A FIRE MANAGEMENT PLAN FOR LICHTENBURG SOLAR PARK

Lichtenburg, North West Province

May 2022

CLIENT

Prepared by:

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1 Introduction

The Biodiversity Company was appointed by Africa Geo-Environmental Engineering and Science (AGES) to compile a fire management plan for the Lichtenburg Solar Park. The plan is for the construction and operational phases for a 120MW Photovoltaic (PV) solar plant with a Battery Energy Storage System (BESS) as per the conditions of the Environmental Authorisation.

Specialist Details

Report Name	**A FIRE MANAGEMENT PLAN FOR LICHTENBURG SOLAR PARK**
Submitted to	AGES
Report Writer	**Jan Jacobs** Jan Jacobs completed his BSc Honours degree in Biodiversity and Conservation Biology at the University of the Western Cape in 2016 and completed his Master of Applied Science degree in Nature Conservation at the Tshwane University of Technology in 2022. His Masters thesis is currently under examination and he is expected to officially graduate in October 2022.
Report reviewer	**Andrew Husted** Andrew Husted is Pr Sci Nat registered (400213/11) in the following fields of practice: Ecological Science, Environmental Science and Aquatic Science. Andrew has more than 12 years' experience in the environmental consulting field.
Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.

1.1 Terms of Reference

A Fire Management Plan for the Lichtenburg Solar Park is a necessity due to the known risk of fires due to lightning strikes, overheating of the BESS, and electrical shorts caused by faulty installation. Some systems are in place to prevent these events, but a fire management plan is still necessary in case of an unplanned fire. The fire management plan will include management protocols to ensure that the surrounding natural environment will not be affected by an unplanned fire sourcing from the facility, thus meeting the condition of the Environmental Management Programme (EMPr).

1.2 Project Background and Location

The Lichtenburg Solar Park will have a generation capacity of 120MW with a BESS and will be located in the North-West corner of Lichtenburg Game Breeding Centre. The project area is situated 7.6 km North-West of Lichtenburg and 7.7 km South-East of Ottoshoop (Figure 1-1). It is adjacent to the R505 road that is found between Ottoshoop and Wolmaransstad in the North West Province. The project area is mainly surrounded by natural areas and some agricultural areas (Figure 1-2).

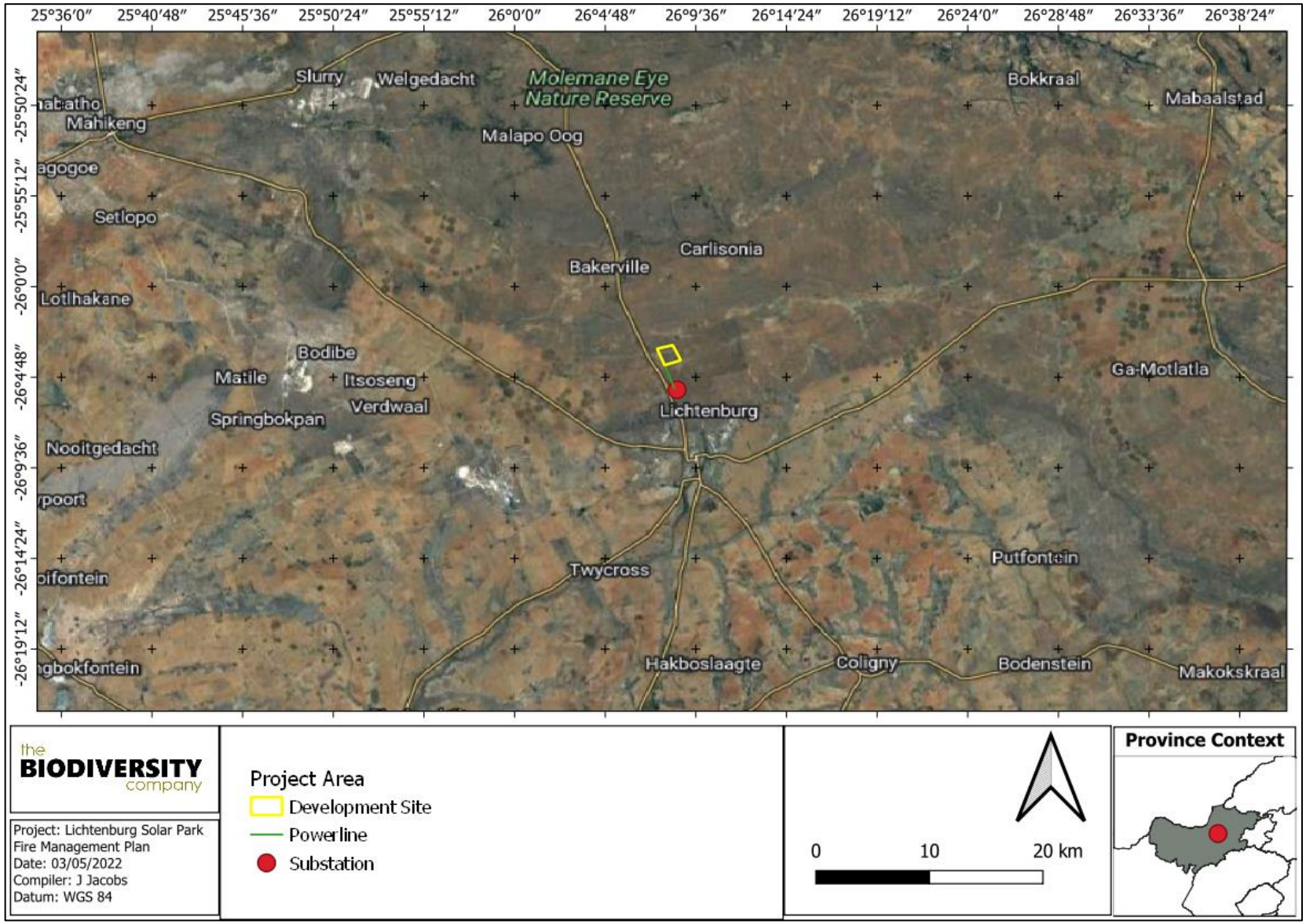

Figure 1-1 Map illustrating the location of the project area

Figure 1-2 The project area

1.3 Legislation

The following legislation is pertinent to the project:

- National Veld and Forest Fire Act No. 101 of 1998. Chapter 4 of the Act prescribes requirements for veldfire prevention through firebreaks; and
- Emergency preparedness, and incident and accident-reporting requirements as required by the Occupatinal Health and Safety Act,1993 (Act No 85 of 1993).

1.4 Limitations

The following limitations should be noted for the assessment:

- No survey was conducted for this fire management plan;
- The project description is based on information provided by AGES; and
- The Environmental management plan and project specifications were not made available.

