ABO Wind Renewable Energies (Pty) Ltd

Ujekamanzi 2 Wind Energy Facility and Associated Infrastructure near Ermelo, Mpumalanga Province

Shadow Flicker Report

DFFE Reference: TBC
Report Prepared by: Kelly Armstrong and Chris Dalgliesh
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ABO Wind Renewable Energies (Pty) Ltd

Ujekamanzi 2 Wind Energy Facility and Associated Infrastructure near Ermelo, Mpumalanga Province

Shadow Flicker Report

EXECUTIVE SUMMARY

ABO Wind Renewable Energies (Pty) Ltd (ABO Wind) proposes to develop Ujekamanzi 2 Wind Energy Facility (WEF), on-site substation(s), Battery Energy Storage Systems (BESS), associated grid infrastructure and internal roads, roughly 30 km south of Ermelo, in the Dr Kixley Ka Isaka Seme Local Municipality, in the Mpumalanga Province (the project). The WEF is anticipated to have a maximum output of ~325 MW over a developable area of ~2 872 ha extending over roughly 54 properties.

SRK Consulting (South Africa) (Pty) Ltd (SRK) has been appointed by SiVEST (SA) (Pty) Ltd (SiVEST) to undertake a Shadow Flicker Impact Assessment (FIA) to inform the required Environmental Impact Assessment (EIA) process required in terms of the National Environmental Management Act 107 of 1998 (NEMA) conducted by SiVEST for Ujekamanzi 2 WEF.

There are no South African legislative requirements and/or thresholds relating to shadow flicker, therefore international guidelines have been used to inform sensitivities and the assessment of impacts in this report.

The proposed project area is gently undulating, with two perennial watercourses draining the area. The vegetation on affected properties appear to be used to cultivation and grazing, and have therefore been largely transformed from the original vegetation extent which largely comprised of grassland plains.

The area around the WEF properties is rural and predominantly characterised by agricultural activities, infrastructure (roads and rail) and interspersed farmsteads. The 54 properties that constitute the project site are largely undeveloped, appear to be used for used for cultivation and grazing.

Potentially sensitive receptors have been identified based on the surrounding land uses and through a desktop-based search. Residents and motorists were identified as potentially sensitive receptors. 84 dwellings were identified within and in close proximity to the project area for Ujekamazi 2 WEF. The N11 borders the project site and several regional and farm roads also traverse the site.

After the buildable areas were identified the potential receptors were further refined to exclude receptors not located within 10x the rotor diameter from the buildable area (i.e. potential locations for WTG)[1], reducing the number of potentially sensitive receptors to 45.

The modelling of shadow flicker will be undertaken prior to the EIA Phase of the project, as the preliminary locations of the WTG are still to be determined. It is expected that some of the identified receptors will experience shadow flicker to some degree. The number of affected receptors and the degree to which they are affected will be confirmed once the modelling has been completed.

[1] Based on the guideline that shadow flicker is negligible beyond 10x rotor diameters from the WTG (Department of Energy & Climate Change, 2011).

It is possible to reduce the duration and / or experience of shadow flicker by implementing the following mitigation measures:

- Mitigation at affected receptors: provision of blinds, shutters or curtains;
- Mitigation on the pathway: provide screening, such as vegetation, close to the affected receptors; and
- Mitigation at the source: shut down turbines at times where shadow flicker exceeds thresholds.

No other approved or operational WEFs have been identified within 30 km of the proposed site. Therefore it is assumed that there is currently no shadow flicker experienced by the receptors in the region. However, should Ujekamanzi 1 WEF be constructed on the neighbouring properties, it is anticipated that potentially affected receptors may experience an increased duration of shadow flicker.

NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998) AND ENVIRONMENTAL IMPACT REGULATIONS, 2014 (AS AMENDED) - REQUIREMENTS FOR SPECIALIST REPORTS (APPENDIX 6)

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	**Section of Report**
1. (1) A specialist report prepared in terms of these Regulations must contain- a) details of- i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	1.3
b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page 6
c) an indication of the scope of, and the purpose for which, the report was prepared;	1
(cA) an indication of the quality and age of base data used for the specialist report;	1.4.3
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	6
d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	1.4.3
e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	1.4
f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	To be included in FIA
g) an identification of any areas to be avoided, including buffers;	5.4.1
h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	N/A
i) a description of any assumptions made and any uncertainties or gaps in knowledge;	2
j) a description of the findings and potential implications of such findings on the impact of the proposed activity, (including identified alternatives on the environment) or activities;	To be included in FIA
k) any mitigation measures for inclusion in the EMPr;	6.1.1

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	**Section of Report**
l) any conditions for inclusion in the environmental authorisation;	7
m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	6
n) a reasoned opinion- i. (as to) whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	To be included in FIA
o) a description of any consultation process that was undertaken during the course of preparing the specialist report;	N/A
p) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
q) any other information requested by the competent authority.	N/A
2) Where a government notice *gazetted* by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Ujekamanzi 2 Wind Energy Facility and Associated Infrastructure near Ermelo, Mpumalanga Province

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	SRK Consulting (South Africa) (Pty) Ltd			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	1	Percentage Procurement recognition	135%
Specialist name:	Kelly Armstrong			
Specialist Qualifications:	BSocSc (Hons) Environmental Science			
Professional affiliation/registration:	N/A			
Physical address:	183 Main Road, Albion Spring Close, Rondebosch, 7700			
Postal address:	Postnet Suite #206, P. Bag X18, Rondebosch, 7701			
Postal code:	7700	Cell:	076 114 9254	
Telephone:	021 659 3060	Fax:	086 530 7003	
E-mail:	karmstrong@srk.co.za			

2. DECLARATION BY THE SPECIALIST

I, ____Kelly Armstrong_____, 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 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

SRK Consulting (South Africa) (Pty) Ltd

Name of Company:

Date:

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, _____ Kelly Armstrong _____, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

SRK Consulting (South Africa) (Pty) Ltd

Name of Company

Date

Signature of the Commissioner of Oaths

Date

ABO Wind Renewable Energies (Pty) Ltd

Ujekamanzi 2 Wind Energy Facility and Associated Infrastructure near Ermelo, Mpumalanga Province

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Appendix A: Specialist CV

Glossary of Terms

This list contains definitions of symbols, units, abbreviations, and terminology that may be unfamiliar to the reader.

