PROPOSED DEVELOPMENT OF THE 15MW LEEUWBOSCH 3 SOLAR PHOTOVOLTAIC (PV) PLANT AND ASSOCIATED INFRASTRUCTURE NEAR LEEUDORINGSTAD, NORTH WEST PROVINCE

DESKTOP GEOTECHNICAL REPORT

MAY 2022

REVISION 00

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VERIFICATION PAGE

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Rev 14

TITLE:

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SYNOPSIS

Desktop geotechnical investigation for the proposed 15MW Leeuwbosch 3 Solar PV Plant.

KEY WORDS:

Bearing Pressure, Foundations, Geology.

QUALITY VERIFICATION

This report has been prepared under the controls established by a quality management system that meets the requirements of ISO 9001: 2015 which has been independently certified by DEKRA Certification.

Quality Management ISO 9001 www.dekra-seal.com DEKRA Certified

Verification	Capacity	Name	Signature	Date
By Author	Associate Geotechnical	K Singh Pr.Sci.Nat.	KSingh	06/05/2022
Checked & Authorised by:	Director Geotechnical	J Norris Pr.Eng.	J.C Norris	06/05/2022

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National Environmental Management Act, 1998 (Act No. 107 of 1998) and Environmental Impact Regulations 2014 (as amended) Requirements for Specialist Reports (Appendix 6)

Section in EIA Regulations 2014 (as amended)		**Clause**	**Section in Report**
Appendix 6	(1)	A specialist report prepared in terms of these Regulations must contain —	
	(a)	details of –	
		(i) the specialist who prepared the report; and	Verification Page
		(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae.	Appendix C
	(b)	A declaration that the person is independent in a form as may be specified by the competent authority;	Appendix C
	(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;	4, 5, 6, 11
	(cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Table 8-1
	(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	N/A
	(e)	A description of the methodology adopted in preparing the report or carrying out the specialized process; inclusive of equipment and modelling used;	1
	(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;	Appendix A Figure 1, 2, 3, 4
	(g)	An indication of any areas to be avoided, including buffers;	Appendix A Figure 1, 2, 3, 4
	(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;	Appendix A Figure 1, 2, 3, 4
	(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;	3, 4, 5, 6, 7
	(k)	Any mitigation measures for inclusion in the EMPr;	Table 8-1
	(l)	Any conditions for inclusion in the environmental authorization;	Table 8-1
	(m)	Any monitoring requirements for inclusion in the EMPr or environmental authorization;	Table 8-1
	(n)	A reasoned opinion –	
		(i) as to whether the proposed activity, activities or portions thereof should be authorized;	10
		(iA) regarding the acceptability of the proposed activity or activities; and	10
		(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorized, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Table 8-1
	(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	None
	(q)	Any other information requested by the 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

PROPOSED DEVELOPMENT OF THE 15MW LEEUWBOSCH 3 SOLAR PHOTOVOLTAIC (PV) PLANT AND ASSOCIATED INFRASTRUCTURE NEAR LEEUDORINGSTAD, NORTH WEST PROVINCE

DESKTOP GEOTECHNICAL REPORT

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EXECUTIVE SUMMARY

This desktop level study presents the findings concluded for the proposed 15MW Leeuwbosch 3 Solar PV Plant situated in the North-West Province. The study area receives a relatively low mean annual precipitation of 588mm, with the warmest month being January. The study area is underlain by the Allanridge Formation part of the Ventersdorp Supergroup, which comprises amygaloidal lava. The Ventersdorp Supergroup is predominantly an accumulation of andesitic to basaltic lavas with related pyroclastic rocks. Regional hydrogeological information indicate an intergranular and fractured aquifer type, with median borehole yields in the range of 0.5-2.0l/s. The desktop study indicates no fatal flaws from a preliminary and geological and geotechnical assessment. The impact of the development from a geotechnical perspective will be restricted to the removal and displacement of soil, boulders and bedrock. The impact assessment matrix impact of the 15MW Leeuwbosch 3 Solar PV Plant was found to be "Negative low impact - The anticipated impact will have negligible negative effects and will require little to no mitigation." The site, from a desktop level geotechnical study is considered suitable for the proposed PV Facility.

PROPOSED DEVELOPMENT OF THE 15MW LEEUWBOSCH 3 SOLAR PHOTOVOLTAIC (PV) PLANT AND ASSOCIATED INFRASTRUCTURE NEAR LEEUDORINGSTAD, NORTH WEST PROVINCE

DESKTOP GEOTECHNICAL REPORT

1 INTRODUCTION

This geotechnical report presents the findings of a desktop study undertaken by JG Afrika (Pty) Ltd, for the proposed 15MW Leeuwbosch 3 Solar PV Plant situated in the North-West Province. It is understood that a desktop level geotechnical report is required as part of an environmental submission for a basic assessment (BA) report being undertaken by SiVEST SA (Pty) Ltd. The proposed development is located approximately 6km north-east of the town of Leeudoringstad. The proposed development is located within the Maquassi Hills Local Muncipality within Dr Kenneth Kaunda District Municipality.

The proposed 15MW Leeuwbosch 3 Solar PV Plant will be located on the following property:

- Portion 37 of the Farm Leeuwbosch No. 44

The key components to be constructed are listed below:

Solar PV arrays:

- The proposed solar PV plant will include PV fields (arrays) comprising multiple PV modules.
- PV panel mountings, PV panels will be single axis tracking mounting and the modules will be either crystalline silicon or thin film technology.
- Each PV module will be approximately 2274mm (≈2.3m) long and 1134mm (≈1.1m) wide and mounted on supporting structures above ground. It is anticipated that the structures will be mono-facial modules. The final design details will become available during the detailed design phase of the proposed development, prior to the start of construction.
- The foundations will most likely be either concrete or rammed piles. The final foundation design will be determined at the detailed design phase of the proposed development.