2 Desktop Vegetation Assessment

The vegetation is an important aspect to consider as it affects the management of fire by influencing the fuel available for fire. The project area is situated within the Grassland biome. In terms of climate, the temperate grasslands of the Highveld in South Africa have cold and dry conditions, with rainfall during the summer (which can sometimes be a strong summer rainfall) and winter drought (Mucina & Rutherford, 2006). Frost is common and there is a high risk of lightning-induced fires (Mucina & Rutherford, 2006).

Grassland vegetation communities are usually dominated by grasses of the Poaceae family (Mucina & Rutherford, 2006).

The property is found within the Carletonville Dolomite Grassland (SANBI, 2018) (Figure 2-1).

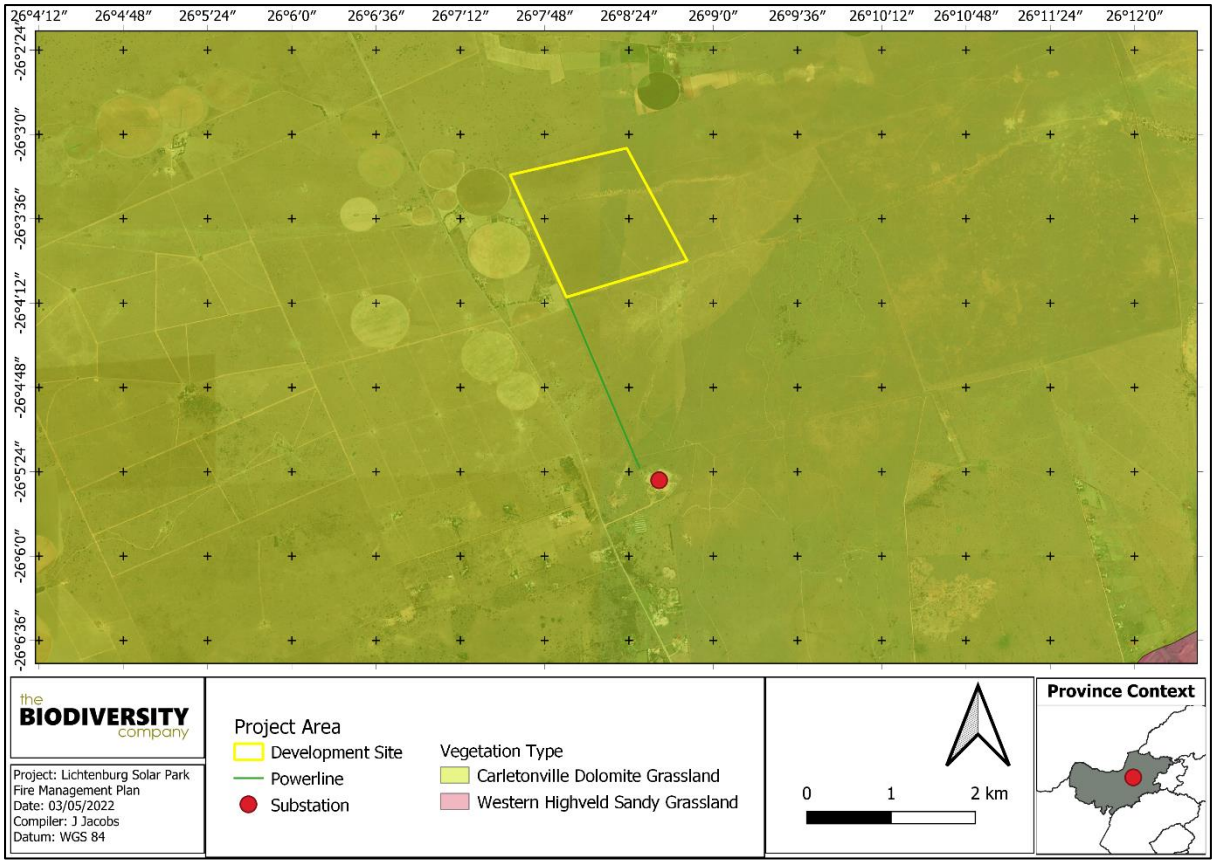

Figure 2-1 Map of the project area in relation the SA vegetation map (SANBI, 2018)

2.1 Fire History

Based on the FIRMS: Fire Information for Resource Management System for the period between 1 January 2000 and 3 May 2022 a number of fires have taken place in the general area but the exact number of fires is unknown. The frequency of fires in the PV site has been found to be low to medium, although it is adjacent to high frequency areas (Figure 2-2).

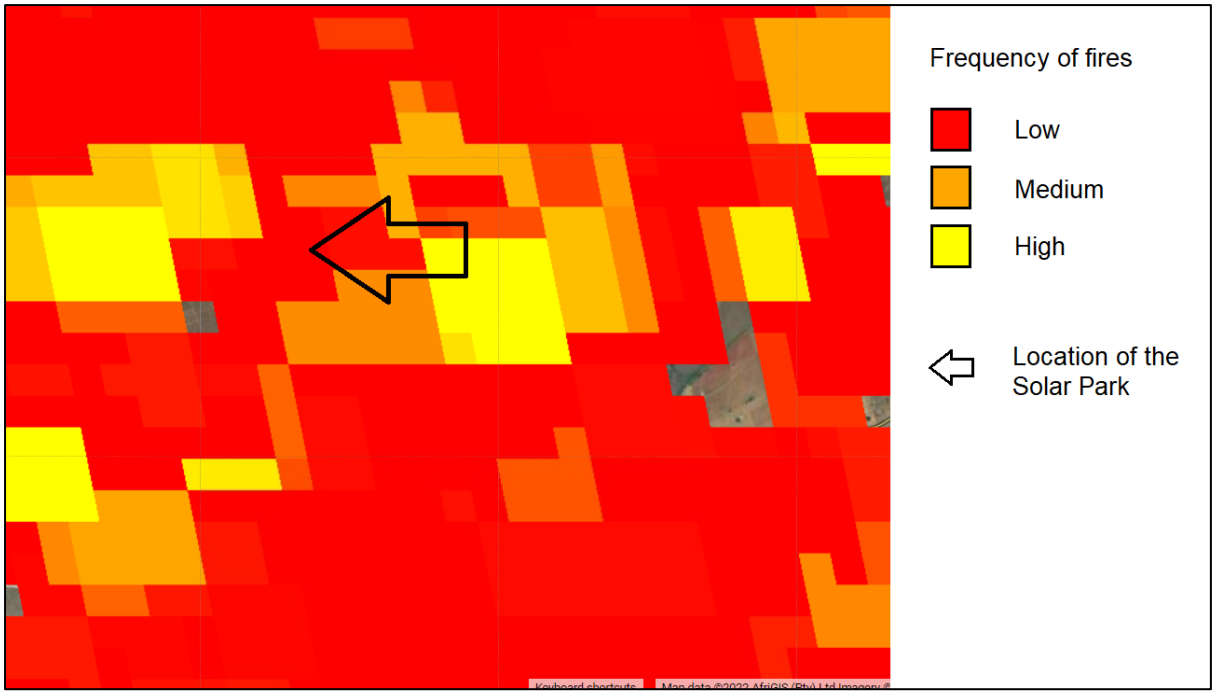

Figure 2-2 The frequency of fires in the area based on data for the period between 1 January 2000 and 3 May 2022 (FIRMS, 2021).