Affected Environment / Baseline	Information gathered at the beginning of a study which describes the environment prior to development of a project and against which predicted changes (impacts) are measured.
Construction Phase	The stage of project development comprising site preparation as well as all construction activities associated with the development.
Decommissioning Phase	The last phase in the lifetime of a facility following their design, construction and operation.
Environmental Authorisation	Permission granted by the competent authority for the applicant to undertake listed activities in terms of the NEMA EIA Regulations, 2014.
Impact	A change to the existing environment, either adverse or beneficial, that is directly or indirectly due to the development of the project and its associated activities.
Operational Phase	The stage of works following the construction phase, during which the development will function or be used as anticipated in the Environmental Authorisation.
Shadow Flicker	The effect of the sun (low on the horizon) shining through the rotating blades of a wind turbine, casting a moving shadow.
Receptors	Potential viewers (individuals or communities) who are subjected to the influence (i.e. shadow flicker) of a project.

List of Abbreviations

ABO Wind	ABO Wind Renewable Energies (Pty) Ltd
amsl	Above mean sea level
BESS	Battery Energy Storage System
DFFE	Department of Forestry, Fisheries and the Environment
EA	Environmental Authorisation
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
FIA	Flicker Impact Assessment
NEMA	National Environmental Management Act 107 of 1998
PV	Photovoltaic
REDZ	Renewable Energy Development Zone
SiVEST	SiVEST (SA) (Pty) Ltd
SRK	SRK Consulting (South Africa) (Pty) Ltd
ToR	Terms of Reference
UK	United Kingdom
US	United States
WEF	Wind Energy Facility
WTG	Wind Turbine Generators

ABO Wind Renewable Energies (Pty) Ltd

Ujekamanzi 2 Wind Energy Facility and Associated Infrastructure near Ermelo, Mpumalanga Province

Shadow Flicker Report

1. INTRODUCTION

ABO Wind Renewable Energies (Pty) Ltd (ABO Wind) proposes to develop Ujekamanzi 2 Wind Energy Facility (WEF), on-site substation(s), Battery Energy Storage Systems (BESS), associated grid infrastructure and internal roads, roughly 30 km south of Ermelo, in the Dr Pixley Ka Isaka Seme Local Municipality, in Mpumalanga Province (the project - Figure 1-1)[2]. The WEF is anticipated to have a maximum output of ~325 MW over a developable area of ~2 872 ha extending over roughly 54 properties. Internal 33 kV powerlines installed overhead or underground will evacuate power produced by the wind turbine generators (WTG) to the on-site substation hubs.

SRK Consulting (South Africa) (Pty) Ltd (SRK) has been appointed by SiVEST (SA) (Pty) Ltd (SiVEST) to undertake a Shadow Flicker Impact Assessment (FIA) to inform the required Environmental Impact Assessment (EIA) process required in terms of the National Environmental Management Act 107 of 1998 (NEMA) conducted by SiVEST for Ujekamanzi 2 WEF.

1.1 Scope and Objectives

Since shadow flicker is only caused by the operation of WTG, this report will mainly be focused on the WTG components of the project.

As the preliminary WTG locations have not been determined yet this report describes the baseline and the potential shadow flicker impacts and proposes high level mitigation measures, to inform the Scoping Report.

Once the preliminary WTG locations have been identified, this report will be updated to produce the FIA describing the baseline, shadow flicker modelling, assessment of impacts associated with the project and identification of effective and practicable mitigation measures. The FIA will be compiled in terms of Appendix 6 of the EIA Regulations, 2014 and will inform the EIA process required in terms of NEMA.

[2] ABO Wind also proposes to develop Ujekamanzi 1 WEF and associated infrastructure. Ujekamanzi 1 WEF will be subject to a separate EA Application. Both properties combined will have a developable area of 5 744 ha and a combined output of 650 MW over a total of 108 properties. For the purposes of this report it is assumed that these specifications are split equally between both projects.