Switching Substation:

- The proposed development will include the construction of one (1) new on-site switching substation with a capacity of more than 33kV but less than 275kV. The switching substation will occupy an area of up to approximately 0.2ha.
- The switching substation will contain transformer(s) for voltage step-up from medium voltage to high voltage. DC power from the modules will be converted into AC power in the inverters and the voltage will be stepped up to medium voltage in the inverter transformers.

- Medium voltage cabling (anticipated to be approx. 0.8m x 0.6m wide at this stage) will link the various PV arrays to the switching substation, as well as the Leeudoringstad Solar Plant Substation. These cables will be laid underground, wherever technically feasible.

Access Roads:

- Access to the facility will be via an existing gravel road which connects to the tarred R502 road.
- Existing internal gravel access roads will be used to access the PV arrays as well as the switching substation.
- New internal gravel roads of up to approximately 4m wide may however be constructed, where necessary.

- One (1No.) permanent guard house, occupying a site of approximately 0.0876ha (i.e. 876m2);
- Fencing will surround the entire proposed solar PV plant. At this stage it is anticipated that the fencing will be approximately 2.1m high and will be made of galvanised steel with electrification on top. In addition, fencing is anticipated to cover an area of up to approximately 18ha.

Temporary infrastructure:

- To obtain water from available local sources, existing boreholes will be utilised. Water will potentially be stored in temporary water storage tanks. The necessary approvals from the Department of Water and Sanitation (DWS) will be applied for separately (should this be required
- One (1No.) temporary building zone which will occupy a site of up to approximately 0.2944ha (i.e. 2 944m2).

1.1 Scope of works

The investigation seeks to give a desktop evaluation of the proposed study site. The objectives of the desktop were to assess the geological and geotechnical conditions across the study area.

This involved a literature review and a review of topographic and geological maps. Consideration was given to, but not limited to the following from a desktop level:

- The influence of topography on site suitability.
- The envisaged geological and geotechnical influences on the competency of foundations for the construction of structures.
- Tectonic influences on overall stability, namely the presence of faulting, lineaments and preferred discontinuity orientations.
- Comments regarding likely founding conditions, geotechnical constraints, problem areas and overall site stability from a desktop level.
- Recommendations regarding requirements for subsequent detailed geotechnical investigations.

1.2 Terms of Reference

The appointment to proceed with the investigation is based upon JG Afrika's cost estimate email referenced, "Quotation for a Desktop Geotechnical Report for the Proposed Leeudoringstad Solar PV5 Project," dated 5th of November 2021. JG Afrika received the appointment via a sub-consultancy agreement letter referenced, "17420: Leeuwbosch PV3 Facility."

1.3 Specialist Credentials

Mr. Singh is a professionally registered and qualified engineering geologist, attaining a Master of Science Degree in Engineering Geology, from the University of KwaZulu-Natal (UKZN).

Mr. Singh holds the position of Associate at JG Afrika's Pietermaritzburg branch. He has experience in the various fields of earth science and ground engineering, namely: engineering geology, geotechnical engineering, environmental geology and geophysics.

1.4 Assessment Methodology

The methodology entailed a literature review and a review of topographic and geological maps. Consideration was given to the terrain, geological, hydrogeology and envisaged geotechnical constraints.

An Environmental Impact Assessment matrix was provided by SiVEST:

- 16343_SiVEST Impact Rating Table_Ver1_20190128 AG

2 ASSUMPTIONS, LIMITATIONS, UNCERTAINTIES - DISCLAIMER

The interpretation of the overall geotechnical conditions across the site are based on observations and point information acquired from a desktop level. Subsurface and geotechnical conditions intermediate to these have been inferred by extrapolation, interpolation and professional judgement. The information and interpretations are given as a guideline only. There is no guarantee that the information given is totally representative of the entire area in every respect and no responsibility will be accepted for consequences arising out of the fact that actual conditions vary from those inferred.

3 TECHNICAL DESCRIPTION

3.1 Project Location

The 15MW Leeuwbosch 3 Solar PV Plant is situated 6 km north-east of the town of Leeudoringstad. The site is buffered in the south by the R502 and a gravel access track to the west.

A Locality Plan is presented as Figure 1, which is included in **Appendix A**.

3.2 Topography and Land Use

The topography on site indicates a flat terrain with an elevation value of 1315m above sea level.

A Site Map and Slope map is presented as Figure 2 and Figure 3 respectively, which is included in **Appendix A**.

3.3 Climate

The study area is characterized by a dry climate with a “BSk” classification according to the Köppen-Geiger climate classification. Leeudoringstad receives a mean annual precipitation of 588 mm. The average lowest rainfall is received in July (6 mm) and the highest in January (103 mm), which is a seasonal variation of 97 mm.

The average maximum midday temperature for Leeudoringstad ranges from 23.2°C in January to 9.5°C in July, which is a seasonal variation of 13.7°C.

Table 3-1 below summarizes the climatic conditions.