The fire history of the last three months as per the Map Scientific Services according to NASA generated data (https://experience.arcgis.com/experience/551cc94e9d0543d9a1a1808ae1a34de3) shows that no fires have taken place in or near the project area. Seventy-eight fires have taken place in Lichtenburg, which is the nearest town in relation to the substation. The extent of these fires is unknown as the information only provides the location of the fires (Figure 2-3).

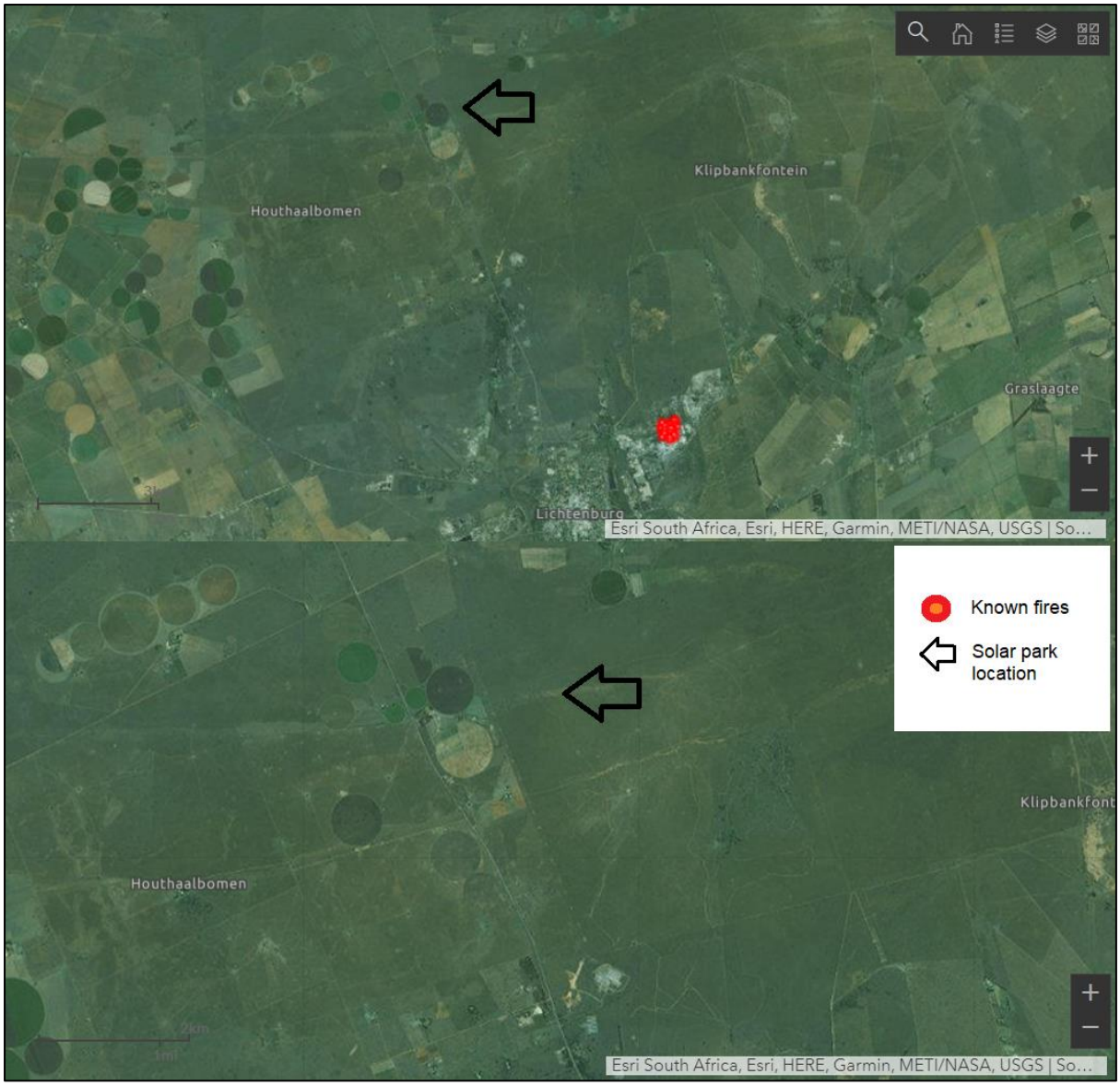

Figure 2-3 Fire history of the last 3 months as per the Map Scientific Services

2.2 Fire Risk

SANBI (2010), provides a shape file of the fire risk of areas for the implementation of veldfire management interventions. This model is based on the social, economic and environmental risk scenarios. The level of risk for each fire scenario was then assessed using the product of likelihood and consequence and categorised as being Extreme, High, Medium or Low (Forsyth *et al.,* 2010). The risk associated with the project area was rated to be extreme (Figure 2-4).