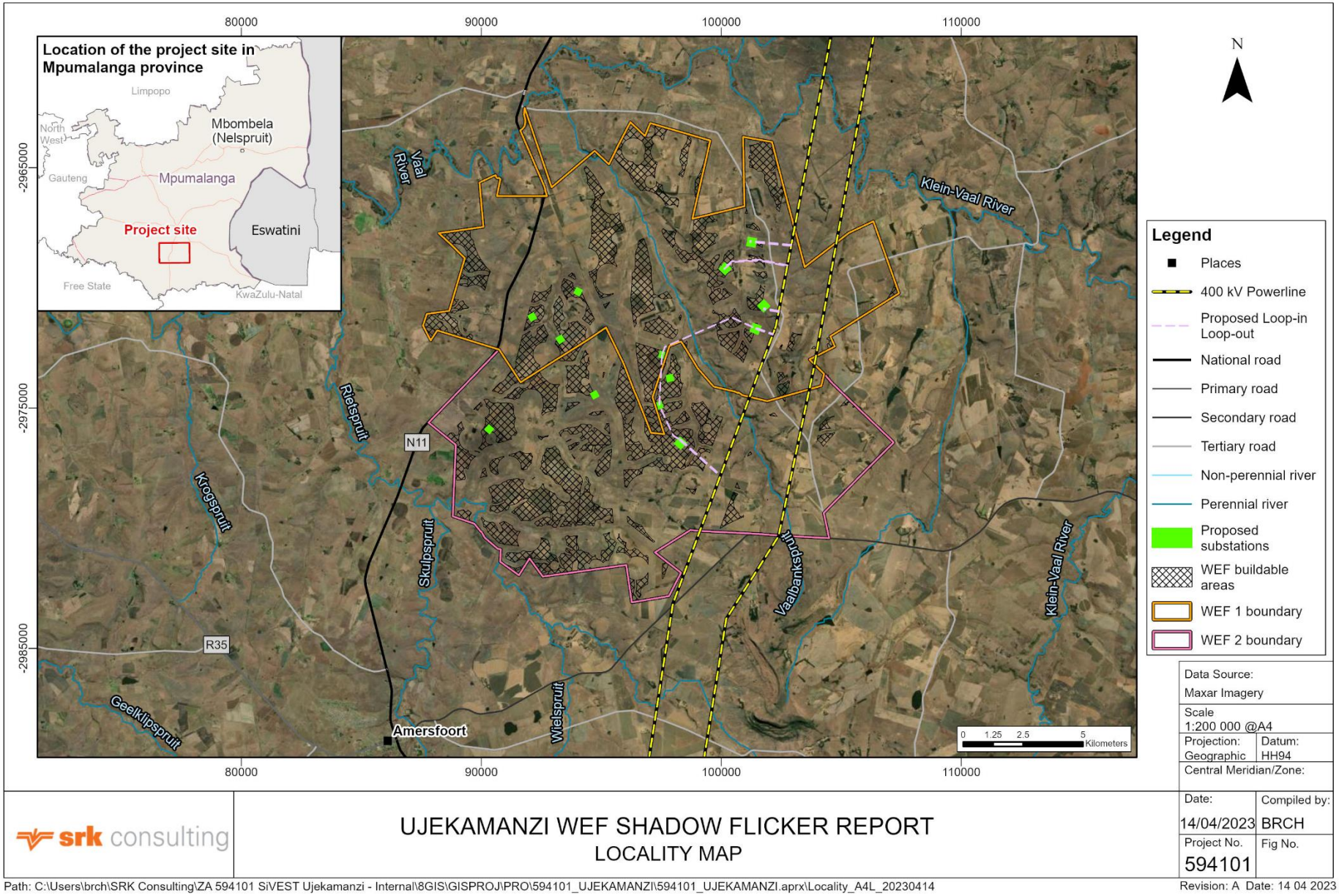

Figure 1-1: Locality map

1.2 Terms of Reference

The Terms of Reference (ToR) for the FIA report (to be compiled after this Shadow Flicker Report) are as follows:

- Describe the baseline environmental conditions of the study area;
- Identify potential shadow flicker receptors;
- Conduct shadow flicker modelling;
- Identify potential shadow flicker impacts associated with the WEF;
- Assess the direct, indirect and cumulative shadow flicker impacts of the WEF using SiVEST's prescribed impact assessment methodology;
- Recommend practicable mitigation measures to minimise / reduce impacts and monitoring requirements; and
- Compile a FIA compliant with Appendix 6 of the EIA Regulations, 2014 and relevant guidelines, where applicable.

1.3 Specialist Credentials

The report was conducted by personnel listed in Table 1-1.

Table 1-1: FIA staff

Staff	Role	Qualification
Christopher Dalgliesh	Project Review and Director	Chris Dalgliesh is a Partner and Principal Environmental Consultant with over 35 years' experience, primarily in South Africa, Southern Africa, West Africa and South America (Suriname). Chris has worked on a wide range of projects, notably in the natural resources, Oil & Gas, waste, infrastructure (including rail and ports) and industrial sectors. He has managed and regularly reviews Visual Impact Assessments. He has directed and managed numerous Environmental and Social Impact Assessments (ESIAs) and associated management plans, in accordance with international standards. He regularly provides high level review of ESIAs, frequently directs Environmental and Social Due Diligence studies for lenders, and also has a depth of experience in Strategic Environmental Assessment, State of Environment Reporting and Resource Economics. He holds a BBusSci (Hons) and M Phil (Env) and is a registered Environmental Assessment Practitioner.
Kelly Armstrong	Specialist Consultant	Kelly Armstrong is an Environmental Consultant at SRK Consulting. She has four years' experience in managing Basic Assessment, Environmental Impact Assessment and Water Use Authorisation processes and acting as an Environmental Control Officer in the renewable energy, residential, aquaculture, marine and mining sectors.

		She also manages and contributes to Visual Impact Assessments for infrastructure, renewable energy and mining projects. Kelly holds a BSocSc (Hons) in Environmental and Geographical Studies from the University of Cape Town.

1.4 Assessment Methodology

1.4.1 Approach

The approach to and reporting of the shadow flicker study comprises three major, phased elements:

- Describe the baseline environmental conditions (i.e. affected environment);
- Model and analysis of shadow flicker results and identification of potential impacts; and
- Assess potential impacts.

The modelling and analysis of shadow flicker and the assessment thereof will be included in the FIA, once the preliminary WTG locations have been identified.

The receiving environment (baseline) will affect the occurrence and experience of shadow flicker. As such, environmental elements such as topography, vegetation, land use and potential receptors are described.

The magnitude of shadow flicker varies spatially and temporally and depends on environmental conditions as well as timing (time of day and year), durations WTG will operate, wind direction, WTG and blade dimensions, surrounding land use and receptor distance and direction in relation to the WTG. The modelling and analysis of shadow flicker is further described in Section 1.4.2.

Potential shadow flicker impacts for the operational phase are identified. Once the shadow flicker modelling has been conducted, the significance of the impacts will be assessed using the prescribed impact rating methodology, which includes the rating of:

- Impact consequence, determined by extent, duration and magnitude/intensity of impact;
- Impact probability;
- Impact significance, determined by combining the ratings for consequence and probability; and
- Confidence in the significance rating.

The significance rating methodology is described in more detail in Appendix B.

High level mitigation measures to avoid and/or reduce the significance of negative impacts, or to optimise positive impacts, are identified. Impact significance will be re-assessed assuming the effective implementation of mitigation measures.

1.4.2 Method

The following method was used to assess the affected environment (baseline) and potential impacts and mitigation measures for the project:

1. Describe the project using information supplied by the proponent and EIA team;

2. Collect and review data, including data on topography, vegetation cover, land use and other background information;
3. Identify sensitive receptors; and
4. Identify potential shadow flicker impacts and mitigation measures.

Shadow flicker modelling can be conducted once the preliminary WTG locations have been determined - prior to the EIA Phase. The following method will be used to assess the shadow flicker impact of the project in the FIA:

1. Determine the exposure by superimposing the wind turbine generators on aerial imagery;
2. Conduct shadow flicker modelling;
3. Rate potential shadow flicker impacts on the environment and receptors based on professional opinion and the SiVEST impact rating methodology; and
4. Recommend practicable mitigation measures to avoid and/or minimise impacts.

1.4.2.1 Shadow Flicker Modelling Methodology

Shadow flicker (experienced as “light variation”) occurs when the sun passes behind the turbine and casts a shadow over a constrained opening, such as window (Department of Energy & Climate Change, 2011). As the blades rotate, shadows pass over the same point causing shadow flicker (World Bank Group, 2015) (see Figure 1-2). This flicker can impact on receptors located in close proximity to wind turbines or have specific orientation in relation to the WEF.