Table 3-1: Summary of Climatic Conditions, Leeudoringstad (information extracted from “Climate-Data.org”)

Months	Average Rainfall (mm)	Temperature (°C)		
		Maximum	Minimum	Average
January	103	30.2	16.3	23.2
February	93	28.6	15.8	22.2
March	80	27	13.7	20.3
April	50	24.4	9.5	16.9
May	23	21.4	5	13.2
June	8	18.2	1.2	9.7
July	6	18.3	0.7	9.5
August	10	21.4	2.9	12.1
September	16	24.9	7.4	16.1
October	51	27.8	11.3	19.5
November	67	28.5	13.6	21
December	81	29.3	15.2	22.4

3.4 Drainage

The proposed PV plant is located within the C25A quaternary catchment. This catchment receives a mean annual precipitation of 542mm over an area of 863m^2.

The Leeudoringspruit River buffers the southern extremity and the Klipspruit River buffers the northern extremity of the site which falls outside the study site.

3.5 Vegetation

The regional biome within which the study site is located is classed as a Dry Highveld Grassland Bioregion. Vaal-Vet sandy grassland can be anticipated.

4 GEOLOGY

According to the 1: 250 000 Geological Map of Kroonstad (2726) compiled by the Council for Geoscience (2000). The study area is underlain by the Allanridge Formation which forms part of the Ventersdorp Supergroup, which comprises amygaloidal lava. The Ventersdorp Supergroup is predominantly an accumulation of andesitic to basaltic lavas with related pyroclastic rocks (Brink, 1979).

A Geological Map is presented as Figure 4, which is included in **Appendix A**.

No structural lineaments in the form of dykes or faults were observed during the review of Geological Maps and aerial photography.

5 ENGINEERING GEOLOGY

Brink (1979), recognised that the occurrence of the Ventersdorp Supergroup within South Africa falls within three distinct climatic zones. The PV Plant study site is located within an area classed as a sub-humid dry zone, in which the soils are potentially expansive. In this climate zone where residual soils have developed, the profiles are not deeper than 12m depth (Brink, 1979).

According to the regional contour map of climatic N-values for Southern Africa by Weinert (1980), the Weinert N-Value of the study site is between 5 and 6. Where gradients are absolutely flat, waterlogging may occur. Deep weathering profiles can be anticipated in certain climatic environments and where montmorillonite is the principal clay mineral. This clay mineral is formed from decomposing basic crystalline rock, montmorillonite is the final decomposition product where climatic N-Value is between 2 and 5 (Weinert, 1980).

The upper 2 m of the residual profile is red or reddish brown in colour, which may contain abundant ferruginous concretions and may be densely cemented by ferricrete. Below this the profile can be a yellow coloured clayey silt can be anticipated which merges into an olive green coloured soil with depth. This typical colour sequence is indicative of well-drained soils in basic igneous rocks (Brink, 1979).

Investigations in Klerksdorp have shown that heaving conditions can be expected in the residual lava profiles. Indicator tests conducted on the Ventersdorp lavas by Brink (1979), record mean plasticity index values in the range of 17 to 23, implying active soil properties.

Clay contents generally averaged 20-21% of the soil composition. More importantly, the clay contains smectite minerals such as montmorillonite, which is subject to shrink and swell upon moisture variations.

The presence of well-developed ferricrete hardpans of substantial thicknesses (1-2m) developed in the upper horizons is not uncommon in the Ventersdorp lavas. Hardpans reduces the effects of heaving, with structures founded on ferricrete recording minimal heave.

6 HYDROGEOLOGY

According to the 1: 500 000 scaled Hydrogeological Series map of Kroonstad (2726). The aquifer type is classed as an intergranular, fractured aquifer type. According to the hydrogeological map the groundwater table can be anticipated at transition zones, weathered zones and joints.

A Hydrogeological Map is presented as Figure 5, **Appendix A**.

Typical boreholes indicate moderate yields estimated in the range of 0.50-2.0 l/s. Regional groundwater quality test results indicate a conductivity value of 0.70 mS/m, indicating relatively non-corrosive groundwater attributes.

7 GEOTECHNICAL APPRAISAL

Soil activity may be influence by the presence of expansive soil conditions if deep, residual andesitic lava horizons are present. The presence of ferricrete hardpans may influence the depth of excavation during exploratory trial pitting.

Depending on site-specific considerations such as the topography and weathering extent of the bedrock. The andesitic bedrock may not be suitable material for construction use. This will have to be assessed during the detailed investigation. Competent founding conditions can be anticipated in the residual soil profile and in weathered bedrock conditions, which will have to be assessed during the detailed investigation.

8 GEOTECHNICAL IMPACT ASSESSMENT MATRIX

From a preliminary geological and geotechnical assessment, no fatal flaws have been identified.

8.1 Impact of the Project on the Geological Environment

The impact of the development from a geotechnical perspective will be restricted to the removal and displacement of soil, boulders and bedrock referred to in this report as “subsoils”. The levelling of areas to create building platforms will also result in the displacement and exposure of subsoils. These impacts will have a negative visual impact on the environment, which in some cases can be remediated.

The potential impact of the development on the terrain and geological environment, will be the increased potential for soil erosion, caused by construction activities and the removal of vegetation. Areas of concentrated surface flow conditions can be anticipated at PV Plants, resulting in gradual erosion of unconsolidated soil, during the operational life of the facility. This can result in the creation of preferential drainage features, unless remediated through proper engineering design (i.e stormwater drainage).

Based on the impact assessment matrix undertaken for this project, from a geotechnical perspective the impact of 15MW Leeuwbosch 3 Solar PV Plant was found to be “Negative low impact - The anticipated impact will have negligible negative effects and will require little to no mitigation.” The assessment impact assessment matrix is presented overleaf as Table 8-1.