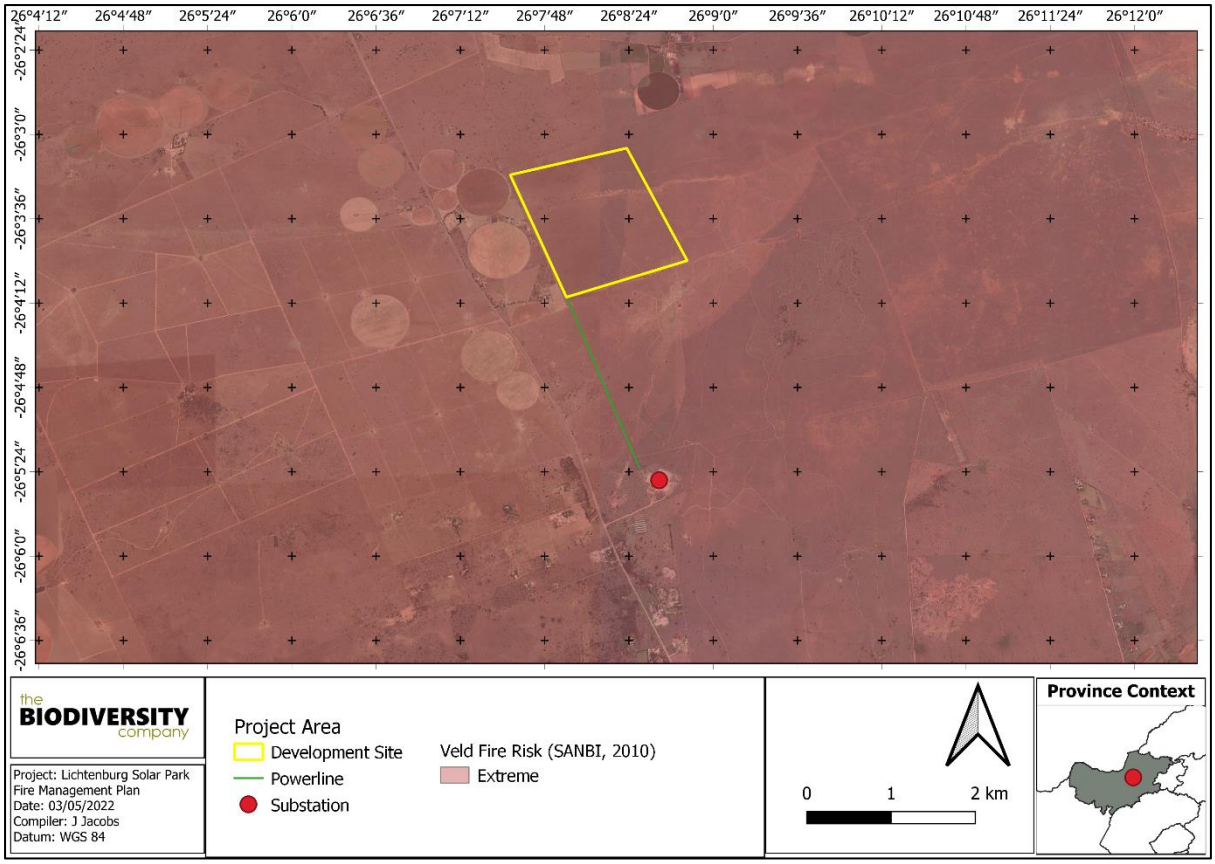

Figure 2-4 Veld fire risk of the area

3 Background

3.1 Fire management

"Fire is regarded as a natural factor of the environment of southern Africa; it is thought to have occurred from time immemorial" (Tainton, 1999).

The type of fire that burns influences vegetation differently and will play a part when determining the fire that will be used for various applications. According to Brown & Davies (1973) as well as literatures by Luke & McArthur (1978) three types of fires are recognised:

- Crown fires which burn the canopies of trees and shrub;
- Surface fires which burn in the surface fuels including grass, small shrubs as well as forbs. This is the most common fire that occurs throughout South-Africa; and
- Ground fires which burn below the surface of the ground in layers of organic material. For example, if a wetland dries up and is burnt the peat that burns will be known as a ground fire.

According to Tainton (1999) the way a fire behaves is controlled by various environmental factors, which need to be considered and monitored when planning a controlled fire or the management of fire:

- The fuel load is one of the most determining factors of fire, the amount of vegetation available that can be burned (Tainton, 1999). The fuel load influences the intensity of the fire and consists mainly of the amount of phytomass (biomass) available to burn;
- Air temperature affects the intensity of the fire: the higher the air temperature the more intense the fire will be, a fire in cold conditions is less intense;
- The moisture content of fully dried out fuels, is relative to the humidity in the immediate area of the fuel at any given time, therefor affecting the intensity of the fire, the higher the humidity the less intense the fire will be (Tainton, 1999);
- The wind is a very important aspect regarding fire as it controls the direction and speed of a fire. The direction as well as the speed of the wind will affect the possibility and the type of burn. A fire occurring in high velocity winds will create a scenario where the fire will behave in an unpredictable way, creating an unfavourable situation (Tainton, 1999). The direction of the wind has to be considered depending on your objectives: a head fire burns with the wind where a back-burn progresses against the wind, a head-fire causes less damage to the herbaceous layer when compared to a back-burn, thus indicating how wind can be used; and
- The angle or the slope in the terrain in the given area, affects the controllability of the fire and thus the difficulty of controlling the fire itself. “The forward spread rate of surface fires is influenced by the slope: by modifying the extent to which the material ahead of the fire is pre-heated” (Tainton, 1999). Burning up a slope causes situation where the fire will behave as a head fire due to the material being pre heated where material burning down slope will act as a back burn.

The tools of the trade that may be required when doing controlled burning/firebreaks and fighting fires (Krynauw, 2013):

- Ignition torches that can easily make a line of fire, this will be needed to create a fire where needed as quick as possible;
- Knapsack sprayers carried on the back of personnel which sprays a controllable stream of water. Firefighting machines that consist of a water tank, which can load onto a vehicle which has petrol motor which pumps water into a hosepipe to spray large amounts of water; and
- Fire beaters which usually consist of rubber conveyer belt used to beat fires.

3.2 BESS

A complete BESS is regarded to include (but not limited to) the Battery Management System (BMS), the core electrical energy storage medium (e.g., a battery bank), the Balance-of-System (BoS) which includes the heating, ventilation, and air conditioning (HVAC) and auxiliary power system, the associated bi-directional Power Conservation System (PCS), the auxiliary power system and the Network Integration Equipment (ESKOM, 2018).

The technical standard does not detail any specific battery storage technologies. A certain standard of technology maturity, track record, proven technical performance, environmental criteria and safety will be taken into consideration when selecting suitable technologies

(ESKOM, 2018). According to Morrow (2001), a variety of battery technologies exist, which are listed in Table 3-1.

Table 3-1 Battery technologies and their life spans

Battery Technology	Lifetime of Battery
Lead Acid	3-15 Years
Nickel Cadmium (NiCd)	15-20 Years
Lithium Ion (Li)	500-1000 Cycle life
Sodium Sulfur (NaS)	12-20 Years
Zinc Bromine (ZnBr)	20 Years at 2 full cycles/day

Allianz Global Corporate & Specialty (2019) discussed several points regarding BESS which included the scenarios which could lead to a fire event with the BESS, and thus will be relevant to the fire management plan in this case:

- A thermal event which occurs when external heating associated with a failure of the ventilation system, cooling or improper design;
- An electrical event that could arise from an internal short circuit due to internal cell defects, overvoltage charging or a defect on the internal resistance; or
- A mechanical failure due to physical damage to any cell which may have occurred during the manufacturing or installation process or while in use.

Ultimately any of these above scenarios could lead to an event which is known as a “thermal runaway”. A thermal runaway is a chain reaction leading to a decomposition reaction of the cell that spreads to adjacent cells which could consequently lead to an exothermic reaction with heat release, release of flammable and toxic gases which are generated within the cell enclosure before venting and an intense fire due to the fact that the cells are constructed primarily of plastic. It is crucial to note that re-ignition can occur long after the fire is fully extinguished and thus should be considered a risk long after the fire event.

