance**
Prior to Mitigation			
Duration	4	Limited to a semi-permanent impact if some vegetation re-establishes within the development	**Moderate Negative (39)**
Extent	3	Significant loss of natural areas	
Magnitude	6	Moderate given the already modified mammal population	

Probability	3	Moderate given the already modified mammal population	

Mitigation/Enhancement Measures

Mitigation:

Additional measures which will further mitigate these impacts include the exclusion of areas of natural grassland and the exclusion of natural wetland areas in the north western portion of the site (Appendix A: Map 4). 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	4	Limited to a semi-permanent impact if some vegetation re-establishes within the development	**Low Negative (20)**
Extent	2	No loss of natural areas as long as these are excluded from development	
Magnitude	4	Moderate given the already modified mammal population	
Probability	2	Moderate given the already modified mammal population	

Cumulative impacts:

The area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had on the mammal population is extensive. Therefore, should the proposed development further encroach into natural areas it will have a further increased cumulative impact on the mammal population. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts on the local mammal population (Appendix A: Map 4).

Residual Risks:

Transformation of the indigenous vegetation on the site will result in a decrease in the mammal population size as available habitat decreases.

Cumulative impact:

As previously indicated, the area has a long history of transformation by mining, agriculture and urban expansion and the cumulative impact that this has had is extensive (Appendix A: Map 1). Therefore, should the proposed development further encroach into natural areas it will have a high cumulative impact. However, since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area (Appendix A: Map 4).

	Overall impact of the proposed project considered in isolation	**Cumulative impact of the project and other projects in the area**
Extent	3	3
Duration	5	4
Magnitude	10	8

Probability	5	5
Significance	**High (90)**	**High (70)**
Status (positive or negative)	Negative	Negative
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes
Confidence in findings: High		
Mitigation: Since transformation is already so extensive the proposed development has the opportunity to make use of these transformed areas and should the development be able to remain within these transformed areas should therefore not contribute significantly toward the cumulative impacts in this area (Appendix A: Map 4).		

6. BIODIVERSITY SENSITIVITY RATING (BSR)

Habitat diversity and species richness:
The natural vegetation types in the study area has been extensively transformed by agricultural and mining operations (Appendix A: Map 1). The site does however still contain fairly large portions of natural grassland though these areas are somewhat uniform with a moderate species diversity. As a consequence the study area has an overall moderate habitat and species diversity (Appendix B)

Presence of rare and endangered species:
Large portions of the site has been transformed while remaining natural grassland areas also contain a degree of disturbance. However, the portions of remaining natural grassland do still contain several protected plant species with significant conservation value (Appendix B). These include *Aloe greatheadii, Lapeirousia plicata* subsp. *foliosa* and *Babiana bainesii*.

Ecological function:
The ecological function of the site has been altered to a significant degree. The site functions as habitat for a variety of fauna, supports specific vegetation types and the wetland systems forming part of the site also provides vital functions in terms of water transportation, wetland and aquatic habitats and bio-remediation. The vegetation type on the site has been transformed to a large degree and this also significantly decreases the habitat extent and condition thereof available to the mammal population (Appendix A: Map 1). The functioning of the wetland areas has been shown to be moderately modified but is still considered highly sensitive. Overall the ecological function of the study is therefore regarded as moderately modified.

Degree of rarity/conservation value:
According to Mucina & Rutherford (2006) the area consists of Vaal-Vet Sandy Grassland (Gh 10) This vegetation type is currently listed as Endangered (EN) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 1). Any remaining areas of natural grassland would therefore be regarded as being of very high conservation value.

The Free State Province Biodiversity Management Plan (2015) has been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The site in question is divided into portions being regarded as Degraded, Other and Critical Biodiversity Area 1 (CBA 1) (Appendix A: Map 2). The Degraded and Other portions are largely transformed from the natural condition and though indigenous grassland still dominate, it is of secondary nature, i.e. the natural, original grass layer was previously removed and a secondary grass layer has been able to re-establish but which is not representative of the natural vegetation type. These areas would therefore entail a fairly low conservation value. However, those areas identified as CBA 1 areas represent remnant patches of the threatened Vaal-Vet Sandy Grassland. These areas remain essential to maintaining the conservation targets for this vegetation type and they should all be regarded as having a very high conservation value.

Although moderately modified the wetland areas still play a vital role in water transport and is therefore considered to have a high conservation value (Appendix A: Map 3).

Overall the site is therefore considered as having a high conservation value given fairly large areas of remaining grassland being present.

Percentage ground cover:
Overall, the percentage vegetation cover is regarded as moderately modified. Large portions of the site has been transformed though secondary grassland has been able to re-establish and consequently the overall grass cover is still regarded as moderate.

Vegetation structure:
The area forms part of the Grassland Biome and should naturally therefore contain a well-developed grass layer and without any significant tree or shrub component being present. Extensive transformation of the site has resulted in large portions of indigenous and exotic shrubs and trees which leads to at least a moderate modification of the natural vegetation structure. Primary and secondary grassland do however also cover large portions of the site and the overall vegetation structure modification is therefore only moderate.

Infestation with exotic weeds and invader plants:
Numerous exotic weeds and invasive tree species are present on the site (Appendix B). They are abundant and may also form dominant patches, that will continue to spread over time. These include *Melia azedarach, Prosopis glandulosa, Eucalyptus camaldulensis, Schinus molle, Cestrum laevigatum, Verbena bonariensis, Bidens bipinnata, Tagetes minuta, Datura stramonium, Schkuhria pinata, Flaveria bidentis, Sphaeralcea bonariensis, Conyza bonariensis, Alternanthera pungens* and *Tamarix chinensis.* 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 area is being utilised as communal grazing and browsing for domestic livestock and there is therefore no structured grazing regime or stocking levels and this results in high levels of overgrazing.