The impact assessment criteria was developed by SiVEST and is included in **Appendix B**.

Table 8-1: Geotechnical Impact Assessment Matrix

Leeuwbosch PV3																				
ENVIRONMENTAL PARAMETER	**ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE**	**ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION**									**RECOMMENDED MITIGATION MEASURES**	**ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION**								
		E	**P**	**R**	**L**	**D**	**I / M**	**TOTAL**	**STATUS (+ OR -)**	**S**		**E**	**P**	**R**	**L**	**D**	**I / M**	**TOTAL**	**STATUS (+ OR -)**	**S**
Construction Phase																				
Removal of subsoils (soil, rock)	Displacement of natural earth material and overlying vegetation. 1) Increase in soil and wind erosion due to clearing of vegetation. 2)Construction and earthmoving vehicles may displace soil during operations. 3) Creation of drainage paths along access tracks. 4) Potential oil spillages from heavy plant. 6) Excessive dust.	1	3	2	2	2	2	20	-	Low Impact	Identify protected areas prior to construction. 1) Construction of temporary berms and drainage channels to divert surface water. 2)Minimize earthworks and fills. 3) Use existing road network and acess tracks. 4)Rehabilitation of affected areas (such as regrassing, mechanical stabilization). 5) Correct engineering design and	1	2	2	1	4	2	20	-	Low Impact

Leeuwbosch PV3																				
ENVIRONMENTAL PARAMETER	**ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE**	**ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION**									**RECOMMENDED MITIGATION MEASURES**	**ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION**								
		E	**P**	**R**	**L**	**D**	**I / M**	**TOTAL**	**STATUS (+ OR -)**	**S**		**E**	**P**	**R**	**L**	**D**	**I / M**	**TOTAL**	**STATUS (+ OR -)**	**S**
											construction of gravel roads and water crossings. 6) Correct construction methods for foundation installations. 7) Vehicle repairs to be undertaken in designated areas. 8) Control stormwater flow 9) Dust suppression									
Operational Phase																				
Removal of subsoils (soil, rock)	Displacement of natural earth material . 1) Increase in soil erosion due to concentrated flow received off PV Panels . 2) Potential oil spillages from maintainence vehicles. 3) Sedimentation of non-perennial features caused by soil erosion.	1	2	2	2	3	1	10	-	Low Impact	1) Use of existing roads and tracks. 2)Rehabilitation of affected areas (such as erosion control mats). 3) Correct engineering design and construction of roads and water crossings. 4) Vehicle repairs to be	1	3	2	2	3	2	22	-	Low Impact

Leeuwbosch PV3																				
ENVIRONMENTAL PARAMETER	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	S
											undertaken in designated areas. 5) Maintainence of stormwater system.									
Decommissioning Phase																				
Removal of subsoils (soil, rock)	Decommissioning of the structure will disturb the geological environment. 1) Increase in soil and wind erosion due to clearance of structures. 2)Construction and earthmoving vehicles will displace the soil. 3) Creation of drainage paths. 4) Potential oil spillages from vehicles. 5) Excessive sediments in non-perennial features.	1	4	2	1	1	3	27	-	Low Impact	1) Use of temporary berms and drainage channels to divert surface water during flooding. 2)Minimize earthworks and demolish footprints. 3) Use of existing roads and tracks. 4)Rehabilitation of affected areas (such as regrassing). 5) Develop a chemical spill response plan. 6)Develop dust and demolitation fly supression plan. 7) Vehicle repairs to be undertaken in	1	3	4	2	2	2	24	-	Low Impact

Leeuwbosch PV3																				
ENVIRONMENTAL PARAMETER	**ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE**	**ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION**									**RECOMMENDED MITIGATION MEASURES**	**ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION**								
		E	**P**	**R**	**L**	**D**	**I / M**	**TOTAL**	**STATUS (+ OR -)**	**S**		**E**	**P**	**R**	**L**	**D**	**I / M**	**TOTAL**	**STATUS (+ OR -)**	**S**
											designated areas. 8) Reinstate channelized drainage features.									
Cumulative																				
Removal of subsoils (soil, rock)	None							0			None							0		

9 GEOTECHNICAL COMPARATIVE ASSESSMENT OF ALTERNATIVES

No design and layout alternatives were considered and assessed as part of this geotechnical report. It is understood that the structures have been placed to avoid site sensitivities identified.

10 CONCLUSIONS AND RECOMMENDATIONS

The foregoing report presents the findings concluded from a desktop study undertaken for the proposed Leeuwbosch 3 Solar PV Plant.

No fatal flaws from a geotechnical perspective were identified during this desktop study. Conclusions presented in this report will have to be more accurately confirmed during the detailed geotechnical investigation phase. The impact of the Solar PV Facility was found to be “Negative low impact - The anticipated impact will have negligible negative effects and will require little to no mitigation.” The site from a desktop level geotechnical study is considered suitable for the proposed PV Plant.

It recommended that a detailed geotechnical investigation be undertaken during the detailed design phase of the project. The detailed geotechnical investigation must entail the following:

- Profiling and sampling exploratory trial pits to determine founding conditions for the PV modules, substation and pylons. Also to determine the subgrade conditions for internal roads and a materials investigation (if required);
- Thermal resistivity and electrical resistivity geophysical testing for electrical design and ground earthing requirements;
- Groundwater sampling of existing boreholes to establish a baseline of the groundwater quality for construction purposes;
- Dynamic Probe Super Heavy (DPSH) tests and rotary core drilling may be required depending on the soil profiles and imposed loads of the structures.