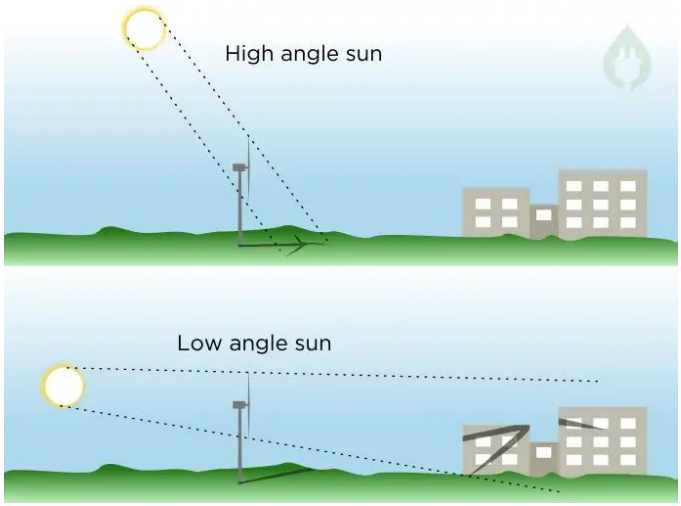

Figure 1-2: Illustration of shadow flicker

Source: energyfollower.com

Shadow flicker will be modelled using the WindPro software package. WindPro performs the calculations to establish the average shadow hours per year at particular receptors. The model will be calibrated to produce ‘worst-case’ results which assumes no clouds, the wind direction is aligned with the direction of the turbine and receptor and that the WTG is constantly operational.

The input data required to model shadow flicker includes:

- WTG specifications – hub height and rotor/blade diameter;

- WTG locations; and
- Receptor locations and specifications.

1.4.3 Data Acquisition

This report has been compiled based on the review of desktop information. No site visit was conducted.

The following information sources were used to inform the baseline and potential impacts:

- Maps indicating the developable area of the project;
- Topographic data, including spatial files with 5 m contours obtained from the Department of Rural Development and Land Reform;
- Aerial images; and
- Other available data pertaining to geology, vegetation, land use, receptors etc.

The information is sufficiently recent and detailed to provide appropriate inputs into the report.

2. ASSUMPTIONS AND LIMITATIONS

As is standard practice, this report is based on a number of assumptions and is subject to certain limitations, which should be borne in mind when considering information presented in this report. These assumptions and limitations include:

- The study is based on technical information supplied to SRK, which is assumed to be accurate. This includes the proposed site and project components;
- The study area is defined as the area within a 2 km radius of the site, as the shadow flicker impact beyond this distance is considered negligible[3];
- There are no South African guidelines or legislated requirements for shadow flicker, therefore, literature other international legislation and guidelines have been used in this report;
- The assessment of receptor-based impacts has been based on the project details, including the buildable area and turbine dimensions, provided by ABO Wind. The buildable area and / or turbine sizes may change, which may require a re-assessment of the shadow flicker impacts on identified receptor locations; and
- This study does not provide motivation for or against the project.

The findings of this report are not expected to be affected by these assumptions and limitations.

3. TECHNICAL DESCRIPTION

This section provides a concise description of the proposed project as provided at the time of compiling this report, focusing on elements relevant to shadow flicker. The general project description may still be refined, and a more detailed description is provided in the Scoping Report for the project.

[3] Shadow flicker is considered negligible beyond 10x rotor diameter from the WTG (Department of Energy & Climate Change, 2011).

3.1 Project Location

ABO Wind is proposing to construct the Ujekamanzi 2 WEF, BESS and on-site substation(s), roughly 30 km south of Ermelo, in the Dr Pixley ka Isaka Seme Local Municipality, in the Mpumalanga Province (Figure 1-1). The siting of the proposed buildable areas (~2 872 ha) within the property boundaries has been informed by environmental constraints and buffers provided by specialists (Section 5.4.1).

This project is not located within one of the 11 Renewable Energy Development Zones (REDZ). The REDZ are geographically defined areas in which the South African Government has encouraged the development of Photovoltaic (PV) and WEF projects by promulgating a streamlined authorisation approach. As such, the REDZ have become areas in which the development of WEF projects is considered more acceptable.

3.2 Project Description

The project will compromise of the following components:

- Roughly 32 WTGs, each with an output of up to 10 MW;
- On-site substation with a footprint of up to 19 ha, including BESS with a footprint of up to ~5 ha;
- Access and internal roads with a width of up to 10 m;
- Temporary laydown area during the construction phase for the construction camp and laydown area;
- Infrastructure including offices, operational control centre, operation and maintenance area, ablution facilities etc.;
- Grid connection infrastructure including 33 kV cabling installed underground (where possible) between the WTG and the on-site substation; and
- Perimeter fencing.

The preliminary locations of the WTG will be provided and assessed (in the FIA) prior to the EIA phase. The footprint of each WTG is dependent on the type / model of WTG used, but is estimated to be ~1 ha. The dimensions of the relevant components of the WTG, shown in Figure 3-1, are listed in Table 3-1 below.

Table 3-1: WTG components dimensions

WTG Component	Dimension
Hub height (from ground)	Up to 180 m
Rotor diameter	Up to 200 m
Blade length	Up to 100 m

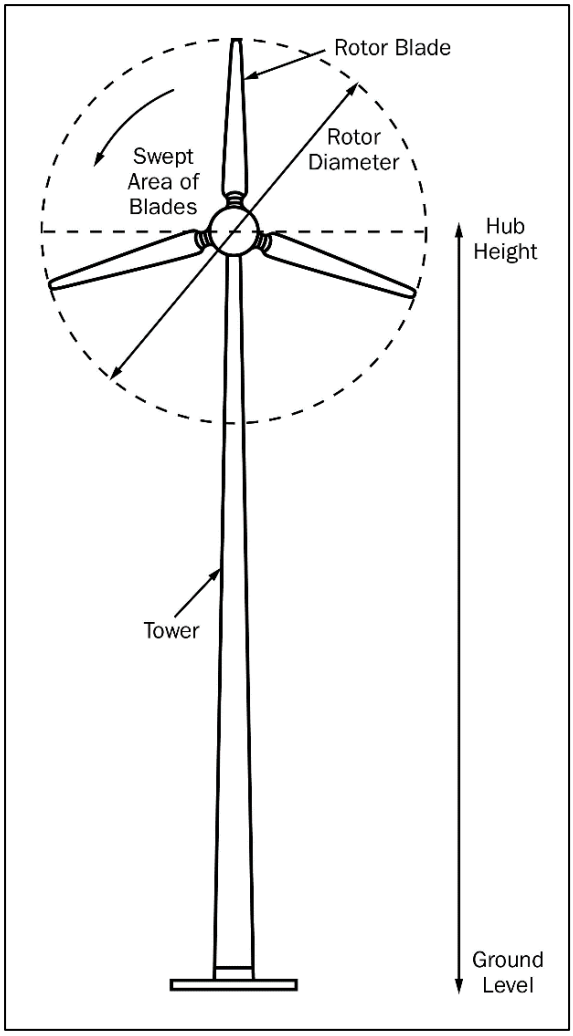

Figure 3-1: Components of a WTG

Source: (Ontario.ca, 2018)