Signs of erosion:
Signs of erosion is common, though not yet extensive and gulley formation is not yet prominent.

Terrestrial animals:
Signs and tracks of mammals are present on the site but notably less when compared to the natural condition. This is most likely a consequence of the fragmented condition of the area, the proximity of mining operations and urban areas and high levels of disturbance. Natural vegetation has a high carrying capacity for mammals which decreases significantly where agriculture and mining transforms this natural vegetation and in such areas the mammal population is normally represented by a generalist mammal population. The area proposed for development contains large areas being transformed from the natural condition while natural grassland does still occur it is also largely fragmented and isolated from surrounding extensive natural areas. The mammal population in the study area is therefore dominated by generalist species while being largely modified from the natural mammal population. 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. Such species may still occur in the portions of remaining natural grassland in the study area though due the fragmented and isolated nature of these areas the likelihood is considered relatively low.

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 will also be the case for the natural pan wetland in the north western portion of the site. Though these areas are also disturbed to some extent and coupled with the close proximity of human activities, these wetlands will still be able to sustain a higher bio-load which in turn supports a larger mammal population. This also substantiates the need to avoid these wetland areas and exclude them from development.

Table 7: 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			1
Vegetation condition			
Percentage ground cover		2	
Vegetation structure		2	
Infestation with exotic weeds and invader plants or encroachers	3		
Degree of grazing/browsing impact	3		
Signs of erosion		2	
Terrestrial animal characteristics			
Presence of rare and endangered species		2	
Sub total	6	14	1
Total		26	

7. BIODIVERSITY SENSITIVITY RATING (BSR) INTERPRETATION

Table 8: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Harmony 1 Plant PV Solar	21	Degraded	3

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

The site proposed for PV solar development has been rated as being Degraded. This is mostly a result of the extensive transformation by agriculture and mining operations. It is however notable that significant portions of remaining natural grassland are still present and since these areas form part of an Endangered ecosystem, are considered to have a very high conservation value. Therefore, as long as areas of high conservation value (remaining natural grassland and wetland areas) are avoided the impact of the development should remain low (Appendix A: Map 4).

The study area is situated approximately 2 km to the south and on the outskirts of the town of Welkom and to the west of the large Witpan waterbody (Appendix A: Map 1). The study area is fairly large but is dominated by grassland plains without prominent slopes and has an approximate extent of 300 hectares. The majority of this area has previously been transformed by urban development, mining operations and agricultural cropfields. Subsequently those portions of previous cultivation has now re-established grassland but which is of secondary establishment while portions of previous residential areas had also been rehabilitated but is evidently still quite degraded. Despite the largely transformed condition of the site, fairly large areas of remaining natural grassland are also still present and these areas clearly have a high conservation value. Two distinct pan wetlands are also present in the area and will be affected by the development.

According to Mucina & Rutherford (2006) the area consists of Vaal-Vet Sandy Grassland (Gh 10) This vegetation type is currently listed as Endangered (EN) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Appendix A: Map 1). Any remaining patches of natural grassland would therefore be regarded as being of very high conservation value. The vegetation type is currently heavily affected by extensive transformation by agriculture, urban expansion and mining operations.

The Free State Province Biodiversity Management Plan (2015) has been published and has identified areas which are essential to meeting conservation targets for specific vegetation types, i.e. Critical Biodiversity Areas. The site in question is divided into portions being regarded as Degraded, Other and Critical Biodiversity Area 1 (CBA 1) (Appendix A: Map 2). The Degraded and Other portions are largely transformed from the natural condition and though indigenous grassland still dominate, it is of secondary nature, i.e. the natural, original grass layer was previously removed and a secondary grass layer has been able to re-establish but which is not representative of the natural vegetation type. These areas would therefore entail a fairly low conservation value. However, those areas identified as CBA 1 areas represent remnant patches of the threatened Vaal-Vet Sandy Grassland. These areas remain essential to maintaining the conservation targets for this vegetation type and they should all be regarded as having a very high conservation value. These areas regarded as CBA 1 should be excluded from the development and should be completely avoided by any associated activities.

As previously stated, the majority of the study area has already been transformed by agricultural land use and mining activities. This is also confirmed by the National Biodiversity Assessment (2018) (Appendix A: Map 1). A large portion of the east of the study area has previously been transformed by a range of buildings, residences and plantings of invasive Bluegum (*Eucalyptus camaldulensis*). In this portion the natural vegetation and surface topography has been transformed to a large degree and is certainly not representative of the

natural vegetation type. Some pioneer grasses and exotic herbs have become re-established though this area is clearly quite degraded.

The north eastern portion of the site is centred around the mining operations and urban areas. As a result, disturbance is high in this portion though remnants of the natural grassland do still occur here. Due to the proximity of transformed areas and mining activities this does result in some disturbance of the natural grassland. However, intact Vaal-Vet Sandy Grassland is still present in these areas and since it is regarded as an Endangered ecosystem and is also listed as CBA 1 these areas would still have a high conservation value (Appendix A: Map 2). Therefore, despite containing significant disturbance, these areas will still have to be excluded from development.

The north western portion of the study area consists of a fairly large area of remaining natural grassland. Some disturbance is also present here though in general this portion is a good representation of the natural grassland in this area, Vaal-Vet Sandy Grassland. This vegetation type is listed as Endangered (EN) and any remaining areas such as this, will be essential to meeting the conservation targets for it (Appendix A: Map 1). The conservation value of this area will be very high and should be excluded from development.