11 REFERENCES

- Brink. A.B.A (1983). Engineering Geology of Southern Africa: The Karoo Sequence. Volume 3. Building Publications: Cape Town.

- Climatic Data, Leeudoringstad. Accessed April 2022 from: https://en.climate-data.org

- COLTO (1998). Standard Specifications for Road and Bridge Works for State Road Authorities, Committee of Land Transport Officials, Published by the South African Institution of Civil Engineering.

- SANS 1200 D. Standardised Specification for Civil Engineering Construction, Section D: Earthworks. South African National Standards, (1990).

- Weinert (1980). The Natural Road Construction Materials of Southern Africa. Council for Scientific and Industrial Research : H & R Academica (Pty) Ltd.

- 1: 250 000 Geological Map Series (2726 Kroonstad). Published by the Council of Geoscience (2000).

- 1: 3 000 000 Groundwater Harvest Potential of the Republic of South Africa. Published by the Department of Water Affairs and Forestry.

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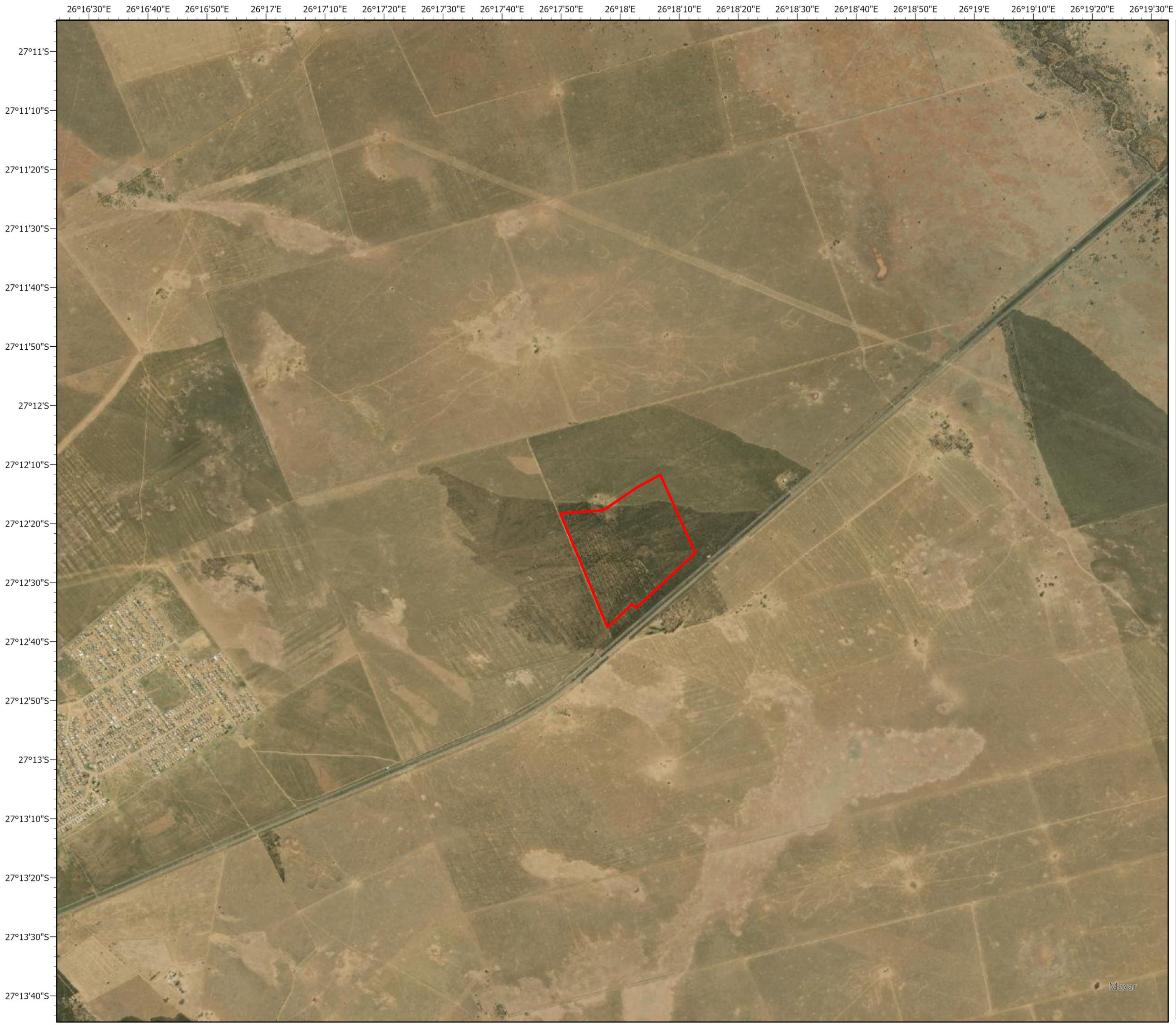
Appendix A: Figures