3.3 PV Site

Although fires caused by PV systems are regarded as rare, such fires still happen. Main causes for these fires include:

- Installation mistakes: Examples include DC connections not matted correctly or connectors that are crimped badly;
- Production failures: This includes all the parts of the system but has been associated with the malfunctioning of the PV modules or inverters;
- External influence: Examples can include animals either directly (getting stuck) or nesting in the various parts resulting in electric arcs as well as lightning; and
- Planning failure: This includes poor mechanical and electrical design, such as the incorrect selection of SC isolators or cabling (Sepanski *et al*., 2018).

The correct management of these fires are crucial as they not only pose a major risk to the PV plant but also the surrounding environment and the firefighters (electrocution).

4 Fire Management Plan

Due to the known risk of fires from the BESS overheating and PV malfunctioning, some systems are in place to prevent this. However, in the case of an unplanned fire, a management plan needs to be in order. The fire management plan will include management protocols to ensure that the surrounding natural environment will not be affected by an unplanned fire sourcing from the facility. The main objective of the fire management plan is to prevent fires on site, and to extinguish them locally before they spread.

4.1 BESS and PV Specific Fire Management Systems

The systems that are standard to be part of the fire protection protocol for the specific BESS and PV project will be addressed superficially below, as it is assumed that these systems are in place. Protocols preventing the BESS overheating, especially “thermal runaway”, should be in order as per the industry standards and take into consideration aspects such as cell quality, ventilation and cooling and that all of the fire supressing equipment is installed/available. The structure and design of the PV site is also assumed to follow national standards and no further guidelines are provided.

Allianz Global Corporate & Specialty (2019) have a set of recommendations to reduce the potential for BESS fires and the affects that may have on the PV solar site:

- Inform and invite the local fire department closest to your property to discuss BESS and PV hazards. An adequate emergency response is the key to avoiding an uncontrolled fire;
- “Standard Operating Procedures (SOP) & Standard Operating Guidelines (SOG) are of major importance and should be updated and tested on a regular basis”;
- Ensure ventilation is provided in accordance with the manufacturer recommendations. Safety ventilation as a separate system from HVAC cooling equipment must be installed;
- Gas detection by installing hydrogen (H_2) detection within the container or BESS room and smoke detection by installing a very early warning fire detection system, such as aspirating smoke detection;
- Fire suppression must be installed inside containers (water spray nozzles);
- Ensure that sufficient water is available at all times in the case of manual firefighting; an external fire hydrant can be considered and should be located within 100 m of the BESS room or containers and should be able to provide a minimum of 1,900 l/min for 2 hours;
- Batteries have passed the non-thermal runaway propagation tests UL9540A in order to minimize the scaling of a fire. This will allow the fire to be contained in just one rack, as per battery supplier specifications;

- Ensure BESS enclosures are 60 min fire resistance as per battery supplier specifications;
- BESS must have an aerosol extinguishing system triggered by temperature as per battery supplier specifications;
- Maintenance regarding the equipment which involves inspections and testing. Ensure that room temperature readings and visual checks are performed on a monthly basis;
- Module-level shutdown devices must be installed. This method is not always fool proof as all systems can fail. However, it would assist with reducing risk to a larger area;
- An electronic safety system, called BMS must be installed. This system allows for the monitoring of the state of the cells. If the cell overheats, the electrical values change and will generate an alarm;
- Perform routine checks on the PV modules and connections to ensure there are no areas that is loose and can potentially arc;
- Mobile electrostatic equipment must be used on a yearly basis to ensure the system is grounded correctly; and
- A lightning rod must be installed to ensure that the risk of fire caused by lightning is reduced. Even though the risk of lightning is not because solar equipment is metallic or electrical in nature, but simply because its sheer size covers more land, increasing the odds of being hit.

4.2 Fire Breaks

Fire breaks prevent external fires from entering a farm property and obstruct internal fires from spreading to neighbouring areas. Firebreaks are enforced by law and are found in the:

- National veld and forest fire Act, 101 of 1998
    - 12. Duty to prepare and maintain fire breaks: A fire break is recommended by law; it must exist to prevent any veld fire from spreading from an area owned by one person, to an area owned by another person. The fire break must be long and wide enough to defend oneself in court as well as prevent soil erosion (Bothma & Du Toit, 2010).

Fire breaks are usually essential on the periphery of any portion of owned land. Firebreaks are created/burnt as soon as the herbaceous component starts losing moisture, which are a few months after the last summer rainfall; usually in autumn (April-May). It is important to burn at this time of year due to many accidental fires occurring because of the dry state of vegetation where any ignition source like an ember, cigarette or matchstick could lead to an unstoppable accidental fire. Roads usually act as the main fire breaking tool, in order to increase the width of the firebreak the vegetation on the roadside can also be slashed or burned. The width of the vegetation burned on the roadside should not exceed 3 m to restrict the impact on the vegetation community.

The periphery of the property, as well as the PV panel and BESS footprint areas, must have a fire break to prevent any fires from firstly spreading from the footprints onto the rest of the

property, and secondly onto neighbouring farms in the case that the fire cannot be contained within the infrastructure footprints.

The creation/burning of a fire break can be completed by consulting a contractor, however based on the maintenance road around the periphery of the property it may be constructed internally if large earth moving machinery is available. This being said, it is assumed all Environmental Authorizations (EA) are in order for any suggested actions contained within the Environmental Impact Assessment (EIA), especially considering the fact that the project site is known to support several protected tree species. Protected tree species require permits in order to be destroyed, i.e., it is assumed that if any protected trees may need to be destroyed for the creation of a firebreak or areas need to be cleared, that the correct permit/EA will be in hand. It is recommended that regular photos are taken of the fire breaks, especially the size and extent of the fire break, to be able to defend the solar site in the case of presumption of negligence.

4.3 Management Plan

The aim of this section is to present actions which should be incorporated into the existing EMPr which will allow for the successful implementation and auditing of mitigation and monitoring actions. The proposed summarised actions are presented in Table 4-1.

Table 4-1 Management measures including requirements for timeframes, roles and responsibilities for this report.