The southern portion of the site consists of a fairly large area that contains a well-developed, dense grassland but which is clearly of secondary establishment (Appendix A: Map 1). Primary grassland is an area that consists of the natural grass vegetation type and which has not previously been cleared or transformed. Secondary grassland establishes in areas where the natural grassland has previously been cleared and the topsoil layer often also being disturbed. This results in a grass layer which is dominated by pioneer species and which is not representative of the natural vegetation type. Since the topsoil layer was also previously disturbed it is also highly unlikely that the natural vegetation type will ever be able to re-establish in any significant manner. This portion of the site can therefore be regarded as transformed from the natural vegetation type though still being dominated by an indigenous grass layer.

The study area also contains several wetland areas which may be affected by the development. These are all pan systems that clearly contain saturated soil conditions on a seasonal basis and has developed wetland conditions (Appendix A: Map 1 & 3). The largest of these is the Witpan, a very large pan system to the east of the site. Though it is located outside the study area and will not be affected by it, the grid connection powerline may occur in close proximity to it. Two other large pans are situated in the north western portion of the site and falls within the boundary of the study area. These are grassy pans which will become shallowly inundated during the rainy season. These areas were also assessed in detail in the wetland assessment section of the report.

From the description of the area given above it is clear that large portions of the area has been transformed by agriculture and mining operations (Appendix A: Map 1). The natural vegetation type in this area, Vaal-Vet Sandy Grassland is also currently under severe transformation pressure. Consequently, any remaining natural areas would therefore be regarded as having a very high conservation value. These natural areas have also been listed as Critical Biodiversity Area 1 (CBA 1) which confirms this (Appendix A: Map 2). These areas should therefore be avoided by the development. The borders of these natural areas have also been refined by the current site survey (Appendix A: Map 4).

Should development of the solar facility be able remain within transformed areas (southern and eastern portions), this will greatly decrease the anticipated impacts (Appendix A: Map 4). However, should the development encroach into areas of remaining natural grassland (northern and north western portions) this will entail a high impact (Appendix A: Map 4). Being a mining area, this results in transformation and degradation of large portions of land. The cumulative impact of development and mining in this area is therefore high. The proposed solar development should therefore first consider the development of areas considered as already transformed and of low sensitivity (Appendix A: Map 4). These include the secondary grassland (southern portion) and areas which previously consisted of buildings and structures (eastern portion). Only if no remaining options remain should the development consider encroaching into remaining natural areas. However, in this instance it will result in high impacts. Likewise the remaining natural wetland areas in the north eastern portion of the site will also have a high level of sensitivity and should be avoided by development but will be discussed in greater detail in the wetland assessment section of the report.

The portions of remaining natural grassland do still contain several protected plant species with significant conservation value (Appendix B). Should areas of natural grassland be excluded from development, these protected species should however also be preserved by default and the impact on them will be negligible. The area also contain quite a substantial infestation of invasive trees 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 present on the site but notably less when compared to the natural condition. This is most likely a consequence of the fragmented condition of the area, the proximity of mining operations and urban areas and high levels of disturbance. Natural vegetation has a high carrying capacity for mammals which decreases significantly where agriculture and mining transforms this natural vegetation and in such areas the mammal population is normally represented by a generalist mammal population. The area proposed for development contains large areas being transformed from the natural condition while natural grassland does still occur it is also largely fragmented and isolated from surrounding extensive natural areas. The mammal population in the study area is therefore dominated by generalist species while being largely modified from the natural mammal population. 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. Such species may still occur in the portions of remaining natural grassland in the study area though due the fragmented and isolated nature of these areas the likelihood is considered relatively low. Mammal species identified on the site indicate only a moderate species diversity of largely widespread and generalist species and is indicative of a modified natural mammal population. A similar mammal population should also be able to re-establish in the solar development footprint after construction has taken place.

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. Large portions of the study area has already been largely transformed and consequently the current mammal population is already modified from the natural condition and will consequently decrease the anticipated impact of the development significantly. In addition, should those

portions of Endangered Vaal-Vet Sandy Grassland and CBA 1 areas be excluded from development, it will further decrease the impact on the natural mammal population (Appendix A: Map 4).

The surface water features of the study area are dominated by two large pan wetland systems in the north western portion of the site (Appendix A: Map 3). The Witpan, an exceedingly large pan system is also located along the north eastern border of the site but does not form part of the study area (Appendix A: Map 3). A grid connection powerline situated adjacent to this pan may however still have some impact on it and this pan will also be included in this assessment, at least in overview. Two areas of surface disturbance (shallow excavations and dumps) also promote the accumulation of surface water and consequent formation of artificial wetland areas but since they are undoubtedly artificial and do not form part of the natural drainage pattern, they will not be assessed and only discussed in overview. The assessment will focus on the two pans forming part of the site while the Witpan will also be included in overview.

As indicated, the north western portion of the site contains two large pan systems which forms part of the site and may therefore be directly affected by it (Appendix A: Map 3). These are seasonal, grassy pans which is dominated by a dense grass and sedge vegetation layer and contain very shallow surface water during the rainy season. The catchment of these pans are limited to the immediate surrounding plains. These pans are still largely natural but affected to some degree by trampling and overgrazing by domestic livestock. The pans are considered important ecosystem which will contribute toward bioremediation, groundwater recharge and wetland habitat.

