APPENDIX E: SPECIALIST INVESTIGATIONS

APPENDIX E1: AIR QUALITY IMPACT ASSESSMENT

GCS WATER AND ENVIRONMENT (PTY) LTD

AIR QUALITY IMPACT ASSESSMENT FOR THE LEPHALALE SOLAR PV FACILITY

PROPOSED SOLAR PV FACILITY

08 OCTOBER 2021

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GCS WATER AND ENVIRONMENT (PTY) LTD

PROJECT NO.: 41103180
DATE:08 OCTOBER 2021
ZUTARI REF: 1001395-G040-REP-NN-0005

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QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3
Remarks	DRAFT	Final		
Date	25 August 2021	08 October 2021		
Prepared by	Nicole Singh	Nicole Singh		
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Checked by	Brad Keiser	Brad Keiser		
Signature				
Authorised by	Brad Keiser	Brad Keiser		
Signature				
Project number	41103180	41103180		
Report number	1 of 1	1 of 1		
File reference	W:\000 NEW Projects\41103180 - GCS Grootegeluk Solar AQIA\41 AQ\2-REPORTS\01-Draft\41103180 GCS LEPHALALE SOLAR PV AQIA_FINAL.docx			

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EXECUTIVE SUMMARY

WSP Group Africa (Pty) Ltd (WSP) was appointed by GCS Water and Environmental (Pty) Ltd (GCS) to undertake an Air Quality Impact Assessment (AQIA) assessing the construction impacts associated with the proposed Lephalale Solar PV facility located in Limpopo Province, South Africa. The proposed project forms part of Exxaro's 2020 Climate Change Policy and strategic move into energy. The project would entail the development of a photovoltaic (PV) solar power plant with a footprint of 256 hectares.

The proposed activity requires environmental authorisation in the form of an Environmental Impact Assessment (EIA) which is currently being undertaken by GCS. As part of the authorisation process an Air Quality Impact Assessment (AQIA) is required to inform the competent authority. Key pollutants associated with onsite activities were identified as PM_{10} (particulate matter with an aerodynamic diameter less than 10 microns), $PM_{2.5}$ (particulate matter with an aerodynamic diameter less than 2.5 microns) and dust fallout (modelled as TSP).

A baseline assessment was undertaken that included a geographic overview and a review of available meteorological data. To characterise the meteorological conditions of the site, local meteorological data was sourced from the South African Weather Services Lephalale Monitoring Station for the January 2018 -December 2020 period. The station is located approximately 9km to the south of the proposed Solar PV plant. MM5 prognostic meteorological data was also obtained for the period January 2018 – December 2020 for input into the air dispersion model.

The impact assessment comprised of an emissions inventory and subsequent dispersion modelling simulations. An emissions inventory was developed using site-specific data and emission factors which were sourced from the United States Environmental Protection Agency AP42 (US EPA, 1995) and the Australian Government National Pollutant Inventory (NPI, 2012) databases. This emissions inventory was input into a Level 2 atmospheric dispersion model, AERMOD, together with prognostic MM5 meteorological data, to calculate ambient air concentrations of key pollutants associated with the proposed operations.

Sensitive receptors are identified as areas that may be impacted negatively due to emissions from the Lephalale Solar Project. Five receptors were identified in the area surrounding the proposed project area, within a 10 km radius, and were used for this assessment.

Construction activities for the Solar PV plant was estimated on an area wide footprint. The emission rate used to calculate such emissions is environmentally conservative for most construction sites, with results likely being higher than those that will be experienced in reality. Further, it must be emphasised that the construction activities are transient in nature.

Long-term (annual) and short-term (24-hour average) concentrations for the pollutants of concern were compared with the South African National Ambient Air Quality Standards (NAAQS) and National Dust Control Regulations (NDCR).

PM_{10} CONCENTRATIONS

- For scenario 1 (Unmitigated) predicted PM_{10} 24-hour average concentrations at receptor 01 (Village) will exceed the PM_{10} 24-hour standard, however annual average concentrations remain compliant with the annual standard. Both the 24-hour and annual average PM_{10} concentrations at receptor 01 are predicted to be compliant with the relevant standards with mitigation (scenario 2);
- For both scenarios (Unmitigated and Mitigated), ambient 24-hour (P99) and annual average PM_{10} concentrations are predicted to be compliant at all remaining sensitive receptors during construction of the proposed Solar PV facility;

- Changes in predicted PM_{10} concentrations between Scenario 1 (Unmitigated) and Scenario 2 (Mitigated) are substantial, with a 63% decrease in average 24-hour (P99) and a 74% decrease in the annual average PM_{10} concentrations predicted with mitigation;
- Unmitigated highest predicted 24-hour and annual average fence-line concentrations are non-compliant with the relevant standards due to the close proximity of the Solar PV access road to the boundary; and
- Mitigated, highest predicted 24-hour average fence-line concentrations are non-compliant, again due to the close proximity of the Solar PV access road to the boundary. However, highest predicted annual average concentrations remain compliant with the standard.
- Importantly, despite the non-compliance predicted on the fence-line of the Solar PV facility, all concentrations predicted at the neighbouring sensitive receptors during scenario 2 (Mitigated) remain compliant with their relevant standards, as noted previously.

$PM_{2.5}$ CONCENTRATIONS

- For both scenarios (Unmitigated and Mitigated), ambient 24-hour (P99) and annual average $PM_{2.5}$ concentrations are predicted to be compliant at all sensitive receptors during construction of the proposed Solar PV facility;
- Changes in predicted $PM_{2.5}$ concentrations between Scenario 1 (Unmitigated) and Scenario 2 (Mitigated) are substantial, with a 55% decrease in average 24-hour (P99) and a 50% decrease in the annual average $PM_{2.5}$ concentrations predicted with mitigation;
- Unmitigated highest predicted 24-hour fence-line concentrations are non-compliant with the relevant standards due to the close proximity of the Solar PV access road to the boundary. However, the highest predicted annual average concentrations remain compliant with the standard; and
- Mitigated, highest predicted 24-hour and annual fence-line concentrations are compliant with the relevant standards.
- Importantly, despite the non-compliance predicted on the fence-line of the Solar PV facility, all concentrations predicted at the neighbouring sensitive receptors remain compliant with their relevant standards, as noted previously.

DUST FALLOUT

- For both scenarios, no exceedances of the dust fallout residential standard are predicted at any of the neighbouring sensitive receptors;
- Unmitigated highest predicted daily fence-line dust fallout rates are non-compliant with the non-residential standard due to the close proximity of the Solar PV access road to the boundary. However, mitigated highest daily dust fallout rates remain complaint with the non-residential standard; and
- Overall levels of dust fallout anticipated to occur during construction activities potentially impacting on surrounding receptors are below the respective National Dust Control Regulations.

CUMULATIVE ASSESSMENT

To determine the proposed cumulative impacts of the Solar PV facility, predicted dust fallout concentrations from both scenarios (Unmitigated and Mitigated) have been added to the background ambient monitored dust fallout concentrations (DFO). The following key items are noted from the cumulative assessment:

- During both Unmitigated and Mitigated scenarios, cumulative dust fallout concentrations are below the respective residential standards; and
- Based on predicted cumulative concentrations, construction impacts from the Solar PV facility are likely to be minimal, as the impacts are transient, and concentrations predicted are well below the respective NDCR.

Cumulative impacts associated with the Lephalale Solar PV facility were not assessed for PM_{10} and $PM_{2.5}$ as ambient monitoring data representative of the site was not available.

All impacts of the proposed project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. The resultant environmental air quality risks for sensitive receptors were ranked “low” during the construction, with mitigation in place.

Based on the findings of the assessment the following mitigation measures would serve to reduce air quality impacts to the receiving environment and sensitive receptors and are detailed further in **Section 6.3.**

MITIGATION MEASURES

- Mitigation measures to be implemented during construction as confirmed by Exarro are:
  - Use of water sprays during heavy construction activities, thereby limiting the dispersion of particulate emissions;
  - Continuous wetting of the access road during vehicle transport; and
  - Wetting of exposed stockpiles to limit the dispersion of wind-blown dust and particulate emissions.
- Information regarding construction activities should be provided to all local communities. Such information includes:
  - Contact details of a responsible person on site should complaints arise to reduce emissions in a timely manner.
  - Complaints register must be kept to record all events.
- Avoid dust generating works during the most windy conditions;
- When working near (within 100 m) a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible;
- Wet suppression and wind speed reduction are common methods used to control open dust sources at construction sites as a source of water and material for wind barriers tend to be readily available;
- Frequent wetting of the Solar PV access road; and
- Use of chemical stabilisation on access road must be considered as its usually cost effective for relatively long term or semi-permanent unpaved roads.

Construction of the Solar PV plant will result in minimal air quality impacts on nearby receptors. Given the low impacts on the receiving environment, based on the findings of this AQIA, it is recommended the proposed Solar PV facility be authorised.

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1 INTRODUCTION

GCS Water and Environment (Pty) Ltd (GCS) appointed WSP Group Africa (Pty) Ltd (WSP) to conduct an Air Quality Impact Assessment (AQIA) for the proposed Lephalale Solar PV facility located on the Farm Appelvlakte No. 448 within the Lephalale Local Municipality, Limpopo Province (**Figure 1-1**). The proposed project forms part of Exxaro's 2020 Climate Change Policy and strategic move into energy. The project would entail the development of a Photovoltaic (PV) solar power plant with a footprint of 256 hectares. Electricity generation capacity is approximately at 80 MW_{ac} (megawatt, alternating current) covering the entire feasible area.

The proposed activity requires environmental authorisation in the form of an Environmental Impact Assessment (EIA) which is currently being undertaken by GCS. As part of the authorisation process an Air Quality Impact Assessment (AQIA) is required to inform the competent authority. This report presents the findings from the AQIA, using a level two dispersion model (AERMOD) to predict potential air quality impacts associated with the construction phase of the proposed Solar PV plant.

1.1 TERMS OF REFERENCE

The scope of work performed by WSP in fulfilment of the requirements of the AQIA is provided below:

Baseline Assessment

- Review of applicable air quality legislation;
- Review of the potential pollutants and associated human health effects;
- Review of available meteorological data for the area;
- Identification of neighbouring sensitive receptors, including adjacent communities and farmers;
- residential areas within the proposed development area; and
- Identification of any neighbouring sources.

Emissions Inventory and Dispersion Modelling

- Compilation of an emissions inventory for activities undertaken during construction;
- Undertake dispersion modelling simulations (AERMOD, Level Two) to determine the air quality impacts associated with the construction of the solar facility; and
- Comparison of predicted model concentrations to air quality standards.

Air Quality Impact Assessment

- Compilation of an Air Quality Impact Assessment.

Figure 1-1: Location of the Lephalale Solar PV

2 REGULATORY FRAMEWORK

Until 2004, South Africa's approach to air pollution control was driven by the Atmospheric Pollution Prevention Act 45 of 1965 (APPA) which was repealed with the promulgation of National Environmental Management: Air Quality Act 39 of 2004 (NEM:AQA)[1]. NEM:AQA represents a shift in South Africa's approach to air quality management, from source-based control to integrated effects-based management. The objectives of NEM:AQA are to:

- Protect the environment by providing reasonable measures for:
  - The protection and enhancement of air quality;
  - The prevention of air pollution and ecological degradation;
  - Securing ecologically sustainable development while promoting justifiable economic and social development; and
  - Give effect to everyone's right "*to an environment that is not harmful to their health and well-being*"[2].

Significant functions detailed in NEM:AQA include:

- The National Framework for Air Quality Management[3];
- Institutional planning matters, including:
  - The establishment of a National Air Quality Advisory Committee;
  - The appointment of Air Quality Officers (AQOs) at each level of government; and
  - The development, implementation and reporting of Air Quality Management Plans (AQMP) at national, provincial and municipal levels.
- Air quality management measures including:
  - The declaration of Priority Areas where ambient air quality standards are being, or may be, exceeded;
  - The listing of activities that result in atmospheric emissions and which have the potential to impact negatively on the environment and the licensing thereof through an AEL;
  - The declaration of Controlled Emitters;
  - The declaration of Controlled Fuels;
  - Procedures to enforce Pollution Prevention Plans or Atmospheric Impact Reporting for the control and inventory of atmospheric pollutants of concern; and
  - Requirements for addressing dust and offensive odours.

2.1 NATIONAL AMBIENT AIR QUALITY STANDARDS

The National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA), which repeals the Atmospheric Pollution Prevention Act (APPA) of 1965, came into effect on 11 September 2005, with the promulgation of regulations in terms of certain sections resulting in the APPA being repealed entirely on 1 April 2010. The NEMAQA introduced a management system based on ambient air quality standards and corresponding emission limits to achieve them.

1 South Africa (2005): *National Environmental Management: Air Quality Act* (No. R. 39 of 2004) Government Gazette, 24 February 2005 (No. 27318)

2 South Africa (1996): *Constitution of the Republic of South Africa (No. 108 of 1996)*

3 Department of Environmental Affairs (2018*): The 2017 National Framework for Air Quality Management in the Republic of South Africa* (No.R.1144 of 2018) Government Gazette, 26 October 2018 (No. 41996)

The National Ambient Air Quality Standard (NAAQS) presented in **Table 2-1** below became applicable for air quality management from their promulgation in 2009[4] and 2012[5]. The NAAQS generally have specific averaging periods, compliance timeframes, permissible frequencies of exceedance and measurement reference methods. The NAAQS pollutants of concern, and applicable to this AQIA are Particulate Matter (PM_{10} and $PM_{2.5}$).

Table 2-1: National Ambient Air Quality Standards

Pollutant	Averaging Period	Concentration (µg/m^3)	Frequency of Exceedance
Particulate Matter (PM_{10})	24-hour	120	4
		75	4
	1 year	50	0
		40	0
Particulate Matter ($PM_{2.5}$)	24-hour	65	4
		40	4
		25	4
	1 year	25	0
		20	0
		15	0
Sulphur Dioxide (SO_2)	10-minute	500	526
	1-hour	350	88
	24-hour	125	4
	1 year	50	0
Nitrogen Dioxide (NO_2)	1-hour	200	88
	1 year	40	0
Carbon Monoxide (CO)	1-hour	30,000	88
	8-hour	10,000	11
Benzene (C_6H_6)	1 year	10	0
		5	0

2.2 NATIONAL DUST FALLOUT STANDARDS

The National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEMAQA) National Dust Control Regulations, were published in Government Notice (GN) 827 of November 2013 (Government Gazette 36974). However, Draft National Dust Control Regulations were published in GN 517 of May 2018 (Government Gazette 41650), bringing about certain changes in the permitted dust fallout monitoring methodology. Notably, since GN 517 of May 2018 are not yet promulgated, GN 827 of November 2013 remain in force and applicable to this AQIA.

The dust fallout rates, applied in this study to assess compliance, are presented in **Table 2-2.**

[4] Department of Environmental Affairs (2009): National Ambient Air Quality Standards. Government Gazette (No. R 1210 of 2009), 24 December 2009 (No. 32816)

[5] Department of Environmental Affairs (2012): National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter less than 2.5 Micro Metres ($PM_{2.5}$). Government Gazette (No. R 486 of 2012), 29 June 2012 (No. 35463)

Table 2-2: National Dust fallout standards

Restriction Areas	Dust fallout rate (mg/m^2/day, 30-day average)	Permitted frequency of exceeding dust fall rate
Residential Area	600	Two within a 12-month rolling period, not sequential months
Non-residential Area	1200	Two within a 12-month rolling period, not sequential months

2.3 PRIORITY AREA

Section 18 of 20 of the National Environmental Air Quality Act (NEM:AQA) deals with the establishment of priority areas in identified "hot-spot" areas of South Africa where ambient air quality standards are often exceeded or may often be exceeded. The establishment of a priority area is intended to achieve the following:

- If effectively allows for the concentration of limited air quality management capacity (human, technical and financial) for dealing with acknowledged problem areas to obtain measurable air quality improvements in the short, medium and long-term.
- It prescribes a co-operative governance regime but effectively handing up air quality management authority to the tier of government that can provide leadership and co-ordination and;
- It allows for "cutting edge" air quality management methodologies that take into consideration all contributors to the air pollution problem, i.e. airshed quality management.

The proposed Lephalale Solar PV plant is located within the Waterberg-Bojanala Priority Area (WBPA). The WBPA was declared a priority area by the Minister of Water and Environmental Affairs on 15 June 2012 (Government Gazette No 35435) as the third National Priority Area, crossing the North West (Bojanala Platinum District Municipality) and Limpopo (Waterberg District Municipality) Provincial borders. The declaration was in response to the predicted NAAQS exceedances in the area and the trans-boundary emission sources and air pollution impacts spanning the Waterberg District Municipality and Bojanala Platinum District Municipality[6].

2.4 REGULATED POLLUTANTS AND THEIR IMPACTS

The composition of air pollutant mixtures, pollutant concentrations, duration of exposure and other susceptibility factors (e.g. age, nutritional status and predisposing conditions) can lead to diverse impacts on human health. Health effects can range from nausea and skin irritation to cancer and mortality[7] (**Table 2-3**). High risk individuals include the elderly, people with pre-existing heart or lung disease, pregnant women, asthmatics and children.

Table 2-3: Air pollutants of concern during construction and their associated health impacts

Pollutant	Description	Health effects
Particulate matter (TSP, PM_{10} & $PM_{2.5}$)	Particulate matter (PM) refers to solid or liquid particles suspended in the air. PM varies in size from particles that are only visible under an electron microscope to soot or smoke particles that are visible to the human eye.	— Increase in lower respiratory symptoms; — Reduced lung function; — Inflammation of the lungs; — Angina; — Myocardial infraction;

[6] Department of Environmental Affairs (DEA). (2014): The Waterberg-Bojanala Priority Area Air Quality Management Plan: Baseline characterisation, October 2014.

[7] Kampa, M. and Castanas, E. (2007): *Human health effects of air pollution*, Environmental Pollution 151 (2008) 362-367, Elsevier

Pollutant	Description	Health effects
	Particles can be classified by their aerodynamic properties into coarse particles, PM_{10} (particulate matter with an aerodynamic diameter of less than 10µm) and fine particles, $PM_{2.5}$ (particulate matter with an aerodynamic diameter of less than 2.5 µm)[8]. Particulate air pollution affects the respiratory system[9]. Particle size is important for health because it controls how far into the respiratory system particles can permeate. Fine particles have been found to be more damaging to human health than coarse particles as larger particles are less respirable in that they do not pass from the lungs into the bloodstream[10].	— Bronchitis; and — Mortality[11]
Dust fallout	Dust fallout also known as settable particulate matter is defined as any material composed of particles small enough to pass through a 1mm screen and large enough to settle by virtue of weight into a sampling container from ambient air[12]. Impacts on the environment as a result of dust fallout are often limited to nuisance effects. Nuisance effect refers to environmental impacts of dust that are not health related. Nuisance dust effects often results in the soiling and discolouration of personal property and can result in physical irritation in plants and animals[13].	Most commonly nuisance impacts

[8] Harrison, R.M. and R.E. van Grieken, (1998): *Atmospheric Aerosols*. John Wiley: Great Britain
[9] World Health Organization (2000): *Air Quality Guidelines for Europe* (2nd edition), Copenhagen, Denmark. (WHO Regional Publications, European Series, No 91)
[10] Manahan, E. (1991): Environmental Chemistry.
[11] Manahan, E. (1991): Environmental Chemistry.
[12] Department of Environmental Affairs (2013): National Environmental Management: Air Quality Act: National Dust Control Regulations (No. R 39 of 2004), 01 November 2013 (No. 36974)
[13] Michigan Department of Environmental Quality. Managing fugitive dust: A guide for compliance with the air regulatory requirements for particulate matter generation. March 2016.

3 PROJECT BACKGROUND

Construction of the proposed facility is anticipated to occur for a duration of 12 months. Site preparation activities will include clearance of vegetation at the footprint of the area infrastructure (substation, BESS and other associated infrastructure) and linear components (access roads and power line).

The solar facility will consist of:

- Solar PV panels;
- Steel support structure and tracker system on concrete foundations;
- Inverter stations as part of the PV field;
- Transformers, switchgear, and related equipment as part of the Substations; and
- Internal roads.

Associated infrastructure will include:

- Substation complex (33/132 kV) including control rooms and grid control yards;
- 132 kV transmission line and transmission towers;
- Battery Energy Storage System (BESS);
- Operations and maintenance buildings;
- Borehole and water treatment plant;
- Access roads;
- Internal roads;
- Perimeter fencing;
- Access control gate;
- Security building;
- Construction yard; and
- Laydown area.

3.1 PROCESS DESCRIPTION

The proposed Photovoltaic Solar Plant requires the construction of an array of crystalline solar PV modules grouped into strings of 28 modules and installed to a solar tracking mounting structure, together with associated infrastructure for the generation of 80 MW_{ac} of electricity. The PV tables will cover an array of 236 hectares surrounded by a perimeter access road and fence. Establishment of a 4km evacuation powerline will follow a 67m corridor along the Applelvlakte fence. The affected area of the power line and access road beyond the PV tables is 20 hectares, giving a total affected area for the project as 256 hectares.

PV tables will be raised approximately 1.5 meters above ground with a single axis tracking system allowing for the maximisation of solar energy (**Figure 3-1)**. The proposed associated infrastructure includes a fenced construction staging/lay-down area (a portion of which will form the operational lay-down area), inverter-transformer stations on concrete pads, a battery energy storage system (BESS) adjacent to the substation platform, office buildings with ablutions, maintenance shed/s and a substation for connection to the power grid, all within the 236 ha PV plant site. It is proposed that the 33kV powerlines within the facility be underground/sub-surface. Connection between the proposed substation to the Grootegeluk 33Kv substation will occur via a 132kV overhead powerline. The Grootegeluk 33 kV substation is located approximately 4km south-west of the proposed development site.

Figure 3-1: Single axis solar PV module tables raised 1.5m above ground level (to a maximum tilt height of 3m)[14]

[14] GCS Project Description: Lephalale Solar Project

4 BASELINE ASSESSMENT

4.1 LOCALITY TOPOGRAPHY

The study area is in proximity to existing industrial and mining activities with the Matimba Power Station and the Grootegeluk Coal Mine located south and west of the site respectively. The broader project area is easily accessible from Lephalale via a road that runs from Lephalale to Grootegeluk Mine and Matimba Power Station. The property is wholly owned by Exxaro but does not fall within a proposed mining area. The town of Lephalale is located approximately 14 km northwest from the proposed site.

4.2 TOPOGRAPHY

Topography of an area plays a role in the dispersion of air pollutants. On hilltops and exposed areas, moderate winds will typically cause pollutants to be dispersed, however in low-lying areas such as valleys, it's difficult for air flow to penetrate, resulting in pollutants being trapped and increasing levels of pollution. Pollutant dispersion processes over complex terrain are more complicated than over flat areas as they are affected by atmospheric interactions with the orography at different spatial scales.

The topography in the region is flat with a gentle slope towards the Limpopo River. Elevation on site varies from 877 m to 922 m above sea level.

4.3 SENSITIVE RECEPTORS

Sensitive receptors, as defined by the USEPA include, but are not limited to, hospitals, schools, day-care facilities, elderly housing and convalescent facilities. These are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides and other pollutants. Extra care must be considered when dealing with pollutants in proximity to areas recognised as sensitive receptors. Based on this definition the residential, educational and recreational land uses in the surrounding area are considered sensitive receptors.

For this study, the position of residential communities/dwellings was taken off 1:6300 DRG maps and verified using Google Earth Pro.

Residential communities, hospitals and schools within a 10 km radium from the site were identified as shown in **Table 4-1** and **Figure 4-1**. It is highlighted that construction related impacts on sensitive receptors are transient and will cease once construction is complete.

Table 4-1: Sensitive Receptors identified in proximity to the Project area

ID	Description	Latitude (DD)	Longitude (DD)	Distance from Site Boundary (Km)	Direction from Site
REC01	Village	-23.660010°S	27.598790° E	2.45	South
REC02	Ditheku Primary School (Marapong)	-23.651540° S	27.617510° E	2.47	South
REC03	Marapong Private Hospital	-23.658540° S	27.618760° E	3.07	South
REC04	Nelsonskop Primary (Marapong)	-23.657610° S	27.626144° E	3.59	South
REC05	Marapong Residential	-23.647228° S	27.622447° E	2.8	South
REC06	Manketti Lodge	-23.667812° S	27.585496° E	3.53	South-West

Other sensitive receptors within the area would be the local fauna and flora. Potential impacts on plants, wildlife and humans may occur during construction of the Solar PV plant.

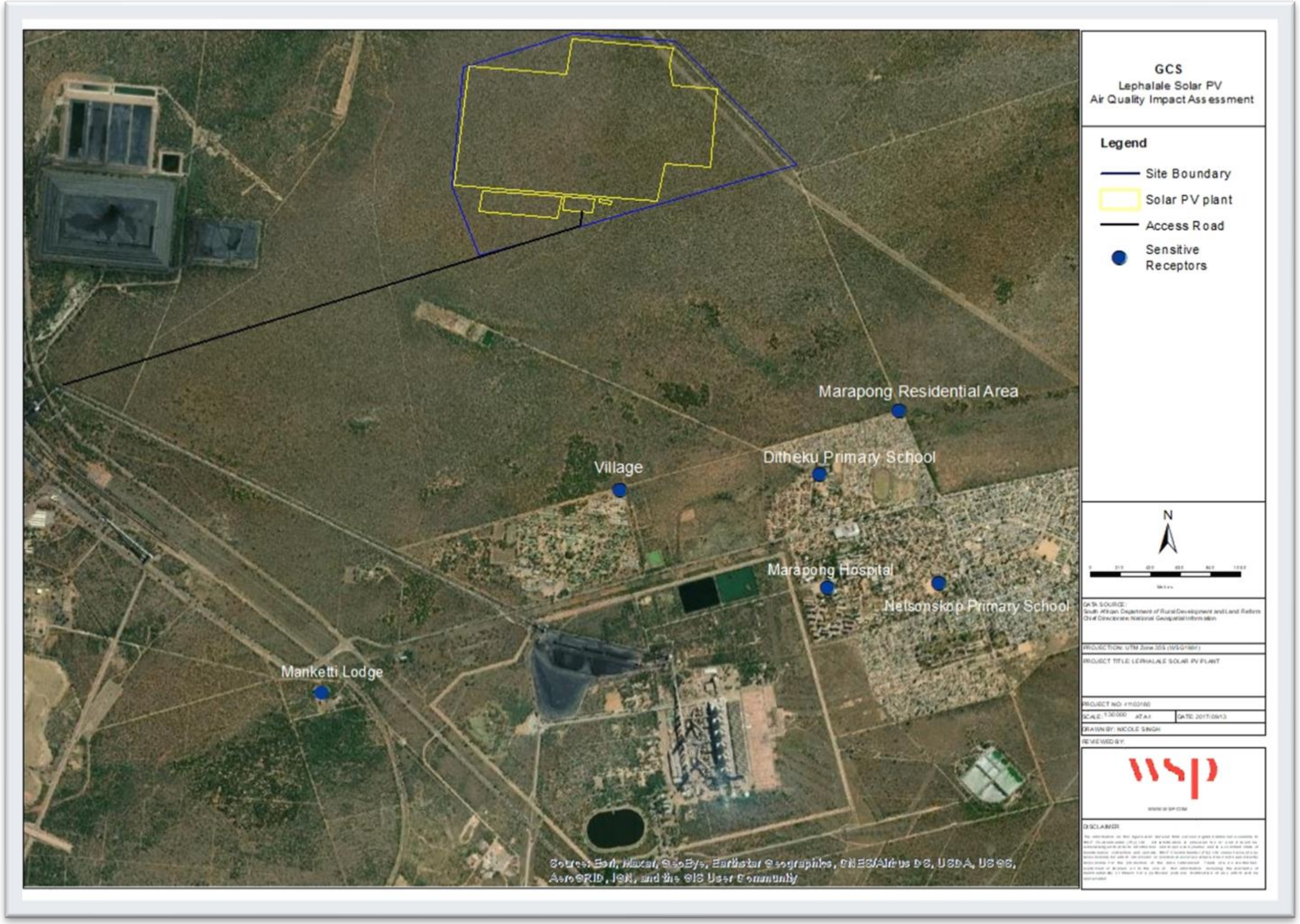

Figure 4-1: Sensitive receptors

LOCAL CLIMATE AND METEOROLOGY

CLIMATIC OVERVIEW

South Africa is situated on the subtropical high-pressure belt. The mean circulation of the atmosphere over the Sub-continent is anticyclonic throughout the year except for near the surface[15]. The synoptic patterns affecting climatic conditions experienced in the project region, owes their origins to the subtropical, tropical and temperate features of the general circulation over Southern Africa (**Figure 4-2)**. The subtropical control is carried via the semi-permanent presence of the South Indian Anticyclones (HP cells), Continental High (HP cell) and the South Atlantic Anticyclone (LP cell) in the high-pressure belt located approximately 30 °S of the equator[15].

Seasonal variations in the positioning and intensity of the HP cells such as the Continental high and South Indian anticyclone determines the extent to which the westerly waves and lows impacts the atmosphere over the region. In winter, the high-pressure belt intensifies and moves northward, while the westerly waves in the form of cyclones moves eastwards around the South African coast or across the country. The positioning and intensity of these systems are able to significantly impact the region[15]. In summer, anticyclonic HP belt weakens and shifts southward where it influences the westerly waves and lows weakens.

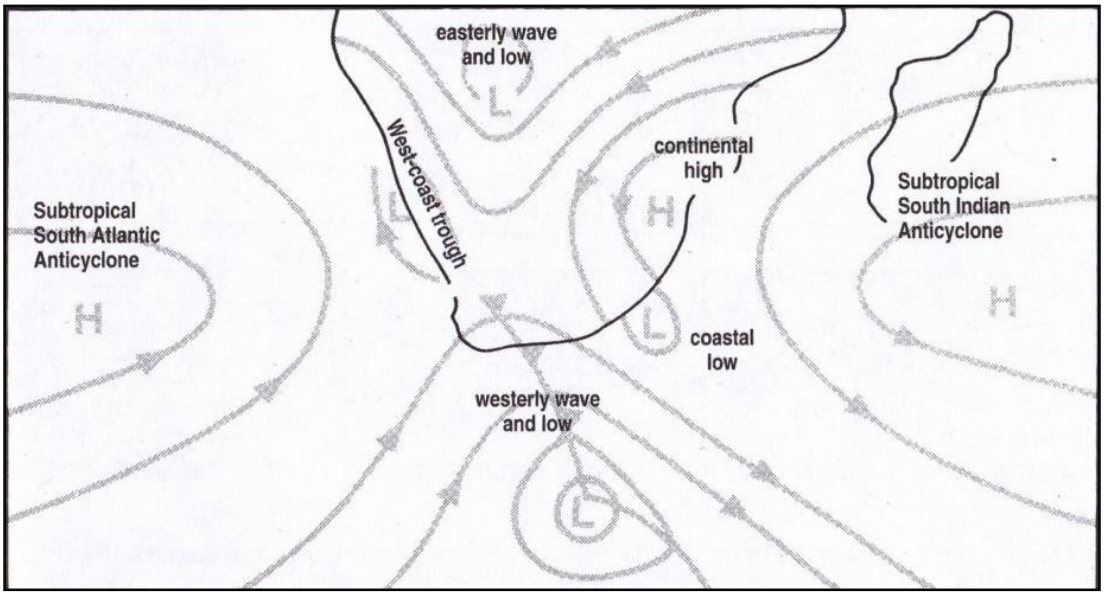

Figure 4-2: South African meteorological phenomena (Tyson and Preston-Whyte, 2000)

Anticyclones (HP cells) are associated with convergence in the upper levels of the troposphere and divergence near the surface of the earth. Air parcels subsidence, inversion, fine conditions and little to no rainfall occur because of such airflow circulation patterns. These conditions are not favourable for air pollutant dispersion, especially with regards to those emissions emitted close to the ground[16].

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[15] Preston-Whyte, R.A., and Tyson, P.D. (1997). *The atmosphere and weather of Southern Africa*. Oxford University Press. Cape Town.

[16] Tyson, P. D., Kruger, F. J., and Louw, C. W. (1988). *Atmospheric pollution and its implications in the Eastern Transvaal Highveld*. National Scientific Programmes Unit: CSIR.

Westerly waves and low-pressure cells are characterised by surface convergence and upper-level divergence that produce sustained uplift, cloud formation and the potential for precipitation. Cold fronts, which are associated with the westerly waves, occur predominantly during winter. The passage of a cold front is characterised by pronounced variations in wind direction and speed, temperature, humidity, pressure and distinctive cloud bands[16]. These unstable atmospheric conditions bring about atmospheric turbulence which creates favourable conditions for air pollutant dispersion.

The tropical easterlies and the occurrence of easterly waves and lows affect Southern Africa mainly during the summer months. These systems are largely responsible for the summer rainfall pattern and the north easterly wind component that occur over the region[16].

In summary, the convection activity associated with the easterly and westerly waves disturbs and hinders the persistent inversion which sits over Southern Africa. This allows for the upward movement of air pollutants through the atmosphere leading to improved dispersion and dilution of accumulated atmospheric pollutants.

METEOROLOGICAL OVERVIEW

Since meteorological conditions affect how pollutants emitted into the air are directed, diluted and dispersed within the atmosphere, the incorporation of reliable data into an air quality impact assessment is of the utmost importance. Dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the atmospheric mixing layer control the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as the plume 'stretches'. Mechanical turbulence is influence by wind speed in combination with surface roughness.

Parameters that need to be considered in the characterisation of dispersion potential include wind speed, wind direction, extent of atmospheric turbulence, ambient air temperature and mixing depth. Modelled MM5 (Penn State/NCAR Mesoscale Model) meteorological data representative of the site was obtained for the period January 2018 to December 2020 to provide an understanding of surface and upper air dispersion characteristics. The data coverage stretches over the surrounding site in Lephalale with a grid cell dimension of 12km x 12 km over a 50km x 50 km domain. Additionally, meteorological data for the 2018 to 2020 period from the Lephalale surface weather station was sourced. The Lephalale weather station is an automated station run by the South African Weather Services (SAWS) located approximately 9km south from the proposed Solar PV plant. Data recovery for the meteorological datasets are provided in **Table 4-2**.

Table 4-2: Meteorological Data recovery

Parameter	Data Recovery	
	MM5	SAWS Lephalale
Temperature	100%	98%
Humidity	100%	98%
Rainfall	100%	98%
Wind Speed	100%	98%
Wind Direction	100%	98%

4.3.1 WIND FIELD

Winds affect the horizontal and vertical dispersion of air pollutants away from their source[17]. Wind roses are useful for illustrating the prevailing meteorological conditions of an area, indicating wind speeds and directional frequency distributions. In the following wind roses, the colour of the bar indicates the wind speed whilst the length of the bar represents the frequency of winds blowing from a certain direction (as a percentage). In this assessment, meteorological data spanning three calendar years (January 2018 – December 2020) as required by the *Regulations Regarding Air Dispersion Modelling*[18], hereafter referred to as " the *Modelling Regulations*", is discussed in the sections below.

MM5 DATA

Figure 4-3 presents the local wind conditions from modelled MM5 data representative of the project site for the period January 2018 to December 2020. Typical wind fields have been analysed using Lakes Environmental WRPlot Freeware (Version 7.0.0) for the full period (January 2018 – December 2020); diurnally for early morning (00h00 – 06h00), morning (06h00 – 12h00), afternoon (12h00 – 18h00) and night (18h00 – 00h00); and seasonally for summer (December, January and February), autumn (March, April and May), winter (June, July and August) and spring (September, October and November). The following is highlighted:

- Calm conditions (wind speeds <1.0 m/s) occurred 19.57 % of the time;
- Wind predominately originated from the north-easterly and easterly sectors, with very few winds originating from the south easterly sectors;
- Wind speeds were predominately a gentle breeze during the period, with a few winds exceeding 11.7 m/s at times, particularly from the north-easterly sector;
- Diurnal winds during the morning and night conditions originated from the north-easterly, with less frequent winds originating from the easterly and southerly sectors;
- Diurnal wind speeds were predominately a gentle breeze during day and night conditions, with few winds exceeding 8.9 m/s during the afternoon hours, predominately from the north-easterly sector;
- Minimal seasonal variability is seen during the period, with a predominant wind direction of north-northeast experienced across all seasons, with few winds originating from the northwest and easterly sector; and
- Average seasonal wind speeds for the region were highest during the spring and summer months with an average wind speed peaking at 10.4 m/s and 9.1 m/s respectively.

SAWS LEPHALALE MONITORING STATION

Figure 4-4 presents the local wind conditions sourced from the SAWS Lephalale Monitoring station located approximately 9km South East from the Solar PV boundary. Typical wind fields have been analysed using Lakes Environmental WRPlot Freeware (Version 7.0.0) for the full period (January 2018 – December 2020); diurnally for early morning (00h00 – 06h00), morning (06h00 – 12h00), afternoon (12h00 – 18h00) and night (18h00 – 00h00); and seasonally for summer (December, January and February), autumn (March, April and May), winter (June, July and August) and spring (September, October and November). The following is highlighted:

- Calm conditions (wind speeds <1.0 m/s) occurred 34.9 % of the time;

[17] Tyson, P.D. & Preston-Whyte, R.A. (2004). *The Weather and Climate of Southern Africa*, 2nd Ed, Oxford University Press Southern Africa, Cape Town.

[18] Department of Environmental Affairs (2014): Regulations Regarding Air Dispersion Modelling (No. R. 533), Government Gazette, 11 July 2014, (No. 37804).

- Wind predominately originated from the north-easterly and easterly sectors, with very few winds originated from the south-easterly sector;
- Winds speed were predominately a gentle breeze during the period, with very few winds exceeding 6 m/s, particularly from the north-easterly sector;
- Diurnal winds during the morning and night conditions originated from the north-easterly sector, with few winds from the south-easterly;
- Minimal seasonal variability is seen during the period, with a predominant wind direction of north-northeast experienced across all seasons, with few winds originating from the east and southerly sector during the summer and autumn months; and
- Average seasonal wind speeds for the region were highest during the summer and spring months with 5.5 m/s and 5.6 m/s respectively .

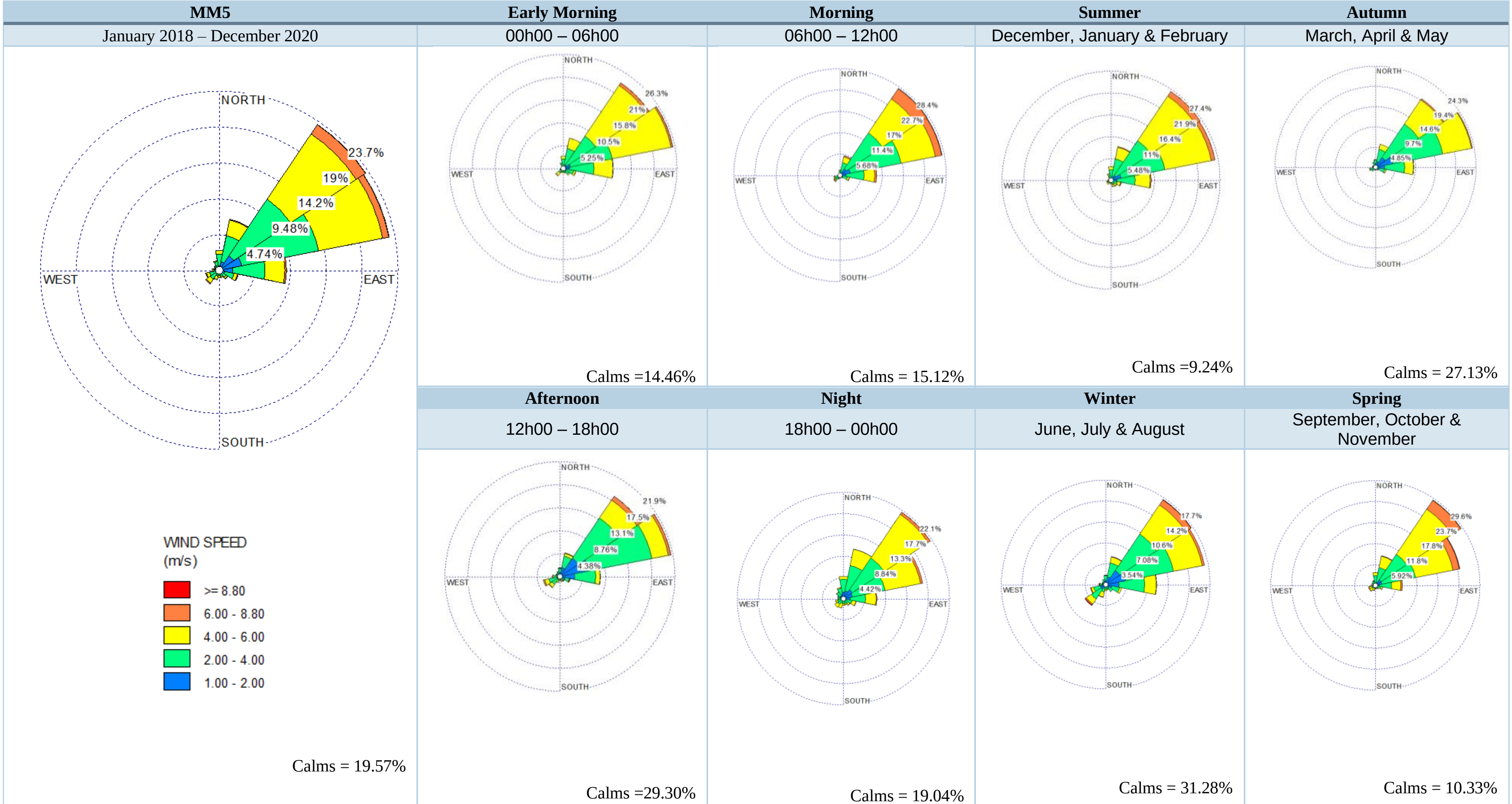

Figure 4-3: MM5 Wind profile for January 2018 – December 2020

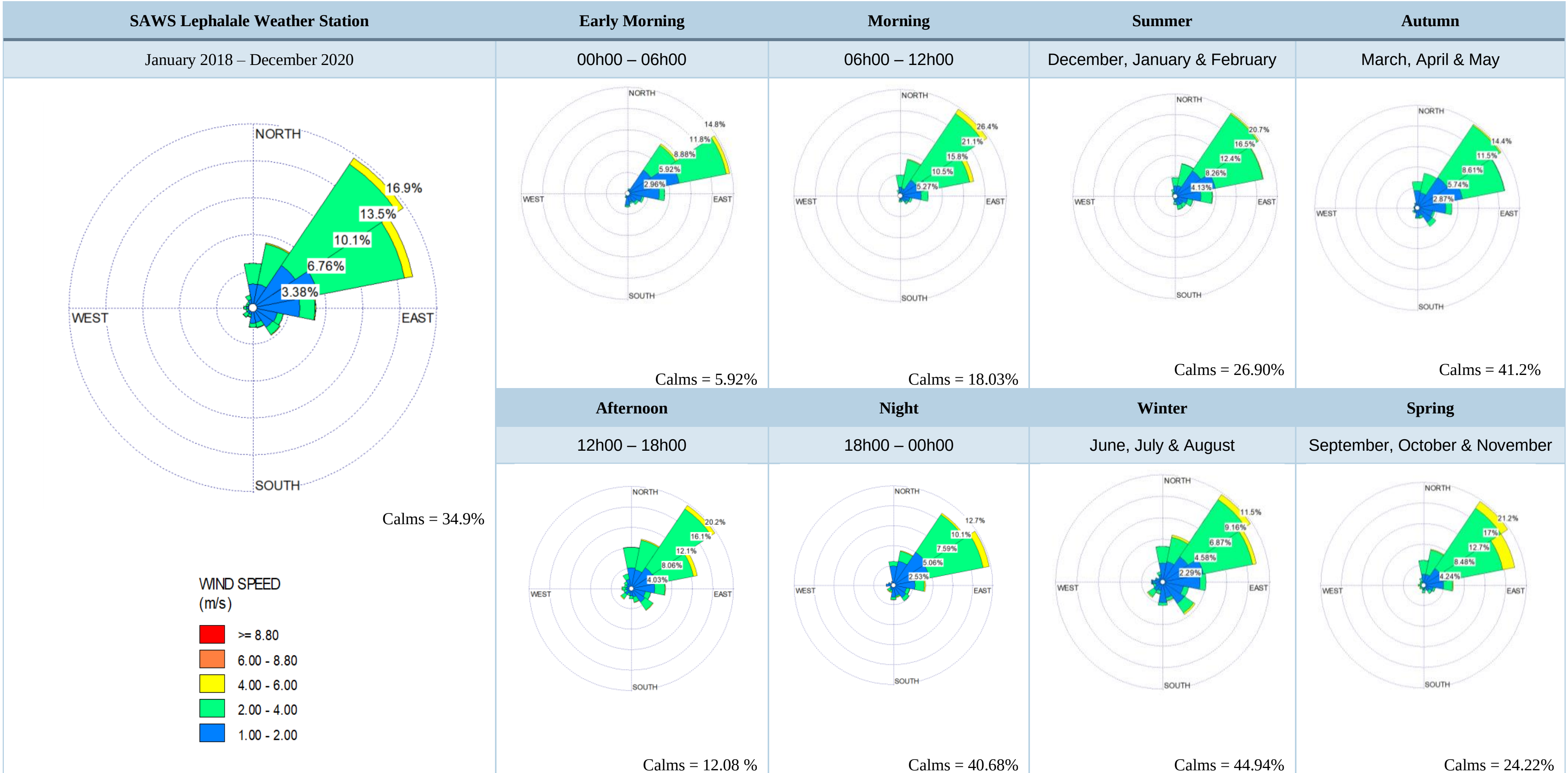

Figure 4-4: SAWS Lephalale Monitoring Station wind profile for January 2018 – December 2020

4.3.2 TEMPERATURE AND RAINFALL

Ambient air temperature influences plume buoyancy as the higher the plume temperature is above the ambient air temperature, the higher the plume will rise. Further, the rate of change of atmospheric temperature with height influences vertical stability (i.e. mixing or inversion layers). Rainfall is an effective removal mechanism of atmospheric pollutants. **Figure 4-5** illustrates the average monthly temperature, temperature range (maximum and minimum) and total rainfall recorded at the Lephalale Weather station. Highest levels of rainfall occurred during the warmer, summer months (December, January and February) with low to no rainfall experienced during the drier colder winter months (June, July and August).

Summer temperatures for the region averaged 24.5°C while winter temperatures averaged 15.4°C. Lephalale received, on average, 1027 mm of rainfall during the period under review, with approximately 58% of that received during the summer months and 0.02% during the winter months.

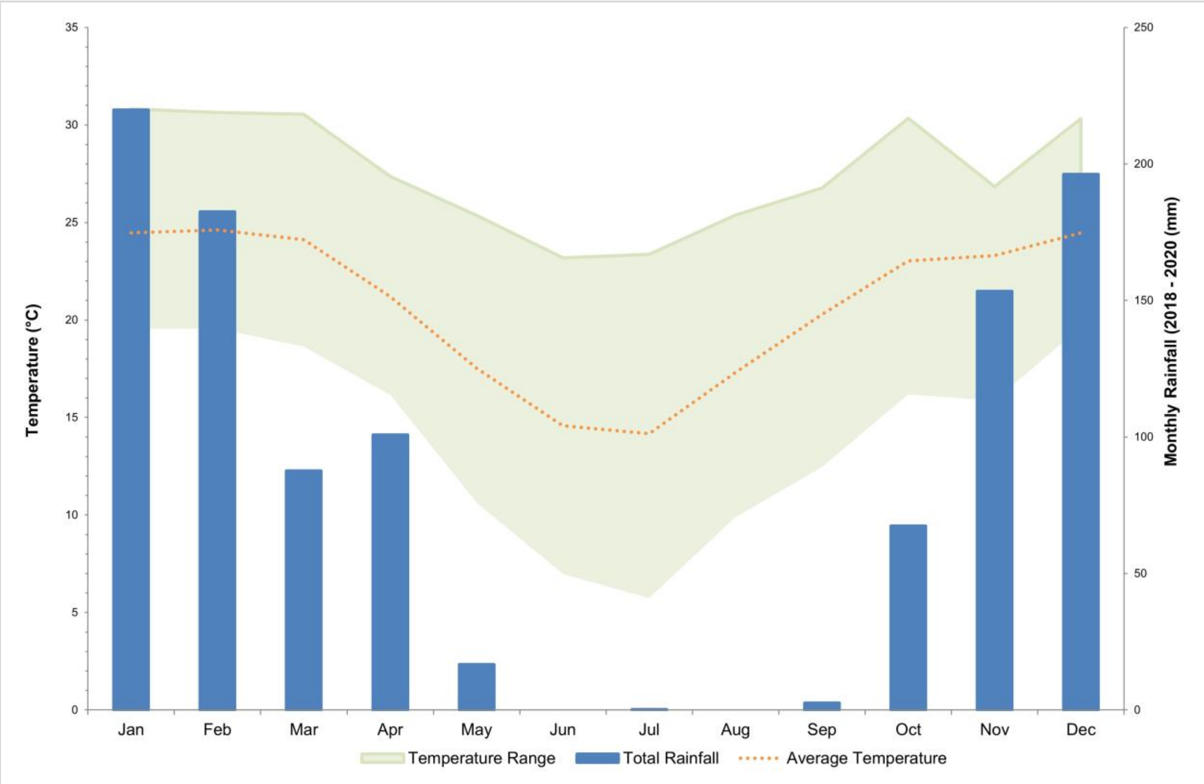

Figure 4-5: Total monthly rainfall, temperature range and average monthly temperature (2018 – 2020) at the Lephalale Weather station

4.4 AMBIENT AIR QUALITY

PM_{10} and $PM_{2.5}$ data for the project site was not available for assessment. It was confirmed by Exarro upon WSP request for ambient data that Dust fallout (DFO) is the only parameter available for assessment.
Exxaro Grootegeluk Coal mine operates 12 single bucket monitoring stations located strategically around the mine boundary to assess the dust fallout impacts arising from mining operations (**Figure 4-6)**. Data for the January 2018 – December 2020 period is assessed in the sections below.

4.4.1 LOCAL DUST FALLOUT MONITORING

Dust fallout monitoring is carried out through use of a single bucket system strategically located around the mine boundary. The results are used to provide representation of the current dust fallout deposition rates taking place within the surrounding environment. The monitoring sites closest to the proposed Solar PV Plant are GGD01, GGD02 and GGD10.

Table 4-3 lists the description, classification and co-ordinates of each sampling location. Dust fallout results are compared to the National Dust Control Regulations (NDCR) to assess compliance against relevant standards. All monitoring sites are classified as non-residential locations and are assessed against the non-residential standard of 1200 mg/m^2/day.

Table 4-3: Exarro Grootegeluk Coal Mine Dust fallout sampling locations

Locality	Description	Latitude (DD)	Longitude (DD)	Classification
GGD01	Behind slime dam	-23.64704 °S	27.57211 °E	Non-residential
GGD02	Behind slime dam	-23.62498 °S	27.57382 °E	Non-residential
GGD03	Border of Mine	-23.64301 °S	27.51617 °E	Non-residential
GGD04	West of mine	-23.67019 °S	27.48408 °E	Non-residential
GGD05	Behind mine pit	-23.6837 °S	27.49056 °E	Non-residential
GGD06	Behind mine pit	-23.69821 °S	27.50064 °E	Non-residential
GGD07	South of mine within Nature Reserve	-23.69304 °S	27.53987 °E	Non-residential
GGD08	Conveyor belt GG to Medupi	-23.69321 °S	27.56206 °E	Non-residential
GGD09	Behind discard dump	-23.62078 °S	27.53476 °E	Non-residential
GGD10	Next to discard dump near WWTW	-23.62988 °S	27.56068 °E	Non-residential
GGD11	Matimba/GG border	-23.68463 °S	27.58877 °E	Non-residential
GGD12	GG entrance road	-23.66616 °S	27.58528 °E	Non-residential

Figure 4-6: Dust fallout monitoring network at Exxaro Grootegeluk Coal Mine

Figure 4-7 represents the dust fallout results for the January – December 2018. No data was recorded at the following locations due to contamination of samples:

- GGD02 (May);
- GGD03 (March);
- GGD05 (May); and
- GGD10 (June).

Exceedances of the NDCR were recorded at GGD04 (November) and GGD06 (April). All monitoring sites remain complaint with the National Dust Control Regulations as two non-sequential exceedances are allowed within a twelve-month rolling period. Apart from exceedances dust fallout rates for the 2018 period remain low across all sites, with GGD10 recording the lowest average dust fallout rates and GGD05 recording the highest average.

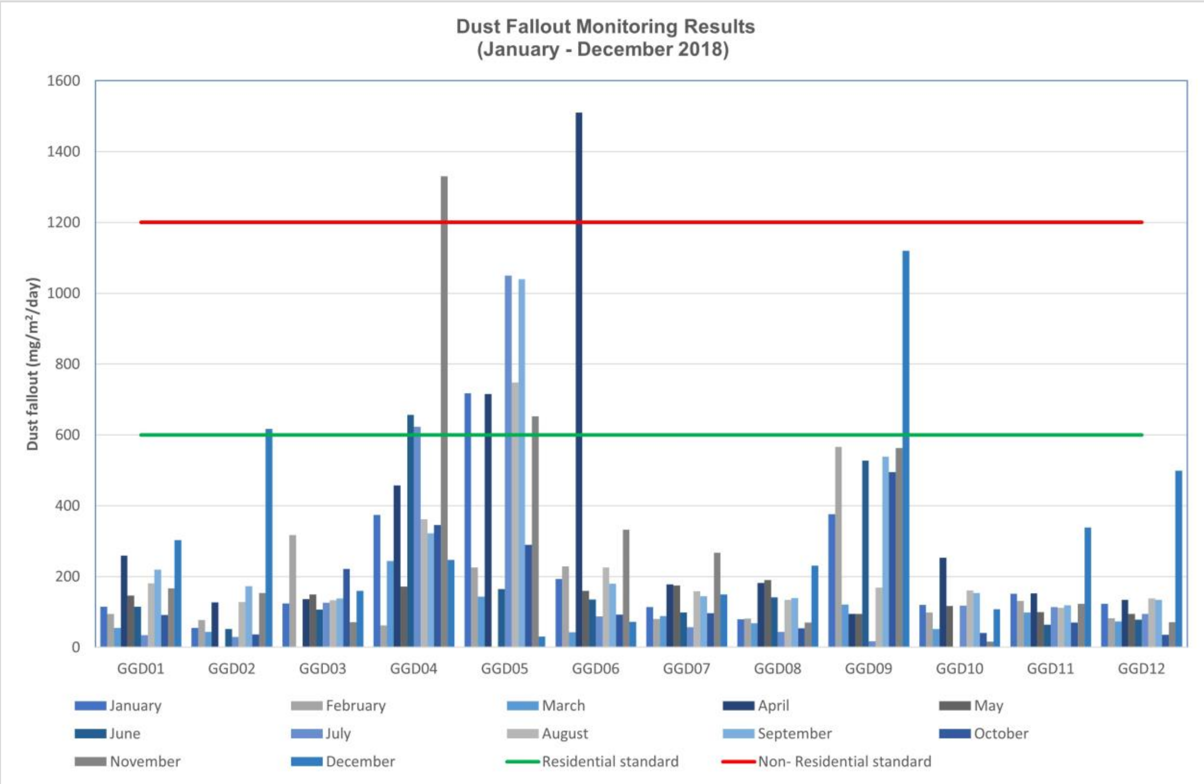

Figure 4-7: Onsite Dust fallout rates recorded during January – December 2018

Figure 4-8 illustrates the dust fallout results for 2019. Five exceedances of the non-residential standard were recorded, occurring at; GGD03 (January), GGD04 (January) and GGD07 (January, February and December). GGD07 exceeded the standard three times during a 12-month rolling period, resulting in non-compliance of the NDCR. All other sites remain complaint with the non-residential standard. Apart from exceedances, dust fallout rates for the monitoring period remained low across all sites, with GGD09 and GGD10 recording the lowest average, while GGD07 recorded the highest average.

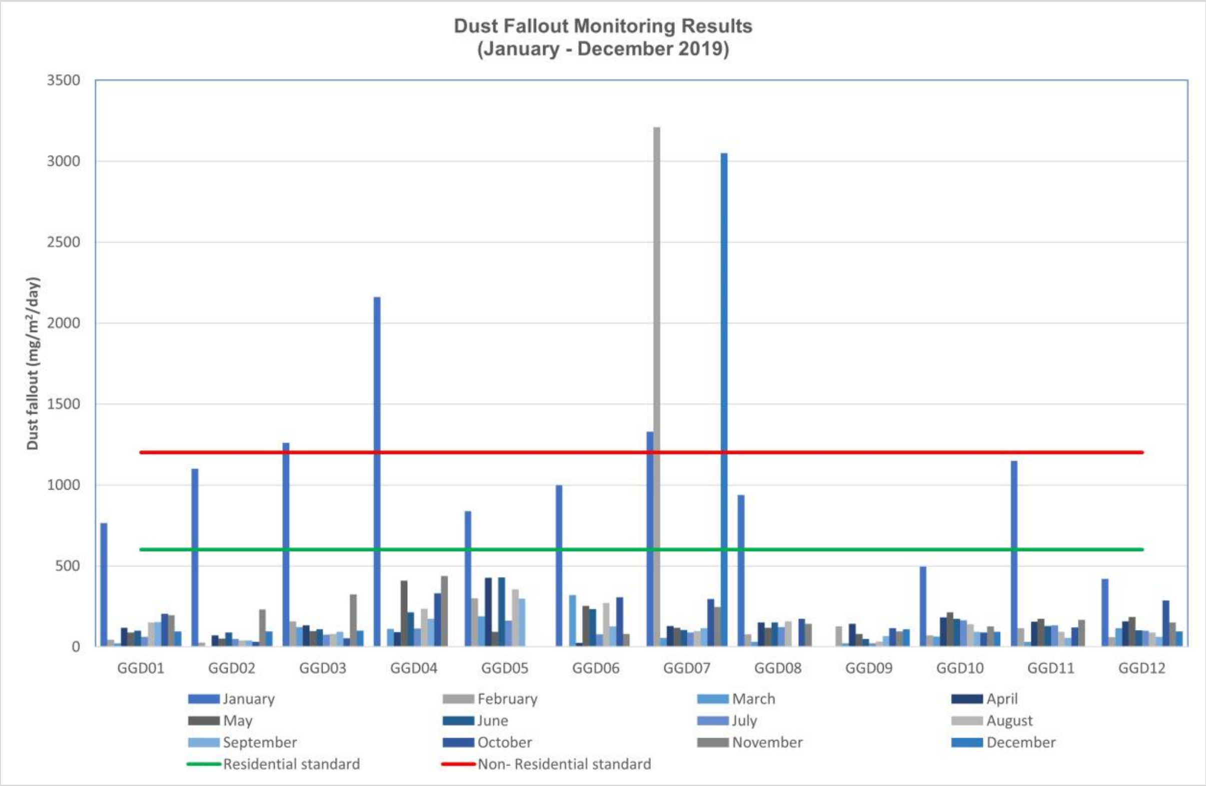

Figure 4-8: Onsite Dust fallout rates recorded during January – December 2019

Figure 4-9 illustrates the dust fallout rates for 2020. All sites remain complaint with the National Dust Control Regulations as no exceedances of the non-residential standard were recorded.

No data was recorded at the following locations due to contamination of samples:

- GGD04 – May, June and July; and
- GGD05 – January, April, May and June.

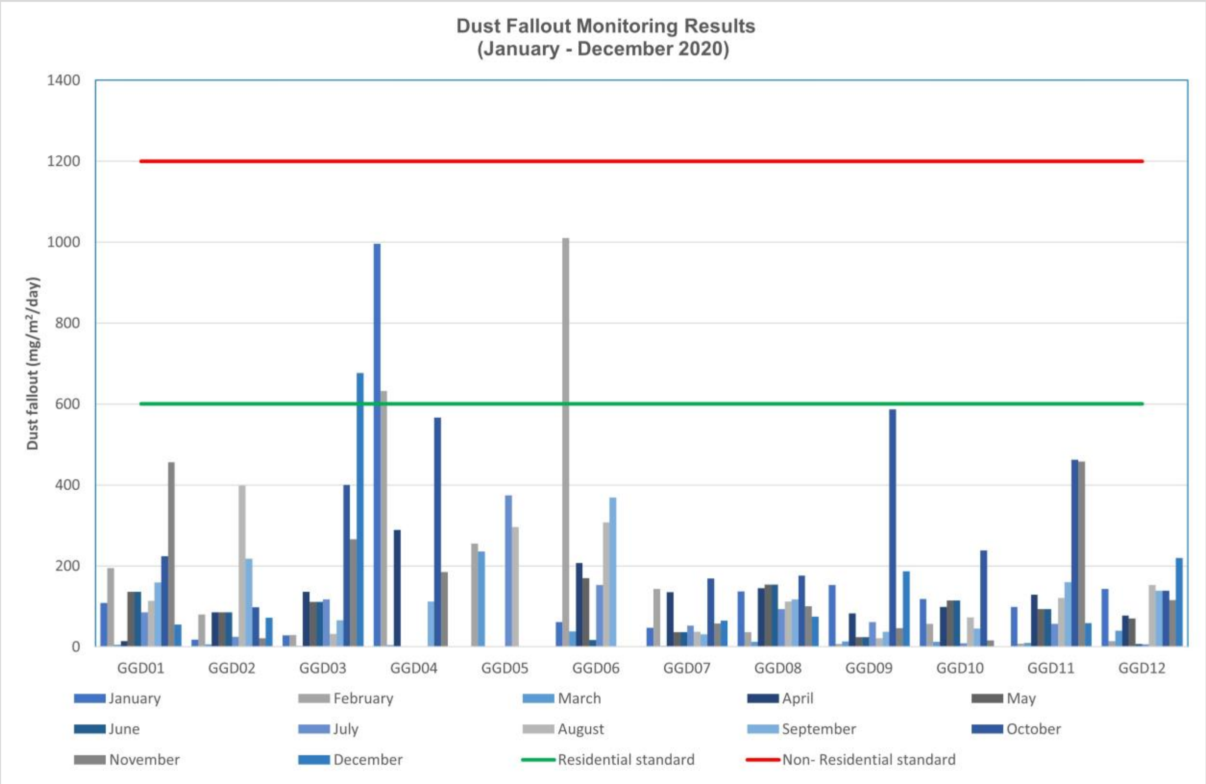

Figure 4-9: Onsite Dust fallout rates recorded during January – December 2020

Overall poor sample recovery was noted to occur frequently at GGD04 (west of mine), GGD05 (behind mine pit) and GGD10 (next to discard dump) due to contaminated results for the 2018 – 2020 monitoring period. 2019 recorded the highest number of exceedances, with dust fallout showing a decrease in 2020, with no exceedances recorded. Site GGD07 was noted to exceed the NDCR more often than any other site, particularly during the summer months. Apart from exceedances, dust fallout levels recorded during the sampling period were low.

4.4.2 EXISTING SOURCES OF POLLUTION

A qualitative discussion of identified emission sources in the vicinity of the study site is provided below. Key emission sources in the region are mining and industrial activities. These emission sources contribute towards the air quality status quo in the Lephalale Local Municipality, with Particulate Matter (PM) being of particular concern in this regard.

MINING ACTIVITIES

Mining is the predominant land use within the Lephalale Local Municipality, with an existing and operational coal mine located west of the proposed Solar PV plant. Coal mining operations are a prevalent source of emissions within the WBPA. Expected fugitive emissions from mining activities include, but are not limited to[19]:

- Vehicle entrainment on paved and unpaved roads;
- Crushing and screening activities;
- Drilling and blasting;
- Wind erosion of exposed stockpiles, waste dumps and tailings storage facilities;

- Stripping of overburden; and
- Materials handling operations[19].

Fugitive emissions are noted to be highest during the loading of fresh coal onto stockpiles as fine coal particulates are easily broken down and dispersed to the atmosphere.

INDUSTRIAL ACTIVITY

Coal reserves in the region has led to the establishment of two large coal fired Power Generation plants. The world's largest dry cooled power station is located approximately 5km south of the proposed Solar PV plant. Air emissions associated with coal fired power stations are particulates, sulphur dioxide, oxides of nitrogen, carbon monoxide, carbon dioxide, nitrous oxide and trace amounts of mercury[20]. South African coal reserves have a high ash content and is noted to be key source of particulate emissions[21].

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[19] USEPA (1995): Compilation of Air Pollutant Emission Factors (AP-42) US Environmental Protection Agency

[20] Department of Environmental Affairs (DEA). (2014): The Waterberg-Bojanala Priority Area Air Quality Management Plan: Baseline characterisation, October 2014.

[21] Everson,R.C., Kalibantonga, P.D., Neomagus, J.P., and Wagner, N.J., (2009): *Combustion characteristic of high ash South African Coal reserves.* United Kingdom, July 2009.

5 STUDY METHODOLOGY

5.1 EMISSION ESTIMATION

Emissions for the proposed Lephalale Solar PV plant were calculated using the US EPA's AP42 and Australian NPI emission factors. An emission factor is a value representing the relationship between an activity and the rate of emissions of a specified pollutant. The AP42 emission factors have been compiled since 1972 and contain emission factors and process information for over 200 air pollution source categories. These emission factors have been developed based on test data, material mass balance studies and engineering estimates.

Emission estimates were based on the AP42 sections: Chapter 13-Section 2.3: Heavy Construction Operations; Chapter 11 Section 9: Western Surface Coal Mining -Wind erosion of exposed areas and Chapter 13.2.2: Unpaved Roads as well National Pollutant Inventory Emission Estimation Technique Manual for Mining (NP1). Calculations were applied to individual processes to obtain an emission to air estimate, based on operational information provided by GCS. The specific processes and emission calculations are discussed in detail below.

Emissions of dust fallout (modelled as TSP), PM_{10} and $PM_{2.5}$ were calculated for construction activities. Where emission factors for PM_{10} were not available, a factor of 50% was applied to the calculated TSP emission rates according to best international practice and as specified in the US EPA's AP42 documentation (US EPA, 1998[22]). Where emission factors for $PM_{2.5}$ were not available the generalised particle size distributions in the AP42 Appendix B.2 were utilised.

All sources quantified for this assessment as shown for **Figure 5-1** and **Figure 5-2**[23].

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[22] USEPA (1995): Compilation of Air Pollutant Emission Factors (AP-42) US Environmental Protection Agency

[23] Site layout Maps Provided by GCS

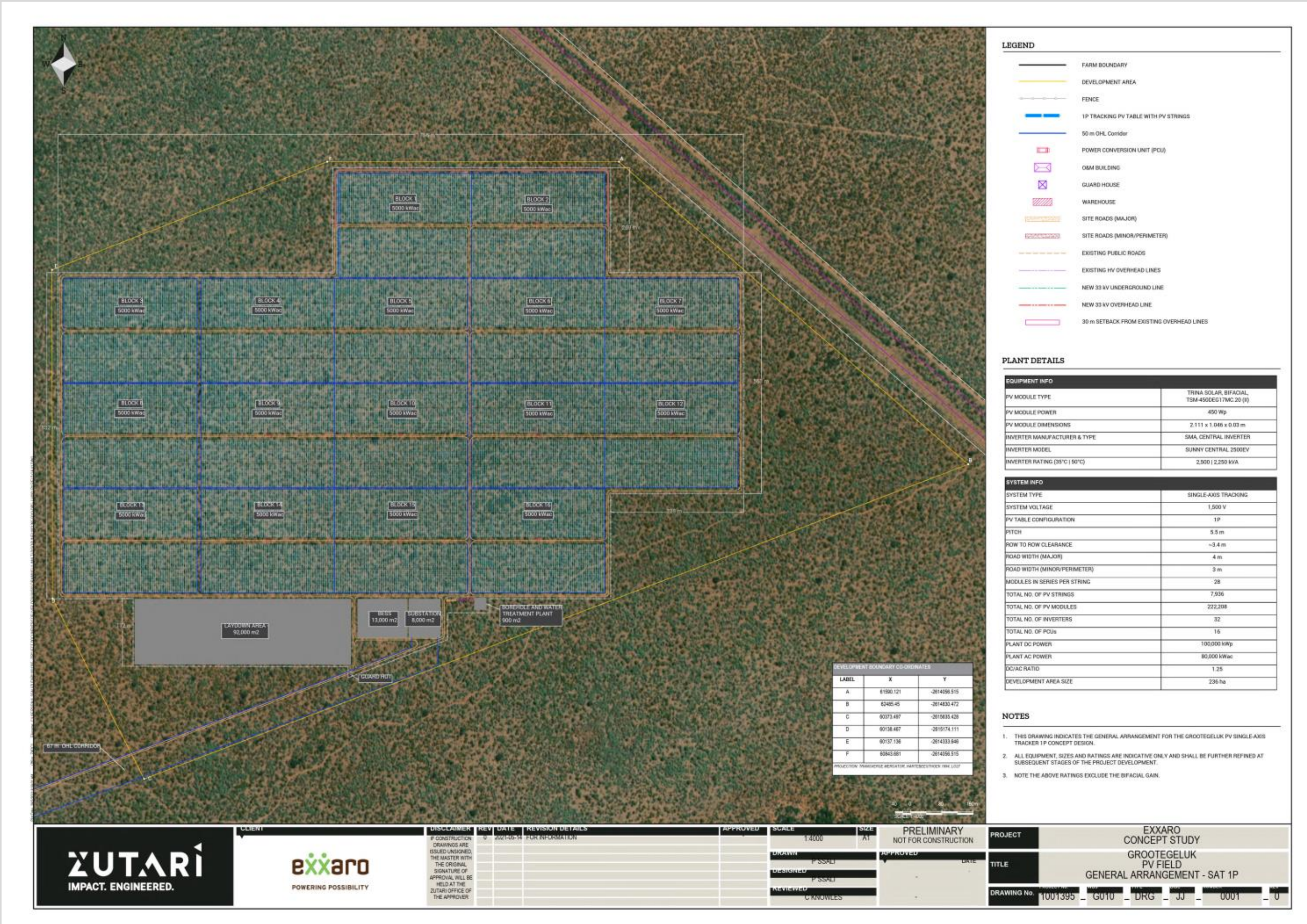

Figure 5-1: Detailed layout of proposed PV plant and associated infrastructure

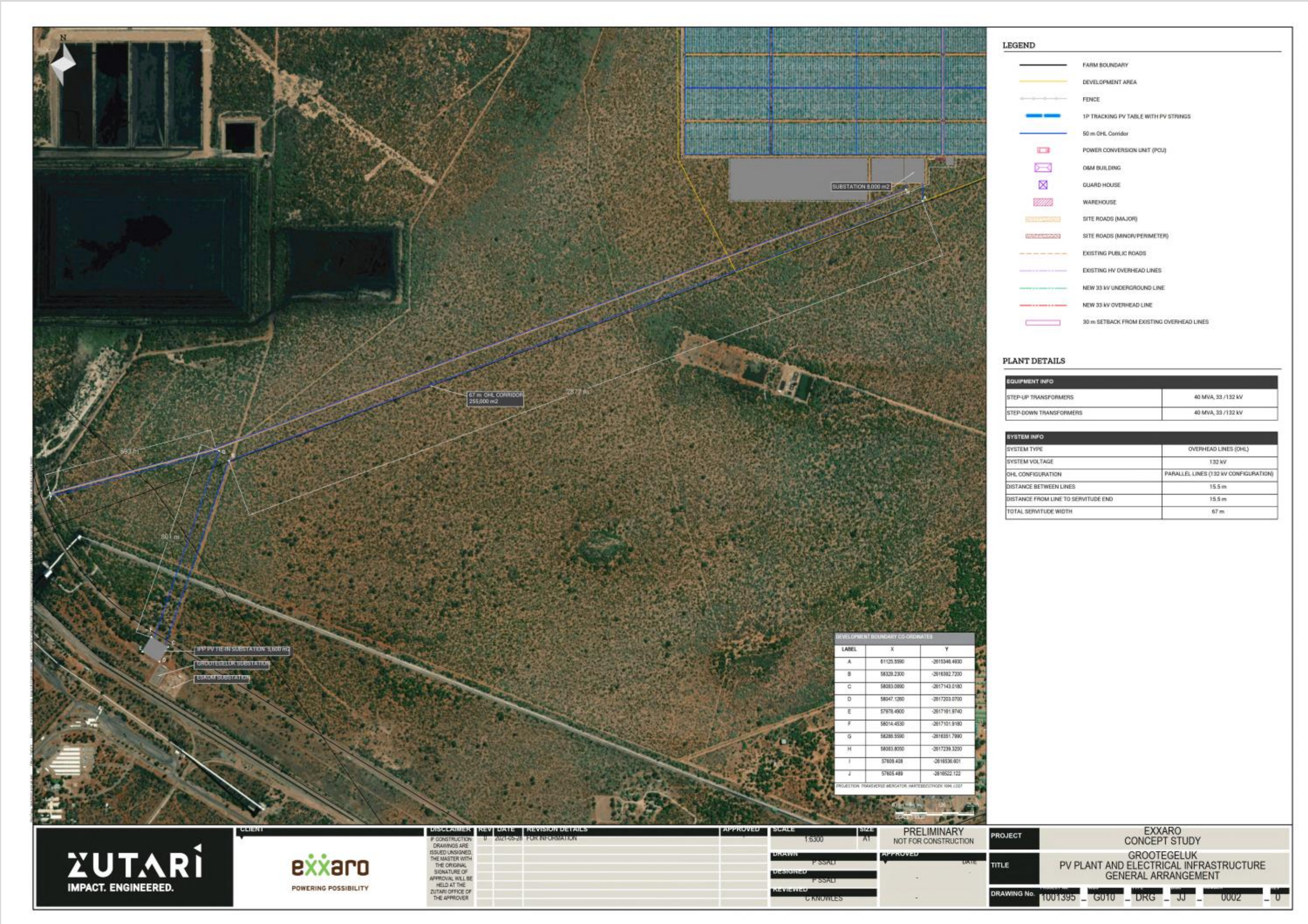

Figure 5-2: Layout of proposed Access road

5.1.1 CONSTRUCTION

Minimal information regarding the construction phase of the proposed Solar PV plant were made available. Due to a lack of detailed information (e.g. number of dozers to be used on site, size and locations of temporary stockpiles and rate of onsite vehicle activity), emissions were estimated on an area wide basis.

The quantity of dust emissions was assumed to be proportional to the area of land being worked and the level of construction activity. The US-EPA documents emission factors that aim to provide a general rule-of-thumb as to the magnitude of emissions, which may be anticipated from construction operations. Based on field measurements of total suspended particulates (TSP), the approximate emission factors for construction activity are given as:

$E = 2.69\ (MG/hectares)/month\ of\ activity$[24]

$\mathrm{E} = 1.2\ \mathrm{tons/acre/month}\ of\ activity$

These values are most useful for developing estimates of overall emissions from construction scattered throughout a geographic area. The value is most applicable to construction operations with (1) medium activity level, (2) moderate silt content and (3) semi-arid climate. Calculated construction emission rates are presented in **Table 5-1** below. Although the equation above represents a relatively simple means of preparing an areawide emissions inventory, the limitations is such that it cannot provide information about which construction activity have the greatest emission potential nor guidance for developing an effective dust control plan. It must be noted that the emission rates used to calculate such emissions are environmentally conservative (i.e. an overestimation of emissions) for most construction sites, with results presented in this AQIA likely being higher than those experienced in reality[24].

The construction emission factor has an emission factor rating of **B** which indicates an above average confidence rating.

Table 5-1: Construction emissions at Lephalale Solar PV Plant

Solar PV Plant	Uncontrolled (t/a)	Controlled (t/a)
TSP	8378.5	4189
PM_{10}	2932	1466
$PM_{2.5}$	444	222

The following assumptions are noted:

- Construction was indicated to take place over a period of 12-14 months. A 12-month construction period was used as a conservative approach to emissions estimation during modelling simulations and applicable to disturbed areas only i.e. Solar PV table, laydown areas, BESS, substation, water treatment plant and guard hut;
- Construction will take place from Monday - Saturday between 06:00 am -18:00pm, model simulation was set up to reflect variable emissions to account for these construction times;
- PM_{10} and $PM_{2.5}$ emission factor ratios were applied based on the US EPA AP-42 Appendix B.2: Generalised particle size distribution (PM_{10} is 35% of TSP and $PM_{2.5}$ is 5.3 % of TSP); and

[24] USEPA (1995): Compilation of Air Pollutant Emission Factors (AP-42) US Environmental Protection Agency, Chapter 13, Section 2.3 - Heavy Construction Operations

- Dust suppression in the form of water sprays will be applied during construction, as confirmed by Exxaro. Therefore a 50% control efficiency was applied as per NPI recommendations utilising water sprays during construction activity.

5.1.2 WIND EROSION

Dust emissions may be generated by wind erosion of open storage piles and exposed areas within a facility. In the absence of data regarding fine material and moisture content of disturbed areas, the US EPA emission factor for wind erosion over exposed areas were used to estimate emissions rates (**Table 5-2**).

Table 5-2: Wind erosion over exposed surfaces

Solar PV plant	TSP	PM_{10}	$PM_{2.5}$
Uncontrolled Calculated emission rate (t/a)			
All exposed/disturbed areas	217.6	108.8	16.32
Controlled Calculated emission rate (t/a)			
All exposed/disturbed areas	108.8	54.4	8.16

The following assumptions are noted:

- Exposed/disturbed areas refers to Solar PV table, BESS, substation, laydown area, water treatment plant and guard hut;
- Variable emissions were not selected during modelling simulations as wind erosion is expected to occur continuously;
- PM_{10} and $PM_{2.5}$ emission factor ratios were calculated based on the US EPA AP-42 Chapter 13.2.5: Industrial Wind erosion (PM$_{10}$ is 50% of TSP, while PM$_{2.5}$ is 7.5% of TSP); and
- Dust suppression in the form of water sprays will be applied during wind erosion over exposed areas, as confirmed by Exxaro. Therefore a 50% control efficiency was applied as per NPI recommendations utilising water sprays over exposed areas.

5.1.3 VEHICLE ENTRAINMENT ON UNPAVED ROADS

Vehicle-entrained dust emissions from unpaved roads represent a significant source of fugitive dust. When a vehicle travels on an unpaved road, the force of the wheels on the road surface causes the pulverisation of surface material[25]. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed[25].

The unpaved road size-specific emission factor equations from the USEPA are given below. The quantity of dust emissions from a given segment of unpaved road varies linearly with the volume of traffic. In addition to the volume of traffic, emissions also depend on source parameters which characterise the condition of a particular road and the associated vehicle traffic. These parameters include vehicle speeds, mean vehicle weight, average number of wheels per vehicle and road surface moisture[25].

[25] USEPA (1995): Compilation of Air Pollutant Emission Factors (AP-42) US Environmental Protection Agency, Chapter 13.2.2, Unpaved roads.

Particulate emission estimates from construction trucks travelling on the main access roads at the Solar PV plant are presented below. The equation used to determine particulate emissions from vehicles travelling on unpaved roads at industrial sites is presented below:

$$E = \left(k\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b}\right)(281.9)\ \frac{g}{VKT}$$

Where s is the surface material silt content (%), W is the mean vehicle weight; and a, b and k are empirical constants

These emission factors relate the amount of particulate emissions (in grams) to the number of kilometres travelled by vehicles on site (VKT). **Table 5-3** presents the empirical constants used in the equation for different particle sizes and **Table 5-4** presents the calculated emissions rates presented in Tons per hour.

Table 5-3: Empirical constants

Constant	TSP	PM_{10}	$PM_{2.5}$
a	0.7	0.9	0.9
b	0.45	0.45	0.45
k	4.9	1.5	0.15

Table 5-4: Unpaved roads emission rates

Route Description	Activity	TSP (t/a)	PM_{10} (t/a)	$PM_{2.5}$ (t/a)
Access road	Trucks from Main road to Solar PV site	Uncontrolled		
		644	183	18
		Controlled		
		161	45	4.6

The following assumptions are noted:

- Surface silt content at Lephalale Solar PV is unknown, therefore the silt content was based on the US EPA AP42 generic values for haul roads to and from a pit at 8.4%;
- A total loaded truck weight of 38 tons was used for construction trucks (30-ton vehicle wight and 8-ton weight capacity);
- It was assumed that trucks will operate at the same time as the plant (12 hours per day);
- The unpaved access road from the Solar Facility to the Exarro Grootegeluk mine was estimated at 4km in length and 5m in width; and
- Dust suppression in the form of water sprays will be applied during vehicle entrainment on unpaved roads, as confirmed by Exxaro. Therefore a 75% control efficiency was applied as per NPI recommendations utilising water sprays over unpaved roads.

5.2 SOURCE APPORTIONMENT

Figure 5-3 - Figure 5-5 illustrates the contribution of individual sources to the overall PM_{10}, $PM_{2.5}$ and TSP concentrations anticipated at the Lephalale Solar PV during construction. The largest source of PM_{10} is attributed to construction activities with 91%, followed by unpaved roads with 6% and wind erosion with 3% (**Figure 5-3**).

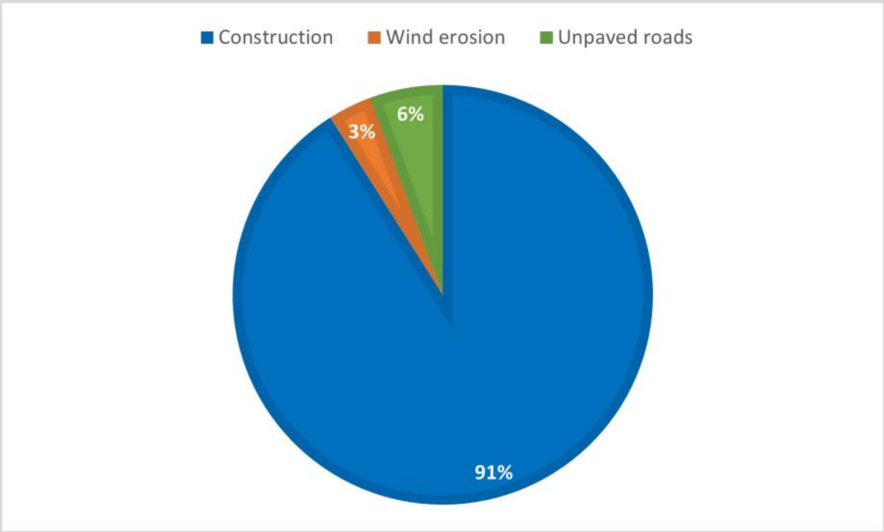

Figure 5-3: PM_{10} source apportionment for Lephalale Solar PV

Figure 5-4 illustrates the source apportionment of $PM_{2.5}$, with the largest source attributed to construction activities with 93%, followed by unpaved road with 4% and wind erosion with 3%.