3.2.1 No Go Alternative

The No-Go alternative is the option of not undertaking the development of the proposed WEF. Hence, if the No-Go option is implemented, there would be no development. This alternative would result in no environmental impacts from the proposed project on the site or the surrounding local area. It provides the baseline against which other alternatives are compared and will be considered throughout the report.

4. LEGAL REQUIREMENTS AND GUIDELINES

4.1 South Africa

Shadow flicker is a recognised impact associated with the operation of WTG, however there are no South African legal requirements, guidelines or stipulated thresholds relating to shadow flicker, nor content requirements for shadow flicker reports.

4.2 International Guidelines

Guidelines have been released in the United Kingdom (UK) and shadow flicker threshold levels have been published in various European countries (Department of Energy & Climate Change, 2011). The shadow flicker limit adopted in Northern Ireland, Republic of Ireland, Germany and Belgium is 30 hours per year with a maximum of 30 minutes per day. It is also generally accepted that the impact of shadow flicker beyond 10 rotor diameters is very low (Department of Energy & Climate Change, 2011).

The Best Practice Guidance to Planning Policy Statement 18 'Renewable Energy' released by the Republic of Ireland's Department of Environment recommends that WTG are located at least 500m from neighbouring offices and dwellings (Department of the Environment, 2009).

Stipulated ordinances for numerous counties and towns in the United States (US) recommend setback distances relating to the placement of WTG in relation to public roads (NREL, 2008). Setback distances of 1 – 5x the hub height from public roads is stipulated, where setbacks are required. The most common setback required is 1.5x the hub height (NREL, 2008).

4.3 World Bank

The World Bank Group issue industry-specific Environmental, Health and Safety (EHS) Guidelines that include Good International Industry Practice. The World Bank EHS Guidelines for Wind Energy recognise shadow flicker as a potential impact associated with onshore WEFs (World Bank Group, 2015). The EHS Guidelines state that shadow flicker experienced at a sensitive receptor must not exceed 30 hours per year and 30 minutes per day on the worst affected day, based on a worst case scenario (World Bank Group, 2015).

4.4 Adopted Guidelines for this Project

Noting that there are no legislated requirements and / or thresholds relating to shadow flicker in South Africa, SRK applies lies the following guidelines to inform sensitivities and assessment of impacts in this report:

- WTG should be setback from public roads by a distance 1.5x the hub height[4];
- WTG should be set back at least 500 m from neighbouring offices and dwellings;
- Receptors located beyond 10 rotor/blade diameters from the WTG are not considered sensitive receptors; and
- Shadow flicker may not exceed 30 hours per year and 30 minutes per day on the worst affected day, based on a worst case scenario.

[4] Due to the rural setting of the proposed project a setback of roughly 1.5x the hub height (i.e. 180m X 1.5 = 270 m, rounded to 300m) was applied.

5. DESCRIPTION OF THE RECEIVING ENVIRONMENT

5.1 Geology and Topography

The topography of the affected properties and surrounding region is gently undulating landscape. Perennial watercourses drain the area.

The Vaalbankspruit River bisects the WEF and the Wetspruit River borders the WEF to the west and traverses the western portion of the WEF. The site generally slopes from east to west with the landscape rising to 1 750 m above mean sea level (amsl) in the eastern portions of the site. The elevation generally decreases thereafter to the west to the lowest point at 1 550 m amsl.

Topography beyond the site is characterised in a similar way, however isolated eminences are located to the south (~1 950.1 m amsl) and north-east (~1 850.1 m amsl) of the site.

5.2 Vegetation

The project is located within the original extent of Amersfoort Highveld Clay Grassland vegetation type which extends in a north-south band from just south of Ermelo to Memel, a town on the border of the Free State Province and KwaZulu-Natal Province.

This vegetation type comprises grassland plains with scattered dolerite outcrops and is largely dominated by red grass *(Themeda triandra)* which ranges in height from 0.3 – 1.5 m (SANBI, 2004).

From GoogleEarth Street View, it appears that the vegetation is largely transformed because of agricultural activity for cultivation and grazing. The vegetation in the project area is predominantly low growing, apart from isolated clusters of trees which are expected to have been introduced to the area or are found within the riparian zones of watercourses which traverse the site.