The Witpan is an exceedingly large pan system with diameter of approximately 2.5 km and situated immediately to the east of the site (Appendix A: Map 3). The pan contains surface water year-round mostly as a result of discharge of effluent from Waste Water Treatment Works (WWTW) and dewatering of mining areas which also has a detrimental impact on this system. It does not form a part of the site and will therefore not be directly affected by it. However, the grid connection powerline will be situated approximately 50 meters from the edge of the pan and there is still a low likelihood of it affecting the pan system. The pan is heavily degraded by surrounding land use, mostly associated with the WWTW and gold mine operations, but still forms an important surface water feature in the area and the grid connection powerline should not contribute to any further impacts on it.

A few areas occur that are clearly not natural watercourses or wetlands but may have formed artificial wetland conditions due to the accumulation of surface runoff. Such areas include a shallow excavation in the eastern portion of the site an area of dumps and general surface disturbance in the southern portion of the site. The southern wetland area may have been associated with remnants of a natural wetland system to the south though investigation of historical images confirms that itself is completely artificial and a manifestation of the local disturbance (Appendix A: Map 3). These artificial areas will be noted in the report but will not form part of the discussions.

The pan wetlands were 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 at sample sites within each of the identified wetland systems to confirm the presence of wetland conditions. The vegetation survey indicated that obligate wetland vegetation dominates the two pan system on the site, while the Witpan also contains obligate wetland vegetation but which is clearly quite heavily

degraded. In all of these instances this was also confirmed by soil samples which indicated a seasonal zone of wetness within the two pan systems on the site while the Witpan is dominated by a perennial zone of wetness. These systems were therefore confirmed as wetland system in terms of topography, obligate wetland vegetation and soil wetness indicators (Appendix A: Map 3). The two pan systems on the site and Witpan to the east of the study area can be categorised as depressions wetlands (SANBI 2009).

The determination of the condition of the wetlands on the site will focus on the pan system in the north western portion of the site (Appendix A: Map 3). The aim is to provide an overall overview of the wetlands in the study area. This pan is the largest and most prominent wetland on the site and should therefore provide the most comprehensive indication of the overall wetland condition on the site. Therefore, a WET-Health determination will be done for this large pan system occurring on the site and should give a good overall indication of the condition of the wetlands on the site. The WET-Health will be taken as representative of the Present Ecological State (PES) of this system (Appendix D). The Witpan does not form a part of the site though there is a low likelihood that it may still be affected by the proposed grid connection powerline (Appendix A: Map 3). The condition of the Witpan will therefore only be assessed at a desktop level, using available resources in order to give a general indication of its condition and the probability that the grid connection powerline will further affect this system.

The pan wetland systems in the north western portion of the site is affected by several impacts which result in a significant level of modification. A WET-Health determination was undertaken for the depression wetland to determine its current condition given the impacts affecting it (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 modified catchment and impacts within the wetland. The EI&S of the pan wetland system has been rated as being Moderate.

From the desktop information of the Witpan it is clearly a heavily degraded system. A WET-Health: Level 1 desktop determination was undertaken for the Witpan to determine its current condition given the impacts affecting it (Appendix D). The results of the desktop assessment indicated an overall Present Ecological State of Category E: Seriously Modified. This is considered relatively accurate given the severe impacts affecting it. The EI&S of the Witpan has been rated as being Moderate.

A Risk Assessment for the proposed solar facility which will affect the two pan systems in the north west of the site and the grid connection powerline which may affect the Witpan 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). Aspects of the development that may have an impact on the surface water features of the site include, construction of the solar facility in close proximity to the two pans in the north west of the site and construction of the grid connection powerline in close proximity to the Witpan to the north east of the site (Appendix A: Map 3).

The two pans situated in the north western portion of the site is imbedded within the remaining natural Vaal-Vet Sandy Grassland in the north western portion of the site which is an endangered ecosystem and also listed as CBA 1 (Appendix A: Map 1 - 4). This portion of the site should be excluded from development and if this remains the case, the development should also by default avoid this pan system and will then have no impact on it. Furthermore, according the National Water Act (1998) any activity which occurs within the regulated area of

a wetland (500 meters from the edge of the wetland) should be assessed and the necessary authorisation obtained. Therefore, where the solar development footprint is retained further than 500 meters from the edge of these pans, it will not require any Water Use License Application (WULA). Where development occurs closer than 500 meters from the edge of either of these pans, there may be some residual impact but is still anticipated to be very low and a low risk is anticipated.

The Witpan does not form part of the site, however, the proposed grid connection powerline will be situated in close proximity to it (approximately 50 meters) along the eastern border of the site (Appendix A: Map 3). Given the severely degraded condition of this pan and the fact that the powerline will only be situated in close proximity to it, the anticipated risk is low. However, the powerline will still be situated within the regulated area of the pan and the necessary authorisation will still have to be obtained.

A large artificial wetland area has development adjacent to the south eastern corner of the site (Appendix A: Map 3). Historical images also confirm that this has developed in response to surrounding mining operations. The area is severely degraded but does contain significant surface inundation and saturated areas. Development within this artificial wetland area may therefore be difficult and will also affect the surface water of the area. The development footprint will largely avoid this artificial wetland area though since it will be situated in close proximity to it, it was also included within the risk assessment, though as can be expected the anticipated risk will remain low in view of the artificial nature of this wetland area.

The impact significance for the development has been determined and should development take place without mitigation it is anticipated that several moderate-high to high impacts will occur. The impact on remaining natural areas of grassland as well as the wetland systems in the north western portion of the site will especially be heavily affected. However, should adequate mitigation be implemented as described these can all be reduced to moderate and low-moderate impacts. This is however subject to the development footprint being retained within areas of low sensitivity and avoiding any areas of remaining natural grassland as well as the wetland systems on the site (Appendix A: Map 4).