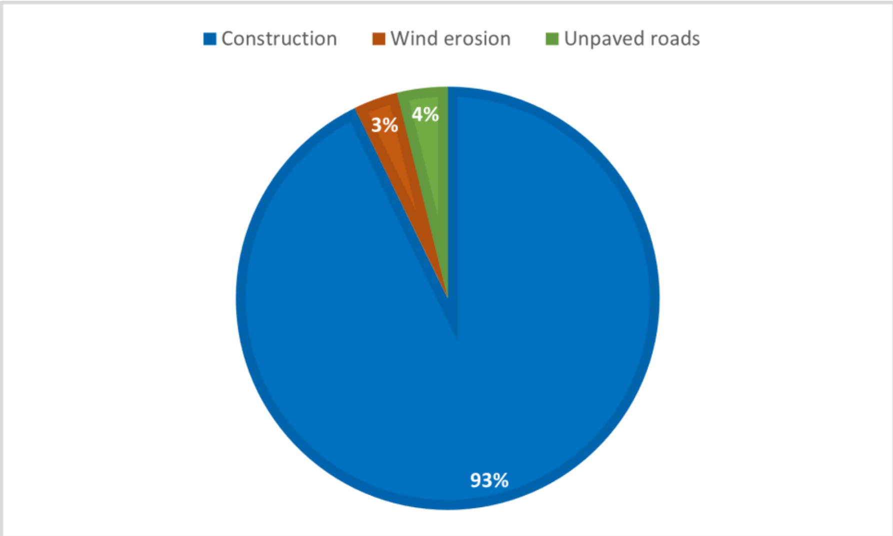

Figure 5-4: $PM_{2.5}$ source apportionment for Lephalale Solar PV

The largest source of TSP is attributed to construction activities with 91%, followed by unpaved roads with 7% and wind erosion with 2% (**Figure 5-5**).

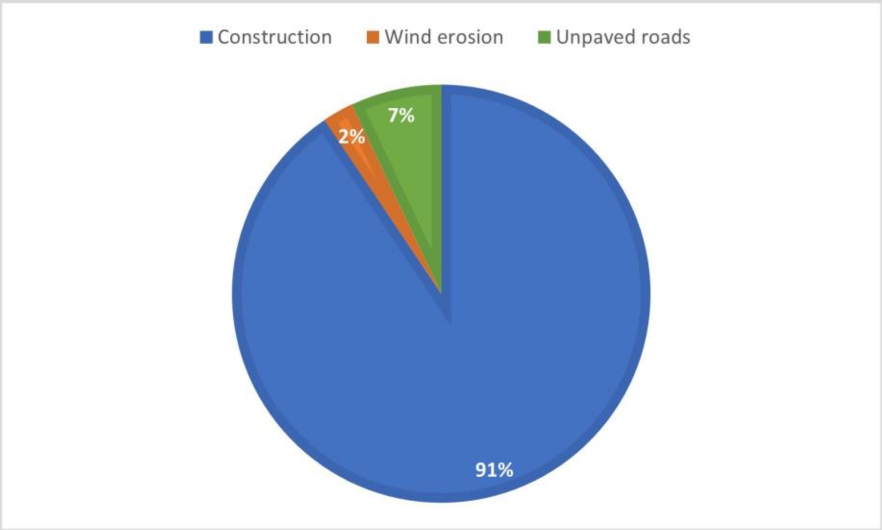

Figure 5-5: TSP source apportionment for Lephalale Solar PV

5.3 DISPERSION MODELLING

Atmospheric dispersion modelling mathematically simulates the transport and fate of pollutants emitted from a source into the atmosphere. Sophisticated software with algorithms that incorporate source quantification, surface contours and topography, as well as meteorology can reliably predict the downwind concentrations of these pollutants.

AERMOD, a Level Two dispersion modelling platform, is recommended in the South African Regulations Regarding Air Dispersion Modelling (the Modelling Regulations, Regulation No 533 of 11 July 2014, Government Gazette 37804) and was utilised to predict ground level downwind concentrations of pollutants emitted from the Lephalale Solar PV project.

AERMOD is a new generation air dispersion model designed for short-range dispersion of airborne pollutants in steady state plumes that uses hourly sequential meteorological files with pre-processors to generate flow and stability regimes for each hour, that produces output maps of plume spread with key isopleths for visual interpretation and enables, through its statistical output, direct comparisons with the latest National and International ambient air quality standards for compliance testing.

The AERMOD atmospheric dispersion modelling system is an integrated system that includes three modules:

— A steady-state dispersion model designed for short-range (up to 50 km) dispersion of air pollutant emissions from stationary industrial sources;
— A meteorological data pre-processor (AERMET) that accepts surface meteorological data, upper air soundings, and optionally, data from on-site instrument towers. It then calculates atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov length and surface heat flux; and
— A terrain pre-processor (AERMAP) whose main purpose is to provide a physical relationship between terrain features and the behaviour of air pollution plumes. It generates location and height data for each receptor location. It also provides information that allows the dispersion model to simulate the effects of air flowing over hills or splitting to flow around hills.

5.3.1 MODELLING SCENARIOS

For the purposes of this investigation, various statistical outputs were generated, as described below:

— Uncontrolled construction scenario (unmitigated)

The unmitigated scenario refers to the 99th percentile concentration. The 99th percentile concentrations are recommended for short-term assessment with the available ambient air quality standards since the highest predicted ground level concentrations can be considered outliers due to complex variability of meteorological processes. This might cause exceptionally high concentrations that the facility may never actually exceed in its lifetime.

— Controlled construction scenario (mitigated)

The mitigated scenario refers to the 99th percentile concentration. The 99th percentile concentrations are recommended for short-term assessment with the available ambient air quality standards since the highest predicted ground level concentrations can be considered outliers due to complex variability of meteorological processes. This might cause exceptionally high concentrations that the facility may never actually exceed in its lifetime.

5.3.2 MODELLING INPUT

Data input into the model includes modelled MM5 surface and upper air meteorological data with wind speed, wind direction, temperature, pressure, precipitation, cloud cover and ceiling height for January 2018 – December 2020 (**Figure 5-6**).

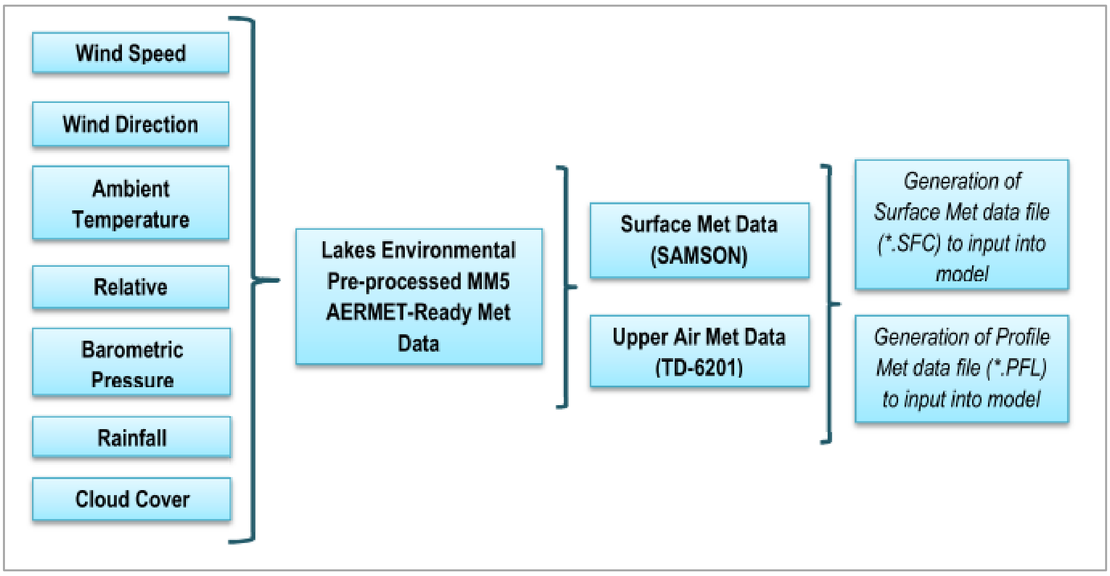

Figure 5-6: Meteorological data path

Table 5-5: Dispersion model input parameters

Parameter	Model Input
Model	
Assessment Level	Level 2
Dispersion Model	Aermod 9.9.0
Supporting Models	Aermet and Aermap
Emissions	
Pollutants modelled	PM_{10}, $PM_{2.5}$, dust fallout
Scenarios	Uncontrolled and Controlled
Chemical transformation	N/A
Exponential decay	N/A
Settings	
Terrain setting	Flat
Terrain data	N/A
Terrain data resolution (m)	N/A
Land characteristics	Rural
Bowen ratio	0.93
Surface albedo	0.29
Surface roughness	0.04
Grid Receptors	
Modelling domain (km)	10 x 10
Property line resolution (m)	50
Fine grid resolution (m)	50 m resolution, 500 m from domain centre
Medium grid resolution (m)	100 m resolution, 2000 m from domain centre
Course grid resolution (m)	250 m resolution, 10000 m from domain centre

5.3.3 MODELLING DOMAIN

A modelling domain of 10 km × 10 km was used (**Table 5-6**) with multi-tier cartesian grid receptor spacing of 50 m, 100 m and 250 m. The grid spacing selected for the receptor grid is in accordance with those specified in the Modelling Regulations.

Table 5-6: Modelling domain coordinates

Domain Point	UTM Coordinates mE	UTM Coordinates mS
North-Western Point	550953.32	7391805.04
North-Eastern Point	573296.67	7392909.77
South-Western Point	550844.82	7380123.40
South-Eastern Point	572255.00	7380087.23

6 RESULTS AND DISCUSSION

6.1 DISPERSION MODELLING RESULTS

This section of the report presents the results of the atmospheric dispersion modelling conducted for the construction phase of the Lephalale Solar PV plant. Concentration results at specified receptors are presented in tabular format, while concentration isopleths are presented graphically to indicate the dispersion of pollutants. Modelling simulations assessed two scenarios; scenario 1 assessing construction activities without mitigation and scenario 2 assessing construction activities with mitigation.

6.1.1 SCENARIO 1 UNCONTROLLED EMISSIONS

PM_{10} CONCENTRATIONS

Ambient annual average PM_{10} concentrations are predicted to be compliant at all sensitive receptors (**Table 6-1**). Sensitive receptor (REC 01 Village) predicted an exceedance of the 24-hourly average PM_{10} concentration, however all other sensitive receptors remain compliant with the 24-hourly standard.

Figure 6-1 and **Figure 6-2** present graphical outputs of the 24-hour average and annual average modelled results respectively. Unmitigated highest predicted 24-hour and annual average fence-line concentrations are non-compliant with the relevant standards due to the close proximity of the Solar PV access road to the boundary. However, despite the non-compliance predicted on the fence-line of the Solar PV facility, all concentrations predicted at neighbouring sensitive receptors (with the exception of REC 01- Village) remain compliant with their relevant standards, as noted previously.

Table 6-1: Predicted PM_{10} concentrations at neighbouring sensitive receptors

ID	Sensitive Receptor	24-Hour Average PM_{10} Standard (µg/m³)	Predicted 24-Hour Average Concentration (µg/m³)	Annual Average PM_{10} Standard (µg/m³)	Predicted Annual Average Concentration (µg/m³)
REC 01	Village	**75**	80	**40**	26.93
REC 02	Ditheku Primary school	**75**	61	**40**	20.35
REC 03	Marapong Private Hospital	**75**	57	**40**	15.67
REC 04	Nelsonkop Primary School	**75**	37	**40**	10.61
REC 05	Marapong Residential	**75**	69	**40**	25.36
REC 06	Manketti Lodge	**75**	63	**40**	15.02
	Maximum fence-line Concentration	**75**	1020	**40**	124

* Concentrations highlighted in red indicate non-compliance

$PM_{2.5}$ CONCENTRATIONS

Ambient 24-hour (P99) and annual average $PM_{2.5}$ concentrations are predicted to be compliant at all sensitive receptors during construction of the Solar PV facility (**Table 6-2**). No exceedances were predicted at sensitive receptors with concentrations remaining below the respective standards. **Figure 6-3** and **Figure 6-4** present graphical outputs of the 24-hour average and annual average modelled results respectively.

Unmitigated highest predicted 24-hour average fence-line concentrations are non-compliant with the relevant standard due to the close proximity of the Solar PV access road to the boundary. Highest predicted annual average fence-line concentration remains compliant with the standard.

Table 6-2: Predicted $PM_{2.5}$ concentrations at neighbouring sensitive receptors

ID	Sensitive Receptor	24-Hour Average $PM_{2.5}$ Standard (µg/m³)	Predicted 24-Hour Average Concentration (µg/m³)	Annual Average $PM_{2.5}$ Standard (µg/m³)	Predicted Annual Average Concentration (µg/m³)
REC 01	Village	**40**	39	**20**	3.99
REC 02	Ditheku Primary school	**40**	29	**20**	3.03
REC 03	Marapong Private Hospital	**40**	22	**20**	2.33
REC 04	Nelsonkop Primary School	**40**	17	**20**	1.57
REC 05	Marapong Residential	**40**	20	**20**	3.99
REC 06	Manketti Lodge	**40**	19	**20**	2.19
	Maximum Fence line Concentration	**40**	141	**20**	19.4

* Concentrations highlighted in red indicate non-compliance

DUST FALLOUT

Maximum predicted daily dust deposition due to construction operations are well within the NDCR at all sensitive receptors (**Table 6-3)**. There were no exceedances of the residential standard. **Figure 6-5** present graphical outputs of the daily modelled dust fallout rates. Highest predicted daily average fence-line dust fallout rates are non-compliant with the NDCR, due to the close proximity of the Solar PV access road to the boundary. Importantly, despite the non-compliance on the fence-line of the Solar PV facility, all dust fallout rates predicted at the neighbouring sensitive receptors remain compliant with their relevant standards, as noted previously.

Table 6-3: Predicted Dust fallout (mg/m²/day) concentrations at neighbouring sensitive receptors

ID	Sensitive Receptor	Residential standard (mg/m²/day)	Predicted 24-hour dust fallout concentration (mg/m²/day)
REC 01	Village	**600**	30.94
REC 02	Ditheku Primary school	**600**	22.35
REC 03	Marapong Private Hospital	**600**	19.35
REC 04	Nelsonkop Primary School	**600**	12.94

ID	Sensitive Receptor	Residential standard ($mg/m^2/day$)	Predicted 24-hour dust fallout concentration ($mg/m^2/day$)
REC 05	Marapong Residential	**600**	34.82
REC 06	Manketti Lodge	**75**	25.47
	Maximum Fence line Concentration	**1200**	2946

* Concentrations highlighted in red indicate non-compliance

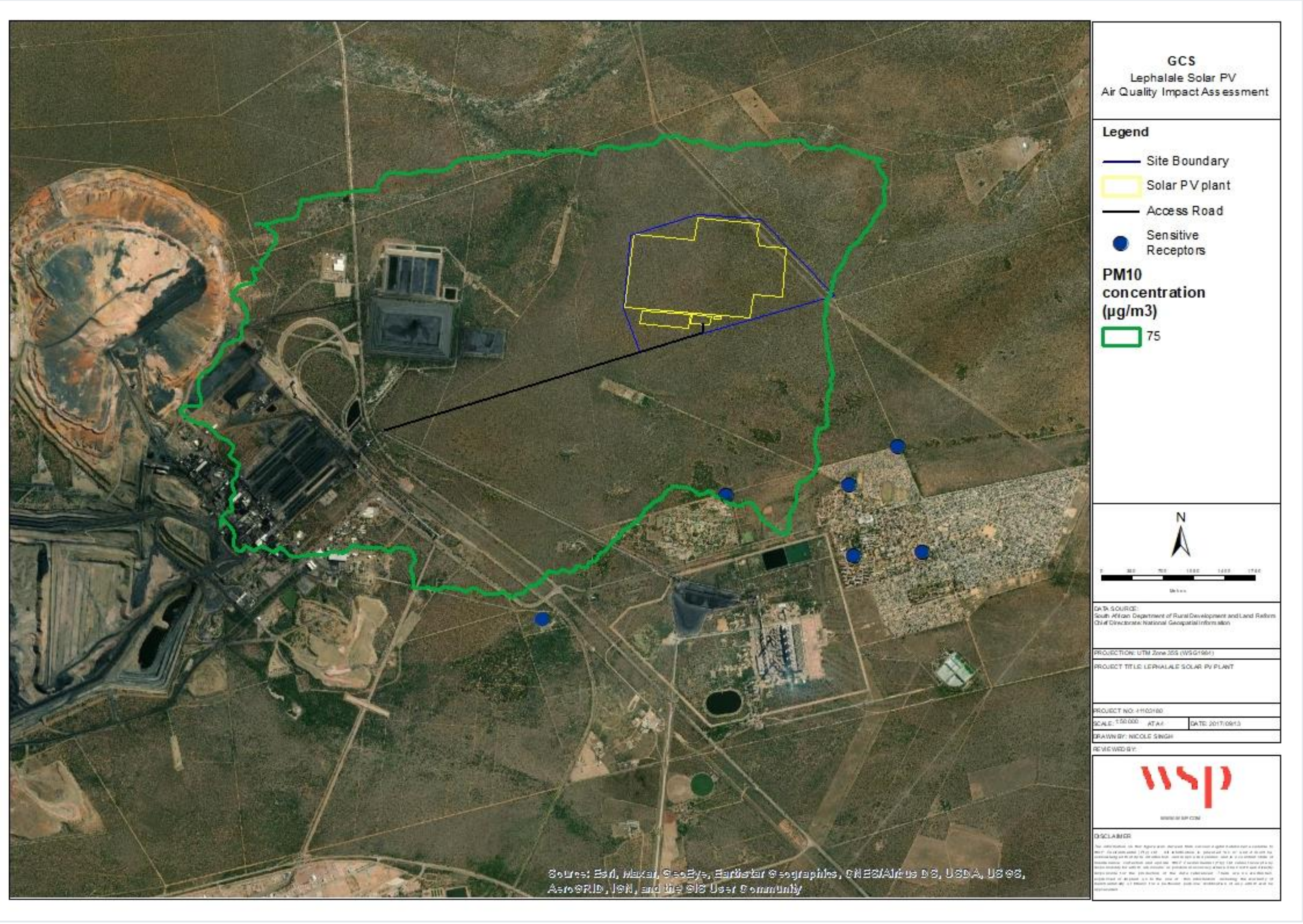

Figure 6-1: P99 24-hour average PM_{10} concentrations (µg/m^3)

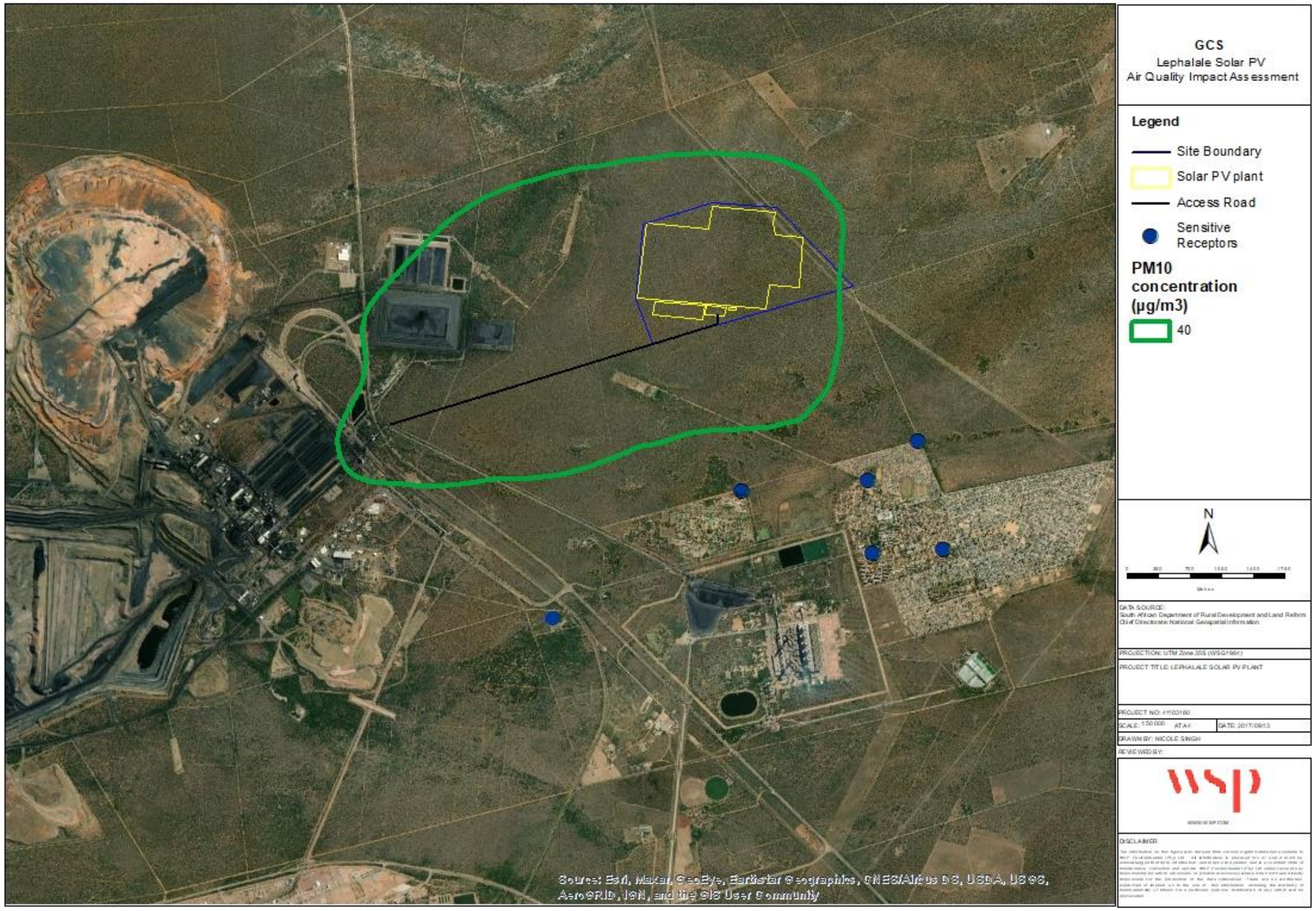

Figure 6-2: Annual average PM_{10} concentrations (µg/m³)

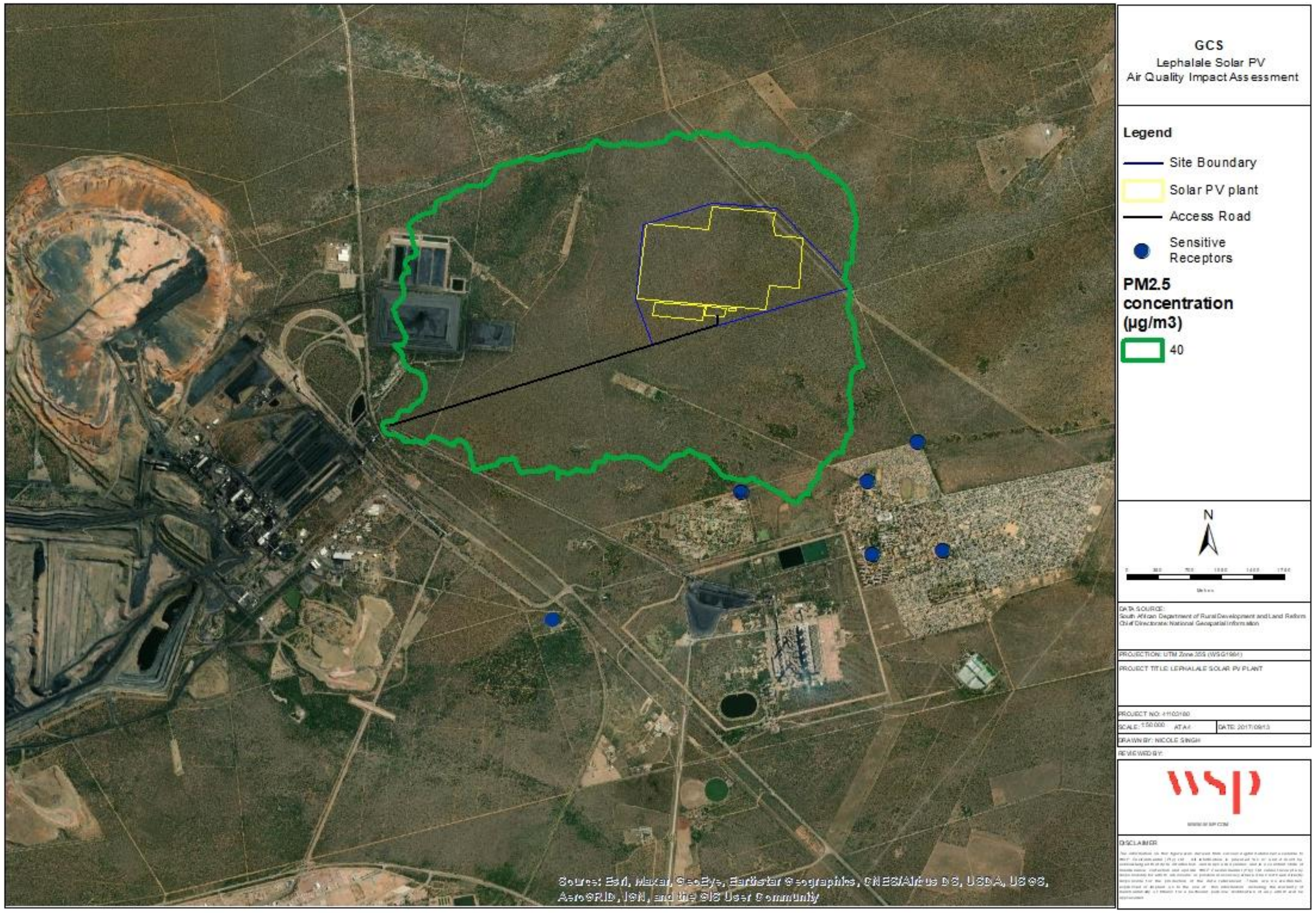

Figure 6-3: P99 24-hour average $PM_{2.5}$ concentrations (µg/m^3)

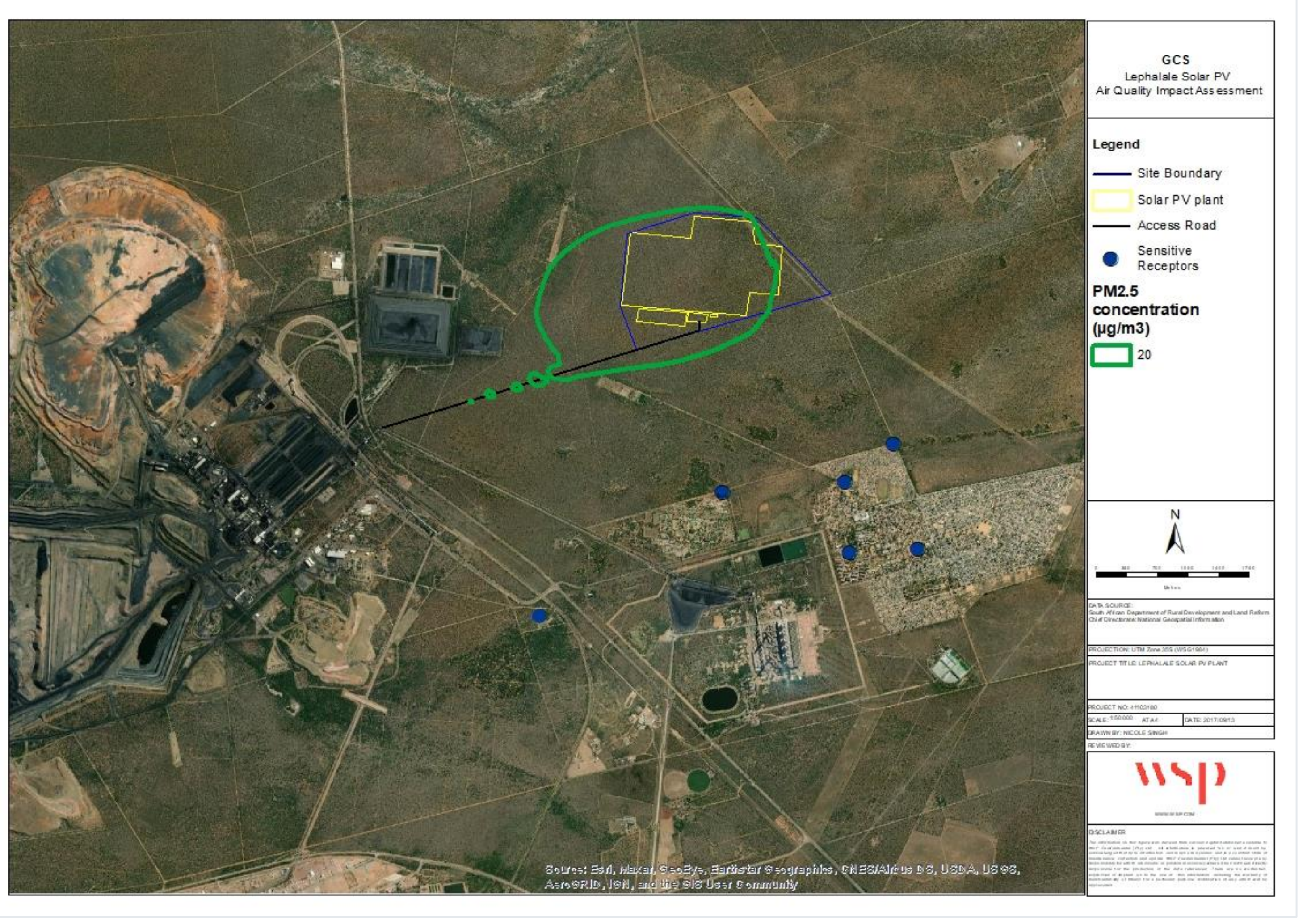

Figure 6-4: Annual average PM2.5 concentrations (µg/m³)

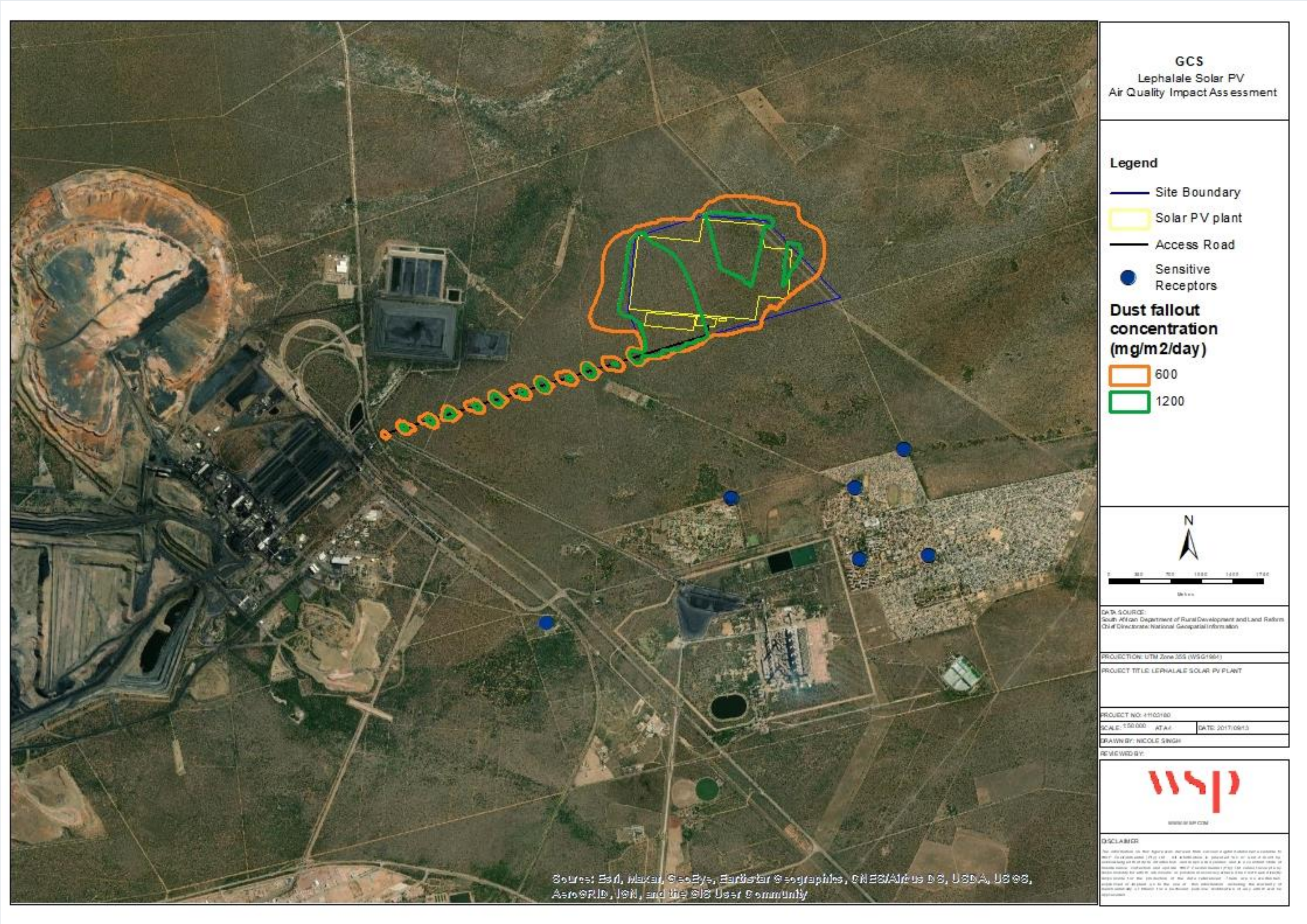

Figure 6-5: 24-hour average Dust fallout rate (mg/m^2/day)

6.1.2 SCENARIO 2 CONTROLLED EMISSIONS

Scenario 2 assessed controlled (Mitigated) emissions anticipated to occur during construction activities at the Solar PV plant.

PM_{10} CONCENTRATIONS

Ambient 24-hour (P99) and annual average PM_{10} concentrations are predicted to be compliant at all sensitive receptors (**Table 6-4**). No exceedances were predicted at sensitive receptors with predicted concentrations remaining below the standard.

Mitigated highest predicted 24-hourly fence-line concentration are, however, non-compliant as the access road to the Solar PV plant is located directly on the boundary. Highest predicted annual PM_{10} concentrations remain compliant with the standard. Importantly, despite the non-compliance on the fence-line of the Solar PV facility, all concentrations predicted at the neighbouring sensitive receptors remain compliant with their relevant standards, as noted previously.

Figure 6-6 and **Figure 6-7** present graphical outputs of the 24-hour average and annual average modelled results respectively.

Table 6-4: Predicted PM_{10} concentrations at neighbouring sensitive receptors

ID	Sensitive Receptor	24-Hour Average PM_{10} Standard (µg/m³)	Predicted 24-Hour Average Concentration (µg/m³)	Annual Average PM_{10} Standard (µg/m³)	Predicted Annual Average Concentration (µg/m³)
REC01	Village	**75**	58	**40**	13.06
REC02	Ditheku Primary school	**75**	44	**40**	9.97
REC03	Marapong Private Hospital	**75**	40	**40**	7.65
REC04	Nelsonkop Primary School	**75**	27	**40**	5.17
REC05	Marapong residential	**75**	57	**40**	12.44
REC 06	Manketti Lodge	**75**	28	**40**	7.09
	Maximum Fence line Concentration	**75**	380	**40**	32.8

* Concentrations highlighted in red indicate non-compliance

$PM_{2.5}$ CONCENTRATIONS

Ambient 24-hour (P99) and annual average $PM_{2.5}$ concentrations are predicted to be compliant at all sensitive receptors (**Table 6-5**). No exceedances were predicted at sensitive receptors with concentrations remaining below the respective standards.

Figure 6-8 and **Figure 6-9** present graphical outputs of the 24-hour average and annual average modelled results respectively. Mitigated highest predicted 24-hourly fence-line concentration is, however, non-compliant as the access road to the Solar PV plant is located directly on the boundary. Highest predicted annual $PM_{2.5}$ concentrations remain compliant with the standard. Importantly, despite the non-compliance on the fence-line of the Solar PV facility, all concentrations predicted at the neighbouring sensitive receptors remain compliant with their relevant standards, as noted previously.

Table 6-5: Predicted $PM_{2.5}$ concentrations at neighbouring sensitive receptors

ID	Sensitive Receptor	24-Hour Average $PM_{2.5}$ Standard ($\mu g/m^3$)	Predicted 24-Hour Average Concentration ($\mu g/m^3$)	Annual Average $PM_{2.5}$ Standard ($\mu g/m^3$)	Predicted Annual Average Concentration ($\mu g/m^3$)
REC01	Village	**40**	18	**20**	1.95
REC02	Ditheku Primary school	**40**	17.1	**20**	1.49
REC03	Marapong Private Hospital	**40**	8.0	**20**	1.14
REC04	Nelsonkop Primary School	**40**	4.0	**20**	0.77
REC05	Marapong residential	**40**	10.0	**20**	1.04
REC 06	Manketti Lodge	**40**	8.9	**20**	0.93
	Maximum Fence line Concentration	**40**	62.96	**20**	9.5

* Concentrations highlighted in red indicate non-compliance

DUST FALLOUT RATE

Maximum daily dust deposition rates due to construction operations were well within the NDCR at all sensitive receptors (**Table 6-6**). There were no predicted exceedances of the residential standard. **Figure 6-5** present graphical outputs of the daily average modelled dust fallout rates. Highest predicted daily average fence-line dust fallout rates remain compliant with the non-residential standard. Highest predicted dust fallout rates are along the access road to the Solar PV facility.

Table 6-6: Predicted Dust fallout concentrations at neighbouring sensitive receptors

ID	Sensitive Receptor	Residential standard ($mg/m^2/day$)	Predicted 24-hour dust fallout concentration ($mg/m^2/day$)
REC01	Village	**600**	17.37
REC02	Ditheku Primary school	**600**	11.7
REC03	Marapong Private Hospital	**600**	9.96
REC04	Nelsonkop Primary School	**600**	7.26
REC05	Marapong residential	**600**	18.2
REC 06	Manketti Lodge	**600**	13.5
	Maximum Fence line Concentration	**1200**	1094

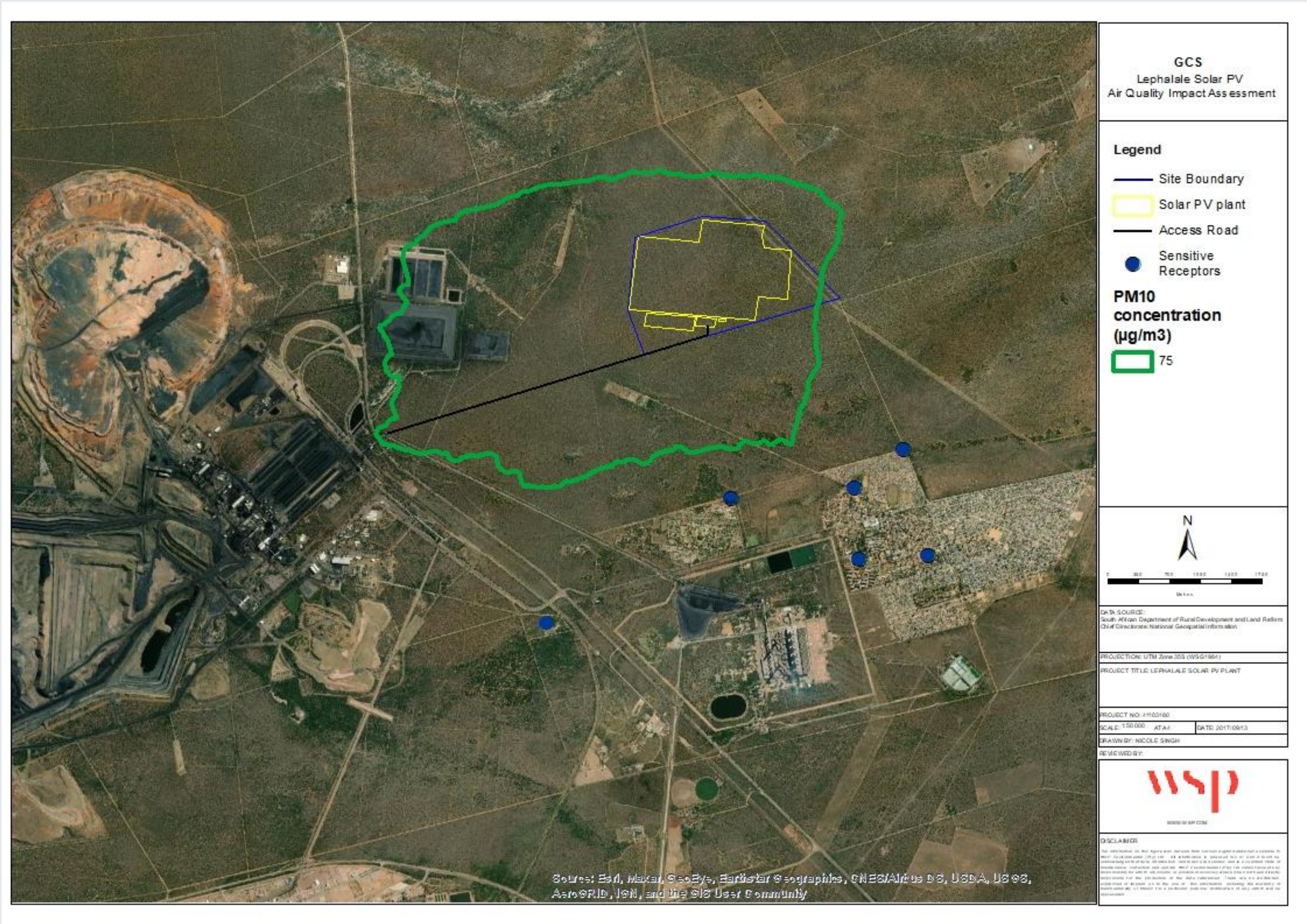

Figure 6-6: P99 24-hour average PM_{10} concentrations (µg/m^3)

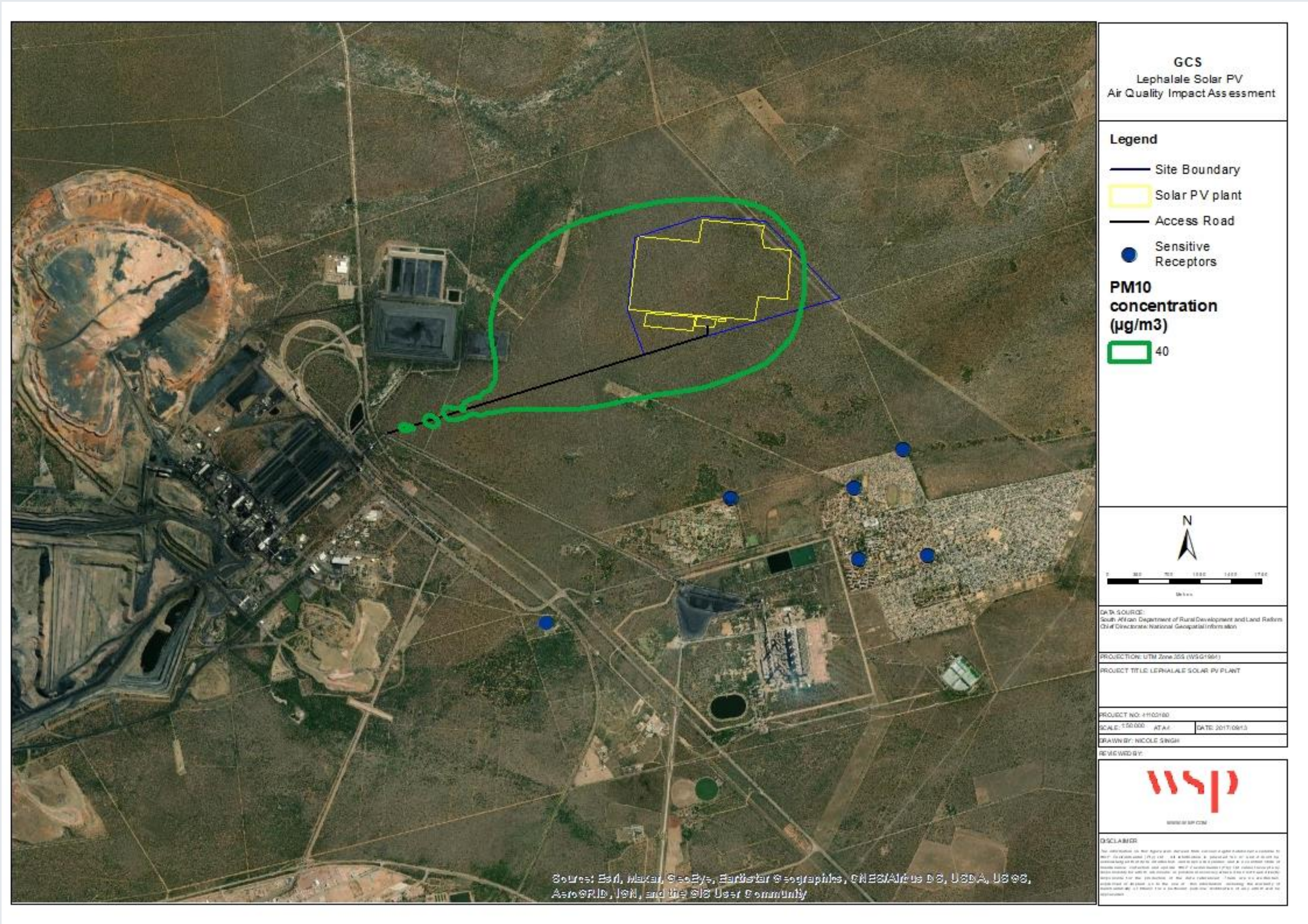

Figure 6-7: Annual average PM_{10} concentrations (µg/m³)

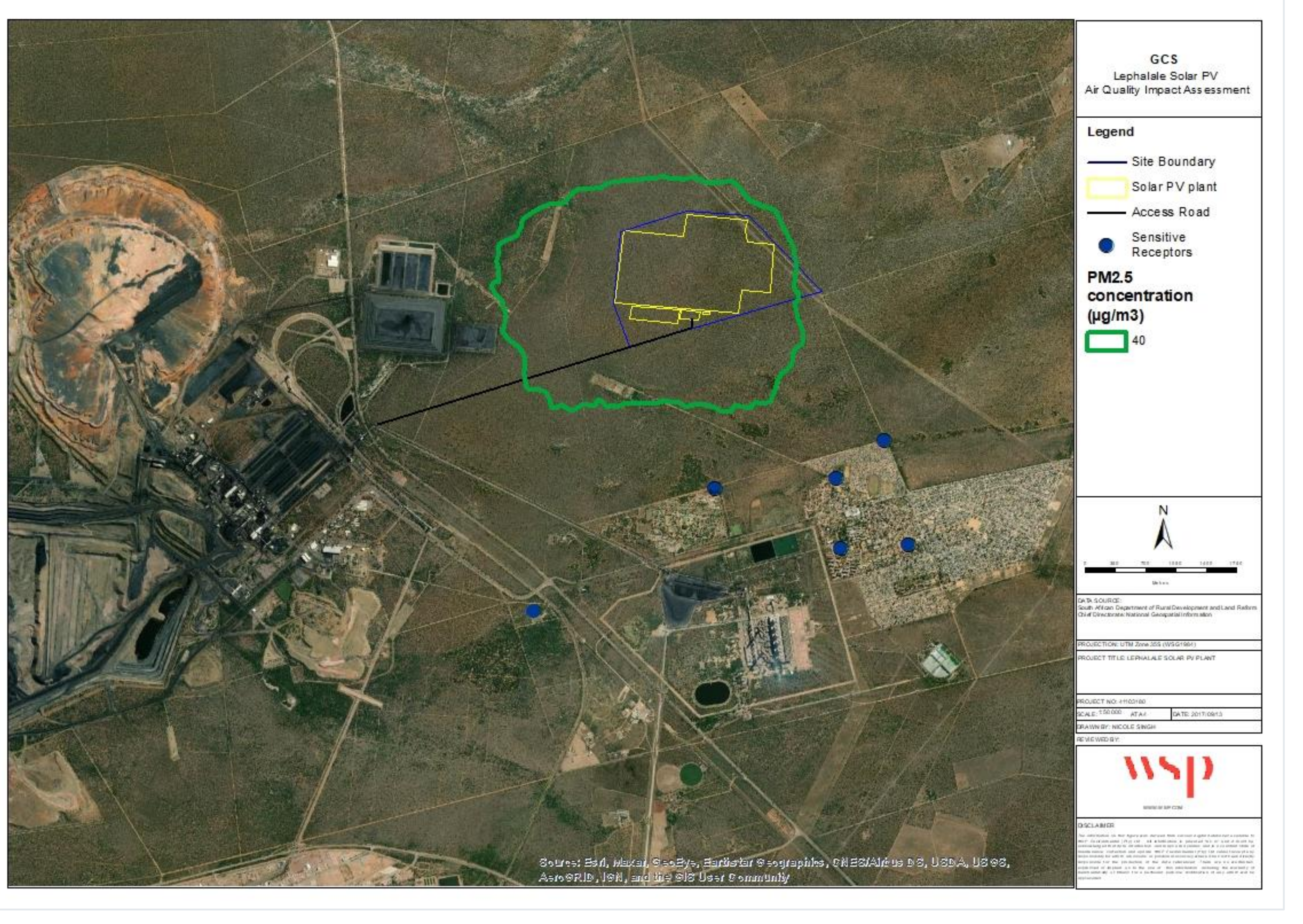

Figure 6-8: P99 24-hour average $PM_{2.5}$ concentrations (µg/m³)

Figure 6-9: Annual average $PM_{2.5}$ concentrations (µg/m^3)

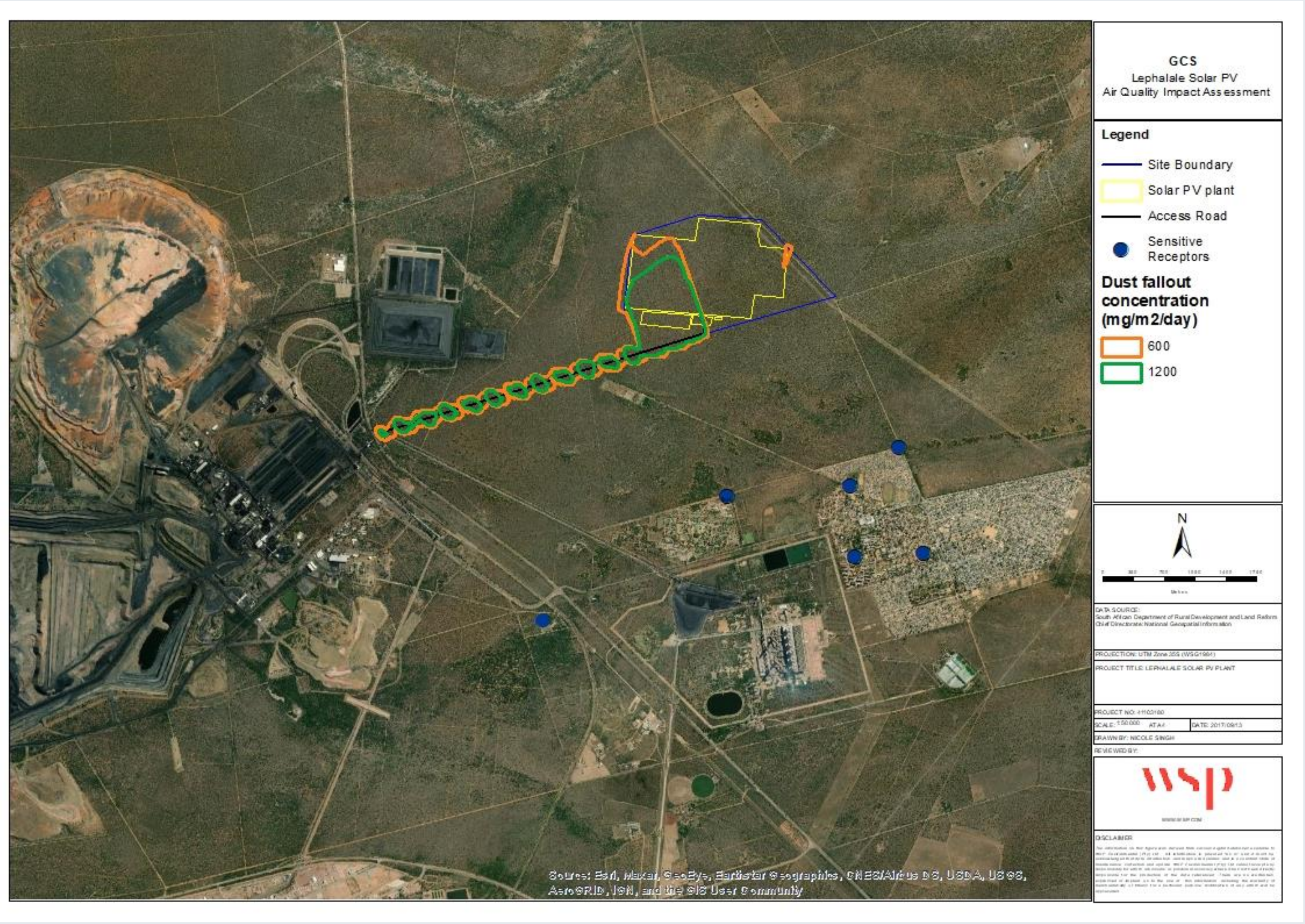

Figure 6-10: 24-hour average Dust fallout rate (mg/m^2/day)

6.1.3 CUMULATIVE ASSESSMENT

The National Framework for Air Quality Management in South Africa calls for air quality assessment in terms of cumulative impacts rather than the contributions from an individual facility. Compliance with the NAAQS is to be determined by considering all local and regional contributions to background concentrations. For each averaging time, the sum of the model predicted concentration (C_P) and the background concentration (C_B) must be compared with the NAAQS. The background concentrations C_B must be the sum of contributions from non-modelled local sources and regional background air quality. If the sum of background and predicted concentrations (C_B + C_P) is more than the NAAQS, the design of the facility must be reviewed (including pollution control equipment) to ensure compliance with NAAQS. Compliance assessments must provide room for future permits to new emissions sources, while maintaining overall compliance with NAAQS. For the different facility locations and averaging times, the comparisons with NAAQS must be based on recommendations in **Table 6-7.**

Cumulative impacts associated with the Lephalale Solar PV facility were not assessed for PM_{10} and $PM_{2.5}$ as data representative of the site was not available.

Table 6-7: Summary of recommended procedures for assessing compliance with NAAQS[26]

Facility Location	Annual NAAQS	Short-term NAAQS (24 hours or less)
Isolated facility not influenced by other sources; C_B insignificant*.	Highest C_P must be less than the NAAQS, no exceedances allowed.	99th percentile concentrations must be less than the NAAQS. Wherever one year is modelled, the highest concentrations shall be considered.
Facilities influenced by background sources e.g. in urban areas and priority areas.	Sum of the highest C_P and background concentrations must be less that the NAAQS, no exceedances allowed.	Sum of the 99th percentile concentrations and background C_B must be less than the NAAQS. Wherever one year is modelled, the highest concentrations shall be considered.
*For an isolated facility influenced by regional background pollution C_B must be considered.		

To determine the proposed cumulative impact of the Solar PV facility, predicted dust fallout concentrations from both scenarios (Unmitigated and Mitigated) have been added to the background ambient monitored dust fallout concentrations.

UNMITIGATED CUMULATIVE ASSESSMENT

Table 6-8: Cumulative concentrations of Dust fallout at neighbouring receptors

Receptor	Residential standard (mg/m²/day)	Measured DFO Average (mg/m²/day)	Predicted DFO Concentration (mg/m²/day)	Cumulative Concentrations (mg/m²/day)	Percentage Contribution of Predicted Concentrations to Cumulative Concentrations (%)
Village	**600**	145.7	30.94	176.64	17.5
Ditheku Primary school		145.7	22.35	168.05	13.2
Marapong Private Hospital		145.7	19.35	165.05	11.7

[26] DEAT. 2004. *Cumulative effects assessment, integrated environmental management, information series 7. Department of environmental affairs and tourism (DEAT), Pretoria.*

Nelsonkop Primary School		145.7	12.94	158.64	8.1
Marapong residential		145.7	34.82	180.52	19.2
Manketti Lodge		145.7	25.47	171.17	14.8

MITIGATED CUMULATIVE ASSESSMENT

Table 6-9: Cumulative concentrations of Dust fallout at neighbouring receptors

Receptor	Residential standard ($mg/m^2/day$)	Measured DFO Average ($mg/m^2/day$)	Predicted DFO Concentration ($mg/m^2/day$)	Cumulative Concentrations ($mg/m^2/day$)	Percentage Contribution of Predicted Concentrations to Cumulative Concentrations (%)
Village	600	145.7	17.30	163.07	10.6
Ditheku Primary school		145.7	11.70	157.40	7.4
Marapong Private Hospital		145.7	9.96	155.66	6.4
Nelsonkop Primary School		145.7	7.26	152.96	4.7
Marapong residential		145.7	18.20	163.90	11.1
Manketti Lodge		145.7	13.50	160.20	8.4

The following key items are noted from the cumulative assessment (**Table 6-8** and **Table 6-9**):

— During both Unmitigated and Mitigated scenario, the cumulative dust fallout concentrations are below the respective residential standards.

— Based on predicted cumulative concentrations, construction impacts from the Solar PV facility are likely to be minimal on the surrounding environment as the impacts are transient and concentrations predicted are well below the respective standard.

6.1.4 ASSUMPTIONS AND LIMITATIONS

The following assumptions have been made for the assessment:

— Data input for the emissions inventory and dispersion model is based on the information provided by the Client. It is assumed that this information provided is accurate and complete at the time of modelling;

— Use of the US EPA’s AP42 Heavy construction emission factor may provide an overestimation of emissions as it is considered to be environmentally conservative for most construction sites, with results presented in this AQIA likely being higher than those experienced in reality.

— A 12-month construction period was used as a conservative approach to emissions estimation during modelling simulations and applicable to disturbed areas only i.e. Solar PV table, laydown areas, BESS, substation, water treatment plant and guard hut;

— In the dispersion model, it was assumed that construction operations will take place from Monday - Saturday between 06:00 am -18:00pm (12-hour day, 6 days per week);

— In the absence of data regarding fine material and moisture content of disturbed areas, use was made of the US EPA AP 42 Industrial Wind Erosion emission factor for wind erosion over exposed areas. Variable emissions were not selected in the dispersion model as wind erosion is expected to occur continuously, regardless of construction times;

— Particulate matter emission factor ratios were applied based on the US EPA AP-42 Appendix B.2: Generalised particle size distribution for the following activities;

  – PM_{10} is 35% of TSP and $PM_{2.5}$ is 5.3 % of TSP for construction activities;

- PM_{10} is 50% of TSP, while $PM_{2.5}$ is 7.5% of TSP for wind erosion;

- A loaded weight of 38 tons for all construction trucks was assumed;
- It was assumed that trucks will operate at the same time as the plant (12 hours per day, 6 days per week);
- Surface silt content at Lephalale Solar PV is unknown, therefore the silt content was based on the US EPA AP42 generic values for haul roads to and from a pit at 8.4%;
- Exxaro has confirmed the use of dust suppression in the form of water sprays to be utilised during construction activities;
- As per NPI recommendations the following control efficiencies were applied:
  - 50% control efficiency utilising water sprays during construction of Solar PV and associated infrastructure;
  - 75% control efficiency utilising water sprays over unpaved roads;
  - 50% control efficiency utilising water sprays over exposed areas; and
- A cumulative assessment could not be undertaken for PM_{10} and $PM_{2.5}$ as ambient air quality data representative of the site was not available.

6.1.5 ASSESSMENT OF IMPACTS

The purpose of this air quality impact assessment is to identify the potential impacts and associated risks posed by the construction of the proposed Solar PV facility on the existing ambient air quality in the area. The outcomes of the impact assessment will provide a basis to identify the key risk drivers and make informed decisions on the way forward to ensure that these risks do not result in unacceptable social or environmental risk.

All impacts of the proposed project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. This system derives an environmental impact level based on the severity, extent, duration, potential intensity and probability of potentially significant impacts. The overall risk level is determined using professional judgement based on a clear understanding of the nature of the impact, potential mitigatory measures that can be implemented and changes in risk profile as a result of implementation of these mitigatory measures. A full description of the risk rating methodology is presented in **Appendix a** . Key localised air quality impacts associated with the proposed facility include:

- Construction phase impacts of air emissions on residential receptors with and without mitigation measures

Outcomes of the impact assessment are contained within **Table 6-10** and **Table 6-11** outlining the impact of each parameter and the resulting risk level. The resultant air quality risks for residential receptors were ranked “low” during both unmitigated and mitigated scenarios. It is noted that the mitigated scenarios were modelled based on control efficiencies provided by the client. Additional mitigation such as chemical stabilisers on the access road and general housekeeping could also be implemented.

Table 6-10: Unmitigated Impact assessment of risks associated with the construction of the proposed Solar PV facility

	Without Mitigation											
Description	Severity rating	Spatial scale	Duration	**consequences**	Frequency of activity	Frequency of impact	Legal issues	Detection	**Likelihood**	Significance	+/-	**Risk rating**
Construction phase impacts of air emissions on residential receptors	2	2	2	**6**	1	2	1	2	**6**	36	-	**Low**

Table 6-11: Mitigated Impact assessment of risks associated with the construction of the proposed facility

	With Mitigation											
Description	Severity rating	Spatial scale	Duration	**consequences**	Frequency of activity	Frequency of impact	Legal issues	Detection	**Likelihood**	Significance	+/-	**Risk rating**
Construction phase impacts of air emissions on residential receptors	1	2	2	**5**	1	2	1	2	**6**	30	-	**Low**

Based on the dispersion model predictions and calculated low impact significance (through the use of an impact assessment ratings matrix), construction impacts from the proposed Lephalale Solar PV facility will have minimal impact on the receiving environment.

Table 6-12 presents the decrease in emissions predicted between unmitigated and mitigated scenarios. The following key items are noted:

- Changes in predicted PM_{10} concentrations between Scenario 1 (Unmitigated) and Scenario 2 (Mitigated) are substantial, with a 63% decrease in average 24-hour (P99) and a 74% decrease in the annual average PM_{10} concentrations predicted with mitigation;
- Changes in predicted $PM_{2.5}$ concentrations between Scenario 1 (Unmitigated) and Scenario 2 (Mitigated) are substantial, with a 55% decrease in average 24-hour (P99) and a 50% decrease in the annual average $PM_{2.5}$ concentrations predicted with mitigation; and
- Changes in predicted Dust fallout rates between Scenario 1 (Unmitigated) and Scenario 2 (Mitigated) are substantial with a 62% decrease in daily fallout rates predicted with mitigation.

Table 6-12: Percentage decrease in emissions between uncontrolled and controlled emissions.

Pollutant	Uncontrolled Emission (Unmitigated)	Controlled Emission (Mitigated)	% Decrease in predicted concentrations
Highest predicted 24-Hourly fence-line concentration			
PM10 (µg/m^3)	1020	380	63%
PM2.5 (µg/m^3)	141	62.96	55%
TSP (mg/m^2/day)	2946	1094	62%
Highest predicted annual average fence-line concentration			
PM10 (µg/m^3)	124	32.8	74%
PM2.5 (µg/m^3)	19.4	9.5	50%

6.2 ANALYSIS OF EMISSIONS ON THE ENVIRONMENT

Construction impacts from the Proposed Solar PV are likely to be minimal on surrounding vegetation and wildlife as the impacts are transient and will cease once construction operations are complete. It must be noted that the emission rates used to calculate construction activities are environmentally conservative (i.e. an overestimation of emissions), with results presented in this AQIA likely being higher than those experienced in reality. Based on modelling predictions, concentrations due to emissions from construction of the Solar PV plant are likely to remain low, with limited impacts on the receiving environment.

6.2.1 EFFECTS ON VEGETATION

Air pollution in South Africa was first identified as a potential threat to vegetation in 1988[27]. The effects of pollution on plants include mottled foliage, 'burning' at leaf tips or margins, twig dieback, stunted growth, premature leaf drop, delayed maturity, abortion or early drop of blossoms, and reduced yield or quality. In general, the visible injury to plants is of three types: (1) collapse of leaf tissue with the development of necrotic patterns, (2) yellowing or other colour changes, and (3) alterations in growth or premature loss of foliage[28].

Factors that govern the extent of damage and the region where air pollution is a problem are (1) type and concentration of pollutants, (2) distance from the source, (3) length of exposure, and (4) meteorological conditions. Other important factors are city size and location, land topography, soil moisture and nutrient supply, maturity of plant tissues, time of year, and species and variety of plants. A soil moisture deficit or extremes of temperature, humidity, and light often alter a plant's response to an air pollutant [28].

Based on predicted emissions and impact ratings, construction impacts from the Proposed Solar PV are likely to be minimal on surrounding vegetation as the impacts are transient and concentrations predicted are low.

6.2.2 EFFECTS ON ANIMALS

Animals are exposed to air pollutants via three pathways: 1) inhalation of gases or small particles; 2) ingestion of particles suspended in food or water; or 3) absorption of gases through the skin. In general, only soft-bodied invertebrates (e.g. earthworms), or animals with thin, moist skin (e.g. amphibians) are affected by the absorption of pollutants. An individual's response to a pollutant varies greatly and depends on the type of pollutant involved, the duration and time of exposure, and the amount taken up by the animal. The individual's age, sex, health, and reproductive condition also play a role in its response. There is a great deal of variability between animal classes, species, and even genotypes, in terms of the level of tolerance to a particular pollutant.

Based on predicted emissions and impact ratings, construction impacts from the Proposed Solar PV are likely to be minimal on surrounding wildlife as impacts are transient and concentrations predicted are low.

6.3 RECOMMENDATIONS

The following recommendations are provided to minimize air quality impacts during construction activities:

- Mitigation measures to be implemented during construction as confirmed by Exarro are:
  - Use of water sprays during construction activities, thereby limiting the dispersion of particulate emissions;
  - Continuous wetting of the access road during vehicle transport; and

— [27] Tyson, P. D., Kruger, F. J., and Louw, C. W. (1988). *Atmospheric pollution and its implications in the Eastern Transvaal Highveld*. National Scientific Programmes Unit: CSIR.

— [28] Sikora EJ, Chappelka AH. (2004): *Air Pollution Damage to Plants. Alabama Cooperative Extension System*. www.aces.edu

- Wetting of exposed stockpiles to limit the dispersion of wind-blown dust emissions.

— Information regarding construction activities should be provided to all local communities. Such information includes:
  — Contact details of a responsible person on site should complaints arise to reduce emissions in a timely manner;
  — Complaints register must be kept recording all events;

— General housekeeping should be implemented on site to keep PM and dust emissions to a minimum;

— All incoming and outgoing truck loads must be covered;

— Avoid dust generating works during extreme windy conditions;

— Use of chemical stabilisation on access road must be considered as its usually cost effective for relatively long term or semi-permanent unpaved roads.

— When working near (within 100 m) a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible; and

— Wet suppression and wind speed reduction are common methods used to control open dust sources at construction sites as a source of water and material for wind barriers tend to be readily available. General control methods for open dust sources, as recommended by the USEPA, are given in **Table 6-13**.

Table 6-13: Mitigation measures for general construction

Emission Source	Recommended Control Method[29]
Debris handling	Wind speed reduction
	Wet suppression
Truck transport(2)	Wet suppression
	Paving
	Chemical stabilisation(2)
Cut/fill material handling	Wind speed reduction
	Wet suppression
General construction	Wind speed reduction
	Wet suppression
	Early paving of permanent roads

Notes:

(1) Dust control plans should contain precautions against watering programs that confound track out problems.

(2) Chemical stabilisation usually cost-effective for relatively long-term or semi-permanent unpaved roads

[29] USEPA (1995): Compilation of Air Pollutant Emission Factors (AP-42) US Environmental Protection Agency

6.4 CONCLUSION

WSP Group Africa (Pty) Ltd (WSP) was appointed by GCS Water and Environmental (Pty) Ltd (GCS) to undertake an Air Quality Impact Assessment (AQIA) assessing the construction impacts associated with the proposed Lephalale Solar PV facility located in Limpopo Province, South Africa. The proposed project forms part of Exxaro's 2020 Climate Change Policy and strategic move into energy. The project would entail the development of a photovoltaic (PV) solar power plant with a footprint of 256 hectares.

The proposed activity requires environmental authorisation in the form of an Environmental Impact Assessment (EIA) which is currently being undertaken by GCS. As part of the authorisation process an Air Quality Impact Assessment (AQIA) is required to inform the competent authority. Key pollutants associated with onsite activities were identified as PM_{10} (particulate matter with an aerodynamic diameter less than 10 microns), $PM_{2.5}$ (particulate matter with an aerodynamic diameter less than 2.5 microns) and dust fallout (modelled as TSP).

A baseline assessment was undertaken that included a geographic overview and a review of available meteorological data. To characterise the meteorological conditions of the site, local meteorological data was sourced from the South African Weather Services Lephalale Monitoring Station for the January 2018 -December 2020 period. The station is located approximately 9km to the south of the proposed Solar PV plant. MM5 prognostic meteorological data was also obtained for the period January 2018 – December 2020 for input into the air dispersion model.

The impact assessment comprised of an emissions inventory and subsequent dispersion modelling simulations. An emissions inventory was developed using site-specific data and emission factors which were sourced from the United States Environmental Protection Agency AP42 (US EPA, 1995) and the Australian Government National Pollutant Inventory (NPI, 2012) databases. This emissions inventory was input into a Level 2 atmospheric dispersion model, AERMOD, together with prognostic MM5 meteorological data, to calculate ambient air concentrations of key pollutants associated with the proposed operations.

Sensitive receptors are identified as areas that may be impacted negatively due to emissions from the Lephalale Solar Project. Five receptors were identified in the area surrounding the proposed project area, within a 10 km radius, and were used for this assessment.

Construction activities for the Solar PV plant was estimated on an area wide footprint. The emission rate used to calculate such emissions is environmentally conservative for most construction sites, with results likely being higher than those that will be experienced in reality. Further, it must be emphasised that the construction activities are transient in nature.

Long-term (annual) and short-term (24-hour average) concentrations for the pollutants of concern were compared with the South African National Ambient Air Quality Standards (NAAQS) and National Dust Control Regulations (NDCR).

PM_{10} CONCENTRATIONS

- For scenario 1 (Unmitigated) predicted PM_{10} 24-hour average concentrations at receptor 01 (Village) will exceed the PM_{10} 24-hour standard, however annual average concentrations remain compliant with the annual standard. Both the 24-hour and annual average PM_{10} concentration at receptor 01 are predicted to be compliant with the relevant standards with mitigation (scenario 2);
- For both scenarios (Unmitigated and Mitigated), ambient 24-hour (P99) and annual average PM_{10} concentrations are predicted to be compliant at all remaining sensitive receptors during construction of the proposed Solar PV facility;

- Changes in predicted PM_{10} concentrations between Scenario 1 (Unmitigated) and Scenario 2 (Mitigated) are substantial, with a 63% decrease in average 24-hour (P99) and a 74% decrease in the annual average PM_{10} concentrations predicted with mitigation;
- Unmitigated highest predicted 24-hourly and annual average fence-line concentrations are non-compliant with the relevant standards due to the close proximity of the Solar PV access road to the boundary; and
- Mitigated, highest predicted 24-hour average fence-line concentrations are non-compliant, again due to the close proximity of the Solar PV access road to the boundary. However, highest predicted annual average concentrations remain compliant with the standard.
- Importantly, despite the non-compliance predicted on the fence-line of the Solar PV facility, all concentrations predicted at the neighbouring sensitive receptors during scenario 2 (Mitigated) remain compliant with their relevant standards, as noted previously.

$PM_{2.5}$ CONCENTRATIONS

- For both scenarios (Unmitigated and Mitigated), ambient 24-hour (P99) and annual average $PM_{2.5}$ concentrations are predicted to be compliant at all sensitive receptors during construction of the proposed Solar PV facility;
- Changes in predicted $PM_{2.5}$ concentrations between Scenario 1 (Unmitigated) and Scenario 2 (Mitigated) are substantial, with a 55% decrease in average 24-hour (P99) and a 50% decrease in the annual average $PM_{2.5}$ concentrations predicted with mitigation;
- Unmitigated highest predicted 24-hourly fence-line concentrations are non-compliant with the relevant standards due to the close proximity of the Solar PV access road to the boundary. However, the highest predicted annual average concentrations remain compliant with the standard; and
- Mitigated, highest predicted 24-hour and annual fence-line concentrations are compliant with the relevant standards.
- Importantly, despite the non-compliance predicted on the fence-line of the Solar PV facility, all concentrations predicted at the neighbouring sensitive receptors remain compliant with their relevant standards, as noted previously.

DUST FALLOUT

- For both scenarios, no exceedances of the dust fallout residential standard are predicted at any of the neighbouring sensitive receptors;
- Unmitigated highest predicted daily fence-line dust fallout rates are non-compliant with the non-residential standard due to the close proximity of the Solar PV access road to the boundary. However, mitigated highest daily dust fallout rates remain complaint with the non-residential standard; and
- Overall levels of dust fallout anticipated to occur during construction activities potentially impacting on surrounding receptors are below the respective National Dust Control Regulations.

CUMULATIVE ASSESSMENT

To determine the proposed cumulative impacts of the Solar PV facility, predicted dust fallout concentrations from both scenarios (Unmitigated and Mitigated) have been added to the background ambient monitored dust fallout concentrations (DFO). The following key items are noted from the cumulative assessment:

- During both Unmitigated and Mitigated scenarios, cumulative dust fallout concentrations are below the respective residential standards; and
- Based on predicted cumulative concentrations, construction impacts from the Solar PV facility are likely to be minimal, as the impacts are transient, and concentrations predicted are well below the respective NDCR.

Cumulative impacts associated with the Lephalale Solar PV facility were not assessed for PM_{10} and $PM_{2.5}$ as ambient monitoring data representative of the site was not available.

All impacts of the proposed project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. The resultant environmental air quality risks for sensitive receptors were ranked “low” during the construction, with mitigation in place.

Based on the findings of the assessment the following mitigation measures would serve to reduce air quality impacts to the receiving environment and sensitive receptors and are detailed further in **Section 6.3.**

MITIGATION MEASURES

- Mitigation measures to be implemented during construction as confirmed by Exarro are:
  - Use of water sprays during heavy construction activities, thereby limiting the dispersion of particulate emissions;
  - Continuous wetting of the access road during vehicle transport; and
  - Wetting of exposed stockpiles to limit the dispersion of wind-blown dust and particulate emissions.
- Information regarding construction activities should be provided to all local communities. Such information includes:
  - Contact details of a responsible person on site should complaints arise to reduce emissions in a timely manner.
  - Complaints register must be kept to record all events.
- Avoid dust generating works during the most windy conditions;
- When working near (within 100 m) a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible;
- Wet suppression and wind speed reduction are common methods used to control open dust sources at construction sites as a source of water and material for wind barriers tend to be readily available;
- Frequent wetting of the Solar PV access road; and
- Use of chemical stabilisation on access road must be considered as its usually cost effective for relatively long term or semi-permanent unpaved roads.

Construction of the Solar PV plant will result in minimal air quality impacts on nearby receptors. Given the low impacts on the receiving environment, based on the findings of this AQIA, it is recommended the proposed Solar PV facility be authorised.

APPENDIX

APPENDIX A

IMPACT ASSESSMENT METHODOLOGY

APPENDIX

The impacts were assessed using the risk matrix defined in tables below. Risk matrix was provided by GCS for use in the AQIA.

The assessment of potential impacts was addressed in a standard manner to ensure that a wide range of impacts were comparable. The ranking criteria and rating scales were applied to all specialist studies for this project. The following methodology was used to rank these impacts. Clearly defined rating and rankings scales (Table 1 - Table 7) were used to assess the impacts associated with the proposed activities. The impacts identified by each specialist study and through public participation were combined into a single impact rating table for ease of assessment.

Each identified impact was assessed in terms of severity, spatial scale and duration (temporal scale). Consequence was then determined as follows:

Table 1:Severity or magnitude of impact

Insignificant/non-harmful (no loss of species / habitat)	1
Small/potentially harmful (replaceable loss with minimal effort)	2
Significant/slightly harmful (replaceable loss of species / habitat with great effort and investment)	3
Highly Significant/harmful (impact to human health or welfare / loss of species / habitat)	4
Extremely Significant /extremely harmful/within a regulated sensitive area (loss of human life / irreplaceable loss of Red Data species / conservation habitat)	5

Table 2: Spatial Scale – extent of area being impacting upon

Area specific (at impact site)	1
Whole site (entire surface right)	2
Local (within 5km)	3
Regional/neighbouring areas (5 km to 50 km)	4
National	5

Table 3:Duration of activity

One day to one month (immediate – immediately reversible with minimal effort)	1
One month to one year (Short term - reversible)	2
One year to 10 years (medium term – difficult to reverse with effort)	3
Life of the activity (long term – very difficult to reverse with extensive effort)	4
Beyond life of the activity (permanent – not reversible)	5

Table 4: Frequency of activity - how often activity is undertaken

Improbable / almost never / Annually or less	1
Low probability / Very seldom / 6 monthly	2
Medium probability / Infrequent / Temporary / Monthly	3
Highly probable / Often / semi-permanent / Weekly	4
Definite / Always / permanent / Daily	5

APPENDIX

Table 5: Frequency of incident/impact - how often activity impacts environment

Almost never/almost impossible/>20%	1
Very seldom/highly unlikely/>40%	2
Infrequent/unlikely/seldom/>60%	3
Often/regularly/likely/possible/>80%	4
Daily/highly likely/definitely/>100%	5

Table 6: Legal Issues - governance of activity by legislation

No legislation	1
Fully covered by legislation	5

Table 7: Detection - how quickly/easily impacts/risks of activity on environment, people and property are detected

Immediately (easier to mitigate)	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered (more difficult to mitigate)	5

Consequence = Severity + Spatial Scale + Duration

The risk of the activity was then calculated based on frequencies of the activity and impact, whether the activity is governed by legislation and how easily it can be detected:

Likelihood = Frequency of Activity + Frequency of Impact + Legal issues + Detection

The risk of each identified impact was then based on the product of consequence and likelihood.

Risk = Consequence x Likelihood

Impacts were rated as either of high, moderate or low significance on the basis provided Table 8. Each impact was also assessed in terms of the level to which there is an irreplaceable loss of resources and its degree of reversibility. The ratings as described in the **Tables 9** and **Table 10**.

Table 8: Impact Significance Ratings

SIGNIFICANCE RATING	CLASS (NEGATIVE IMPACT)	CLASS (POSITIVE IMPACT)
1 - 55	(L) Low Significance	(L) Low Significance
56 - 169	(M) Moderate Significance	(M) Moderate Significance
170 - 600	(H) High Significance	(H) High Significance

APPENDIX

Table 9: Irreplaceability of resource caused by impacts

No irreplaceable resources will be impacted (the affected resource is easy to replace/rehabilitate)	**Low**
Resources that will be impacted can be replaced, with effort	**Medium**
Project will destroy unique resources that cannot be replaced	**High**

Table 10: Reversibility of impacts

Low reversibility to non-reversible	**Low**
Moderate reversibility of impacts	**Medium**
High reversibility of impacts	**High**

APPENDIX E2: ECOLOGICAL ASSESSMENT

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ECOLOGICAL ASSESSMENT FOR THE PROPOSED LEPHALALE SOLAR PROJECT, NEAR LEPHALALE, LIMPOPO PROVINCE

Report

Version - final

August 2021

K2021699383 (South Africa) (PTY) Ltd

GCS Project Number: 21-0037

Client Reference: PR-CLI-001

GCS (Pty) Ltd. **Reg No:** 2004/000765/07 Est. 1987
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ECOLOGICAL ASSESSMENT FOR THE PROPOSED LEPHALALE SOLAR PROJECT, NEAR LEPHALALE, LIMPOPO PROVINCE

Version - final

August 2021

DOCUMENT ISSUE STATUS

Report Issue	Final		
GCS Reference Number	21-0037		
Zutari Reference Number	1001395-G040-REP-NN-0002		
Client Reference	PR-CLI-001		
Title	ECOLOGICAL ASSESSMENT FOR THE PROPOSED LEPHALALE SOLAR PROJECT, NEAR LEPHALALE, LIMPOPO PROVINCE		
	Name	**Signature**	**Date**
Author	Magnus van Rooyen		August 2021
Reviewer	Kate Cain		August 2021
Director	Magnus van Rooyen		August 2021

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ECOLOGICAL ASSESSMENT FOR THE PROPOSED LEPHALALE SOLAR PROJECT, NEAR LEPHALALE, LIMPOPO PROVINCE

1 INTRODUCTION

GCS Water and Environment (Pty) Ltd (GCS) has been appointed to conduct and Ecological Assessment associated with the development of the Lephalale Solar Project within the boundaries of the Grootegeluk Mining Right area near Lephalale, Limpopo Province.