Fire			
Impact Management Actions	**Implementation**	**Monitoring**	
	Responsible Party	**Aspect**	**Frequency**
Staff/contractors or visitors should be educated about fire risk associated with smoking and cooking actions; discarding of lit cigarette butts and/or glowing embers from cooking fires. A designated smoking area within the project site must be provided and should have a fireproof sand filled container for extinguishing cigarettes. Smoking shall otherwise be prohibited across the site and in the work areas. Educate construction workers regarding risks and correct disposal of cigarettes.	Project manager, Environmental Officer & Health and Safety Officer.	Fire Risk Awareness and training	Ongoing
Portable firefighting equipment must be provided at strategic locations throughout the site, in line with the building Code of South Africa and the relevant provincial building code. All emergency equipment including portable fire extinguishers, hose reels and hydrants must be maintained and inspected by a qualified contractor in accordance with the relevant legislation and national standards.	Health and Safety Officer.	Portable firefighting equipment	As per the standards
Each employee, subcontractor or any other visitor should be made aware of the provisions of the fire management plan and is made familiar of the location and proper use of firefighting equipment as well as the location of assembly points.	Health and Safety Officer.	Fires safety awareness and training	Ongoing
Fire Management training for all staff about the correct steps to take in case of an accidental fire, including the report of a fire as well as the use of the available equipment.	Health and Safety Officer.	Fires safety awareness and training	Monthly
Monitoring of early detection warming system's state, such as the battery or battery container temperature monitors, the state of the battery cell itself etc.	Contractor, Environmental Officer & Design Engineer	State of the different warning systems as per the standards	Ongoing as per the standards
Fire occurrence emergency protocol training.	Project manager, Environmental Officer	Fire emergency drill tests	From April until October, every two months
The creation and maintenance of a firebreak wide enough to prevent a fire from crossing as well as the monitoring of this fire break. Based on the high risk of fires in the area, this must be widened.	Environmental Officer	Size and condition of fire break	Bi-annually (Wet and Dry season) but also every two weeks at the end of the dry season (July-Sep) when the risk is high
The state and size of the firebreak need to be assessed to ensure that it is large enough and devoid of vegetation that may allow fire to go across. The establishment and proliferation of Alien Invasive Plants (AIP) at the firebreaks should be monitored. Ensure fire breaks are done on wind still days to avoid run away fires.	Environmental Officer & Contractor	Assess the state of fire break and establishment /encroachment of alien vegetation	Quarterly, especially during the dry season.

Fire risk should be reduced by removing the dry vegetation or combustible materials from any hazardous material storage areas, cooking areas, smoking areas or vehicle/equipment that may create a spark. Grass should also be slashed under and around the PV system.	Project manager, Environmental Officer & Health and Safety Officer.	Removal of dry vegetation or combustible material	Daily
Local firefighting/fire protection agencies should be contacted in order to establish a relationship and shall have access to the solar site and the access road should allow any relevant fire fighting vehicle/truck to travel without hinder.	Project manager, Environmental Officer & Health and Safety Officer.	Access to solar site	Ongoing
The number of the Ditsobotla Fire Station (018 632 1474) in Lichtenburg must be displayed in the site offices.	Health and Safety Officer.	Number displayed in site office	Ongoing
Adjacent landowners need to be informed in the case of any fire. Their information must be easily accessible.	Environmental Officer & Health and Safety Officer.	Case of fire	In the occurrence of any fire
No open fires are allowed at sites. Fires for cooking should be restricted to designated areas, extra care should be taken to ensure to prevent veld fires from occurring. Cooking facilities within a designated area needs to be provided	Project manager, Environmental Officer & Health and Safety Officer.	Incidence of open fires and cooking within designated areas	Daily
A Fire Prevention and Fire Emergency Method should be in order and limited to the following: • Fire Fighting training for designated site staff; • Sources of fire risk and hazards, especially the BESS; • How to comply with any requirements of local authority fire departments and standards; • How to minimise the risk of accidental fires; • How to control accidental fires • Appropriate distance to stand away from PV system to avoid electrocution.	Health and Safety Officer.	Availability and Awareness of the Fire Prevention and Fire Emergency Method	Ongoing
The “fire team” who are people for generic maintenance, who should have attended a comprehensive fire-fighting training program, should drive/use/manage properly the fire extinguishers and the fire fighting vehicle/s, that should be available on the site.	Project manager, Environmental Officer & Health and Safety Officer as well as the Fire Team	Fire Management in case of occurrence	Daily
The solar site should be part of or form a Fire Protection Association (FPA). (https://www.fpasa.co.za/)	Project manager, Environmental Officer	Membership of an FPA.	Ongoing
Routine checking of all the connections and panels	Electrician	Presence of any loose wiring, malfunctioning parts	Ongoing, with a check of all connections yearly
Mobile electrostatic equipment must be used to ensure the system is grounded correctly.	Technician	Presence of an electrostatic reading	Monthly
Check for animals and nests in the PV system and in/around the BESS	Environmental Officer	Presence of animals and nests	Bi-weekly
Lightning rod must be installed as per national guidelines	Contractor	Lightning strike events	Ongoing
Installations should have emergency power disconnects to ensure manual, remote, and local disconnect is possible adjacent to the BESS.	Contractor	Presence of trip switch	Bi-yearly the switch much be checked to ensure it functions correctly

Ensure that fire alarm and detection systems, emergency lighting and fire extinguishers are appropriately located and properly maintained	Contractor	Equipment in working order	During construction
Quarterly fire safety inspections must be carried out	Environmental Officer	Safety inspections	Quarterly
Fire alarms must be tested on a weekly basis	Environmental Officer	Fire alarms	Weekly
Review the emergency plan issued to all staff on a bi-yearly basis	Environmental Officer, External subcontractor	Emergency plan	Bi-Yearly
Keep the fire log book or equivalent up to date	Project manager, Environmental Officer & Health and Safety Officer as well as the Fire Team	Fire Log	Ongoing
Ensure all escape routes are kept clear of obstructions and that access to fire extinguishers and fire alarms is not impeded;	Project manager, Environmental Officer & Health and Safety Officer as well as the Fire Team	Safety Routes	Ongoing
Ensure that the annual testing of portable electrical equipment and periodic testing (5 yearly) of the fixed electrical installations has been carried out	Environmental Officer & Health and Safety Officer as well as the Fire Team	Equipment in working order	Yearly and every five years
Employees must: – Ensure they are familiar with the emergency plan for their workplace and co–operate by participating in fire evacuation/drill procedures and by observing practical fire safety arrangements; – Know, and co-operate with, the responsible person for their workplace; – Report to their manager or supervisor any concerns about fire safety; – Be familiar with all escape routes; – Not wedge fire doors open, nor block or obstruct them; – Be aware of the action to be taken on discovering a fire, hearing a fire alarm, for raising the alarm (including the location of fire alarm call points) and calling the fire and rescue service; – Promptly evacuate the premises, in accordance with the emergency plan, to a place of safety without putting themselves and others at risk, and NOT attempt to extinguish a fire unless they have been specifically trained; and – Comply with the No Smoking legislation.	Project manager, Environmental Officer & Health and Safety Officer as well as the Fire Team	Employee awareness	Ongoing

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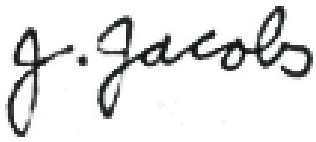
6 Appendices

Appendix A Specialist declarations

DECLARATION

I, Jan Jacobs, declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.