Figure 5-1: Vegetation on either side of the N11 looking north

Figure 5-2: Riparian zone and vegetation adjacent to the N11

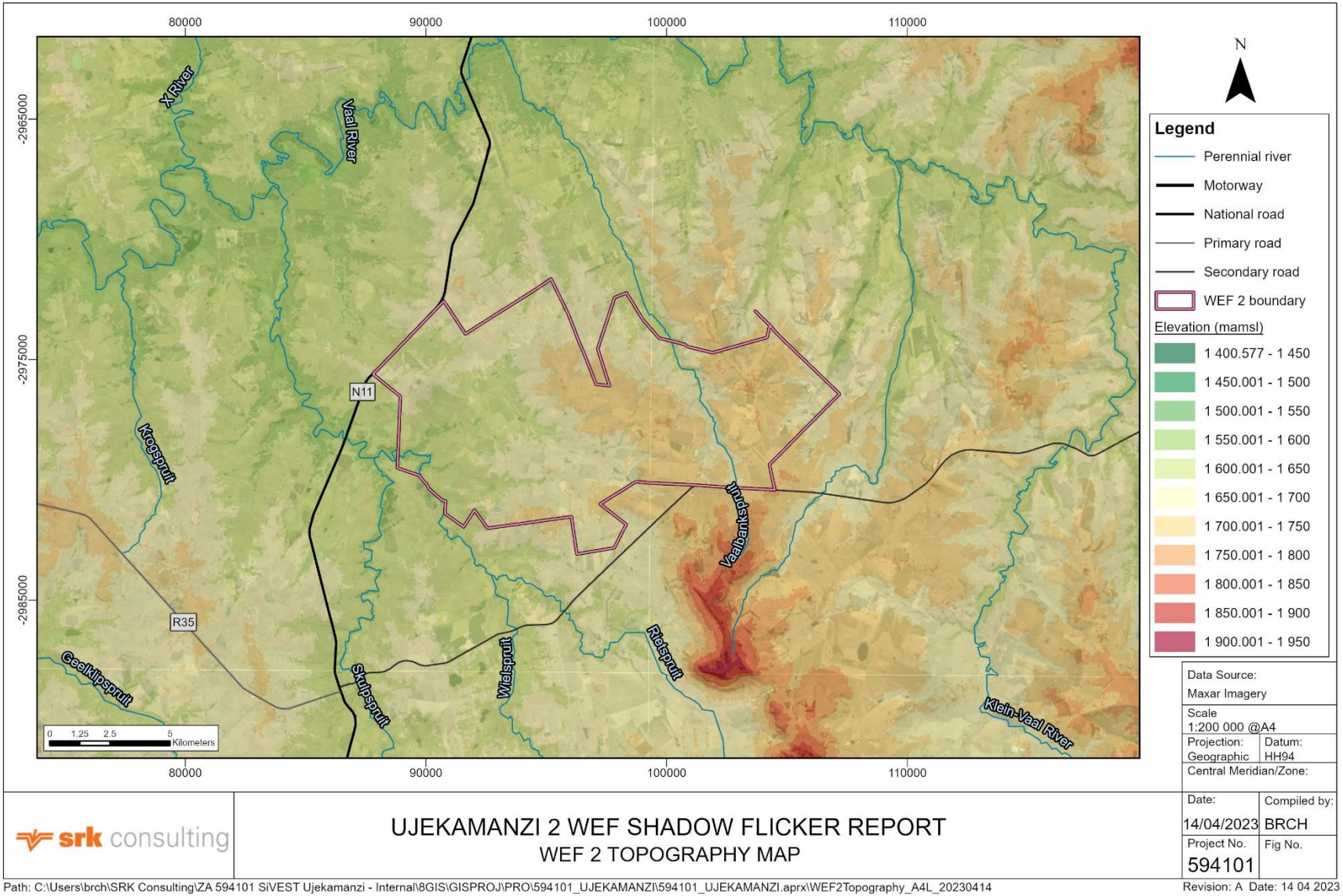

Figure 5-3: Topography map

5.3 Land Use

The area around the WEF properties is rural and predominantly characterised by agricultural activities, infrastructure (roads and rail) and interspersed farmsteads. Agriculture, mainly livestock farming and cultivation, is the predominant land use surrounding the site, with farmsteads throughout the area. The N11 connects the towns of Ermelo and Amersfoort to the north and south of the proposed project area, respectively, and borders Ujekamanzi 2 WEF to the north-west. Small (low voltage) powerlines are routed adjacent to the N11.

Three approved PV projects are located within a 30 km radius of the site and have a total generation capacity of ~195 MW according to data made available by the Department of Forestry, Fisheries and the Environment (DFFE) South African Renewable Energy EIA Application Database. From the examination of aerial imagery these facilities do not appear to be operational.

The 54 properties that constitute the project site are largely undeveloped, and appear to be used for cultivation and grazing.

5.4 Receptors

Potentially sensitive receptors were identified based on surrounding land uses and through a desktop-based search primarily using GoogleEarth aerial imagery. The following receptors were identified:

- **Residents**: 84 dwellings and / or farmsteads were identified within and in close proximity to the project area for Ujekamanzi 2 WEF; and
- **Motorists:** The N11 national road borders Ujekamanzi 2 WEF to the north-west. Several regional and farm roads also traverse the Ujekamanzi 2 WEF.

5.4.1 Sensitivity of Receptors

The identified buildable area was informed by, *inter alia,* areas sensitive to shadow flicker. The areas identified as being sensitive to shadow flicker were based on the location of potential receptors; i.e. residents and motorists. The following buffers, informed by international guidelines, were considered when defining the buildable area:

- 300 m[5] from public roads – based on the guideline that WTG should be setback from public roads by a distance 1.5x the hub height; and
- 500 m from offices and houses - based on the Best Practice Guidance to Planning Policy Statement 18 'Renewable Energy'.

After the buildable areas were identified, the potential receptors were refined to exclude receptors not located within 10x the rotor diameter from the buildable area (i.e. potential locations for WTG)[6], reducing the number

[5] The WTG expected hub height of the WTG is 180 m

[6] Based on the guideline that shadow flicker is negligible beyond 10x rotor diameters from the WTG (Department of Energy & Climate Change, 2011).

of potentially sensitive receptors to 45. The location of these receptors is shown in