The Ecological Assessment will be submitted in support of the Application for Environmental Authorisation in accordance with the National Environmental Management Act (Act No. 107 of 1998): Environmental Impact Assessment Regulations (2014), as amended as well as a Water Use Licence Application in accordance with the National Water Act (Act No. 36 of 1998).

1.1 Background

The proposed Lephalale Solar Project is located on the Remaining Extent of Farm Appelvlakte No. 448 within the Lephalale Local Municipality. The property is located approximately 15km to the northwest of the town of Lephalale and immediately east of the Exxaro Grootegeluk Coal Mine. The location of the site is provided in Figure 1-1. The corner point coordinates are provided in the Table 1-1.

Table 1-1: Corner point coordinates of the proposed Lephalale Solar Project

Coordinate	Latitude	Longitude
A	23° 37' 44.80" S	27° 35' 21.73" E
B	23° 37' 35.63" S	27° 35' 46.46" E
C	23° 37' 35.59" S	27° 36' 12.85" E
D	23° 38' 00.60" S	27° 36' 44.57" E
E	23° 38' 27.07" S	27° 35' 30.13" E
F	23° 38' 12.07" S	27° 35' 21.80" E

The project area is approximately 256ha in size and is wholly within the boundaries of the Farm Appelvlakte No. 448, the extent of the site is provided in Figure 1-2.

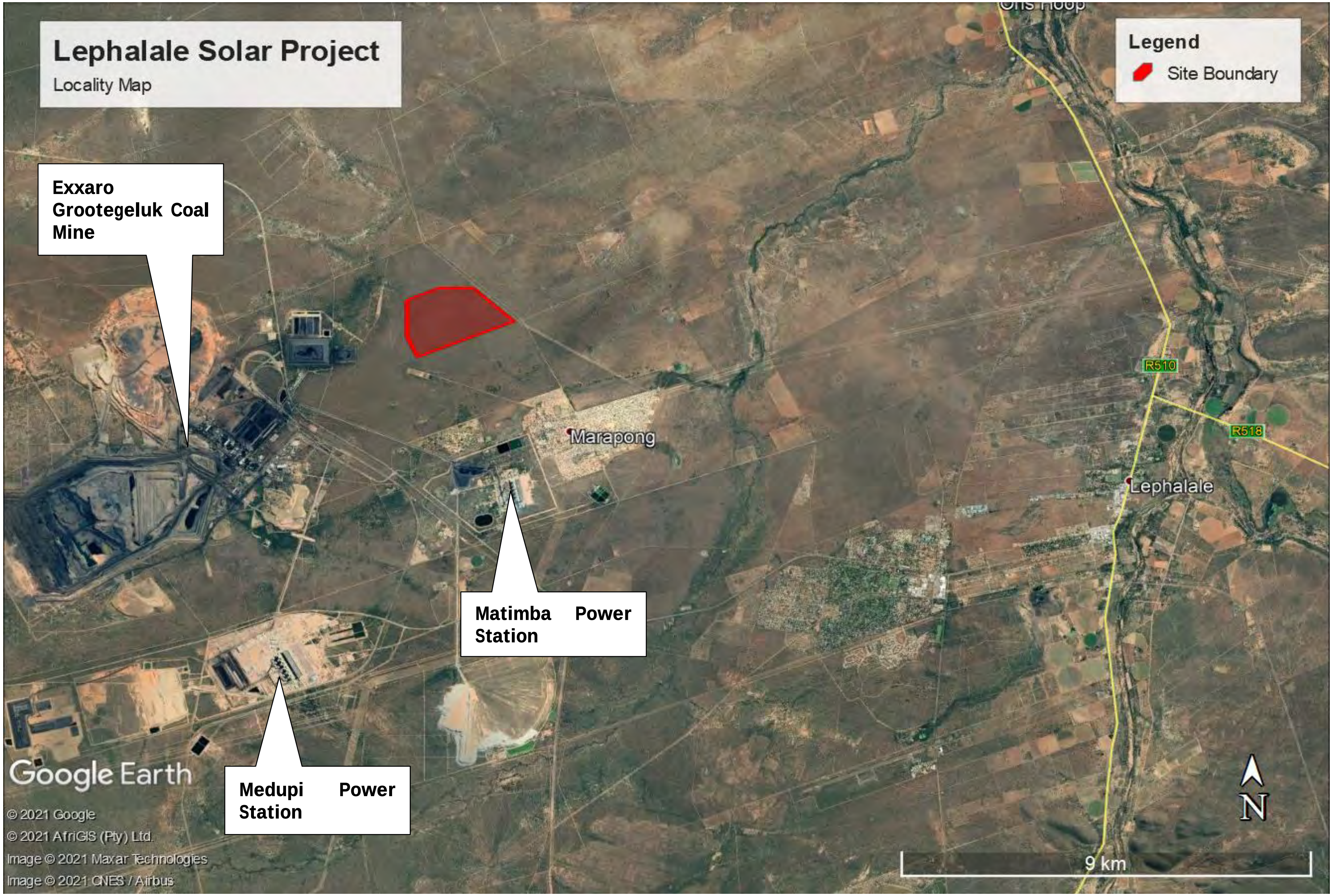

Figure 1-1: Location of the Lephalale Solar Project in relation to the town of Lephalale

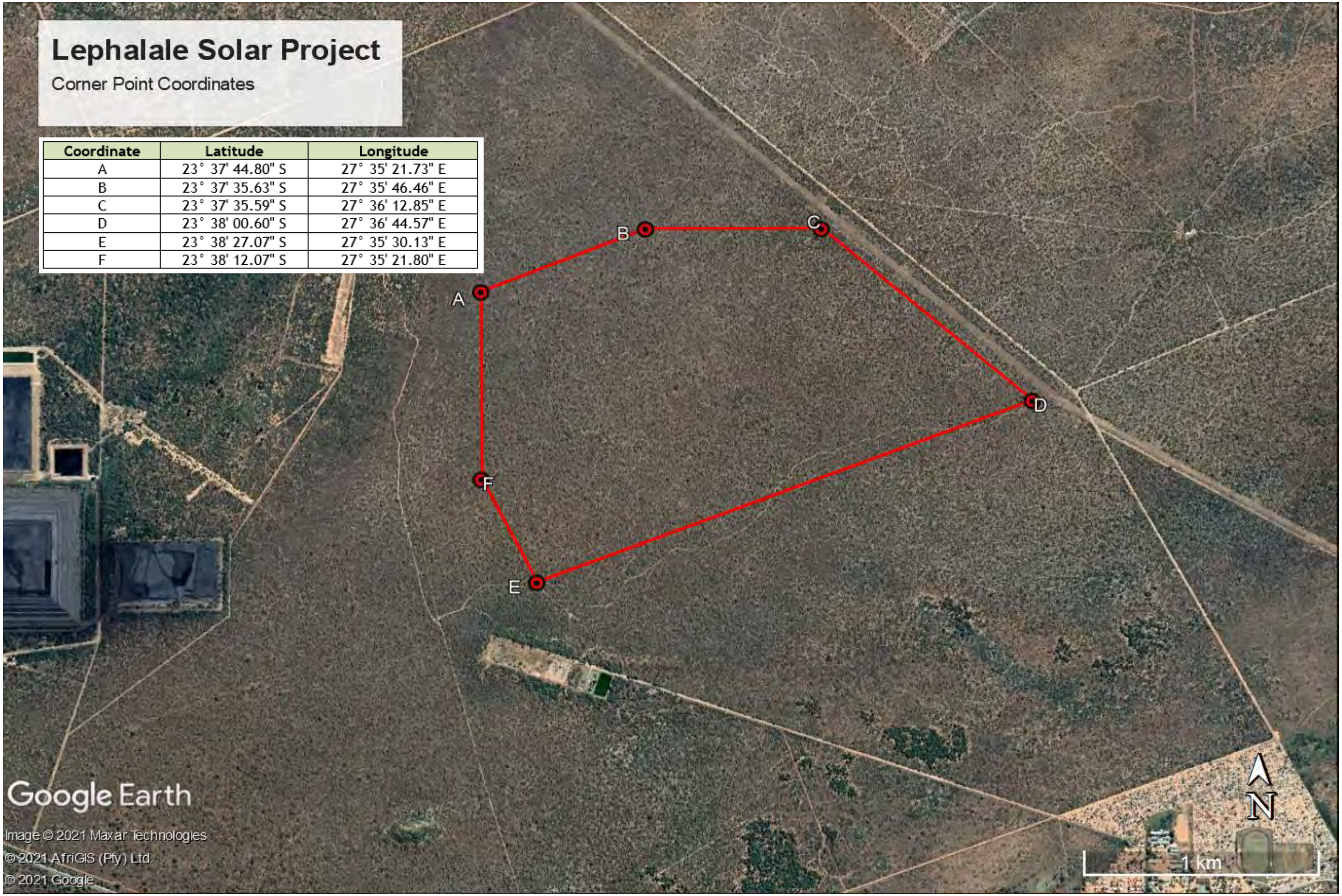

Figure 1-2: Extent of the Lephalale Solar Project site

1.2 Project description

The proposed Photovoltaic (PV) solar plant will make provision for the establishment of an array of crystalline solar photovoltaic (PV) modules grouped into strings of 28 modules and installed to solar tracking mounting structures, together with associated infrastructure for the generation of 80MWac of electricity. The PV tables will form and array covering an area of approximately 236ha, surrounded by a perimeter access road and fence. Provision will be made for 4km long evacuation powerlines that will follow a 67m wider corridor along the southern boundary of the fenceline of the Appelvlakte Farm No. 448. This corridor will have a surface area of approximately 25ha and will contain the main access road to the facility. The combined land requirement for the project therefore is approximately 256ha.

The PV tables will be raised approximately 1.5m above natural ground level and will make provision for a single axis tracking system allowing maximization of solar energy harvesting for conversion to electrical energy. Plates 1-1 and 1-2 provides an example of similar PV tables as described above.

Plate 1-1: Single axis solar PV module tables raised 1.5m above ground level (to a maximum tilt height of 3m).

Plate 1-2: Single axis solar PV module tables raised 1.5m above ground level (to a maximum tilt height of 3m).

The proposed associated infrastructure includes a fenced construction staging/lay-down area (a portion of which will form the operational lay-down area), inverter-transformer stations on concrete pads, a battery energy storage system (BESS) adjacent to the substation platform, office buildings with ablutions, maintenance shed/s and a substation for connection to the power grid, all within the 236 ha PV plant site.

It is proposed that the 33kV powerlines within the facility be underground/sub-surface. From the proposed future substation tie-in to the Grootegeluk 33kV Substation will occur via 132kV overhead powerlines. The Grootegeluk 33 kV substation is located approximately 4km south-west of the proposed development site.

Figure 1-3 provides the layout of the key infrastructure associated with the PV plant project.

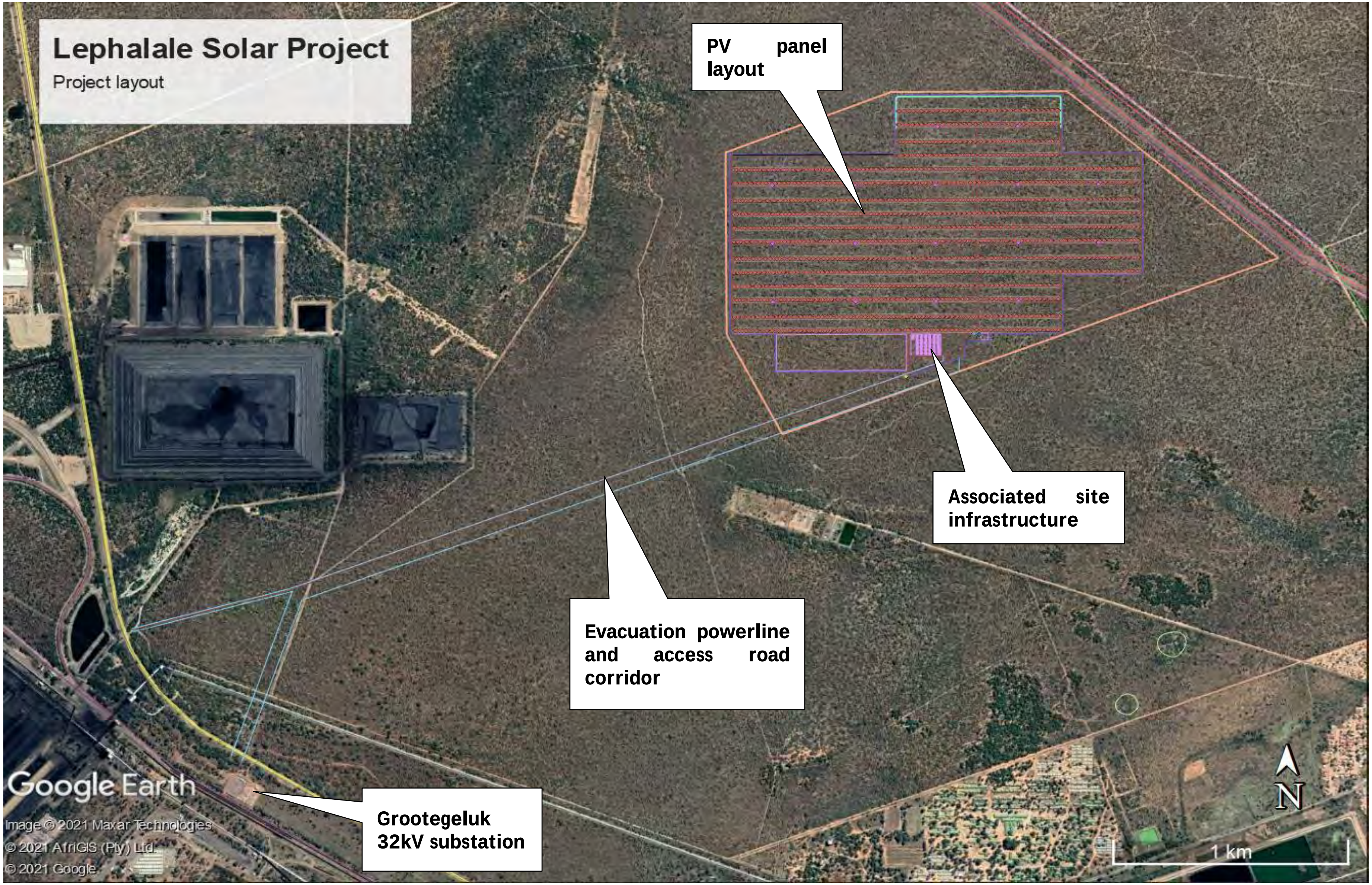

Figure 1-3: Layout of the Lephalale Solar Project

2 APPLICABLE SOUTH AFRICAN LEGISLATION

The national and provincial legislation briefly described in this section relates directly with the legal aspects associated with the biodiversity associated with the project.

2.1 Applicable National Legislation

Constitution of the Republic of South Africa (Act No. 108 of 1996). According to the South African Constitution, South African citizens have the right to have the environment protected for the benefit of the present and future generations.

Conservation of Agricultural Resources Act (Act No. 43 of 1983). This Act includes the use and protection of land, soil, wetlands and vegetation and the control of weeds and invader plants. In the regulations published in 1984 under the Act, which declared approximately 50 plant species as “weeds” or “invader plants”. This list was further expanded on 30 March 2001 to now contain a comprehensive list of declared weed and invader plant species.

White Paper on Environmental Management Policy for South Africa (1998). Through this Policy, the government of South Africa commits to give effect to the many rights in the Constitution that relate to the environment.

National Veld and Forest Fire Act (Act No. 101 of 1998). The purpose of the Act is to prevent and combat veld fires in the country. The Act was amended by the National Forest and Fire Laws Amendment Act (Act No. 12 of 2001).

National Water Act (Act No. 36 of 2998). This Act recognises that water is a scarce and unevenly distributed natural resource that should be equitably utilised in a sustainable manner. The Act ensures that water resources are protected, used, developed, conserved and controlled in ways that take into account a range of needs and obligations, including the need to “protect aquatic and associated ecosystems and their biological diversity”. The Act further specifies the water uses that must be authorised and it details the authorisation procedures as well as the minimum requirements for evaluation and decision-making by the relevant authority.

National Forests Act (Act No. 84 of 1998). An objective of the Act is to provide special measures for the protection of certain forest and tree species, and to promote the sustainable use of forests for environmental, economic, educational, recreational, cultural, health and spiritual purposes. In terms of Section 15(1) of the Act, forest trees or Protected Tree Species may not be cut, disturbed, damaged, destroyed and their products may not be possessed, collected, removed, transported, exported, donated, purchased or sold - except under license granted by the relevant authority. Government Notice 35648 of 2012 provides the latest List of Protected Tree Species within the borders of South Africa.

National Environmental Management Act (Act No. 107 of 1998). The Act is an umbrella act covering broad principles of environmental management which makes provision for three main areas, namely Land Planning and Development, Natural and Cultural Resources Use and Conservation and Pollution Control and Waste Management. In accordance with the Act, sustainable development requires the consideration of all relevant factors, including:

- That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied;
- That the use and exploitation of non-renewable natural resources are conducted in a responsible and equitable manner and takes into account the consequences of the depletion of the resource; and
- That the development, use and exploitation of renewable resources and the ecosystems of which they are part of do not exceed the level beyond which their integrity is jeopardised.

According to Section 2(r) of the Act, sensitive, vulnerable, highly dynamic or stressed ecosystems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.

National Environmental Management: Protected Areas Act (Act No. 57 of 2003). The Act focuses on the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural land-and seascapes. The Act addresses *inter alia*:

- The protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural land- and seascapes;
- The establishment of a national register of all national, provincial and local protected areas;
- The management of those areas in accordance with national standards; and
- Inter-governmental co-operation and public consultation in matters concerning protected areas.

National Environmental Management: Biodiversity Act (Act No. 10 of 2004). The main objective of the act is to provide for the management and conservation of South Africa's biodiversity and to ensure the sustainable use of indigenous biological resources. In addition to regulations on Threatened, Protected, Alien and Invasive Species in South Africa, the Act also identifies Terrestrial and Aquatic Priority Areas and Threatened Ecosystems for biodiversity conservation.

2.2 Applicable Provisional Legislation

In addition to national legislation, some of South Africa's nine provinces have their own provincial biodiversity legislation.

Limpopo Environmental Management Act (Act No. 7 of 2003). This Act provides the lists for Protected and Specifically Protected Species under Schedule 2, 3 and 12 as well as the stipulation for permit application to remove these species. In addition, it gives protection measures for the terrestrial and aquatic biota and systems. Schedule 9 lists aquatic plant species that are prohibited in the province.

Limpopo Conservation Plan version 2, 2013. This conservation plan is consistent with the principles of national legislation and is designed to support integrated development planning and sustainable development by identifying an efficient set of Critical Biodiversity Area (CBAs) that are required to meet national and provincial biodiversity objectives, in a configuration that is least conflicting with other land uses and activities.

Municipal Biodiversity Summaries Project, 2010. This was the most relevant biodiversity conservation plan for the Lephalale Municipality prior to the publication of the Limpopo Conservation Plan version 2, 2013.

Limpopo State of the Environment Report, 2004. This report provides a high level overview of the State of the Environment in Limpopo.

Waterberg Environmental Management Plan, 2006. This management plan provides for the protection of the environment and describes how activities that have, or could have, and adverse impact on the environment, should be managed, mitigated, controlled and monitored. The management plan is a coarse-scale planning tool that outlines strategic objectives for environmental management. All new developments in the Waterberg District Municipality should be aligned with these environmental management objectives.

Lephalale Spatial Development Framework, 2008. The spatial development framework was compiled by the Lephalale Municipality with the purpose of guiding the form and location of future physical development within the municipal area in order to address imbalances of the past. The plan identifies environmentally sensitive areas (e.g. mountain ridges, riverine environments, etc.) and makes recommendations regarding proposed developments in these areas.

3 TERMS OF REFERENCE

It is understood that the assessment will be submitted as part of the Application for Environmental Authorisation in accordance with the National Environmental Management Act (Act No. 107 of 1998): Environmental Impact Assessment (EIA) Regulations (2014). As such, the assessment report is completed in accordance with the minimum requirements for specialist assessments as included in Appendix 4 of the EIA Regulations (2014).

In brief, these requirements have as an outcome to achieve the following:

- A methodology of the site visit and techniques used to assess the specific aspects of the site;
- Details of the assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of site plan identifying site alternatives (where applicable);
- An indication of any areas that are to be avoided, including provision of buffers;
- A description of any assumptions made and any uncertainties or gaps in knowledge;
- A description of the findings and potential implications of such findings on the impact of the proposed activities;
- Any mitigation measures for inclusion in the Environmental Management Programme Report (EMPr);
- Any conditions for inclusion in the Environmental Authorisation and the Water Use Licence;
- Any monitoring requirements for inclusion into the EMPr or Water Use Licence; and
- A reasoned opinion whether the activity should be authorised based on the findings of the assessment.

In addition to the above terms of reference, cognisance of the requirements of the Department of Forestry, Fisheries and the Environment's biodiversity assessment requirements as detailed in their Online Screening Assessment Tool. The outcome of the Online Screening Tool has identified the following sensitivities associated with the site.

Table 3-1: Results generated by the Department of Forestry, Fisheries and the Environment's Online Screening Assessment Tool

Theme	Very high sensitivity	High sensitivity	Medium sensitivity	Low sensitivity	Comments
Agriculture Theme			X		This theme is addressed in the Agricultural Potential Assessment that was conducted for the development.
Animal Species Theme			X		Due to the medium sensitivity rating of the site for this theme, no specific specialist assessment will be conducted for this theme.
Aquatic Biodiversity Theme	X				This theme is addressed in the Aquatic Assessment that was conducted for the development.
Archaeological and Cultural Heritage Theme				X	This theme is addressed in the Heritage Assessment that was conducted for the development.
Civil Aviation Theme			X		No specialist assessment has been conducted for this theme
Defence Theme				X	No specialist assessment has been conducted for this theme
Palaeontology Theme		X			This theme is addressed in the Heritage Assessment that was conducted for the development.
Plant Species Theme			X		Due to the medium sensitivity rating of the site for this theme, no specific specialist assessment will be conducted for this theme.
Terrestrial Biodiversity Theme	X				Due to the very high sensitivity rating of the theme a specialist assessment was conducted in accordance with the requirements of Protocol for the Specialist Assessment and minimum report content requirements for Environmental Impacts on Terrestrial Biodiversity.

As mentioned above, this Biodiversity Assessment is conducted in accordance with the specified protocol. The requirements of the protocol are provided in Table 3-2.

Table 3-2: Terrestrial Biodiversity Protocol Requirements

No.	Protocol requirement
1.	A description of the ecological drivers or processes of the system and how the proposed development will impact these.
2.	A description of the ecological corridors that the proposed development would impede including migration and movement of flora and fauna.
3.	A description of any significant terrestrial landscape features (including rare or important flora-faunal associations, presence of strategic water source areas or freshwater ecosystem priority areas (FEPA) sub catchments.
4.	A description of terrestrial biodiversity and ecosystems on the preferred site, including: • Main vegetation types; • Threatened ecosystems, including listed ecosystems as well as locally important habitat types identified; • Ecological connectivity, habitat fragmentation, ecological processes and fine-scale habitats; and • Species, distribution, important habitats (e.g. feeding grounds, nesting sites, etc.) and movement patterns identified.
5.	An identification of any alternative development footprints within the preferred site which would be of “low” sensitivity as identified by the screening tool and verified through the site sensitivity verification.
6.	An identification of Critical Biodiversity Areas (CBAs) within the development site. The following must be provided for these CBAs: • Reasons why an area has been identified as a CBA; • An indication of whether or not the proposed development is consistent with maintaining the CBA in a natural or near natural state or in achieving the goal of rehabilitation; • Identification of the impact no species composition and structure of vegetation with an indication of the extent of clearing activities in proportion to the remaining extent of the ecosystem type(s); • Identification of the impacts on the ecosystem threat status; • Identification of impacts on explicit subtypes in the vegetation; • Identification of impacts on the overall species and ecosystem diversity of the site; and • Identification of impacts on any changes to threat status of populations of species conservation in the CBA.
7.	An identification of terrestrial ecological support areas (ESAs) within the development site. The following must be provided for these ESAs: • Identification o the impacts on the ecological processes that operation within and across the site; • Identification of the extent to which the proposed development will impact on the functionality of the ESA; and • Identification of any potential loss of ecological connectivity (on site, and in relation to the broader landscape) due to the degradation and severing of ecological corridors or introducing barriers that impede migration and movement of flora and fauna.
8.	Identification of any protected areas as defined by the National Environmental Management: Protected Areas Act, 2004, including an opinion on whether the proposed development aligns with the objectives or purpose of the protected area and zoning as per the protected area management plan.
9.	Identification of priority areas for protected area expansion, including the way in which the proposed development will compromise or contribute to the expansion of the protected area network.
10.	Identification of Strategic Water Source Areas (SWSAs), including the impacts on the terrestrial habitat of a SWSA and the impacts of the proposed development on the SWSA water quality and quantity (e.g. describing potential increased runoff leading to increased sediment load in water courses.
11.	Identification of Freshwater Ecosystem Priority Area (FEPAs) sub-catchments, including the impacts of the proposed development on habitat condition and species in the FEPA sub-catchment.

12.	Identification of indigenous forests, including impacts on the ecological integrity of the forest and percentage of natural or near natural indigenous forest area lost and a statement on the implications in relation to the remaining areas.

4 AIMS AND OBJECTIVES

The aim and objectives of this study is as follows:

- Identification of any areas of ecological sensitivity on the property;
- Determination of the extent of these ecological sensitive areas;
- Determination of the key aspects within each of these identified areas that require conservation;
- Identification of potential impacts on these areas posed by the development;
- Management and mitigation measures to be implemented to limit or mitigate these impacts; and
- Determination of applicable buffers around these ecological sensitive areas, where applicable.

5 KNOWLEDGE GAPS

No direct knowledge gaps have been identified that may influence the outcome of this assessment. The following assumptions however, have been made in the completion of the study:

- The assessment is based on site visits conducted on 8 April 2021, 21 April 2021 and 27 July 2021 by Mr Magnus van Rooyen of GCS;
- The assessment is based on the design information provided by the client and the project management team;
- The following standardised and accepted methods to determine the various aspects of the study were used:
  - Electronic biodiversity/wetland databases managed by the South African National Biodiversity Institute (SANBI);
  - Available provincial electronic biodiversity/wetland databases;
  - Wetland and Riparian Habitat Delineation Document (Department of Water and Sanitation report).

6 EXPERTISE OF THE SPECIALIST

The curriculum vitae of the specialist, Mr Magnus van Rooyen is attached in Appendix A.

Mr Magnus van Rooyen is a registered natural scientist with the South African Council of Natural Scientific Professions (SACNASP) and holds a Master's degree in Environmental Management, a BSc Honours degree in Botany and a BSc degree in Botany and Zoology from the University of Stellenbosch. Mr van Rooyen has in excess of 15 years' experience in the field of wetland and terrestrial ecological studies in Southern and Western Africa.

7 STUDY AREA AND SITE SENSITIVITY VERIFICATION

The determination of the extent of the study area is an important factor for any assessment. As such, the study area will be limited to the project footprint area as indicated in Figure 1-3 and makes provision for the Solar PV Plant footprint as well as the associated transmission lines connecting the plant to the grid. Refer to Plate 7-1 for an aerial view\of the study are showing the land use as private game reserve.

In addition, the Terrestrial Biodiversity Protocol outlined above makes provision for the completion of a Site Sensitivity Verification. The verification is based on a preliminary desktop analysis based on Google Earth imagery, a pre-liminary site visit and other available relevant information.

The outcome of these steps are as follows:

- The Online Screening Tool highlights the Terrestrial Biodiversity Theme as being of a Very High Sensitivity based on the site being located in a CBA1 as identified by the Limpopo Conservation Plan version 2 (2013). The CBA1 classification is based on the site being present in an area that is classified as an ESA as well as a FEPA sub-catchment. The FEPA sub-catchment forms part of the Matlabas / Mokolo sub-water management area within the Limpopo water management area. All databases that have been interrogated confirms the presence of these aspects. It must however be highlighted that the Aquatic Assessment has not identified any aquatic features within the boundaries of the study area or within a 500m radius of the study area; and
- The study site is understood to form part of the Manketti Private Nature Reserve which is under ownership of Exxaro. The reserve has a size of 22 000ha and houses a number of animal species typical to the area. The land use on the study site is therefore part of the private nature reserve. This land use is in line with the findings of the desktop information related to the study area.

Plate 7-1: Aerial view, looking in an easterly direction, of the study are showing the land use as private game reserve

8 METHODOLOGY

The methodology that was followed in completing this study is in line with the requirements of the National Environmental Management Act (Act No. 107 of 1998): Environmental Impact Assessment (EIA) Regulations (2014) and includes the following aspects.

The assessment was undertaken in two phases which made provision for a preliminary desktop assessment of the study area, followed by a field study and reporting.

The desktop assessment will make provision of the available Geographical Information System (GIS) information from various platforms to determine any potentially ecological sensitive areas that need to be considered during the assessment. Furthermore, it is understood that an Ecological Assessment (fauna and flora) was conducted for the site during a previous application. This assessment will be reviewed and used as the baseline description of the site and the associated terrestrial ecological conditions. This review will form part of the desktop phase of the assessment.

In addition to the historical information referred to above, it is understood that a number historical applications have been conducted on the Grootegeluk Mine area which will be used as a reference to establish the baseline terrestrial ecology on the larger area surrounding the site as well as the site itself. This baseline determination will make provision for the identification of any potentially sensitive areas within the development site.

The desktop assessment consisted of an interrogation of available desktop information. This included the following references:

- *The Vegetation of South Africa, Lesotho and Swaziland*, Mucina, L. and Rutherford, M.C. (2006);
- *National Vegetation Map*, South African National Biodiversity Institute (SANBI) (2012);
- *Limpopo Conservation Plan version 2 (2013);*
- *Important Bird Areas (2015);*
- *National Freshwater Ecosystem Priority Areas (NFEPA) (2011); and*
- *National Threatened Ecosystem*, SANBI (2012).

The information gathered through the interrogation of these references was used as baseline information for the site assessment. Any pertinent information generated through the desktop assessment was checked and/or verified during the site assessment.
The site assessment will take the form site visits to verify the potentially sensitive ecological areas identified during the desktop assessment and to identify any additional areas of features that require consideration from an ecological point of view. The site visits will be

limited to observations on the site and will not make any provision for any vegetation sampling or animal trapping.

The desktop and field assessment will culminate in an impact assessment report that will make provision for the following:

- Identification of any potential impacts that the development might have on the ecological baseline;
- Assessment of these impacts in terms of an assessment criteria that will has as goal to establish the severity of these impacts; and
- Provision for possible management and mitigation measures to be implemented during the various project phases to alleviate or negate these identified impacts.

9 RESULTS

The findings relating to the terrestrial ecology is based on the desktop assessment of available databases as well as site investigations.

9.1 Topography

The study site is situated on the flat plains between the Waterberg to the south and southwest and the Limpopo River to the north and northwest. The topography of this area is relatively gentle and slopes in an easterly direction towards a tributary of the Limpopo River, the Mokolo River.

9.2 Climate and Rainfall

The closest weather station to the site is the town of Lephalale approximately 16km to the southeast. As such, the climatological data for Lephalale is considered representative of the study area (Figure 9-1). The climatological condition on the site is characterized by long hot summers (early September to late April) and short cool winters (early May to late August). The mean daily maximum temperatures during the summer months vary between 28°C and 32°C while the mean daily minimum temperatures during the winter months vary between 7°C and 10°C.

The annual average rainfall for the area is approximately 390mm with rain falling mostly during the summer months. The rainfall events are characterized by localized to wide spread thundershowers as a result of moist tropical air from the north.

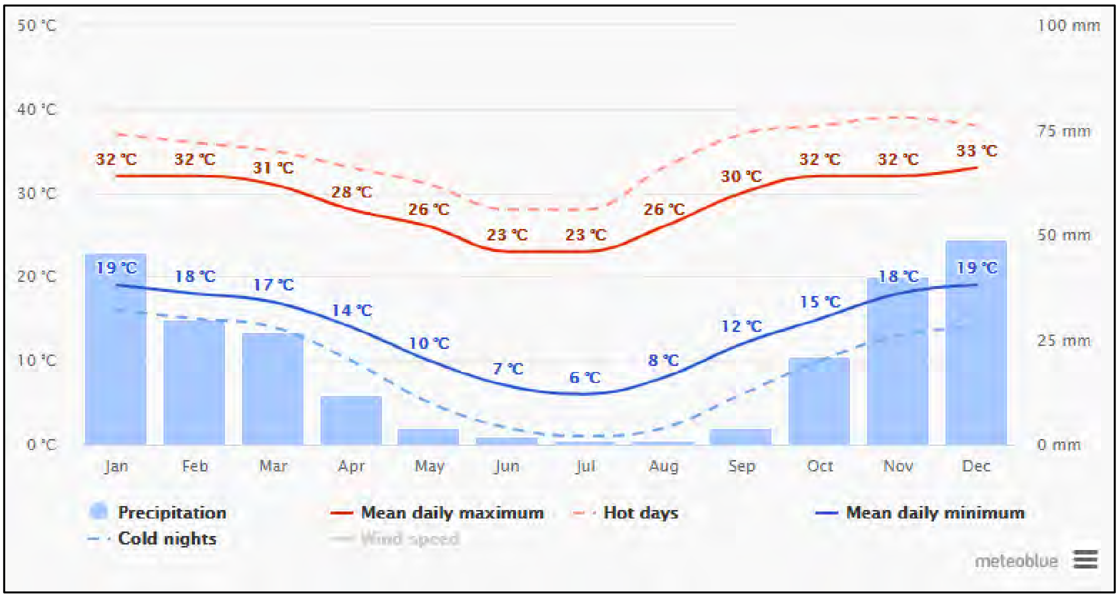

Figure 9-1: Lephalale Climate (Meteoblue.com)

9.3 Geology and soils

The northern half of the area is dominated by gneisses, metasediments and metavolcanics of the Malala Drift Group, Beit Bridge Complex (Swazian Erathem), basalts of the Letaba Formation (Lebombo Group of the Karoo Supergroup) are also found in the northeast. Sandstone, siltstone and mudstone of the Clarens Formation (Karoo Supergroup), as well as the Matlabas Subgroup (Mokolian Waterberg Group) are found to the south and west.

The following soil types were identified in the Soils, Land Capability and Land Use specialist assessment (Eco Assist, 2021) conducted for the project (Figure 9-2):

- Hutton (Orthic topsoil over a thick Red Apedal Horizon)
- Ermelo (Orthic topsoil over a thick Yellow-brown Apedal Horizon); and
- Fernwood (Orthic topsoil over a thick Albic Horizon).

The study area falls within the Ab85 land type which is characterized by predominantly deep sandy to loam soils that are eutrophic. Soil colours vary from red through yellow-brown to bleached indicating a potential wetness gradient. The project area is dominated by deep freely draining Ermelo and Hutton soil forms, which are situated in the midslopes to upper sloped landscape positions.

Plate 9-1: View of the Ermelo/Hutton Soil Form on the site

Plate 9-2: View of the Fernwood Soil Form on the site

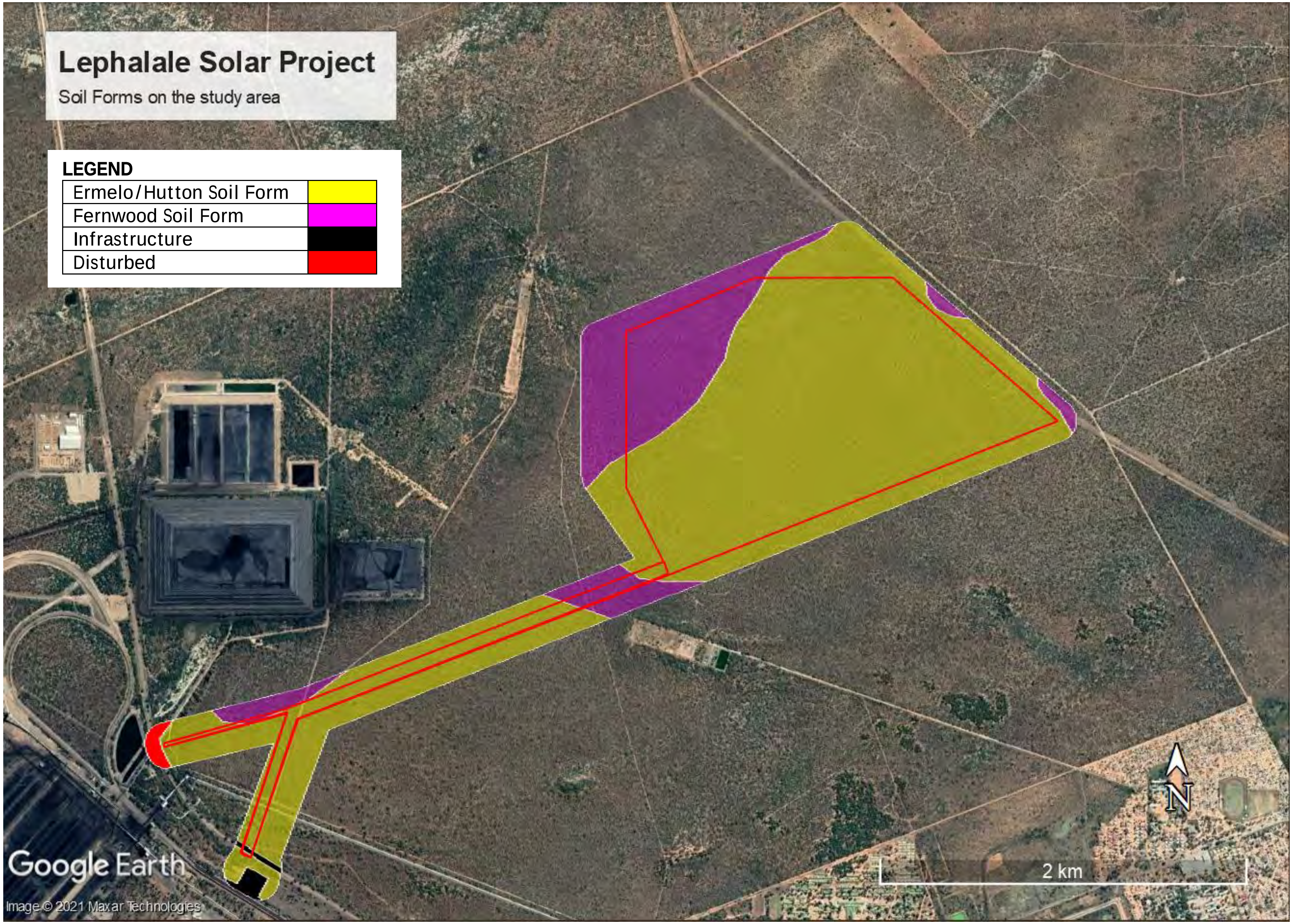

Figure 9-2: Soil form identified on the study area (Eco Assist, 2021)

9.4 Land use

The study site is understood to form part of the Manketti Private Nature Reserve which is under ownership of Exxaro. The reserve has a size of 22 000ha and houses a number of animal species typical to the area. The land use on the study site is therefore part of the private nature reserve.

As such the study area is largely in its natural state with extensive mining activities located to the west of the site (Plate 9-3) as well a densely urbanized area as well as a large coal fired power station to the south of the site (Plate 9-4).

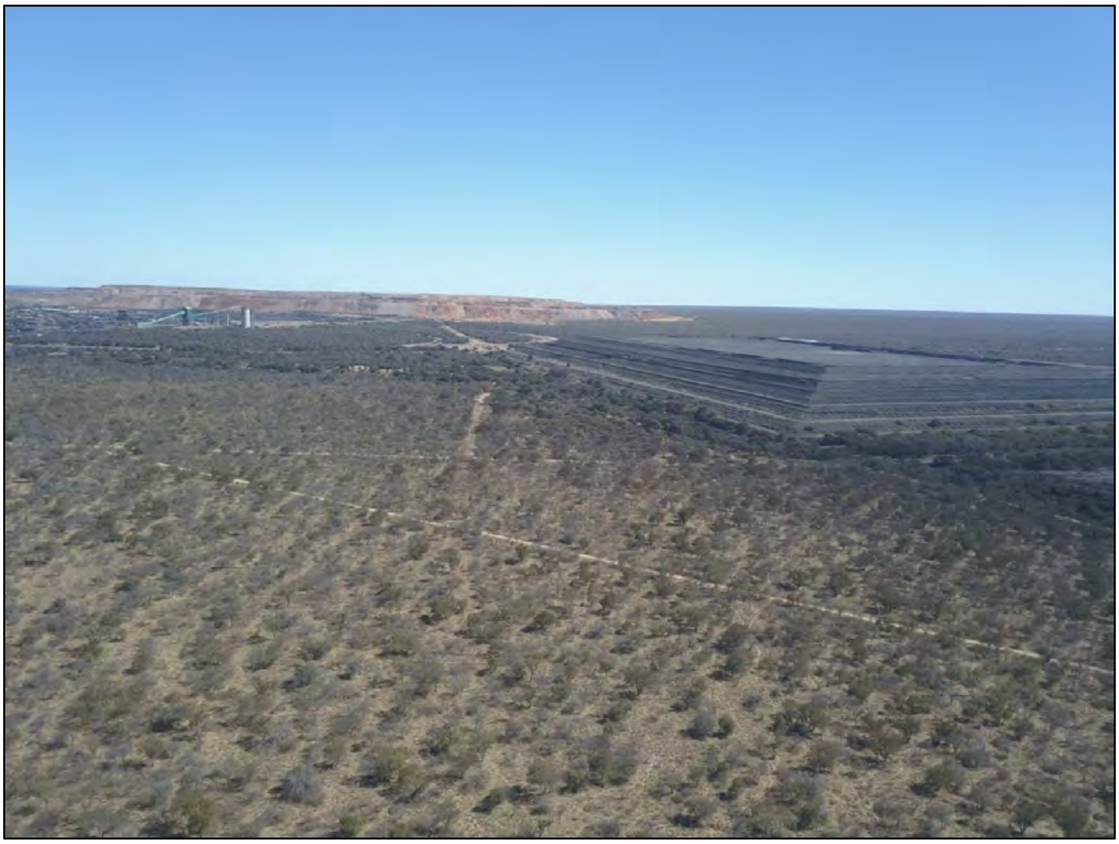

Plate 9-3: View of the extensive mining activities to the west of the study site

Plate 9-4: View of the urbanised area and associated power station to the south of the site

9.5 Vegetation

The study area is located within the Limpopo Sweet Bushveld (SVcd19) vegetation type (Mucina and Rutherford, 2006). This vegetation type occurs in the Limpopo Province from the lower reaches of the Crocodile and Marico Rivers around the Makoppa and Derdepoort, down the Limpopo River, including Lephalale, past Tom Burke to the Usutu Border Post and Taaiboschgroet area in the north (Mucina and Rutherford, 2006). It occurs on plains, sometimes undulating or irregular, traversed by several tributaries of the Limpopo River. The vegetation type is characterized by short open woodland.

The vegetation on the site primarily consists of woodland dominated by *Terminalia sericea* (Silver Cluster Leaf), *Combretum apiculatum* (Red Bushwillow) and *Dichrostachys cinerea* (Sickle bush). Other tree species of interest are *Sclerocarya birrea* subspecies *africana* (Marula), *Senegalia nigrescens* (Knob-thorn Acacia), *Vachellia erioloba* (Camel Thorn), *Senegalia burkei* (Black-monkey Thorn); *Senegalia meliffera* (Black-thorn Acacia), *Combretum imberbe* (Hardekool), *Philenoptera violacea* (Bushveld Apple-leaf) and *Gardenia volkensii* (Bushveld Gardenia).

The presence of dense stands of *Terminalia sericea* (Silver Cluster Leaf) on large parts of the site is indicative of historical overgrazing of the area. These trees are known bush encroachers and will settle in dense stands in areas of disturbance.

A site-specific vegetation classification has been conducted based on the observation of dominant species within each of these areas (Figure 9-3). The species used are all characteristic of the species that can be expected in the Limpopo Sweetveld Vegetation Type. The identified vegetation communities are as follows:

- *Combretum apiculatum* Woodland community;
- *Terminalia sericea* Woodland community; and
- Mixed Bushveld Woodland community.

The Combretum apiculatum Woodland community (Plate 9-5) primarily consist of stands of *Combretum apiculatum* and *Dichrostachys cinerea* and forms dense stands of vegetation in places. The vegetation community is located in the eastern portions of the study area. The presence of *Dichrostachys cinerea* is an indicator that the vegetation has been impacted upon by historical overgrazing. Confirmation of this is that all the individuals of this species is more or less of similar size which indicates that they have all established at a similar time.

The *Terminalia sericea* Woodland community (Plate 9-6) primarily consist of stands of this tree species inter-mixed with other typical bushveld trees. In places, the stands or *Terminalia sericea* is relatively dense and indicative of "bush encroachment" by this species.

A very small portion of the study area can be classified as a Mixed Bushveld Woodland community (Plate 9-7) that consists of stands of *Sclerocarya birrea* subspecies *africana* (Marula), *Senegalia nigrescens* (Knob Thorn), *Senegalia burkei* (Black Monkey Thorn), *Vachellia karroo* (Sweet Thorn), *Vachellia tortilis* subspecies *heteracantha* (Umbrella Thorn) and *Spirostachys africana* (Tamboti).

The locations and approximate extent of these vegetation types are provided in the Figure 9-3.

Figure 9-3: Location and extent of the on-site vegetation communities

Plate 9-5: View of the *Combretum apiculatum* **Woodland community**

Plate 9-6: View of the *Terminalia sericea* Woodland community

Plate 9-7: View of the Mixed Bushveld Woodland community

Important plant species

From the POSA website (QDS 2327DA) and data from previous studies in the area, three Conservation Important (CI) species have been recorded in the region. The most threatened of these species recorded in the QDS is the *Eulalia aurea* (Golden Velvet Grass), which is classified as Near Threatened. This grass species is typical to seasonal swamps and vleis and in the absence of these habitats on the study is considered to be absent from the site. The other species of interest is *Corchorus psammophilus* could occur on the site based on the habitat requirement, but none of these species were identified during the site assessment.

Furthermore, Government Notice No. 41100 of 8 September 2017 provides the latest List of Protected Tree Species in accordance with the National Forests Act (Act No. 84 of 1998). The following tree species that are included in the abovementioned list was identified on the study site. These are as follows:

- *Boscia albitrunca* (Shepherds Tree) (Plate 9-8);
- *Sclerocarya birrea* subspecies *caffra* (Marula) (Plate 9-9);
- *Spirostachys africana* (Tamboti) (Plate 9-10); and
- *Vachellia erioloba (*Camel Thorn).

As these species have been identified within the study area, any disturbance of these species must be authorised through a licence / permit issued by the relevant authority in terms of the National Forests Act (Act No. 84 of 1998).

Plate 9-8: View of a *Boscia albitrunca* (Shepherds Tree) on the study site

Plate 9-9: View of a *Sclerocarya birrea* **subspecies** *caffra* **(Marula) on the study site**

Plate 9-10: View of a *Spirostachys africana* **(Tamboti) on the study site**

Disturbances to the vegetation on the site

Alien species, especially invasive species, are a major threat to the ecological functioning of the natural systems and to the productive use of land. As such, the presence alien invasive plant species within the study site is of interest in this regard. As the study site is relatively pristine in nature, very few alien invasive plant species were encountered. However, a list of species that have been identified in the areas surrounding the study site is provided in Table 9-1. These species will need to be managed during the construction and operational phases of the development to ensure that they do not spread on to and from the study site.

Table 9-1: Alien invasive plant species identified in the surrounding areas

Family	Species	Growth form	CARA* category
AMARANTHACEAE	*Gomphrena celosioides*	Herb	Weed
ASTERACEAE	*Conyza bonariensis*	Herb	Weed
AMARANTHACEAE	*Achyranthes aspera*	Herb	Cat. 1**
ASTERACEAE	*Xanthium strumarium*	Herb	Cat. 1**
ASTERACEAE	*Verbesina encelioides*	Herb	Weed
CHENOPODIACEAE	*Chenopodium album*	Herb	Weed
SOLANACEAE	*Nicotiana glauca*	Shrub	Cat. 1**
VERBENACEAE	*Verbena bonariensis*	Herb	Weed

*Conservation of Agricultural Resources Act (Act No. 43 of 1983)

**It is a landowner's legal obligation to control all Category 1 weeds as identified in accordance to the Conservation of Agricultural Resources Act (Act No. 43 of 1983).

9.6 Faunal communities

Historic studies that have been conducted in the area has yielded 43 mammal, 158 bird, 20 reptile, 16 frog, nine butterfly, two dragonfly and one scorpion species to be present in the surrounding area. From the above species the presence of frogs and dragonflies on the study site is highly unlikely due to the absence of any waterbodies with which these species will be directly associated. In addition to the above studies, local farmers reported the presence of Leopard, Cheetah, Pangolin (all classified as Vulnerable), African Wild Dog (classified as Endangered), Spotted Hyaena (classified as Near Threatened) and Southern African Python (classified as a Protected Species).

Mammals

The Limpopo Sweet Bushveld vegetation type and associated characteristics provide suitable habitat for a range of mammal species. Table 9-2provides a list of the mammal species that were either observed during the site visits or of which signs were present on site.

Table 9-2: Confirmed mammal species present on the study site

Common name	Scientific name	Observed	Signs
Kudu	*Tragelaphus strepsiceros*	X	
Impala	*Aepyceros melampus*	X	
Blue Wildebeest	*Connochaetes taurinus*		X
Steenbok	*Raphicerus capestris*	X	
Common Duiker	*Sylvicapra grimmia*	X	
Vervet Monkey	*Cercopithecus aethiops*	X	
Chacma Baboon	*Papio ursinus*	X	
Black Backed Jackal	*Canis mesomelas*	X	
Blesbok	*Damaliscus dorcas phillipsi*	X	
Scrub Hare	*Lepus saxatilis*	X	
Porcupine	*Hystrix africaeaustralis*		X
Banded Mongoose	*Mungos mungo*	X	
Slender Mongoose	*Galerella sanguinea*	X	
Warthog	*Phacochoerus aethiopicus*	X	

The farm portion that contains the study site is more or less heavily fenced by game fencing. The total fenced off area containing this farm portion supports at least nine of the 22 regionally occurring large game species. These include Zebra, Giraffe, Nyala, Blue Wildebeest, Red Hartebeest, Blesbok, Waterbuck, Eland and Kudu.

Other mammal species that are suited to the habitat on the study site are provided in Table 9-3.

Table 9-3: Other mammal species of conservation importance that may occur on the study site

Common name	Scientific name	Conservation status			Likelihood of occurrence	Comment
		Global red data list	RSA red data list	RSA TOPS list		
Juliana's Golden Mole	*Neamblysomus julianae*	EN	EN	VU	4	No suitable habitat and very edge of distribution range
Southern African Hedgehog	*Atelerix frontalis*	LC	NT	PS	4	Not common anywhere in their distribution, very edge of their natural distribution range
Percival's Short-eared Trident Bat	*Cloeotis percivalli*	LC	EN		4	
Pangolin	*Manis temminckii*	VU	VU	VU	4	Not common anywhere in their distribution
Water Rat	*Dasymys incomtus*	LC	NT		4	No suitable habitat on the study site
Spotted Hyaena	*Crocuta crocuta*	LC	NT	PS	4	Not common anywhere in their distribution
Brown Hyaena	*Hyaena brunnea*	NT	NT	PS	4	Not common anywhere in their distribution
Cheetah	*Acinonyx jubatus*	VU	VU	VU	5	
Leopard	*Panthera pardus*	VU	VU	VU	3	Migratory species not common anywhere in their distribution
Lion	*Panthera leo*	VU	VU	VU	5	
Black-footed Cat	*Felis nigripes*	VU	VU	PS	4	Not common anywhere in their distribution
Serval	*Leptailurus serval*	LC	NT	PS	1	

Common name	**Scientific name**	**Conservation status**			**Likelihood of occurrence**	**Comment**
		Global red data list	**RSA red data list**	**RSA TOPS list**		
African Wild Dog	*Lycaon picuts*	**EN**	**EN**	**EN**	**4**	Not common anywhere in their distribution
Cape Fox	*Vulpes chama*	**LC**	**LC**	**PS**	**3**	
Honey Badger	*Mellivora capensis*	**LC**	**LC**	**PS**	**3**	
African Weasel	*Poecilogale albinucha*	**LC**	**NT**		**2**	
African Elephant	*Loxodonta africana*	**VU**	**LC**	**PS**	**5**	Not common anywhere in their distribution, no visible signs or reports from site
White Rhinoceros	*Ceratotherium simum*	**NT**	**NT**	**PS**	**5**	Not common anywhere in their distribution, no visible signs or reports from site
Black Rhinoceros	*Diceros bicomis*	**CR**	**EN**	**EN**	**5**	Not common anywhere in their distribution, no visible signs or reports from site
Black Wildebeest	*Connochaetes gnou*	**LC**	**LC**	**PS**	**5**	
Tsessebe	*Damaliscus lunatus*	**LC**	**VU**	**EN**	**5**	
Roan	*Hippotragus equinus*	**LC**	**VU**	**EN**	**5**	
Sable	*Hippotragus niger*	**LC**	**VU**		**5**	
Reedbuck	*Redunca arundinum*	**LC**	**LC**	**PS**	**4**	Not common anywhere in their distribution

Common name	Scientific name	Conservation status			Likelihood of occurrence	Comment
		Global red data list	RSA red data list	RSA TOPS list		
Mountain Reedbuck	*Redunca fulvorufula*	**EN**	**EN**		**4**	No suitable habitat
Grey Rehbok	*Pelea capreolus*	**NT**	**NT**		**4**	Not common anywhere in their distribution
Oribi	*Ourebia ourebi*	**LC**	**EN**	**EN**	**4**	No suitable habitat

Key: **Status:** CR = Critically Endangered; EN = Endangered; LC = Least Concern; NT = Near Threatened; PS Protected Species; VU Vulnerable

Likelihood of occurrence: 1 = Present; 2 = High; 3 = Moderate; 4 = Low; 5 = May occur as a managed population

9.7 Avifauna

The study site is not located in an Important Bird Area (IBA) as classified by the SANBI, however, the Waterberg System IBA is located within 30km to the east of the study site (Figure 9-4).

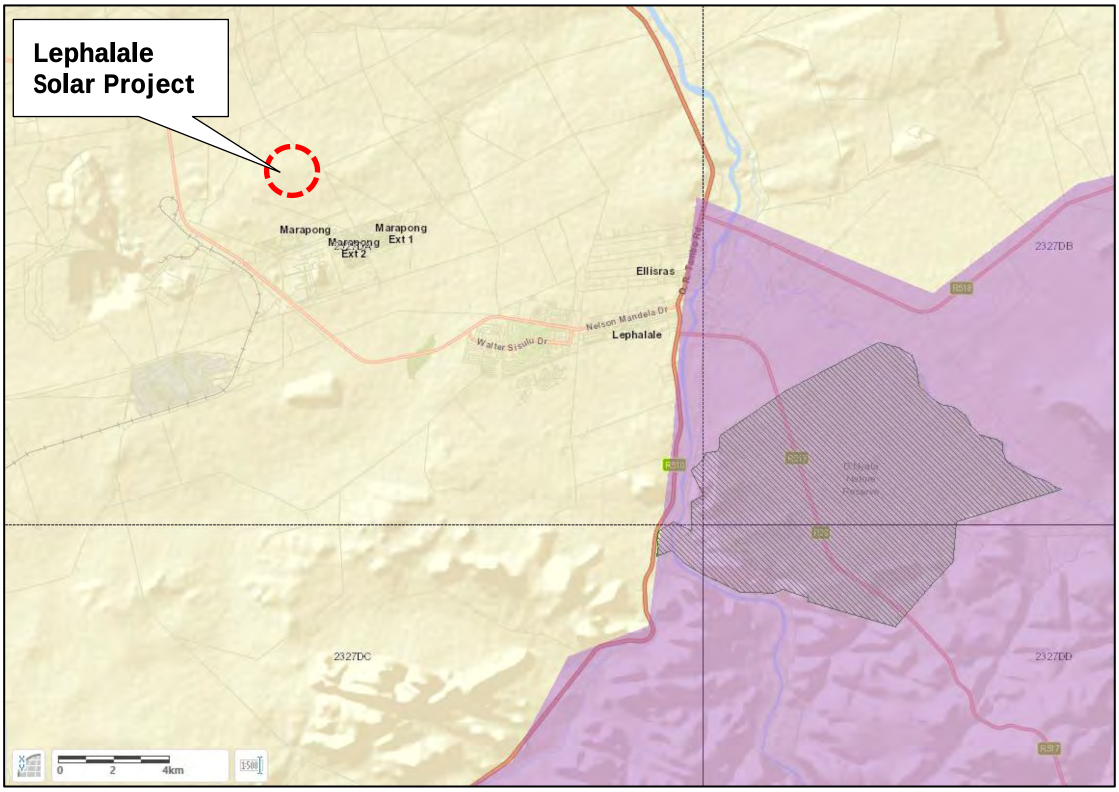

Figure 9-4: Location of the Waterberg System IBA (shown in purple) in relation to the study site

Of the estimated 345 regionally occurring bird species some 304 species are considered likely to occur on the study site, based on the species' known distribution and the diversity of available habitat in the areas surrounding the study site.

Of the 20 regionally occurring bird species of conservation importance, eight are likely to occur within the study area, one of which was seen flying above the site (White-backed Vulture) and another viewed along the existing access road to the site (Tawny Eagle). Both these species are classified as endangered.

The presence of White-backed Vultures in the area is a key component of the inclusion of the area as a CBA1 in the Limpopo C-Plan. This bird species is generally associated with dry woodland and tall trees, which they depend on for breeding. Although no nests were detected within the boundaries of the study area, trees suitable for nesting do occur within the study area. The species constructs large stick nests at the tops of tall trees, particularly

Terminalia species, Acacia nigrescens, Boscia albitrunca and Boscia foetida, all of which are present within the study site. The breeding season in South Africa is from May to June.

The single Tawny Eagle was observed perched in a large tree along the existing access road to the study site. The species inhabits mostly wooded to lightly wooded areas but is generally scarce outside of major reserves. It is likely that the individual originated from the D'Nyala Reserve to the east of the town of Lephalale.

The extensive tracts of relatively undisturbed Limpopo Sweet Bushveld vegetation type on the study site as well as the areas surrounding the site supports high representations of aerial feeding, regular insect- and seed-eating species. Figure 9-4 provides the species of conservation importance that may be present within the study site.

Table 9-4: Bird species of conservation importance that may occur on the study site

Common name	Scientific name	Conservation status			Likelihood of occurrence	Comment
		Global red data list	RSA red data list	RSA TOPS list		
Black Stork	*Ciconia nigra*	LC	VU		4	Suitable habitat on the site is absent
Marabou Stork	*Leptoptilos crumeniferus*	LC	NT		4	Suitable habitat on the site is absent
Yellow-billed Stork	*Mycteria ibis*	LC	EN		4	Suitable habitat on the site is absent
Greater Flamingo	*Phoenicopterus roseus*	LC	NT		4	Suitable habitat on the site is absent
Lesser Flamingo	*Phoeniconaias minor*	NT	NT		4	Suitable habitat on the site is absent
Black-winged Pratincole	*Glareola nordmanni*	NT	NT		4	Suitable habitat on the site is absent
African Pygmy-goose	*Nettapus auritus*	LC	VU		4	Suitable habitat on the site is absent
Maccoa Duck	*Oxyura moccoa*	NT	NT		4	Suitable habitat on the site is absent
Greater Painted Snipe	*Rostratula benghlensis*	LC	VU		4	Suitable habitat on the site is absent
Secretary Bird	*Sagittarius serpentarius*	VU	VU		2	
Kori Bustard	*Ardeotis kori*	NT	NT	PS	2	
Cape Vulture	*Gyps coprotheres*	VU	EN	EN	2	
White-backed Vulture	*Gyps africanus*	EN	EN	EN	1	Viewed flying over the study site
Lapped-faced Vulture	*Torgos tracheliotos*	VU	EN	EN	3	
Tawny Eagle	*Aquila rapax*	LC	EN	EN	1	Viewed on the boundary of the site
Martial Eagle	*Polemaetus bellicosus*	VU	EN	EN	2	Suitable habitat present on site
Bateleur	*Terathopius ecaudatus*	NT	EN	EN	4	Suitable habitat on the site is absent
Lanner Falcon	*Falco biarmicus*	LC	VU		2	Suitable habitat present on site
European Roller	*Coracias garrulus*	NT	NT		1	Viewed on site
Short-clawed Lark	*Certhilauda chuana*	LC	NT		2	Suitable habitat present on site

Key: **Status:** CR = Critically Endangered; EN = Endangered; LC = Least Concern; NT = Near Threatened; PS Protected Species; VU Vulnerable

Likelihood of occurrence: 1 = Present; 2 = High; 3 = Moderate; 4 = Low; 5 = May occur as a managed population

9.8 Reptiles

It is estimated that approximately 90 reptile species occur in the larger region surrounding the study site. Based on the habitat present on the study site, it is anticipated that none of the reptile species that are dependent on a permanent water source will be present on the site. As such, the number of reptiles present on the study site could be considerably less than the estimated number of regionally occurring species.

Of the two species of conservation importance that occur regionally, it is only possible that that one, the Southern African Python, may occur on the study site. No signs of this species was viewed during the site assessments, but the presence of the species has been observed on neighbouring properties around waterholes. Again, in the absence of any permanent water sources on the study site, the presence of this species is highly unlikely. The other species of conservation importance is the Nile Crocodile and with the absence of any permanent water sources, these species will not occur on the study site.

The diversity of reptiles on the study site largely consists of tortoises, lizards, geckos and snakes that are generally adapted to the soft red sands that characterise the Limpopo Sweet Bushveld. Large trees provide important habitats for geckos, skinks and larger lizards. Two tortoise species have been recorded in the area, the Leopard Tortoise and Speke's Hinged-back Tortoise.

The only snake that was observed during the site assessment conducted in March was Sundevall's Garter Snake, with no other snakes or signs of snakes recorded in any of the other visits. The presence of venomous species such as Puff Adder, Black Mamba, Boomslang, Vine Snake, Snouted Cobra, etc. are also expected as the study site falls well within the range of distribution of these species.

Figure 9-5 provides the species of conservation importance that may be present within the study site.

Table 9-5: Reptile species of conservation importance that may occur on the study site

Common name	Scientific name	Conservation status			Likelihood of occurrence	Comment
		Global red data list	RSA red data list	RSA TOPS list		
Southern African Python	*Python natalensis*		**LC**	**PS**	**1**	Species reported in the region
Nile Crocodile	*Crocodylus niloticus*	**LC**	**VU**	**PS**	**4**	No suitable habitat present on the site

Key: **Status:** CR = Critically Endangered; EN = Endangered; LC = Least Concern; NT = Near Threatened; PS Protected Species; VU Vulnerable

Likelihood of occurrence: 1 = Present; 2 = High; 3 = Moderate; 4 = Low; 5 = May occur as a managed population

9.9 Amphibians

Surveys that have been done in the area has found that approximately 20 frog species may occur in the larger area surrounding the site. Noteworthy frog species that occur within the larger area are the Giant Bullfrog and African Bullfrog. Both these species have been recorded in the area and are believed breed in the majority of the pans / depressions in the area. In the absence of any such pans / depressions within the bounds of the study site makes the presence of these and other frog species within the study site highly unlikely.

9.10 Response to the Terrestrial Biodiversity Protocol requirements

As previously discussed, the DFFE Online Screening Tool has identified the study site to be of "Very High Sensitivity Rating" for terrestrial biodiversity. As such the Terrestrial Biodiversity Protocol is to be followed in the compilation of this assessment. The following are key aspects that has to be addressed in the protocol.

Presence of any protected areas as defined by the National Environmental Management: Protected Areas Act (Act No. 57 of 2004).

The interrogation of the Protected Area Register managed by the DFFE has indicated that no protected areas are present of on the study site. The nearest conservation areas are the D-Nyala Game Reserve located 18km to the southeast of the study site and the Tierkop Private Game Reserve 10km to the southwest (see Figure 9-5). Neither of these reserves will be impacted upon by the development of the project on the study site.

Presence of any critically endangered or endangered ecosystems as identified in the National Environmental Management: Biodiversity Act (Act No. 10 of 2004).

No critically endangered and endangered ecosystems as identified in accordance with the National Environmental Management: Biodiversity Act (Act No. 10 of 2004) were identified within the study site (Figure 9-5).

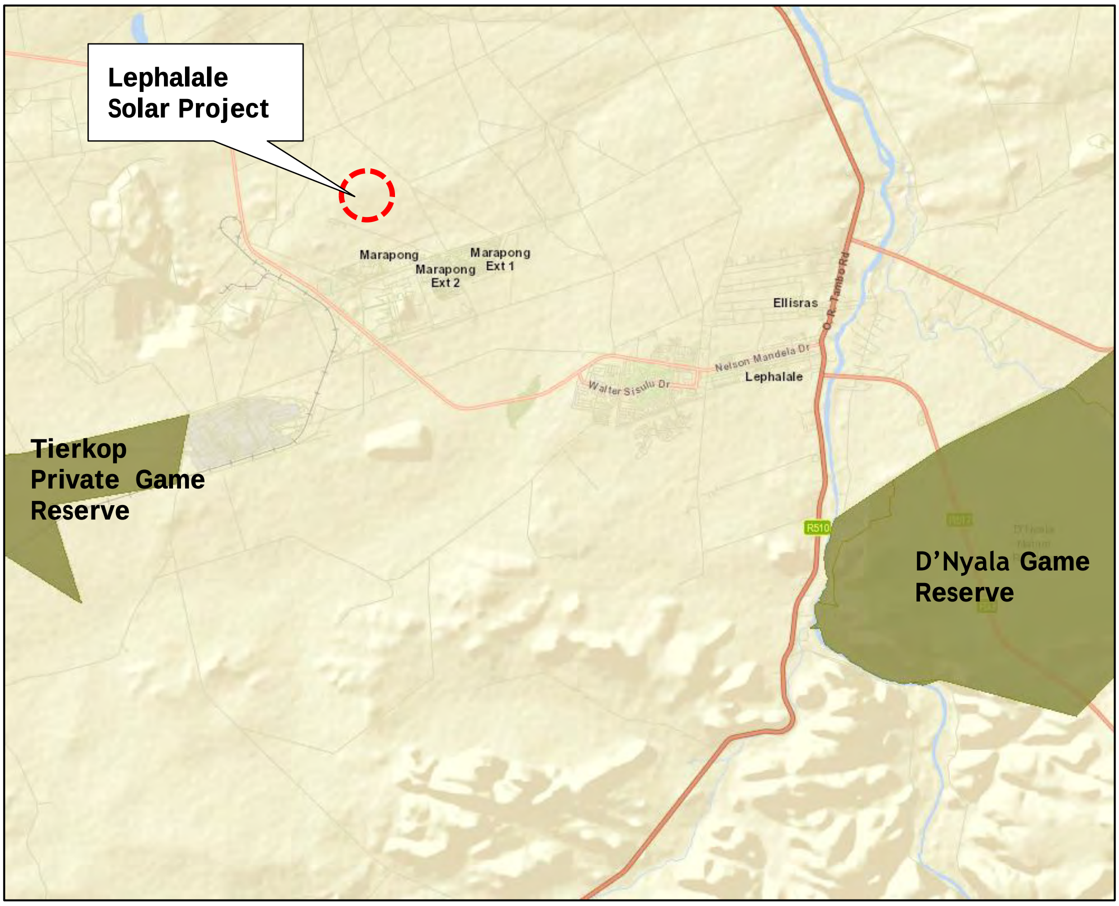

Figure 9-5: Location of the protected areas as identified in the DFFE Protected Area Register

Table 9-6provides further feedback with regards the protocol requirements.

Table 9-6: Responses to the Terrestrial Biodiversity Protocol

No.	Requirement	Section in the report
1.	A description of the ecological drivers or processes of the system and how the proposed development will impact these.	Aquatic ecosystems for the key ecological drivers in semi-arid and arid areas. In the absence of any such ecosystems within the study site, there are no dominant ecological drivers within the study site. The absence of these ecosystems impact on the abundance of faunal species, in particular the presence of reptiles, amphibians and water bird species. The description of the species abundance is provided in Section 9.
2.	A description of the ecological corridors that the proposed development would impede including migration and movement of flora and fauna.	The broad scale vegetation type on the study site consists of Limpopo Sweet Bushveld with three vegetation types classified within the study site along the species prevalence in each of these. These three fine scale vegetation classifications consist of Combretum appiculatum Woodland, Terminalia sericea Woodland and a very small stand of Mixed Bushveld. None of these vegetation types are considered to be ecological corridors. Similarly, in the absence of any watercourses within the study site, these typical ecological corridors are also absent on the study site.
3.	A description of any significant terrestrial landscape features (including rare or important flora-faunal associations, presence of strategic water source areas or freshwater ecosystem priority areas (FEPA) sub catchments.	There are no aquatic features (wetlands or watercourses) within the study site, as such the contribution that the study site will make to its classification as a FEPA Strategic Water Source Area is very limited. In addition, no flora-faunal associations are present within the study area.
4.	A description of terrestrial biodiversity and ecosystems on the preferred site, including: o Main vegetation types; o Threatened ecosystems, including listed ecosystems as well as locally important habitat types identified; o Ecological connectivity, habitat fragmentation, ecological processes and fine-scale habitats; and o Species, distribution, important habitats (e.g. feeding grounds, nesting sites, etc.) and movement patterns identified.	The description of the terrestrial biodiversity and associated ecosystems within the study site is provided in Section 9 of this report.
5.	An identification of any alternative development footprints within the preferred site which would be of “low” sensitivity as identified by the screening tool and verified through the site sensitivity verification.	No alternatives were considered as part of this assessment as the location of the project has been optimized for the location of the study site. A key consideration of the selection of the study site was that the vegetation and associated ecosystems on the surrounding properties that were considered as possible project sites are similar to that of the study site.
6.	An identification of Critical Biodiversity Areas (CBAs) within the development site. The following must be provided for these CBAs: o Reasons why an area has been identified as a CBA; o An indication of whether or not the proposed development is consistent with maintaining the CBA in a natural or near natural state or in achieving the goal of rehabilitation;	From the available information, it has been determined that the study site is located within a CBA1 in terms of the Limpopo C-Plan (2013). The reason for this classification is that the study site is located within the FEPA sub-catchment classified as the Matlabas / Mokolo Sub-water Management Area within the Limpopo Water Management Area. It must however be highlighted that the Aquatic Assessment has not identified any aquatic features within the boundaries of the study area or within a 500m radius of the study area. As such, it is believed that the contribution to the sub-management

No.	Requirement	Section in the report
	o Identification of the impact no species composition and structure of vegetation with an indication of the extent of clearing activities in proportion to the remaining extent of the ecosystem type(s); o Identification of the impacts on the ecosystem threat status; o Identification of impacts on explicit subtypes in the vegetation; o Identification of impacts on the overall species and ecosystem diversity of the site; and o Identification of impacts on any changes to threat status of populations of species conservation in the CBA.	area and associated water management area is through a contribution to the regional groundwater.
7.	An identification of terrestrial ecological support areas (ESAs) within the development site. The following must be provided for these ESAs: o Identification of the impacts on the ecological processes that operation within and across the site; o Identification of the extent to which the proposed development will impact on the functionality of the ESA; and o Identification of any potential loss of ecological connectivity (on site, and in relation to the broader landscape) due to the degradation and severing of ecological corridors or introducing barriers that impede migration and movement of flora and fauna.	See Section 10 for the impact assessment
8.	Identification of any protected areas as defined by the National Environmental Management: Protected Areas Act, 2004, including an opinion on whether the proposed development aligns with the objectives or purpose of the protected area and zoning as per the protected area management plan.	No protected areas as defined by the National Environmental Management: Protected Areas Act, 2004 occur within the study site or within a 5km radius from the site. As such, the development on the study site will not impact on any protected area.
9.	Identification of priority areas for protected area expansion, including the way in which the proposed development will compromise or contribute to the expansion of the protected area network.	The ecological state of the study site is in a relatively natural condition and forms part of the Manketti Private Nature Reserve (www.mankettilodge.co.za) that consists of vegetation that is typical of the natural surrounding area as well as managed faunal communities. However, the presence of mining operations, power generation facilities (and associated infrastructure) as well as residential areas in close proximity of the the study site significantly detracts from the study site's potential to form part of any protected area expansion plans.
10.	Identification of Strategic Water Source Areas (SWSAs), including the impacts on the terrestrial habitat of a SWSA and	The study site is located in a FEPA Sub-catchment forming a part of the Limpopo Water Management Area but have no direct surface water connectivity to the catchment. Due

No.	Requirement	Section in the report
	the impacts of the proposed development on the SWSA water quality and quantity (e.g. describing potential increased runoff leading to increased sediment load in water courses.	to the high permeability of the sandy soils on the site it is considered that the site will make a contribution to the regional groundwater in the sub-catchment.
11.	Identification of Freshwater Ecosystem Priority Area (FEPAs) sub-catchments, including the impacts of the proposed development on habitat condition and species in the FEPA sub-catchment.	The study site is located in a FEPA Sub-catchment forming a part of the Limpopo Water Management Area but have no direct surface water connectivity to the catchment. Due to the high permeability of the sandy soils on the site it is considered that the site will make a contribution to the regional groundwater in the sub-catchment.
12.	Identification of indigenous forests, including impacts on the ecological integrity of the forest and percentage of natural or near natural indigenous forest area lost and a statement on the implications in relation to the remaining areas.	No indigenous forests were identified within the study site.

9.11 Buffer determination

As no areas of ecological sensitivity were identified within the study site, no buffers are required.

10 IMPACT ASSESSMENT

Likely impacts associated with the proposed development of the Lephalale Solar Project on the identified terrestrial baseline have been identified through the undertaking of site visits, consultation of published information and independent assessment by the Environmental Project Team. Impacts have also been identified by the specialist assessments undertaken.

The impact assessment will make provision for the assessment of the following impacts:

- No-go impacts;
- Planning and design phase impacts;
- Construction phase impacts;
- Operational phase impacts;
- Decommissioning phase impacts; and
- Cumulative impacts.

Impacts identified were assessed according to the criteria outlined in Appendix B. Each impact was ranked according to extent, duration, magnitude and probability. These criteria are based on the Department of Environmental Affairs and Tourism (DEAT) (now the Department of Environmental Affairs, Forestry and Fisheries) Guideline Document to the EIA Regulations(1998). Where possible, mitigatory measures were recommended for the impacts identified.

10.1 No-go impacts

To contextualise the potential impacts of the project's activities and associated infrastructure, the existing impacts (or status quo) associated with current terrestrial biodiversity conditions need to be described. This status quo should be used as the comparison against which the other project impacts are assessed. The main issues identified with the existing impacts are:

- The study site will be left in its current state with the existing land use.
- The presence of limited alien invasive vegetation within the property will proliferate at its current rate.

Since these existing impacts will continue even if the project is not implemented, they are considered to be "no-go" impacts.

10.2 Planning and design phase impacts

Activities associated with the design and pre-construction phase pertain mostly to a feasibility assessment which is done mostly at a desktop level. In some cases, further site visits need to take place, but the impacts of these visits are negligible, if any, as these activities will be limited to non-invasive activities such as photographs and field surveys, etc.

For the purposes of this assessment, no impacts have been identified that are directly associated with the project.

10.3 Construction phase impacts

This section will assess the impacts associated with the implementation of the proposed development on the aquatic and terrestrial biodiversity on the Farm Sweet Vale No. 15257. During the construction phase the of the proposed development the following impacts have been identified:

- Potential loss of indigenous vegetation units;
- Potential increase in alien vegetation;
- Potential loss of floral species of conservation importance;
- Potential loss of faunal species of conservation importance;
- Potential loss of vulture breeding habitat (White-backed Vulture);
- Potential increase in the number of bird-strikes along the connection powerline;
- Potential loss of foraging habitat for game species;
- Loss of catchment area and decreased water inputs;
- Contamination of the area by petrochemical spillages;
- Contamination of the area by construction waste;
- Contamination of the area by domestic waste; and
- Contamination of the area as a result of leaking portable toilet facilities.

10.4 Operational phase impacts

This phase assesses the impacts associated with the operational phase of the new development. The following impacts have been identified:

- Loss of catchment area and consequent decrease in water inputs;
- Spreading of alien invasive vegetation;
- Potential loss of foraging habitat for game species;
- Potential increase in the number of bird-strikes along the connection powerline;
- Disruption of open space corridor;
- Contamination of the area by petrochemical spillages;

- Contamination of the area by construction waste;
- Contamination by domestic waste generated by the operation; and
- Contamination of the area as a result of leaking portable toilet facilities

10.5 Decommissioning phase impacts

As the development will not be decommissioned within the next 20 years, no provision is made for the any decommissioning impacts. If a decision is reached that the facility is to be decommissioned, a reassessment of the potential impacts at that time must be conducted.

10.6 Cumulative impacts

The following cumulative impacts associated with the development on the Lephalale Solar Project have been identified:

- Loss of indigenous vegetation;
- Spread of alien invasive plant species;
- Disruption of an open space corridor; and
- Loss of catchment area and consequent decrease in water inputs.

Refer to Table 10-1 to Table 10-3 for the impact identified and the mitigation measures proposed.