9. RECOMMENDATIONS

- The survey has indicated several areas that are considered highly sensitive and with a high conservation value and should be excluded from development as far as possible (Appendix A: Map 4):

    - Remaining portions of endangered Vaal-Vet Sandy Grassland situated in the northern and north western portion of the site should be excluded from development and retained in their current condition.
    - Two pan wetlands situated in the north western portion of the site should be excluded from development together with the grassland within which they are imbedded.

- The following recommendations and mitigation measures should be implemented in order to manage impacts on the wetland systems on the site (Appendix A: Map 3):
    - Two pan wetlands situated in the north western portion of the site should be completely excluded from development in order to ensure no impacts on them occur (Appendix A: Map 3).
    - The Witpan to the east of the site does not form part of the development footprint but should still be regarded as a no-go area (Appendix A: Map 3).
    - These wetland areas should all be regarded as no-go areas and no construction or operational activities including stockpiling, clearing, laydown areas, vehicle movement or any other associated activities should occur in or near these systems.
    - The development should design and implement a comprehensive storm water management system in order to manage runoff and prevent erosion which will affect the wetland systems.
    - The storm water management system should include design of erosion prevention structures such as soakaways, attenuation areas and dissipation structures.
    - All structures and mitigation measures should be maintained throughout the lifetime of the development.
    - It will be important to implement a monitoring programme so that any changes to the surrounding wetlands can be identified quickly before it leads to irreversible changes. This monitoring programme should include, at least during the construction phase, a bi-annual biomonitoring of the affected wetlands. This should be conducted by a suitable qualified wetland specialist.
    - The necessary authorisations should be obtained from the Department of Water and Sanitation (DWS) where any construction occurs within 500 meters from the edge of any of the delineated wetlands in the study area.

- 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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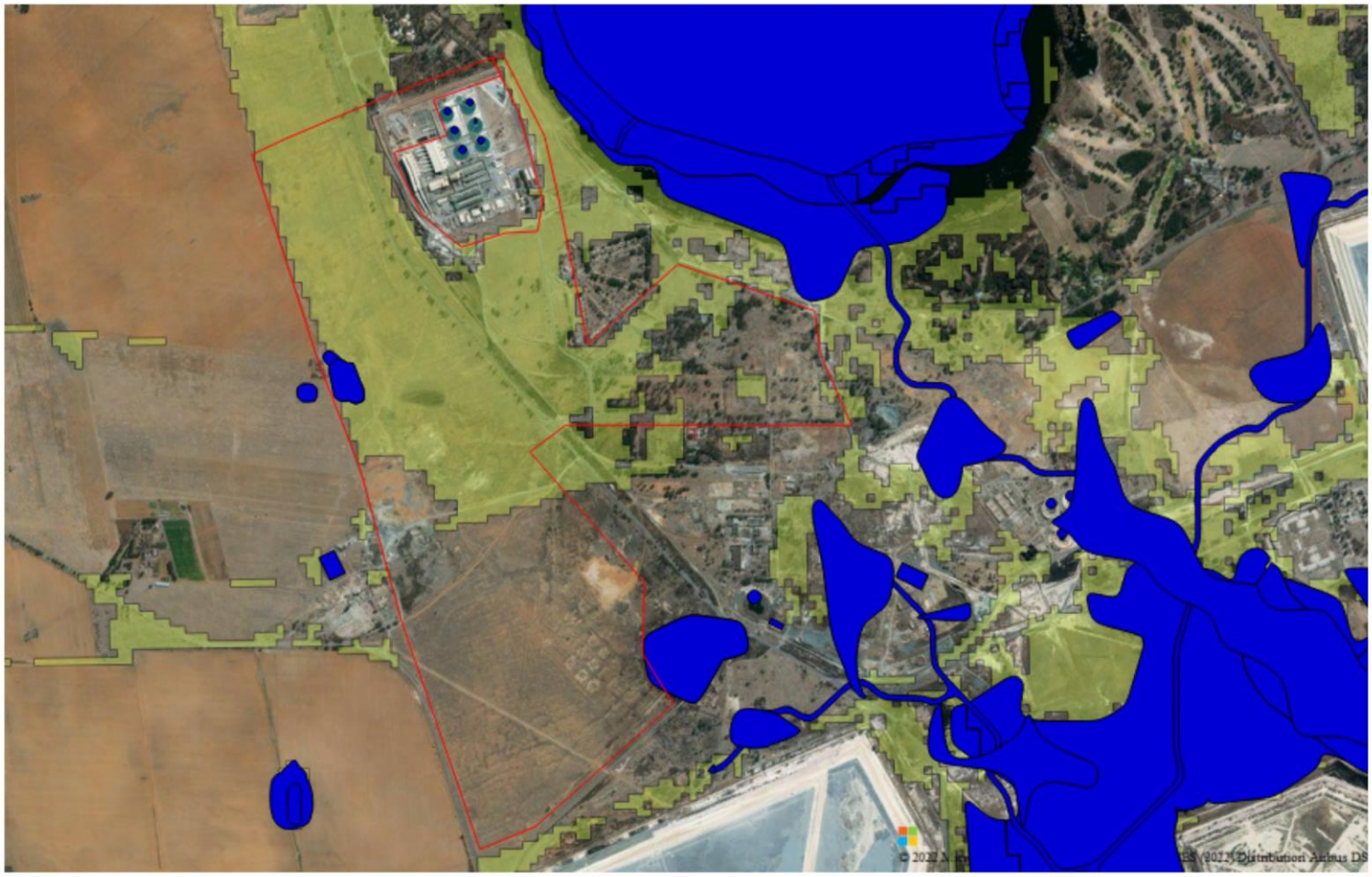
Annexure A: Maps

Locality map for the proposed Harmony 1 Plant PV solar development situated in Welkom, Free State Province.