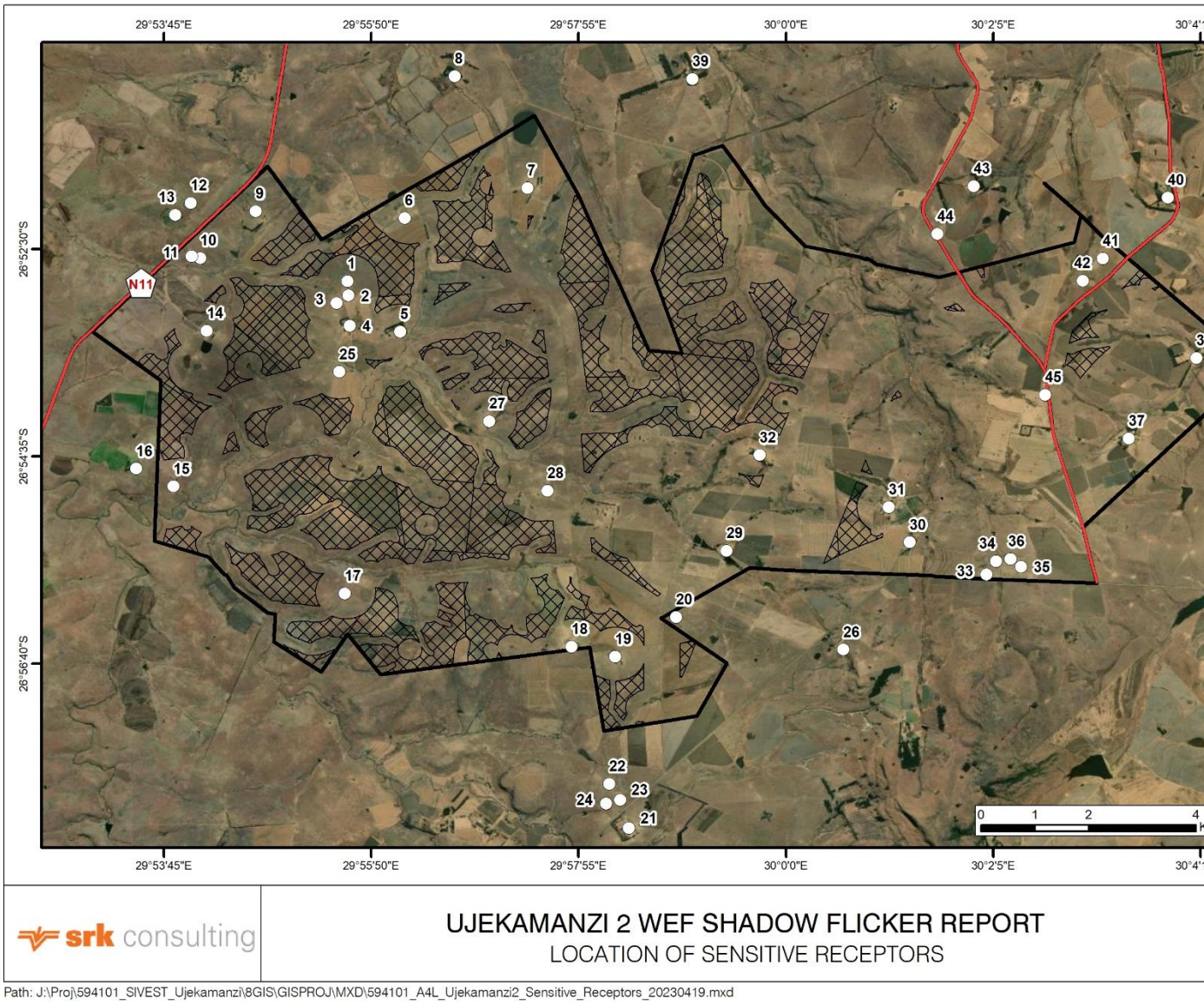

Figure 5-4.

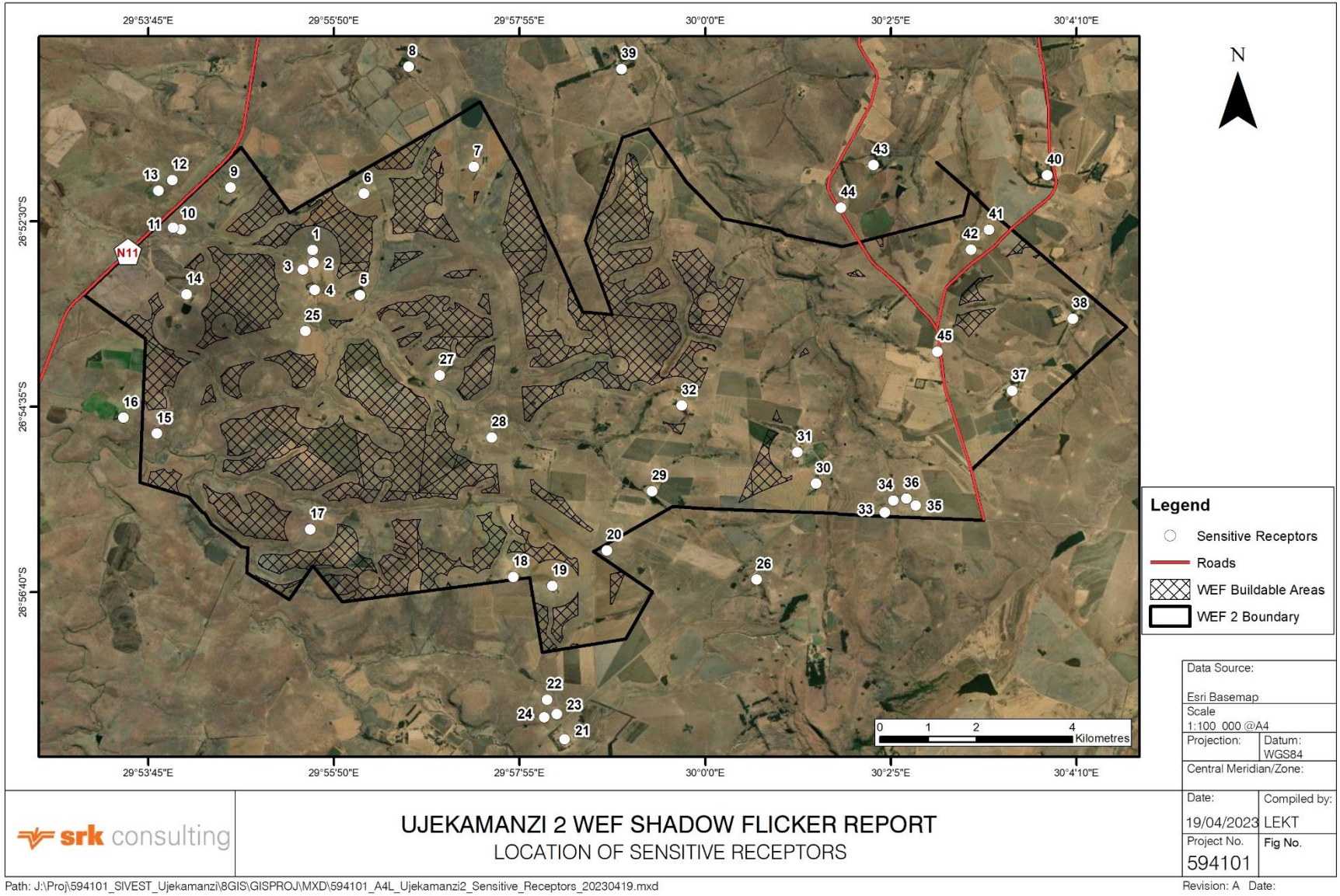

Figure 5-4: Location of sensitive receptors

6. PRELIMINARY IDENTIFICATION AND ASSESSMENT OF IMPACTS

The following section describes the potential[7] impacts anticipated during the operational phases, since shadow flicker impacts will not occur during the construction and / or decommissioning phases.