Table 10-1: No-go impacts associated with the development **of the Lephalale Solar Project**

Nature of impact	Impact summary	Without mitigation S = Status; E = Spatial extent; D = Duration; P = Probability; M = Magnitude					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation S = Status; E = Spatial extent; D = Duration; P = Probability; M = Magnitude					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
Vegetation	The study site will be left in its current state with the existing land use and indigenous vegetation. The risk of overgrazing of areas by the wildlife on the property will remain.	N	1	5	2	3	Score: 24 Low Negative	None, as the no-go option reflects the *status quo*.	N	1	5	2	3	Score: 24 Low Negative
Biodiversity	The presence of limited alien invasive vegetation within the property will proliferate at its current rate.	-	1	5	2	4	Score: 32 Medium Negative	None, as the no-go option reflects the *status quo*.	-	1	5	2	4	Score: 32 Medium Negative

Table 10-2: Construction phase impacts associated with the development of the Lephalale Solar Project

Nature of impact	Impact summary	Without mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
Potential loss of indigenous vegetation units	The development of the project will require the removal of indigenous vegetation from the solar PV area, the operational area as well as the powerline servitude connecting the solar PV are to the grid. The assumption is made that the entire study site will be cleared of all vegetation that is currently present.	-	1	4	8	4	Score: 52 Medium Negative	Any mitigation measures with regards to the rehabilitation of the vegetation within the study site will only commence once the decommissioning of the project commences. Provision will therefore need to be made for the rehabilitation of the site in the Quantum Cost for Rehabilitation Calculation in accordance with the appropriate guideline document at the time. No "No-Go" areas have been identified within the study site, so no provision is required for the demarcation of these areas.	-	1	2	4	2	Score: 14 Low Negative
Potential increase in alien vegetation	The occurrence of alien invasive vegetation on the study site is relatively low, however, any disturbance of the indigenous vegetation will create and opportunity for alien species to settle on the study site. If these alien species settle on the study site, the site might become an area from which these species can proliferate into the surrounding areas.	-	2	2	6	3	**Score: 30 Medium Negative**	If the project schedule can accommodate the systematic clearance of the indigenous vegetation from the site, this should be included in the construction plan. This will make provision for current work areas to be cleared of indigenous vegetation which will limit the disturbances which will allow the settlement of the alien invasive species. An Alien Invasive Species Management Plan must be put in place for the duration of the construction phase of the project which must make provision for the following: • Identification of the alien invasive species that have settled on the site; • Clear instructions on how to eradicated these species;	-	1	2	2	1	**Score: 5 Low Negative**

Nature of impact	Impact summary	Without mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
								• A schedule of eradication; and • A schedule of regular monitoring of the success of the implementation of the eradication.						
Potential loss of floral species of conservation importance	As the construction of the project will make provision for the removal of all indigenous vegetation from the study area, all floral species of conservation importance will also be removed. These species have been identified as follows: • *Boscia albitrunca* (Shepherds Tree); • *Sclerocarya birrea* subspecies *caffra* (Marula); • *Spirostachys africana* (Tamboti); and • *Acacia erioloba* (Camel Thorn). These species occur in limited numbers on the study site and is also widespread in the region surrounding the study area.	-	1	2	8	4	**Score: 33 Medium Negative**	It is important to note that in accordance with the National Forests Act (Act No. 84 of 1998) the removal of the identified tree species can only occur upon the authorisation of a permit to do so. The number of these trees must be recorded before removal to ensure that an equal number of these species can be replanted during the closure / rehabilitation of the vegetation on the site. The need for the collection and germination of seeds for these species are not necessary as all these species can be sourced from nurseries in the area.	-	1	2	4	1	**Score: 7 Low Negative**
Potential loss of faunal species of conservation importance	The clearance of indigenous vegetation from the study site will result in the removal of habitat for faunal species that currently occur within the study site.	-	1	4	6	4	**Score: 44 Medium Negative**	The current land use on the study site is very similar to the land use of the surrounding properties. Any faunal species that are considered to currently occur within the study site are all mobile species that will either move independently to the neighbouring properties once the disturbance of the construction commences or will require	-	1	1	4	3	**Score: 18 Low Negative**

Nature of impact	Impact summary	Without mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
								active repatriation before construction commences. It is therefore important to note that, if possible, the construction activities are to commence in the winter months to ensure that the animal species that will actively move from the site is not currently rearing young as the movement with young animals could potentially cause mortality amongst the young animals.						
Potential loss of vulture breeding habitat (White-backed Vulture)	The engendered White-backed Vulture was seen to fly over the study area which creates the possibility of the species nesting in the region. These species are known to make their nests in large trees of which a number are present within the study site. As such, the removal of these trees during the construction phase will decrease the nesting habitat for this endangered species from the site. It must be pointed out that no nesting sites for this species were identified during the assessment.	-	1	3	6	4	**Score: 40 Medium Negative**	Provision should be made in the project schedule to assess the project area for the presence of any White-backed Vulture nesting sites two months before the construction will commence. If any nesting sites are observed, these trees should be left untouched during the clearance of vegetation phase and buffered by a 20m buffer around these trees. Once the young birds have fledged and the birds have left the nests, these trees and the associated buffer vegetation can be cleared. If no nesting sites are identified during the assessment, all large trees (trees higher than 10m) must be felled directly after the assessment to prevent any settlement of these trees by the vultures. Provision must be made in the vegetative species mix during the rehabilitation phase	-	1	2	6	2	**Score: 18 Low Negative**

Nature of impact	Impact summary	Without mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
								of the project site for the planting of trees that will establish to large specimens which will act as nesting sites for future vulture communities.						
Potential loss of foraging habitat for game species	The clearance of vegetation from the project site will result in the reduction in the amount of available foraging habitat for game species in the area.	-	2	4	4	4	**Score: 40 Medium Negative**	This impact will only be mitigated during the rehabilitation phase of the project as discussed above. The rehabilitation will make provision for the re-establishment of the vegetation type (Limpopo Sweet Bushveld) on the project area. Once the vegetation type has been replaced on the project area, the vegetation communities will recover to such an extent that the foraging habitat for game species will return.	-	2	2	4	2	**Score: 16 Low Negative**
Loss of catchment area and decreased water inputs	The assessment has identified that the study area is located within the Matlabas / Mokolo Sub-catchment which forms a part of the Limpopo Water Management Area that is considered to be a Strategic Water Resource Area. No aquatic features were identified within the boundaries of the study site and as such, the contribution that the study site will make to the sub-catchment is to the groundwater that infiltrates through the highly permeable sandy soils on the site.	-	3	4	6	3	**Score: 39 Medium Negative**	A Stormwater Management Plan must be put in place for the construction phase of the development that will allow all the rainwater that fall within the study area to be allowed to percolate into the substrate for continuous supply of the local groundwater.	-	3	1	4	2	**Score: 16 Low Negative**

Nature of impact	Impact summary	Without mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
	As such, any impact on the substrate on the study site that will prevent the infiltration of water into the substrate will decrease the water inputs from the area to the larger catchment.													
Contamination of the area by petrochemical spillages	The presence of plant and equipment on the construction site that make use of petrochemical substances to operation pose a risk of contamination soils on the study site which could result in the contamination of the groundwater on the site.	-	2	3	6	3	**Score: 33 Medium Negative**	The following management and mitigation measures must be included into the Environmental Management Programme for the project: • All plant and equipment that make use of petrochemical substances must be checked leakages on a daily basis before operations commence. • All plant and equipment that are found to be leaking must be removed from the property and only returned once the leakages have been addressed. • If any petrochemical substances are stored on the property, this storage must be done on an impermeable surface in a bunded area that makes provision for 110% of volume of the substances that are stored. • All refuelling of plant and equipment must be conducted over a drip-tray or designated bunded areas. • If any plant or equipment is to be parked on the site, these must be parked within the demarcated construction footprint that has been cleared.	-	1	1	4	2	**Score: 12 Low Negative**

Nature of impact	Impact summary	Without mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
								• If any spillages from plant or equipment occur, the spill must be immediately contained, the contaminated soils must be collected and bagged in impermeable bags and stored on site to be removed and disposed of by a registered service provider.						
Contamination of the area by construction waste	The construction activities will generate an amount of construction waste on the site.	-	1	1	6	4	**Score: 32 Medium Negative**	The following waste management activities must be provided for in the Environmental Management Programme for the project: • Skips must be made available on-site into which all construction waste can be discarded. • All construction waste must be cleared from the site on a daily basis and placed in these skips. • The capacity of these skips must be monitored on a daily basis to ensure that a replacement skip can be arranged on the same day as the filled skips are removed. • The disposal of the content of these skips must be done at a municipal landfill site. • No dumping of construction waste on open areas on the property will be allowed. • No burial of construction waste within the project site or in the surrounding areas will be allowed.	-	1	1	2	2	**Score: 8 Low Negative**

Nature of impact	Impact summary	Without mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
Contamination of the area by domestic waste.	The presence of a labour force associated with the construction will generate an amount of domestic waste (food wrapping, plastic bottles, etc.) on the site.	-	1	1	6	4	**Score: 32 Medium Negative**	The following waste management activities must be provided for in the Environmental Management Programme for the project: • A designated eating area must be established within the construction site. • Covered domestic waste bins must be present at the eating area to receive all the domestic waste generated by the labour. • The capacity of these domestic waste bins must be monitored on a daily basis to ensure that they are emptied timeously. • The domestic waste from these waste bins must be removed off site and disposed of at a municipal landfill site on a weekly basis or more regularly if the bins fill up quicker.	-	1	1	2	2	**Score: 8 Low Negative**
Contamination of the area as a result of leaking portable toilet facilities.	Portable toilet facilities will be present of the property to service the labour associated with the construction. These toilets will pose a risk of leakages and spillages which may impact on the groundwater quality on the site.	-	2	2	8	3	**Score: 36 Medium Negative**	The following management and mitigation measures must be included into the Environmental Management Programme Report for the project: • Only portable chemical toilets with a sealed reservoir will be allowed on site. • The capacity of the reservoirs in the portable chemical toilets must be monitored on a daily basis to ensure that they can be serviced timeously. • All removal of the collected sewage waste from the portable chemical toilets must be conducted by a registered service provider for disposal	-	1	2	6	2	**Score: 18 Low Negative**

Nature of impact	Impact summary	Without mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
								at a municipal waste water treatment facility.						

Table 10-3: Operational phase impacts associated with the development of the Lephalale Solar Project

Nature of impact	Impact summary	Without mitigation					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
		S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability							S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					
Loss of catchment area and consequent decrease in water inputs	The assessment has identified that the study area is located within the Matlabas / Mokolo Sub-catchment which forms a part of the Limpopo Water Management Area that is considered to be a Strategic Water Resource Area. No aquatic features were identified within the boundaries of the study site and as such, the contribution that the study site will make to the sub-catchment is to the groundwater that infiltrates through the highly permeable sandy soils on the site. As such, any impact on the substrate on the study site that will prevent the infiltration of water into the substrate will decrease the water inputs from the area to the larger catchment.	-	3	4	6	3	**Score: 39 Medium Negative**	A Stormwater Management Plan must be put in place for the construction phase of the development that will allow all the rainwater that fall within the study area to be allowed to percolate into the substrate for continuous supply of the local groundwater. • An Alien Invasive Management Plan must be established and implemented for the operational phase of the development. This plant must be in place when the development goes operational. • The Alien Invasive Management Plan must make provision for the identification of all the alien invasive plant species on the property as well as the management and control measures to be implemented. • The implementation of this plan must be responsibility of the owners of the development.	-	3	1	4	2	**Score: 16 Low Negative**
Spreading of alien invasive vegetation	The occurrence of alien invasive vegetation on the study site is relatively low, however, any disturbance of the indigenous vegetation will	-	2	2	6	3	**Score: 30 Medium Negative**	An Alien Invasive Management Plan must be established and implemented for the operational phase of the development. This plant must be in place when the development goes operational.	-	1	2	2	1	**Score: 5 Low Negative**

Nature of impact	Impact summary	Without mitigation S*	E	D	M	P	Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation S	E	D	M	P	Significance rating (post-mitigation)
		S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability							S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					
	create and opportunity for alien species to settle on the study site. If these alien species settle on the study site, the site might become an area from which these species can proliferate into the surrounding areas.							The Alien Invasive Management Plan must make provision for the identification of all the alien invasive plant species on the property as well as the management and control measures to be implemented. In addition, the Alien Invasive Management Plan must make provision for the monitoring of all management and control interventions to gauge the success of these activities.						
Potential loss of foraging habitat for game species	The clearance of vegetation from the project site will result in the reduction in the amount of available foraging habitat for game species in the area.	-	2	4	4	4	**Score: 40 Medium Negative**	This impact will only be mitigated during the rehabilitation phase of the project as discussed above. The rehabilitation will make provision for the re-establishment of the vegetation type (Limpopo Sweet Bushveld) on the project area. Once the vegetation type has been replaced on the project area, the vegetation communities will recover to such an extent that the foraging habitat for game species will return.	-	2	2	4	2	**Score: 18 Low Negative**
Potential increase in the number of bird-strikes along the connection powerline	The presence of the overhead powerline connecting the solar PV plant to the electricity grid has the potential to generate bird-strikes in the area. The relative pristine nature of the site and the surrounding areas make the presence of large birds of prey likely.	-	1	4	8	3	**Score: 39 Medium Negative**	The following suggest considerations must be given to the design of the intended overhead powerline: • Making provision to have the powerline as low as possible. It is generally accepted that the lower the powerlines are above ground level, a reduction in the risk of bird-strikes will take place; and	-	1	4	8	2	**Score: 26 Low Negative**

Nature of impact	Impact summary	Without mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
	As such, the risk of these birds colliding with the powerline becomes increased.							• Provision of line markers along the powerline to make the powerline more visible to birds.						
Disruption of open space corridor	Even though no defined ecological corridors have been identified on the site the risk is present that the project may result in a disruption of the current open space corridor used by the species that occur on the site as well as the surrounding properties.	-	2	4	4	4	**Score: 40 Medium Negative**	The land use on the project site as well as the surrounding properties are similar and makes provision for the presence of large areas under indigenous vegetation, which will naturally allow for the movement of species through the area irrespective of the presence of the project. The rehabilitation plan that will accompany the Quantum Cost Calculation for Rehabilitation must make provision for the rehabilitation of the vegetation on the project site to ensure that the vegetation resembles the of the surrounding areas to ensure that the open space corridors that have been disrupted are again allowed to continue.	-	2	2	2	2	**Score: 12 Low Negative**
Contamination of the area by petrochemical spillages	The presence of substations within the project design, presents a risk of leakages of petrochemical fluids from these structures. Any such leakages can result in the contamination of the soils on the property as well the groundwater associated with the property.	-	3	4	8	2	**Score: 30 Low Medium**	The design of the substation(s) that will be present on the site must make provision for the transformers to be located within bunded areas that has a containment capacity of 110% of the total volume of petrochemical fluids as contained within the facility. A specific emergency response plant must be included the Operational Management Plan for the project that specifically details the actions that must be taken when the	-	3	4	8	1	

Nature of impact	Impact summary	Without mitigation					Significance rating (pre-mitigation)	Proposed mitigation and management measures	With mitigation					Significance rating (post-mitigation)
		S*	E	D	M	P			S	E	D	M	P	
		S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability							S = Status; E = Spatial extent; D = Duration; M = Magnitude P = Probability					
								spill from the substation or transformers occur.						
Contamination by domestic waste generated by the operations	Domestic waste will be generated by the employees that will be managing the facility.	-	1	1	6	4	**Score: 32 Medium Negative**	The following waste management activities must be provided for in the Environmental Management Programme for the project: • A designated eating area must be established within the project site. • Covered domestic waste bins must be present at the eating area to receive all the domestic waste generated by the employees. • The capacity of these domestic waste bins must be monitored on a daily basis to ensure that they are emptied timeously. • The domestic waste from these waste bins must be removed off site and disposed of at a municipal landfill site on a weekly basis or more regularly if the bins fill up quicker.	-	1	1	2	2	**Score: 8 Low Negative**
Contamination by leaking sewage from operations ablutions facilities.	The design of the facility will make provision for onsite ablution facilities which will be serviced by a conservancy tank system. The presence of a conservancy tank creates a risk of leakages from this tank.	**-**	**2**	**2**	**8**	**3**	**Score: 36 Medium Negative**	Monitoring of the sewage system for any malfunctions or leaks must be provided for in the Operational Management Plan for the project. Regular servicing and maintenance of the sewage system must be included in the Operational Management Plan for the project.	**-**	**2**	**2**	**8**	**1**	**Score: 12 Low Negative**

Table 10-4: Cumulative impacts associated with the development of the Lephalale Solar Project

Nature of impact	Impact description	Impact rating post mitigation
Loss of indigenous vegetation	The loss of indigenous vegetation from the study site is directly associated with the clearance of the entire site which comprises an area of 256ha. This indigenous vegetation falls within the Limpopo Sweet Bushveld vegetation type that is classified as "least threatened" due to the high percentage (approximately 95%) of the vegetation type that is still intact. The cumulative impact based on the removal of the vegetation from the site is therefore considered to be very low when viewed in the context of the entire distribution of the vegetation type in South Africa.	**Low Negative**
Spread of alien invasive plant species	The occurrence of alien invasive vegetation on the study site is relatively low, however, any disturbance of the indigenous vegetation will create and opportunity for alien species to settle on the study site. If these alien species settle on the study site, the site might become an area from which these species can proliferate into the surrounding areas. Furthermore, the management of alien invasive plant species must be included in the Environmental Management Programme for the construction phase, as well as the Operational Management Plan for the project. The measures included in this plan must have as a goal to reduce the spread of the alien invasive species and to eradicate them from area within the property in which they occur. This cumulative impact can therefore be successfully managed and mitigated.	**Low Negative**
Disruption of an open space corridor	Even though no defined ecological corridors have been identified on the site the risk is present that the project may result in a disruption of the current open space corridor used by the species that occur on the site as well as the surrounding properties. The land use on the project site as well as the surrounding properties are similar and makes provision for the presence of large areas under indigenous vegetation, which will naturally allow for the movement of species through the area irrespective of the presence of the project. The rehabilitation plan that will accompany the Quantum Cost Calculation for Rehabilitation must make provision for the rehabilitation of the vegetation on the project site to ensure that the vegetation resembles the of the surrounding areas to ensure that the open space corridors that have been disrupted are again allowed to continue. This cumulative impact can therefore be successfully managed and mitigated.	**Low Negative**
Loss of catchment area and consequent decrease in water inputs	The assessment has identified that the study area is located within the Matlabas / Mokolo Sub-catchment which forms a part of the Limpopo Water Management Area that is considered to be a Strategic Water Resource Area. No aquatic features were identified within the boundaries of the study site and as such, the contribution that the study site will make to the sub-catchment is to the groundwater that infiltrates through the highly permeable sandy soils on the site. As such, any impact on the substrate on the study site that will prevent the infiltration of water into the substrate will decrease the water inputs from the area to the larger catchment.	**Low Negative**

Nature of impact	Impact description	Impact rating post mitigation
	The implementation of the requirements of the Stormwater Management Plans that must be done for the construction phase as well as the operational phase will make provision for the rainfall that occurs within the project site to be allowed to percolate into the sandy substrate to ensure that the groundwater recharge contribution from the area is still provided to the aquifer. This cumulative impact can therefore be successfully managed and mitigated.	

11 MANAGEMENT AND MITIGATION MEASURES

The management and mitigation measure to be included in the Environmental Management Programme Report and Operational Management Plant for the construction and operational phases of the development on the Lephalale Solar Project is provided in Tables 10-1 to 10-3, above.

12 MONITORING REQUIREMENTS

It is recommended that an Environmental Control Officer, who meets the requirements of the NEMA: EIA Regulations (2014) as amended, be appointed to conduct monthly audits of the construction and rehabilitation works for the duration of the project. An audit report must be completed for each monthly audit and be submitted to the relevant authority.

Furthermore, a specialist ecologist should conduct a site visit prior to the commencement of the construction activities to identify any White-backed Vulture nesting sites as well as any possible trees that could serve as potential nesting sites.

13 REASONED OPINION BY THE SPECIALIST

Appendix 6 of the National Environmental Management Act (Act No. 107 of 1998): Environmental Impact Assessment Regulations (2014), as amended requires that the specialist conducting a specialist study for submission with an Application for Environmental Authorisation provide a reasoned opinion on whether an authorisation should be granted. The following is the specialist's reasoned opinion in this regard.

13.1 Key findings of the assessment

The following key findings were made during the assessment and will be used to provide a reasoned opinion on whether the development should proceed or not.

13.1.1 Wetlands and watercourses

No aquatic features were identified within the study site. No such features will therefore be impacted upon by the development of the project.

13.1.2 Vegetation

The vegetation type on the study site has been classified as Limpopo Sweet Bushveld which is considered to be "least threatened" as a result of a the small area of this vegetation type that has been disturbed (approximately 5%). The loss of approximately 256ha of the vegetation type (and associated species) is therefore considered to be a negligible loss to the total distribution of the vegetation type.

However, the appropriate authorisations / permits must be obtained from the relevant authorities for the clearance and removal of the special species identified in the assessment.

13.1.3 Avifauna

No Important Bird Areas (IBA) were found to overlap the property. However, the presence of two bird species of conservation importance were noted on the site. Provision must be made in the design of the overhead powerline to limit the amount potential bird-strikes that may occur as a result of the high number of birds of prey that is present in the area.

13.1.4 Mammals

The mammals that were identified on the study site does not limit their range land or distribution to the site in particular. As such, they largely move freely between the surrounding properties which significantly reduces the impact of the facility on these species.

13.1.5 Reptiles

The diversity of reptiles on the study site largely consists of tortoises, lizards, geckos and snakes that are generally adapted to the soft red sands that characterise the Limpopo Sweet Bushveld. It is believed that the species that are dependent on a permanent water source will not be present on the study site as there no such features on the site. Similarly, to the situation with the mammal species on the site, the reptiles will move off the study site during construction and will move into the surrounding properties that have similar ecological conditions.

13.1.6 Amphibians

The absence of any aquatic features within the study site will make the presence of any amphibians very rare on the site. As such, the impact on this animal class is considered to be neglible.

13.1.7 Conservation significance

The conservation significance of the study site is greatly decreased by the wide distribution and relatively pristine Limpopo Bushveld vegetation type that is present on the study site. As such, the impact on species, ecological processes, etc. associated the vegetation type is considered to also be reduced. The site does however fall within a CBA1 as a result of its location within a Strategic Water Resource Area (Limpopo Water Management Area), however, it is believed that the contribution of the study site to the catchment is through its groundwater contribution as a result of the high permeability of the sandy soils on the site.

The development of the project will have a very limited to neglible impact on this groundwater contribution.

13.1.8 Species of special concern

The species of special concern has been highlighted within the assessment. Where these species are to be removed from the site, the appropriate authorisations / permits must be sourced from the relevant authorities.

14 CONCLUSION

Based on the findings of the assessment it is the opinion of the Specialist that there are no reasons that the development should not be authorised in accordance with the specifications as presented in this assessment. The authorisation must make provision for the various management and mitigation measures detailed in this report.

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APPENDIX A

SPECIALIST CURRICULUM VITAE

APPENDIX B

IMPACT ASSESSMENT METHODOLOGY

IMPACT ASSESSMENT METHODOLOGY

Likely impacts associated with the proposed development on the identified aquatic and terrestrial biodiversity baseline have been identified through the undertaking of site visits, consultation of published information, comments from Interested and Affected Parties, comments from the relevant authority and independent assessment by the Environmental Project Team. Impacts have also been identified by the specialist assessments undertaken.

The impact assessment will make provision for the assessment of the following impacts:

- No-go impacts;
- Planning and design phase impacts;
- Construction phase impacts;
- Operational phase impacts;
- Decommissioning phase impacts; and
- Cumulative impacts.

Impacts identified were assessed according to the criteria outlined below. Each impact was ranked according to extent, duration, magnitude and probability. These criteria are based on the Department of Environmental Affairs and Tourism (DEAT) (now the Department of Environmental Affairs, Forestry and Fisheries) Guideline Document to the EIA Regulations(1998). A significance rating was calculated as per the methodology outlined below. Where possible, mitigatory measures were recommended for the impacts identified.

Status of the Impact

The impacts were assessed as having either of the following:

Table 1: Impact status classification

Classification	Definition
Negative effect	at a cost to the environment
Positive effect	a benefit to the environment
Neutral	Neutral effect on the environment

Extent of the Impact

The extent of each impact was rated as being one of the following:

Table 2: Impact extent classification

Classification	Definition
1	Site - within the boundaries of the development site
2	Local - the area within 5 km of the site
3	Municipal - the Local Municipality
4	Regional - The Province

5	National - South Africa
6	International - Southern Africa

Duration of the Impact

The duration of each impact was rated as being one of the following:

Table 3: Impact duration classification

Classification	Definition
1	Immediate - > 1 year
2	Short term - 1 to 5 years
3	Medium term - 6 to 15 years
4	Long Term - the impact will cease when the operation stops
5	Permanent - no mitigation measure will reduce the impact after construction

Magnitude of the Impact

The intensity or severity of each impact was rated as being one of the following:

Table 4: Impact severity classification

Classification	Definition
0	None - where the aspect will have no impact on the environment
2	Minor - where the impact affects the environment in such a way that natural, cultural and social functions / processes are not affected
4	Low - where the impact affects the environment in such a way that the natural, cultural and social functions / processes are slightly affected
6	Moderate - where the affected environment is altered but natural, cultural and social functions / processes continue, albeit in a modified way
8	High - natural, cultural or social functions / processes are altered to the extent that they will temporarily cease
10	Very high / unknown - natural, cultural or social functions / processes are altered to the extent that they will permanently cease

Probability of Occurrence

The likelihood of the impact actually occurring is indicated as either:

Table 5: Impact probability classification

Classification	Definition
0	None - the impact will not occur
1	Improbable - the possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate corrective actions
2	Low - there is a probability that the impact will occur
3	Medium - the impact may occur
4	High - it is most likely that the impact will occur
5	Definite / unknown - the impact will occur regardless of the implementation of any prevention or corrective actions, or it is not known what the probability will be, based on a lack of published information

Significance of the Impact

Based on the information contained in the points above, the potential impacts have been assigned a significance weighting (S). This weighting is formulated by adding the sum of the numbers assigned to extent (E), duration (D) and magnitude (M) and multiplying this sum by the probability (P) of the impact.

$S = (E+D+M)*P$

The significance weightings are ranked as:

Table 6: Impact significance rating

Impact rating	Definition
< 30	Low – the impact would not have a direct influence on the decision to develop in the area;
30 – 60	Medium – the impact could influence the decision to develop in the area unless it is effectively managed / mitigated;
> 60	High - the impact must have an influence on the decision-making process for development in the area.

APPENDIX C

SPECIALIST DECLARATION

APPENDIX E3: SOIL, LAND CAPABILITY AND LAND USE SPECIALIST ASSESSMENT

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SOILS, LAND CAPABILITY, AND LAND USE SPECIALIST ASSESSMENT FOR THE LEPHALALE SOLAR PROJECT NEAR LEPHALALE, LIMPOPO PROVINCE

Date
July 2021

Client
GCS Water & Environment (Pty) Ltd

SPECIALIST ASSESSMENT DETAILS & DECLARATION OF INDEPENDENCE

Document Title	SOILS, LAND CAPABILITY, AND LAND USE SPECIALIST ASSESSMENT FOR THE LEPHALALE SOLAR PROJECT NEAR LEPHALALE, LIMPOPO PROVINCE	
GCS Ref	21-0037	
Zutari Ref	1001395-G040-REP-NN-0001	
Report No.	V1	
Version	Final	
Date	30 July 2021	
Report completed by	Wayne Jackson *Cert.Sci.Nat. (Registration 119037)*	
Client	GCS Water & Environment (Pty) Ltd	
Fieldwork and Report Writing	Wayne Jackson	

I, Wayne Jackson, hereby declare that this report has been prepared independently of any influence or prejudice as may be specified by the Department of Environmental Affairs.

Wayne Jackson

Wetland & Soils Specialist

Eco-Assist

30th July 2021

Specialist Details

Specialist	Role	Details
Wayne Jackson *Cert.Sci.Nat. (Registration 119037)*	Field work and author (Soils)	Wayne Jackson graduated from the University of KwaZulu-Natal, Pietermaritzburg, with a BSc. degree in Soil Science & Hydrology. Wayne has 12 years' experience in Wetlands & Soils Scientist with a demonstrated history of working in the environmental services industry. He is skilled in Soil Classification, Wetlands, Hydropedology, and Surface Water Hydrology. He has a strong Environmental mitigation and rehabilitation knowledge. He has also gained experience in large post-mining rehabilitation projects, providing specialist inputs on land capability and soil utilisation. He has extensive exposure to a wide range of projects in many sectors across South Africa, and parts of Africa. He is knowledgeable on how soils, wetlands, and hydrological systems are linked in the landscape and how activities could impact all these aspects. Wayne is a registered Natural Scientist with the South African Council for Natural Scientific Professionals (SACNASP) – Registration No. 119037.

The relevant experience of specialist team members involved in the compilation of this report are briefly summarized above. Curriculum Vitae's of the specialist team are available on request.

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1 INTRODUCTION

Eco-Assist Environmental Consultants (here after Eco-Assist) were appointed by GCS Water & Environment (Pty) Ltd (hereafter GCS) to conduct the Soils, Land Capability, and Land Use Specialist Assessment for the Lephalale Solar Project Near Lephalale, Limpopo Province.

1.1 Background

The applicant proposes to generate electricity from the solar energy resource using photovoltaic panels.

The solar field and the project associated infrastructure are listed below. Detailed descriptions of the project components including the locations and coordinates of the structures are included in the sections below.

The proposed project would entail the development of a Photovoltaic (PV) solar power plant up to 256 hectares in extent with a generation capacity of approximately 100 MWp (80 MWac) covering the entire feasible area. The final capacity would be dependent on ongoing development of photovoltaic technologies, as more efficient modules may become available by the time that the project would begin construction. The development footprint is approximately 256 hectares, however the generation capacity may vary based on the availability of more efficient PV panels.

The solar facility will consist of:

- Solar PV panels;
- Steel support structure and tracker system on concrete foundations;
- Inverter stations as part of the PV field;
- Transformers, switchgear and related equipment as part of the Substations; and
- Internal roads

The project associated infrastructure will consist of:

- Substation complex (33/132 kV) including control rooms and grid control yards;
- existing Grootegeluk substation upgrades;
- 132 kV transmission line and transmission towers;
- Battery Energy Storage System (BESS);
- operations and maintenance buildings;
- borehole and water treatment plant;
- access roads;
- internal roads;
- perimeter fencing;
- access control gate;
- security building;
- temporary concrete batching facility;
- temporary offices for the construction period;
- construction yard; and
- laydown area.

1.2 Project Locality

The study area is located 15 km west of Lephalale town in the Limpopo Province, South Africa. The local setting of the study presented in Figure 1-1, with the project infrastructure layout being shown in Figure 1-2.

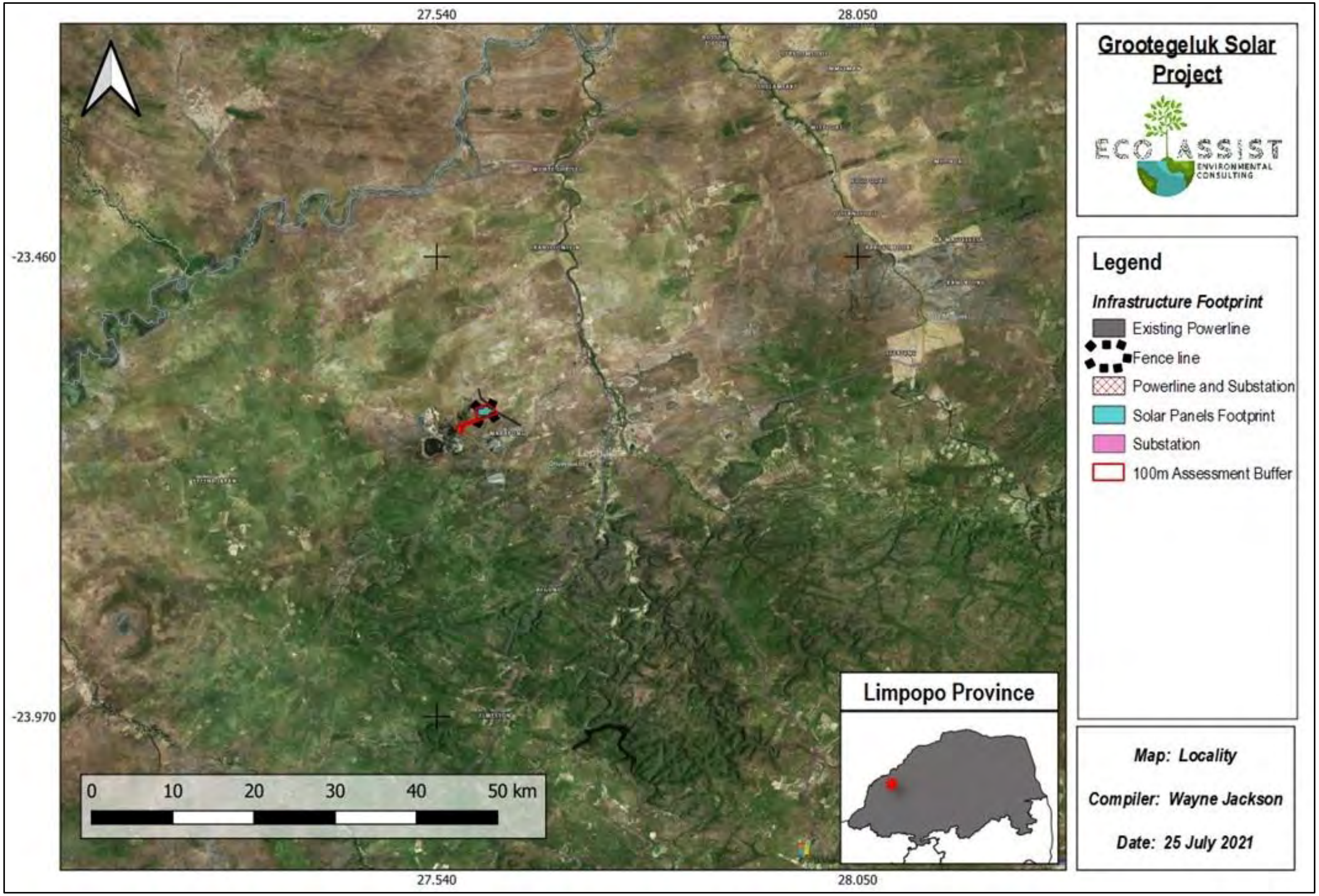

Figure 1-1: Local setting of the study.

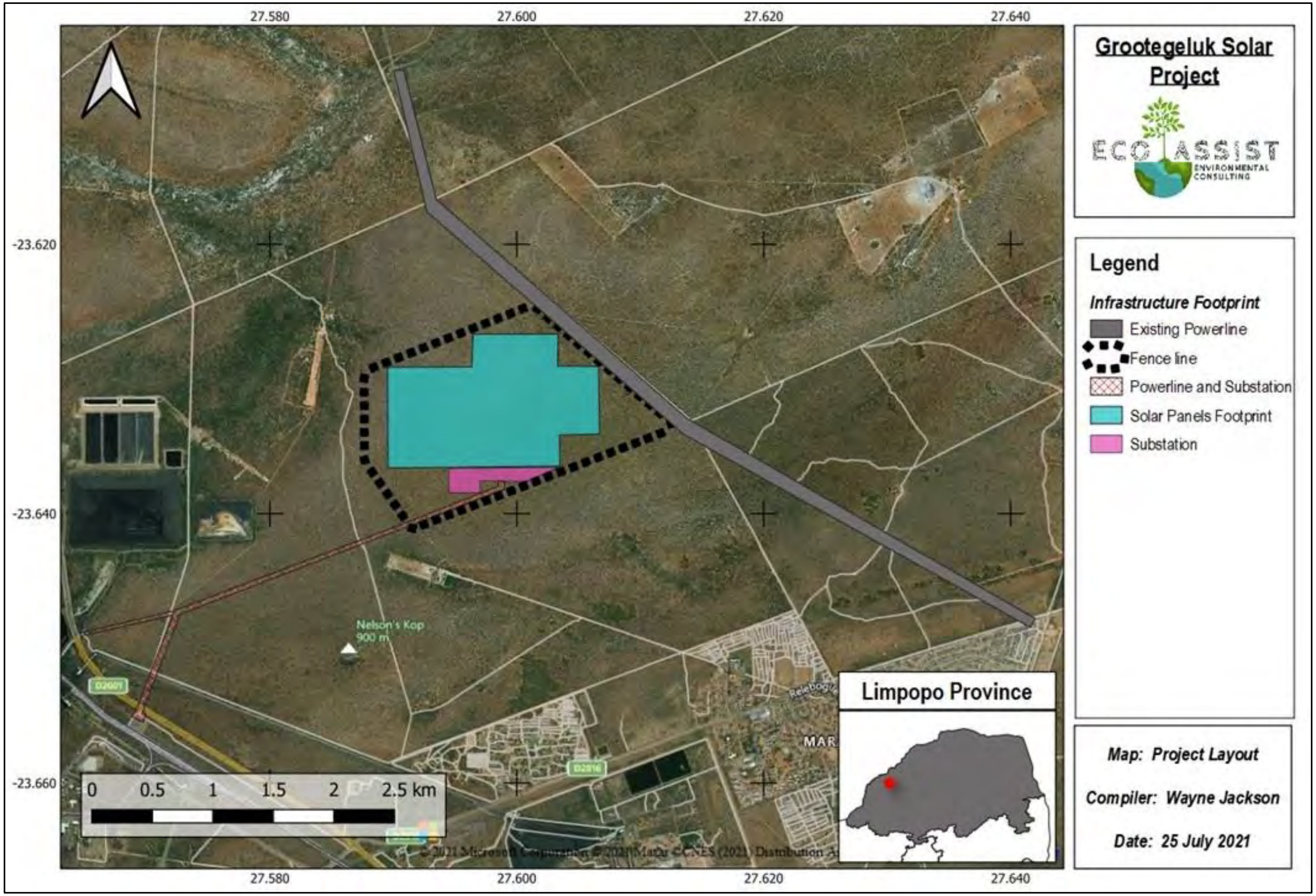

Figure 1-2: Project layout.

1.3 Project Opportunity

Private electricity supply options are becoming popular to supplement the electricity purchased from Eskom. This opportunity leverages the potential cost savings of such supplementary supply, while taking advantage of the reduced carbon footprint of the renewable nature of the technology.

This project is the establishment of an array of crystalline solar photovoltaic (PV) modules grouped into strings of 28 modules and installed to solar tracking mounting structures, together with associated infrastructure for the generation of 80MWac of electricity. The PV tables for Lephalale Solar Project would form an array covering an area of approximately 236 ha, surrounded by a perimeter access road and fence. The 4km evacuation powerlines will follow a 67m corridor along the Appelvlakte fence (25.5 ha) which will also include the main access road. The affected area of the power lines and access road beyond the 236 ha of the main plant is 20 ha giving the total affected area of the project as 256 ha.

The PV tables will be raised approximately 1.5 m above ground level and have single axis tracking systems allowing maximization of solar energy harvesting for conversion to electrical energy. Similar solar PV arrays are depicted in Figure 1-3 below.

Figure 1-3: Single axis solar PV module tables raised 1.5m above ground level (to a maximum tilt height of 3m).

The proposed associated infrastructure includes a fenced construction staging/lay-down area (a portion of which will form the operational lay-down area), inverter-transformer stations on concrete pads, a battery energy storage system (BESS) adjacent to the substation platform, office buildings with ablutions, maintenance shed/s and a substation for connection to the power grid, all within the 236 ha PV plant site. It is proposed that the powerlines within the facility, as well as the approximately 33kV powerline/s used for evacuation of electricity from the solar PV facility to a proposed future substation on the Lephalale Solar plant property, be underground/sub-surface. From the proposed future substation tie-in to the Grootegeluk 33kV Substation will occur via overhead powerlines. The Grootegeluk 33 kV substation is located approximately 4km south-west of the proposed development site.

Figure 1-4 below indicates the position of the proposed Lephalale Solar PV Facility relative to the connection point at the Grootegeluk Substation as well as array relative to the proposed high voltage powerlines connecting the Solar Power Plant to the Grootegeluk substation.

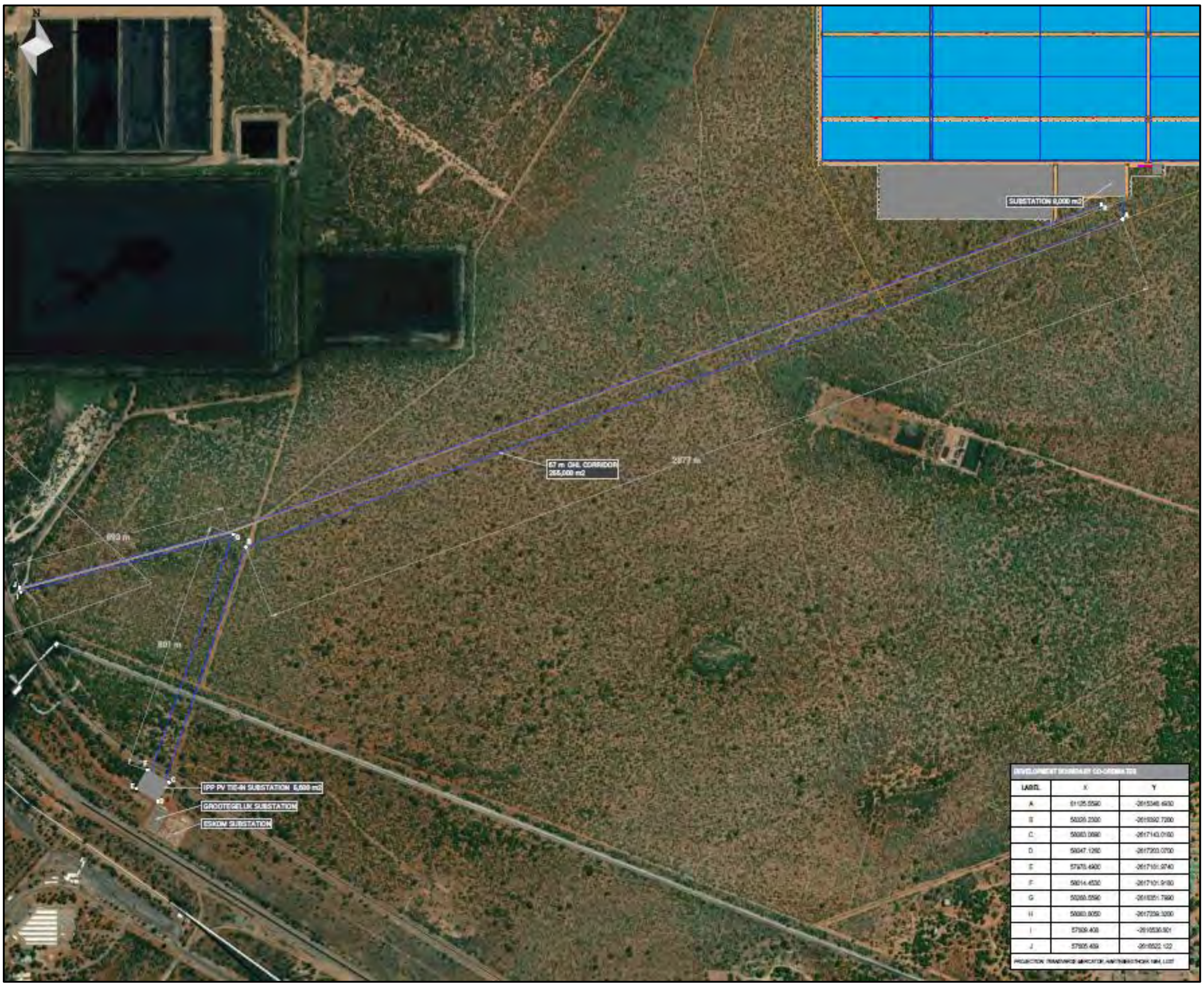

Figure 1-4: The position of the proposed Lephalale Solar PV Facility relative to the connection point at the Grootegeluk Substation as well as array relative to the proposed high voltage powerlines connecting the Solar Power Plant to the Grootegeluk substation (provided by client).

1.4 Project Description

The proposed project will make use of solar PV technology to generate electricity from the sun's energy. The Applicant is proposing to develop a facility with a possible maximum installed capacity of 100 MWp (DC capacity) and an export capacity of 80 MWac (AC capacity). The facility will be an embedded generator, connecting "behind the meter" at the Grootegeluk Mine.

The solar facility will consist of the following components:

- Solar Field:
  - ≤250 ha Free Field Single Axis Tracker PV – 100 MWp;
  - Solar module mounting structures comprised of galvanised steel and aluminium;
  - Buried electrical cables connecting the PV arrays to the inverter stations, O&M building, and collector substation; and

- Inverter/MV transformer stations.
- Collector substation:
    - ≤1 ha 33 kV to 132 kV collector substation to receive, convert and step-up electricity from the PV facility to the 132 kV grid suitable supply. The facility will house control rooms and grid control yards for the Independent Power Producer.
- O&M area:
    - Operations and Maintenance (O&M) buildings;
    - ≤9 ha hectare O&M laydown area (near / adjacent substation);
    - ≤0.01 ha solar measuring station;
    - Parking, reception area, offices, guest accommodations and ablution facilities for operational staff, security and visitors;
    - Workshops, storage areas for materials and spare parts;
    - Water storage tanks (~160 kl/day during first 3 months; ~90 kl/day for 21 months during the rest of the construction period; ~20 kl/day during operation);
    - One 5kl septic tank and sewer lines to service ablution facilities; and
    - Central Waste collection and storage area.
- Battery Storage System:
    - 100 MWh Battery Storage Facility with container heights of 5m (with lightning masts of 20m) and a volume of 2,700m3 of batteries and associated operational, safety and control infrastructure.
- Access road:
    - ≤ 15 km long, ≤8 m wide gravel access road running from the main Lephalale road to the site.
- Service roads:
    - ≤10 km of ≤4 m wide gravel internal service roads within the plant boundary;
- Other infrastructure:
    - Perimeter fencing and internal security fencing and gates as required.
    - Access control gate and guard house on access road;
    - ≤3.5 km length of small diameter water supply pipeline connecting existing boreholes to storage.
    - Stormwater channels
- Construction Site office area (used during construction and rehabilitated thereafter):
    - ≤ 1 ha site office area;
    - ≤ 100 ha laydown area; and
    - ≤ 1 ha concrete batching plant
- Tie-in substation (next to Eskom / Grootegeluk Mine Main 132 / 33kV Substation):
    - ≤1 ha 132 kV to 33 kV Tie-in substation to receive, convert and step-down electricity from the PV facility to the 33 kV main substation for the Mine. The facility will house control rooms and grid control yards for the Independent Power Producer.

The Lephalale Solar facility is being developed with a maximum installed capacity of 100 MWp (DC) which produces 80 MWac (AC) of electricity. The facility will be in operation for at least 20 years. It is important to note that the final specifications of the project components will be determined during the detailed engineering phase which would commence after receipt of an EA from the competent authority.

1.4.1 Solar Field

The solar panels are composed of several solar cells containing a photovoltaic material which produce direct current electric power when exposed to solar radiation. The solar cells are interconnected and encapsulated between a transparent front (usually glass) and a backing material to form a solar panel. Typically, the photovoltaic material is Crystalline Silicon, however other viable options such as Cadmium Telluride and Copper indium gallium selenide are also available. The most recent advancements in bifacial technology are becoming an industry standard for utility-scale solar PV. The final technology that will be used for the Lephalale Solar facility will be determined during the detailed engineering phase which would commence after receipt of an EA from the competent authority.

The two options of mounting structure which were considered by the applicant are fixed mounting and tracking mounting structures. Typically, in a tracking system, the panels are mounted on a steel rack and a tracking motor is placed at the end of the array to control the tilt and movement of the panel as required to track the sun. The mounting structure influences the exposure of the photovoltaic panels to sunlight with single axis tracking systems, dual axis tracking systems, and fixed tilt mounting structure. Based on the findings of the scoping phase and to ensure the most optimal use of solar energy to generate electricity, the use of tracking photovoltaic panel arrays is the preferred option for the proposed development.

The photovoltaic panels will be installed to the mounting structures and will have a height of up to 4 m above ground level at maximum tilt. The mounting structures are founded into the ground through either concrete foundations or screw or pile foundations. The photovoltaic panels will be connected to each other in strings and the strings connected to inverter stations by low voltage underground direct current cables. The central inverter power stations are represented in the preliminary final site layout map (*1001395-G010-DRG-JJ-0001 PV Field GA*) included in the overall EIA report. Power from the inverter will be transformed from low to medium voltage (33 kV) at the medium voltage transformers. Power from the inverters is collected in medium voltage transformers through alternating current cables, which may be buried or pole-mounted depending on voltage level and site conditions. The electric power is then transported to a proposed 132 kV or 33/132 kV onsite substation complex, via medium voltage underground cables (33 kV). Cables and trenches required for underground cables will remain along internal roads and already disturbed areas as far as possible.

1.4.2 Substation Complex

The onsite substations complex will cover an area of approximately 2 ha with a maximum height of 30 m. It is constructed to receive, convert and step up the electricity generated by the PV facility to a grid suitable power supply. The onsite substation complex will include transformers, measurements equipment, feeder bay, control rooms and grid control yards for the IPP/Owner (housing unit to control switch gears in the form of a concrete single storey building). The onsite substation complex will be divided into a medium and high voltage sides. The medium voltage side of the onsite substation complex contains collection, transformation (i.e., 33 kV to 132kV) and measurement equipment. The high voltage side contains mainly measurement equipment and connection to the 132 kV transmission line. In the EIA and BA reports, the medium voltage side of the onsite substation complex is referred to as a “collector substation” as it collects and transforms the power produced by the solar PV facility and the high voltage side of the onsite substation complex is referred to as “switching substation” as it acts as a switch to evacuate the electricity into the 132 kV transmission line. The 4.5km 132KV transmission line will connect the Lephalale Solar plant via another switching substation to the Grootegeluk Mine 33 KV substation. This switching substation will be located next to the existing Grootegeluk mine substation. In this switching Substation the voltage will be stepped down from 132 KV High Voltage to 33 KV Medium Voltage from where it will be connected to the Grootegeluk Mine substation. Where required, stormwater infrastructure will be constructed on the site and other switching substations to ensure that stormwater run-off from the site is appropriately managed. As described below, it is however recommended that a development envelope is approved to allow for the micro-sitting of the associated infrastructure during the detailed engineering phase of the project (i.e., post EA).

1.4.3 Power Line

The power will be transmitted from the onsite substation complex into the Grootegeluk Substation via a 132 kV overhead transmission line. The route for the transmission line only traverses Exxaro owned land.

The co-ordinates of the power corridor are provided in the abovementioned drawing and in Figure 1-4.

1.4.4 Battery storage facility

The applicant proposes to install a battery storage facility, at some point in time, for storage of the electricity generated from solar energy resources in the grid which includes batteries and associated operational, safety and control infrastructure.

The battery storage system allows to balance the supply and demand of electrical energy during the day and uses the stored energy during peak demand periods (typically in the mornings and evenings).

This facility will be set up in a series of containers / buildings, with a maximum height of 5 m (excluding lightning masts) and will cover an area of approximately 2 hectares. The battery storage facility will house an encapsulated battery solution with associated operational, safety and control infrastructure. The associated operational, safety and control infrastructure comprises the monitoring units and the plant controller.

1.4.5 Operations and maintenance buildings

Additional building infrastructure is required to support the functioning of the facility and provide services to personnel that will operate and maintain the facility. These operations and maintenance (O&M) buildings, of approximately 1 ha in size will be located next to the onsite substation complex and will include:

- Workshops;
- Small storage areas for materials and spare parts for use on site for maintenance activities during the operation phase;

- Single storey brick building with control room, offices, ablution facilities and kitchen for staff, security and visitors;
- Security building at the entrance of the proposed site with ablution facilities;
- septic tanks and sewer lines connected to the service ablution facilities;
- water storage tanks;
- small diameter water supply pipeline connecting existing boreholes or existing pipeline access points to storage;
- central waste collection and storage area; and
- parking facilities.

1.4.6 Access Roads

Where required access roads will be constructed with a width of, up to 15 m at some points for the transport of material and equipment. Road signage, stormwater channels and drainage controls will be provided required. The equipment and material envisaged to be transported to site include, inter alia:

- Building material (bricks, sand, aggregate, cement, gravel, sheeting, fencing, etc.);
- Construction equipment (piling rigs, rollers, graders, batch plant, etc.);
- Solar modules (modules, frames, packing material etc.);
- Electrical components (transformers, switch gear, inverters, cables, etc.);
- Substation steelwork; and
- Water.

The transportation of the above-mentioned equipment and material are based on the following assumptions:

- All bulk material required on site, shall be transported to site on vehicles, which conform with the legal limits listed above;
- Solar modules and most of the electrical components required on site, shall be transported to site on heavy vehicles, which conform with the legal limits listed above; and
- Transformers are to be transported to site by abnormal load vehicles which conform with the legal limits.

1.4.7 Internal Roads

The internal roads will have a maximum width of 4 m and will be gravel and/or dirt roads. The length of the internal roads will be confirmed as the location, design and layout of the facility progresses. Road signage, stormwater channels and drainage controls will be provided required. The internal site road network will be finalised during the detailed engineering phase of the project (i.e., post EA). During the operation phase, the internal roads will provide access to the solar field and associated infrastructure for maintenance, inspections, and panel cleaning.

All road material will be sourced from local licensed suppliers and sources.

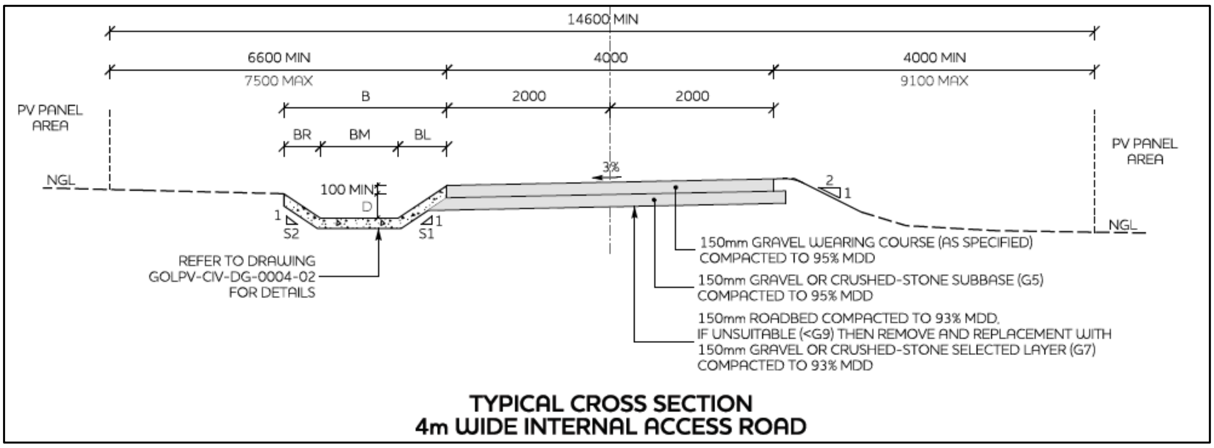

Figure 1-5: Typical internal road cross-section

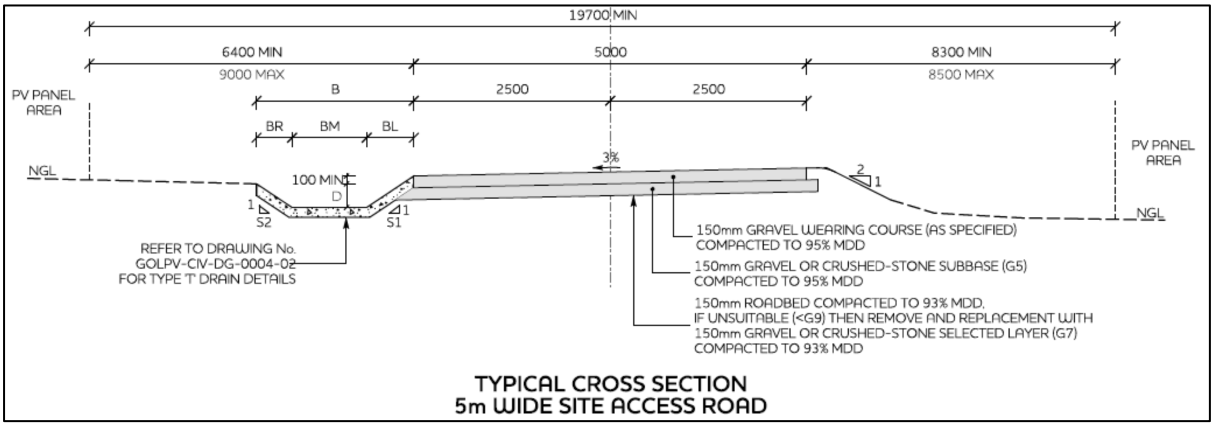

Figure 1-6: Typical access road cross-section

1.4.8 Perimeter Fencing

Perimeter fencing, and internal security fencing and gates will be installed in accordance with:

- The Fencing Act (Act 31 of 1963);
- The Fencing Amendment Act, (Act 3 of 1971); and
- Government Gazette 40229 Notice 509 of 26 August 2016 prescribing the General Authorisation Regulations for water uses in terms of section 21(c): impeding or diverting the flow of water in a watercourse, and (i): altering the bed, banks, course or characteristics of a watercourse of the National Water Act 36 of 1998 (NWA).

Security fence

The entire facility will have a perimeter fence. Due to the nature and value of the components in the plant this fence will have perimeter sensor to detect any breaches. One method can be optic fibre which runs on the fence and if broken will sound an alarm. An alternative method would be where the fibre is buried and trenches and is triggered when stepped on. Other security features will include CCTV cameras motion sensors and flood lights.

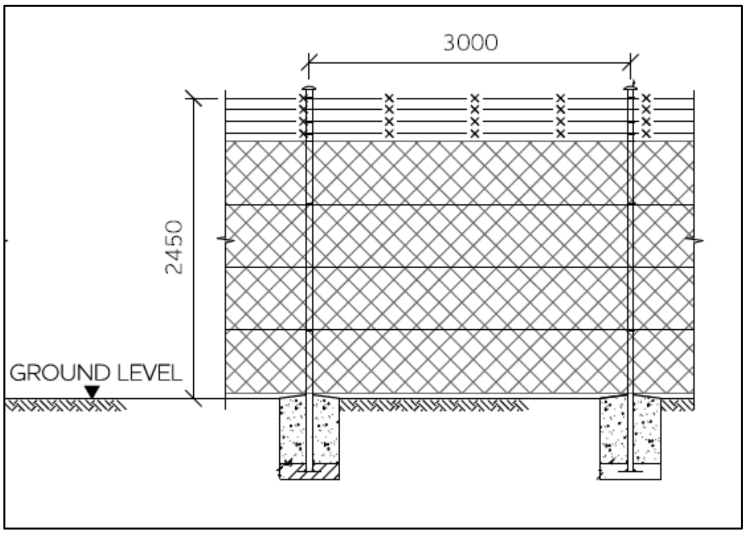

Figure 1-7: Typical security fence drawing

Buffer area

Two fences will be utilised. A plant fence and a perimeter fence, 5m apart. On the inside of the plant fence and on the outside of the perimeter fence, vegetation will be limited to grass and will be cut twice a year. In between the plant fence and the perimeter fence a buffer area will be maintained as a fire break. The road will be part of the 5m perimeter area.

1.4.9 Access Control Gate and Guard House

A 24-hour security service will be required to guard the solar PV facility during the construction and operation phases. A guard hut and access control gate will be located on the access road at the site entrance (Latitude: 28°55'9.21"S/Longitude: 19°31'19.15"E). The security staff will be accommodated in a brick building with ablution facilities at the site entrance.

1.4.10 Temporary Structures

Temporary structures will be installed within the proposed development area, with a combined maximum size of 10 ha, including:

- A batching facility;
- Temporary offices;
- A construction yard; and
- A laydown area.

A batching facility is typically composed of a cement bin, an aggregate bin, an aggregate conveyor and the cement and aggregate batchers. This single unit facility can be dismantled and reassembled in a few days' time and will be used at multiple construction sites as required. The construction yard will be used to perform small tasks during the construction phase including equipment preparation, cleaning activities and will include one or few container-type offices for contractors and technical staff.

1.4.11 Utilities Requirements

- Electricity and where it will be sourced

  - Mine substation
  - Diesel generators
- Water and where it will be sourced
  - Drilling of two water boreholes of approximately 60 metres each (total of 120 m)
    - Holes will be drilled to 6.5-inch diameter
    - Holes will have a 5-inch slotted casing across the water zones
    - Solid 5-inch casing through the unconsolidated material (top ~ 18 metres)
    - Headworks – sanitary seal and concrete block with lockable cap
- Sewage removal
  - During construction all sewage waste must be stored in a closed system. A schedule for servicing and disposal of the sewage waste will be set forth so as not to cause unpleasant or unhygienic conditions for the site personnel by an approved service provider specializing in the maintenance and treatment/disposal of sewage waste. Soak away systems must only be allowed during the construction period. Financial Feasibility of using dry waste sanitation systems must be undertaken and used and implemented
- Waste removal
  - Waste Management: During the construction/operation phase all attempts will be made by the proponent to implement the general principles of integrated waste management through the waste hierarchy. This hierarchy includes: waste minimisation, waste reduction, waste recycling and finally disposal to an approved municipal facility. The waste generated during the construction phase will be mainly packaging, general construction and domestic waste; however, the majority of waste produced during operation is of domestic nature.
  - During plant operation the brine from the water treatment plant will be collected in a 5kl tank and disposed of together with the sanitation waste and will be disposed of at a licenced facility.

It is also recommended that the proponent implements the general waste management principals of in terms of waste hierarchy such as; waste reduction, reuse, recycling and finally disposal.

2 PURPOSE & OBJECTIVES

The purpose of the soils, land capability, and land use Assessment (agricultural theme) is to ensure that the sensitivity of the site to the proposed land use change is sufficiently considered. Also, that the information provided in this report, enables the Competent Authority to come to a sound conclusion on the impact of the proposed project on the food production potential of the site.

To meet this objective, the scope requires that a site verification assessment be conducted for the soils, land capability, and land use for the project area. The site verification requires the following:

1) The site sensitivity verification must be undertaken by an environmental assessment practitioner or a specialist.

2) The site sensitivity verification must be undertaken through the use of:
   a) a desk top analysis, using satellite imagery;
   b) a preliminary on-site inspection; and
   c) any other available and relevant information.

3) The outcome of the site sensitivity verification must be recorded in the form of a report that:
   a) confirms or disputes the current use of the land and the environmental sensitivity as identified by the screening tool, such as new developments or infrastructure, the change in vegetation cover or status etc.;
   b) contains a motivation and evidence (e.g. photographs) of either the verified or different use of the land and environmental sensitivity; and
   c) is submitted together with the relevant assessment report prepared in accordance with the requirements of the Environmental Impact Assessment Regulations.

According to GN320, the protocol established for the specialist assessment and minimum report content requirements of environmental impacts on agricultural resources by onshore wind and /or solar energy generation facilities where the electricity output is 20 megawatts or more provides the criteria for the specialist assessment and reporting of impacts on agricultural resources. This protocol replaces the requirements of Appendix 6 of the Environmental Impact Assessment Regulations.

The assessment and reporting requirements of this protocol are associated with a level of environmental sensitivity identified by the national web based environmental screening tool (screening tool) for agricultural resources, which is based on the land capability evaluation values as provided by the Department responsible for agriculture.

3 TERMS OF REFERENCE

GCS requires that a soil survey be conducted and that the following be assessed as per the Provincial and National Departments of Agriculture recommendations:

- Assess and discuss historic climate statistics;
- Assess and discuss geological information;
- Assess and discuss the terrain features using 5m contours;
- Source best recent satellite or aerial imagery and georeferenced;
- Assess and discuss current agricultural land use on site and comment on crop performance and estimated yields (if any);
- Conduct soil assessment as described in the methodology;
- Assess and discuss agricultural land potential (eight class scale);
- Discuss the impact of the proposed land use change on loss of agricultural land production (If any);
- Recommend best location for proposed development to reduce any impacts;

- Compile informative reports and maps on current land use and agricultural land potential;
- Discuss the impact of the proposed land use change on loss of agricultural land production; and
- A basic soil management guideline will be completed.

The results will be mapped in GIS format and will include the following maps:

- A soil distribution map;
- A current land use map; and
- An agricultural potential map.

An Impact assessment of the proposed development will be conducted, and the recommendations can be used in the Environmental Management Plan (EMP).

4 KEY LEGISLATION

Relevant environmental legislation pertaining to the soil/agricultural resources in South Africa is listed below, but is not limited to:

- The Constitution of the Republic of South Africa (Act 108 of 1996);
- Sub-division of Agricultural Land Act (Act 70 of 1970);
- Municipal Structures Act (Act 117 of 1998);
- Municipal Systems Act (Act 32 of 2000); and
- Spatial Planning and Land Use Management Act, 16 of 2013.

The above is supported by additional legislation that aims to manage the impact of development on the environment and the natural resource base of the country. Related legislation to this effect includes:

- Conservation of Agricultural Resources Act (Act 43 of 1983);
- Environment Conservation Act (Act 73 of 1989);
- National Environmental Management Act (Act 107 of 1998); and
- National Water Act (Act 36 of 1998).

5 SENSITIVITY ANALYSIS BASED ON THE ENVIRONMENTAL SCREENING TOOL

The result of the Department of Environmental Affairs screening tool for the proposed site, showed that the area has medium combined agricultural sensitivity. The screening tool was accessed on the 25th of July 2021 by Wayne Jackson. The results are shown in Figure 5-1 for the 100m buffered assessment area.

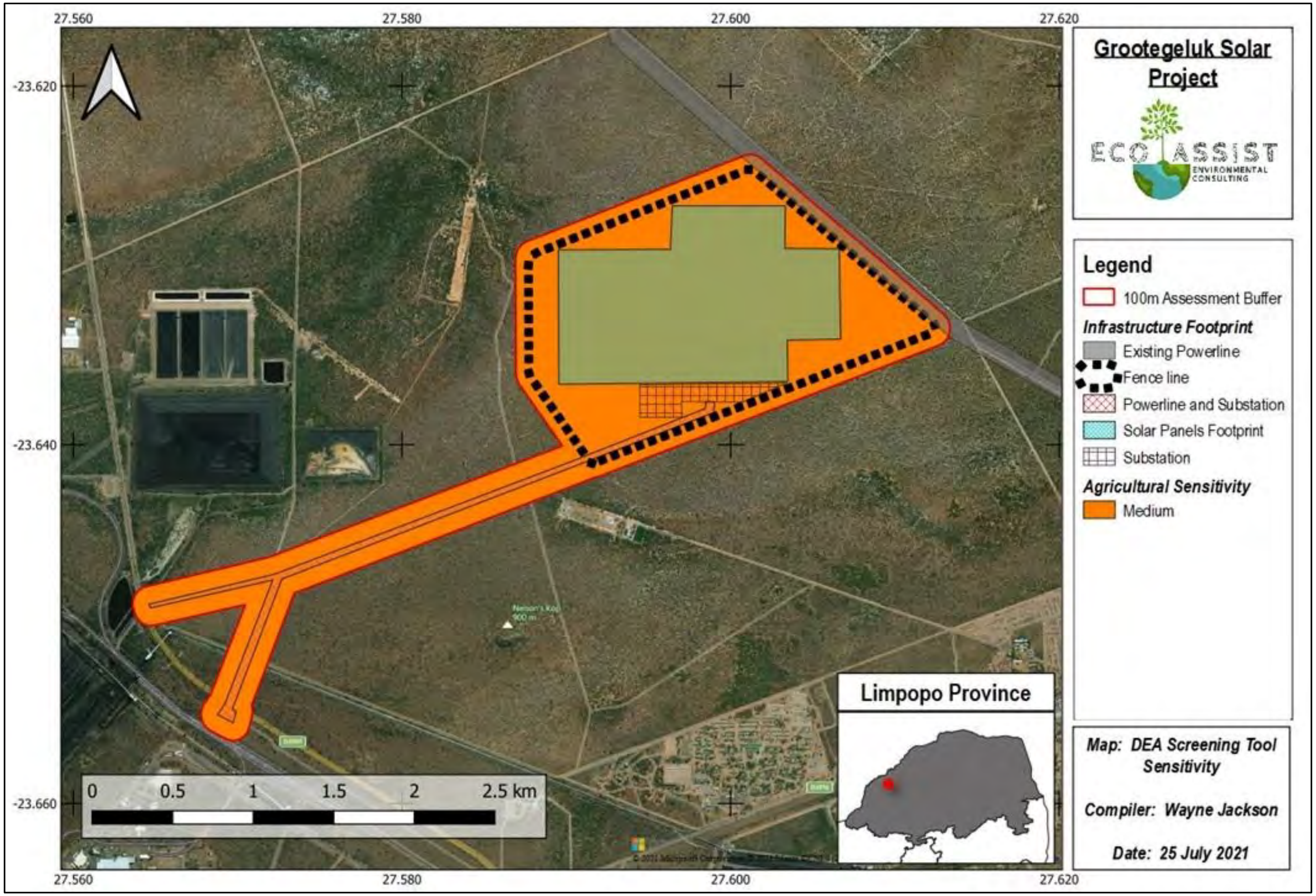

Figure 5-1: DEA screening tool results for the agricultural sensitivity theme.

The sensitivity analysis has identified the project area to have a medium sensitivity and as such an Agricultural Compliance Statement will be required. The assessment has also determined that the development falls within the allowable limits as described in GN320. The project area is in a medium agricultural sensitivity and is not located within any crop boundary.

6 METHODOLOGY

6.1 Desktop Assessment

The following data layers were assessed to determine whether the development could have an impact on important national & provincial feature:

- Aerial imagery (Google Earth™);
- Land Type Data (Land Type Survey Staff, 1972 - 2006);
- Topographical data;
- Contour data (5 m)
- Basic Assessment Level report on the Soils, Land Use, Land Capability and Agricultural Potential Survey for the Proposed Exxaro Photovoltaic Facility: Lephalale Norther Province (Terra Soil Science, 26 September 2011).

6.2 Field Procedure

The site was traversed by vehicle and on foot. A soil auger was used to determine the soil form/family and depth. The soil was hand augured to the first restricting layer or 1.5 m. Soil survey positions were recorded as waypoints using a GPS device.

Soils were identified to the soil family level as per the "Soil Classification: A Natural and Anthropogenic System for South Africa" (Soil Classification Working Group, 2018). Landscape features such as existing open trenches were also helpful in determining soil types and depth.

6.3 Land Capability Assessment

Land capability and agricultural potential is determined by a combination of soil, terrain and climate features. Land capability is defined by the most intensive long-term sustainable use of land under rain-fed conditions. At the same time an indication is given about the permanent limitations associated with the different land use classes (Smith, 2006).

Land capability is divided into eight (8) classes and these may be divided into three (3) capability groups. Table 6-1 shows how the land classes and groups are arranged in order of decreasing capability and ranges of use. The risk of use increases from class I to class VIII (Smith, 2006).

Table 6-1: Land capability class and intensity of use (Smith, 2006).

Land Capability Class	Increased Intensity of Use									Land Capability Groups
I	W	F	LG	MG	IG	LC	MC	IC	VIC	Arable Land
II	W	F	LG	MG	IG	LC	MC	IC		
III	W	F	LG	MG	IG	LC	MC			

Land Capability Class	Increased Intensity of Use									Land Capability Groups
IV	W	F	LG	MG	IG	LC				
V	W	N/A	LG	MG						Grazing Land
VI	W	F	LG	MG						
VII	W	F	LG							
VIII	W									Wildlife

W - Wildlife | MG - Moderate Grazing | MC - Moderate Cultivation

F- Forestry | IG - Intensive Grazing | IC - Intensive Cultivation

LG - Light Grazing | LC - Light Cultivation | VIC - Very Intensive Cultivation

The land potential classes are determined by combining the land capability results and the climate capability of a region as shown in Table 6-2. The final land potential results are then described in Table 6-3.

Table 6-2: The combination table for land potential classification.

Land capability class	Climate capability class							
	C1	C2	C3	C4	C5	C6	C7	C8
I	L1	L1	L2	L2	L3	L3	L4	L4
II	L1	L2	L2	L3	L3	L4	L4	L5
III	L2	L2	L3	L3	L4	L4	L5	L6
IV	L2	L3	L3	L4	L4	L5	L5	L6
V	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei	Vlei
VI	L4	L4	L5	L5	L5	L6	L6	L7
VII	L5	L5	L6	L6	L7	L7	L7	L8
VIII	L6	L6	L7	L7	L8	L8	L8	L8

Table 6-3: The Land Potential Classes.

Land potential	Description of land potential class
L1	Very high potential: No limitations. Appropriate contour protection must be implemented and inspected.
L2	High potential: Very infrequent and/or minor limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L3	Good potential: Infrequent and/or moderate limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L4	Moderate potential: Moderately regular and/or severe to moderate limitations due to soil, slope, temperatures or rainfall. Appropriate permission is required before ploughing virgin land.
L5	Restricted potential: Regular and/or severe to moderate limitations due to soil, slope, temperatures or rainfall.
L6	Very restricted potential: Regular and/or severe limitations due to soil, slope, temperatures or rainfall. Non-arable

Land potential	Description of land potential class
L7	Low potential: Severe limitations due to soil, slope, temperatures or rainfall. Non-arable
L8	Very low potential: Very severe limitations due to soil, slope, temperatures or rainfall. Non-arable

7 LIMITATIONS

The following aspects were considered as limitations of the assessment:

- Hand augers were used, and the limiting layer was the depth to which the auger could drill;
- The assessment is based on the design and layout information provided by the client;
- It has been assumed that the extent of the development area provided by the responsible party is accurate;
- The GPS used for ground truthing is accurate to within five meters. Therefore, the observation site's delineation plotted digitally may be offset by up to five meters to either side; and
- Only a soil auger was used for this assessment, no open pits were dug.

8 EXPERTISE OF THE SPECIALIST

The site inspection and subsequent reporting was conducted by Mr. Wayne Jackson.

Wayne Jackson graduated from the University of KwaZulu-Natal, Pietermaritzburg, with a BSc. degree in Soil Science & Hydrology.

Wayne is an experienced Wetlands & Soils Scientist with a demonstrated history of working in the environmental services industry (12 years'). He is skilled in Soil Classification, Wetlands, Hydropedology, and Surface Water Hydrology. He has a strong Environmental mitigation and rehabilitation knowledge. He has also gained experience in large post-mining rehabilitation projects, providing specialist inputs on land capability and soil utilisation. He has extensive exposure to a wide range of projects in many sectors across South Africa, and parts of Africa. He is knowledgeable on how soils, wetlands, and hydrological systems are linked in the landscape and how activities could impact all these aspects.

Wayne is a registered Natural Scientist with the South African Council for Natural Scientific Professionals (SACNASP) – Registration No. 119037.

9 RESPONSES TO INTERESTED AND AFFECTED PARTIES

To this point no concerns have been raised as ye. If any concerns are raised with regards to the agricultural impact assessment it will be address in this report.

10 RESULTS FROM DESKTOP ASSESSMENT

10.1 Climate

The climate for the area is mainly summer rainfall with very dry winters including the shoulder months of May and September. Mean annual precipitation (MAP) ranges from about 350 mm in the northeast to about 500 mm in the southwest. Frost is fairly infrequent. Mean monthly maximum and minimum temperatures for Lephalale is 38.2°C and 2.1°C for December and June, respectively (Mucina, et al., 2006).

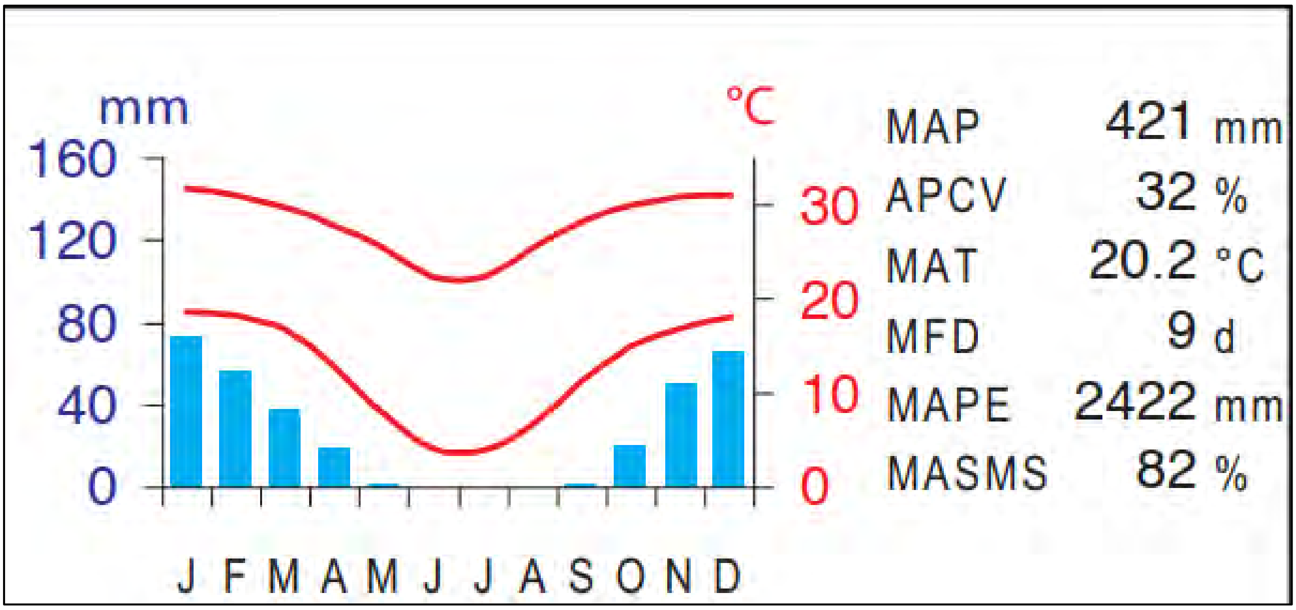

Figure 10-1: Climate summary for the Limpopo Sweet Bushveld (Mucina, et al., 2006).

The land capability evaluation 2016 data layer is a refined and updated spatial modelled data layer depicting the land capability evaluation values for the country. The climate capability data layer is a sub-set data layer that contributes to the land capability data layer. It includes both the spatial as well as attributes description of the climate capability values (Department of Agriculture, Forestry and Fisheries, 2017). The climate capability as per Figure 10-2 shows a Low-Moderate rating for the project area.

The climate class was determined to be C6 – with a severe limitation rating (Smith, 2006). The climate class has a moderately restricted growing season due to low temperatures, frost and/or moisture stress. the limited crops that can grow in this climate region will experience frequent yield loss.

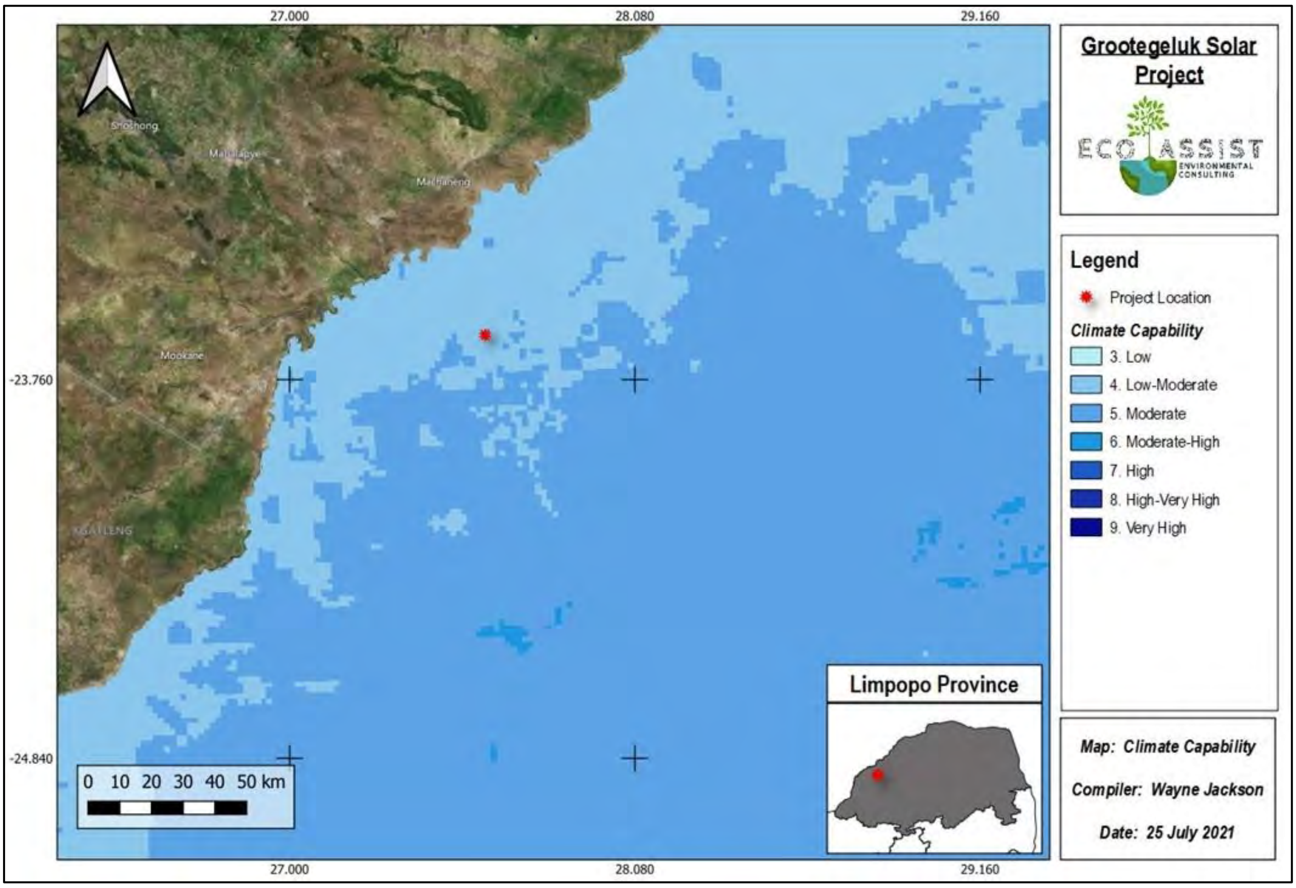

Figure 10-2: Climate capability (Department of Agriculture, Forestry and Fisheries, 2017).

10.2 Terrain

The terrain analysis was conducted using the processing tools within the QGIS mapping software. The SAGA terrain analysis tools were used to determine the Digital Elevation Model (DEM) (see Figure 10-3).

The project relief shows that the elevation ranges from approximately 830 masl to about 900 masl. The slopes are shallow ranging between 0% and 5%. The project area is slightly east facing and situated on a crest landscape unit.

In land capability modelling terrain plays an important role not only from a plants' physiological growth requirements but also from a sensitivity and accessibility perspective (Department of Agriculture, Forestry and Fisheries, 2017). Two main terrain modelling concerns were included in the terrain capability modelling exercise namely:

- Plant physiology; and
- Terrain sensitivity

The terrain capability was determined to be high (class 7) (see Figure 10-4). This is mainly due to the shallow slopes and the landscape position. This forms part of the overall desktop land capability determination.

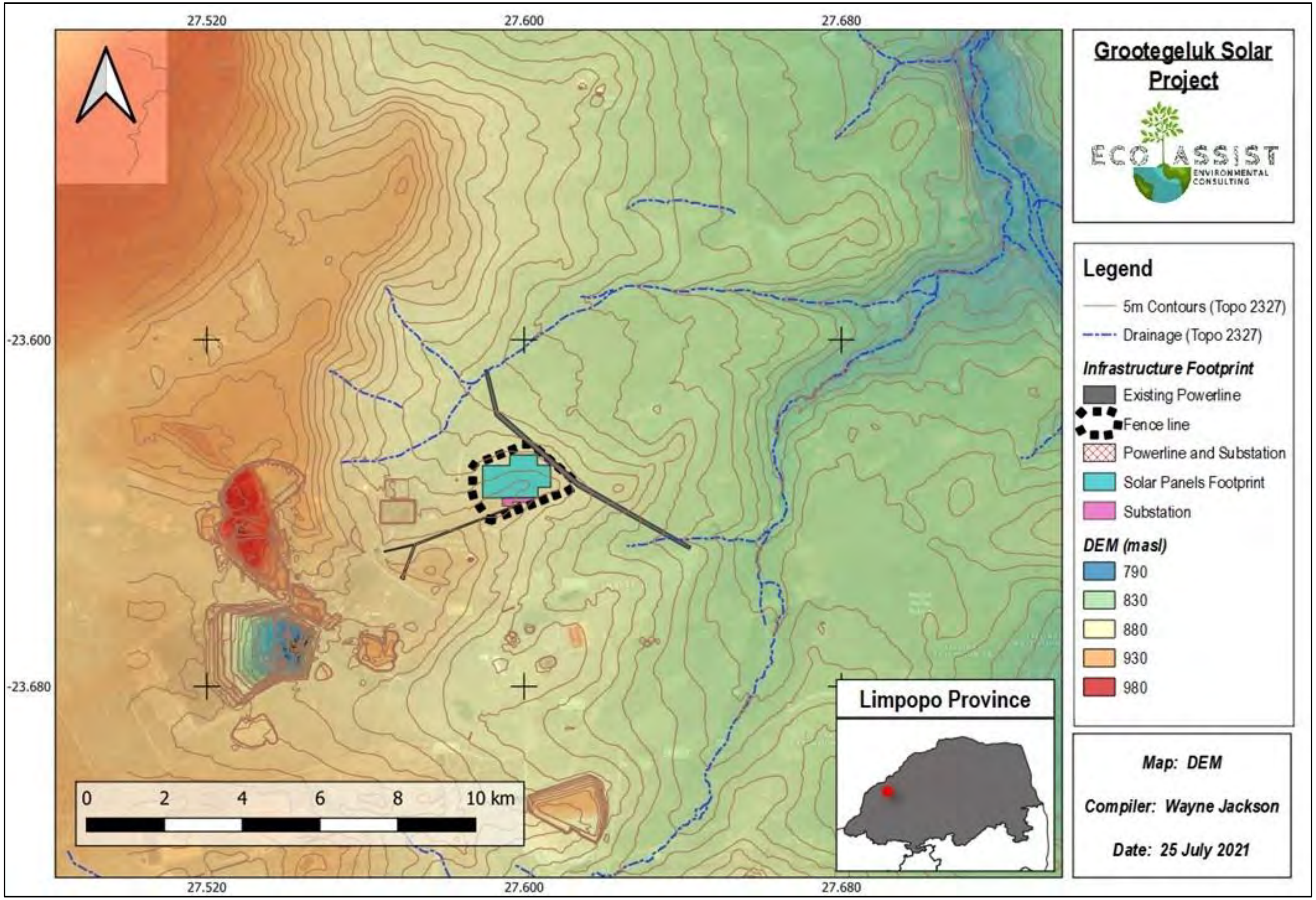

Figure 10-3: The DEM for the project area.