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

Legend:

- Study area
- Watercourses
- NFEPA Wetlands
- Vaal-Vet Sandy Grassland

Map Information

Spheroid: WGS 84

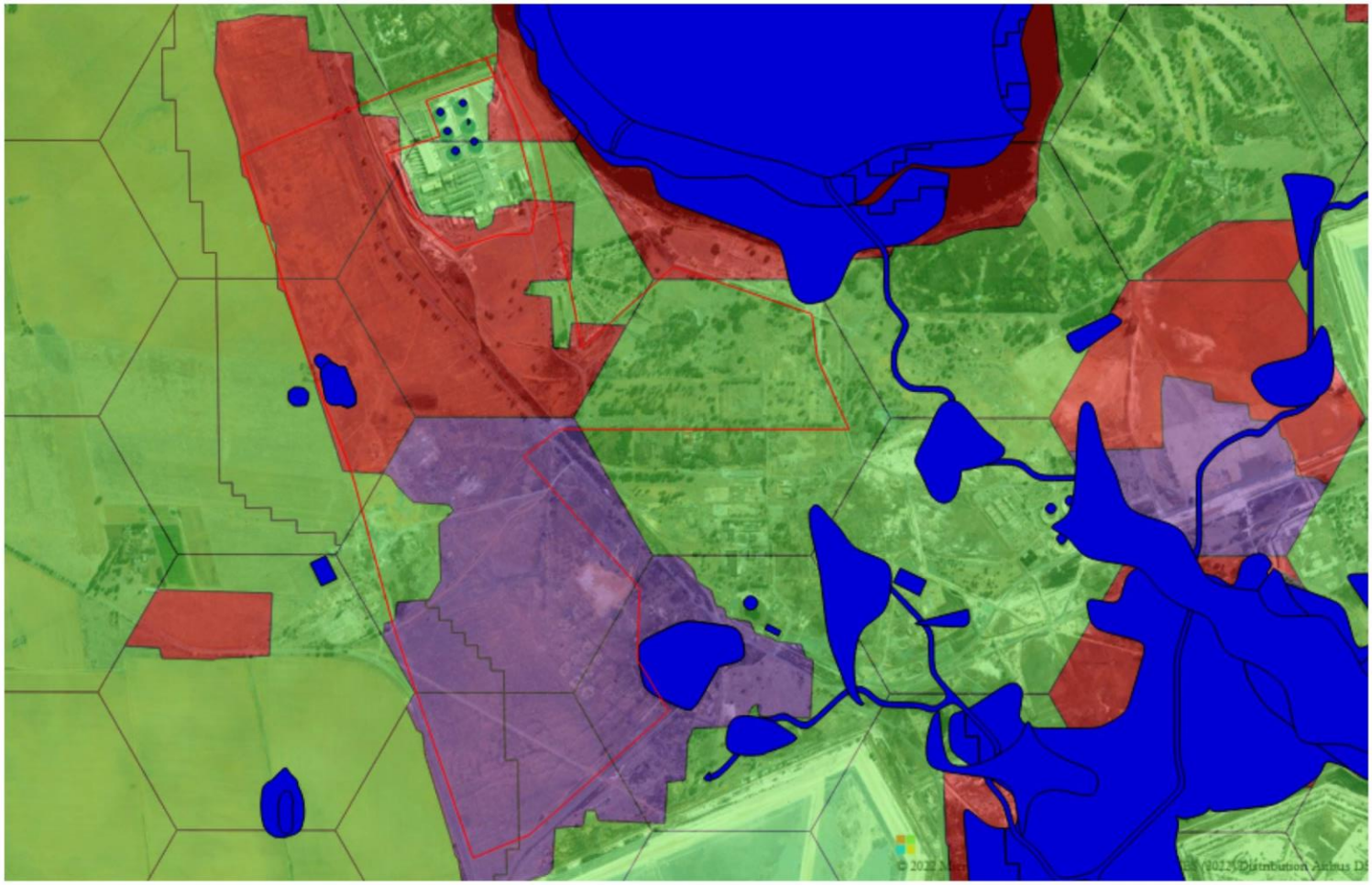
Quantum GIS

Scale: 1:25 000

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

Map 1: Locality map of the proposed Harmony 1 Plant PV solar development near the town of Welkom. Those portions of remaining and intact natural vegetation are indicated and transformation caused by mining and agriculture is prominent. Tthough extensive transformation is evident there are still large portions of natural grassland present in the northern portion of the site. Remaining natural areas also form part of the Endangered (EN) Vaal-Vet Sandy Grassland which is considered to have a high conservation value. Locations of NFEPA and probable identified wetland areas are also indicated. Note however that these may not be accurate and on-site delineation should be used for the location of wetlands (Map 3).

Free State Biodiversity Plan map for the proposed Harmony 1 Plant PV solar development situated in Welkom, Free State Province.



Preparred for:
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Sunninghill
2157

Legend:

- Study area
- Watercourses
- NFEPA Wetlands
- Critical Biodiversity Area 1
- Critical Biodiversity Area 2
- Ecological Support Area 1
- Ecological Support Area 2
- Degraded
- Other

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:25 000

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Map 2: Free State Biodiversity Plan map of the proposed Harmony 1 Plant PV solar development near the town of Welkom. The area is largely being regarded as Degraded and Other and also indicates the largely transformed condition of the natural vegetation. However, the majority of the northern portion of the site consists of a Critical Biodiversity Area 1 and indicate remaining natural portions of the Endangered Vaal-Vet Sandy Grassland which is considered essential for meeting conservation targets for this vegetation type.