LEEUWBOSCH POLAR PV

LOCALITY MAP

Legend

Project Area

Production Date: 25 April 2022

0 0.15 0.29 0.59 0.89 1.18 Kilometers

N

SCALE

1: 18 944

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LEEUWBOSCH SOLAR PV

SITE MAP

Legend

Project Area

Production Date: 25 April 2022

0 0.03 0.05 0.1 0.15 0.2 Kilometers

N

SCALE

1:3 178

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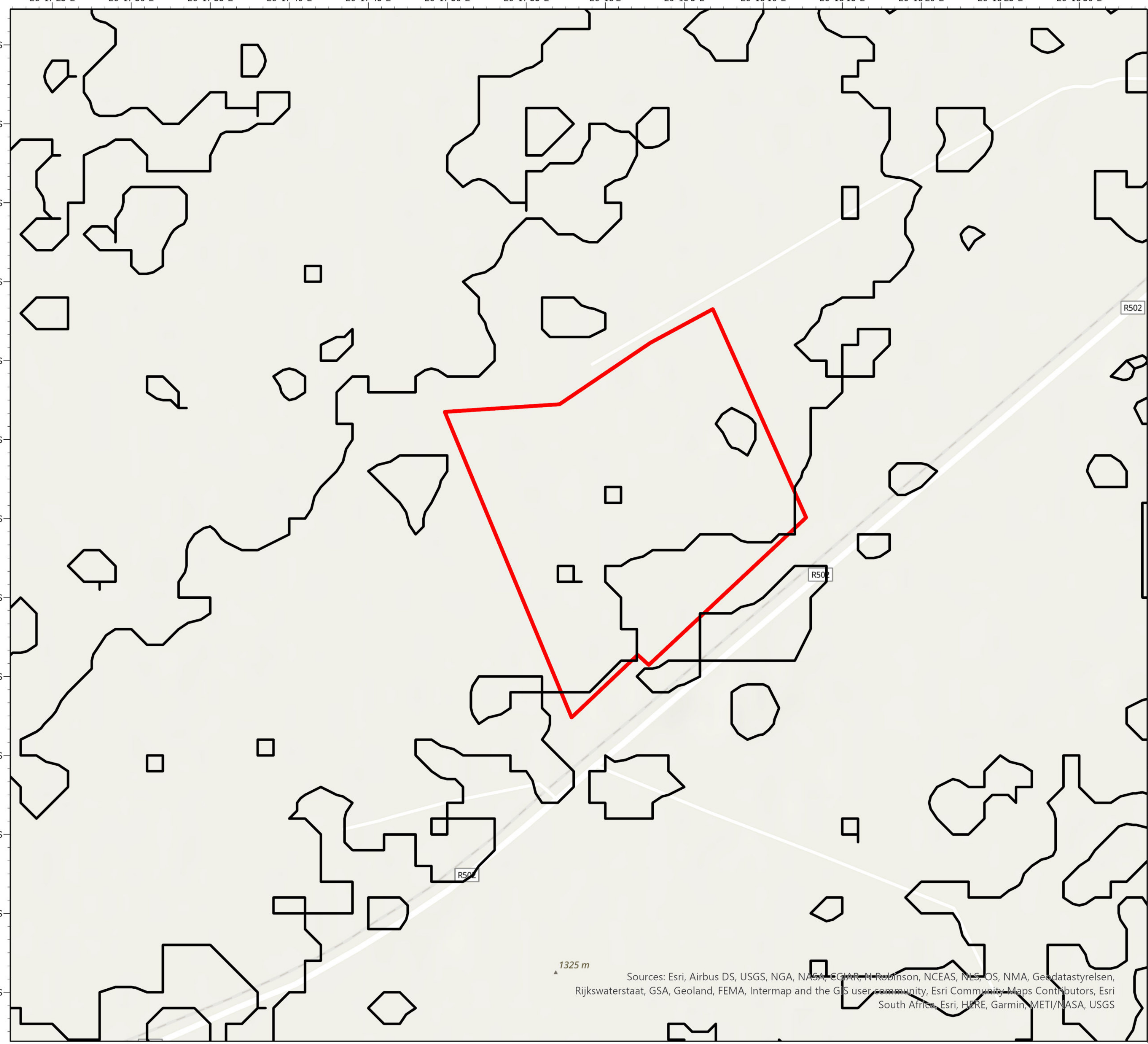