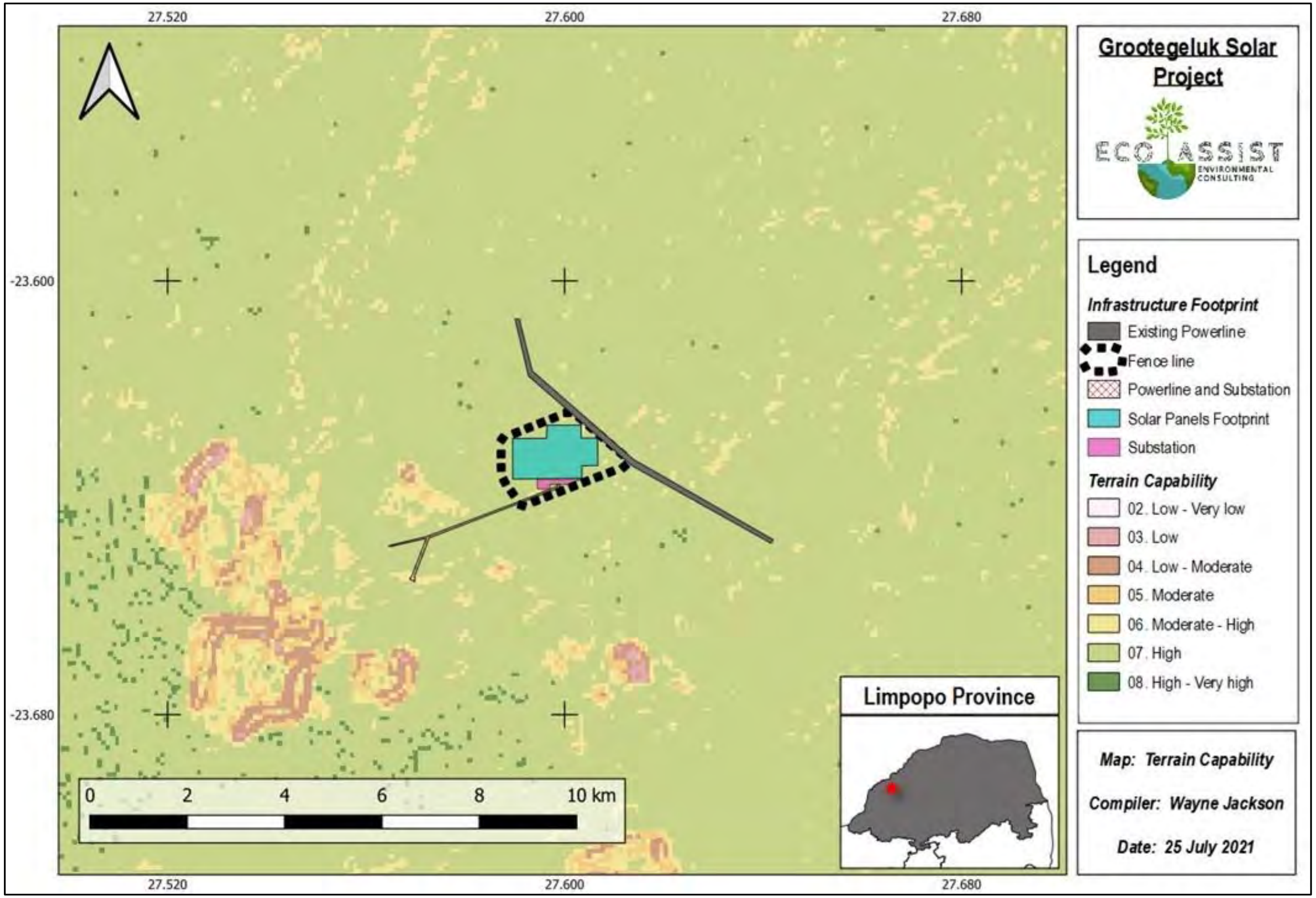

Figure 10-4: The terrain capability (Department of Agriculture, Forestry and Fisheries, 2017).

10.3 Desktop Soils & Geology

10.3.1 Geology

The northern half of the area is dominated by gneisses, metasediments and metavolcanics of the Malala Drift Group, Beit Bridge Complex (Swazian Erathem), basalts of the Letaba Formation (Lebombo Group of the Karoo Supergroup) are also found in the northeast. Sandstone, siltstone and mudstone of the Clarens Formation (Karoo Supergroup), as well as of the Matlabas Subgroup (Mokolian Waterberg Group) are found to the south and west. Soils with calcrete and surface limestone layers, brownish sandy (Clovelly soil form) clayey-loamy soils (Hutton soil form) on the plains and low-lying areas, with shallow, gravelly, sandy soils on the slightly undulating areas, localised areas of black clayey soils (Valsrivier or Arcadia soil forms) and Kalahari sand (Mucina, et al., 2006).

The land type database describes the geology for land type Ah85 as forming part of the Karoo Sequence: sandstone and siltstone of the Clarens Formation as well as undifferentiated shale, sandstone, mudstone and coal. The land type database describes the geology for land type Bc44 as mainly Sandstone and conglomerate of the Kransberg Subgroup, Waterberg Group as well as undifferentiated shale, sandstone, mudstone and coal of the Karoo Sequence (Land Type Survey Staff, 1972 - 2006).

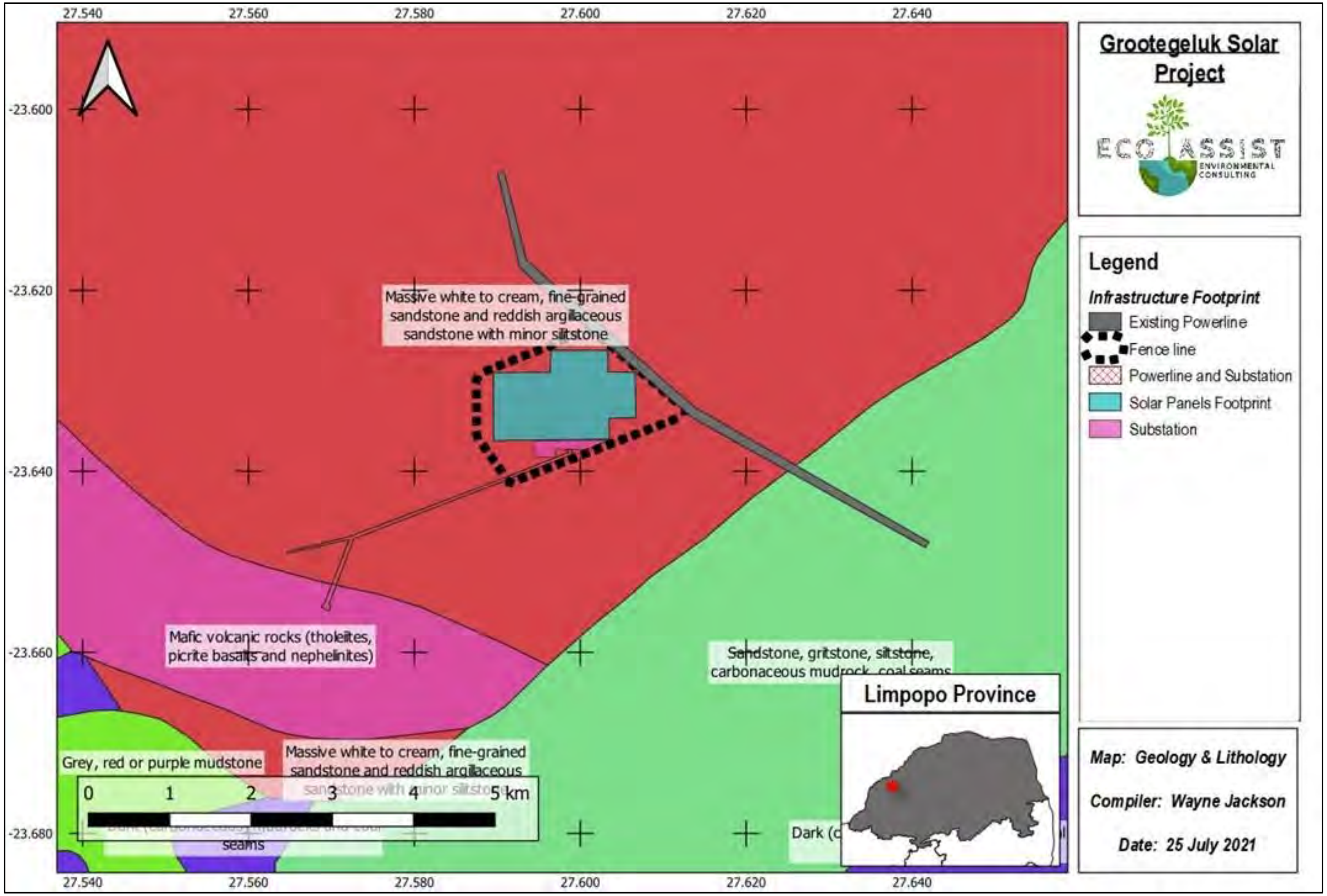

Figure 10-5: Regional geology for the project area.

10.3.2 Land Types

The Land Type data was used to obtain generalised soil patterns and terrain types for the site. Land Type data exists in the form of published 1:250 000 maps. These maps indicate delineated areas of similar terrain types, pedosystems (uniform terrain and soil pattern) and climate (Land Type Survey Staff, 1972 - 2006).

The new developable footprint for the project area falls within land type Ah85 only (see Figure 10-7). This land type is dominated by the midslope and footslope landscape positions and consists largely of freely draining soils such as the Hutton and Clovelly/Ermelo soil forms. The average slope for this land type is relatively flat with slopes ranging from 0% to 3%. Clay content in the freely drained soils is estimated at between 1% and 10%. The shape of the landscape catena is shown in Figure 10-6.

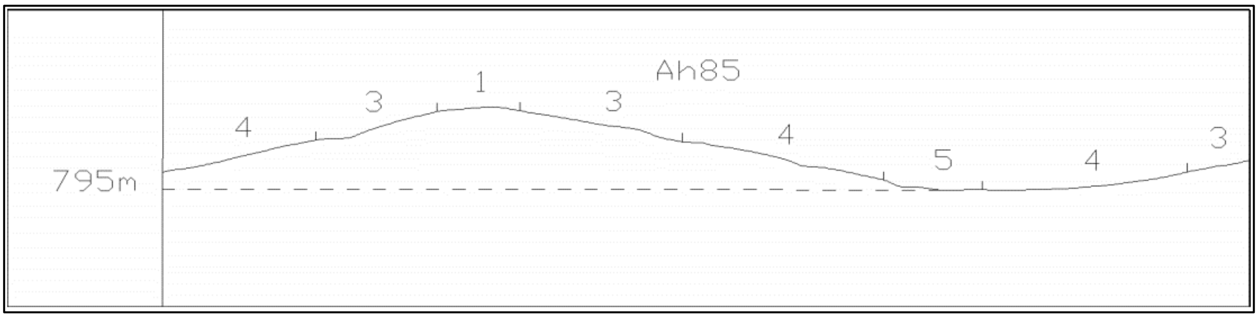

Figure 10-6: Hillslope catena for land type Ah85.

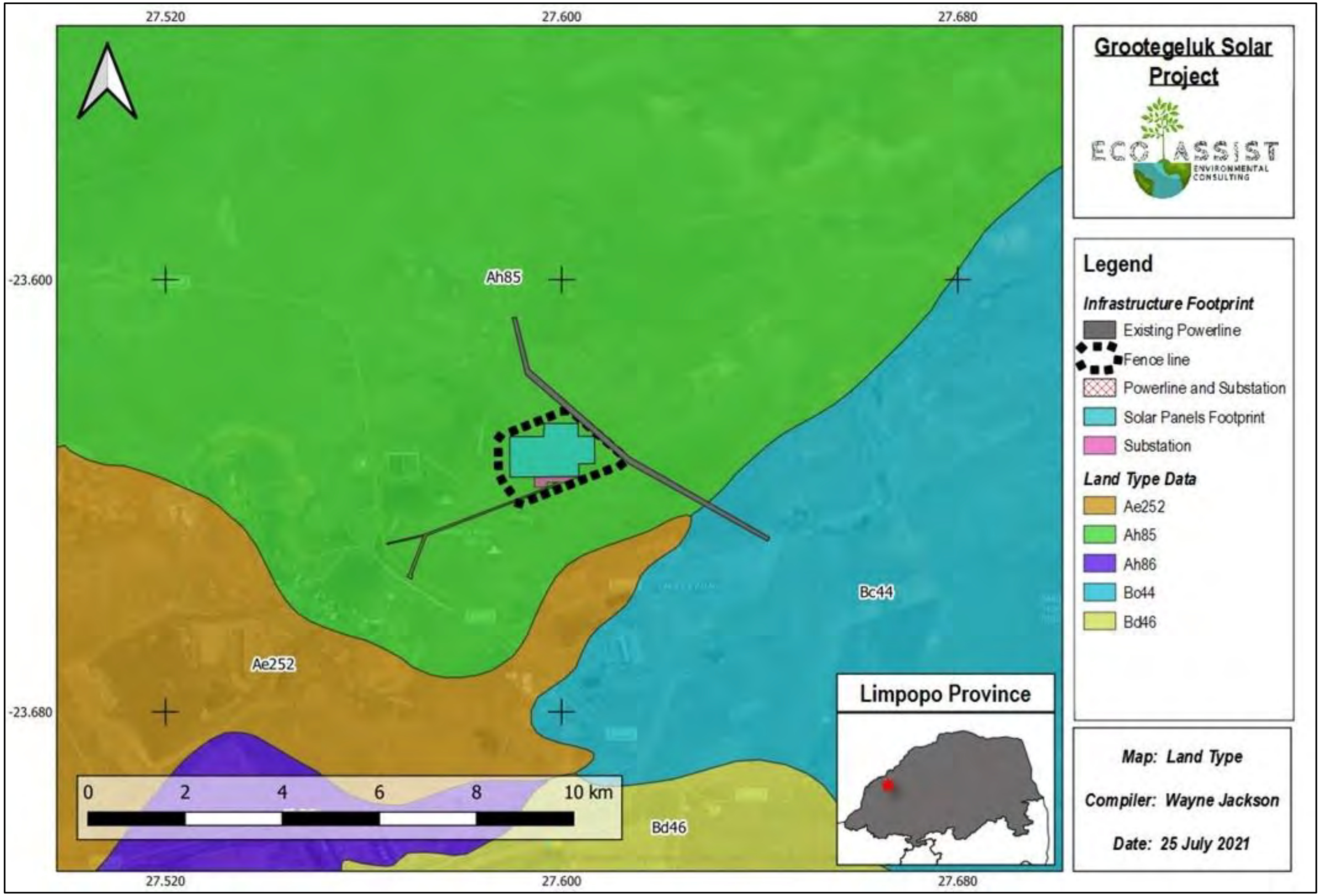

Figure 10-7: Land Types within the project area.

10.3.3 Soil Capability

Soil capability takes into consideration all aspects pertaining to the characteristics of the soil and their contributions towards plant production (Department of Agriculture, Forestry and Fisheries, 2017).

Three databases were used a part of the soil capability modelling:

- Land type data modelled and mapped into topographical units (Beukes). The data were modelled and rasterised form the original land type data base and the 90 m SRTM DEM. All the soil attributes are linked to fixed boundary zones. The soil concerns, issues and data are therefore aimed at an attribute rather than a spatial level;
- The land type soil attribute data base (ARC); and
- Soil fertility data (DAFF).

Three main modelling concerns formed part of the soil capability modelling:

- Plant available water;
- Soil sensitivity; and
- Soil fertility.

The soil capability was rated as Low for the project area (see Figure 10-8). This is potentially based on the sandy nature of the soils as well as the lac o plant available water in the region.

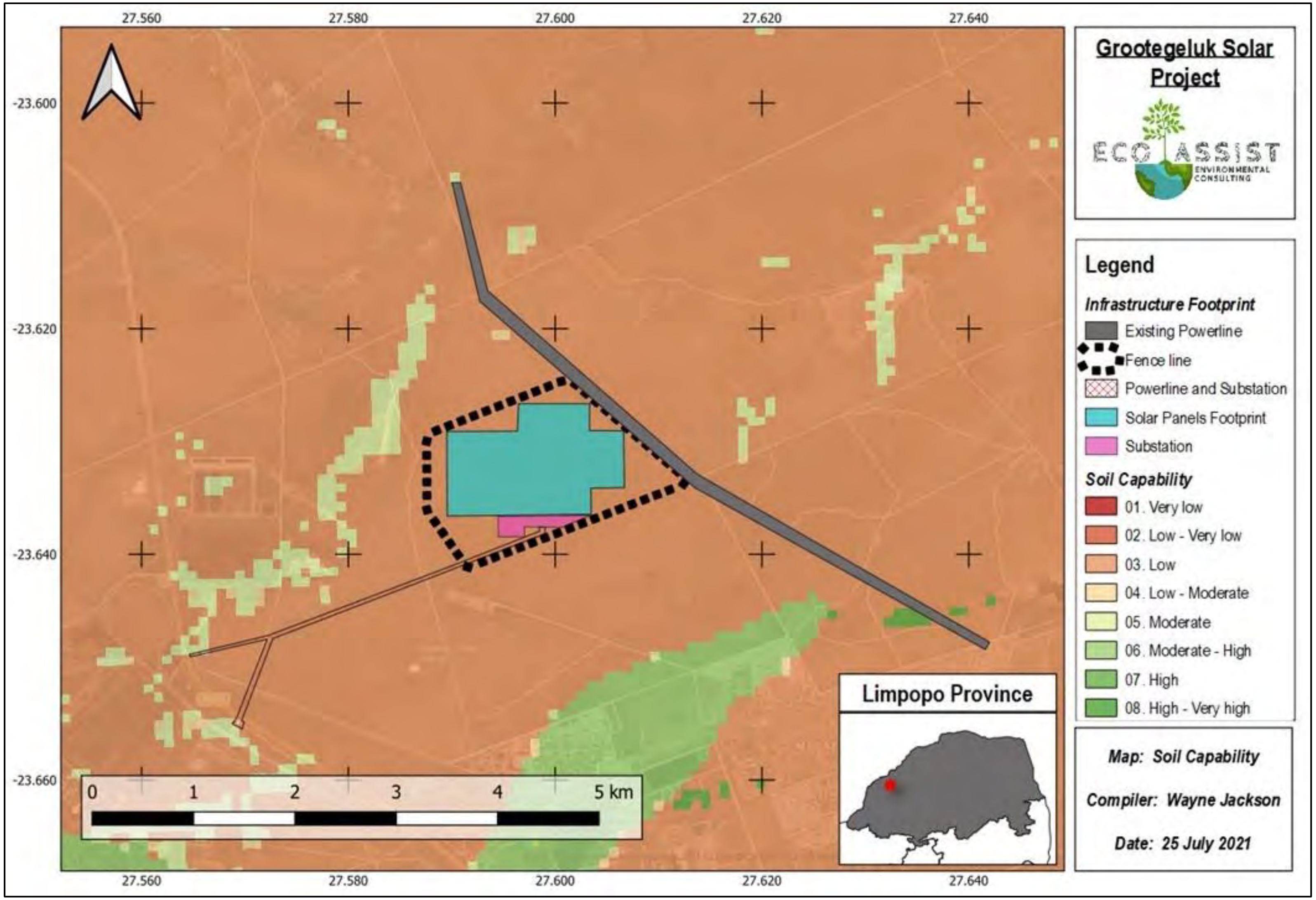

Figure 10-8: Soil capabilities within the project area (Department of Agriculture, Forestry and Fisheries, 2017).

10.4 Land Capability

Land capability is defined as the most intensive long-term use of land for purposes of rainfed farming determined by the interaction of climate, soil and terrain.

To represent the distribution of the land capability evaluation values in the country, used as one of the input data layers to determine and demarcate all high value agricultural land for ensuring that these areas, pending availability, are preserved for continued agricultural production, thereby ensuring long-term national food security (Department of Agriculture, Forestry and Fisheries, 2017).

The data layer is a seamless data layer and does not exclude permanently transformed areas (built up; waterbodies; mining etc.).

The land capability ratings show that the overall desktop land capability was Low-Moderate at best (see Figure 10-9). The result is based on the combination of the climate capability, the soil capability, and the terrain capabilities described earlier.

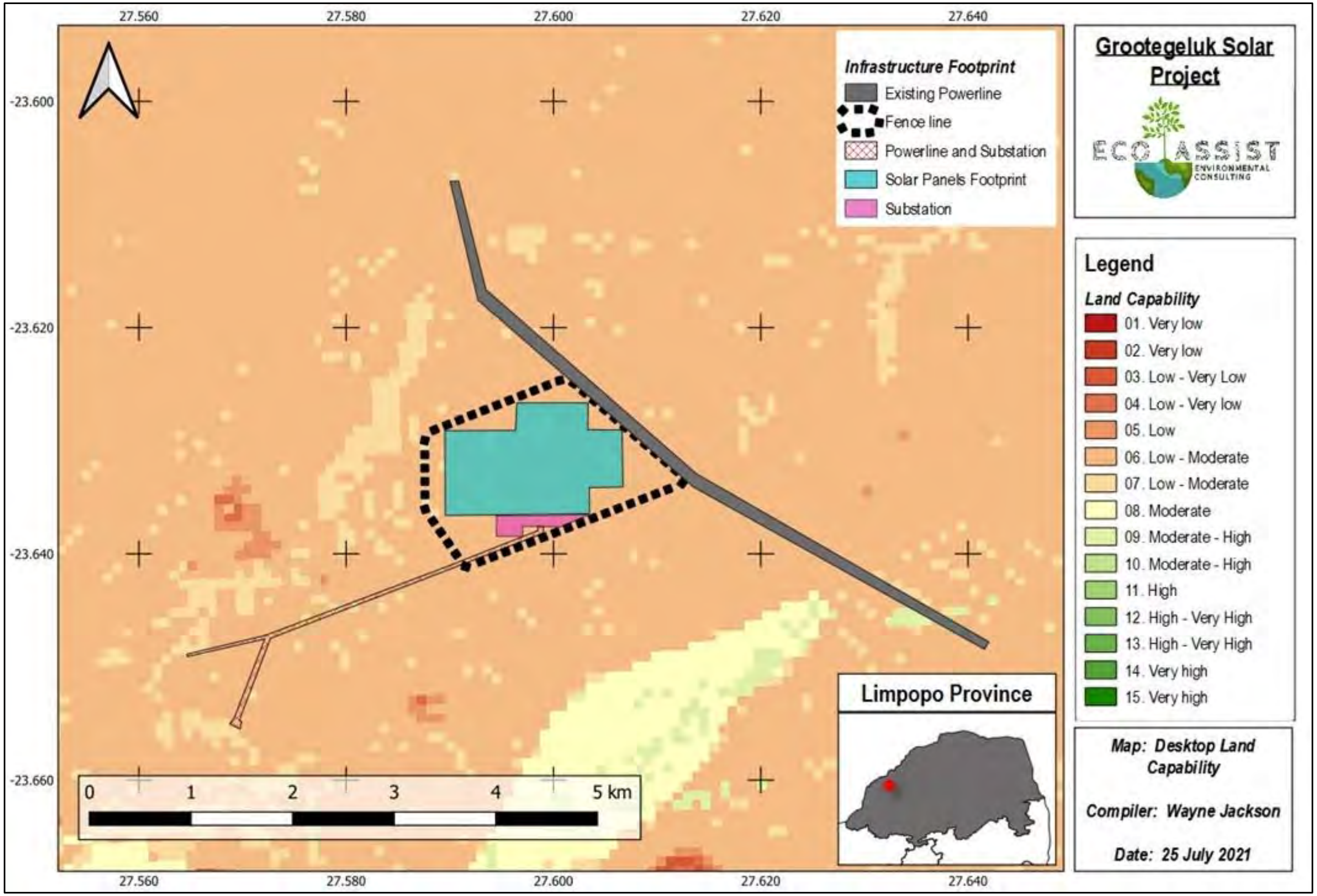

Figure 10-9: Land capabilities within the project area (Department of Agriculture, Forestry and Fisheries, 2017)

10.5 Grazing Capacity

The long-term production potential of the herbaceous layer (grasses and forbs) of an area of vegetation that is required to maintain an animal with a weight of 450 kg (1 Large Stock Unit (LSU)) with an average fodder intake of 10 kg dry mass per day over a period that vegetation is suitable for grazing (mostly 1 year) without degrading the natural resources (vegetation and soil) and is measured in “Hectares per Large Stock Unit” (ha/LSU) (South Africa (Republic), 2018).

The long-term sustainable grazing capacity for the project area was rated as 12 ha per large stock unit (see Figure 10-10).

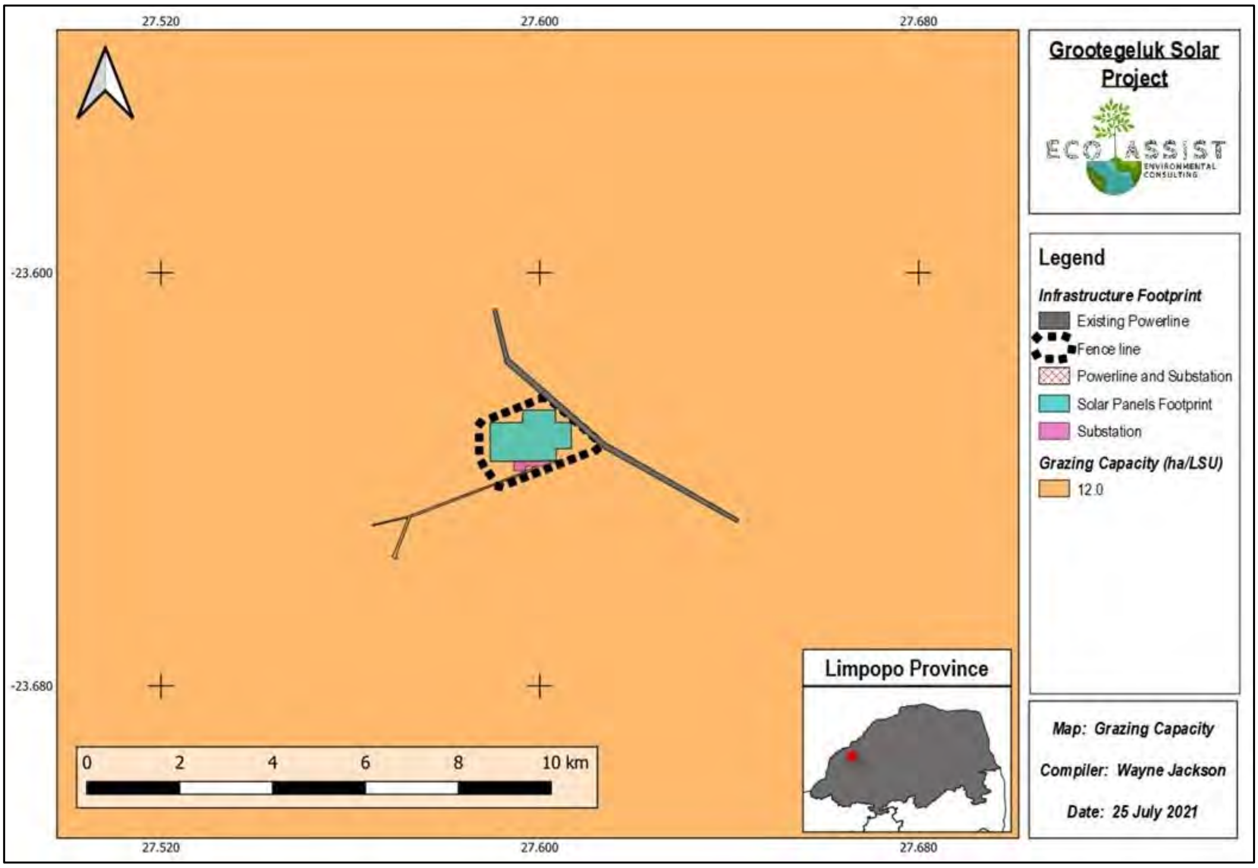

Figure 10-10: The grazing capacity within the project area (South Africa (Republic), 2018).

11 SITE ASSESSMENT RESULTS

A detailed soil survey was conducted for the Lephalale Solar site in June 2021 using a hand-held auger and a GPS to log all information in the field. The soils were classified to the family level as per the “Soil Classification: A Natural and Anthropogenic System for South Africa” (Soil Classification Working Group, 2018). The soil forms found are described in the subsequent sections and the extent is shown in Figure 11-4.

11.1 Soil Forms

The following soil forms were identified on-site (see Table 11-1);

- Hutton (Orthic topsoil over a thick Red Apedal horizon);
- Ermelo (Orthic topsoil over a thick Yellow-Brown Apedal horizon); and
- Fernwood (Orthic topsoil over a thick Albic horizon).

The project area is dominated by the deep freely draining Ermelo and Hutton soil forms, which are situated in the midslopes to upper sloped landscape positions. The Ermelo/Hutton accounts for 337.72 hectares of the project area.

The soils in the midslope to footslope positions due to the macro catena effect of water movement through the landscape have become bleached. The soils were classified as deep Fernwood soils and they accounted for 85.32 hectares of the project area.

Note the area calculation is based on the area within the 100m assessment buffer.

Table 11-1: Soil forms within the Lephalale Solar project area.

Soil Form	Soil Family	Area (ha)
Ermelo	2210	337.72
Hutton	2210	
Fernwood	2110	85.32
Disturbed	N/A	5.05
Total		428.09

Figure 11-1: The Hutton/Ermelo soil form found on site.

Figure 11-2: The Fernwood soil form found on site.

Figure 11-3: The sand fraction of the soils for the project area.

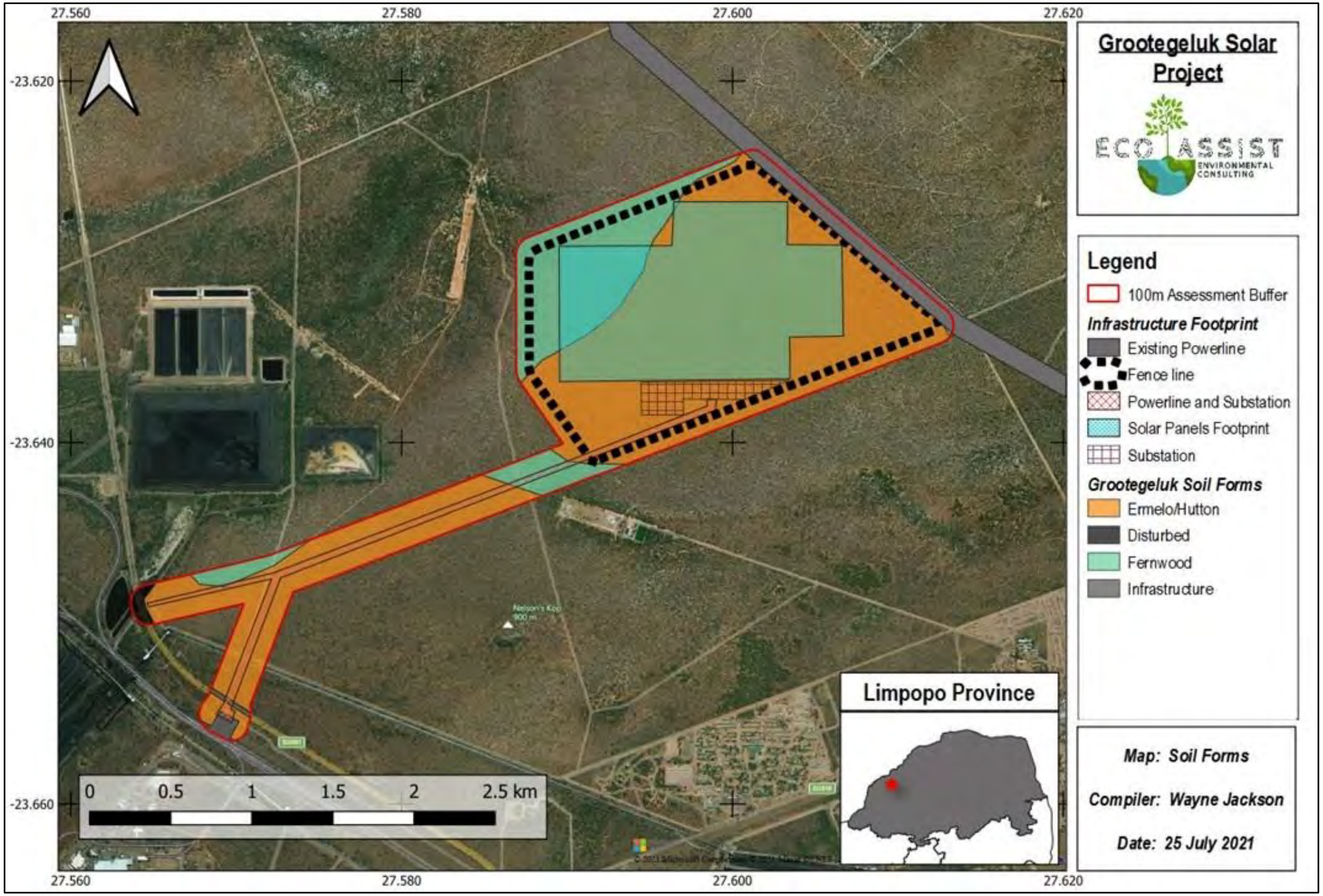

Figure 11-4: The soil delineation for the project area.

11.2 Land Capability Classification

Agricultural potential is determined by a combination of soil, terrain and climate features. Land capability classes reflect the most intensive long-term use of land under rain-fed conditions.

The land capability is determined by the physical features of the landscape including the soils present. The land potential or agricultural potential is determined by combining the land capability results and the climate capability for the region.

The land capability is determined by using the guidelines described in “The farming handbook” (Smith, 2006). A breakdown of the land capability classes is shown in Table 6-1.

The land capability for the project area is shown in Figure 11-5. The classification of the soil forms to the associated land capabilities is shown in Table 11-2 and the breakdown of the areas is shown in

Table 11-3.

The Ermelo, Hutton, and Fernwood soil forms were classified as having a class IV (light cultivation/intensive grazing) capability.

Land capability class IV accounted for 423.04 ha and the remaining area was classed as being disturbed.

Table 11-2: Soil forms and their associated land capability within the Lephalale Solar project area.

Soil Form	Land Capability
Ermelo	Class IV
Hutton	Class IV
Fernwood	Class IV
Disturbed	N/A

Table 11-3: Land capability within the Lephalale Solar project area.

Land Capability	Area (ha)
IV	423.04
N/A	5.05
Total	428.09

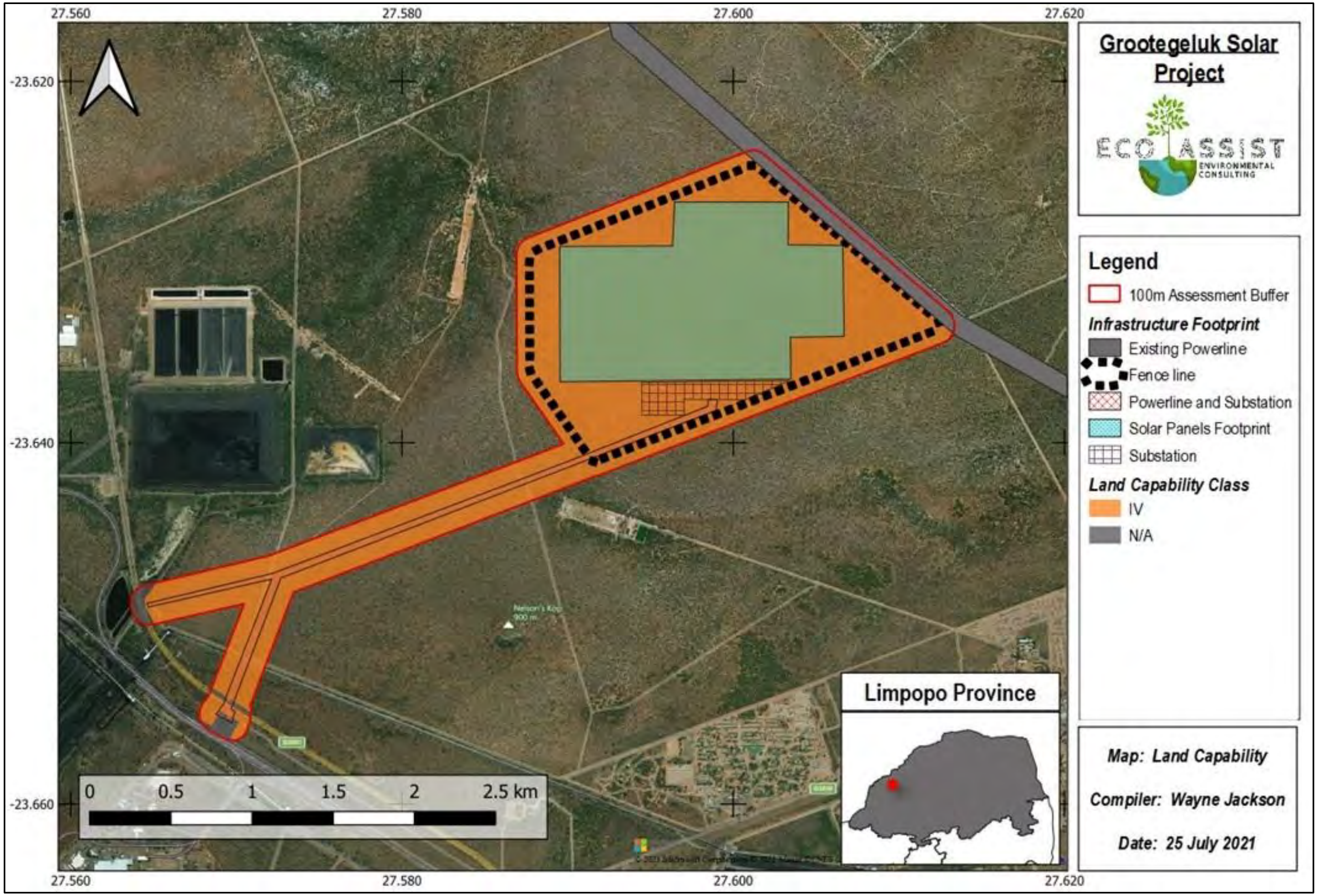

Figure 11-5: The land capability for the project area.

11.3 Land Potential Classification

The climate capability for the project area is determined to be C6 – with a severe limitation rating (Smith, 2006). The climate class has a moderately restricted growing season due to low temperatures, frost and/or moisture stress. the limited crops that can grow in this climate region will experience frequent yield loss.

The Land potential / Agricultural potential of the project area is shown in Figure 11-6 and the breakdown of the areas is shown in Table 11-4. The class IV land capability was determined to be class **L5 (Restricted potential),** accounting for 423.04 ha.

L5 - Restricted potential: Regular and/or moderate to severe limitations due to soil, slope, temperatures or rainfall.

Table 11-4 Land potential within the Lephalale Solar project area.

Land Potential	Area (ha)
L5	423.04
N/A	5.05
Total	428.09

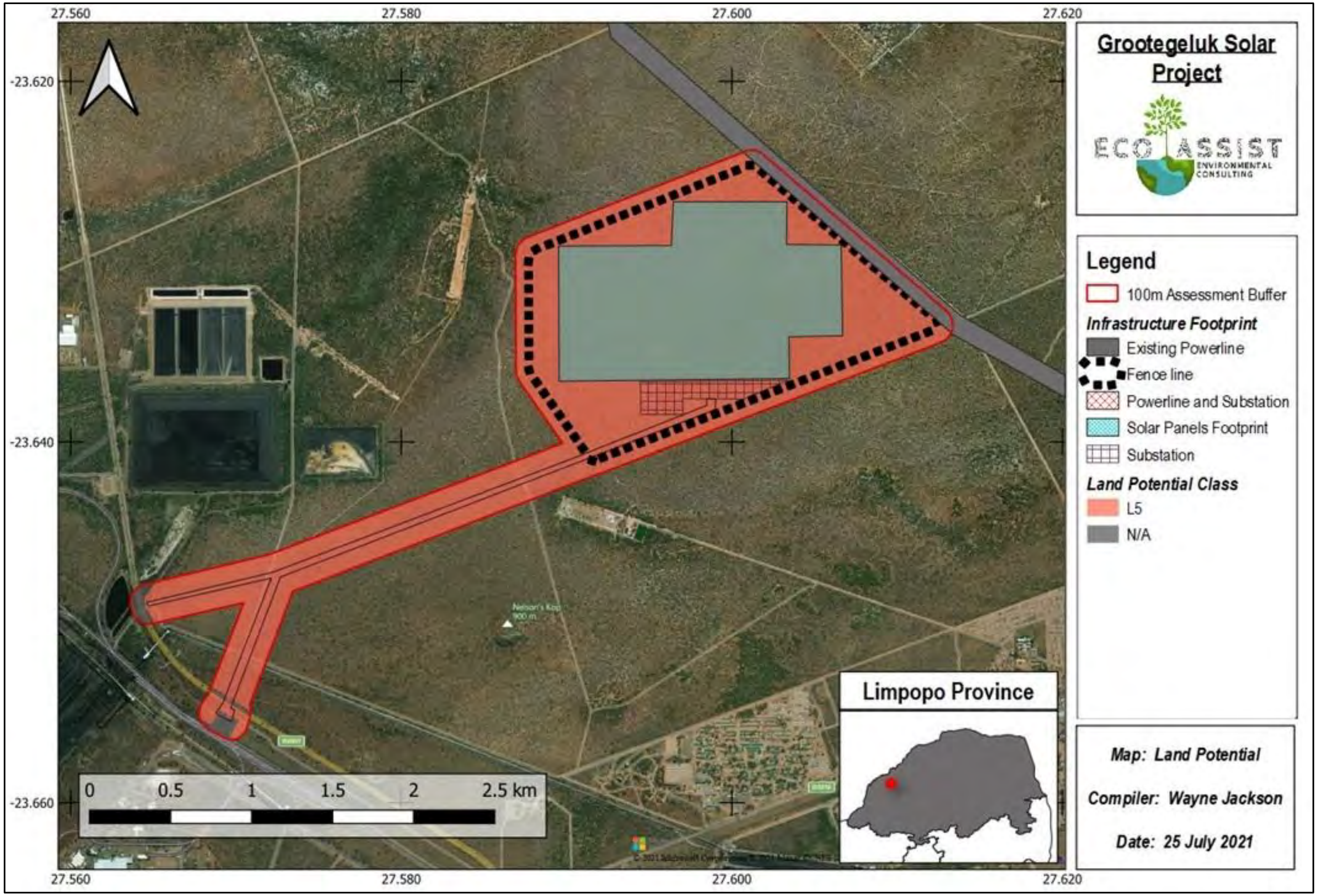

Figure 11-6: The land potential for the project area.

11.4 Current Land Use

The project area has three (3) primary land uses (see Figure 11-9 namely;

- Infrastructure (Figure 11-7);
- Veld (Figure 11-8); and
- Disturbed areas.

The land in the area is currently being utilised as game farms in natural veld conditions. No commercial crop production is currently taking place on the project area.

Figure 11-7: Infrastructure in the project area.

Figure 11-8: Veld in the project area.

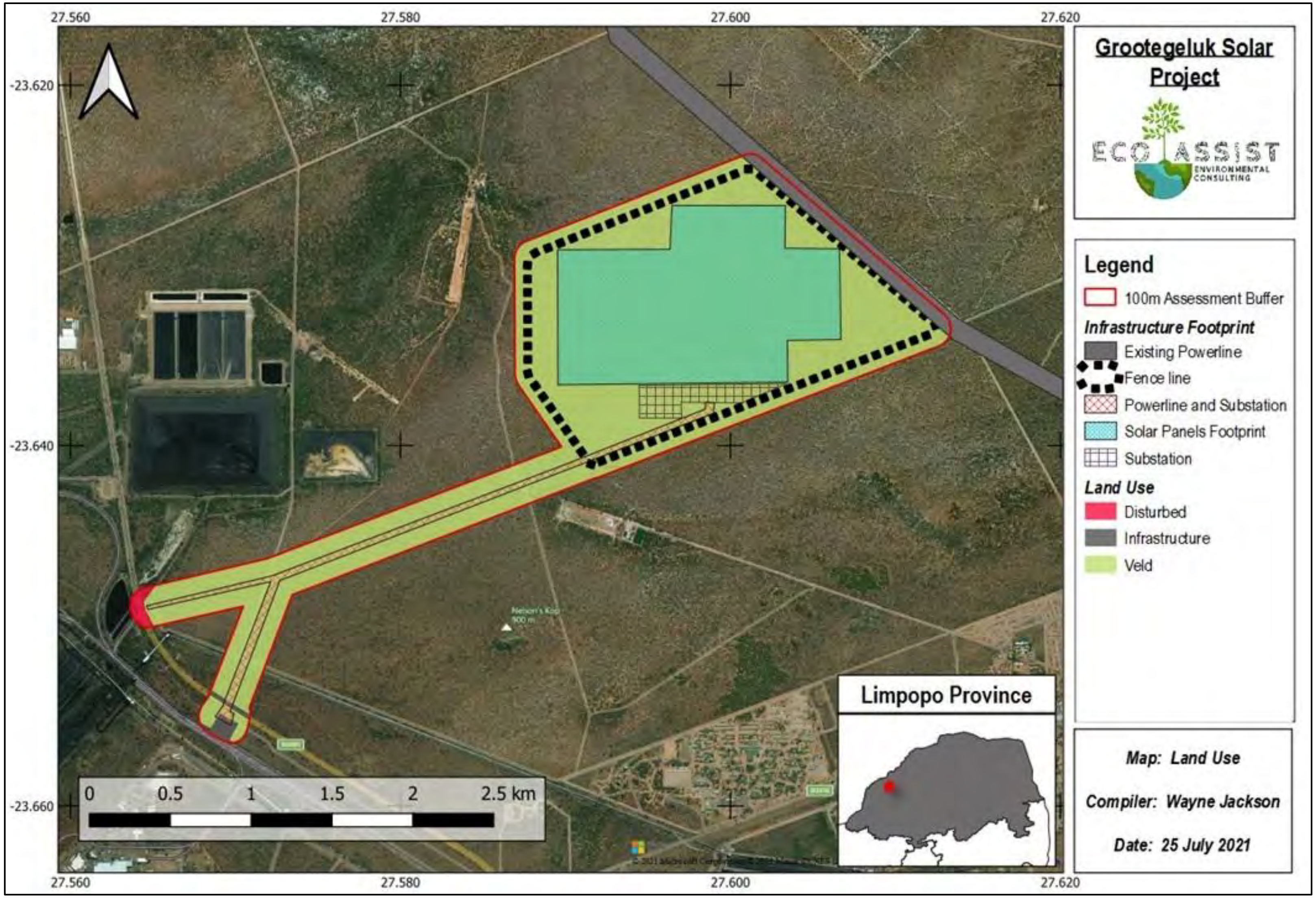

Figure 11-9: The land use for the project area.

11.5 Verified Site Sensitivity

The screening assessment rated the agricultural sensitivity as medium. The desktop results as well as the field verification and detailed soils assessment have concurred that the agricultural potential is rated as medium to low based on the climatic restrictions that are limiting the potential for sustainable yields. Therefore an agricultural compliance statement will be sufficient for this report.

12 AGRICULTURAL COMPLIANCE STATEMENT

The sensitivity analysis has identified the project area to have a medium sensitivity and as such an Agricultural Compliance Statement will be required. The assessment has also determined that the development falls within the allowable limits as described in GN320. The project area is in a medium agricultural sensitivity and is not located within any crop boundary.

The desktop results as well as the field verification and detailed soils assessment have determined that the agricultural potential is rated as medium to low based on the climatic restrictions that are limiting the potential for sustainable yields. The following supports the above-mentioned findings:

- Desktop Results;
  - DEA screening assessment determined the agricultural sensitivity to be medium;
  - The project is not within a crop field boundary and is therefore within the allowable limits as per GN320;
  - The desktop land capability rated the project area as Low-Moderate;
  - The climate capability was determined to be Low-Moderate;
  - The desktop soil capability rated the project area as Low; and
  - The desktop grazing capability rated the project area as having a 12 ha/LSU.

- Site Assessment Results;
  - Land capability was determined as grazing;
  - Land potential was determined to be L5 (restricted potential); and
  - Land use showed no agricultural activity.

13 RECOMMENDATIONS

The potential impacts described in (Terra Soil Science, 26 September 2011) was confirmed for this project. These aspects are to be manged to minimise any potential impacts:

- Erosion was not considered a large risk; however, stormwater mitigation should be considered to mitigate and manage any risks;
- Risks from oil/hydrocarbon spills from vehicles should be mitigated; and
- Dust control measures should be put in place.

14 ACCEPTABILITY STATEMENT

The specialist opinion is that the proposed project be considered favourably as the DEA screening tool value of medium sensitivity was verified by confirming the project was not within any crop farming boundaries and that the proposed development of the Solar project was therefor within the allowable limits stated in GN 320. This was further strengthened by the detailed in-field survey confirming the land potential to have a restricted potential.

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APPENDIX E4: GEOHYDROLOGICAL INVESTIGATION

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Geohydrological Report (GN 267) for Abstraction for the Lephalale Solar Project

Version - Final

August 2021

K2021699383 (South Africa) (PTY) LTD

GCS Project Number: 21-0037

Client Reference: Geohydrological Investigation

GCS (Pty) Ltd. **Reg No:** 2004/000765/07 Est. 1987
Offices: **Johannesburg** (Head Office) | Durban | Gaborone | Lusaka | Maseru | Windhoek | Ostrava
Directors: AC Johnstone (CEO) | A Gunn (COO) | A Wilke | M Van Rooyen | W Sherriff (Financial) | N Marday (HR)
Non-Executive Director: B Wilson-Jones

Geohydrological Report (GN 267) for Abstraction for the Lephalale Solar Project

Report
Version - Final

August 2021

DOCUMENT ISSUE STATUS

Report Issue	Final		
GCS Reference Number	21-0037		
Zutari Reference Number	1001395-G040-REP-NN-009		
Client Reference	PR-CLI-002		
Title	Geohydrological Report (GN 267) for Abstraction for Lephalale Solar Project		
	Name	**Signature**	**Date**
Author	Lukas Marais		August 2021
Document Reviewer	Andries Wilke	27/9/2021	September 2021
Director	Andries Wilke	27/9/2021	September 2021

EXECUTIVE SUMMARY

GCS Water and Environmental (Pty) Ltd (hereinafter referred to as GCS) was requested by K2021699383 (South Africa) (PTY) LTD (hereinafter referred to as the client) to conduct drilling supervision and a hydrogeological investigation for abstraction boreholes at farm Appelvlakte 448 forming part of the Mankatti private game reserve. The document will be submitted as supporting documentation for a Water Use License Application (WULA).

The site is located situated approximately 20 km West of the town of Lephalale and falls within the Lephalale Local Municipality area, Waterberg District Municipality in the Limpopo Province. Rainfall data gathered from the WARMS database indicates a total of 428.3 mm of rainfall in the region.

The study area is underlain by sedimentary rocks consisting of sandy soils, cream-colored sandstones and red mudstones of the Vaalwater formation. Based on available data, the production borehole BH2 intersect the fractured to semi fractured sandstone aquifer.

The original scope of work involved a desktop study, drilling supervision and aquifer testing for 2 boreholes as part of a hydrogeological assessment for water supply purposes at Appelvlakte 448.

The client has specified a total annual abstraction rate requirement of 2920 m^3/annum for industrial use in category 3 applications.

2 Boreholes were drilled (BH1 and BH2), however the first hole (BH1) was found to be dry. Abstraction of borehole BH2 was found to be able to satisfy the abstraction requirement of the client.

Aquifer testing was conducted for BH2 by GCS and analysed accordingly. Based on the analysis of the aquifer tests total volume of 18 m^3/day can be abstracted from BH2. The borehole can be abstracted for 12 hours, with a 12 hour recovery period. Abstraction of BH2 should not exceed 12 hours/day, and the borehole should have a minimum recovery period of 12 hours.

Laboratory water quality results revealed that no constituents analysed for BH2 exceeded DWAF guidelines for water used for industrial purposes for category 3 activities.

A groundwater balance was prepared for the sub-catchment, which evaluated all major resource input and outputs. The theoretical groundwater reserve indicates that sufficient water is available for abstraction to meet the water requirement of 2920 m^3/annum.

The results of the desktop assessment, groundwater reserve determination was used to assess the potential hydrogeological impact of groundwater abstraction. The impact of abstraction by lowering of regional groundwater levels within the aquifer may be mitigated by keeping to the recommended pumping schedule.

The following is recommended:

- It is recommended that the groundwater levels and hydrochemistry of the boreholes are monitored as per the groundwater management plan
- Water should be used sparingly, and all leaks and faulty reticulation should be attended to as soon as detected.
- The data collected from monitoring must be interpreted by a hydrogeologist in order to assess long-term impacts of abstraction.
- It is imperative that drawdown within BH2 does not exceed 20 m (with a static water level of 44 mbgl), in order to reduce the likelihood of dewatering the fractures in the aquifer and only at the prescribed pumping rate or lower.
- It is recommended that the abstraction (pumping) schedule be re-evaluated on an annual basis
- It is recommended that an additional backup borehole be sited, drilled and commissioned as a single water supply borehole will leave the project vulnerable to failure of the production borehole due to aquifer dewatering or mechanical breakdown.

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1 INTRODUCTION

GCS Water and Environment (Pty) Ltd (GCS) was requested by K2021699383 (South Africa) (PTY) LTD to conduct a hydrogeological investigation for two abstraction boreholes that would involve drilling and aquifer testing at Appelvlakte 448, Lephalale in Limpopo Province, South Africa. The document will be submitted as supporting documents for a Water Use Licence Application (WULA).

2 SCOPE OF WORK

The following components were accepted as the scope of work:

- a detailed desktop study of the project area.
- drilling supervision and hydrogeological logging of the hard rock conditions;
- aquifer testing of the newly drilled boreholes
- groundwater quality sampling of the newly installed boreholes;
- pump specification recommendations and recommended abstraction schedule;
- compilation of a hydrogeological report with the findings of the study as well as detailed recommendations for resource development, management and monitoring with relevant information for inclusion within the WULA.

3 METHODOLOGY

3.1 Desktop Study

GCS conducted a review of groundwater related information to establish prevailing groundwater resource conditions within the project area and immediate surrounds. The review will focus on the following:

- Topographic 1:150 000 maps
- Geological 1:250 000 map
- Hydrogeological 1:500 000 map
- National Groundwater Archive (NGA);
- Groundwater Resource Assessment (GRAII);
- Groundwater Resource Directed Measures (GRDM);
- Groundwater Resources of Republic of South Africa;
- Existing geological, hydrological and hydrogeological reports; and
- Data and sampling information (water quality certificates).

The data review will provide background and historical information about existing boreholes, groundwater use, groundwater levels, groundwater harvesting potential, groundwater quality and raise potential issues regarding the groundwater resources at project area and immediate surrounds (+/- 1 km).

No hydrocensus was done as part of this study although those sites used in the current monitoring program around the site has been included.

3.2 Groundwater Reserve Determination

A groundwater balance was prepared for the **sub-catchment**, which evaluated all major resource input and outputs. It takes into account the existing abstraction, rainfall, recharge and basic human needs. The groundwater balance was used to assess the volume of groundwater available for abstraction and included abstraction from BH2.

3.3 Siting of Boreholes and Drilling Supervision

The borehole locations were sited based on a ground magnetic and electromagnetic survey performed by Exxaro. The results of the surveys can be seen in Appendix A

The drilling supervision included the following activities:

- GPS location
- Logging of geology/Lithology during drilling
- Sampling of drill cuttings
- Noting water strikes
- Borehole depth and construction

3.4 Aquifer Testing

Borehole BH2 was pumped by GCS for 24 hours at a constant rate (CR). A CR test is a field experiment in which a well is pumped at a controlled rate and water-level response (drawdown) is measured. The response data from the pumping test was used to estimate the hydraulic properties of the aquifer, such as transmissivity and hydraulic conductivity.

After pumping the water level within the borehole was monitored to determine the recovery of the water level with time. This allows for the evaluation of dewatering and pumping schedules. The aquifer test data was analysed to determine the following:

- Sustainable yield;
- Abstraction schedule;
- Pump inlet depth; and
- Management.

3.5 Groundwater Sampling of BH2

A groundwater sample was collected from BH2 to determine the groundwater condition. The methodology in the collection and preservation of groundwater samples are important for the reliability of the analysis.

The samples were submitted to a South African National Accreditation System (SANAS) accredited laboratory for analysis and included the following analyses:

The samples were submitted to an accredited laboratory services for analysis and will include the following analyses:

- Metals: Na (Sodium), K (Potassium), Ca (Calcium), Mg (Magnesium), Al (Aluminium), As (Arsenic), Cd (Cadmium), CrVI (hexavalent Chrome), Cu (Copper), Fe (Iron), Pb (Lead), Mn (Manganese), & Zn (Zinc);
- Physio-chemical properties: Chemical oxygen demand (COD) Total dissolved solids (TDS), pH, Electrical conductivity (EC), Total hardness and Total suspended solids (TSS);
- Nitrate, Chloride, Sulphate;

The water quality results received from the laboratory are presented in Appendix B.

4 SITE DESCRIPTION

4.1 Locality and Climate

Appelvlakte 448 is situated approximately 20 km West of the town of Lephalale and falls within the Lephalale Local Municipality area, Waterberg District Municipality in the Limpopo Province. The locality map is shown in Figure 4.1.

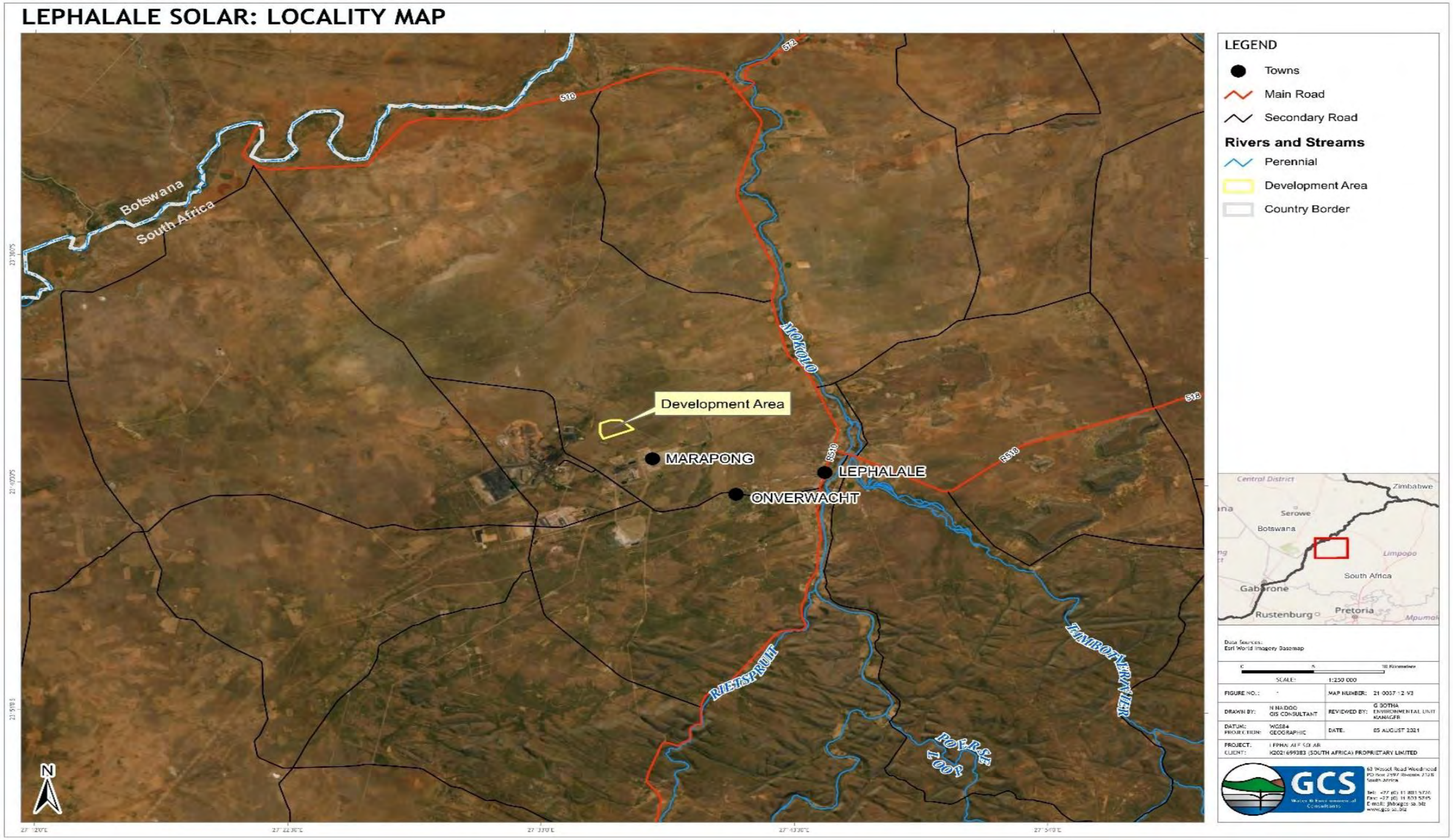

Figure 4.1 Site location

The climatological condition at Appelvlakte 448 is characterized by long hot summers (early September to late April) and short cool winters (early May to late August) The site falls under a summer rainfall region, receiving the highest rainfall reading in January and lowest in July with average mid-day temperatures of 28-32ºC in the summer and 7-10ºC in the winter. Mean annual precipitation (MAP) ranges from 300 to 500 mm (South African weather service) as can be seen in Figure 4.2.

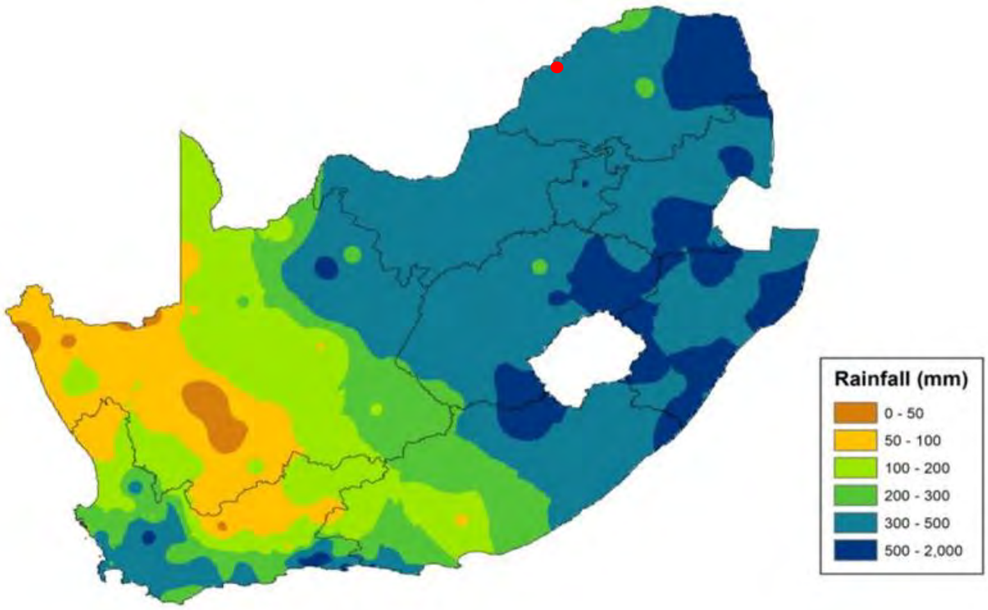

Figure 4.2 Rainfall (SAWS)

4.2 Topography and Hydrology

The topography in the study area is relatively flat with a topographic high in the north-west. The site is located within quaternary catchment B42JA of the Limpopo Management Area. Drainage across the study area predominantly occurs in an eastern direction and locally towards the Sandloop River to the east of the site, Tributaries flow towards the Mokolo River. The drainage from the site is very restricted due to the high infiltration rate of the sandy soils on the site. Figure 4.3 shows the regional topography.

4.3 Land Use

The study site is 22 000 ha in size and forms part of the Manketti Private Nature Reserve which is owned by Exxaro.

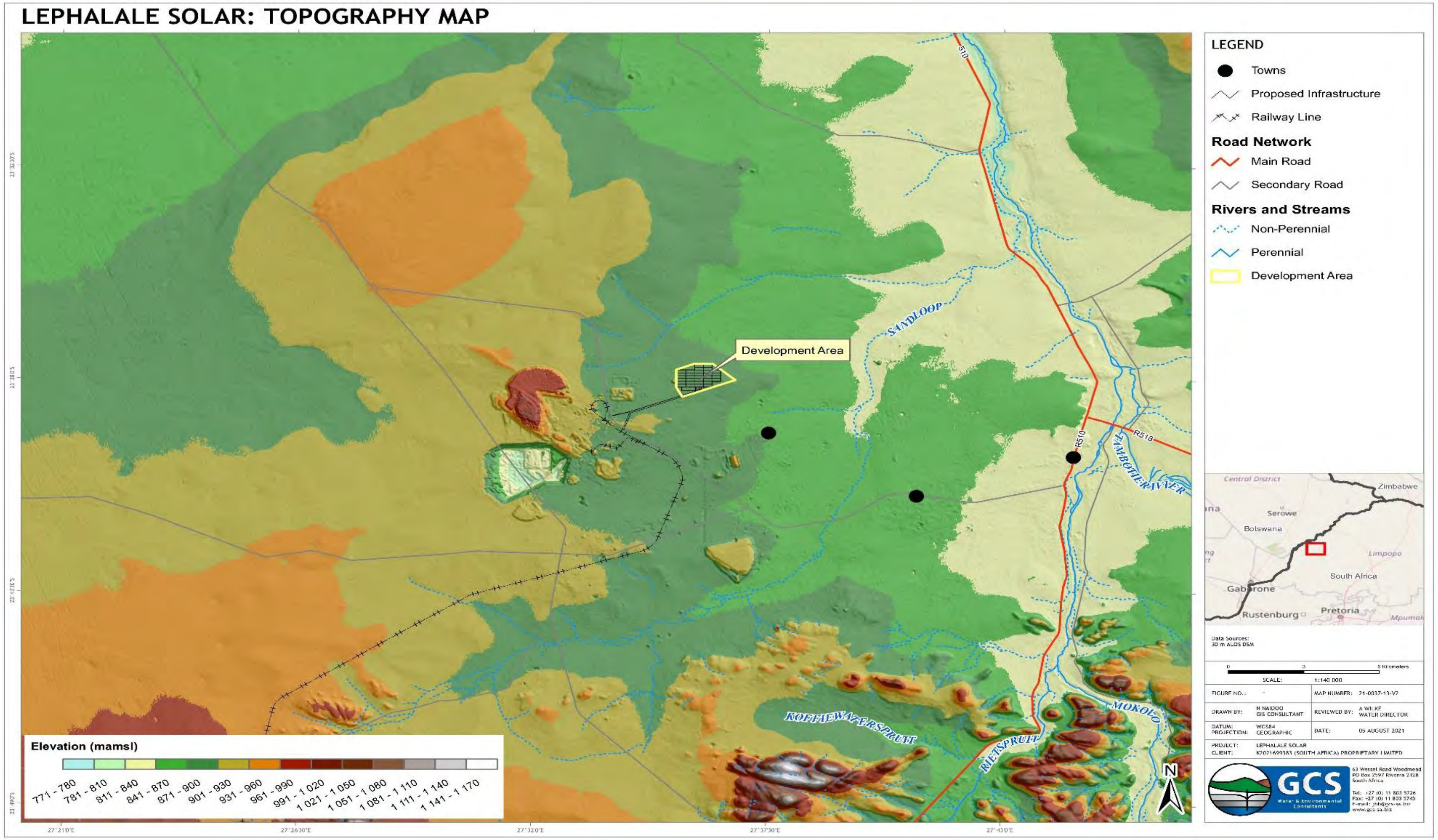

Figure 4.3 Topography

4.4 Geological setting

The Clarens Formation is the upper most unit of the Stormberg group of Jurassic age that extends from the main Karoo Basin of South Africa. The unit covers the red beds of the Elliot Formation and is partly covered by flood basalts of the Pliensbachian-Toarcian Drakensberg Group.

The Clarens Formation is dominated by fine to medium-grained, thick, cross-bedded sandstones that range from pale orange or pinkish to cream in color. Regional variations in thickness, sedimentary facies and fossil content were driven by changes in climatic conditions. The sedimentology was derived from aeolian desert sands, minor playa lakes, transient stream deposits followed by basaltic lava flows.

The Clarens Formation lithological uniformity mainly outcrop as high cliffs and are characterized by shallow caves and overhangs, because of erosion processes, at the contact of the underlying Upper Elliot Formation (Brody et al. & Octavian et al.)

The stratigraphic sequence can be seen in Figure 4.4 below.

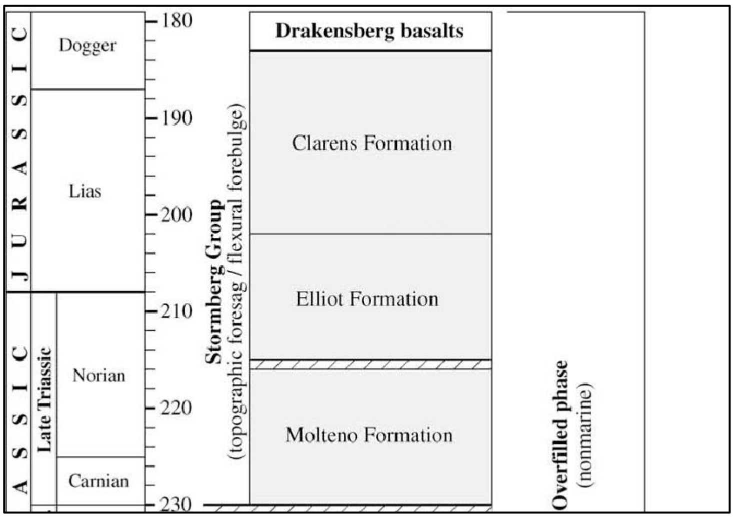

Figure 4.4 Regional geological stratigraphy of the Stormberg group (Octavian et al.)

4.4.1 Local Geology

The local geology consists of sandy soils, cream-colored sandstones and red mudstones of the Clarens formation, just north of the Darby fault, as can be seen in Figure 4.5. The Clarens formation represents the primary portion of the Stormberg Subgroup.

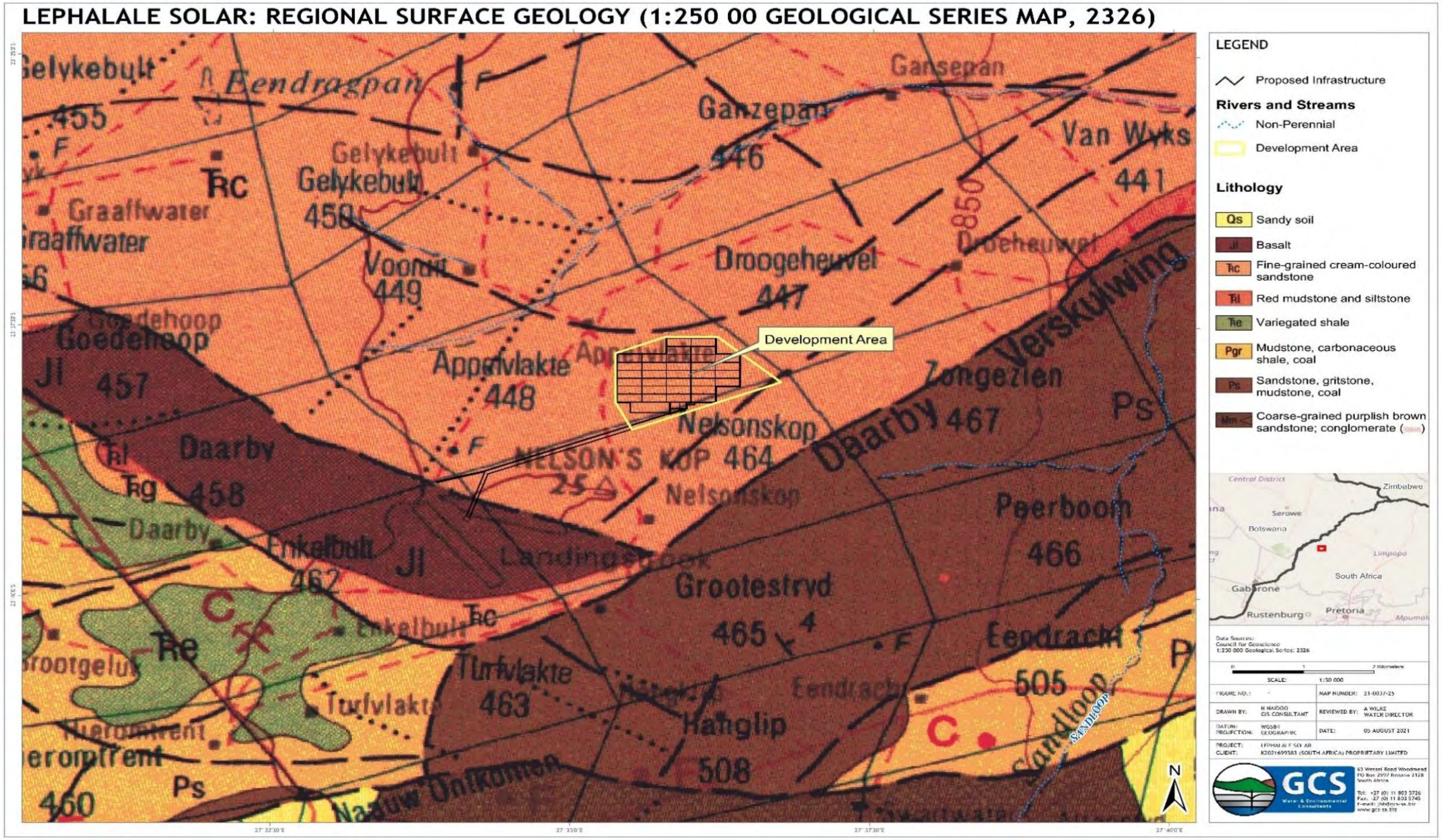

Figure 4.5 Regional Geology

5 AQUIFER CHARACTERISATION

5.1 Aquifer Classification

Figure 5.1 represents the hydrogeological characterisation across the greater project area, consisting of fractured or potentially fractured arenaceous rocks (sandstone, feldspathic sandstone, Arkose, shale and grit) which do not have a high primary permeability or inconsistent permeability. The aquifer underlying the study area may be classified as a minor aquifer system (Parsons et al, 1995), of an intergranular and fractured type with a d2 borehole yield class of 0.1-0.5 l/s. The aquifer extent may be restricted with a variable water quality. Although these types of aquifers do not often produce large quantities of water, they are crucial both for local supplies and in providing river base flow.

5.2 Groundwater levels

According to the available NGA and WARM data regional groundwater levels range between 1.12 and 150 mbgl whereas locally water levels range between 16.76-27.43 mbgl.

The regional spatial distribution of the existing boreholes around the site can be seen in Figure 5.2.

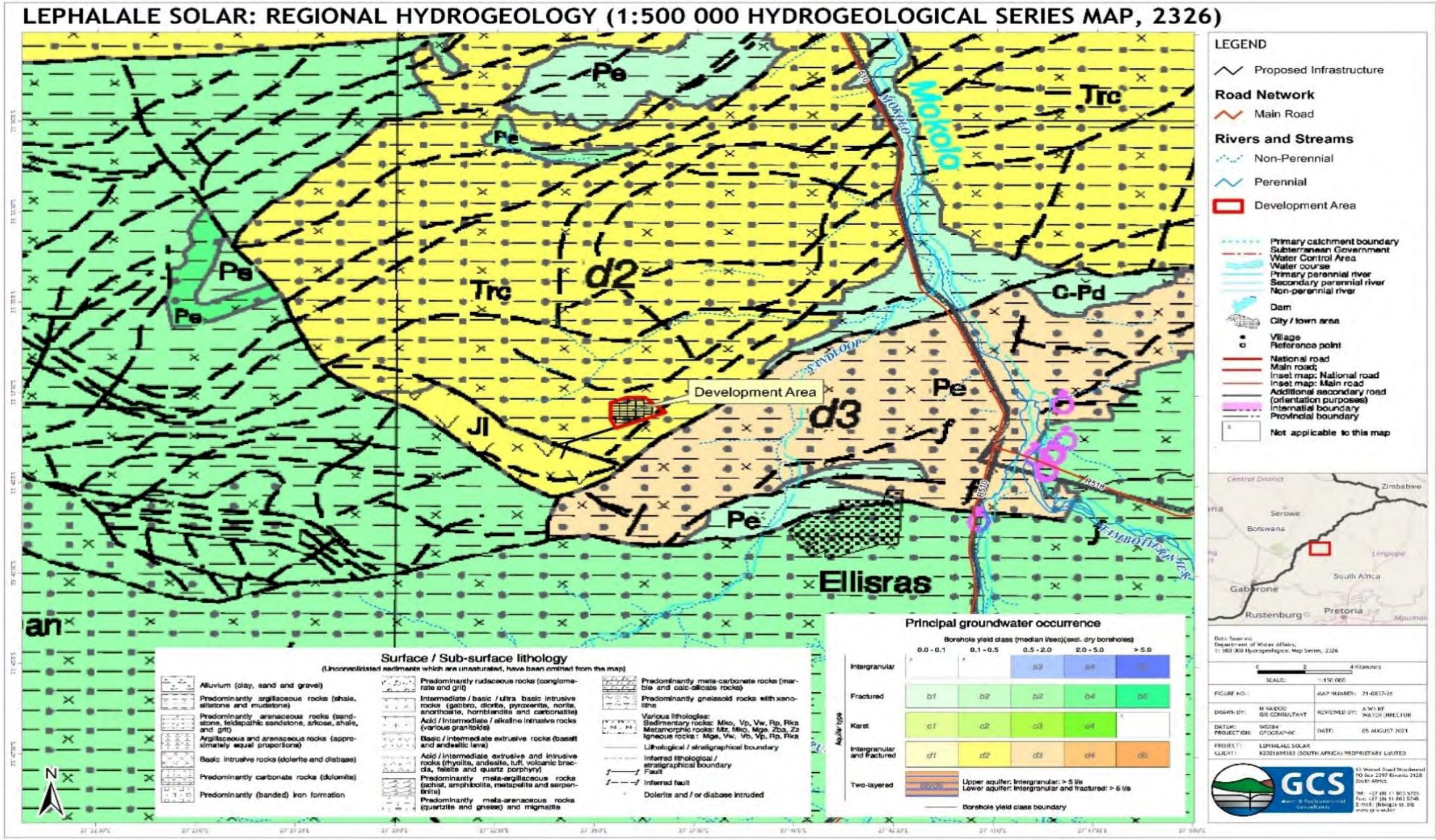

Figure 5.1 Regional hydrogeology

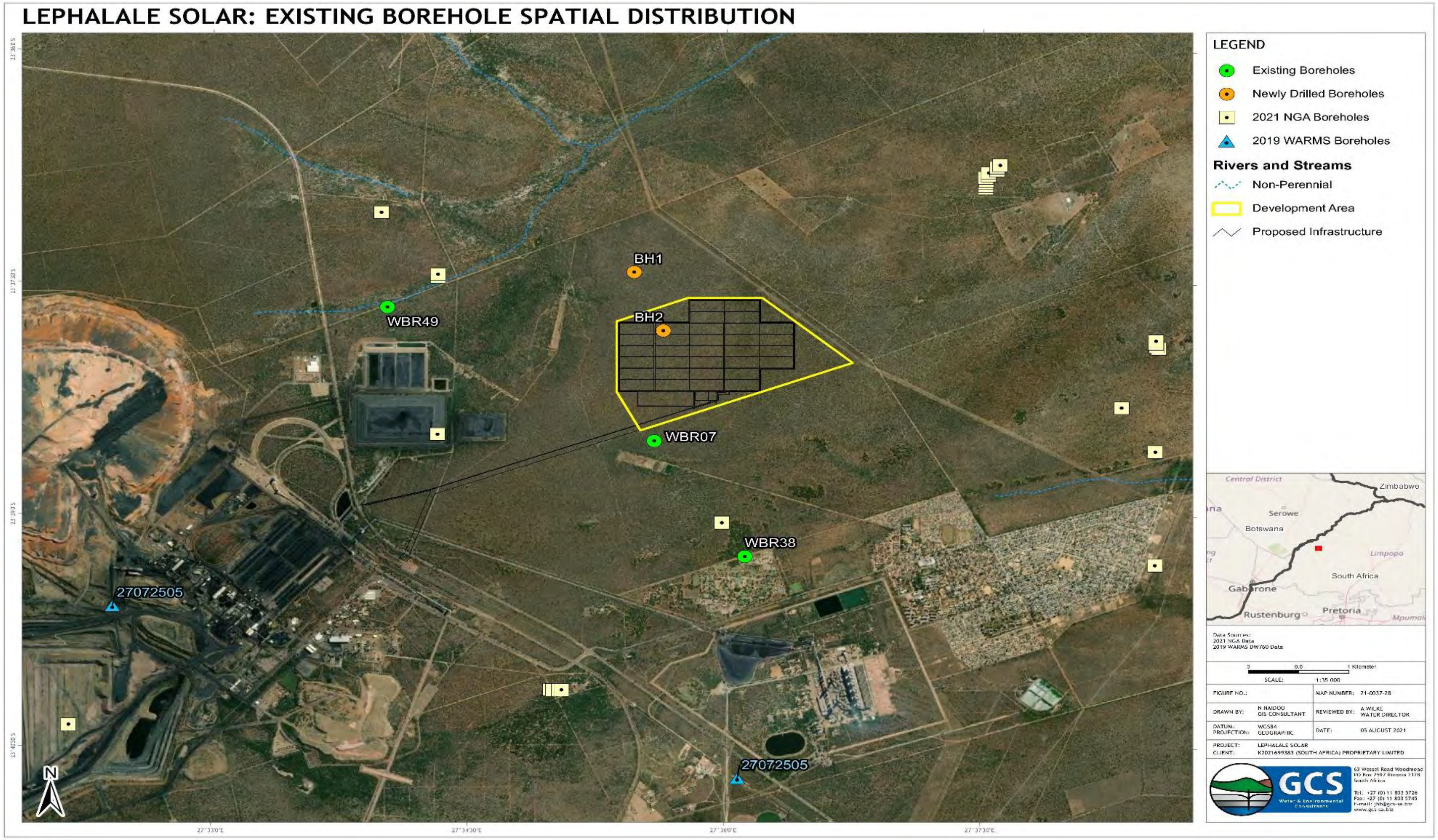

Figure 5.2 Borehole spatial distribution

5.3 Groundwater Reserve Determination

A groundwater reserve determination was completed to assess the status of the groundwater resource unit and to determine the scale of abstraction that can safely be abstracted in relation to groundwater recharge. The Groundwater Reserve Determination takes into account the following parameters:

- Area of the sub-catchment delineated for the site;
- Effective recharge from rainfall and specific geological conditions;
- Basic Human needs for the site;
- Groundwater contribution to surface water (baseflow);
- Existing abstraction; and
- Surplus, if any, available for abstraction.