Jan Jacobs

Terrestrial Ecologist

The Biodiversity Company

May 2022

DECLARATION

I, Andrew Husted, declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Andrew Husted

Terrestrial Ecologist

The Biodiversity Company

May 2022

Appendix B Specialists CVs

Jan Jacobs

B.Sc. Honours Biodiversity and Conservation Biology

Cell: +27 79 935 2041

Email: jan@thebiodiversitycompany.com

Identity Number: 9112055125086

Date of birth: 5 December 1991

Profile Summary

Working experience in South Africa (Gauteng, Limpopo and KwaZulu-Natal)

Experience with sampling herpetofauna, small mammals and invertebrates using pitfall trap arrays, coverboards as well as surveys on foot

Specialist expertise include Herpetology and investigating human-crocodile conflict

Areas of Interest

Herpetology

Ethnoherpetology

Human-wildlife conflict

Key Experience

- Herpetofauna assessments
- Handling and relocation of potentially dangerous reptiles
- Soil erosion control
- Bush encroachment control
- Alien plant control
- Veld condition assessments

Country Experience

South Africa

Nationality

South African

Languages

Afrikaans – Proficient

English – Proficient

Qualifications

- B-Tech (Tshwane University of Technology) – Nature Conservation
- BSc Honours (University of the Western Cape) – Biodiversity and Conservation Biology
- MSc (Pending)

Andrew Husted

M.Sc Aquatic Health (*Pr Sci Nat*)

Cell: +27 81 319 1225

Email: andrew@thebiodiversitycompany.com

Identity Number: 7904195054081

Date of birth: 19 April 1979

Profile Summary

Working experience throughout South Africa, West and Central Africa and also Armenia.

Specialist experience with on-shore drilling, mining, engineering, hydropower and renewable energy.

Experience with project management of national and international multi-disciplinary projects. Including managing and compiling ESHIAs and EMPs

Specialist guidance, support and facilitation for the compliance with legislative processes, for in-country requirements, and international lenders.

Specialist expertise include Instream Flow and Ecological Water Requirements, aquatic ecology and wetlands resources.

Areas of Interest

Mining, Oil & Gas, Renewable Energy & Bulk Services Infrastructure Development,

Key Experience

- Familiar with World Bank, Equator Principles and the International Finance Corporation requirements
- Environmental, Social and Health Impact Assessments (ESHIA)
- Environmental Management Programmes (EMP)
- Ecological Water Requirement determination experience
- Wetland delineations and ecological assessments
- Terrestrial Ecological Assessments
- Aquatic Ecological Assessments
- Rehabilitation Plans and Monitoring
- Aquaculture

Country Experience

Botswana, Cameroon

Democratic Republic of Congo

Ghana, Ivory Coast, Lesotho

Liberia, Mali, Mozambique

Nigeria, Republic of Armenia, Senegal

Sierra Leone, South Africa

Swaziland, Tanzania

Nationality

South African

Languages

English – Proficient

Afrikaans – Conversational

German - Basic

Qualifications

- MSc (University of Johannesburg) – Aquatic Health.
- BSc Honours (Rand Afrikaans University) – Aquatic Health
- BSc Natural Science
- Pr Sci Nat (400213/11)
- Certificate of Competence: Mondi Wetland Assessments
- Certificate of Competence: Wetland WET-Management
- SASS 5 (Expired) – Department of Water Affairs and Forestry for the River Health Programme
- EcoStatus application for rivers and streams

Sustainability and Conservation.

Publication of scientific journals and articles.

SELECTED PROJECT EXPERIENCE

Project Name: The Environmental and Social Impact Assessment (ESIA) the proposed Nondvo Dam

Client: WSP

Personal position / role on project: Project Manager.

Location: Swaziland

Main project features: To conduct a dual season terrestrial and aquatic ecological baseline and impact assessment for the proposed dam. The study was required to meet national and IFC requirements, including a Critical Habitat assessment.

Project Name: The environmental flow assessment for the Mara River system

Client: IHE Delft Institute for Water Education

Personal position / role on project: Project Manager / Freshwater Ecologist

Location: Tanzania

Main project features: To conduct a dual season campaign to the Lower Mara River Basin in Tanzania to collect hydrological and ecological information as part of an environmental flow assessment on the Tanzanian side of the Mara River in collaboration with GIZ and NBI-NELSAP.

Project Name: The Environmental and Social Impact Assessment (ESIA) the proposed solar photovoltaic facility and transmission in Cuamba

Client: WSP

Personal position / role on project: Project Manager.

Location: Mozambique

Main project features: To conduct a single season terrestrial and aquatic ecological baseline and impact assessment for the proposed dam. The study was required to meet national and IFC requirements, including a Critical Habitat assessment.

Project Name: A biodiversity baseline assessment for the proposed Siguiri Gold Mine Project, in Kankan Province, Guinea.

Client: SRK Consulting.

Personal position / role on project: Project Manager.

Location: Siguiri, Guinea, West-Africa (2018).

Main project features: To conduct a dual season ecological baseline assessment for the expected impact footprint area. The study was required to meet national and IFC requirements, including a Critical Habitat assessment.

Project Name: A biodiversity baseline and impact assessment for the proposed Lesotho Bulk Water Supply Scheme, Lesotho.

Client: WSP.

Personal position / role on project: Wetland & Aquatic Ecologist, PROBFLO and Project Manager.

Location: Mohale's Hoek, Lesotho (2018).

Main project features: To conduct a dual season terrestrial and aquatic ecological baseline and impact assessment for the pipeline route and proposed weir. The study was required to meet national and IFC requirements, including a Critical Habitat assessment. The study also contributed to prescribing Instream Flow Requirements using PROBFLO for the system.

Project Name: A biodiversity baseline and impact assessment for the proposed Pavua Hydropower Project, in Sofala Province, Central Mozambique.

Client: Mott MacDonald.

Personal position / role on project: Project Manager.

Location: Sofala Province, Mozambique (2017).

Main project features: To conduct a dual season terrestrial and aquatic ecological baseline and impact assessment for the expected impact footprint area, including Gorongosa National. The study was required to meet national and IFC requirements, including a Critical Habitat assessment. The study also contributed to prescribing Instream Flow Requirements for the system.

EMPLOYMENT EXPERIENCE

CURRENT EMPLOYMENT: The Biodiversity Company (January 2015 – Present)

I founded The Biodiversity Company in 2015, now consisting of experienced ecologists who provide technical expertise and policy advice to numerous sectors, such as mining, agriculture, construction and natural resources. The team at The Biodiversity Company have conducted stand-alone specialist studies, and provided overall guidance of studies with a pragmatic approach for the management of biodiversity that takes into account all the relevant stakeholders, most importantly the environment that is potentially affected. We manage risks to the environment to reduce impacts with practical, relevant and measurable methods.