LEEUWBOSCH SOLAR PV

SLOPE MAP

Legend

- Project Area
- 5m contour

Production Date: 25 April 2022

0 0.06 0.12 0.23 0.35 0.46 Kilometers

N

SCALE

1: 7 294

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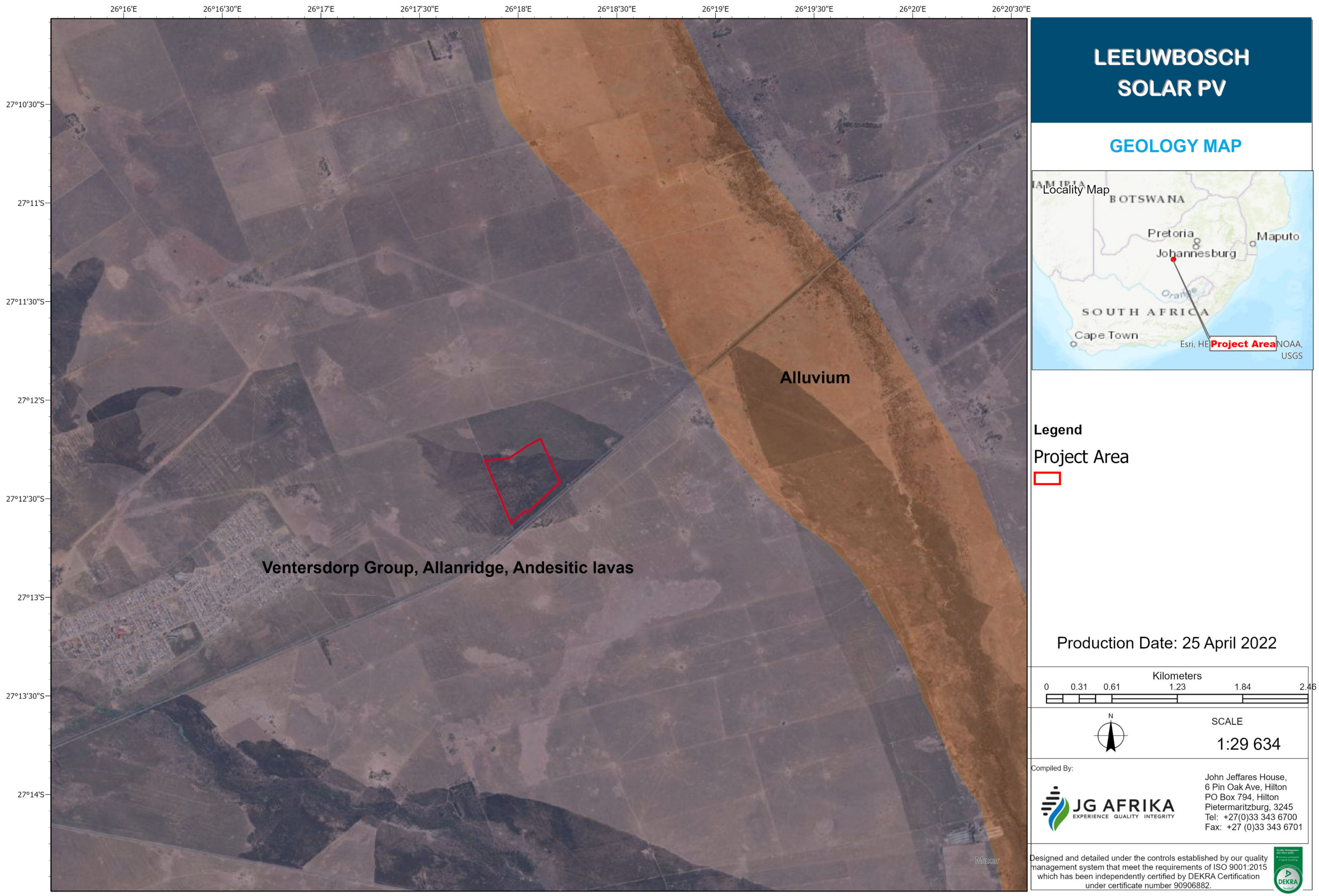

LEEUWBOSCH SOLAR PV
GEOLOGY MAP
Locality Map
BOTSWANA
Pretoria
Johannesburg
Maputo
SOUTH AFRICA
Cape Town
Project Area
Esri, HERE, NOAA, USGS
Alluvium
Ventersdorp Group, Allanridge, Andesitic lavas
26°16'E
26°16'30"E
26°17'E
26°17'30"E
26°18'E
26°18'30"E
26°19'E
26°19'30"E
26°20'E
26°20'30"E
27°10'30"S
27°11'S
27°11'30"S
27°12'S
27°12'30"S
27°13'S
27°13'30"S
27°14'S
Legend
Project Area
Production Date: 25 April 2022
Kilometers
0 0.31 0.61 1.23 1.84 2.46
N
SCALE
1:29 634
Compiled By:
JG AFRIKA
EXPERIENCE QUALITY INTEGRITY
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Designed and detailed under the controls established by our quality management system that meet the requirements of ISO 9001:2015 which has been independently certified by DEKRA Certification under certificate number 90906882.

LEEUWBOSCH POLAR PV

GEOHYDROLOGY MAP

Legend

Project Area

Production Date: 25 April 2022

0 0.23 0.46 0.92 1.38 1.84 Kilometers

N

SCALE

1: 29 600

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Appendix B: SiVEST Impact Assessment Methodology

Example

ENVIRONMENTAL PARAMETER - A brief description of the environmental aspect likely to be affected by the proposed activity e.g. Surface water	ISSUE / IMPACT / ENVIRONMENTAL EFFECT/ NATURE - A brief written statement of the environmental aspect being impacted upon by a particular action or activity e.g. oil spill in surface water.	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION									RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION								
		Extent [E] - The area over which the impact will be expressed	Probability [P] - The chance of occurrence of an impact	Reversibility [R] - The degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity	Irreplaceable loss of resources [I] - The degree to which resources will be irreplaceably lost as a result of a proposed activity	Duration [D] - The lifetime of the impact as a result of the proposed activity	Intensity / Magnitude [I / M] - A brief description of whether the impact has the ability to alter the functionality or quality of a system permanently or temporarily	TOTAL = Extent + probability + reversibility + irreplaceability + duration) x magnitude/intensity	STATUS (+ OR -)	Significance Rating [S] - A brief description of the importance of an impact which in turn dictates the level of mitigation required		E	P	R	L	D	I / M	TOTAL	STATUS (+ OR -)	
Construction Phase																				
Vegetation and protected plant species	Vegetation clearing for access roads, turbines and their service areas and other infrastructure will impact on vegetation and protected plant species.	2	4	2	2	3	3	39	-	Medium	**Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.**	2	4	2	1	3	2	24	-	Low
Operational Phase																				
Fauna	Fauna will be negatively affected by the operation of the wind farm due to the human disturbance, the presence of vehicles on the site and possibly by noise generated by the wind turbines as well.	2	3	2	1	4	3	36	-	Medium	**Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.**	2	2	2	1	4	2	22	-	Low
Decommissioning Phase																				
Fauna	Fauna will be negatively affected by the decommissioning of the wind farm due to the human disturbance, the presence and operation of vehicles and heavy machinery on the site and the noise generated.	2	3	2	1	2	3	30	-	Medium	**Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.**	2	2	2	1	2	2	18	-	Low
Cumulative																				
Broad-scale ecological processes	Transformation and presence of the facility will contribute to cumulative habitat loss and impacts on broad-scale ecological processes such as fragmentation.	2	4	2	2	3	2	26	-	Medium	**Outline/explain the mitigation measures to be undertaken to ameliorate the impacts that are likely to arise from the proposed activity. These measures will be detailed in the EMPr.**	2	3	2	1	3	2	22	-	Low