5.4 Catchment Area Delineation

The study area (sub-catchment 61 km^2 in size) falls within the Limpopo Water Management Area (WMA) quaternary catchment A42J (~ 1 811 km^2 in size), delineated in Figure 5.3 and Figure 5.4.

Table 5.1 summarises the Groundwater Resource Directed Measures (GRDM, 2013) hydrogeological information for quaternary catchment A42J.

Table 5.1 Quaternary Catchment A42J Information Summary (GRDM, 2013)

Description	Quaternary Catchment	A42J
Total Catchment Area	1 811	[km^2]
Total Catchment Area’s Population	0	[No]
Mean Annual Precipitation	428.3	[mm/a]
Recharge	1.7	[%]
	7.3	[mm/a]
Total Catchment Area’s Current Groundwater Use	3 980	[m^3/d]
Total Catchment Area’s Groundwater Contribution to Baseflow	0	[Mm^3/a]

Note/s:

MAP - mean annual precipitation

[m/a] - metres per annum

[m^2] - squared metres

[m^3/d] - cubic metres per day

[m^3/a] - cubic metres per annum

[Mm^3/a] - mega cubic metres per annum

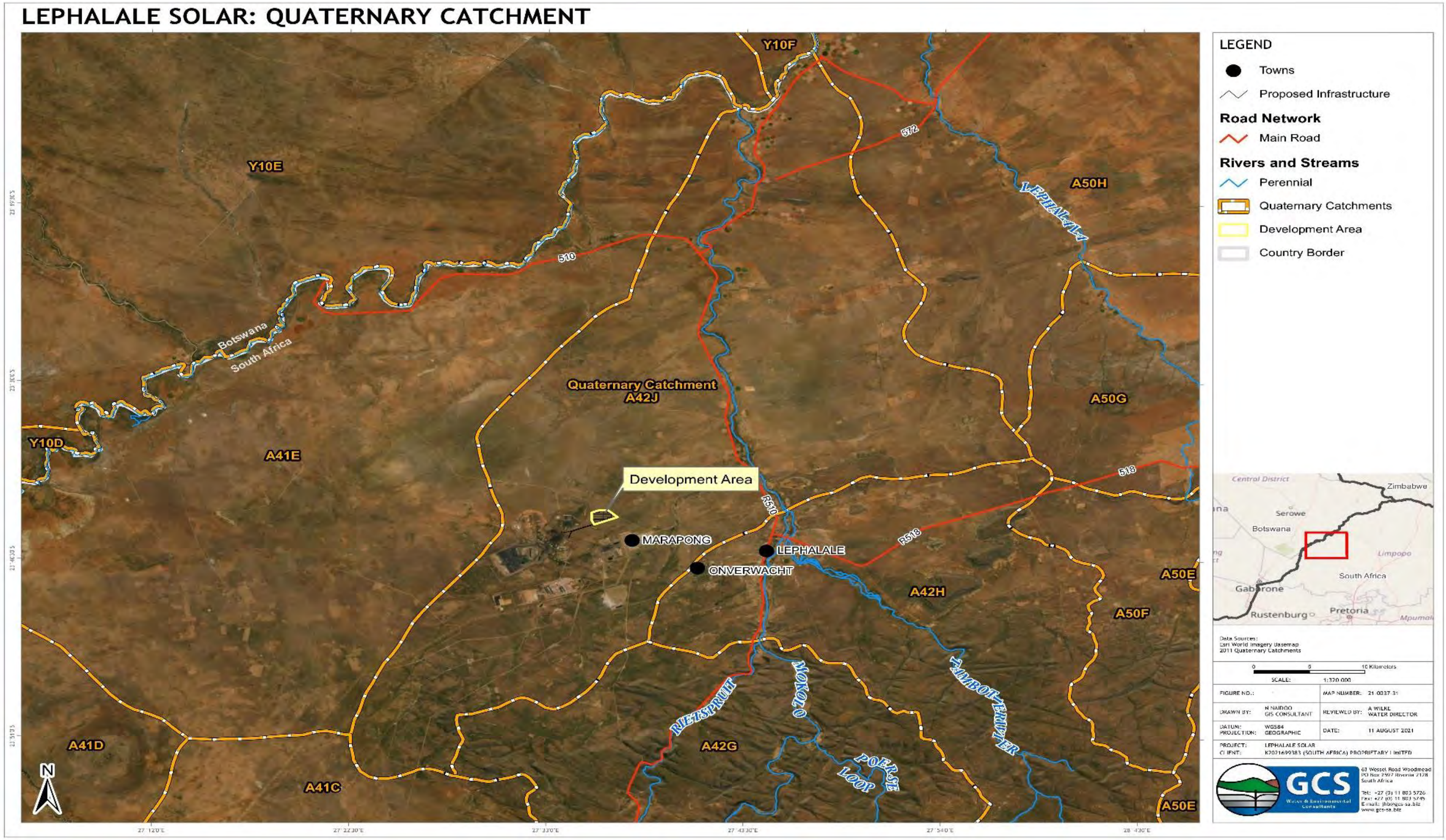

Figure 5.3 Quaternary catchment A42J delineated

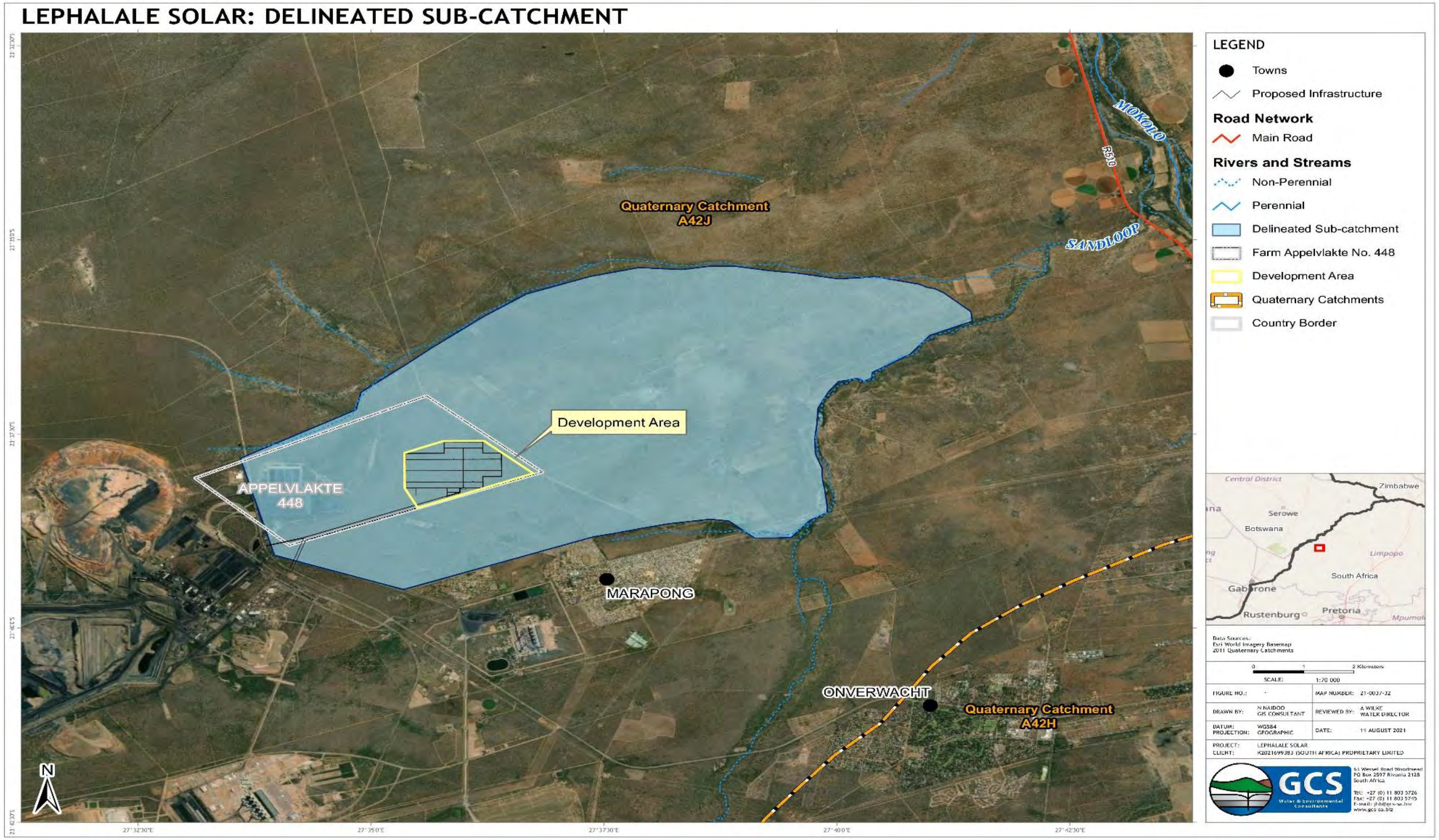

Figure 5.4 Sub-catchment delineated

5.5 Groundwater Recharge

The effective groundwater recharge from precipitation is the portion of precipitation that reaches the groundwater. The remainder of the precipitation comprises surface water runoff, evapotranspiration and soil moisture. The effective recharge is dependent on the geology, soils, surface run-off and stream morphology but most importantly for the study area, the effective storage.

Based on values sourced from the scientific literature (i.e., Vegter, 1995), a recharge of ~1.7 % of the annual precipitation is estimated. Higher recharge is however expected along geological structural features due to their increase permeability and associated storage.

The precipitation recharge, for the sub-catchment areas (see Figure 5.4), is described below and summarised in Table 5.2.

$$\mathbf{Re}_{\,Delineated\ Area} = \mathbf{Re}_{\,\%MAP}\ \mathbf{x}\ \mathbf{Area}_{\,Delineated\ Area}$$

Where:

- $Re_{\%MAP}$ Recharge (1.7 % of MAP) [mm/a] for the delineated catchment area
- $Area_{Delinated\ Area}$- Area [m^2]

Table 5.2 Delineated Catchment Area Recharge Summary

Description	K2021699383 (South Africa) (PTY) LTD	
Recharge (1.7 % of MAP)	0.4283	[m/a]
Delineated Area	61 000 000	[m^2]
Delineated Recharge	1217	[m^3/d]
	444 147	[m^3/a]

Note/s:

MAP - mean annual precipitation

m/a - metres per annum

m^2 - squared metres

m^3/d - cubic metres per day

m^3/a - cubic metres per annum

Mm^3/a - mega cubic metres per annum

5.6 Basic Human Need

Basic Human need is set by the Water Service Act (Act No. 108 of 1997) at 25 liters per person per day. The reserve is calculated by multiplying the number of people living within the confines of a source unit by 25 l/d.

Based on the GRDM (2013), ~no users reside in the 1810.8 km^2 quaternary catchment A42J, and no residents reside within the delineated sub-catchment.

The delineated sub-catchment is not situated in a highly urbanized area, therefore the most people in the surrounding urbanised environment are using municipal water supply and are not reliant on groundwater. Therefore, the 25 l/d per person value as their main source of water, will not apply to this study.

5.7 Total Abstraction

With reference to the NGA, WARMS and GRDM (2013) databases as well as the current on-site groundwater usage, the abstraction within the delineated areas is estimated at ~ 3980 m^3/d existing use.

The total estimated abstraction for the delineated catchment areas is described below and summarised in Table 5.3.

$$\mathbf{ABS}_{\boldsymbol{Total}\ (\boldsymbol{Delineated\ Area})} = \mathbf{ABS}_{\boldsymbol{Existing}\ (\boldsymbol{Delineated\ Area})} + \mathbf{ABS}_{\boldsymbol{Proposed}\ (\boldsymbol{Delineated\ Area})}$$

Where:

- $ABS_{Existing\ (Delineated\ Area)}$ - Existing abstraction within the delineated area [m^3/d]
- $ABS_{Proposed\ (Delineated\ Area)}$ - Proposed abstraction within the delineated area [m^3/d]

Table 5.3 Total estimated abstraction

Total Abstraction Summary		
Description	**K2021699383 (South Africa) (PTY) LTD Delineated Sub catchment**	
Existing Abstraction	3980	[m^3/a]
Proposed Abstraction	18	[m^3/d]
Delineated Catchment Area's Total Abstraction	134	[m^3/d]
	48 937	[m^3/a]
	0.049	[Mm^3/a]

Note/s:

MAP - mean annual precipitation

[m/a] - metres per annum

[m^2] - squared metres

[m^3/d] - cubic metres per day

[m^3/a] - cubic metres per annum

[Mm^3/a] - mega cubic metres per annum

5.8 Groundwater Contribution to Baseflow

Based on the available information from GRDM no contribution is made from the catchment to base flow. Water Balance (Delineated Catchment Area)

Table 5.4 summarises quaternary catchment A42J's water balance and is based on the information provided to GCS and information obtained at the time of the investigation.

Table 5.4 Water balance in Quaternary catchment

Water Balance for Delineated Subcatchment		
Description	K2021699383 (South Africa) (PTY) LTD **Delineated Subcatchment**	
Recharge through Precipitation	444 147	[m^3/a]
Basic Human Need	0	[m^3/a]
Existing Abstraction	48 937	[m^3/a]
Proposed Abstraction	6570	[m^3/a]
Baseflow	0	[m^3/a]
Surplus Amount	388 640	[m^3/a]

Note/s:

[m^3/a] - cubic metres per annum

Based on the groundwater balance calculated (Table 5.4), a surplus amount of ~1065 m^3/d when the groundwater abstraction is considered for the delineated 61 km^2 catchment area.

5.9 Scale of Abstraction

Based on the Department of Water and Sanitation (DWS) "Requirements for Water Use License Application: Groundwater Abstraction [S21(a)]", the license application must be evaluated in terms of three possible categories. Categories A, B and C each have an applicable list of information requirements for the license application, as should be provided by the applicant to the DWS.

- Category A -Small scale abstractions (<60% recharge on property);
- Category B -Medium scale abstractions (60-100% recharge on property); and
- Category C -Large scale abstractions (>100% of recharge on property)

The scale of abstraction is described below.

$$\boldsymbol{ABS_{scale}} = \frac{\boldsymbol{BHN + ABS_{Existing} + ABS_{Proposed} + Baseflow_{GRDM}}}{\boldsymbol{Re_{Catchment\ Area}}} \boldsymbol{x\ 100}$$

Where:

- o BHN - Basic human need [m^3/d]
- o $ABS_{Existing}$ - Existing abstraction within the delineated area [m^3/d]
- o $ABS_{Proposed}$ - Proposed abstraction within the delineated area [m^3/d]
- o $Baseflow_{GRDM}$ - Literature values for baseflow (as per GRDM, 2013) [m/a]

- o $Re_{Catchment\ Areas}$ - Recharge (1.7 % of MAP) [mm/a]

With reference to DWS scale of abstraction categories; the scale of abstraction from the groundwater unit, relative to recharge, across delineated catchment area is classified as Class B “Medium Scale” abstraction with a percentage of 90%

5.10 Stress Index

The recent status of a groundwater resource unit can be assessed in terms of sustainable use, observed ecological impacts or water stress. Since no information about ecological impacts of groundwater abstraction is available, the concept of water stress was applied for the classification process.

The concept of stressed water resources is addressed by the National Water Act but is not defined. Part 8 of the Act gives some guidance by providing the following qualitative examples of ‘water stress’:

- Where demands for water are approaching or exceed the available supply;
- Where water quality problems are imminent or already exist; or
- Where water resource quality is under threat.

Table 5.5 Stress index

STRESS INDEX		
Present Status Category	**Description**	**Stress Index**
A	Unstressed or low level of stress	<5%
B		**5% - 20%**
C	Moderate levels of stress	20% - 50%
D		50% - 75%
E	Highly Stressed	75% - 95%
F	Critically stressed	>95%

Based on the guide for determining the level of stress of the groundwater resource unit, the abstraction of ~ 483 m^3/day across the delineated catchment area is classified as status category B (5-20%). Therefore, the aquifer unit/s is considered to be unstressed as can be seen in Table 5.5

6 FIELD INVESTIGATION

6.1 Siting of Boreholes

The borehole locations were sited based on a ground magnetic and electromagnetic survey performed by Exxaro. One geophysical profile of 1360m was performed using both the magnetometer and EM methods in a an approximately southeast to northwest alignment. Figure 6.1 shows the locality of the traverse.

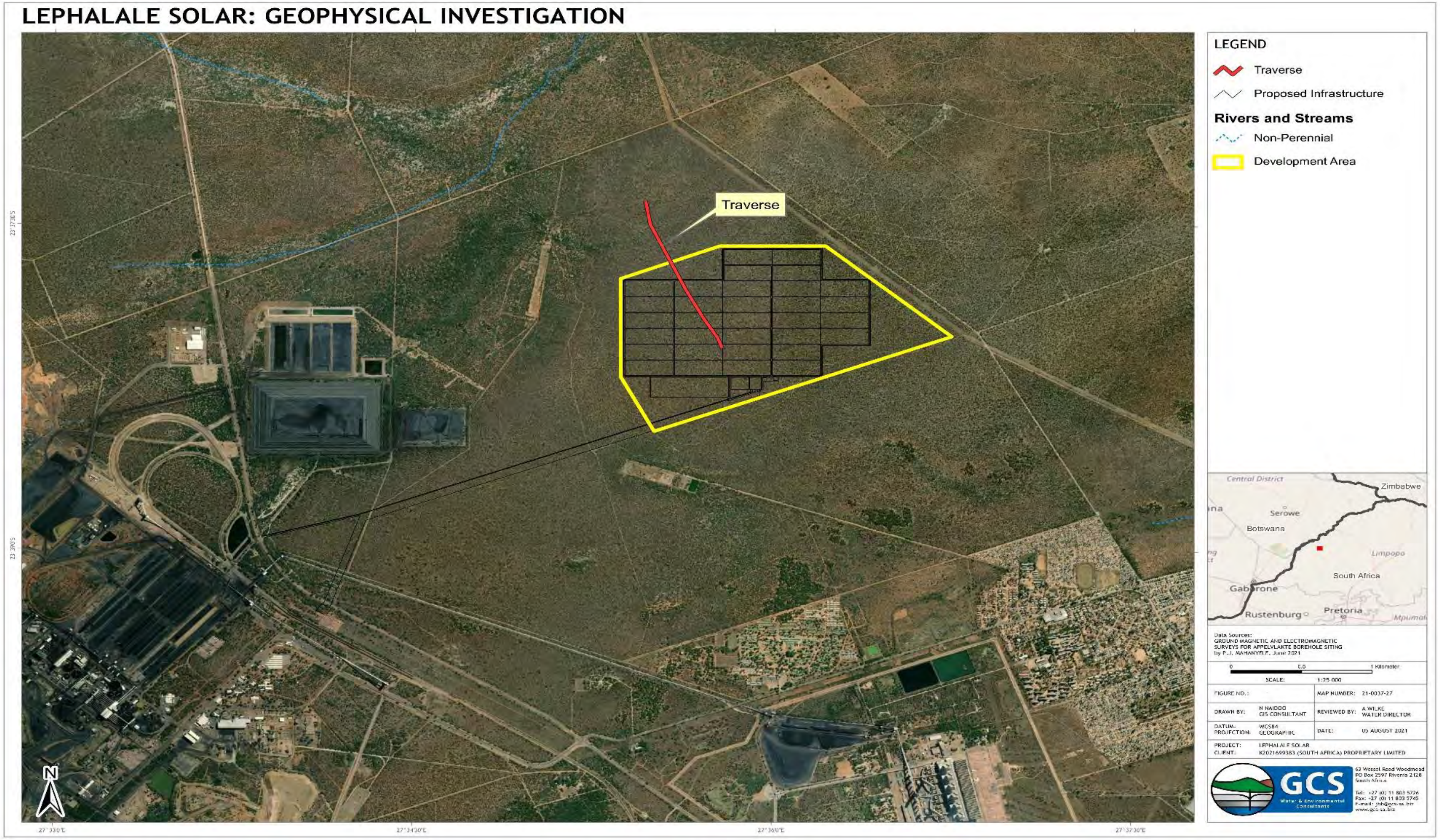

Figure 6.1 Geophysical survey traverse

6.2 Drilling Supervision

Sub-contractors were used to undertake drilling under the supervision of a hydrogeologist from GCS using the air percussion drilling technique.

Two boreholes were drilled based on the sites proposed, however, the first hole drilled (BH1-Site2) was found to be dry at a depth of 60m and the hole was abandoned. The first hole later collapsed due to the soft sandy lithology at a depth of 31m.

The second borehole BH2 (site1) was drilled to a final depth of 72 mbgl. BH2 had a static water level of 23.98 mbgl. The first water strike was encountered at 28 mbgl with an estimated strike yield of 0.14 l/s (500 l/hr). The first water strike was situated on the contact between a light grey sandstone and red mudstone at 28 mbgl. Additional fractures were encountered within a green sandstone interbedded with mudstone layers yielding more than 0.42 l/s (1500 l/hr)

A 219 mm diameter hole was drilled up to a depth of 12 mbgl. The hole was then fitted with a 200 mm solid steel casing up to a depth of 12 mbgl to prohibit the collapse of the hole due to the sandy lithology. After the steel casing was fitted, the borehole was drilled with a 195 mm diameter drill bit up to its final depth. A 125 mm perforated PVC casing was installed in the borehole along with a gravel pack to ensure stability.

The boreholes were situated as shown in Figure 5.2 as BH1 and BH2 The borehole construction and hydrogeological conditions encountered during drilling can be seen presented in Figure 6.2 and the information is summarized in Table 6.1.

Table 6.1 Borehole information

Description				BH2 (Site1)			
Borehole Location	Geographic Coordinate System			Latitude		Longitude	
	Projection: WGS 84			-23.63009		27.59390	
	Commence Date			07/07/2021			
	Completion Date			08/07/2021			
Bore/Hole Type Information	Monitoring / Production Bore / Exploration			Production			
Drilling Information	Method			Air Percussion			
	Depth Advanced			72			
	Drilling Diameter	219 mm	From [mbgl]	0			
			To [mbgl]	12			
		195 mm	From [mbgl]	12			
			To [mbgl]	72			
Hydrogeological Information	Water Strike & Yield Information	Water Strike 1	D:[mbgl] Y:[L/s]	D:	28	Y:	<0.2
	Static Water Level		[mbgl]	23.98.			
	Borehole Casing Information	STEEL Solid Casing (200 mm)	From [mbgl]	0			
			To [mbgl]	12			
		PVC Solid Casing (125 mm)	From [mbgl]	0			
			To [mbgl]	12			
		PVC Perforated Casing (125 mm)	From [mbgl]	12			
			To [mbgl]	69			
		PVC Solid Casing (125 mm)	From [mbgl]	69			
			To [mbgl]	72			

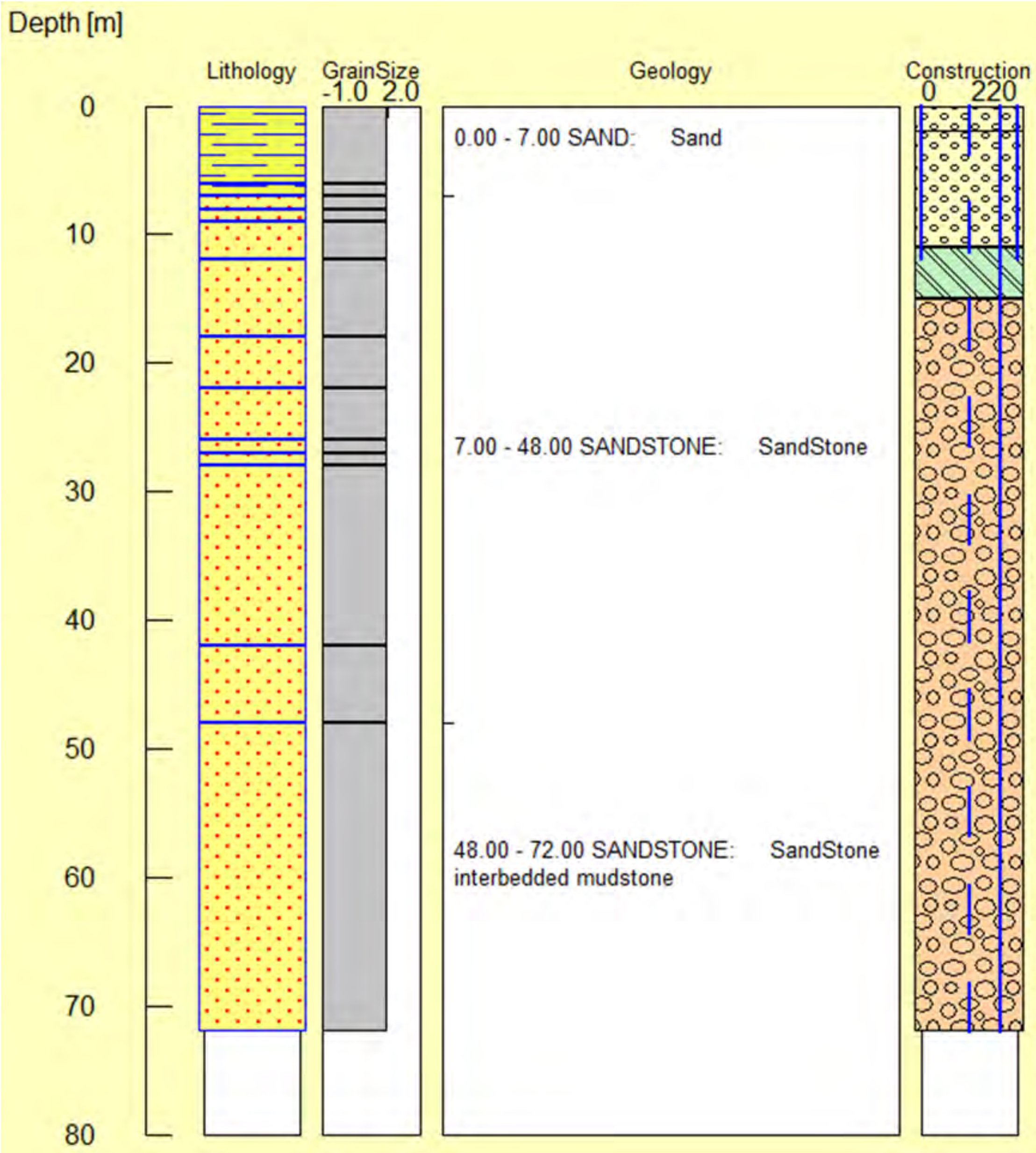

Figure 6.2 Borehole geological log and construction

6.3 Aquifer Testing

6.3.1 Aquifer Test Results

A short duration step test including recovery was done to determine a sustainable rate to perform a 24 hour constant rate test. The following steps were used:

- Step 1 & 2 at 0.43 l/2 for 60 minutes
- Step 3 at 0.53 l/s for 30 minutes
- Step 4 at 0.74 l/s for 30 minutes

The results of the step test can be seen in Figure 6.3.

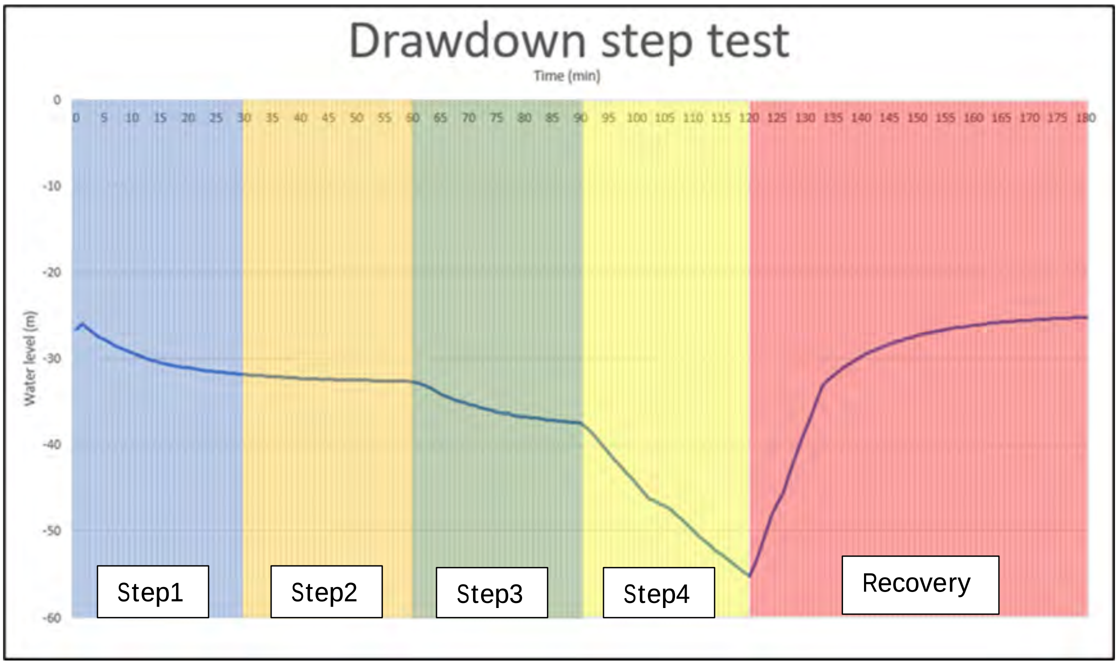

Figure 6.3 Drawdown step test

The borehole aquifer test details are presented in Table 6.2 and aquifer test results are presented in Table 6.3. The constant rate drawdown and recovery data is shown in Figure 6.4. After the first step an adjustment was made, however due to the decrease in the head, the effective discharge rate did not change and remained at 0.42 l/s. During step 4 and in the recovery an inflection in the curve can be seen at approx. 46 mbgl, indicating an additional fracture.

A constant Rate (CR) test including a recovery test was conducted for BH2. A CR test is a field experiment in which a well is pumped at a controlled rate and water-level response (drawdown) is measured. The response data from the pumping tests are used to estimate the hydraulic properties of aquifers.

Table 6.2 Aquifer test borehole details for BH2

BH ID	Coordinates		Static Water Level	Main Water Strike	Pump Inlet Depth	Borehole Depth	Test Duration
	Latitude	Longitude					
[-]	[DD]	[DD]	[mbgl]	[mbgl]	[mbgl]	[mbgl]	[hrs:min]
BH2	-23.63009	27.59390	23.98	28	68	72	24:00

The Static Water Level (SWL) of the borehole before pumping began was 23.98 mbgl with the pump inlet situated at 68 mbgl. This gave a total available drawdown of 44 meters to the pump inlet for the purposes of the test. The borehole was pumped for 24 hours at a constant rate of 0.43 l/s (1550 l/hr). The Total drawdown achieved during the 24 hours of pumping was 10.75 meters. The water level within the borehole stabilized during pumping (below the first water strike of 28 mbgl) at 34 mbgl. After pumping ceased the water level recovered to within 95 % of the static water after 2 hours and 45 minutes.

Table 6.3 Aquifer test results

BH ID	95% Recovery	Recovery	Total Drawdown	Pump Yield	Transmissivity
[-]	[%]	[%]	[m]	[l/s]	[m²/day]
BH2	02:45	95.00	10.75	0.43	4.2

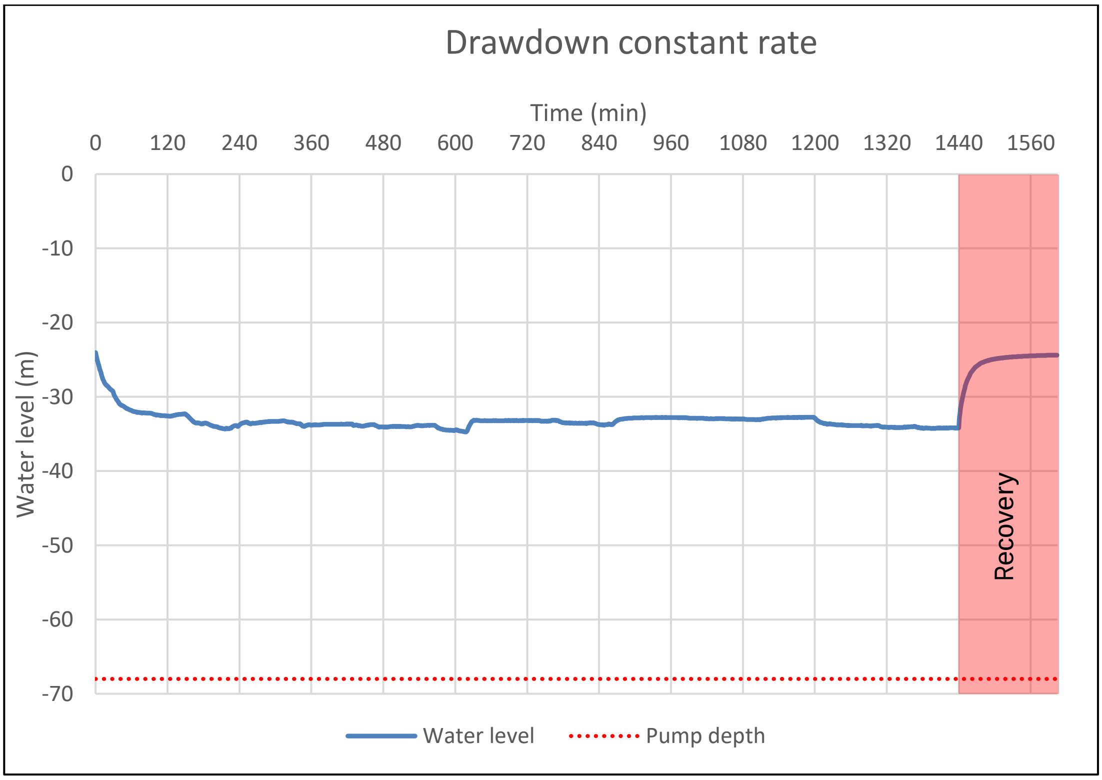

Figure 6.4 Constant rate drawdown and recovery

6.3.2 Aquifer Test Analysis

The aquifer test data was analysed with using FC method. The FC Method was developed by the Institute for Groundwater Studies, University of the Free State (Van Tonder et al. 2001). The transmissivity is defined as the measure of the ease with which water will pass through the earth's material; expressed as the product of the average hydraulic conductivity and thickness of the saturated portion of an aquifer. It therefore indicates the ease with which water moves through the subsurface and is used to calculate rates of groundwater movement. The transmissivity in the borehole was calculated to be 4.2 m^2/day using the FC Method.

6.3.3 Pumping Schedule

Based on the aquifer test data the recommended pumping schedule can be seen summarized in Table 6.4 below. It is recommended that the pump inlet be installed at 68 mbgl and that the borehole be pumped at a yield of 0.42 L/s (1500 L/hr) for 12 hours and left to recover for at least 12 hours before pumping commences again. Given this pumping schedule the total volume of water that can be abstracted per day is 18 000 L/day (18.0 m^3 /day).

Table 6.4 Pumping schedule

BH ID	Pump Depth	Pump Cycle	Recovery Time	Recommended Yield		
[-]	[mbgl]	[hrs]	[hrs]	[l/s]	[l/hr]	[l/d]
BH2	68	12	12	0.42	1500	18000

6.4 Impact Assessment

The following methodology was used to rank potential impacts. Clearly defined ranking scales were used to assess the impacts associated with the proposed activities.

Each impact identified was rated according to the expected magnitude, duration, scale and probability of the impact (refer to Table 6.12). Each impact identified was assessed in terms of scale (spatial scale), magnitude (severity) and duration (temporal scale). Consequence is then determined as follows:

Consequence = Severity + Spatial Scale + Duration

The Risk of the activity is then calculated based on frequency of the activity and impact, how easily it can be detected and whether the activity is governed by legislation. Thus:

Likelihood = Frequency of activity + frequency of impact + legal issues + detection

The risk is then based on the consequence and likelihood.

Risk = Consequence x likelihood

In order to assess each of these factors for each impact, the ranking scales in Table 6.5 to Table 6.11 were used.

Table 6.5: Severity

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful / within a regulated sensitive area	5

Table 6.6: Spatial Scale - How big is the area that the aspect is impacting on?

Area specific (at impact site)	1
Whole site (entire surface of site)	2
Local (within 5km)	3
Regional / neighbouring areas (5km to 50km)	4
National	5

Table 6.7: Duration

One day to one month (immediate)	1
One month to one year (Short term)	2
One year to 10 years (medium term)	3
Life of the activity (long term)	4
Beyond life of the activity	5

Table 6.8: Frequency of the activity - How often do you do the specific activity?

Annual or less	1
Bi-annually	2
Monthly	3
Weekly	4
Daily	5

Table 6.9: Frequency of the incident/impact - How often does the activity impact the environment?

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitively / >100%	5

Table 6.10: Legal issues - How is the activity governed by legislation?

No legislation	1
Fully governed by legislation	5

Table 6.11: Detection - How quickly/easily can the impacts/risks of the activity be detected on the environment, people and property?

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Environmental effects will be rated as either of high, moderate or low significance on the basis provided in **Error! Reference source not found.**.

Table 6.12: Impact Ratings

Rating	Class
1-55	(L) Low Risk
56 - 169	(M) Moderate Risk
170 - 600	(H) High Risk

6.5 Impact Assessment Results

The impact assessment results are summarized in Table 6.13 Lowering of regional groundwater levels within the aquifer may be mitigated by keeping to the recommended pumping schedule.

Table 6.13 Impact assessment results

Impact description					Significance before mitigation	Significance after mitigation	Mitigation measures	Responsible Person
No.	Phases	Activity	Aspect	Impact				
1	Operation	Groundwater Abstraction from BH2	Lowering of groundwater levels	Lowering of regional groundwater levels within the aquifer	M	M	Adhere to pumping schedule and amendment of schedule by hydrogeologist, if necessary. Monitoring of the groundwater levels and quality of the surrounding monitoring boreholes and the production and reserve boreholes.	On site environmental representative

6.6 Sampling and Chemical Analysis

Groundwater samples were collected from BH2 and submitted to an accredited laboratory for inorganic analysis, as presented in Table 6.14. the following analyses were performed:

- Metals: Na, K, Ca, Mg, Al, As, Cd, Cr, Cu, Fe, Pb, Mn, & Zn;
- Chemical oxygen demand Total dissolved solids, pH, Electrical conductivity, Total hardness and suspended solids;
- Nitrate, Chloride, Sulphate;

The laboratory certificate is attached in Appendix B.

Table 6.14 Laboratory results from inorganic analysis

Analyte Name	Units	BH2	Standard target industrial (CAT3)	Domestic
Bicarbonate Alkalinity as CaCO3	mg/l	70	300	
Carbonate Alkalinity as CaCO3	mg/l	<12		
Total Alkalinity as CaCO3	mg/l	70	300	
Conductivity in mS/m @ 25ºC	mS/m	35	70	70
TDS (0.7µm) @ 105ºC	mg/l	240	450	450
TSS (0.7µm) @ 105ºC	mg/l	44	5	
Calcium	mg/l	16		100
Ca hardness as CaCO3	mg/l	40		
Iron	mg/l	<0.05	0.3	0.1
Potassium	mg/l	9		50
Magnesium	mg/l	6.5		30
Mg hardness as CaCO3	mg/l	27		
Sodium	mg/l	41		100
Silicon	mg/l	15	0-20	
Total hardness as CaCO3	mg/l	66	250	50-100
Zinc	mg/l	<0.01		3
Aluminium	mg/l	<0.003		0.15
Arsenic	mg/l	<0.0005		10
Cadmium	mg/l	<0.0001		5
Chromium	mg/l	0.006		
Copper	mg/l	0.001		1
Manganese	mg/l	<0.002	0.2	0.05
Lead	mg/l	<0.0005		10
Hexavalent Chromium	mg/l	<0.02		0.05
Chloride	mg/l	56	100	100
Nitrate	mg/l	15		6
Sulphate	mg/l	0.67	200	200
pH in water at 25ºC	-	6.5	6.5-8.0	6.0-9.0
Chemical oxygen demand	mg/l as O2	<5.10	30	
Mercury	µg/l	0.001		1

The sample was compared to the following standards / guidelines:

- Department of Water Affairs & Forestry (DWAF). 1996a. South African Water Quality Guidelines volume 1 - Domestic use Second Edition, 1996
- Department of Water Affairs & Forestry (DWAF). 1996a. South African Water Quality Guidelines Volume 3: Industrial use Second Edition, 1996

It was found that the water is suitable for industrial use when compared to the DWAF guidelines for industrial use category 3, however suspended solids were found to be high 44 mg/l. The sample was also compared to the DWAF guidelines for domestic use, however the water was found to have nitrate values in excess of the target range of 6 mg/l. The water sample showed sodium chloride to be the only dominant species. A Piper and STIFF diagrams can be seen in Figure 6.5 and Figure 6.6 below.

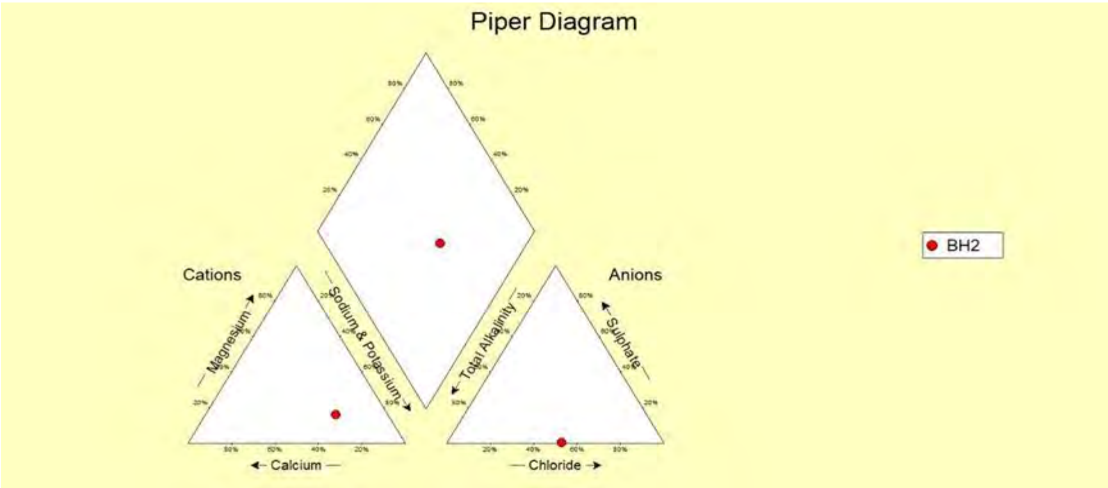

Figure 6.5 Piper diagram plot of major elements

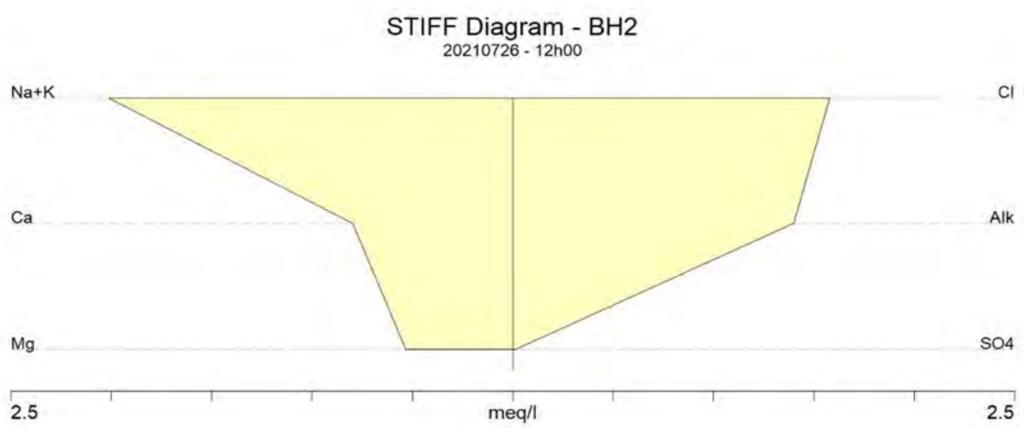

Figure 6.6 STIFF diagram plot of major elements

7 GROUNDWATER MANAGEMENT PLAN

GCS recommends the implementation of a groundwater monitoring and associated management plan of the groundwater level and quality to allow assessment of potential impacts to the groundwater system over time. The key objective of the groundwater monitoring and management is to:

- Provide specific and reliable data on the water level and quality of the groundwater; and
- Provide consistent data system for oversight on contamination or excessive aquifer drawdown.

Groundwater Level Monitoring

Routine monitoring of groundwater levels of the sites production boreholes will be required this is important to:

- Assess borehole performance; and
- Assess adherence to statutory water management license conditions and potential effects on the surrounding environment.

Groundwater level monitoring should be undertaken at a frequency as recommended by the DWS; however, at a minimum, levels should be recorded at a monthly basis.

Groundwater Quality Monitoring

Monitoring of the groundwater quality of the abstraction borehole should be conducted at a quarterly frequency and analysed at a South African National Accreditation System accredited laboratory. Table 7.2 summarises the analytical parameters the collected groundwater samples should be analysed for as a minimum.

Parameters of existing monitoring at the slimes dam facility site (location as per the client see Figure 5.2) found levels as listed in Table 7.1.

Table 7.1 Levels of determinants currently being monitored

Parameter	**WBR01**		**WBR07**		**WBR38**	
	Min	Max	Min	Max	Min	Max
Nitrate	1.97	17.7	0.03	700	0.013	70.7
Sulfate	2	10	0.3	700	9	700
Chloride	20	30	6	60	30	2000
Fluoride	0.088	0.51	0.022	0.95	0.042	6.5
Magnesium	20	0	1	80	30	200
Sodium	30	60	20	100	50	700
Calcium	30	50	30	300	30	300
Electrical Conductance	38	45	11	140	98	630
pH	7.4	8.5	6.6	8.3	2.7	8.4

Table 7.2 Analytical parameters that should be monitored

Analyte Name	Units
Bicarbonate Alkalinity as CaCO3	mg/l
Total Alkalinity as CaCO3	mg/l
Calcium	mg/l
Ca hardness as CaCO3	mg/l
Iron	mg/l
Potassium	mg/l
Manganese	mg/l
Magnesium	mg/l
Mg hardness as CaCO3	mg/l
Sodium	mg/l
Total hardness as CaCO3	mg/l
Chloride	mg/l
Nitrate	mg/l
Sulphate	mg/l
pH in water at 25ºC	-
Conductivity in mS/m @ 25ºC	mS/m
TDS (0.7µm) @ 105ºC	mg/l
TSS (0.7µm) @ 105ºC	mg/l

Abstraction Monitoring

Monitoring of abstraction from the production borehole should also be undertaken for regular assessment of borehole sustainability (in comparison with groundwater levels) and for applicable compliance reporting.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 General

The site is located situated approximately 20 km West of the town of Lephalale and falls within the Lephalale Local Municipality area, Waterberg District Municipality in the Limpopo Province. Rainfall data gathered from the WARMS database indicates a total of 428.3 mm of rainfall in the region.

The study area is underlain by sedimentary rocks consisting of sandy soils, cream colored sandstones and red mudstones of the Vaalwater formation. Based on available data, the production borehole BH2 intersect the fractured to semi fractured sandstone aquifers,

Aquifer testing was conducted for BH2 by GCS and analysed accordingly. Based on the analysis of the aquifer tests total volume of 18 m^3/day can be abstracted from BH2. The borehole can be abstracted for 12 hours, with a 12 hour recovery period. Abstraction of BH2 should not exceed 18 m^3/day, and the borehole should have a minimum recovery period of 12 hours.

Laboratory water quality results revealed that no constituents analysed for BH2 exceeded DWAF guidelines for water used for industrial purposes for category 3 activities.

A groundwater balance was prepared for the sub-catchment, which evaluated all major resource input and outputs. The theoretical groundwater reserve indicates that sufficient water is available for abstraction to meet the water requirement of 2920 m^3/annum.

8.2 Field investigation:

Aquifer testing was conducted for BH2 by GCS and analysed accordingly.

Groundwater level drawdown within the well could be approximately 10.75 m.

Based on the analysis of the aquifer tests and informed by the analytical model, a total volume of 18 m^3/day can be abstracted from BH2. The borehole can be abstracted for 12 hours, with a 12 hour recovery period.

Abstraction of BH2 should not exceed 18 m^3/day, and the borehole should have a minimum recovery period of 12 hours.

Groundwater Quality:

Laboratory water quality results revealed that no constituents analysed for BH2 exceeded DWAF guidelines for water used for industrial purposes for category 3 activities.

Groundwater Reserve Determination:

A groundwater balance was prepared for the sub-catchment, which evaluated all major resource input and outputs. The theoretical groundwater reserve indicates that sufficient water is available for abstraction to meet the water requirement of 2920 m^3/annum.

Groundwater Impact:

The impact of abstraction by lowering of regional groundwater levels within the aquifer may be mitigated by keeping to the recommended pumping schedule.

Recommendations:

It is recommended that the groundwater levels and hydrochemistry of the boreholes are monitored as per the groundwater management plan

Water should be used sparingly, and all leaks and faulty reticulation should be attended to as soon as detected.

The data collected from monitoring must be interpreted by a hydrogeologist in order to assess long-term impacts of abstraction.

It is imperative that drawdown within BH2 does not exceed 20 m (with a static water level of 44 mbgl), in order to reduce the likelihood of dewatering the fractures (Section 6.3) in the aquifer and only at the prescribed pumping rate or lower.

It is recommended that the abstraction (pumping) schedule be re-evaluated on an annual basis.

It is recommended that an additional backup borehole be commissioned.

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APPENDIX A - GEOPHYSICAL SURVEY

exxaro
POWERING POSSIBILITY

GROUND MAGNETIC AND ELECTROMAGNETIC SURVEYS FOR APPELVLAKTE BOREHOLE SITING

by

P.J. MAHANYELE

JUNE 2021

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1. INTRODUCTION

At the request of Mr. Reynie Reyneke, a ground magnetic (mag) and electromagnetic (EM) surveys were done at Appelvlakte farm near Grootegeluk mine in Lephalale. The field work was done by P.J. Mahanyele in June 2021. One profile of 1360m was using both the mag and EM methods. Figure 1 shows the locality of the profiles. It must be borne in mind that these methods do not indicate the presence of water, but rather map the geological structures which are the possible conduits for groundwater.

2. OBJECTIVES

The objective of the survey was to site boreholes to be be drilled for groundwater for possible domestic use.

3. FIELD WORK

Data were collected on a 10m interval (stations) along the prolfile for EM. A 100m measuring tape was used to determine the stations. A hand held GPS was used to mark all the stations for the positions. For the mag survey a walkmag magnetometer with an in-built GPS was used for data collection (continuous data sampling takes place).

Magnetic method

The Magnetic survey measures the magnitude and orientation of the Earth's magnetic field. Geological structures such as faults, lithological contacts and dykes may produce small magnetic fields that distort the main magnetic field of the Earth. Such a disturbance is called a magnetic anomaly. Groundwater is associated with such geological structures and delineating the geological structures helps in optimising the selection of drilling positions for possible occurrence of groundwater.

Electromagnetic method

The EM survey was done using a Geonics EM34 conductivity meter. This is a frequency domain electromagnetic system, using a transmitter coil and a receiver coil separated by 10m, 20m, or 40m cable, depending on the operating frequency being used. The instrument can be operated in a vertical loop (VL) and horizontal loop (HL) mode. The VL is also known as horizontal dipole and the HL as vertical dipole. Figure 2 shows the loop orientations.

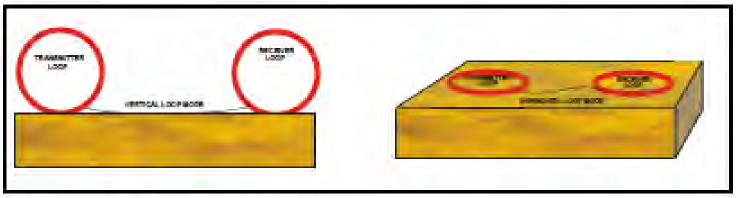

Figure 2: EM34 operating modes

The investigation depth is determined by the loop separation as well as the loop orientation. Approximate investigation depths are shown in table 1.

Table 1: Investigation depths of the EM34

COIL SEPARATION	DEPTHS VERTICAL LOOPS	DEPTHS HORIZONTAL LOOPS
10m	7m	14m
20m	15m	30m
40m	30m	60m

The instrument is designed and calibrated to give values of the subsurface electrical conductivities as a read-out. Measurements were taken at a 10m station spacing utilizing both vertical and horizontal modes of operation and a 20m coil spacing.

4. DATA PRESENTATION

Combined conductivity and mag profile data are shown in Figure 2.

5. RESULTS AND DATA DISCUSSION

Mag

Waterberg coalfield is known to be generally magnetically "quiet". That means there is less magnetic acitivity in the area. That can be oberved in the dataset (Figure 2) as there are no significant magnetic anomalies to target for structural interpretation. As such only the EM data were considered for siting of the boreholes.

EM

The EM data show conductivity increasing gradually from south to north on both the vertical and horizontal dipole data (Figure 3). A slightly resistive anomay on the edge of a higher conductive zone is observed at a distance of ~540m. This is the main distinct anomaly along the profile and will be a priority drilling position 1.

There are other less prominent anomalies, with the promising one being at a distance of 1300m. This will be marked as priority drilling position 2.

6. CONCLUSION AND RECOMMENDATIONS

A significant anomaly is observed on the EM data, with the other less prominent anomalies observed along the profile. The anomalies on the magnetic data were less prominent and as such the proposed drilling positions were based on the EM data. This area is known for its dryness, therefore it must be borne in mind that the interpreted anomalies may not contain groundwater. Table 2 shows the coordinates of the recommended drilling positions.

Table 2: Proposed borehole drilling positions

Priority drilling position	Latitude	Longitude
1	-23.6300967	27.5938975
2	-23.6238028	27.5910480

Submitted respectfully by

P.J. Mahanyele

4

Figure 1. Locality map.

5

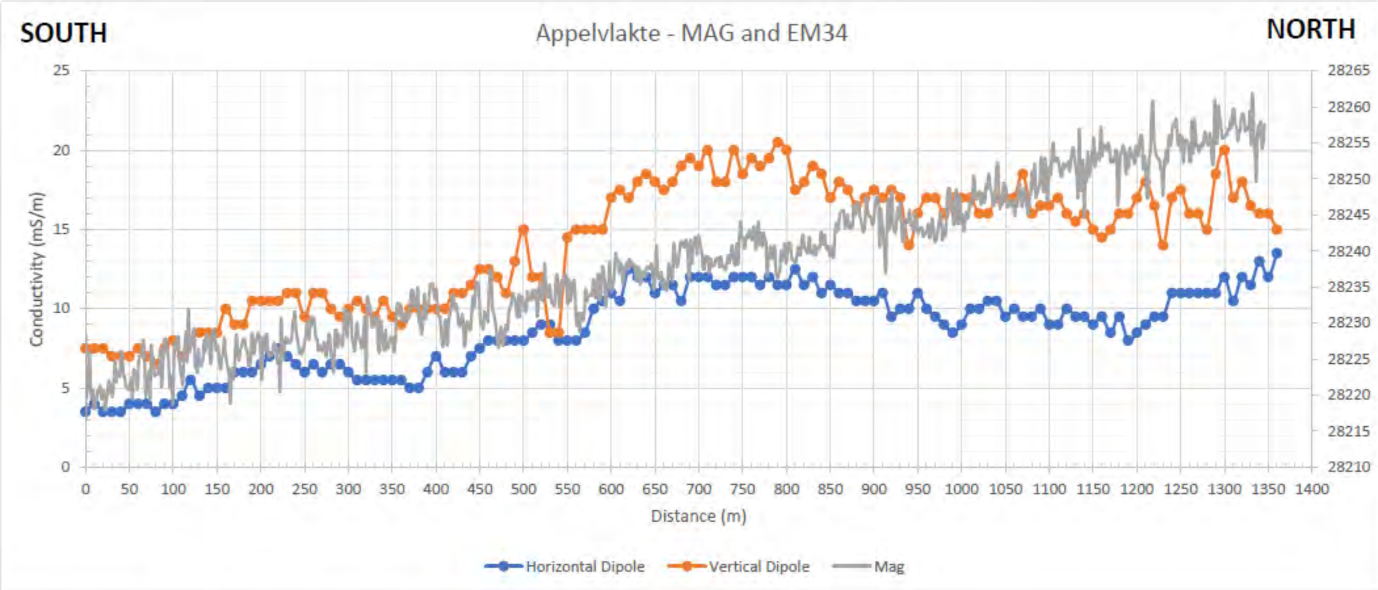

Figure 3. Mag and EM data plots.

6

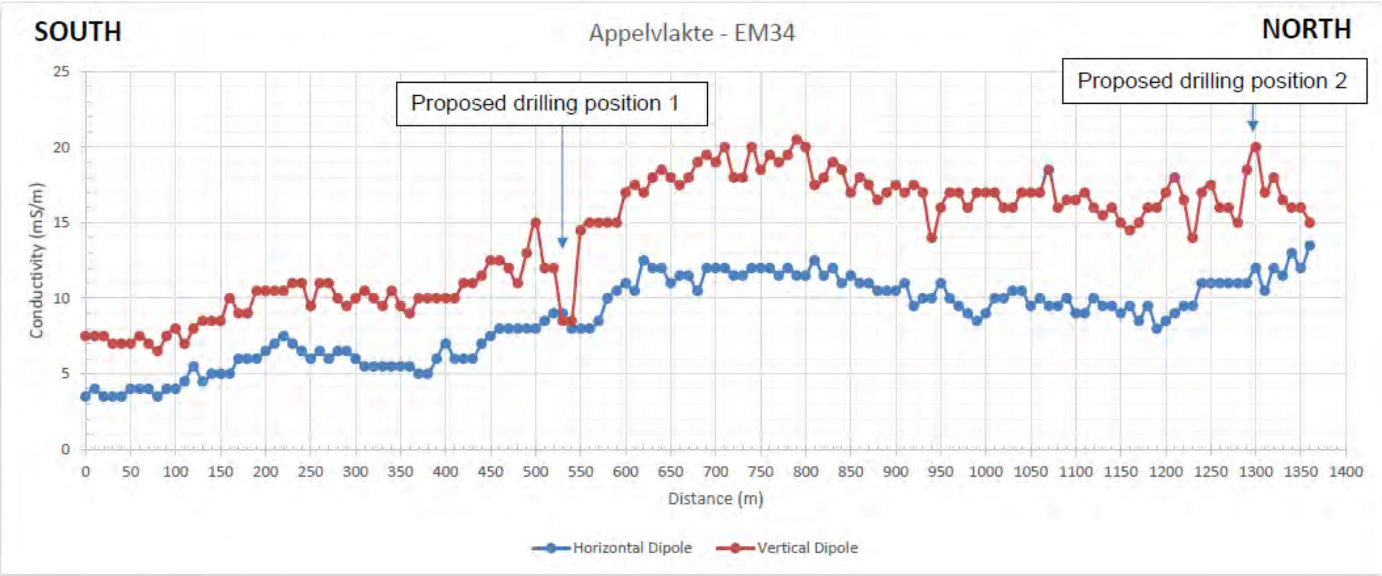

Figure 4. EM data plot.

APPENDIX B - CHEMICAL ANALYSIS

X-LAB EARTH

TEST REPORT

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Andries	Laboratory	X-Lab Earth Science
Client	GCS - GROUNDWATER CONSULTING SERVICES (PTY) LTD	Address	259 Kent Avenue Ferndale, 2194
Address	4a Old Main Road Judges Walk Kloof	Telephone	+27 (0)11 590 3000
		Laboratory Manager	Mrs Tasneem Tagari
Telephone		Lab Reference	JBX21-9275
Facsimile		Report Number	0000029100
Email	andriesw@gcs-sa.biz	Date Received	26/07/2021 16:24
Order Number	21-0037	Date Started	28/07/2021 7:45
Samples	1	Date Reported	30/07/2021 16:08
Sample matrix	AIR		

The document is issued in accordance with SANAS's accreditation requirements.
Accredited for compliance with ISO/IEC 17025. SANAS accredited laboratory T0107.

Samples recieved at ambient temp good condition.

ilac-MRA sanas Testing Laboratory T0775

SIGNATORIES

Tasneem Tagari

General Manager/Technical Signatory

X-Lab Earth Science (Pty) Ltd www.xlab.earth LAB-QLT-REP-001

X-LAB EARTH

JBX21-9275

Report number 0000029100
Client reference:
21-0037

TEST REPORT

Parameter	Units	LOR	Sample Number JBX21-9275.001 Sample Name APVL1

Alkalinity on waters by titration Method: ME-AN-001

Total Alkalinity as CaCO3	mg/l	12	70
Bicarbonate Alkalinity as CaCO3	mg/l	12	70
Carbonate Alkalinity as CaCO3	mg/l	12	<12

Conductivity on waters Method: ME-AN-007

Conductivity in mS/m @ 25°C	mS/m	2	35

Total Dissolved Solids (TDS) in water at 105 deg Method: ME-AN-011

TDS (0.7µm) @ 105°C	mg/l	21	240

Total Suspended Solids Method: ME-AN-009

TSS (0.7µm) @ 105°C	mg/l	21	44

ICP-OES Metals on waters (Dissolved) Method: ME-AN-027

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X-LAB EARTH

JBX21-9275

Report number 0000029100
Client reference:
21-0037

TEST REPORT

Parameter	Units	LOR	Sample Number JBX21-9275.001 Sample Name APVL1
ICP-OES Metals on waters (Dissolved) Method: ME-AN-027 (continued)			
Ca hardness as CaCO3	mg/l	1.4	40
Calcium	mg/l	0.5	16
Iron	mg/l	0.05	<0.05
Magnesium	mg/l	0.01	6.5
Mg hardness as CaCO3	mg/l	0.05	27
Potassium	mg/l	0.2	9.0
Silicon	mg/l	1	16
Sodium	mg/l	0.5	41
Total hardness as CaCO3	mg/l	1.5	66
Zinc	mg/l	0.01	<0.01
ICP-MS Metals on waters (Dissolved) Method: ME-AN-026			
Aluminium	mg/l	0.003	<0.003
Arsenic	mg/l	0.0005	<0.0005
Cadmium	mg/l	0.0001	<0.0001
Chromium	mg/l	0.002	0.006
Copper	mg/l	0.0009	0.0010
Lead	mg/l	0.0005	<0.0005
Manganese	mg/l	0.002	<0.002
Hexavalent Chromium by Discrete Analyser Method: MS_EN_ME-AN-040			
Hexavalent Chromium	mg/l	0.02	<0.02

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X-LAB EARTH

JBX21-9275

Report number 0000029100

Client reference: 21-0037

TEST REPORT

Parameter	Units	LOR	Sample Number JBX21-9275.001 Sample Name APVL1

Anions on Waters by Ion Chromatography Method: ME-AN-014

Chloride	mg/l	0.05	56
Nitrate	mg/l	0.1	15
Sulphate	mg/l	0.05	0.67

pH in water Method: ME-AN-016

pH in water at 25ºC	-	1	6.5

SUB_Chemcial Oxygen Demand in Water

Chemical oxygen demand ^*	mg/l as O2	5.1	<5.10

Dissolved Hg on waters by ICP-MS Method: ME-AN-026

Mercury	µg/l	0.001	0.001

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X-LAB EARTH

JBX21-9275

Report number 0000029100

Client reference:

21-0037

METHOD SUMMARY

METHOD	METHOD SUMMARY
ME-AN-009	Total suspended solids (TSS) is determined gravimetrically by filtering an aliquot of well-shaken aqueous sample through a pre-weighed filter which is then dried at 105 deg C. The method is based on APHA 2540 D.
ME-AN-016	The pH of an aliquot of aqueous sample is measured electrometrically using an electrode connected to a calibrated meter with automated temperature correction. This method is based on APHA 4500-H B.
ME-AN-007	The conductivity of an aliquot of aqueous sample is measured electrometrically using a standard cell connected to a calibrated meter with automated temperature correction. This method is based on APHA 2510.
ME-AN-011	Total dissolved solids (TDS) is determined gravimetrically on a filtered aliquot of aqueous sample by evaporating the sample to dryness in a pre-weighed container at 105 deg C. The method is based on APHA 2540 C.
ME-AN-027	Dissolved metals are determined on a filtered and acidified (to 1% HNO3) portion of aqueous sample by inductively coupled plasma optical emission spectrometry (ICP-OES). The method is based on EPA 200.7 and APHA 3120.
ME-AN-026	Dissolved metals are determined on a filtered and acidified (to 1% HNO3) portion of aqueous sample by inductively coupled plasma mass spectrometry (ICP-MS). The method is based on EPA 200.8 and APHA 3030 B.
ME-AN-026	Dissolved Hg on waters by ICP-MS
ME-AN-001	An aliquot of aqueous sample is titrated first to pH 8.3 and then to 4.3 using standardised acid. The volumes of acid titrated are used to calculate total alkalinity and/or alkaline species. The method is based on EPA 310.2 and APHA 2320 B.
ME-AN-040	Hexavalent chromium, when reacted with diphenylcarbizide in acid solution, produces a red-violet colour which is measured photometrically at wavelength 540 nm.
ME-AN-014	Inorganic anions (Br, Cl, F, NO3, NO2, SO4) are determined on aqueous samples by ion chromatography. The method is based on EPA 300.1 and APHA 4110 B.

FOOTNOTES

IS	Insufficient sample for analysis.	QFH	QC result is above the upper tolerance
LNR	Sample listed, but not received.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
LOR	Limit of Reporting	*	Results marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this laboratory / certification body / inspection body".

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Unless otherwise indicated, samples were received in containers fit for purpose.

LAB-QLT-REP-001

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APPENDIX E5: HYDROLOGICAL INVESTIGATION

63 Wessel Road, Rivonia, 2128 PO Box 2597, Rivonia, 2128 South Africa
Tel: +27 (0) 11 803 5726 **Fax:** +27 (0) 11 803 5745 **Web:** www.gcs-sa.biz

Lephalale Solar Project Surface Water Study as part of the Water Use License Application and Environmental Impact Assessment

Report

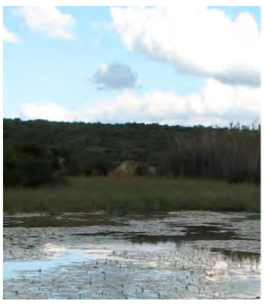
Version - 3

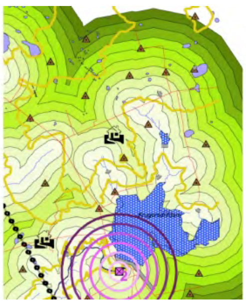
08 March 2022

GCS Project Number: 21-0037

Client Reference: Lephalale Solar Surface Water

K2021699383 (South Africa) (PTY) LTD



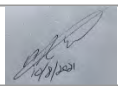
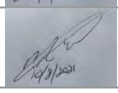




Lephalale Solar Project Surface Water Study
Report
Version - 3

K2021699383 (South Africa) (PTY) LTD

12 November 2021

DOCUMENT ISSUE STATUS

Report Issue	Version 3 – Report updated with internal comments		
GCS Reference Number	21-0037		
Client Reference	Lephalale Solar Surface Water		
Zutari Ref No.	1001395-G040-REP-NN-008		
Title	Lephalale Solar Project Surface Water Study as part of the Water Use License Application and Environmental Impact Assessment		
	Name	**Signature**	**Date**
Author	Jennifer Meneghelli	JMeneghelli	13 August 2021
Document Reviewer	Andries Wilke		11 August 2021
Director	Andries Wilke		11 August 2021

EXECUTIVE SUMMARY

K2021699383 (South Africa) (Pty) LTD appointed GCS Water and Environment Consultancy (Pty) Ltd to carry out a surface water assessment of the proposed site for solar plant development to be used for water use license application (WULA) and the environmental impact assessment. The solar project is planned to be located on farm Appelvlakte 448, east of the existing Grootegeluk mine discard dumps.

The site lies in quaternary catchment A42J which has a relatively low MAP of 428 mm/a with a high evaporation of 1 949 mm/a. The SAWS rainfall station Tambootivlei (0673636) was identified as being most representative of site conditions and thus design rainfall depths as per this station were used for hydrological analysis. There are no permanent surface water features or drainage lines through the site, and it is undeveloped at present and in its natural state. There is an artificial pan within 500 m of the site, but it will not influence the drainage management of the site. The site is located on top of a ridge and drains in an easterly direction towards the Sandloop River.

As such, the conceptual SWMP did not need to divert any water coming from upstream catchments. The development site was divided into internal sub-catchments draining along the topography. It is assumed that the entire site is clean and that if chemicals are used for cleaning the solar panels, they will be environmentally, eco-friendly biodegradable detergents and that dust on the solar panels will only be from the surrounds, not from fall-out from the mining activities, as the wind is predominantly in a northerly direction, and the site is east of the mining operations. Dust from the surrounds will consist only of small sand particles and organic matter and will not contain any harmful chemicals that could potentially degrade water quality. The conceptual SWMP proposes that the site be allowed to free drain into the environment. This is the preferred method of management as this will avoid the concentration of flows to a single release point, which creates a risk of surface erosion. This is based on requirement of vegetation being re-established between the solar modules. The vegetation is necessary to control sedimentation and protect against erosion. If localized areas of erosion develop, these should be treated with appropriate measures such as the installation of gabions.

A water balance was determined for the construction and operational phases of the project. During construction, the borehole water yield will be inadequate to supply construction water demands, therefore raw water will be tankered in from Grootegeluk. During the operational phase, all water used by the site will come from the borehole. The borehole's yield of 18 m^3/d is greater than the predicted demand of 5.6m^3/d. A water treatment plant will treat the raw water to potable standards and also demineralise the water required for washing of the solar modules. The brine from this WTP will be collected and disposed of off-site at a suitable facility. There shall be a tank for storage of potable water and a tank for storage of demineralised water. Domestic effluent will be discharged to a buried, concrete conservancy tank, recommended to have a capacity of 25 m^3. The tank shall then be emptied weekly by tanker and disposed of off-site at an appropriate facility.

No surface water monitoring is recommended for the site as there are no permanent surface water features that can be sampled.

A hydrological risk impact assessment was carried out for the site. The largest impact is a result of converting the area from a permeable, vegetated surface into a less pervious surface. The increase in run-off volumes and frequency will negatively affect the environment. The risk of water quality degradation from impacted runoff from the site is a concern. The water quality degradation would be in the form of increased total suspended solids (sediment transport). No total dissolved solids component is anticipated based on the assumption stated previously that dirt on the solar panels will be from naturally occurring dust only, and cleaning would be by biodegradable, eco-friendly detergents. In the case of water being polluted, it would be stored and then treated prior to release. However, as stated, runoff from the site is assumed to be clean, with sediments removed by the infiltration trenches. It is therefore acceptable for the runoff to discharge from the site directly into the environment. It is also essential that during construction, sedimentation is controlled and the working area minimized.

In conclusion, the hydrological impacts of the proposed development are not significant based on the assumption that it is a clean catchment. Opportunities for water reuse and conservation should be identified during detailed design phase.

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

K2021699383 (South Africa) (Pty) LTD (the Client) proposes the development of a solar plant that will generate electricity using photovoltaic (PV) panels. The electricity produced will supplement power at the Grootegeluk coal mine in Lephalale, Limpopo province. The solar plant will be approximately 256 hectares (ha) in area and will generate approximately 100MW of power. The farm Appelvlakte 448 has been selected as the optimal location for the solar plant. The site falls within quaternary catchment A42J in the Limpopo Water Management Area (WMA). The site locality is shown in Figure 1-1.

The Client has appointed GCS Water and Environment Consultancy (Pty) Ltd (GCS) to carry out all specialist studies supporting the water use license application (WULA) and the environmental impact assessment. This study investigates surface water at the proposed site and potential impacts of the development on the local hydrology. The solar panels, substations and all associated infrastructure will be included in the assessment (i.e. all development on the footprint).

A conceptual stormwater management plan (SWMP) that identified all stormwater infrastructure requirements will be designed in this study and will ensure that run-off from the site is appropriately managed with minimal impact to the receiving environment.

A water balance of the site will be carried out. Water supply to the site will be from Grootegeluk Mine and will be stored in tanks (approximately 160kl/day for the first three months of construction, and 90 kl/day for the remainder of the construction period). During operation, water will be supplied via borehole (approximately 20 kl/day during operation). During operation, a package water treatment plant will disinfect and purify the water for potable use. The offices and security building will have ablutions, water will be piped to these facilities. The sewage from the ablutions will be collected in conservancy tanks, connected by a sewage network. The conservancy tanks will preriodically be emptied by tankers and the sewage disposed of off-site at a suitable facility.

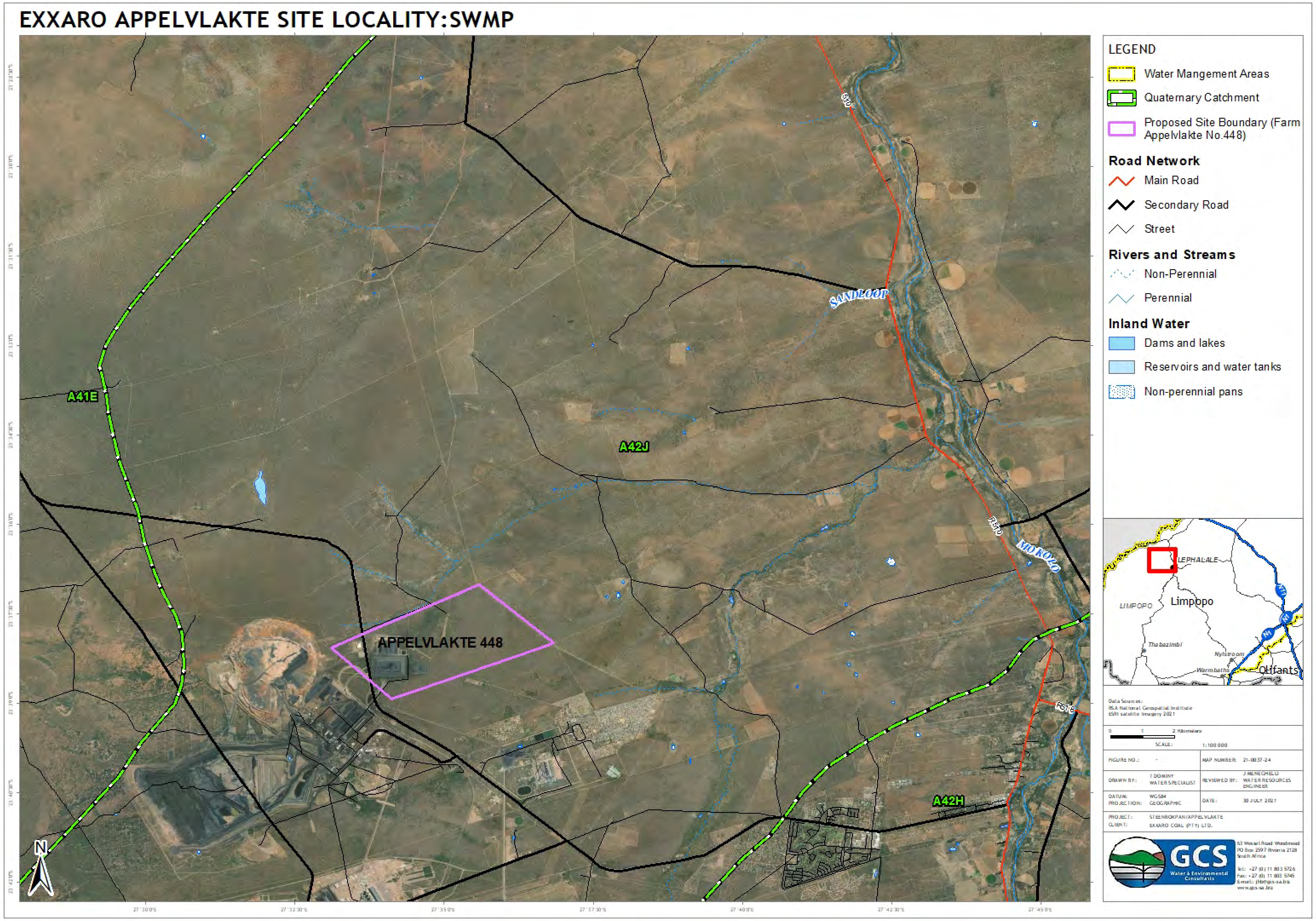


Figure 1-1 Site locality

2 SCOPE OF WORK

This study will support the Client's WULA and environmental authorisation by assessing the surface water of the site in accordance with the minimum requirements set out in Government Notice No. R. 267 of the National Water Act (Act 36 of 1998) (as amended) *Regulations regarding the procedural requirements for water use licence applications and appeals* (South Africa. Dept. of Water and Sanitation, 2017) and as per guidance in Appendix 6 of the environmental impact assessment (EIA) regulations for specialist reports, National Environmental Management Act (Act No. 107 of 1998). The Scope of Work (SoW) is comprised of the following tasks:

- Desktop study and project initiation: review previous studies done on the site, review client information and identify applicable legislation.
- Catchment characterisation and baseline hydrology assessment.
- Conceptual stormwater management plan for the site.
- Water balance for proposed infrastructure.
- Surface water monitoring program is to be specified if deemed necessary.
- Surface water impact assessment of all infrastructure including run-off impacts.
- Project report detailing findings of the study for inclusion in the WULA and EIA.

Note that floodline delineation is excluded from the scope as no defined channels run through or near the site.

3 METHODOLOGY

3.1 Information sourcing and literature review

A site investigation was carried out by the GCS hydrologist, Ms. Jennifer Meneghelli, on 16th April 2021. Drainage lines and any other surface water features, any existing infrastructure, topography, land use, vegetation, soils and surface characteristics were observed if present. Findings form the basis of this report.

The *Grootegeluk Complex Integrated Water and Waste Management Plan (IWWMP) 2019* (Exxaro, 2019) was referred to as existing data on the site area.

The *Project Description of the Lephalale Solar Project* (2021) and the preliminary site layout was provided by the Client for reference.

The following national legislation was referred to guidance on best practices with regard to the hydrological assessment:

- South African Department of Water and Sanitation (formerly the department of Water Affairs – DWA) Best Practice Guidelines G1: Storm Water Management (DWA, 2006a) and Best Practice Guidelines G2: Water and Salt Balances (DWA, 2006b).

3.2 Baseline climate and hydrology assessment

A desktop climate and hydrology assessment were completed.

The hydrological setting of the site will be defined both at a regional level – by characteristics of the quaternary catchment A42J – and at a local level. The regional hydro-meteorological data (rainfall, evaporation, temperature) will be extracted from the 2012 South African Water Resources Study (WR2012) (Bailey & Pitman, 2015). Local rainfall will be obtained from the Daily Rainfall Extraction Utility, developed by the Institute for Commercial Forestry Research (ICFR) in conjunction with the School of Bio-resources Engineering and Environmental Hydrology (BEEH) at the University of Kwa-Zulu Natal, Pietermartizburg (Kunz, 2003). This database has summary data and calculates design rainfall for many of the South African Weather Service (SAWS) rainfall stations, also those within the vicinity of the site. These values will then be used to calculate peak flow volumes. The peak flow volumes will be calculated using the Rational Method and SCS Method, as described in the SANRAL Drainage Manual (SANRAL, 2013).

3.3 Conceptual stormwater management plan

The conceptual SWMP will include the management of runoff on the site only as there are no contributing upstream catchments. The design, sizing and placement of conceptual stormwater infrastructure used relevant South African Best Practice Guidelines, described in the South African Drainage Manual (SANRAL, 2013). Sizing and modelling of the SWMP was undertaken using PCSWMM software (Chiwater, 2017).

The conceptual SWMP will be devised in accordance with the South African Department of Water and Sanitation (DWS) (formerly the department of Water Affairs – DWA) Best Practice Guidelines G1: Storm Water Management (DWA, 2006a).

3.4 Water balance

Process Flow Diagrams (PFD) for the site (during both construction and operational phases) were developed using information gathered from the Client’s proposed site layout and Project Description (2021). Principles of mass balance were then applied to predict the flows of water within the site. The PFD schematically indicates the sources of water, linkages between different components and losses from the system.