Wetland delineation map for the proposed Harmony 1 Plant PV solar development situated in Welkom, Free State Province.

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Sunninghill
2157

Legend:

- Study area
- Watercourses
- Delineated Wetland Areas
- Wetland sampling points

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:25 000

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Map 3: Wetland delineation map of the proposed Harmony 1 Plant PV solar development near the town of Welkom. The different wetland areas on and around the site are labeled and indicated. The large Witpan is situated to the north east of the site and though it does not form part of the site, it may be affected by the grid connection powerline. Two large pans are also situated in the north western portion of the site but should remain unaffected by development as long as portions of natural grassland are excluded from development. A large, but certainly artificial wetland areas is also situated in the south of the site. Being artificial is of low conservation value but since it contains saturated soils conditions, should still be taken into account by the development. The wetland sampling points are also indicated.

Sensitivity map for the proposed Harmony 1 Plant PV solar development situated in Welkom, Free State Province.

Preparred for:
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Sunninghill
2157

Legend:

- Study area
- Very High Sensitivity
- High Sensitivity
- Moderate Sensitivity
- Low Sensitivity

Map Information

Spheroid: WGS 84

Quantum GIS

Scale: 1:25 000

DPR Ecologists
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Tel: 083 410 0770

Map 4: Sensitivity map of the proposed Harmony 1 Plant PV solar development near the town of Welkom. Areas which have been listed as CBA 1 areas represent portions of remaining Endangered grassland and should therefore be afforded a Very High level of sensitivity. Likewise the two wetland systems in the north western portion of the site should also be regarded as having a Very High level of sensitivity. A portion of remaining natural grassland in the central portion of the site is not listed as a CBA 1 but still represents portions of remaining Endangered grassland which should therefore be regarded as having at least a High level of sensitivity. A small portion of grassland in the east is heavily degraded and only scattered remnants of the natural grassland and since it is no longer a good representative of the natural grassland is only regarded as being Moderately Sensitive. A large artificial wetland in the south of the site is also only regarded as Moderately Sensitive owing to the saturated soils. The remainder of the area consists of previously transformed areas, but now rehabilitated, areas which, although indigenous grasses have been able to re-estalish is clearly degraded and transformed from the natural vegetation type.

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
**Cestrum laevigatum*	Shrub
**Cirsium vulgare*	Herb
**Conyza bonariensis*	Herb
**Datura stramonium*	Herb
**Eucalyptus camaldulensis*	Tree
**Flaveria bidentis*	Herb
**Melia azedarach*	Tree
**Prosopis glandulosa*	Tree
**Schinus molle*	Tree
**Schkuhria pinata*	Herb
**Solanum incanum*	Herb
**Sphaeralcea bonariensis*	Herb
**Tamarix chinensis*	Shrub
**Tegetes minuta*	Herb
**Verbena bonariensis*	Herb
Aloe greatheadii	Succulent
Andropogon eucomis	Grass
Anthospermum rigidum	Herb
Aristida congesta	Grass
Asparagus larcinus	Shrub
Babiana bainesii	Geophyte
Barleria macrostegia	Herb
Berkheya onopordifolia	Herb
Bulbine abyssinica	Geophyte
Chenopodium album	Herb
Chloris virgata	Grass
Chrysocoma ciliata	Dwarf shrub
Colchicum burkei	Geophyte
Colchicum longipes	Geophyte
Cymbopogon pospischillii	Grass
Cynodon dactylon	Grass
Cyperus difformis	Sedge
Cyperus eragrostis	Sedge
Dicoma macrocephala	Herb
Diplachne fusca	Grass
Drimia elata	Geophyte
Eragrostis echinochloidea	Grass
Eragrostis gummiflua	Grass

Eragrostis lehmanniana	Grass
Eragrostis superba	Grass
Eriospermum cooperi	Geophyte
Felicia muricata	Dwarf shrub
Gazania krebsiana	Herb
Helichrysum caespititum	Herb
Hermannia depressa	Herb
Hibiscus pusillus	Herb
Hypoxis haemerocallidae	Geophyte
Indigofera sessilifolia	Herb
Juncus rigidus	Rush
Lapeirousia plicata subsp. *foliosa*	Geophyte
Lotononis listii	Herb
Lycium horridum	Dwarf shrub
Marsilea sp.	Fern
Massonia jasminiflora	Geophyte
Melolobium candicans	Dwarf shrub
Moraea pallida	Geophyte
Nidorella resedifolia	Herb
Nolletia ciliaris	Dwarf shrub
Osteospermum scariosum	Herb
Oxalis depressa	Geophyte
Pentzia incana	Dwarf shrub
Phragmites australis	Reed
Pogonarthria squarrosa	Grass
Ruschia hamata	Succulent
Salvia verbenaca	Herb
Schoenoplectus corymbosus	Sedge
Scilla nervosus	Geophyte
Searsia lancea	Tree
Selago densiflora	Herb
Sporobolus fimbriatus	Grass
Stachys spathulata	Herb
Stipagrostis uniplumis	Grass
Themeda triandra	Grass
Trachyandra laxa	Geophyte
Trichoneura grandiglumis	Grass
Triraphis andropogonoides	Grass
Typha capensis	Bulrush
Ursinia nana	Herb
Vachellia karroo	Tree
Vigna sp.	Herb
Ziziphus mucronata	Tree