EMPLOYMENT: Digby Wells Environmental (October 2013 – December 2014)

Digby Wells assigned me to the role of Country Manager for the united Kingdom. This was a new endeavour for the company as the company's global footprint continues to increase. The primary responsibilities for the role included the following:

- **Client liaison** to be able to interact more efficiently and personally with current mining clients, mining industry service providers, legal firms and banking institutions in order to introduce Digby Wells as a services provider with the aim of securing work.
- **Project management** for international projects which may require a presence in the united Kingdom, this was dependent on the location and needs of the client. These

projects would mostly be based on the Equator Principles (EP) and International Finance Corporation (IFC) Performance Standards.

- **Technical input** to provide specialist technical expertise for projects, this included fauna, aquatic ecology, wetlands and rehabilitation. Continued with the design and implementation of Biodiversity and Land Management Plans to assist clients with managing the natural resources. Responsibilities also included the mentorship and management (including reviewing and guiding) other expertise such as flora, fauna and pedology.

EMPLOYMENT: Digby Wells Environmental (March 2012 – September 2013)

Manager of a multi-disciplinary department of scientists providing specialist services in support of national and international requirements as well as best practice guidelines, primarily focussing on the mining sector. In addition to managing the department, I was also expected to contribute specialist services, most notably focusing on water resources. Further responsibilities also included the management of numerous projects on a national or international scale. A general overview of the required responsibilities are as follows:

- **Project management** for single as well as multi-disciplinary studies on a national and international scale. This included legislation and commitments for the respective country being operated in, as well as included the World Bank (WB), EP and IFC requirements.
- **Individual and/or team management** in order to provide mentoring and supportive structures for development and growth in support of the company's strategic objectives.
- **Scientific report writing** to ensure that the relevant standards and requirements have been attained, namely local country legislation, as well as WB, EP and IFC requirements.
- **Report reviewing** in order to ensure compliance and consideration of relevant legislation and guidelines and also quality control.
- **Specialist management** to facilitate the collaboration and integration of specialist skills for the respective projects. This also included the development of Biodiversity and Land Management Plan for clients.
- **Client Resource Manager** for numerous clients in order to establish as well as maintain working relationships.

An overview of the tenure working with the company is provided below**:**

- **October 2013 – December 2014: London Operations Manager** – Deployed to establish a presence for the company (remote office) in the united Kingdom by means of generating project work to support the employment of staff and operation of a business structure.
- **March 2012 – September 2013: Biophysical Department Manager** – Responsible for the development and growth of the department to consist of four specialist units. This included the development of a new specialist unit, namely Rehabilitation.
- **January 2011 - February 2012: Ecological unit Manager** – In addition to implementing aquatic and wetland specialist services, the role required the overall management of additional specialist services which included fauna & flora.
- **June 2010 - December 2010: Aquatic Services Manager** – This required the marketing and implementation of specialist programmes for the client base such as biomonitoring and wetland off-set strategies. In addition to this, this also included expanding on the existing skill set to include services such as toxicity, bioaccumulation and ecological flow assessments.
- **August 2008: Aquatic ecologist** – Employed as a specialist to establish the aquatic services within the company. In addition to this, wetland specialist services were added to the existing portfolio.

PREVIOUS EMPLOYMENT: Econ@UJ (University of Johannesburg)

- June 2007 – July 2008: Junior aquatic ecologist

- Researcher
- Technical assistant for fieldwork
- Reporting writing
- Project management

ADDITIONAL EXPERIENCE

Compliance audits	Conducting site investigations in order to determine the level of compliance attained, ensuring that the client maintains an appropriate measure of compliance with environmental regulations by means of a legislative approach
Control officer	Acting as an independent Environmental Control Officer (ECO), acting as a quality controller and monitoring agent regarding all environmental concerns and associated environmental impacts
Screening studies	Project investigations in order to determine the level of complexity for the environmental and social studies required for a project. This is a form of risk assessment to guide the advancement of the project.
Public consultation	The provision of specialist input in order to communicate project findings as well as assist with providing feedback if and when required.
Water use licenses	Consultation with the relevant authorities in order to establish the project requirements, as well as provide specialist (aquatics/wetland) input for the application in order to achieve authorisation.
Closure	Primarily the review of closure projects, with emphasis on the closure cost calculations. Support was also provided by assisting with the measurements of structures during fieldwork.
Visual	The review of visual studies as well as the collation of field data t considered for the visual interpretation for the project.

ACADEMIC QUALIFICATIONS

University of Johannesburg, Johannesburg, South Africa (2009): MAGISTER SCIENTIAE (MSc) - Aquatic Health:

Title: *Aspects of the biology of the Bushveld Smallscale Yellowfish (Labeobarbus polylepis): Feeding biology and metal bioaccumulation in five populations.*

Rand Afrikaans University (RAU), Johannesburg, South Africa (2004): BACCALAUREUS SCIENTIAE CUM HONORIBUS (Hons) – Zoology

Rand Afrikaans University (RAU), Johannesburg, South Africa (2001 - 2004): BACCALAUREUS SCIENTIAE IN NATURAL AND ENVIRONMENTAL SCIENCES. Majors: Zoology and Botany.

PUBLICATIONS

Mahomed D, Husted A, Fry C, Downsa CT and O'Brien GC. 2019. Spatial shifts and habitat partitioning of ichthyofauna within the middle-lower region of the Pungwe Basin, Mozambique, Journal of Freshwater Ecology, 34:1, 685-702, DOI: 10.1080/02705060.2019.1673221

Tate RB and Husted, A. 2015. Aquatic Biomonitoring in the upper reaches of the Boesmanspruit, Carolina, Mpumalanga, South Africa. African Journal of Aquatic Science.

Tate RB and Husted A. 2013. Bioaccumulation of metals in *Tilapia zillii* (Gervai, 1848) from an impoundment on the Badeni River, Cote D'Iviore. African Journal of Aquatic Science.

O'Brien GC, Bulfin JB, Husted A. and Smit NJ. 2012. Comparative behavioural assessment of an established and new Tigerfish (*Hydrocynus vittatus*) population in two manmade lakes in the Limpopo catchment, Southern Africa. African Journal of Aquatic Science.

Tomschi, H, Husted, A, O'Brien, GC, Cloete, Y, Van Dyk C, Pieterse GM, Wepener V, Nel A and Reisinger U. 2009. Environmental study to establish the baseline biological and physical conditions of the Letsibogo Dam near Selebi Phikwe, Botswana. EC Multiple Framework Contract Beneficiaries.8 ACP BT 13 – Mining Sector (EDMS). Specific Contract N° 2008/166788. Beneficiary Country: Botswana. By: HPC HARRESS PICKEL CONSULT AG

Husted A. 2009. Aspects of the biology of the Bushveld Smallscale Yellowfish (*Labeobarbus polylepis*): Feeding biology and metal bioaccumulation in five populations. The University of Johannesburg (Thesis).