3.5 Surface water quality monitoring program

Based on the water flows on the site, a surface water quality and monitoring program will be suggested as part of this study to ensure that the water leaving the site is of acceptable quality to release to the environment with minimal detrimental effects.

3.6 Surface water impact assessment

Surface water impacts resulting from the hydrology of the site were predicted and quantified using a modified version of the DHSW&S Risk Assessment Matrix, adjusted for hydrological assessment. The same approach used to weight the impacts and assign value to the impacts was used.

4 LEGISLATION AND GUIDELINES

4.1 Storm water management

The South African DWS (formerly the department of Water Affairs – DWA) Best Practice Guidelines G1: Storm Water Management (DWA, 2006a) states the following general principles:

1. Keep clean water clean;
    - Route all clean water into a natural watercourse,
    - Limit the dirty water areas to the smallest area possible,
    - Ensure that the dirty water is kept separate and ensure the dirty water system has a low risk of spillage.
2. Collect and contain dirty water;
    - Dirty water should be diverted, collected and contained separately from the clean water system,
    - Containment of dirty water should minimise the impact on the clean water resources.
3. Sustainability over life cycle;
    - Stormwater measures should be sustainable over the life of operation and over different hydrological cycles.
4. Consideration of regulations and stake-holders;
    - Consideration and incorporation of stakeholders and regulatory agencies should be taken into account according to the statutory requirements.

These principles were adopted as guidelines when designing the conceptual SWMP.

4.2 Water balances

The South African DWS Best Practice Guidelines for Water and Salt Balances (DWA, 2006b) states the following general principles:

1. Clear objectives and account for the current and future situation i.e. over the life cycle of operations.
2. Where flow or concentrations of the water are not taken a calculated balance should be determined through mass balance calculations.
3. Basic principle of mass balance should be taken into account i.e. total water in is equal to total water out.

These principles were adopted as guidelines when calculating the water balance.

5 BASELINE CLIMATE AND HYDROLOGY

5.1 General climate

The climate in the Limpopo province is classified as a hot semi-arid climate (Bsh) by the Köppen-Geiger system (Climate-Data.org, 2021). The rainfall is the region is generally low, ranging from as little as 200 mm/yr to 560 mm/yr. Rainfall occurs during the summer months with the highest rainfall occurring in January while June and July are the driest months. Evaporation is estimated to range from 1 600 mm/yr in the mountainous regions to as high as 3 100 mm/yr for the WMA, which is many times higher than rainfall resulting in a net loss of water meaning that the area is arid. The Limpopo province is one of the warmest areas in South Africa with predominantly sunny conditions prevailing. Summers are warm with temperatures getting as high as 40°C and winters are mild with frost, and temperatures dropping to 0°C at night. The climate is heavily influenced by eastern wind systems, particularly tropical cyclones from the Indian Ocean coming through Mozambique (Climate of the Limpopo Basin, 2010).

5.2 Water Management Area

The site falls within quaternary catchment A42J in the Limpopo Water Management Area (WMA) (South Africa. Dept. of Water and Sanitation, 2016). The quaternary catchment has an area of 1 812 km^2.

5.3 Regional rainfall

Rainfall that is representative of site conditions is required to carry out a hydrological assessment and predict surface runoff flows that will enter the site during rainfall events. Quaternary catchment data was gathered from the WR2012 study and used as an indicator against which data from South African Weather Service (SAWS) stations was cross-compared.

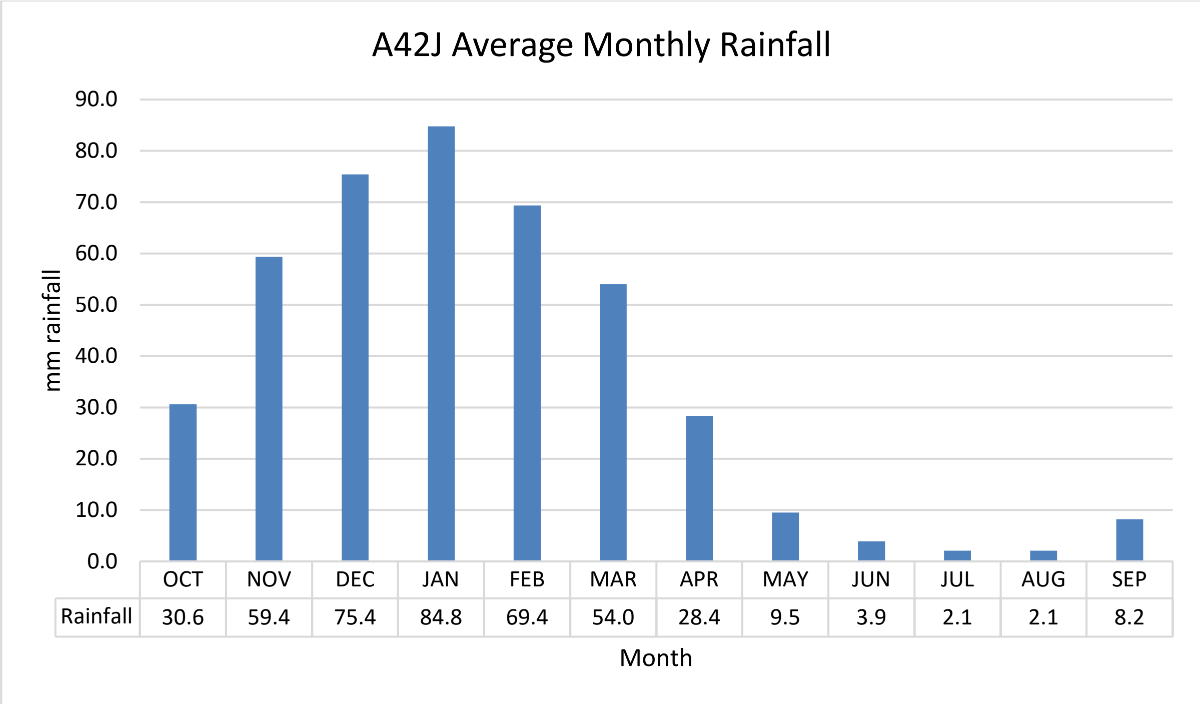


Figure 5-1 A42J average monthly rainfall

The site falls in quaternary catchment A42J, in the A4E rainfall zone and has an MAP of 428 mm/a characteristic of the arid north of the country, and on par with the MAP of South Africa of approximately 460 mm/a (World Bank Group, 2021). The catchment has a gross area of 1 812 km^2 and drains to the Sandloop then Mokolo Rivers, which subsequently drain to the Limpopo River at the downstream, northern boundary of the quaternary catchment. Average monthly rainfall data for the catchment was extracted from WR2012 by multiplying the MAP of A42J with the percentage distribution for the rainfall zone and is graphed inFigure 5-1. The catchment experiences its highest rainfall during the summer months of November to March and its dry period is during winter.

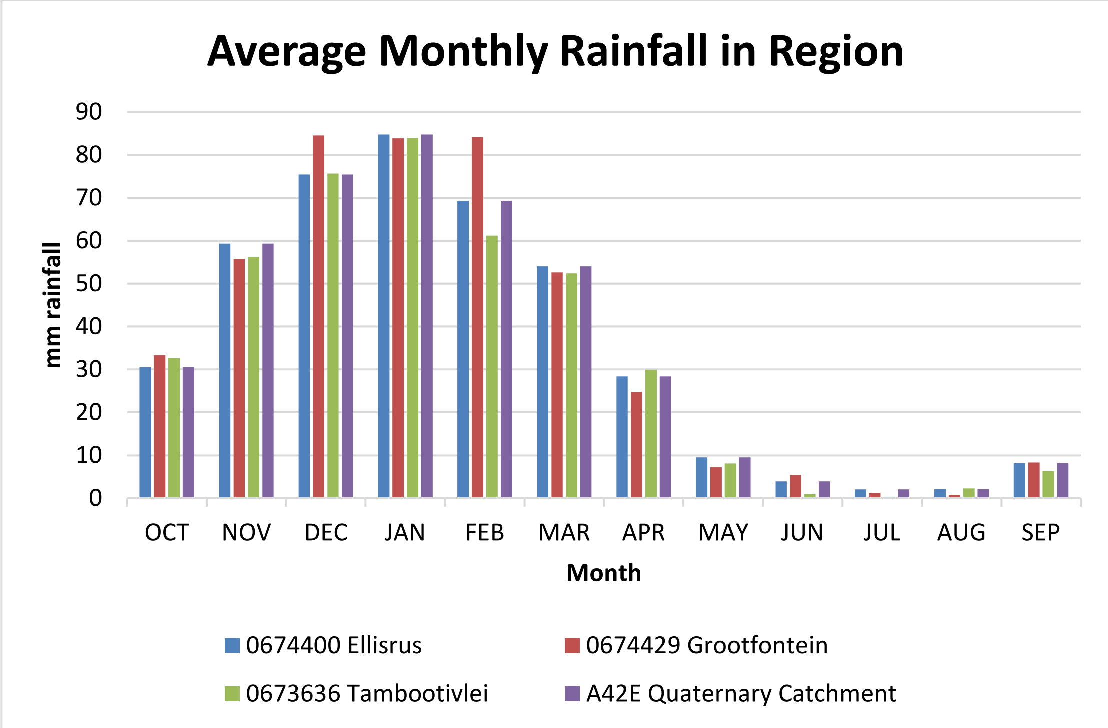
Seven South African Weather Service (SAWS) stations were identified in the vicinity of the site. There parameters are summarized in Table 5-1.

Table 5-1 SAWS stations parameters

Station name	Number	Years	MAP (mm/yr)	Altitude (mamsl)	Distance (km)	Latitude	Longitude
Site				893		23° 37’	27° 35’
Grootegeluk Mine	0674100	34	383	890	4.5	23° 40’	27° 42’
Lephalale	0674341				11.8	23° 39’	27° 33’
Ellisras Pol	0674400	31	465	820	14.5	23° 40’	27° 44’
Grootfontein	0674429	45	463	830	14.9	23° 39’	27° 44’
Tambootivlei	0673636	41	425	865	25.3	23° 36’	27° 21’
Zyferbult	0673645	43	471	945	27.5	23° 45’	27° 22’
Sterkfontein	0674207	59	519	1 060	34.4	23° 56’	27° 37’

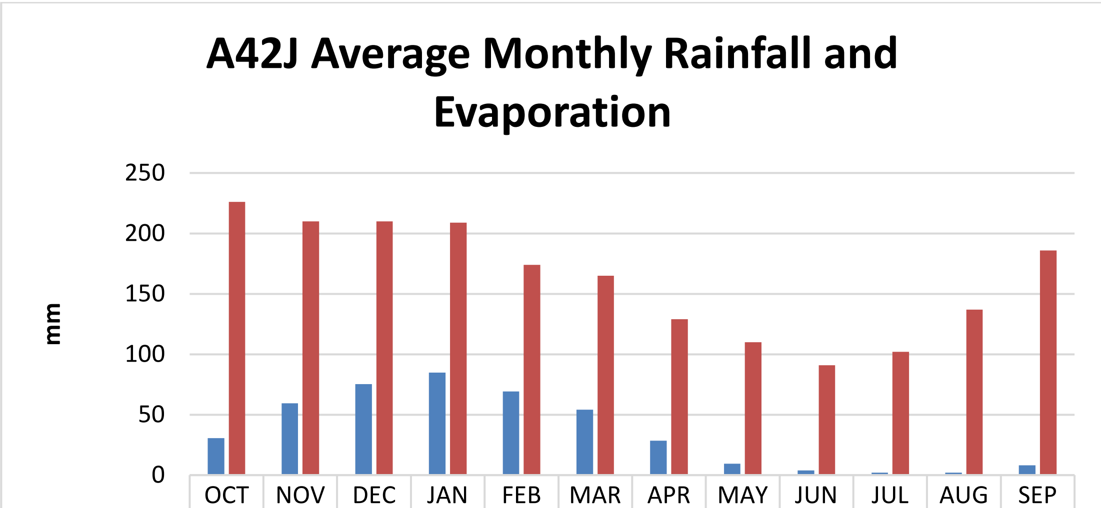
- Grootegeluk Mine is the closest station to the site and therefore most similar in altitude. However, its MAP of 383 mm/a is 10% lower than that of the quaternary catchment A42J of 428 mm/a. This is possibly due to the data collected not reflecting wet years as a result of the relatively short rainfall record of 34 years. This station was therefore not considered to be representative of the site.
- Lephalale station appears to be a recent station and data was not available for it. It was therefore excluded from the study.
- Ellisras has a short rainfall record of 31 years. However, it is within close distance of the site and its MAP of 465 mm/a better reflects that of the quaternary catchment of 428 mm/a.
- Grootfontein has very similar parameters to Ellisrus, but with a longer rainfall record of 45 years. It is deemed to be a good representation of site conditions.
- Tambootivlei is at a similar altitude to the site and is most similar to the quaternary catchment MAP at 425 mm/a. This is considered a good representation of site conditions.
- Zyferbult is at a higher altitude than the site and is quite distant at 27.5 km away, but does have a suitable MAP that in within the range of the quaternary catchment MAP.
- Sterkfontein is 34.4 km away from the site, sits at an altitude of 1 060 mamsl which is 167 m higher than the site, and has an MAP of 519 mm/a, 21% higher than that of the quaternary catchment. This station was excluded from the analysis as it is unlikely to be a good representation of site conditions.

The monthly average rainfalls for Ellisras, Grootfontein and Tambootivlei were plotted and compared (rainfall records collected from WR2012).



5.4 Evaporation

The Mean Annual Evaporation (MAE) for quaternary catchment A42J is 1 949 mm/a and the catchment falls in evaporation zone 1D. This is 4.5 times more than the MAP of 428 mm/a, indicating that this is an arid region. The comparison of monthly rainfall and evaporation for the catchment is shown in Figure 5-2.



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Rainfall	30.6	59.4	75.4	84.8	69.4	54.0	28.4	9.5	3.9	2.1	2.1	8.2
Evaporation	226	210	210	209	174	165	129	110	91	102	137	186

Figure 5-2 Average monthly rainfall and evaporation for quaternary catchment A42J

5.5 Mean Annual Runoff

The WR2012 Pitman model estimates the Mean Annual Runoff (MAR) of quaternary catchment A42J to be 5 370 000 m^3/a. This is based on calibration factors of:

- 200 mm soil moisture storage capacity.
- A subsurface flow at full soil moisture capacity of 0 mm/month.
- A maximum soil moisture recharge rate of 1 mm/month.
- A minimum catchment absorption rate of 25 mm/month.

5.6 Design rainfall depth

The design rainfall depths for the Lephalale solar study site were calculated using the Design Rainfall software for South Africa (Smithers and Schulze, 2002). The design rainfall depths for the overall site for 1:5-year, 1:10-year, 1:20-year, 1:50-year, 1:100-year and 1:200 year return periods can be seen in Table 5-2. As mentioned above, Tambootivlei SWAS was identified as the station best representing site conditions and thus was used for design rainfall events.

Table 5-2 Tambootivlei 0673636_W design rainfall depths (mm)

Duration	Return period (years)						
	2	5	10	20	50	100	200
24h	50.8	71.7	86.8	102.1	123.3	140.3	158.2
1d	46.2	65.2	78.9	92.8	112.1	127.5	143.8
2d	54.7	76.9	92.7	108.8	131.1	149.0	167.8
3d	61.5	86.1	103.1	120.1	142.9	160.6	178.8
4d	65.2	91.5	109.7	127.5	151.5	170.1	189.1
5d	69.4	97.6	117.0	136.2	161.9	181.7	202.1
6d	72.4	101.5	121.4	141.0	167.1	187.3	207.8
7d	77.3	107.7	128.2	148.0	174.1	194.0	214.0

5.7 Surface water hydrology of the site and site description

There are a number of farms surrounding the Grootegeluk mining establishment. The topography in the area is flat with very gentle undulations and low points. There are no surface water features in terms of streams. At most, depressions that may have been rivers in ancient times are identifiable. The soil is loose and sandy, with a high potential for infiltration. The vegetation is extremely dense, and made up of grasses, shrubs and trees.

5.3 km west of the study site, Sandloop River flows in a northerly direction towards the Mokolo River and then the Limpopo River. There is only one clearly identifiable tributary to the Sandloop River, and it begins (as estimated from aerial imagery) some 2.7 km from the site. During the site visit, the site and areas that appear to have possibly been drainage lines in the past were investigated, and no surface flow, evidence of scour or defined drainage channels were observed.

On the Appelvlakte 448 Farm, there is an existing Slimes dam facility that rises many metres above ground level, and there is an existing rifle range. The slimes dam has no effect on the hydrology of the remaining extent of the farm in terms of surface water. It is located 1.3 km west of the proposed solar project site. Immediately adjacent to the rifle range, an artificial pan is present, presumably constructed for the watering of game. The pan is small at no more than 10 m in diameter. The hydrological extent of influence of the pan is limited to approximately 250 m from the rifle range and 300 m downstream from the proposed development site. Therefore, it has been assumed that this feature will have no impact on the development.

Other than the abovementioned features, there is no permanent surface water or defined drainage channel on the Appelvlakte Farm.

To the south of the farm and the development boundary, lies the municipal wastewater treatment plant. This is also topographically downstream of the proposed development site and ponds are raised above ground level by berms, meaning that there will be no interaction between them and the surrounding environment. They are assumed to be lined. The WWTP is approximately 500 m south of the study site and therefore is assumed to have no influence on its hydrology.

6 CONCEPTUAL STORMWATER MANAGEMENT PLAN

6.1 Principles of the SWMP

In accordance with *Best Practice Guideline - G1: Stormwater Management* (2006) the SWMP for the site will seek to achieve certain objectives based on a philosophy of protecting the environment from impacts. This is of utmost importance as the proposed site is undeveloped. Therefore, impacts to the pristine environment should be minimised.

- Clean and dirty water should be separated, and it should be ensured that all stormwater structures are designed to keep dirty and clean water separate and can accommodate a defined precipitation event.
- The clean water catchment area should be maximised, and clean water should be routed to a natural watercourse with minimal damage to that watercourse in terms of quantity and frequency of discharge.
- Dirty areas should be minimised, and runoff from these areas contained and treated for reuse. Natural watercourses and the environment should be protected from contamination by dirty areas by ensuring that the dirty water cannot enter the clean water system by spillage or seepage.

In addition to these aims, this SWMP has the following criteria:

- Stormwater should be directed such that no water flows in an unruly fashion that may jeopardize the safety of personnel or infrastructure, or such that it is a nuisance.
- Protection of the soils by preventing erosion is also a key requirement of the SWMP.
- Minimise modification of the natural topography of the area and avoid any modification of the natural watercourses as far as possible.

In terms of *SANRAL Drainage Manual* (2013) the area is rural, with low traffic volumes providing access to individual farms and is therefore considered a Class 5 area so stormwater management infrastructure should be sized for the 1 in 10-year recurrence interval.

These objectives have guided the planning of the proposed SWMP.

6.2 Existing infrastructure

The site proposed for the solar project is completely undeveloped and has no existing infrastructure, aside from the dirt road on the boundary of the property. Therefore, all proposed surface water management infrastructure will be new and will discharge to the surrounding environment, not into existing drainage systems.

6.3 Contributing catchments

The digital elevation model (DEM) of the terrain was generated using geographical information systems (GIS) from Advanced Land Observation Satellite (ALOS) information (publicly available). This enabled the assessment of the topography of the site and it was determined that the proposed solar project area lies on a hill, of maximum elevation 892 mamsl, decreasing by 10 m in height to approximately 882 mamsl on the northern side of the site, and less in other directions. Refer to Figure 6-1 to observe the ridge on which the site is located.

The placement of the site is advantageous because this means that there are no upstream contributing catchments that must be diverted around the site. The are no drainage lines within the site that need to be accommodated. The only water that requires management is that resulting from direct rainfall onto the site. As the site is located on a ridge, surface runoff will drain away from the site over the natural topography.

As such, the subcatchments within the site have been divided according to the fall of the topography. The subcatchments and the direction of fall are indicted in Figure 6-1. Four subcatchments were identified. Their surface areas, widths, flow lengths and slopes were determined from the DEM. All subcatchments were assumed to be 100% impervious as the majority of the site will be covered with glass solar PV panels and the remainder of the site will be roofs or compacted soil. Vegetation will be re-established between the solar panels. An n-value of 0.01 was assigned to these catchments as that is the recommended value for glass.

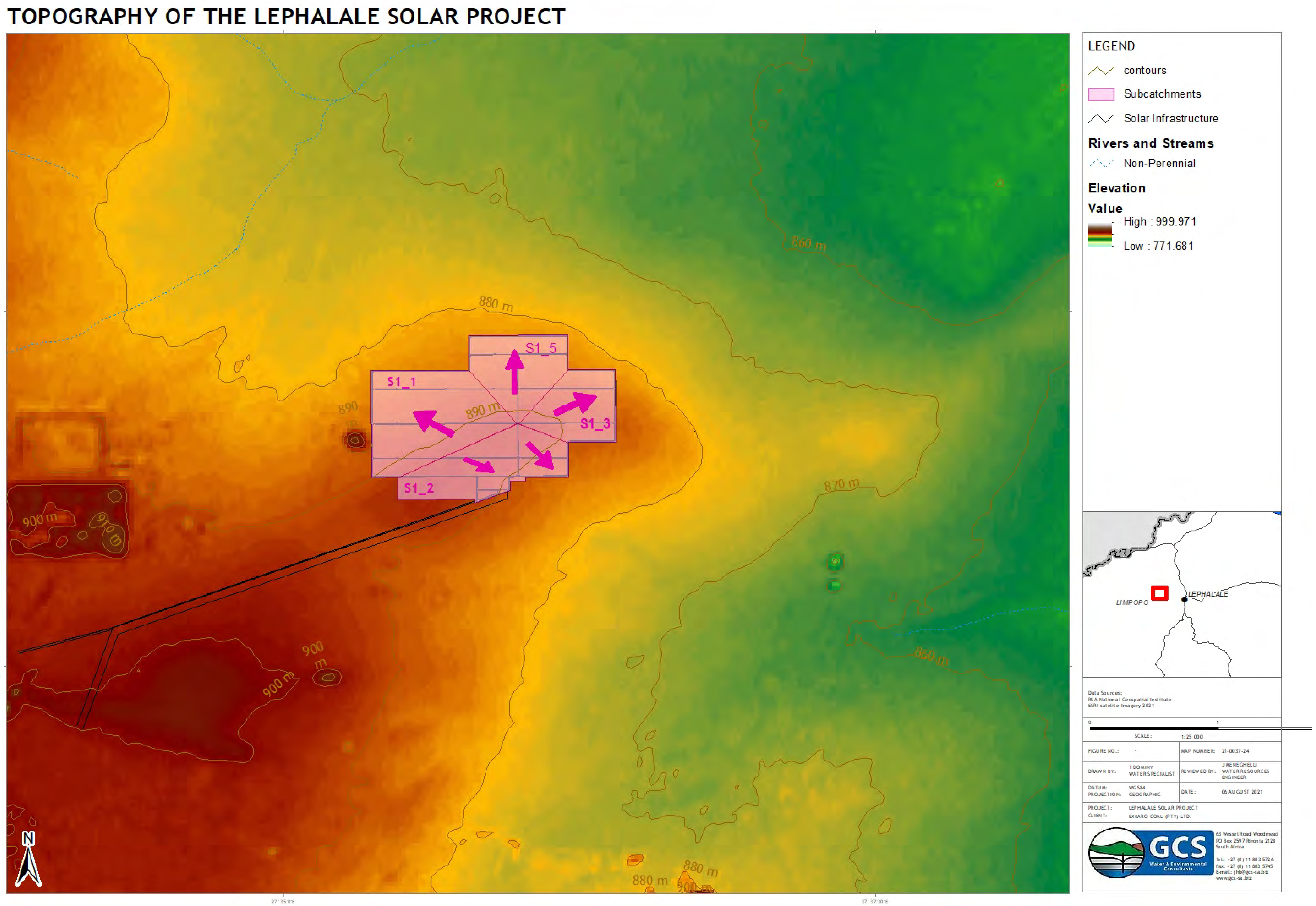


Figure 6-1 Topography of proposed solar project development site

6.4 Peak flows

Peak flows were determined by assigning the design rainfall for a 24-hour, 1:10 year return interval storm (86.8 mm of rainfall depth) to the sub-catchments in PCSWMM modeling software, using a South African SCS type III design storm. The hyetograph of the storm is shown in Figure 6-2 and the peak flow values per catchment are shown in **Error! Reference source not found.**.

The site was assumed to be 50% impervious in terms of concrete surfaces, roofs and roads and 50% pervious compacted soil with a runoff coefficient of 0.5.

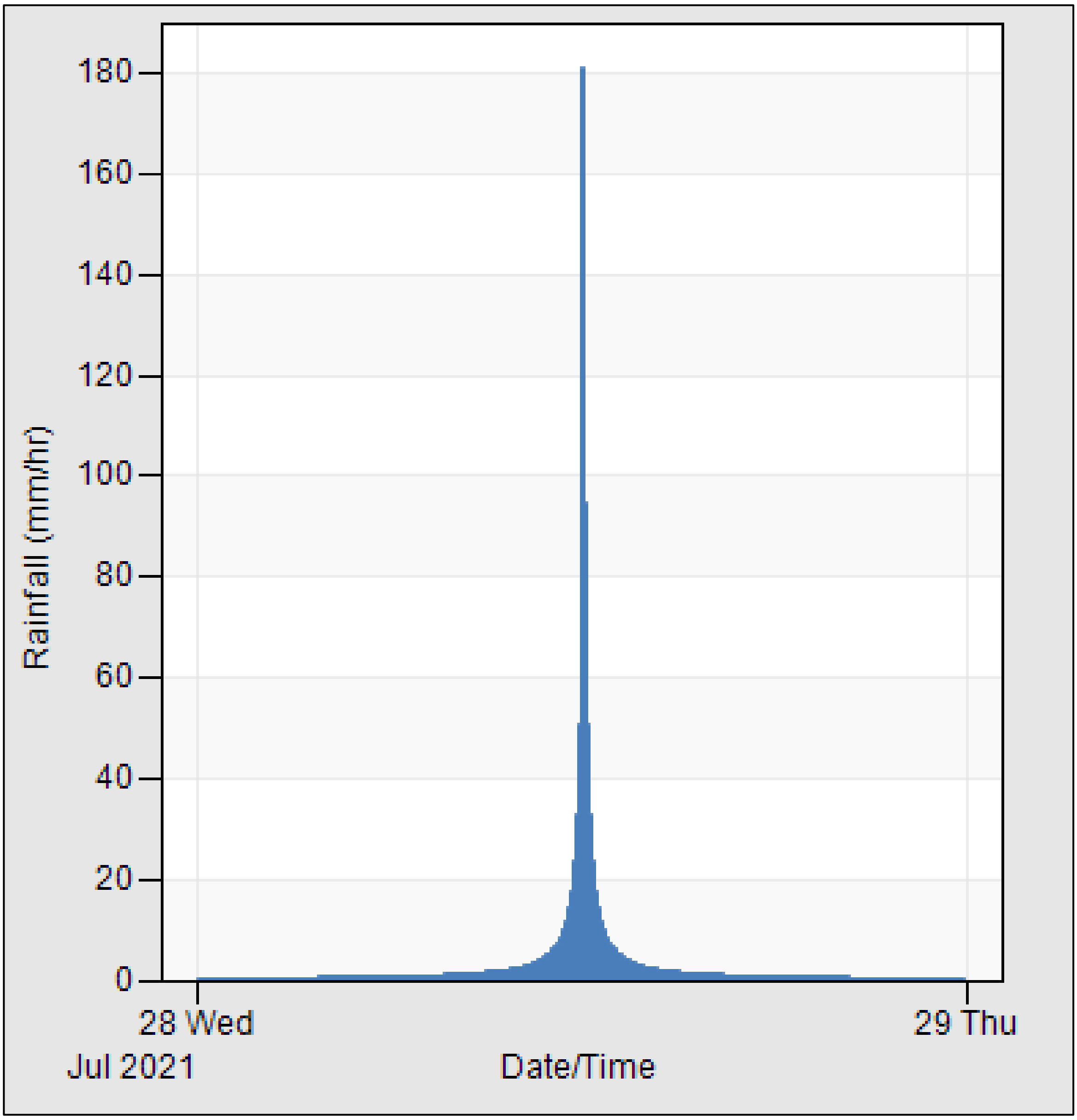


Figure 6-2 Design storm hyetograph for 1:10 year return interval, 24-hour duration SCS type III

Table 6-1 Peak flows and catchment parameters for the site

Name	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Runoff Depth (mm)	Runoff Volume (ML)	Peak Runoff (m^3/s)	Runoff Coefficient
S1_1	62.78	565	1112	1.07	72.66	45.62	10.67	0.837
S1_2	43.86	999	439	1.12	78	34.21	10.3	0.899
S1_3	29.39	425	692	0.855	75.19	22.1	5.74	0.866
S1_5	34.29	501	685	1.33	76.47	26.23	7.24	0.881

6.5 Overview of the SWMP

The proposed development site is in its natural state. It is therefore likely that in its undeveloped form, incident rainfall is infiltrated at source, first by interception by vegetation and then by infiltration into the soil. There would thus be little to no rainfall runoff for smaller recurrence interval storms in the catchment in its natural state prior to development. In terms of good stormwater management practice, the goal is to have runoff from the developed site not exceed what it would have been in its undeveloped state. Introducing the solar project will create a 256 ha surface with a lower permeability. It is therefore necessary to reintegrate the runoff into the surrounding environment with minimal impact in terms of frequency of exceedance and water quality to simulate as best as possible the pre-development conditions and hydrological response.

As there is no defined watercourse to which the runoff flows can be directed, it is proposed that the runoff be allowed to free-drain from the site along the natural topography of the ridge. As the site is located on the ridge, this means that drainage will occur in all directions.

It is assumed that dust fallout from the mine will be minimal on the solar panels as the wind predominantly is in a north, north-east direction and therefore blows pollutants away from the proposed site. Thus, the solar panels can be assumed to only have dust from the surroundings on them which will be washed off during cleaning. It is assumed that no detergent or chemical is used for cleaning and if it is, it will be ecologically friendly and biodegradable. It follows that water from the washing of the solar panels may report to the environment, subject to allowance for sedimentation of the dust carried in it. As the flows from washing will be smaller than rainfall events in terms of outflow hydrographs, the infiltration trenches proposed will enable the settling, filter and capture of these dust particles.

It is proposed that the site free drain and that vegetation be re-established between solar modules to prevent erosion and sediment transport.

6.6 Stormwater management during construction

The construction phase is planned to be 24 months in duration. During the construction phase stormwater management interventions are required, particularly to manage sediments washing off the site. The sediments result from the removal of vegetation, disturbance of the soils, and stockpiling of materials. From all these sources, particles are transported during rainfall events and if not managed can cause a problem in receiving waterways.

Means of managing stormwater runoff during construction may be achieved by the following methods:

- Carry out dust suppression practices during construction to trap the dust particles and minimize their transport into waterways.
- Use silt-fences (strips of permeable geotextile) around the perimeter of the works.
- Although sediment is the primary pollutant arising from construction activities, cement from concrete mixing activities and paint can also enter stormwater. This can be minimized by working in a dedicated area and keeping the area clean.
- Divert stormwater away from construction activities by the use of temporary berms. The topography of the site is favorable in that it is situated on a ridge so runoff will naturally drain away from the site, but diversion/[protection berms can be constructed around concrete mixing areas and stockpiles to prevent rainwater from running through them and becoming contaminated.
- Protect stockpiles with waterproof coverings.
- Keep waste in covered bins or pits.
- Stage the works:
    - Reduce the risk of erosion by only working in specific areas and stripping the site as development progresses.
    - Complete one area before moving to the next. This will be especially beneficial due to the large area of the site.
    - Install geotextiles to cover surfaces where erosion is observed.
    - Attempt to schedule works that result in the destabilizing of soil for the dry season e.g. foundations.
- Ongoing inspection and maintenance of drainage management measures should be carried out throughout the construction period.
- As the site changes during the progression of construction, the drainage system may need to be reevaluated and altered.

- Re-establish natural grasses on the areas of site that remain exposed after the construction is complete.
- If local areas of erosion are observed, install gabions or hay bales to prevent the erosion from progressing.

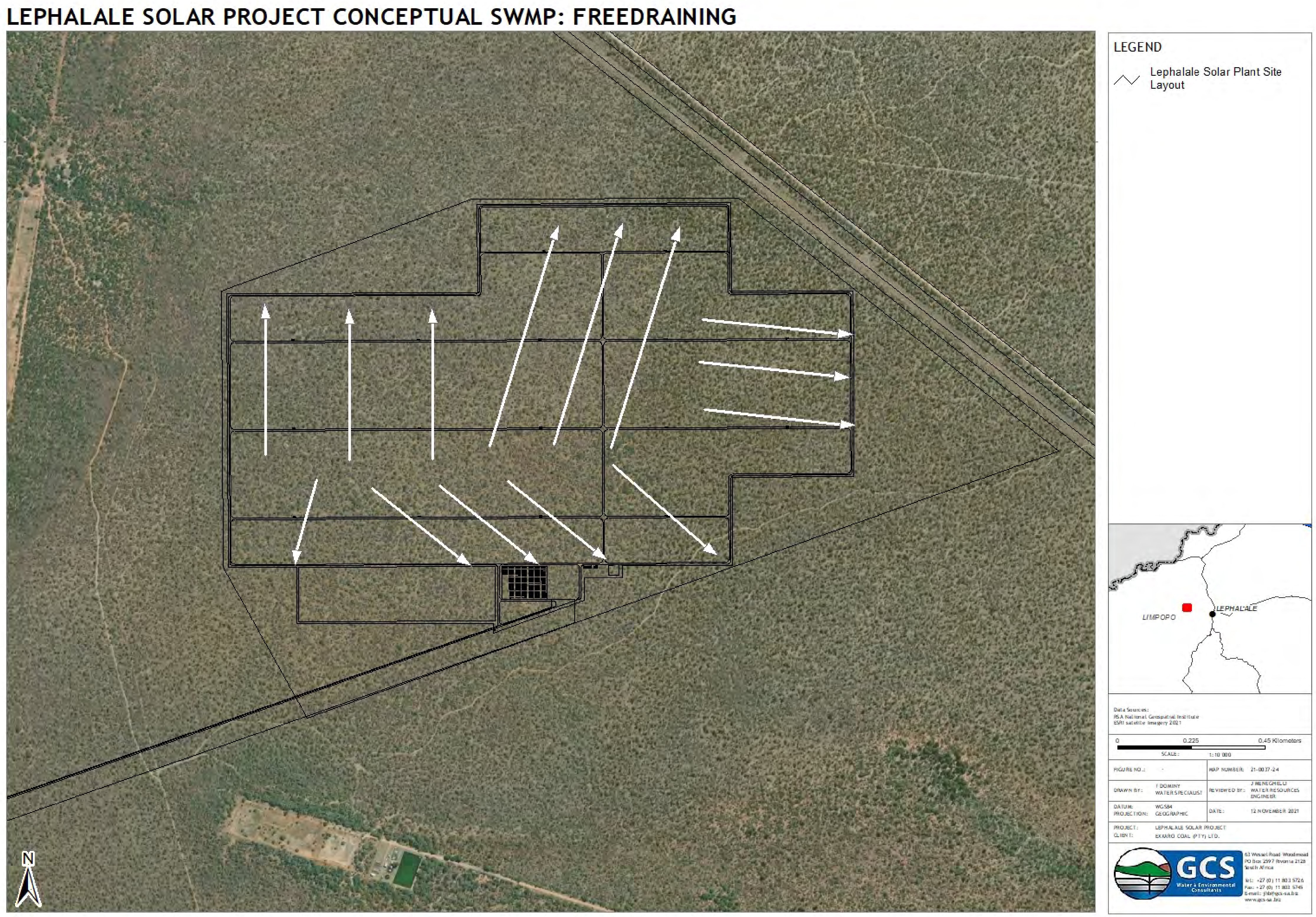


Figure 6-3 Conceptual SWMP layout

7 WATER BALANCE

7.1 Assumptions

Water balances were formulated for the construction and operational phases of the project. The construction phase of the project refers to the construction of the PV plant and additional infrastructure (i.e., road and road maintenance, concrete works such as foundations) and the latter phase entails the operations of the site by personnel. The construction phase was presented as being in two parts in the project description provided by the Client – the first 3 months followed by the next 21 months.

The following assumptions were made in the preparation of the water balance:

- No storm water is to be collected and stored on the site. Only water abstracted from the borehole will be stored on site.
- It follows that there are no contributing catchments running off into storage facilities. This is not possible as the site is located on a ridge, and thus all water drains away from it.
- There is a small proportion of surface runoff generated from the site and its impact on the calculation of the water balances is negligible, and therefore was not included as it reports directly to the environment.
- The entire catchment is clean and therefore it is not necessary to contain any water for treatment. Surface runoff will flow over the site, and free-drain overland to ultimately enter the Sandloop River, although it is most likely that it will evaporate and infiltrate before such a time.
- Raw water to the site is supplied by tanker from Grootegeluk during the construction phase, as the borehole cannot supply the volumes estimated to be needed.
- Water to the site is supplied by borehole during the operational phase of the project. A maximum volume estimated at 18 m^3/day can be supplied by the borehole as per the groundwater study (GCS, 2021).
- Water from the borehole is to be stored in tanks.
- The tanks will be modular and thus will be put in place on site as required.
    - o It therefore follows that water tanks sufficient to store 160 m^3 of water per day will be provided for the first 3 months of construction and storage of 90 m^3/d will be provided for the next 21 months of construction. The construction contractor will provide these tanks.

  - It was assumed that during the operational phase, it would be recommended to have 48 hours' supply of water, which would equate to 12 m^3/d storage and thus 12 m^3 of tank storage. Permanent tanks will be installed for the storage of this water.
- Water from the borehole is treated in the water treatment plant (WTP).
  - Borehole water will receive only minimal water treatment to be used as potable water. This will include filtration, UV treatment and chlorination.
  - Potable water will then provide supply for domestic demands by personnel.
  - Water will further undergo demineralization prior to being used for washing the solar panels.
  - One WTP will perform all processes required for water treatment.
- Potable water will be stored in tanks, prior to distribution.
- Demineralised water will be stored in tanks prior to use.
- During construction, portable toilets will be used and will be emptied by tanker and sewage removed from the site for disposal at municipal works.
- Domestic use:
  - During operation, there will be a maximum of thirty personnel on site. This will most likely be during washing periods. On a continuous basis, there are expected to be less people.
  - Personnel are assumed to require 130 ℓ/c/day for domestic and consumption purposes.
  - 90% of the water consumed for domestic use is assumed to be discharged as wastewater to the conservancy tank, while 10% is consumed or used for cleaning.
  - There will be no showers on site, only ablutions and a kitchen.
  - Assuming that the conservancy tank is emptied once weekly, it should be sized for seven days' worth of sewage which is approximately 25 m^3.
- It has been assumed that there will be no washing of vehicles on the site as this would introduce hydrocarbons into the environment.
- During operation, a buried, concrete conservancy tank will receive sewage.
- The conservancy tank will periodically be emptied and disposed of at a suitable facility.

- During construction, 160 m^3/d is assumed to be demanded for the first three months as per the project description provided by the Client. Of this 100 m^3/d is assumed to be used for road construction, 48 m^3/d for concrete construction and curing and 12 m^3/day for dust control. Each use is assumed to have 10% losses associated with it.
    - o Road construction will include the use of water for compaction of material to optimum moisture content.
    - o Concrete construction will include water for mixing and curing. Water will also be used for mortar during the building of offices.
    - o Dust control will include dust suppression on the construction site and on the roads.
- During construction, 90 m^3/d is assumed to be demanded for the next twenty-one months as per the project description provided by the Client. Of this 56 m^3/d is assumed to be used for road construction, 27 m^3/d for concrete construction and curing and 7 m^3/day for dust control. Each use is assumed to have 10% losses associated with it.
- During operations, it is assumed that 20 m^3/d of water is demanded as per the Client's project description. Of this, 3.9 m^3/d will be treated for potable use, and 16.1 m^3/d will be used for the washing of the solar panels.
- Solar panel modules:
    - o Water running off the solar panels when washing is clean and reports by direct runoff for discharge to the environment.
    - o Only 1.2 litres of water is used to clean each module. There are 177 000 modules so this means there will be a demand of 212 400 litres, equivalent to 212.4 m^3, per cleaning period.
    - o The modules will be cleaned twice a year, at most three times a year depending on their efficiency.
    - o To be conservative, it was assumed that cleaning will take place three times a year. This results in an annual demand of 637.2 m^3, or 1.7 m^3/d.
    - o Washing will take place over a few days to allow recharge of the demin tank.

- Dust suppression: there will be dust suppression by raw water during construction. During operations, there will be no dust suppression. Vegetation will be re-established between the panels so the only dust would be from the road. However, traffic volumes are expected to be low so minimal dust will result. If necessary, it will be done with raw water from the borehole.

7.2 Water process flow diagrams

Water flow processes on the site were developed based on the above assumptions and information from the Client. Refer to Figure 7-1, Figure 7-2 and Figure 7-3. The in and out flows per unit are summarised in the tables that follow (

Table 7-1 Water balance for the first 3 months of construction

First 3 months of construction					
	IN	m^3/day	OUT	m^3/day	BALANCE
Water tanks (160 m^3 capacity)	External water supply	160			
			Concrete	48	
			Mixing		
			Curing		
			Losses	10% of total	
			Roads	100	
			Construction		
			Maintenance		
			Losses	10% of total	
			Dust control	12	
			Suppression on the site and roads		
			Losses	10% of total	
SUM		160		160	0

Table 7-2 Water balance for the following 21 months of construction

Following 21 months of construction					
	IN	**m^3/day**	**OUT**	**m^3/day**	**BALANCE**
Water tanks (90 m^3 capacity)	External water supply	90			
			Concrete	27	
			Mixing		
			Curing		
			Losses	10% of total	
			Roads	56	
			Construction		
			Maintenance		
			Losses	10% of total	
			Dust control	7	
			Suppression on the site and roads		
			Losses	10% of total	
SUM		90		90	0

Table 7-3 Water balance during operations

Operation					
	IN	**m^3/day**	**OUT**	**m^3/day**	**BALANCE**
Water tanks (40 m^3 capacity)	Borehole abstraction	5.6	Water Treatment Plant	5.6	0
		5.6		5.3	0
Water Treatment Plant	Water tanks	5.6	Domestic potable supply	3.9	
			Demineralization process	1.7	
		5.6		5.6	0
Demineralization process	Water Treatment Plant	1.7	Solar panel washing	1.7	0
Domestic potable supply	Water Treatment Plant	3.9	Consumption	0.39	
			Wastewater/sewage	3.51	
		5.6		5.6	0
Conservancy tanks 25 m^3 capacity	Domestic use	3.51	Removal by tanker	3.51	
		3.51		3.51	0
SUM		20.31		20.31	0

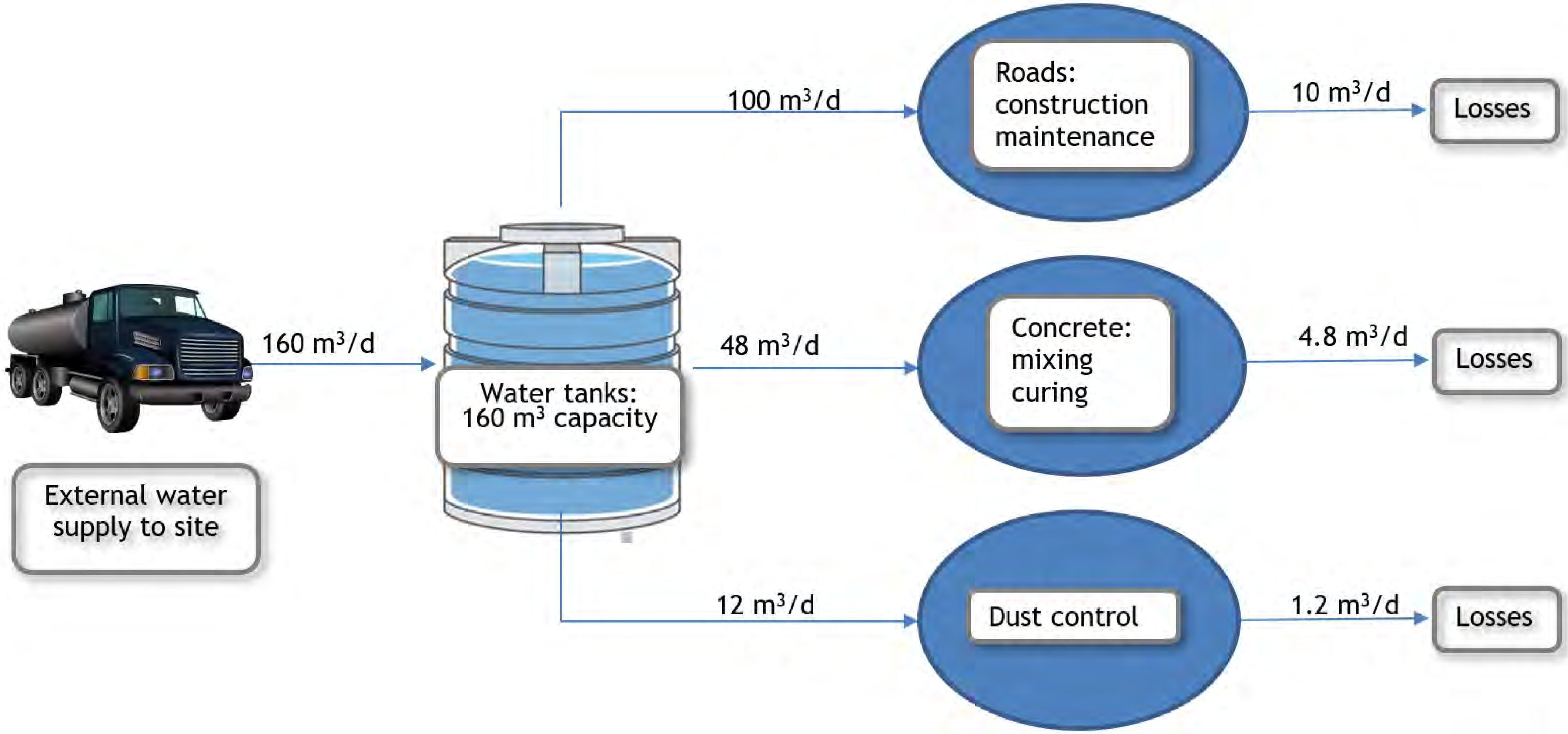


Figure 7-1 Water process flow diagram for first 3 months of construction

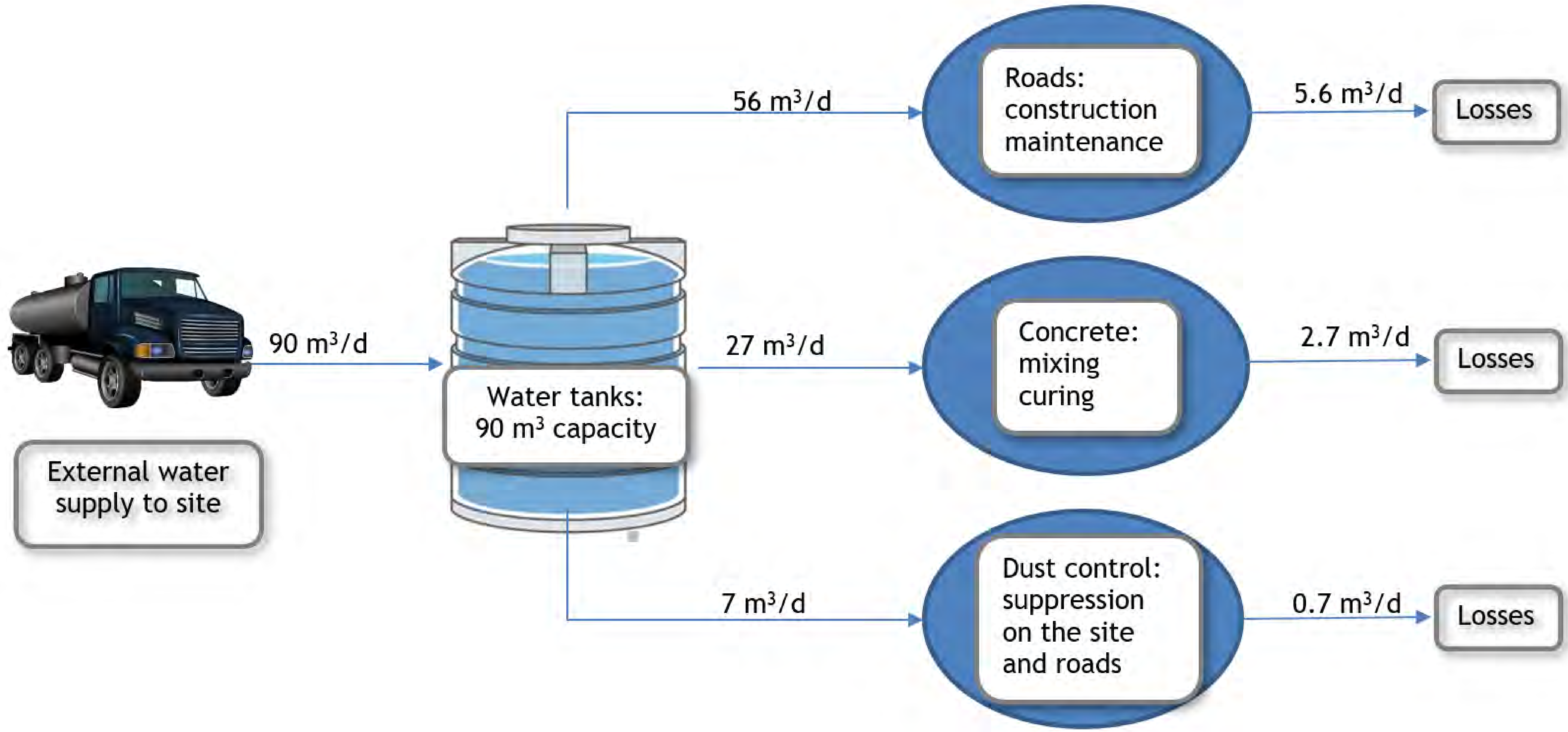


Figure 7-2 Water process flow diagram for next 21 months of construction

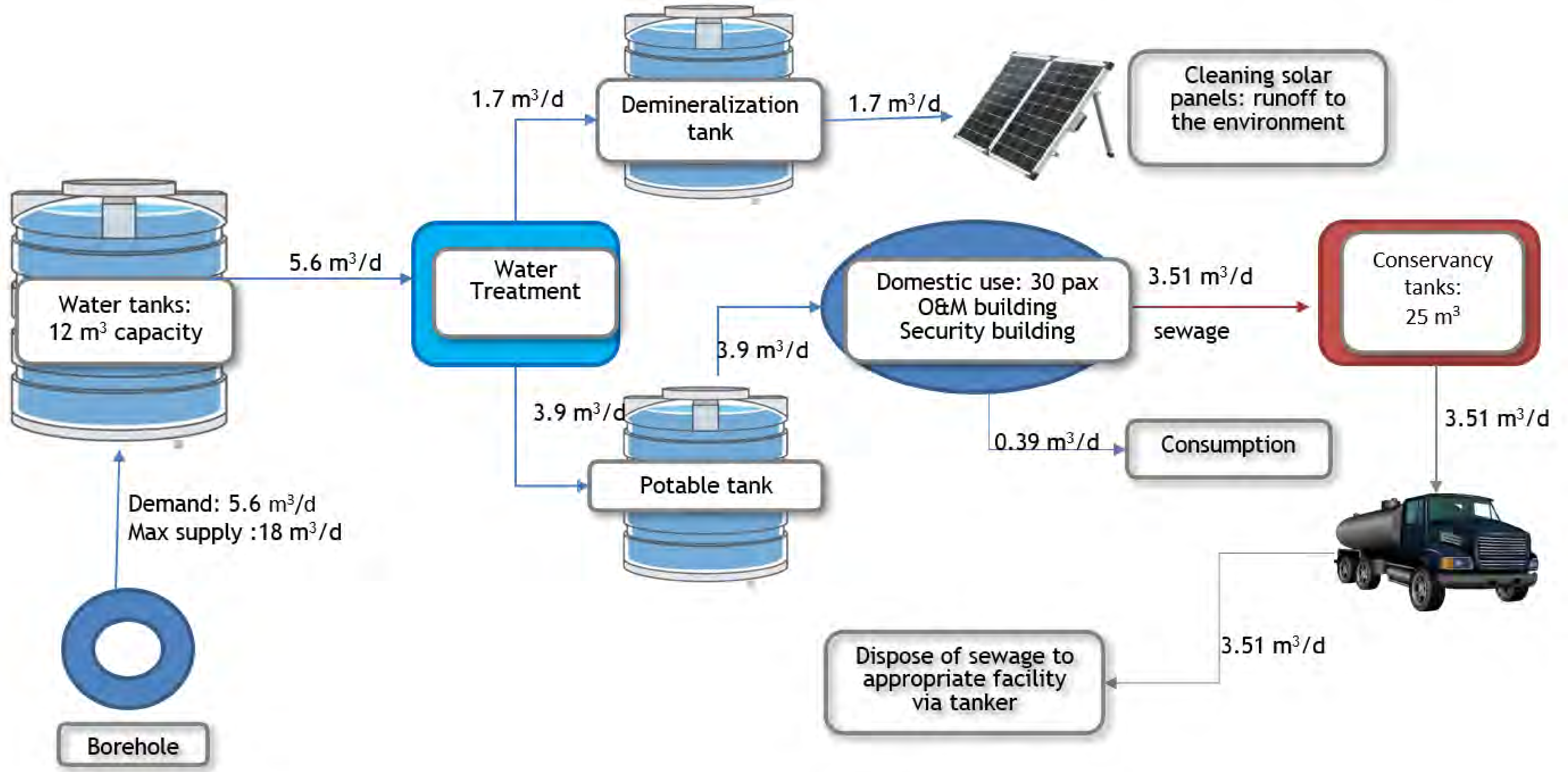


Figure 7-3 Water process flow diagram during operation

8 SURFACE WATER QUALITY MONITORING PROGRAMME

There are no drainage lines or streams on the site or within 500 m of it, asides from the artificial pan as determined by an assessment of the topography of the site and site observations (GCS, 2021). There is an artificial pan constructed adjacent to the rifle range, 270 m from the site. This pan is fed by piped water and therefore would not give indications of water quality impacts resulting from the solar project. Any runoff from the site will be overland flow and is predicted to have evaporated or infiltrated the ground before reaching any drainage lines.

The existing monitoring points for the surface water management program at Grootegeluk Mine were investigated to see if it would be possible to use any of these points to identify alterations in water quality due to the solar project development. It was found that all site are to the west of the proposed solar development, and therefore upstream of. Thus, no indication of water quality impacts would be measurable at these points.

For the above two reasons, there is no opportunity to carry out surface water monitoring as there are no permanent surface water features within the vicinity of downstream of the site. Therefore, no water quality monitoring program has been proposed.

9 SURFACE WATER IMPACT RISK ASSESSMENT

9.1 Impact assessment methodology

Due to the hydrological assessment forming part of a larger risk assessment for the study area, the potential impacts and the determination of impact significance was assessed. The process of assessing the potential impacts of the project encompasses the following four activities:

1. Identification and assessment of potential impacts;
2. Prediction of the nature, magnitude, extent and duration of potentially significant impacts;
3. Identification of mitigation measures that could be implemented to reduce the severity or significance of the impacts of the activity; and
4. Evaluation of the significance of the impact after the mitigation measures have been implemented i.e. the significance of the residual impact.

Per GNR 982 of the EIA Regulations (2014), the significance of potential impacts was assessed in terms of the following criteria:

I. Cumulative impacts;
II. Nature of the impact;
III. Extent of the impact;

IV. Probability of the impact occurring;
V. The degree to which the impact can be reversed;
VI. The degree to which the impact may cause irreplaceable loss of resources; and
VII. The degree to which the impact can be mitigated.

Table 9-1 provides a summary of the criteria used to assess the significance of the potential impacts identified. An explanation of these impact criteria is provided in Table 9-2.

The net consequence is established by the following equation:

- Consequence = (Duration + Extent + Irreplaceability of resource) x Severity

And the environmental significance of an impact was determined by multiplying consequence with probability.

Note that the DWS Risk Assessment Matrix is not applicable to the hydrological study, but to the wetlands study. The matrix has been adapted in the above methodology to reflect the same approach and principles of the DHSW&S Risk Assessment Matrix such that hydrological risks can be represented.

Table 9-1: Proposed Criteria and Rating Scales to be used in the Assessment of the Potential Impacts

Criteria	Rating Scales	Notes
Nature	Positive (+)	An evaluation of the effect of the impact related to the proposed development.
	Negative (-)	
Extent	Footprint (1)	The impact only affects the area in which the proposed activity will occur.
	Site (2)	The impact will affect only the development area.
	Local (3)	The impact affects the development area and adjacent properties.
	Regional (4)	The effect of the impact extends beyond municipal boundaries.
	National (5)	The effect of the impact extends beyond more than 2 regional/ provincial boundaries.
	International (6)	The effect of the impact extends beyond country borders.
Duration	Temporary (1)	The duration of the activity associated with the impact will last 0-6 months.

Criteria	Rating Scales	Notes
	Short term (2)	The duration of the activity associated with the impact will last 6-18 months.
	Medium-term (3)	The duration of the activity associated with the impact will last 18 months-5 years.
	Long term (4)	The duration of the activity associated with the impact will last more than 5 years.
Severity	Low (-1)	Where the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected.
	Moderate (-2)	Where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; and valued, important, sensitive or vulnerable systems or communities are negatively affected.
	High (-3)	Where natural, cultural or social functions and processes are altered to the extent that the natural process will temporarily or permanently cease; and valued, important, sensitive or vulnerable systems or communities are substantially affected.
Potential for impact on irreplaceable resources	No (0)	No irreplaceable resources will be impacted.
	Yes (1)	Irreplaceable resources will be impacted.
Consequence	Extremely detrimental (-25 to -33)	A combination of extent, duration, intensity and the potential for impact on irreplaceable resources.
	Highly detrimental (-19 to -24)	
	Moderately detrimental (-13 to -18)	
	Slightly detrimental (-7 to -12)	
	Negligible (-6 to 0)	
	Slightly beneficial (0 to 6)	
	Moderately beneficial (13 to 18)	
	Highly beneficial (19 to 24)	
	Extremely beneficial (25 to 33)	
Probability (the likelihood of the impact occurring)	Improbable (0)	It is highly unlikely or less than 50 % likely that an impact will occur.

Criteria	Rating Scales	Notes
	Probable (1)	It is between 50 and 70 % certain that the impact will occur.
	Definite (2)	It is more than 75 % certain that the impact will occur or it is definite that the impact will occur.
Significance	Very high – negative (-49 to -66)	A function of Consequence and Probability.
	High – negative (-37 to -48)	
	Moderate – negative (-25 to -36)	
	Low – negative (-13 to -24)	
	Very low (0 to -12)	
	Low – positive (0 to 12)	
	Moderate – positive (13 to 24)	
	High – positive (37 to 48)	
	Very high – positive (49 to 66)	

Table 9-2: Explanation of Assessment Criteria

Criteria	Explanation
Nature	This is an evaluation of the type of effect the construction, operation and management of the proposed development would have on the affected environment. Will the impact change in the environment be positive, negative, or neutral?
Extent or Scale	This refers to the spatial scale at which the impact will occur. The extent of the impact is described as: footprint (affecting only the footprint of the development), site (limited to the site) and regional (limited to the immediate surroundings and closest towns to the site). Extent of scale refers to the actual physical footprint of the impact, not to the spatial significance. It is acknowledged that some impacts, even though they may be of small extent, are of very high importance, e.g. impacts on species of very restricted range. To avoid "double counting, specialists have been requested to indicate spatial significance under "intensity" or "impact on irreplaceable resources" but not under "extent" as well.
Duration	The lifespan of the impact is indicated as temporary, short, medium and long term.
Severity	This is a relative evaluation within the context of all the activities and the other impacts within the framework of the project. Does the activity destroy the impacted environment, alter its functioning, or render it slightly altered?

Impact on irreplaceable resources	This refers to the potential for an environmental resource to be replaced, should it be impacted. A resource could be replaced by natural processes (e.g. by natural colonisation from surrounding areas), through artificial means (e.g. by reseeding disturbed areas or replanting rescued species) or by providing a substitute resource, in certain cases. In natural systems, providing substitute resources is usually not possible, but in social systems, substitutes are often possible (e.g. by constructing new social facilities for those that are lost). Should it not be possible to replace a resource, the resource is essentially irreplaceable e.g. red data species that are restricted to a particular site or habitat of very limited extent.
Consequence	The consequence of the potential impacts is a summation of the above criteria, namely the extent, duration, intensity and impact on irreplaceable resources.
Probability of occurrence	The probability of the impact occurring based on the professional experience of the specialist with environments of a similar nature to the site and/or with similar projects. It is important to distinguish between the probability of the impact occurring and the probability that the activity causing a potential impact will occur. Probability is defined as the probability of the impact occurring, not as the probability of the activities that may result in the impact.
Significance	Impact significance is defined to be a combination of the consequence (as described below) and the probability of the impact occurring. The relationship between consequence and probability highlights that the risk (or impact significance) must be evaluated in terms of the seriousness (consequence) of the impact, weighted by the probability of the impact occurring. In simple terms, if the consequence and probability of an impact is high, then the impact will have a high significance. The significance defines the level to which the impact will influence the proposed development and/or environment. It determines whether mitigation measures need to be identified and implemented and whether the impact is important for decision-making.
Degree of confidence in predictions	Specialists and the EIR team were required to indicate the degree of confidence (low, medium or high) that there is in the predictions made for each impact, based on the available information and their level of knowledge and expertise. Degree of confidence is not taken into account in the determination of consequence or probability.
Mitigation measures	Mitigation measures are designed to reduce the consequence or probability of an impact, or to reduce both consequence and probability. The significance of impacts has been assessed both with mitigation and without mitigation.

9.2 Impact risk assessment matrix

The predicted surface water impacts are listed in the tables below, with proposed mitigation measures and estimates of risk intensity. From the assessment, it was found that during both construction and operational phases, the risk of impact to surface water from the site is negligible if appropriate mitigation measures are put in place.

The risk assessment matrix finds the proposed activities to be slightly detrimental, reduced to negligible with the inclusion of mitigation measures.

CONSTRUCTION

Component Being Impacted On	Activity Which May Cause the Impact	Activity	Pre- Mitigation							Recommended Mitigation Measures	Post Mitigation							Confidence
			Duration	Extent	Potential for impact on irreplaceable resources	Severity	Consequence	Probability	Significance		Duration	Extent	Severity	Potential for impact on irreplaceable resources	Consequence	Probability	Significance	
Primary surface water Receivers -> Non-Perennial & Perennial Streams	Risk of erosion an sedimentation	Earthworks, channel modifications	Temporary (1)	Site (2)	Yes (1)	Low (-1)	Negligible (0 to -6) (-4)	Definite (2)	Negligible (0 to -12) (-8)	• Install a temporary cut off trench, protection berms and sediment traps such as silt fences around the construction area to contain poor quality runoff (if observed). • Cover soil stockpiles with a temporary liner to prevent contamination (both topsoil and building materials). • Construct temporary silt traps at drainage points to allow sediment settlement from runoff.	Temporary (1)	Site (2)	Yes (1)	Negligible (0)	Negligible (0 to -6) (0)	Definite (2)	Negligible (0 to -12) (0)	Medium
	Environmental impacts due to: o Spillage of fuels and chemicals; and o Construction equipment and vehicles.	Plant on site during construction	Temporary (1)	Site (2)	Yes (1)	Low (-1)	Negligible (0 to -6) (-4)	Definite (2)	Negligible (0 to -12) (-8)	• Clean up spillages immediately. • Keep chemicals and fuel in bunded areas. • Keep vehicles and equipment clean by washing them in dedicated bunded wash bay areas, or off site.	Temporary (1)	Site (2)	Yes (1)	Negligible (0)	Negligible (0 to -6) (0)	Probable (1)	Negligible (0 to -12) (0)	Medium
	Increased runoff due to: o Vegetation removal; and o Compacting of soil.	Site clearing and preparation	Temporary (1)	Site (2)	Yes (1)	Low (-1)	Negligible (0 to -6) (-4)	Definite (2)	Negligible (0 to -12) (-8)	• Vegetation clearing to be limited to what is essential. • Retain as much indigenous vegetation as possible. • Compact the site footprint only, minimise working area.	Temporary (1)	Site (2)	Yes (1)	Negligible (0)	Negligible (0 to -6) (0)	Probable (1)	Negligible (0 to -12) (0)	Medium

OPERATIONAL

Component Being Impacted On	Activity Which May Cause the Impact	Activity	Pre- Mitigation							Recommended Mitigation Measures	Post Mitigation							Confidence
			Duration	Extent	Potential for impact on irreplaceable resources	Severity	Consequence	Probability	Significance		Duration	Extent	Severity	Potential for impact on irreplaceable resources	Consequence	Probability	Significance	
Primary surface water Receivers - > Non-Perennial & Perennial Streams	Increased runoff due to compacted surfaces from the proposed site onto the surrounding soils may cause higher velocities and frequency of occurrence and sediment transport to the nearby streams	Runoff	Long-term (4)	Local (3)	Yes (1)	Low (-1)	Slightly detrimental (-7 to -12) (-8)	Probable (1)	Negligible (0 to -12) (-8)	• The site has been designed as free-draining. This will avoid the concentration of flows. • Re-establishment of vegetation is critical to prevent sediment transport and protect against erosion.	Long-term (4)	Local (3)	Yes (1)	Negligible (0)	Negligible (0 to -6) (0)	Improbable (0)	Negligible (0 to -12) (0)	Medium
	Potential sedimentation several months after the site has been constructed. It is anticipated that the sediment load will decrease with time to pre-construction levels.	Net result of earthworks and development	Medium Term (3)	Local (3)	Yes (1)	Low (-1)	Slightly detrimental (-7 to -12) (-7)	Definite (2)	Low (-13 to -24) (-14)	• Vegetation to be re-established between solar modules. Vegetation will prevent sediment transport.	Medium Term (3)	Site (2)	Yes (1)	Low (-1)	Negligible (0 to -6) (-6)	Probable (1)	Negligible (0 to -12) (-6)	Medium
	Water quality impacts due to chemical spills, vehicle pollutants, fuel and oil spillages and leaks	Site operations	Long-term (4)	Site (2)	Yes (1)	Low (-1)	Slightly detrimental (-7 to -12) (-7)	Probable (1)	Negligible (0 to -12) (-7)	• Demarcated dirty areas to be limited to roads, parking areas and chemical storage areas. • Spills to be cleaned up immediately. • Vehicles and equipment to be regularly maintained and cleaned in dedicated bunded areas.	Long-term (4)	Footprint (1)	Yes (1)	Low (-1)	Negligible (0 to -6) (-6)	Probable (1)	Negligible (0 to -12) (-6)	Medium
	Erosion due to change in topography, land use and vegetation removal.	Catchment modification	Long-term (4)	Local (3)	Yes (1)	Low (-1)	Slightly detrimental (-7 to -12) (-8)	Probable (1)	Negligible (0 to -12) (-8)	• Manage sites of local erosion that develop with interventions such as gabions. • Re-establishment of vegetation will protect against erosion.	Long-term (4)	Footprint (1)	Yes (1)	Low (-1)	Negligible (0 to -6) (-6)	Probable (1)	Negligible (0 to -12) (-6)	Medium

10 CONCLUSIONS

A surface water assessment was carried out for the proposed solar plant project at Lephalale. Rainfall of the quaternary catchment A42J and nearby SAWS rainfall stations was assessed. Tambootivlei station was selected as best representing site conditions, and hydrological calculations were carried out based on these parameters, being an MAP of 428 mm/a and associated design rainfall depths.

A conceptual SWMP was designed for the site. It was found that the site is located on a ridge and therefore has no upstream catchments draining towards it. Thus, only rainfall from the site itself requires management. This site will be made up of solar modules with vegetation re-established between them after construction in order to make the site as pervious as possible. All runoff from the site will be clean. It is proposed that the runoff be allowed to free drain off the site over the natural topography as this will have less hydrological impacts than concentrated flow in a collection system. Recommendations for stormwater management practices to be employed during the construction period were made.

Water balances were carried out based on water demands supplied by the Client for construction and operational phases. All water will be supplied via borehole abstraction. During operations, a WTP will treat the borehole water to potable standards. Sewage from domestic water use will be directed to a buried tank. Effluent will be collected by tanker and disposed of off-site at an appropriate facility. Water required for cleaning of the solar panels will be sent from the WTP to a demineralization process. It is assumed that water from washing the panels will runoff to the environment.

The surface water risk assessment found that there would be slightly detrimental impacts to the site based on proposed activities, and that the implementation of mitigation measures would reduce these risks to negligible. The entire site is considered a clean water catchment as there are no chemical processes occurring or mining activities. The only threats to the environment include compaction of the site soils, increased run-off, erosion, and sedimentation all of which can be managed to protect the surrounds by the SWMP.

As there are no streams on or near the site, surface water monitoring is not feasible and therefore no program was recommended. Grootegeluk is going to be approached regarding their current water monitoring programs to see if these can be used to monitor the impacts of the site's development.

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APPENDIX E6: WETLAND ASSESSMENT

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WETLAND ASSESSMENT FOR THE PROPOSED LEPHALALE SOLAR PROJECT, NEAR LEPHALALE, LIMPOPO PROVINCE

Version - final

30 July 2021

K2021699383 (South Africa) (PTY) LTD

GCS Project Number: 21-0037

Client Reference: PR-CLI-002

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WETLAND ASSESSMENT FOR THE PROPOSED LEPHALALE SOLAR PROJECT, NEAR LEPHALALE, LIMPOPO PROVINCE

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DOCUMENT ISSUE STATUS

Report Issue	Final		
GCS Reference Number	21-0037		
Zutari Reference Number	1001395-G040-REP-NN-010		
Client Reference	PR-CLI-002		
Title	WETLAND ASSESSMENT FOR THE PROPOSED LEPHALALE SOLAR PROJECT, NEAR LEPHALALE, LIMPOPO PROVINCE		
	Name	**Signature**	**Date**
Author	Magnus van Rooyen		30 July 2021
Reviewer	Kate Cain		30 July 2021
Director	Magnus van Rooyen		30 July 2021

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WETLAND ASSESSMENT FOR THE PROPOSED LEPHALALE SOLAR PROJECT, NEAR LEPHALALE, LIMPOPO PROVINCE

1 INTRODUCTION

GCS Water and Environment (Pty) Ltd (GCS) has been appointed to conduct a Wetland Assessment associated with the development of the Lephalale Solar Project within the boundaries of the Grootegeluk Mining Right area near Lephalale, Limpopo Province.

The Wetland Assessment will be submitted in support of the Application for Environmental Authorisation in accordance with the National Environmental Management Act (Act No. 107 of 1998): Environmental Impact Assessment Regulations (2014), as amended as well as a Water Use Licence Application in accordance with the National Water Act (Act No. 36 of 1998).

1.1 Background

The proposed Lephalale Solar Project is located on the Remaining Extent of Farm Appelvlakte No. 448 within the Lephalale Local Municipality. The property is located approximately 16km to the northwest of the town of Lephalale and immediately east of the Exxaro Grootegeluk Coal Mine. The location of the site is provided in Figure 1-1.

The corner point coordinates are provided in the table below.

Table 1-1: Corner point coordinates of the proposed Lephalale Solar Solar Project

Coordinate	Latitude	Longitude
A	23° 37' 44.80" S	27° 35' 21.73" E
B	23° 37' 35.63" S	27° 35' 46.46" E
C	23° 37' 35.59" S	27° 36' 12.85" E
D	23° 38' 00.60" S	27° 36' 44.57" E
E	23° 38' 27.07" S	27° 35' 30.13" E
F	23° 38' 12.07" S	27° 35' 21.80" E

The project area is approximately 256ha in size and is wholly within the boundaries of the Farm Appelvlakte No. 448, the extent of the site is provided in Figure 1-2.

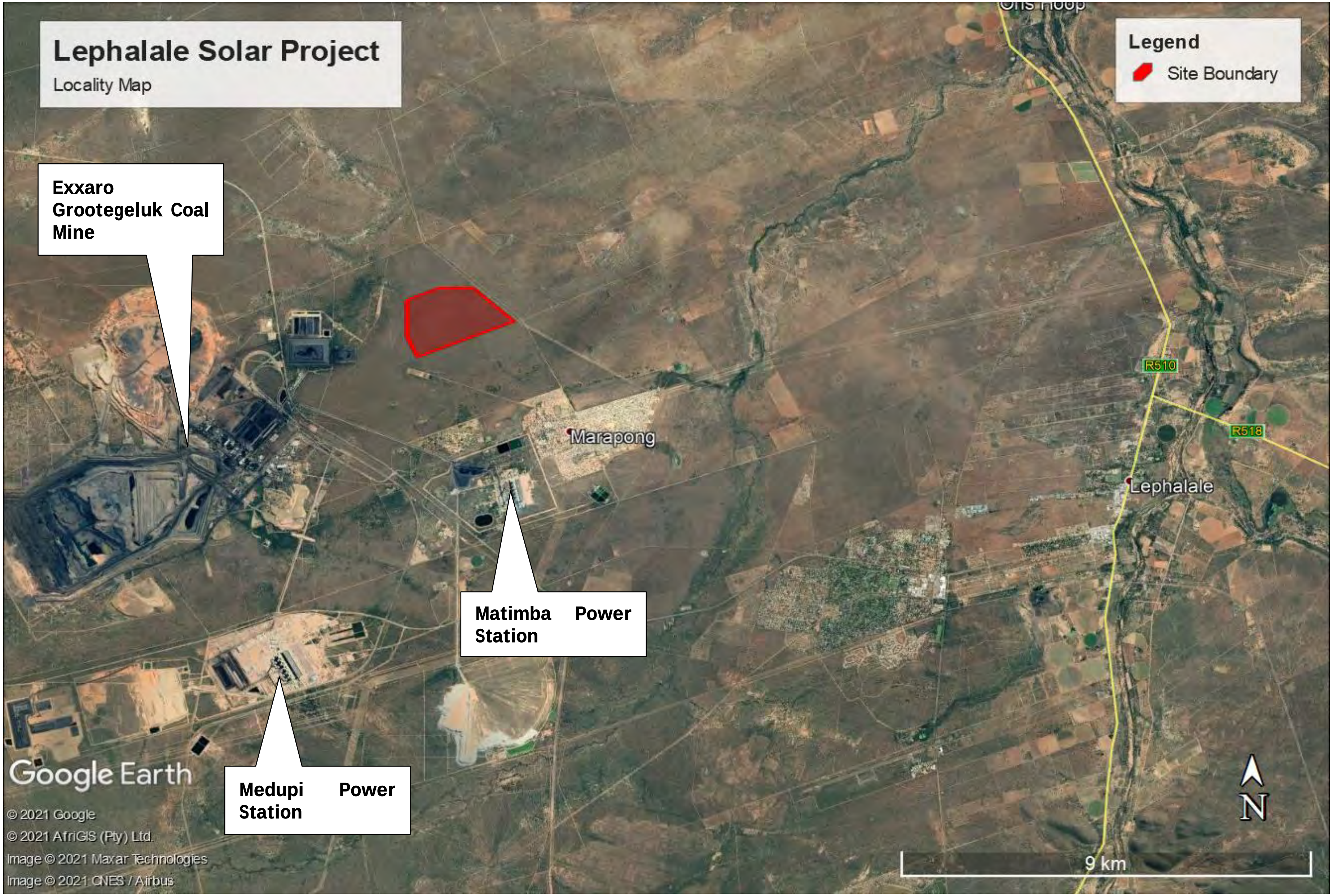
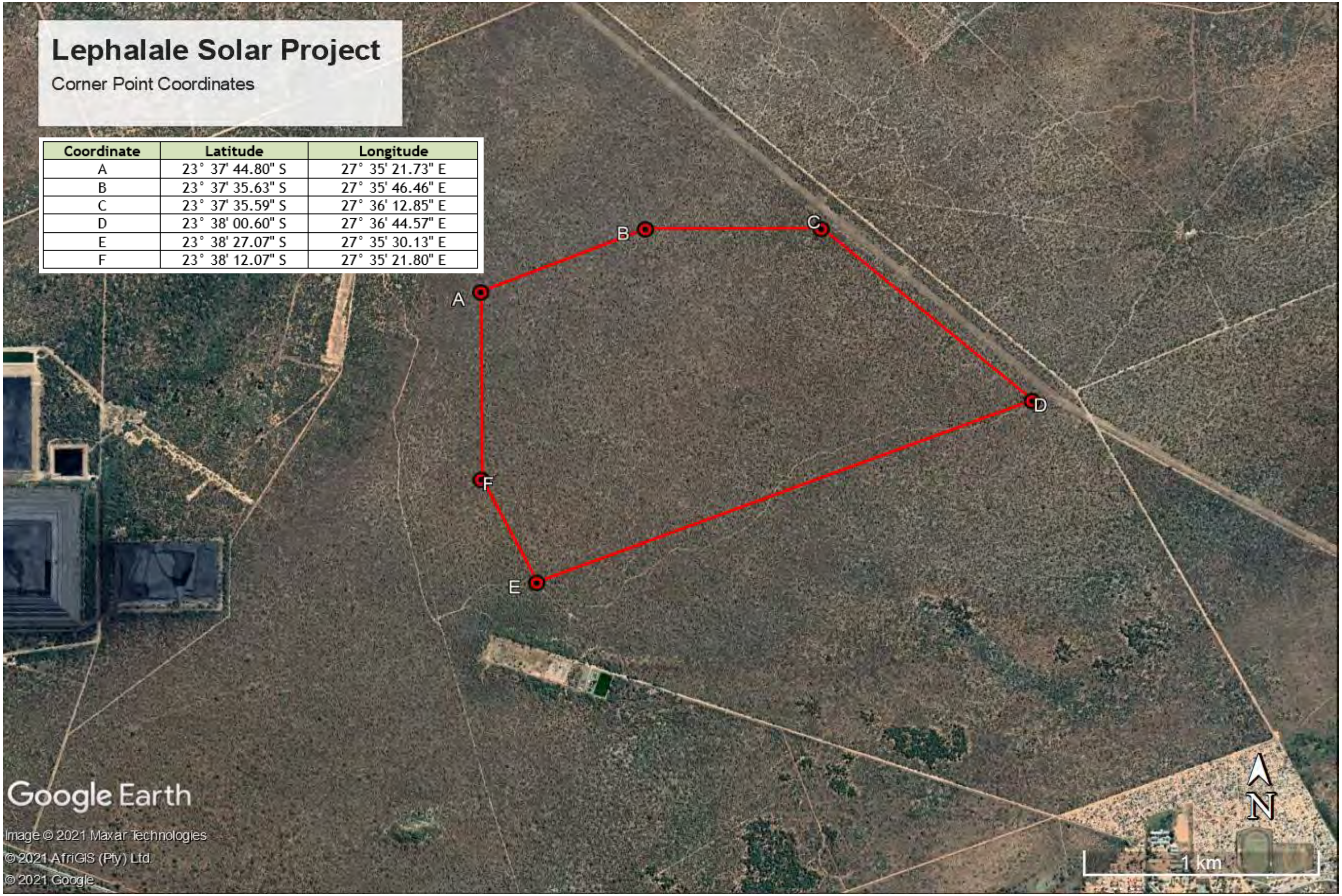


Figure 1-1: Location of the Lephalale Solar Project in relation to the town of Lephalale



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F	23° 38' 12.07" S	27° 35' 21.80" E

Figure 1-2: Extent of the Lephalale Solar Project site

1.2 Project description

The proposed Photovoltaic (PV) solar plant will make provision for the establishment of an array of crystalline solar photovoltaic (PV) modules grouped into strings of 28 modules and installed to solar tracking mounting structures, together with associated infrastructure for the generation of 80MWac of electricity. The PV tables will form and array covering an area of approximately 236ha, surrounded by a perimeter access road and fence. Provision will be made for 4km long evacuation powerlines that will follow a 67m wider corridor along the southern boundary of the fence line of the Appelvlakte Farm No. 448. This corridor will have a surface area of approximately 25ha and will contain the main access road to the facility. The combined land requirement for the project therefore is approximately 256ha.

The PV tables will be raised approximately 1.5m above natural ground level and will make provision for a single axis tracking system allowing maximization of solar energy harvesting for conversion to electrical energy. Plates 1-1 and 1-2 provides an example of similar PV tables as described above.

Plate 1-1: Single axis solar PV module tables raised 1.5m above ground level (to a maximum tilt height of 3m).

Plate 1-2: Single axis solar PV module tables raised 1.5m above ground level (to a maximum tilt height of 3m).

The proposed associated infrastructure includes a fenced construction staging/lay-down area (a portion of which will form the operational lay-down area), inverter-transformer stations on concrete pads, a battery energy storage system (BESS) adjacent to the substation platform, office buildings with ablutions, maintenance shed/s and a substation for connection to the power grid, all within the 236 ha PV plant site.

It is proposed that the 33kV powerlines within the facility be underground/sub-surface. From the proposed future substation tie-in to the Grootegeluk 33kV Substation will occur via 132kV overhead powerlines. The Grootegeluk 33 kV substation is located approximately 4km south-west of the proposed development site.

Figure 1-3 provides the layout of the key infrastructure associated with the PV plant project.