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	One Plant Pan
Assessment Unit Name / No.	1
Assessor	D van Rensburg
Date of Assessment	24/06/2022
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)	1.9
Upslope catchment size (Ha)	75.4
Quaternary Catchment[1]	C42J
MAR (Mm3)	13.0
MAR per unit area (m3/Ha)	195.0
MAP (mm)	521
PET (mm)	1600
MAP:PET ratio	0.3
Vulnerability Factor	1.0
Hydrogeological Type Setting[2]	Other
Connectivity of wetland to a regional aquifer	No connection
Change in groundwater levels in the regional aquifer	
Water quality of regional aquifer	
Channel characteristics (if present)	
Natural wetness regimes	Dominated by seasonally saturated soils
Broad vegetation attributes	Dense wetland grasses and sedges.
Number of dams in the catchment	0
Average surface area of dams (m2)	0
Perimeter of wetland (m)	573
Perimeter-to-area ratio (m/ha)	301.6
Down-slope length of wetland (m)	230
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	One Plant Pan
Assessment Unit	1
HGM type	Depression without flushing
Areal extent (Ha)	1.9 Ha

Unadjusted (modelled) Scores				
PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	3.8	0.7	0.8	4.0
PES Score (%)	62%	93%	92%	60%
Ecological Category	**C**	**A**	**A**	**D**
Combined Impact Score	2.5			
Combined PES Score (%)	75%			
Combined Ecological Category	**C**			
Hectare Equivalents	1.4 Ha			
Confidence (modelled results)	RATE-TO-HIGH: Field-based assessment including information about the regional a			

Final (adjusted) Scores				
PES Assessment	Hydrology	Geomorphology	Water Quality	Vegetation
Impact Score	4.5	0.7	0.8	4.0
PES Score (%)	55%	93%	92%	60%
Ecological Category	**D**	**A**	**A**	**D**
Trajectory of change				
Confidence (revised results)	Not rated	Not rated	Not rated	Not rated
Combined Impact Score	2.7			
Combined PES Score (%)	73%			
Combined Ecological Category	**C**			
Hectare Equivalents	1.4 Ha			

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	Witpan
Assessment Unit Name / No.	1
Assessor	D van Rensburg
Date of Assessment	14/06/2022
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)	550
Upslope catchment size (Ha)	10500
Quaternary Catchment[1]	C42J
MAR (Mm3)	13.0
MAR per unit area (m3/Ha)	195.0
MAP (mm)	521
PET (mm)	1600
MAP:PET ratio	0.3
Vulnerability Factor	1.0
Hydrogeological Type Setting[2]	Other
Connectivity of wetland to a regional aquifer	No connection
Change in groundwater levels in the regional aquifer	
Water quality of regional aquifer	
Number of dams in the catchment	0
Average surface area of dams (m2)	0

WET-Health Level 1B assessment: PES Summary

	Wetland PES Summary			
Wetland name	**Witpan**			
Assessment Unit	**1**			
HGM type	Depression without flushing			
Wetland area (Ha)	550.0 Ha			
Unadjusted (modelled) Scores				
PES Assessment	**Hydrology**	**Geomorphology**	**Water Quality**	**Vegetation**
Impact Score	7.3	5.7	9.8	9.6
PES Score (%)	27%	43%	2%	4%
Ecological Category	**E**	**D**	**F**	**F**
Combined Impact Score	7.8			
Combined PES Score (%)	22%			
Combined Ecological Category	**E**			
Hectare Equivalents	119.0 Ha			
Confidence (modelled results)	Low to Moderate: Desktop assessment based mostly on refined landcover mapping			
Final (adjusted) Scores				
PES Assessment	**Hydrology**	**Geomorphology**	**Water Quality**	**Vegetation**
Impact Score	7.3	5.7	9.8	9.6
PES Score (%)	27%	43%	2%	4%
Ecological Category	**E**	**D**	**F**	**F**
Trajectory of change				
Confidence (revised results)	Not rated	Not rated	Not rated	Not rated
Combined Impact Score	7.8			
Combined PES Score (%)	22%			
Combined Ecological Category	**E**			
Hectare Equivalents	119.0 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	Two pan systems are situated in the north western portion of the site and where development may occur within 500 meters of these wetlands, it will require the necessary authorisation.	The construction of the facility may encroach into the regulated area of these wetlands in which case it may then impact on the catchment of these wetlands which will then have an indirect impact on them.	1	2	1	1	1.25	1	3	5.25	1	1	5	2	9	47.25	L	80	These pan wetlands are imbedded within endangered grassland which is likely to be excluded by development and which case it is highly unlikely that the development will have any significant impact on these pans. It will however still be important to implement a comprehensive storm water management system.
	Mostly Operational Phase but also during construction	Construction of a solar facility	A large artificial wetland area occurs in the south eastern corner of the site and development will occur in close proximity to it.	Given that this is an artificial wetland area there are no significant impacts anticipated though the development may still affect the surface water in this area.	0	1	0	0	0.25	1	3	4.25	1	1	5	1	8	34	L	80	Given the artificial condition of this wetland area the development is unlikely to have any significant impacts on it. It will however still be important to implement a comprehensive storm water management system.
	Mostly Operational Phase but also during construction	Construction of a grid connection powerline	Construction of a grid connection powerline in close proximity to the Witpan along the eastern border of the site.	Construction of the powerline in close proximity to the pan may cause local disturbance which then also affect the pan system in terms of increased sediment and weed establishment.	1	2	1	1	1.25	1	3	5.25	1	1	5	2	9	47.25	L	80	Given the already heavily degraded condition of the pan, it is highly unlikely that the proposed powerline will contribute any additional significant impacts on it. Rehabilitation and monitoring should still be implemented and should aim to establish an indigenous vegetation layer.

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.		