JG AFRIKA

Appendix C: Specialist’s CV

KEVAL SINGH

Profession	*Engineering Geologist*
Position in Firm	*Associate*
Area of Specialisation	*Engineering Geology, Geotechnical Engineering, Material Investigations, Engineering Geophysics, Project Management.*
Qualifications	*Pr.Sci.Nat., MSAIEG, MSc (Engineering Geology)*
Years of Experience	*10 Years*
Years with Firm	*9 Years*

SUMMARY OF EXPERIENCE

Mr. Singh is a professionally registered and qualified engineering geologist, attaining a Master of Science Degree in Engineering Geology, from the University of KwaZulu-Natal (UKZN).

Mr. Singh holds the position of Associate at JG Afrika's Johannesburg's branch. He has experience in the various fields of earth science and ground engineering, namely: engineering geology, geotechnical engineering and geophysics.

At present Mr. Singh specializes in conducting foundation investigations and material investigations for dams, roads, photo-voltaic plants and quarries. He has experience in conducting slope stability assessments and settlement analyses for design purposes.

Mr. Singh has both local and international (Africa) experience, in small, medium and large-scale investigations. More specifically, his international experience includes the countries of Lesotho, Mozambique and Zambia.

PROFESSIONAL REGISTRATIONS & INSTITUTE MEMBERSHIPS

Pr.Sci.Nat. - Registered Professional Natural Scientist with the South African Council for Natural Scientific Professions - Registration No 400119/16

SAIEG - Registered Member of the South African Institute of Engineering and Environmental Geologists - Registration No 11/302

NHBRC - Registered Competent Engineer with the National Home Builders Registration Council - Registration No 3000156472

EDUCATION

2011 - **BSc** (Geological Science) - University of KwaZulu-Natal
2012 - **BSc Hons.** (Engineering & Environmental Geology) – University of KwaZulu-Natal
2018 - **MSc** (Engineering Geology) – University of KwaZulu-Natal

RENEWABLE ENERGY - SPECIFIC EXPERIENCE

Council for Scientific and Industrial Research (CSIR) Pretoria

2020 - 2021

Position- Research and Innovation Specialist: Engineering Geologist

- Development of research, development and innovation in conducting transport infrastructure projects in South Africa.
- Kenhardt Solar Farm: Advanced material blending analysis for gravel road infrastructure.
- Materials expert on state-affairs and engineering geology team leader.
- Publication of geotechnical investigation guidelines for renewable energy development: Green Building: Volume 2 of the Sustainability Handbook (article can be provided on request)

JG Afrika (Pty) Ltd Johannesburg

2013 - 2020

Position - Engineering Geologist

Brandvalley, Kareebosch, Rietkloof Wind Energy Facilities – desktop level geotechnical investigation for proposed wind farms and related infrastructure. Client: G7 Renewables

Oya Renewable Energy Hybrid Energy Facility, Matjiesfontein – high level assessment for founding conditions for a wind farm and solar PV farm with related infrastructure. Client: G7 Renewables

Leeudoringstad PV Facility – Desktop geotechnical assessment for a proposed photovoltaic plant and associated electrical grid infrastructure. Client: SiVest

Blackrock/Oya Renewable Hybrid Energy Facility – Desktop geotechnical assessment for a proposed photovoltaic plant, WEF and associated electrical grid infrastructure. Client: SiVest

Wobben Wind Turbine, Port Elizabeth – technical specialist for a detailed foundation investigation for a single wind turbine and associated infrastructure. Client: Integrated Wind Power.

Mocuba PV Plant, Mozambique – project leader for thermal conductivity testing for the proposed Mocuba PV plant. Involved in data analysis and project management. Client: Scatec Solar.

32 kV Welgevonde to New Valley Transmission Line, Kuruman – assistant project leader/technical specialist for a geophysical and geotechnical investigation for an overhead Eskom transmission cable. Involved in 2D resistivity testing and profiling. Client: ESKOM

Robben Island PV Plant, Cape Town – project leader for a geotechnical and geophysical investigation for a PV Plant and related infrastructure. Client: SolaFutura Energy

Adams PV Plant-Pullout Testing, Kuruman – project leader for the optimization of pile types for the proposed Adams PV Plant. Client: Exosun

Mocuba Photovoltaic Plant, Mozambique – assistant project leader and involved in a deep GI for a PV plant which included resistivity surveying, percussion drilling and DPSH testing. Client: Scatec Solar

Roggeveld Windfarm GI, Sutherland – field supervisor/geologist and involved in a deep GI for a windfarm development for 46No. wind turbine positions and associated infrastructure. Profiling and rotary core drilling was undertaken. Client: Acconia Energy

Adams and Bellatrix Photovoltaic Plants, Northern Cape – project leader for a GI for two PV sites and related infrastructure. Profiling, 2D resistivity and undisturbed sampling was undertaken. Client: Aurora Power Solutions