Possible measures to avoid, mitigate or compensate impacts will be considered and recommended, depending on the severity of impacts and the feasibility of measures.

6.1 Operational Phase

6.1.1 Light Variation caused by Shadow Flicker from the WTG

Light variation caused by shadow flicker is likely to present as a nuisance to receptors rather than having a significant impact on human health. Research from the UK indicate that less than 5% of photo-sensitive epileptics[8] are sensitive to the lowest frequencies; 2.5 – 3 Hz (Verkuijlen & Westra, 1984). Commercial wind turbines generally rotate at a frequency of between 0.3 – 1.0 Hz (Department of Business Enterprise and Regulatory Reform, 2007), and are therefore not expected to affect photo-sensitive epileptics.

The avoidance of, *inter alia*, areas / receptors sensitive to shadow flicker when defining the developable area for the project has effectively screened out fatal flaws (i.e. unacceptably high impacts) associated with shadow flicker. The shadow flicker modelling and analysis (i.e. the number of affected receptors and the degree to which they are affected) scheduled to take place before the EIA Phase will inform the significance *rating* of the impact of shadow flicker on receptors.

Although shadow flicker modelling has not yet been undertaken, it is expected that some of the identified receptors will experience shadow flicker to some degree.

It is possible to reduce the duration and / or experience of shadow flicker by implementing the following mitigation measures:

- Mitigation at affected receptors: provision of blinds, shutters or curtains;
- Mitigation on the pathway: provide screening, such as vegetation, close to the affected receptors; and
- Mitigation at the source: shut down turbines at times where shadow flicker exceeds thresholds.

Shutting down turbines to prevent shadow flicker durations exceeding the thresholds is often not feasible from an operational perspective. Mitigation measures implemented at the receptor or on the pathway are generally considered more feasible, however require planning during the design and construction phase to ensure that the mitigation (e.g. blinds or vegetation screening) is in place at the start of the operational phase.

[7] Once the preliminary WTG locations have been determined and the shadow flicker modelled, the impacts will be finalised.

[8] Approximately 0.5 % of the UK's population suffers from epilepsy and between 3.5% and 5% of these are photo-sensitive (Department of Business Enterprise and Regulatory Reform, 2007).

6.2 Cumulative Impacts

6.2.1 Introduction

For the purposes of this report, cumulative impacts are defined as 'direct and indirect impacts that act together with existing or future potential impacts of other activities or proposed activities in the area / region that affect the same resources and / or receptors'.

For the most part, cumulative effects or aspects thereof are too uncertain to be quantifiable, due mainly to a lack of data availability and accuracy. This is particularly true of cumulative effects arising from potential or future projects, the design or details of which may not be finalised or available and the direct and indirect impacts of which have not yet been assessed.

For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognised as important on the basis of scientific concerns and/or concerns of affected communities, in this case effects of other WEF.

6.2.2 Cumulative Impacts Analysis

No other approved or operational WEFs have been identified within 30 km of the proposed site. Therefore it is assumed that shadow flicker is not currently experienced by the receptors in the region. However, should Ujekamanzi 1 WEF be constructed on the neighbouring properties, potentially affected receptors may experience an increased duration of shadow flicker.

The cumulative impact of Ujekamanzi 1 and 2 WEFs can only be considered once the shadow flicker modelling for both WEFs has been undertaken.

6.3 No-Go Alternative

The No Go alternative entails no change to the status quo, in other words, no WEF (see Section 3.2.1).

Should the application for the Ujekamanzi 2 WEF be refused the shadow flicker impacts will not be realised.

7. CONCLUSION

This shadow flicker report describes and interprets the context or affected environment in which the project is located.

The following findings are pertinent:

- ABO Wind propose to develop Ujekamanzi 2 WEF and associated grid infrastructure on roughly 54 properties, ~30 km south of Ermelo, in the Dr Pixley Ka Isaka Seme Local Municipality, in the Mpumalanga Province. The developable area is ~2 872 ha.
- The project site generally slopes from east to west with the landscape rising to 1 750 m amsl in the eastern portions of the site and decreasing to 1 550 m amsl in the west. Watercourses that drain the area bisect and border the site. Isolated eminences are located to the south and north-east of the site.

- The original vegetation type on the project site is Amersfoort Highveld Clay Grassland, which largely comprises grassland plains with dolerite outcrops. It appears that the vegetation is largely transformed because of agricultural activity for cultivation and grazing.
- The land use on and around the site is rural and predominantly used for agricultural activities, infrastructure (roads and rail) and interspersed farmsteads. Only three approved PV projects are located within 30 km radius of the site. These PV projects do not appear to have been constructed.
- Potentially sensitive receptors have include 84 dwellings and / or farmsteads and motorists on the N11 and several regional and farm roads.
- The developable area for WTG is set back 300 m from public roads and 500 m from offices and / or dwellings, thereby screening out potential shadow flicker fatal flaws.
- Based on the guideline that stipulates the shadow flicker beyond 10x the rotor diameter is considered negligible, the number of receptors was reduced to 45.
- Shadow flicker caused by the rotating WTG blades can only occur when a WTG is operating during the operational phase.
- Light variation caused by shadow flicker is likely to present as a nuisance to receptors rather than having a significant impact on human health. Research indicates that wind turbines rotate too slowly for the frequency of light variation to affect photo-sensitive epileptics.
- It is anticipated that some of the identified receptors will experience shadow flicker impacts, however the duration of exposure and the number of receptors affected can only be confirmed once shadow flicker modelling has taken place.
- Mitigation measures to reduce the duration and / or experience of shadow flicker include:
    - Provision of blinds, shutters or curtains to affected receptors;
    - Provision of screening, such a vegetation, close to the affected receptors; and
    - Shut down turbines at times where shadow flicker exceeds thresholds.
- No other approved or operational WEFs have been identified within 30 km of the proposed site. Therefore it is assumed that shadow flicker is not currently experienced by the receptors in the region. However, should Ujekamanzi 1 WEF be constructed on the neighbouring properties, it is anticipated that potentially affected receptors may experience an increased duration of shadow flicker.

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Appendix A: Specialist CV