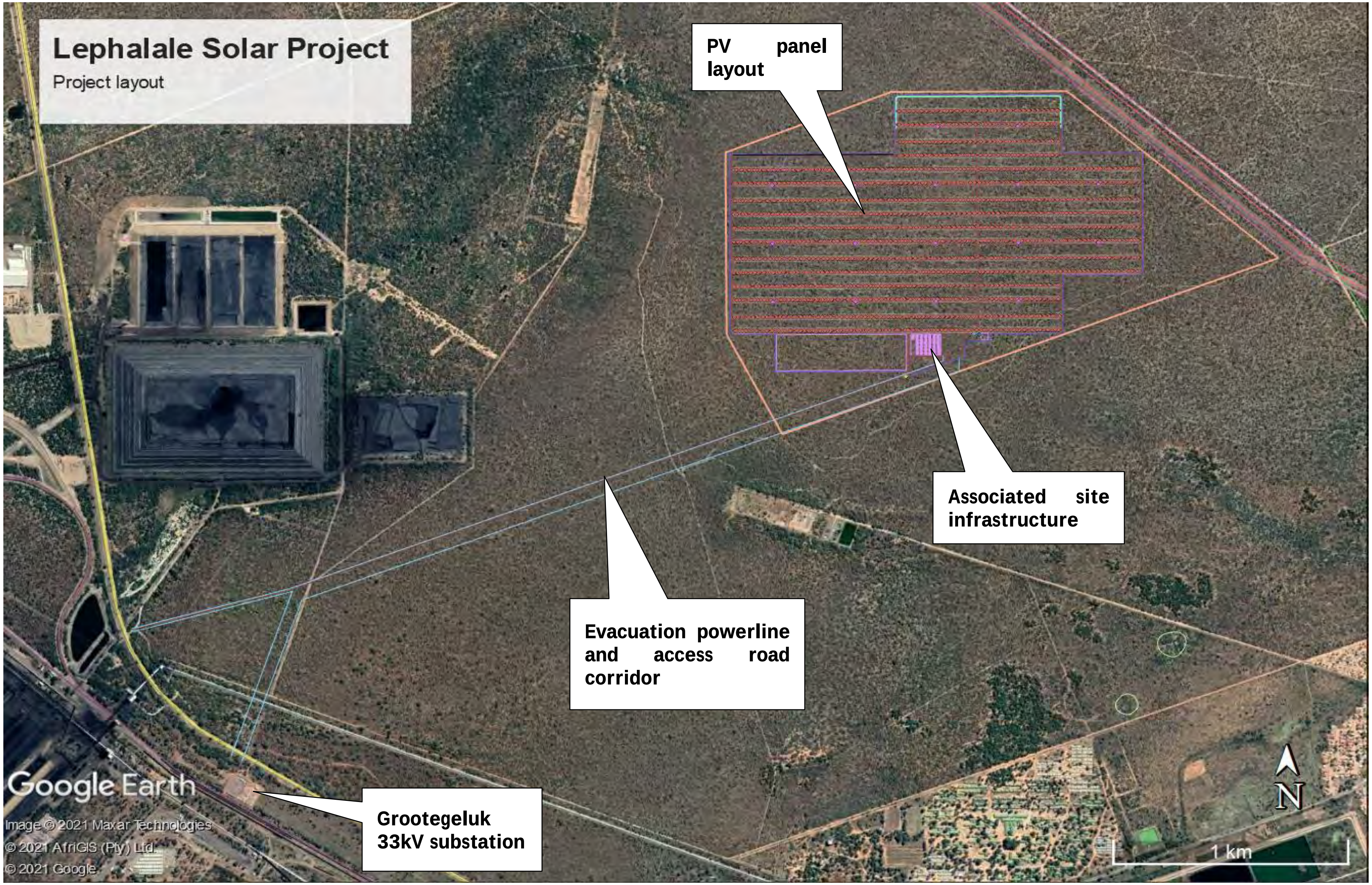


Figure 1-3: Layout of the Lephalale Solar Project

2 TERMS OF REFERENCE

It is understood that the assessment will be submitted as part of the Application for Environmental Authorisation in accordance with the National Environmental Management Act (Act No. 107 of 1998): Environmental Impact Assessment (EIA) Regulations (2014) as well as the Water Use Licence Application in accordance the National Water Act (Act No. 36 of 1998). As such, the assessment is completed in accordance with the minimum requirements for specialist assessments as included in Appendix 4 of the EIA Regulations (2014) as well as the requirements for the Regulations for the Water Use Licence Applications and Appeals (2017).

In brief, these requirements have as an outcome to achieve the following:

- A methodology of the site visit and techniques used to assess the specific aspects of the site;
- Details of the assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of site plan identifying site alternatives (where applicable);
- An indication of any areas that are to be avoided, including provision of buffers;
- A description of any assumptions made and any uncertainties or gaps in knowledge;
- A description of the findings and potential implications of such findings on the impact of the proposed activities;
- Any mitigation measures for inclusion in the Environmental Management Programme Report (EMPr);
- Any conditions for inclusion in the Environmental Authorisation and the Water Use Licence;
- Any monitoring requirements for inclusion into the EMPr or Water Use Licence; and
- A reasoned opinion whether the activity should be authorised based on the findings of the assessment.

3 KNOWLEDGE GAPS

No direct knowledge gaps have been identified that may influence the outcome of this assessment. The following assumptions however, have been made in the completion of the study:

- The assessment is based on site visits conducted on 8 April 2021, 21 April 2021 and 27 July 2021 by Mr Magnus van Rooyen of GCS;
- The assessment is based on the design information provided by the client and the project management team;
- The following standardised and accepted methods to determine the various aspects of the study were used:

- o Electronic biodiversity/wetland databases managed by the South African National Biodiversity Institute (SANBI);
- o Available provincial electronic biodiversity/wetland databases;
- o Wetland and Riparian Habitat Delineation Document (Department of Water and Sanitation report);
- o Wetland Buffer Determination Guideline (SANBI Water Research Commission project report);
- o Classification system for wetlands and other aquatic ecosystems in South Africa (Inland Systems) (Ollis et al., 2013 - SANBI Biodiversity Series 22); and
- o Risk Assessment Protocol and associated Matrix (Department of Human Settlements, Water and Sanitation (DHSWS).

4 STUDY AREA

The determination of the extent of the study area is an important factor for any assessment. Consideration of the requirements below has assisted in determining this extent of the study area in so far as the aquatic ecology is concerned.

The General Authorisation in terms of Section 39 of the National Water Act, 1998 (Act No. 36 of 1998) for Water Uses as defined in Section 21 (c) and (i)", Notice 509 of 2016, specifies that the "regulated aera of a watercourse" is to mean:

a) The outer edge of the 1 in 100 year flood line and / or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse or a river, spring, natural channel, lake or dam;
b) In the absence of a determined 1 in 100 year flood line or riparian area, the area within 100m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or
c) A 500m radius from the delineated boundary (extent) of any wetland or pan.

To this end, the study area therefore includes an area of 500m from the location of the proposed project site.

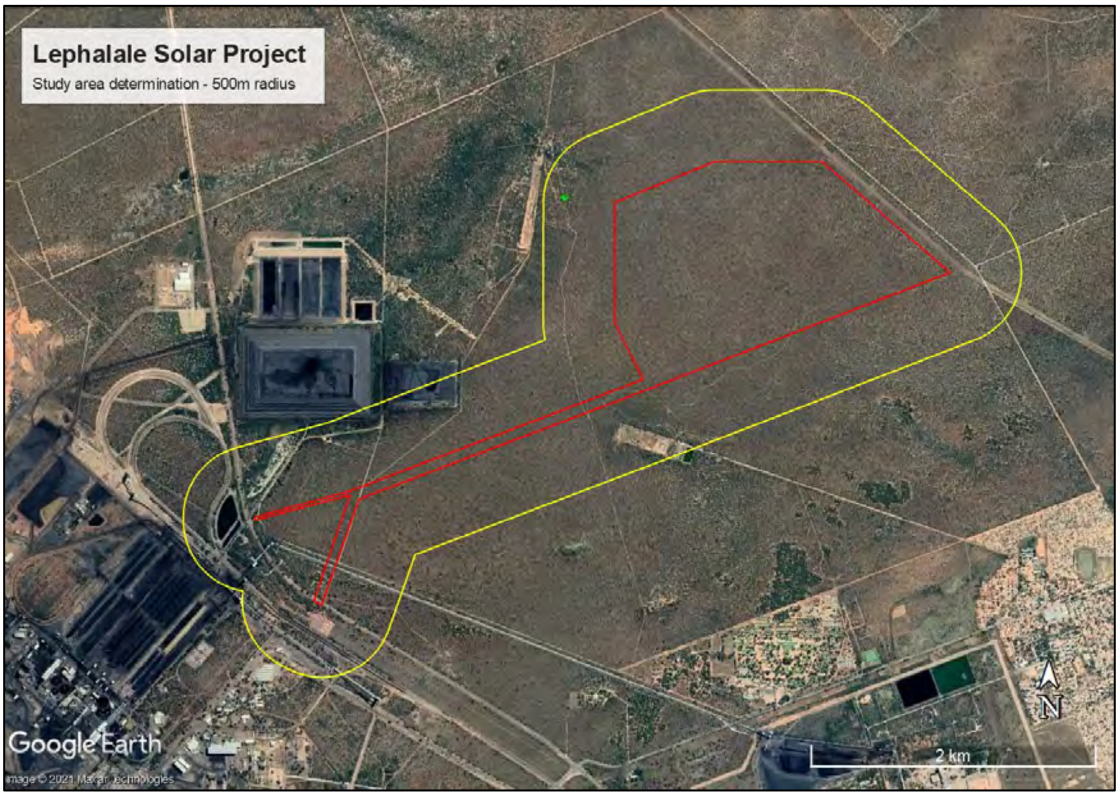


Figure 4-1: Extent of the aquatic ecological study area (500m radius in yellow)

5 EXPERTISE OF THE SPECIALIST

The *curriculum vitae* of the specialist, Mr Magnus van Rooyen is attached in Appendix A.
Mr Magnus van Rooyen is a registered natural scientist with the South African Council of Natural Scientific Professions (SACNASP) and holds a Master's degree in Environmental Management, a BSc Honours degree in Botany and a BSc degree in Botany and Zoology from the University of Stellenbosch. Mr van Rooyen has in excess of 15 years' experience in the field of wetland and terrestrial ecological studies in Southern and Western Africa.

6 AIMS AND OBJECTIVES

The aim and objectives of this study is as follows:

- Identification and classification of any possible wetlands within footprint of the development site;
- Identification and classification of any wetland and other aquatic features that are located within a 500m radius of the development site;
- Assessment of the identified wetlands which are considered to be directly impacted upon by the development;
- Modelling of the identified wetland and other aquatic features that may be directly impacted by the development;
- Identification of potential impacts on the wetlands and aquatic features;

- Management and mitigation measures to implemented to limit or mitigate these impacts; and
- Provision of applicable buffers around each of the wetlands that have been identified as being directly impacted upon by the development proposal.

7 SITE DESCRIPTION

7.1 Climate and Rainfall

The closest weather station to the site is the town of Lephalale approximately 16km to the southeast. As such, the climatological data for Lephalale is considered representative of the study area. The climatological condition on the site is characterized by long hot summers (early September to late April) and short cool winters (early May to late August). The mean daily maximum temperatures during the summer months vary between 28°C and 32°C while the mean daily minimum temperatures during the winter months vary between 7°C and 10°C.

The annual average rainfall for the area is approximately 930mm with rain falling mostly during the summer months. The rainfall events are characterized by localized to wide spread thundershowers as a result of moist tropical air from the north.

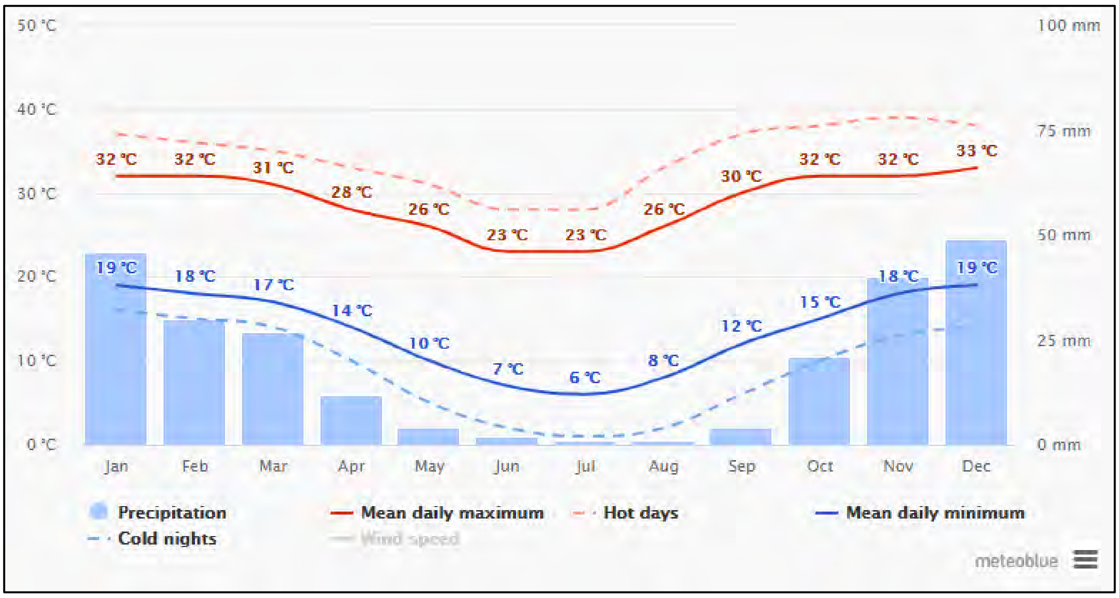


Figure 7-1: Lephalale Climate (Meteoblue.com)

7.2 Vegetation

The study area is located within the Limpopo Sweet Bushveld (SVcd19) vegetation type (Mucina and Rutherford, 2006). This vegetation type is characterized by savanna woodland plains with dense stands of *Acacia erubescens*, *Acacia mellifera* and *Dichrostachys cinerea*. The vegetation on the site primarily consists of woodland dominated by *Terminalia sericea*

(Silver Cluster Leaf), *Combretum apiculatum* (Red Bushwillow) and *Dichrostachys cinerea* (Sickle bush).

Other tree species of interest are *Sclerocarya birrea* subspecies *africana* (Marula), *Acacia nigrescens* (Knob-thorn Acacia), *Acacia erioloba* (Camel Thorn), *Acacia burkei* (Black-monkey Thorn); *Acacia meliffera* (Black-thorn Acacia), *Combretum imberbe* (Hardekool), *Philenoptera violacea* (Bushveld Apple-leaf) and *Gardenia volkensii* (Bushveld Gardenia).

The presence of dense stands of *Terminalia sericea* (Silver Cluster Leaf) on large parts of the site is indicative of historical overgrazing of the area. These trees are known bush encroachers and will settle in dense stands in areas of disturbance.

Plate 7-1: View of the vegetation within the study area

Plate 7-2: View of the vegetation within the study area

7.3 Soils

The study area falls within the Ab85 land type which is characterized by predominantly deep sandy to loam soils that are eutrophic. Soil colours vary from red through yellow-brown to bleached indicating a potential wetness gradient. Soils in higher lying areas lack signs of clay movement whereas soils in lower lying landscape positions often have varied cutanic character indicating signs of incipient soil formation.

7.4 Topography and drainage

The topography on the study site is very flat with a very small gradient in a northernly and easterly direction towards the Sandloop River to the east of the site. The fall across the site is approximately 3m over a distance of 2km.

The drainage from the site is very limited due to the high percolation rate of the sandy soils on the site. This, partnered to the flat topography leads to the absence of any aquatic features that will allow drainage.

7.5 Land use

The study site is understood to form part of the Manketti Private Nature Reserve which is under ownership of Exxaro. The reserve has a size of 22 000ha and houses a number of animal species typical to the area. The land use on the study site is therefore part of the private nature reserve.

Plate 7-3 Aerial view across the study area, looking in a south-easterly direction indicating the land use and topography

8 METHODOLOGY

The methodology that was followed in completing this study is in line with the requirements and specifications of the Department of Human Settlements, Water and Sanitation and includes the following aspects.

8.1 Wetland Identification and Mapping

The initial wetland identification process was conducted at a desktop level during which available GIS databases were interrogated to determine the presence of any wetland areas that has been determined in the past. The key database in that was interrogated was the National Freshwater Ecosystem Priority Area (NFEPA) as managed and updated by the South African National Biodiversity Institute (SANBI) as well as the databased managed by the SANBI.

In addition to the database interrogation, the most recent Google Earth and Zoom Earth Imagery of the site was considered to see if any wetland areas or “anomalies” within the site are visible.

Following the desktop assessment of the site, site visits were conducted on 8 April 2021, 21 April 2021 and 27 July 2021. During the site visits, the potential aquatic features identified through the desktop assessment were verified and any other aquatic features were identified and their boundaries accurately delineated.

8.2 Wetland Delineation

The delineation of these wetlands areas was conducted in accordance with the Department of Human Settlement, Water and Sanitation document, *“A practical field procedure for identification and delineation of wetlands and riparian areas”* (2005).

This field guide makes use of several specific indicators which show the presence and the boundaries of wetlands. The presence of the following indicators was used during the identification and delineation of the site:

- *Terrain Unit Indicator* - Identification of the part of the landscape where wetlands are more likely to occur;
- *Soil Form Indicator* - Identification of the soil types which are associated with prolonged and frequent saturation;
- *Soil Wetness Indicator* - Identification of the morphological signatures that develop in soil profiles as a result of prolonged and frequent saturation; and
- *Vegetation Indicator* - Identification of the hydrophilic vegetation associated with frequently saturated soil.

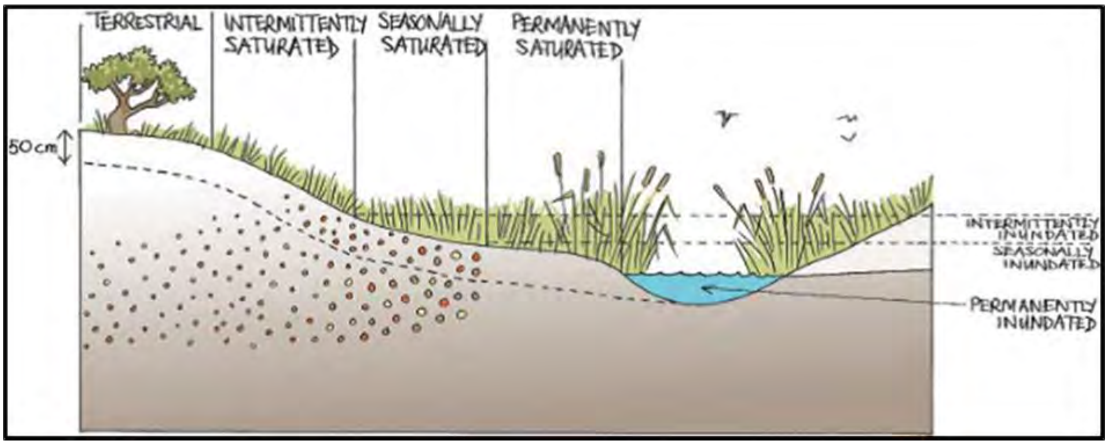
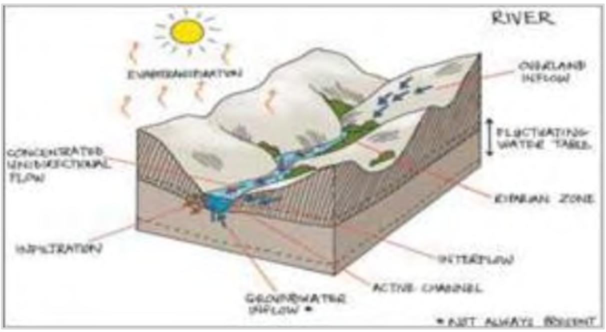
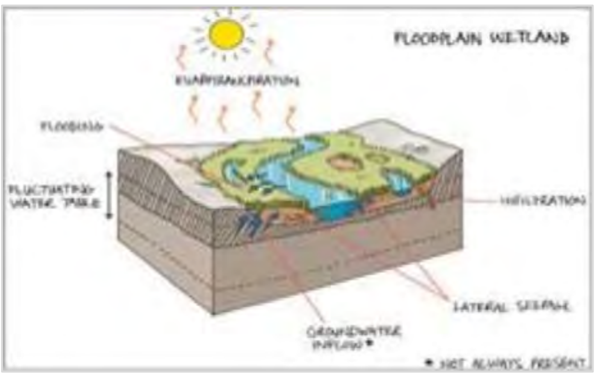
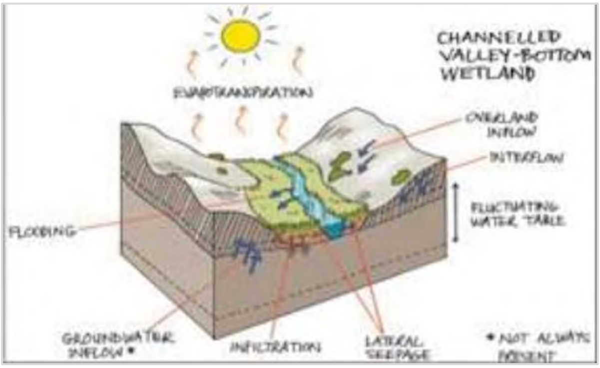
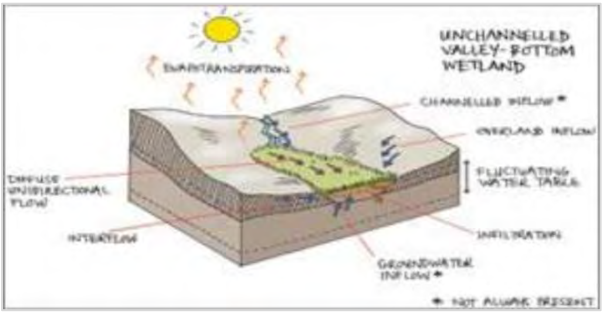
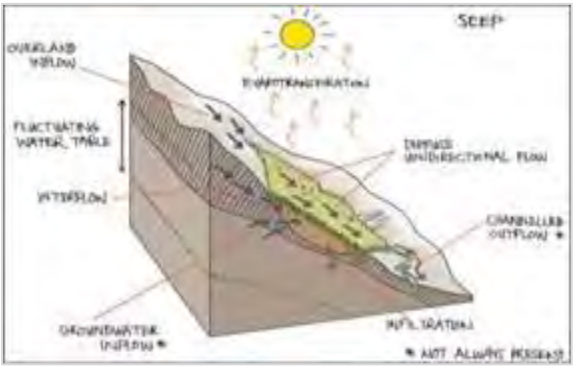
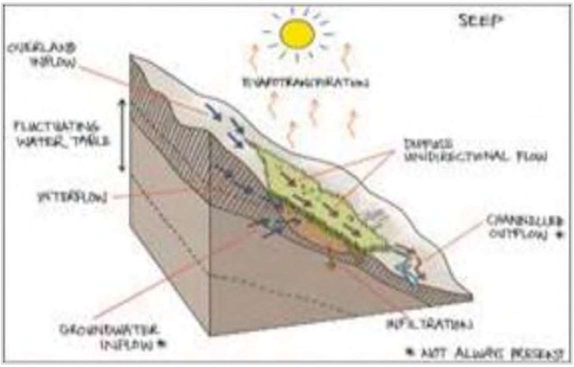


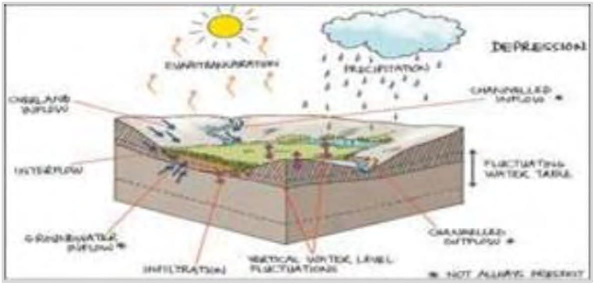
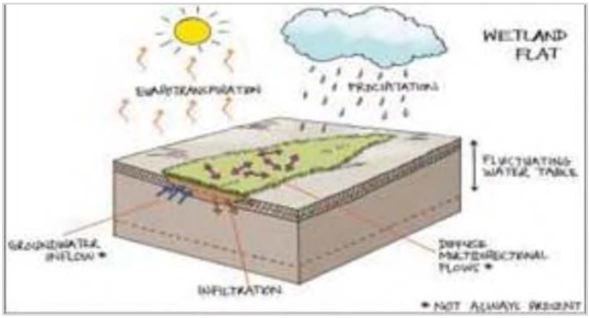
Figure 8-1: Cross section through a wetland, indicating the interaction between the soil wetness and vegetation

Following the identification of the wetland areas on the site, these are then classified into specific hydrogeomorphic (HGM) units according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa (inland systems) (Ollis et al., 2013).

Table 8-1: Wetland hydrogeomorphic (HGM) types typically supporting inland wetlands in South Africa (Ollis *et al.*, 2013)

Hydrogeomorphic types		Description
River		Rivers are linear landforms with clearly discernible banks and a channel, which permanently or periodically, carries a contained and defined flow of water. A river is taken to include both the active channel and the riparian zone.
Floodplain		Valley bottom areas with a well-defined stream channel, gently sloped and characterised by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.

Valley bottom with channel	 	Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterised by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley bottom without a channel	 	Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterised by alluvial sediment deposition generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.
Hillslope seepage linked to a stream channel	 	Slopes on hillsides, which are characterised by the colluvial (transported by gravity) movement of materials. Water inputs are mainly sub-surface flow and outflow is usually via a well- defined stream channel connecting the area directly to a stream channel.
Isolated Hillslope seepage	 	Similar to other hillslope seeps but with no direct surface water connection to a stream channel. Slopes on hillsides, which are characterised by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow primarily by diffuse sub-surface and/or limited surface flow.

Depression (includes Pans)		A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network.
Wetland Flat		A flat wetland with no apparent inlet or outlet points. Water is obtained from surface or near surface flows and is lost either by downward percolation or evapotranspiration. May be only seasonal in terms of its wetness and hydromorphic soils may be only weakly developed or else be absent. Vegetation may be the strongest indicator.

8.3 Riparian Delineation

The delineation of the riparian areas was conducted in accordance with the Department of Human Settlement, Water and Sanitation document, “A practical field procedure for identification and delineation of wetlands and riparian areas” (2005).

Like wetlands, riparian areas have their own unique set of indicators. It is possible to delineate riparian areas by checking for the presence of these indicators. The riparian delineation process takes the following physical aspects into consideration:

- *Topography associated with the watercourse* – The topography is a good rough indicator of the outer edge of the riparian area as the riparian edge is the same as the edge of the macro channel bank.
- *Vegetation* – The delineation of riparian areas relies primarily on the vegetative indicators. Using vegetation, the outer boundary of a riparian area must be adjacent to a watercourse and can be defined as the zone where a distinctive change occurs:
  - In species composition relative to the adjacent terrestrial area; and
  - In the physical structure, such as vigour or robustness of growth forms of species similar to that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure and/or numbers of individual plants.
- *Alluvial soils and deposited material* – Alluvial soils can be defined as relatively recent deposits of sand, mud, etc. set down by flowing water, especially in the valleys of large rivers. Riparian areas often, but not always, have alluvial soils.

8.4 Wetland Functional Assessment

Once the wetland areas had been identified and their boundaries determined, the assessment of the ecosystem services these wetland areas provide to the hydraulic system that they contribute to, as well as the immediate natural and social environment, was undertaken. An understanding of this functionality of the wetland contributes directly to the level importance that is attributed to the specific wetland is developed. The assessment was conducted by using a wetland modelling tool that forms part of the WET-Management Series (issued by the Water Research Commission), WET-EcoServices (Kotze *et al*. 2008).

The WET-EcoServices tool makes provision for the rapid assessment of the ecosystem services provided by a wetland and is designed for inland palustrine wetlands, i.e. marshes, floodplains, vleis and seeps. The process of applying the tool is based on the characterisation of hydrogeomorphic wetland types based on desktop and field assessment and observations of identified and delineated wetland areas. This model, furthermore, considers the biophysical and social conditions around a wetland and converts these considerations into a fixed score for a series of defined ecosystem services that the wetland delivers. The services include the following:

- Flood Attenuation
- Sediment trapping
- Nitrate Assimilation
- Erosion control
- Maintenance of biodiversity
- Provision of harvestable resources
- Cultural significance
- Education and research
- Streamflow regulation
- Phosphate assimilation
- Toxicant Assimilation
- Carbon storage (sequestration)
- Provision of water for human use
- Provision of cultivated food
- Tourism and recreation

The maximum score for any service is a value of 4 and the rating of the probable extent of the service is shown in the table below.

Table 8-2: Ecoservices rating of the probable extent to which a benefit is being supplied

Score	Rating of likely extent to which a benefit is being supplied
< 0.5	Low
0.6 - 1.2	Moderately Low
1.3 - 2.0	Intermediate
2.1 - 3.0	Moderately High
> 3.0	High

8.5 Determining the Present Ecological State of Wetlands

The determination of the present ecological state (PES) of wetlands was conducted by using a tool from the WET-Management Series (issued by the Water Research Commission), the WET-Health (Macfarlane et al. 2008).

This tool is designed to assess the health or integrity of a wetland. Wetland health is defined as a measure of the deviation of wetland structure and function form the wetland's natural reference condition. The tool therefore attempts to assess the hydrological, geomorphological and vegetation impacts that has been imparted on the wetland at the time of assessment. The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a PES score. This takes the form of assessing the spatial extent of impact of individual activities/occurrences and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The impact scores and Present State categories are provided in the tables below.

Table 8-3: The magnitude of impacts on wetland functionality (Macfarlane et al, 2008)

Impact Category	Description	Score
None	No Discernible modification or the modification is such that it has no impacts on the wetland integrity	0 to 0.9
Small	Although identifiable, the impact of this modification on the wetland integrity is small.	1.0 to 1.9
Moderate	The impact of this modification on the wetland integrity is clearly identifiable, but limited.	2.0 to 3.9
Large	The modification has a clearly detrimental impact on the wetland integrity. Approximately 50% of wetland integrity has been lost.	4.0 to 5.9
Serious	The modification has a highly detrimental effect on the wetland integrity. More than 50% of the wetland integrity has been lost.	6.0 to 7.9
Critical	The modification is so great that the ecosystem process of the wetland integrity is almost totally destroyed, and 80% or more of the integrity has been lost.	8.0 to 10

The level of impacts on these three parameters is a direct indication of the PES of the wetland as well as the functioning of the wetland. A wetland area that has undergone severe impacts on its hydrology, geomorphology or vegetation or a combination of all three will reflect a low present ecological state while the converse is also true for pristine wetlands. Since hydrology, geomorphology and vegetation are interlinked in the model, their scores are aggregated to obtain the overall PES health score using the formula:

Health = ((Hydrology value x 3) + (Geomorphology value x 2) + (Vegetation value x 2))/7

Table 8-4: Definitions of the PES categories (Macfarlane *et al*, 2008)

Impact Category	Description	Impact Score Range	Present State Category
None	Unmodified, natural	0 to 0.9	A
Small	Largely Natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1.0 to 1.9	B
Moderate	Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.	2.0 to 3.9	C
Large	Largely Modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4.0 to 5.9	D
Serious	Seriously Modified. The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognizable.	6.0 to 7.9	E
Critical	Critical Modification. The modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.0 to 10	F

8.6 Determining the Ecological Integrity of the Wetlands

The ecological integrity (EI) of a wetland is determined by a combining the findings of the WET-EcoServices and WET-Health tool as both these tools provide considerations in this regard. For instance, a wetland that makes very little ecosystem services contribution to the hydraulic system that it is linked to and has a low PES score will consequently have a low ecological integrity. The converse is also therefore true for wetlands making a large ecological contribution to the hydraulic system it is linked to as well as a high PES score.

8.7 Determining the Ecological Importance and Sensitivity of Wetlands

The outcomes of the implementation of the WET-EcoServices tool discussed above, is key in the determination of the ecological importance and sensitivity of wetlands as the results is a direct indication of the contribution that the wetland is making to the hydraulic system with which it is linked. This contribution is linked to the sensitivity of this wetland to any possible change and how this will impact on the hydraulic system it is linked to.

8.8 Ecological Classification and Description

The ecological classification and description are direct results of the implementation of the methodology and tools described above as the results of these determinations contribute to the understanding of the ecology of the wetland. The description of the wetland will therefore make provision for a description of the physical attributes of the wetland (location, size, etc.), the ecosystem services that the wetland provides, the current ecological state of the wetland and the importance of the wetland as well as its sensitivity.

8.9 Hydropedological conditions

The methodology used to conduct the assessment consists of a Desktop Assessment of the soils on the property. This assessment aims to characterize the dominant surface and subsurface flow paths of water through the landscape to wetland and streams or groundwater. The key steps to follow during the desktop assessment is as follows:

1. Identification of dominant hillslopes;
2. Conceptualizing hillslope hydropedological responses;
3. Quantification of hydraulic properties and flowrates; and
4. Quantification of hydropedological fluxes.

Only steps 1 and 2 above has been conducted for this assessment as the nature of the development will not result in a drastic land use change (e.g. open cast mine, etc.).

The hydropedological conditions on the assessment area was determined by using desktop soil classifications to assist in the understanding of the soil characteristics that are present on the site. In addition to the soil characteristics, various GIS datasets were used to determine the various slopes that occur within the development area to identify areas that may be prone to the development of seep wetland areas.

The desktop soil classification will be used to categories the soils on the site into the applicable hydropedological soil type based on their characteristics. These soil types and their descriptions are provided in Table 8-5.

Table 8-5: Hydropedological soil categories (Le Roux, et al., 2015)

Hydropedo-logical soil type	Description	Symbol
Recharge	Soils without any morphological indication of saturation. Vertical flow through and out the profile into the underlying bedrock is the dominant flow direction. These soils can either be shallow or fractured bedrock with limited contribution to evapotranspiration or deep freely drained soils with significant contribution to evapotranspiration.	
Interflow (A/B)	Duplex soils where the textural discontinuity facilitates build-up of water in the topsoil. Duration of drainable water depends on the rate of evapotranspiration, position in the hillslope (lateral addition/release) and slope (discharge in a predominantly lateral direction).	
Interflow (soil/bedrock)	Soils overlying relatively impermeable bedrock. Hydromorphic properties signify temporal build-up of water on the soil/bedrock interface and slow discharge in a predominantly lateral direction.	

Responsive (shallow)	Shallow soils overlying relatively impermeable bedrock. Limited storage capacity results in the generation of overland flow after rain events.	
Responsive (saturated)	Soils with morphological evidence of long periods of saturation. These soils are close to saturation during rainy seasons and promote the generation of overland flow due to saturation excess.	

9 RESULTS

The results of the Wetland Assessment relates to wetlands and watercourses that occur within the property boundaries and the 500m radius from these property boundaries.

9.1 Wetland Identification and delineation

The available desktop information that was used in this assessment consisted of the following:

- National Freshwater Ecosystem Priority Areas (NFEPA) (2014);
- SANBI wetland database (2008); and
- Critically Endangered and Endangered Ecosystems (SANBI, 2012).
-

The NFEPA database indicates the presence of a single area that shows wetland characteristics and identifies this feature as artificial in nature (see Fig. 9-1) while the SANBI wetland database does not indicated any wetland features within the study area.

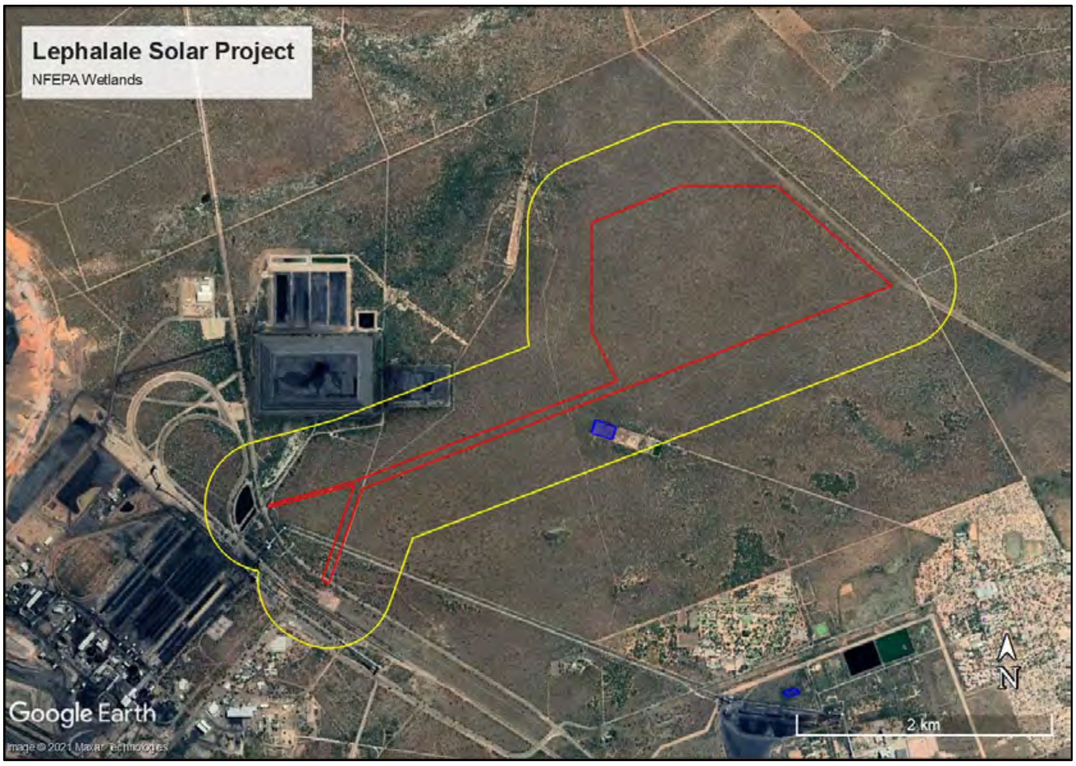


Figure 9-1: Locality of the NFEPA wetlands (shown in blue) in the study area

The site assessment confirmed the presence of the artificial wetland area that has been identified by the NFEPA database. This artificial wetland area is directly associated drying beds that are associated with the Waste Water Treatment Works that services the residential area of Marapong to the southeast of the site.

Plate 9-1: Aerial view of the Waste Water Treatment Works and associated drying beds

Furthermore, the site assessment identified a wetland area located approximately 350m to the northwest of the site boundary. This wetland area is considered artificial in nature as the water supply is provided by a borehole. The feature is considered to be an artificial watering hole for game and is/has been used for game viewing purposes which is evident by the presence of a viewing hide.

No natural wetland features were identified within the study area during the site assessment.

Plate 9-2: View of the watering hole and associated infrastructure

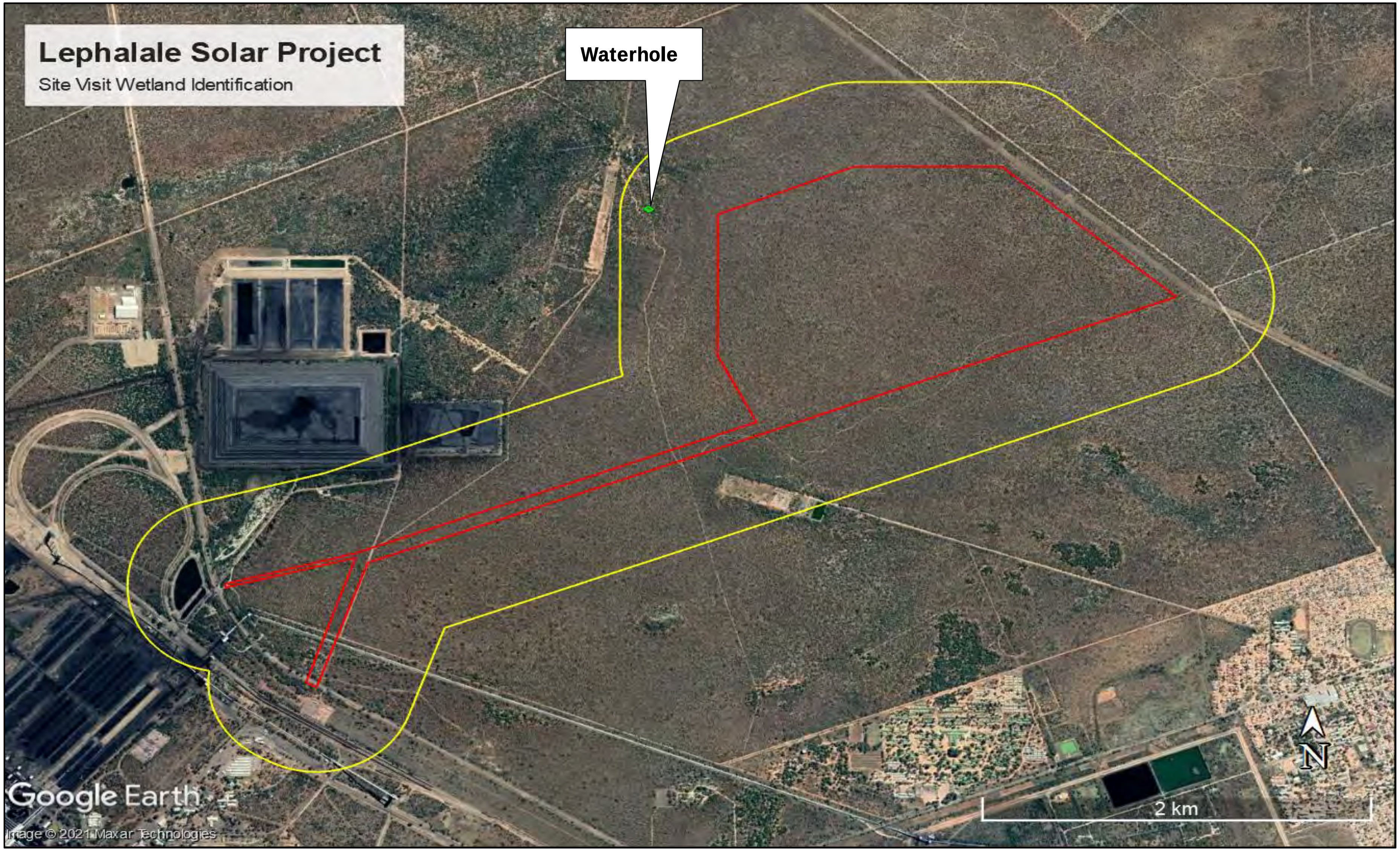


Figure 9-2: Location of the watering hole in relation to the site boundaries

9.2 Wetland Unit Setting

As no natural wetland features were identified within the study area, no discussion can be provided regarding the wetland unit setting.

9.3 Riparian Delineation

The NFEPA databased does not identify any rivers within the study area. According to the database, the closest river to the study area is the Sandloop Rivier approximately 5km to the east of the site (see Fig. 8-2) which is a tributary of the Mokolo Rivier.

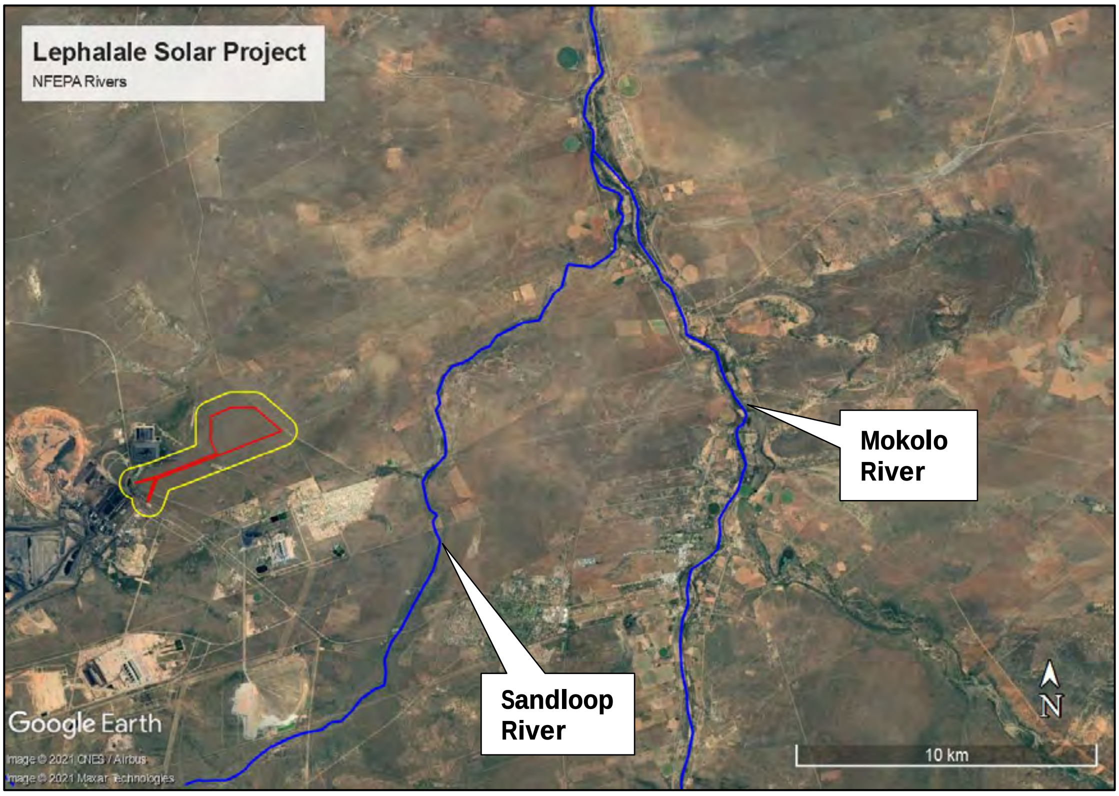


Figure 9-3: Location of the NFEPA rivers (shown in blue) in relation to the study area

The site assessment confirmed the presence of the rivers identified in the NFEPA database as well as the absence of any watercourses within the study area. As such, no further assessment will be conducted on watercourse or riparian areas.

9.4 Description of Wetland Type

No natural wetland features were identified within the study area so no further assessment will be conducted in this regard.

9.5 Wetland Soils

No natural wetland features were identified within the study area so no further assessment will be conducted in this regard.

9.6 General Functional Description of Wetland Types

No natural wetland features were identified within the study area so no further assessment will be conducted in this regard.

9.7 Wetland Ecological Functional Assessment

No natural wetland features were identified within the study area so no further assessment will be conducted in this regard.

9.8 The Present Ecological State of the wetlands

No natural wetland features were identified within the study area so no further assessment will be conducted in this regard.

9.9 Ecological importance and sensitivity of the wetland

No natural wetland features were identified within the study area so no further assessment will be conducted in this regard.

9.10 Buffer determination

No natural wetland features were identified within the study area so no further assessment will be conducted in this regard.

9.11 Hydropedological conditions

No natural wetland features were identified within the study area so no further assessment will be conducted in this regard.

10 IMPACT ASSESSMENT

In the absence of any wetland areas or watercourses within the study area, the development of the Lephalale Solar Project will not have any impact on any such features.

11 MANAGEMENT AND MITIGATION MEASURES

In the absence of any impacts on wetland areas or watercourses within the study area, no management of mitigation measures relating to these features are applicable.

12 REASONED OPINION BY THE SPECIALIST

Appendix 6 of the National Environmental Management Act (Act No. 107 of 1998): Environmental Impact Assessment Regulations (2014), as amended requires that the specialist conducting a specialist study for submission with an Application for Environmental Authorisation provide a reasoned opinion on whether an authorisation should be granted.

As such, based on the findings of the Wetland Assessment, there is no fatal flaws relating to the presence of any wetland areas or watercourses that should prevent the development to proceed.

13 CONCLUSION

Based on the findings of the assessment it is the opinion of the Specialist that there are no reasons that the development should not be authorised in accordance with the specifications as presented in this assessment.

14 REFERENCES

MUCINA, L. and RUTHERFORD, M.C. (eds.), 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia Publishers.

APPENDIX A

SPECIALIST CURRICULUM VITAE

APPENDIX B

SPECIALIST DECLARATION

APPENDIX E7: SOCIO-ECONOMIC IMPACT ASSESSMENT

SOCIAL IMPACT ASSESSMENT FOR THE LEPHALALE SOLAR PROJECT NEAR LEPHALALE, LIMPOPO PROVINCE

SOCIAL IMPACT ASSESSMENT REPORT
May 2021

Prepared by:

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SOCIAL IMPACT ASSESSORS

Social Impact Assessors
PO Box 145412
Bracken Gardens
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Submitted to:

GCS
Water & Environmental Consultants

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Sandton
South Africa

DETAILS OF PROJECT

Report Title	:	Social Impact Assessment for the Proposed Lephalale Solar Project near Lephalale, Limpopo Province.
Author	:	Dr Neville Bews
DEA Reference Number	:	K2021699383 (South Africa) (PTY) LTD. Reg no 2021/699383/07
Project Developer	:	Exxaro Power
Environmental Consultant	:	GCS (Pty) Ltd
GCS Ref No		21-0037
Zutari Ref		1001395-G040-REP-NN-0004
Review Period	:	04 April 2021 – 06 July 2021
Status of Report	:	Final

EXECUTIVE SUMMARY

INTRODUCTION

The Lephalale Solar Facility proposes to take advantage of the option to supplement the electricity required and purchased by the Grootegeluk Coal Mine from Eskom through the self-generation of electricity from the solar energy resource, by constructing and operating the Lephalale Solar PV Facility. This opportunity leverages the potential cost savings of such supplementary supply, while taking advantage of the reduced carbon footprint of the renewable nature of the technology.

In terms of the Environmental Impact Assessment (EIA) Regulations, published on 04 December 2014, as amended on 07 April 2017; various aspects of the proposed development are considered listed activities under GNR 327 and GNR 324 which may have an impact on the environment and therefore require authorisation from the Department of Environment, Forestry and Fisheries (DEFF). GCS Water & Environmental Consultants (Pty) Ltd (GCS) was appointed as the independent Environmental Assessment Practitioner (EAP), tasked with undertaking the required environmental assessment for the project and has accordingly sub-contracted Dr Neville Bews & Associates (NBA) to undertake a social impact assessment in respect the project.

PROJECT DESCRIPTION

The proposed project, referred to as the Lephalale Solar PV Facility, will make use of solar PV technology to generate electricity from the sun and consist of a maximum installed capacity of approximately 100 MWp (DC), with an export capacity of approximately 80 MWac (AC). The facility will be an embedded generator, connecting “behind the meter” at the Grootegeluk Mine. The development footprint is approximately 256 hectares, however the generation capacity may vary based on the availability of more efficient PV panels.

LOCATION

The Lephalale Solar PV Facility and associated infrastructure is to be located on the farm Appelvlakte 448 LQ which is the property of Exxaro Grootegeluk Coal Mine and is located in the Lephalale Local Municipality, Waterberg District, Limpopo Province.

IMPACTS IDENTIFIED

The potential social impacts associated with the project are as follows:

Construction Phase

Health and social wellbeing

- Annoyance, air quality and noise
- Increase in crime
- Increased risk of HIV infections
- An influx of workers and job seekers
- Hazard exposure.

Quality of the living environment

- Disruption of daily living patterns
- Disruptions to social and community infrastructure.

Economic

- Job creation and skills development
- Socio-economic stimulation.

Operational Phase

Health and wellbeing

- Glare and glint.

Quality of the living environment

- Transformation of the sense of place.

Economic

- Job creation and skills development
- Socio-economic stimulation.

Cumulative impacts

Health and social wellbeing

- Risk of HIV and AIDS.

Quality of the living environment

- Population growth
- Sense of place
- Service supplies and infrastructure and.

Economic

- Job creation and skills development
- Socio-economic stimulation.

A pre- and post-mitigation comparison of the impacts is presented in a tabular format below.

The no project option would mean that the social environment is not affected as the status quo remains. On a negative front, it would also mean that all the positive aspects associated with the project would not materialise.

COMPARATIVE ASSESSMENT OF LAYOUT ALTERNATIVES

Although it is necessary to consider viable alternatives regarding the project, the only viable alternatives that existed were two alternatives in respect of the access to roads and power lines. These alternatives were assessed during the basic assessment and it was found that.

> "*From a visual perspective the preferred alternatives for both the access road off the Stockpoort road and the proposed power line are supported by virtue of their shorter length. Furthermore, the preferred access road is located on the alignment of existing roads for the most part*" (Savannah Environmental, 2011, p. 86).

On a social basis, less of a visual intrusion would be preferred and therefore the shorter power line option and preferred access road would be supported.

The requirement to make minor adjustments to the associated infrastructure during the detailed engineering phase of the project, in order to avoid any social and/or environmental obstacles that may become apparent, is also supported. Apart from this no further social preferences have emerged in respect of any of the alternatives.

IMPACT SUMMARY

Construction Phase			
Environmental parameter	Issues	Rating prior to mitigation	Rating post-mitigation
Health & social wellbeing	Annoyance, air quality and noise	-91 M	-72 M
	Increase in crime	-104 M	-91 M
	Increased risk of HIV infections	-120 M	-120 M
	An influx of construction workers	-49 L	-42 L
	Hazard exposure.	-104 M	-91 M
Quality of the living environment	Disruption of daily living patterns	-70 M	-48 L
	Disruptions to social and community infrastructure	-164M	-56 M
Economic	Job creation and skills development	+72 M	-104 M
	Socio-economic stimulation	+ 99 M	-120 M
Operational Phase			
Health & Wellbeing	Glint & glare	-72 M	-72 M
Quality of the living environment	Transformation of the sense of place	-130 M	-120 M
Economic	Positive economic impacts	+168 M	+168 M
	Socio-economic stimulation	+99 M	+120 M
Decommissioning Phase			
Considering a time period of 20 years plus, prior to decommissioning, and the dynamics of social variables, it would be rather meaningless to attach assessment criteria to decommissioning at this point due to the high level of uncertainty that such assessment would be based upon.			
No Project Alternative			
No project	Project does not proceed	-156 M	No mitigation measures
Cumulative Impacts			
Health & social wellbeing	Risk of HIV	-196 H	-196 H
Quality of the living environment	Sense of place	-182 H	-182 H
	Population increase	-182 H	-182 H
	Services, supplies & infrastructure	-143 M	-143 M
Economic	Economic	+182 H	+182 H

CONCLUSION

Regarding the negative impacts associated with the project, it was evident that most apply over the short-term construction phase of the project. Of these impacts, all can be mitigated to within acceptable ranges and there are no social fatal flaws associated with the construction or operation of the project. Although over the operational phase, the project will be visible and is likely to alter the sense of place of the area, this should be limited to the extent that the PV facility and infrastructure is placed within an industrialised setting.

On a cumulative basis, considering a range of developments that have occurred over an extended period in the area; Lephalale and surrounds have undergone extensive transformation. Although the project will contribute towards this transformation, this will be at an insignificant level, as the project falls within what is already an industrialised area with Grootegeluk Coal Mine, Matimba and Medupi power stations and associated infrastructure all within close proximity.

On the positive front the project clearly fits with policy and legislation and the Presidential announcement to increase the threshold for generation license exemptions for embedded generation projects from 1 MW to 100 MW. In this regard the project will not only ensure that the mine enjoys a more reliable, available and sustainable electricity supply but will also contribute towards reducing CO^2 emissions. On a cumulative basis, considering other renewable energy initiatives across the country and the opportunity of wheeling surplus energy to the grid, the project could also have a positive effect on the security of the National Electricity Grid.

Impact statement

Considering all social impacts associated with the project, it is evident that the positive elements outweigh the negative, and that the project carries with it a significant social benefit and as such is supported and should proceed. In addition, the project fits with the Government's requirement for the urgent generation of electricity by means of renewable energy initiatives.

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LIST OF ABBREVIATIONS

AIDS	Acquired immunodeficiency syndrome
AC	Alternating current
BESS	Battery energy storage system
BID	Background Information Document
DBSA	Development Bank of South Africa
DEFF	Department of Environment, Forestry and Fisheries
DEAT	Department of Environmental Affairs and Tourism
DWS	Department of Water and Sanitation
DM	District Municipality
EIA	Environmental Impact Assessment
GPS	Global Positioning System
HIA	Heritage Impact Assessment
HIV	Human Immunodeficiency Virus
I&AP	Interested and Affected Party
IDP	Integrated Development Plan
IPPPP	Independent Power Producers Procurement Programme
IRP	Integrated Resource Plan
IRR	Issues and Response Report
kV	Kilovolt
LM	Local Municipality
MW	Megawatt
NEMA	National Environmental Management Act (No. 107 of 1998)
NERSA	The National Energy Regulator of South Africa
NGO	Non-Governmental Organisation
OHS	Occupational Health and Safety
O&M	Operation and Maintenance
PA	Per Annum (Yearly)
PGDS	Provincial Growth and Development Strategy
PV	Photovoltaic
PPP	Public Participation Process
REIPPPP	Renewable Energy Independent Power Producer Procurement Program
SACPVP	South African Council for the Property Valuers Profession

SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
SDF	Spatial Development Framework
SIA	Social Impact Assessment
SIPs	Strategic Integrated Projects
SMME	Small Medium and Micro Enterprises
Stats SA	Statistics South Africa
STDs	Sexually Transmitted Diseases
ToR	Terms of Reference

QUALIFICATIONS AND EXPERIENCE OF SPECIALIST

Qualifications:

University of South Africa: B.A. (Honours) – 1984

Henley Management College, United Kingdom: The Henley Post-Graduate Certificate in Management – 1997

Rand Afrikaans University: M.A. (cum laude) – 1999

Rand Afrikaans University: D. Litt. et Phil. – 2000

Projects:

The Social Impact Assessment (SIA) for the Gautrain Rapid Rail Link; The impact assessment for the Australian – South African sports development programme; SIA for Kumba Resources, Sishen South Project; Evaluation of a Centre for Violence Against Women for The United Nations Office on Drugs and Crime; SIAs for the following Exxaro Resources Ltd.'s mines, Leeuwpan Coal Mine Delmas, Glen Douglas Dolomite Mine Henley-on-Klip, Grootegeluk Open Cast Coal Mine Lephalale; SIA for the South African National Road Agency Limited (SANRAL) on Gauteng Freeway Improvement Project; SIA for SANRAL on the N2 Wild Coast Toll Highway; Research into research outputs of the University for the University of Johannesburg; SIA for Waterfall Wedge housing and business development in Midrand Gauteng; SIA for the Environmental Management Plan for Sedibeng District Municipality; Social and Labour Plan for the Belfast Project on behalf of Exxaro Resources Ltd; SIA for the Transnet New Multi-Product Pipeline (Commercial Farmers) on behalf of Golder Associates Africa (Pty) Ltd; SIA for the Proposed Vale Moatize Power Plant Project in Mozambique on behalf of Golder Associates Africa (Pty) Ltd; SIA for Kumba Resources Ltd.'s proposed Dingleton Resettlement Project at Sishen Iron Ore Mine on behalf of Water for Africa (Pty) Ltd; SIA for Gold Fields West Wits Project for EcoPartners; SIA for the Belfast Project for Exxaro Resources Ltd; SIA for Eskom Holdings Ltd.'s Proposed Ubertas 88/11 kV Substation on behalf of KV3 Engineers (Pty) Ltd; SIA for the Mokolo and Crocodile River (West) Water Augmentation Project for the Department of Water and Sanitation on behalf of Nemai Consulting and the Trans Caledonian Water Authority; Assisted Octagon Consulting with the SIA for Eskom's Nuclear 1 Power Plant on behalf of Arcus GIBB Engineering & Science. SIA for the 150 MW Photovoltaic Power Plant and Associated Infrastructure for Italgest Energy (Pty) Ltd, on behalf of Kalahari Survey Solutions cc. SIA for Eskom Holdings Limited, Transmission Division's Neptune-Poseidon 400kV Power Line on behalf of Nemai Consulting. Ncwabeni Off-Channel Storage Dam for the security of water supply in Umzumbe, Mpumalanga. Social Impact Assessment for Eskom Holdings Limited, Transmission Division, Forskor-Merensky 275kV ±130km Powerline and Associated Substation Works in Limpopo Province. Social impact assessment for the proposed infilling of the Model Yacht Pond at Blue Lagoon, Stiebel Place, Durban.ABC Prieska Solar Project; Proposed 75 MWp Photovoltaic Power Plant and its associated infrastructure on a portion of the remaining extent of ERF 1 Prieska, Northern Cape.Sekoko Wayland Iron Ore, Molemole Local Municipalities in Limpopo Province.Langpan Chrome Mine, Thabazimbi, Limpopo; Jozini Nodal Expansion Implementation Project, Mpumalanga, on behalf of Nemai Consulting; SIA for Glen Douglas Dolomite Burning Project, Midvaal Gauteng, on behalf of Afrimat Limited; SIA for Lyttelton Dolomite mine Dolomite Burning Project, Marble Hall Limpopo on behalf of Afrimat Limited; Tubatse Strengthening Phase 1 – Senakangwedi B Integration for Eskom Transmission on behalf of Nsovo Environmental Consulting; Department of Water and Sanitation, South Africa (2014). Environmental Impact Assessment for the Mzimvubu Water Project: Social Impact Assessment DWS Report No: P WMA 12/T30/00/5314/7. Umkhomazi Water Project Phase 1 – Raw Water Component Smithfield Dam - 14/12/16/3/3/3/94; Water Conveyance Infrastructure - 14/12/16/3/3/3/94/1; Balancing Dam - 14/12/16/3/3/3/94/2. Umkhomazi Water Project Phase 1 – Potable Water Component: 14/12/16/3/3/3/95. Expansion of Railway Loops at Arthursview; Paul; Phokeng and Rooiheuwel Sidings in the Bojanala Platinum District Municipality in the North West Province for Transnet Soc Ltd; Basic Social Impact Assessment for the Cato Ridge Crematorium in Kwazulu-Natal Province; SIA for the Kennedy Road Housing Project, Ward 25 situated on 316 Kennedy Road, Clare Hills (Erf 301, Portion 5); Eskom's Mulalo Main Transmission Substation and Power Line Integration Project, Secunda;

Regularly lecture in the Department of Sociology at the University of Johannesburg and collaborated with Prof.Henk Becker of Utrecht University, the Netherlands, in a joint lecture to present the Social Impact Assessment Masters course via video link between the Netherlands and South Africa. Presented papers on Social Impact Assessments at both national and international seminars. Published on both a national and international level.

Affiliation:

Registered on the database for scientific peer review of iSimangaliso GEF project outputs.

DECLARATION OF INDEPENDENCE

I, Neville Bews, as the appointed independent specialist, in terms of the 2014 EIA Regulations, hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application objectively, even if this results in views and findings that are not favourable to the applicant;
- I regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- 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 have no vested interest in the proposed activity proceeding;
- 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 concerning 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;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study 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: 

Name of Specialist: Neville Bews

Date: 06 July 2021

1. INTRODUCTION

The Lephalale Solar Facility proposes to take advantage of the option to supplement the electricity required and purchased by the Grootegeluk Coal Mine from Eskom through the self-generation of electricity from the solar energy resource, by constructing and operating the Lephalale Solar PV Facility. This opportunity leverages the potential cost savings of such supplementary supply, while taking advantage of the reduced carbon footprint of the renewable nature of the technology.

In terms of the Environmental Impact Assessment (EIA) Regulations, published on 04 December 2014, as amended on 07 April 2017; various aspects of the proposed development are considered listed activities under GNR 327 and GNR 324 which may have an impact on the environment and therefore require authorisation from the Department of Environment, Forestry and Fisheries (DEFF). GCS Water & Environmental Consultants (Pty) Ltd (GCS) was appointed as the independent Environmental Assessment Practitioner (EAP), tasked with undertaking the required environmental assessment for the project and has accordingly sub-contracted Dr Neville Bews & Associates (NBA) to undertake a social impact assessment in respect the project.

1.1. PURPOSE OF REPORT

The purpose of the report is to identify the social baseline conditions in which the proposed project will unfold and acquire an understanding of the proposed project. Against this background, the primary objective is to identify the issues and concerns associated with the Lephalale Solar PV Facility and to identify, assess and propose mitigation measures in respect of the likely social impacts that may occur as a result of the proposed project.

1.2. STRUCTURE OF THE REPORT

This specialist study is undertaken in compliance with Requirements of Appendix 6 – GN R326 EIA Regulations 2014, as amended on 7 April 2017. **Table 1** indicates how the requirements of Appendix 6 have been fulfilled in this report.

Table 1: Report content requirements in terms of EIA Regulations

Requirements of Appendix 6 – GN R326 EIA Regulations 2014, as amended on 7 April 2017	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;	Page xiv
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page xvi
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.1 & 1.3
(cA) an indication of the quality and age of base data used for the specialist report;	Section: 1.5.2
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 6 & 7
(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 specialised process inclusive of equipment and modelling used;	Section 1.4 & Appendix 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;	Section 6 & 7
(g) an identification of any areas to be avoided, including buffers;	N/A
(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;	Section 2.2 Figure 1
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.5
(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;	Section: Sections: 6, 7, 8 & 9
(k) any mitigation measures for inclusion in the EMPr;	Section 6
(l) any conditions for inclusion in the environmental authorisation;	N/A
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section: 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;	Section 10
(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 -No feedback has yet been received from the public participation process regarding the visual environment
(q) any other information requested by the competent authority.	N/A. No information regarding the SIA has been requested from the competent authority to date.
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

1.3. TERMS OF REFERENCE

To undertake an SIA in respect of the proposed, Lephalale Solar Project near Lephalale, Limpopo Province. To consider the extent of the proposed project and its likely effect on the social environment within which the project will be placed.

General requirements:

- Adherence to all appropriate best practice guidelines, relevant legislation and authority requirements;
- Adherence to the content requirements for specialist reports in accordance with Appendix 6 of the EIA Regulations 2014, as amended;
- Identification of sensitive areas to be avoided (if any);
- An assessment and impact significance ratings of the impacts with regard to pre-construction, construction, operational and the decommissioning of the project;
- Cumulative impact identification and assessment as a result of other projects in the area;
- An assessment of the significance of the cumulative impacts;
- Comparative assessment of alternatives;
- Recommend mitigation measures in order to minimise the impacts of the proposed development and note any specific mitigation measures for a particular phase.

1.4. APPROACH TO STUDY

Data was gathered through the following techniques.

1.4.1. COLLECTION OF DATA

Data was gathered through:

- The project description prepared by Lephalale Solar Project Team.
- Statistics South Africa, Census 2011 and other relevant demographic data generated by Stats SA such as the Quarterly Labour Force Survey and Mid-year Population Estimates.
- Discussions with the project proponents and Environmental Impact Assessment Consultants, GCS Water & Environmental Consultants.
- A literature review of various documents such as the relevant Municipal Integrated Development Plans (IDPs) and other specialist reports and documents.
- A broader literature scan.

1.4.2. Impact assessment technique

The assessment technique used to evaluate the social impacts was provided by GCS Environmental Consultants and is attached in **Appendix 1**.

1.5. Assumptions and limitations

The following assumptions and limitations apply in respect to this report.

1.5.1. Assumptions

It is assumed that the technical information provided by the project proponent, Lephalale Solar Power and the environmental consultants, GCS, was credible and accurate at the time of compiling the report. It is also assumed that the data provided by the various specialists as used in this report are credible and accurate.

1.5.2. Limitations

The demographic data used in this report was sourced from Statistics South Africa and is based on data gathered during Census 2011 and Community Survey 2016. This data is somewhat outdated but where possible is supplemented with the latest Stats SA's Survey data such as the Mid-year population estimates and the Quarterly Labour Force Survey. The limitation of this is that this survey data is restricted to a provincial level and does not extend to a municipal level.

The study was undertaken during the State of National Disaster declared in South Africa because of the COVID-19 pandemic at the midst of the third wave of infections. Accordingly, the need for social distancing and limiting unnecessary interpersonal contact and travel was respected throughout this study.

2. Project Description

The proposed project, referred to as the Lephalale Solar PV Facility, will make use of solar PV technology to generate electricity from the sun and consist of a maximum installed capacity of approximately 100 MWp (DC), with an export capacity of approximately 80 MWac (AC). The facility will be an embedded generator, connecting "behind the meter" at the Grootegeluk Mine. The development footprint is approximately 256 hectares, however the generation capacity may vary based on the availability of more efficient PV panels.

2.1. ENERGY FACILITY COMPONENTS

The solar facility will consist of the following components:

- Solar Field:
  - ≤250 ha Free Field Single Axis Tracker PV – 100 MWp;
  - Solar module mounting structures comprised of galvanized steel and aluminum; and
  - Buried electrical cables connecting the PV arrays to the inverter stations, O&M building, and collector substation; and
  - Inverter/MV transformer stations.
- Collector substation:
  - ≤1 ha 22/33 kV to 132 kV collector substation to receive, convert and step-up electricity from the PV facility to the 132 kV grid suitable supply. The facility will house control rooms and grid control yards for the Independent Power Producer.
- O&M area:
  - Operations and Maintenance (O&M) buildings;
  - ≤9 ha hectare O&M laydown area (near / adjacent substation);
  - ≤0.01 ha solar measuring station;
  - Parking, reception area, offices, guest accommodations and ablution facilities for operational staff, security and visitors;
  - Workshops, storage areas for materials and spare parts;
  - Water storage tanks (~160 kl/day during first 3 months; ~90 kl/day for 21 months during the rest of the construction period; ~20 kl/day during operation);
  - One 5kl septic tank and sewer lines to service ablution facilities; and
  - Central Waste collection and storage area.
- Power line
  - The power will be transmitted from the onsite substation complex into the Grootegeluk Substation via a 132 kV overhead transmission line. The route for the transmission line only traverses Exxaro owned land.
- Battery Energy Storage System:
  - 100 MWh battery energy storage system (BESS) with container heights of 5 m (with lightning masts of 20 m) and a volume of 2,700 m^3 of batteries and associated operational, safety and control infrastructure.
- Access road:
  - ≤ 15 km long, ≤8 m wide gravel access road running from the main Lephalale road to the site.

- Service roads:
  - ≤10 km of ≤4 m wide gravel internal service roads within the plant boundary.
- Other infrastructure:
  - Perimeter fencing and internal security fencing and gates as required;
  - Access control gate and guard house on access road;
  - ≤3.5 km length of small diameter water supply pipeline connecting existing boreholes to storage.
  - Stormwater channels
- Construction Site office area (used during construction and rehabilitated thereafter):
  - ≤ 1 ha site office area;
  - ≤ 100 ha laydown area; and
  - ≤ 1 ha concrete batching plant
- Tie-in substation (next to Eskom / Grootegeluk Mine Main 132 / 33kV Substation):
  - ≤1 ha 132 kV to 33 kV Tie-in substation to receive, convert and step-down electricity from the PV facility to the 33 kV main substation for the Mine. The facility will house control rooms and grid control yards for the Independent Power Producer.

2.2. LOCATION

The Lephalale Solar PV Facility and associated infrastructure is to be located on the farm Appelvlakte 448 LQ which is the property of Exxaro Grootegeluk Coal Mine and is located in the Lephalale Local Municipality, Waterberg District, Limpopo Province. The location of the site and property are placed within the regional context in **Figure 1**. The layout of the general arrangements of the PV plant and electrical infrastructure are illustrated in **Figure 2** and **Figure 3** respectively.

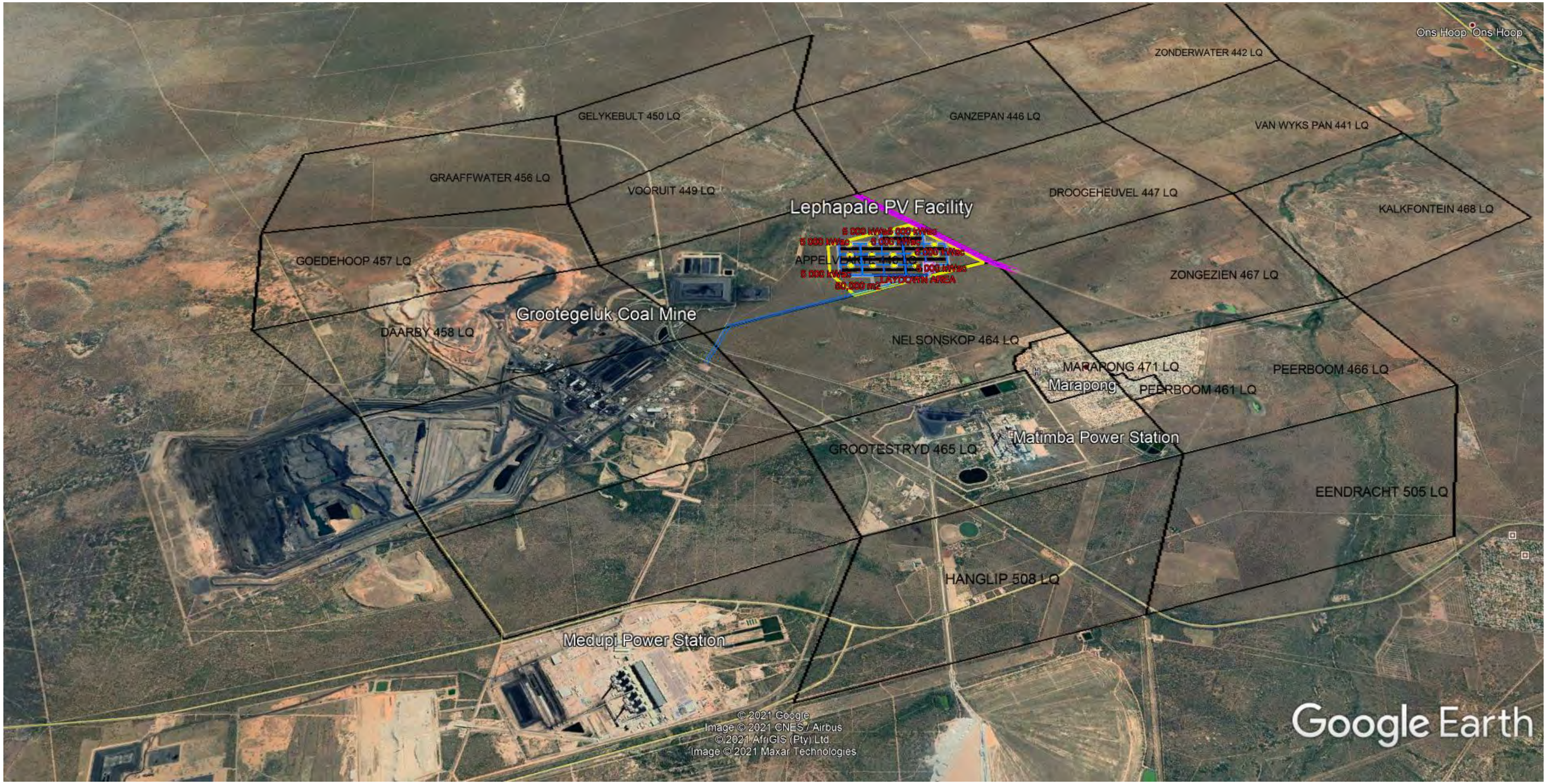


Figure 1: Location of Lephalale Photovoltaic Facility

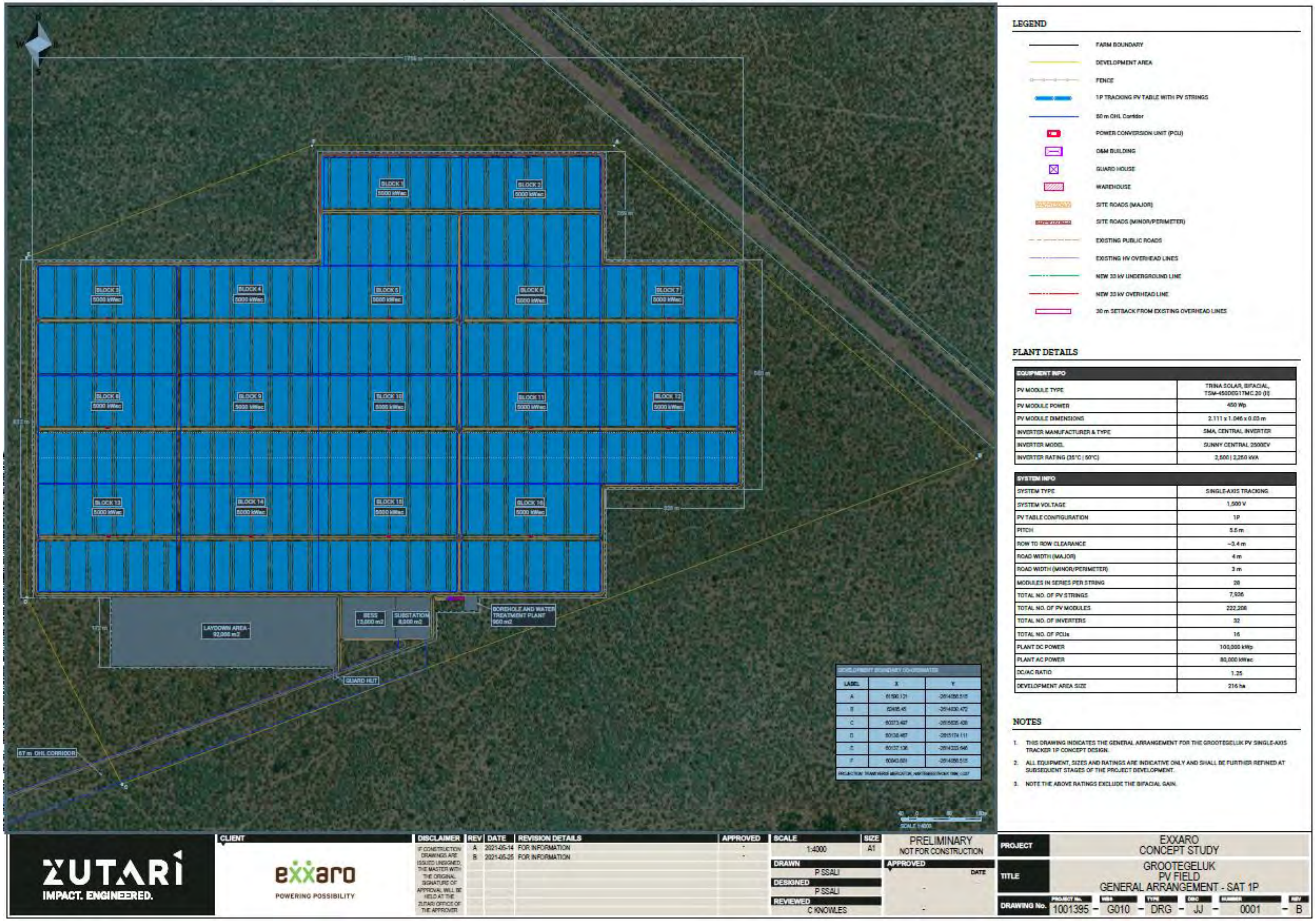


Figure 2: Lephalale PV Field General Arrangement

Figure 3: **Lephalale PV Plant and Electrical Infrastructure General Arrangement**

2.3. Basic Assessment alternatives

The following alternatives are considered.

- Location alternative
- Technology alternative
- Design and layout alternative
- Operational alternative and
- No project alternative.

Detailed descriptions of these alternatives are provided below.

2.3.1. Location alternative

No site alternatives for this proposed development are being considered as placing solar PV installations depends on several factors, all of which are favourable at the proposed site. This includes land availability and ownership, environmental sensitivities, distance to the national grid, solar resource site accessibility and current land use, as shown in Table 2.

Table 2: Lephalale PV Plant site ranking

Grootegeluk - Technical adjudication:		Scoring						Weighting	Weighted Scores					
#	Metric	Nelsonskop	Appelvlakte	Onbelyk	Van der Waltspan	Steenbokpan	Theunispan		Nelsonskop	Appelvlakte	Onbelyk	Van der Waltspan	Steenbokpan	Theunispan
1	Solar energy potential	8	8	8	8	8	8	5%	0.4	0.4	0.4	0.4	0.4	0.4
2	Space availability	10	10	10	8	10	8	5%	0.5	0.5	0.5	0.4	0.5	0.4
3	Terrain	8	8	8	8	8	8	5%	0.4	0.4	0.4	0.4	0.4	0.4
4	EIA	9	8	9	8	9	8	15%	1.35	1.2	1.35	1.2	1.35	1.2
5	Ease of expansion	5	8	10	8	8	8	0%	0	0	0	0	0	0
6	Land and rights	7	7	7	6	6	6	8%	0.56	0.56	0.56	0.48	0.48	0.48
7	Water Use Licensing	6	6	6	6	6	6	8%	0.48	0.48	0.48	0.48	0.48	0.48
8	Dust	7	7	8	8	8	8	5%	0.35	0.35	0.4	0.4	0.4	0.4
9	Electrical connection costs	10	10	7	7	6	6	25%	2.5	2.5	1.75	1.75	1.5	1.5
10	Community risk during construction	6	7	9	9	8	6	12%	0.72	0.84	1.08	1.08	0.96	0.72
11	Risk of possible community expansion	5	7	9	9	9	7	4%	0.2	0.28	0.36	0.36	0.36	0.28
12	Re-zoning	7	7	7	4	4	4	8%	0.56	0.56	0.56	0.32	0.32	0.32
	Overall Score:	88	93	98	89	90	83	100%	8.02	8.07	7.84	7.27	7.15	6.58
		Overall Weighted Score %:							80%	81%	78%	73%	72%	66%
		Rank:							2	1	3	4	5	6

2.3.2. TECHNOLOGICAL ALTERNATIVE

Concentrated solar power (CSP) was originally proposed for the site. However, based on feasibility studies, this option was changed in favour of solar photovoltaic because of the following reasons.

- Photovoltaic technology is quicker to build than CSP technology.
- PV technology is less water intense than CSP technology. Generally, the steam turbines at CSP facilities are cooled using water, through a process referred to as wet cooling. PV consumes water only for washing mirrors and surfaces. As the area is a semi-arid region water is scarce and is pumped in over long distances.
- Due to the climatic conditions in the area, wind is not an option.

Consequently, PV remains the only viable option.

The most recent advancements in bifacial technology are becoming an industry standard for utility-scale solar PV. The final technology that will be used for the Lephalale Solar facility will be determined during the detailed engineering phase which would commence after receipt of an EA from the competent authority.

Based on the findings of the scoping phase and to ensure the most optimal use of solar energy to generate electricity, the use of tracking photovoltaic panel arrays is the preferred option for the proposed development.

2.3.3. LAYOUT ALTERNATIVES

The final specifications of the project components will be determined during the detailed engineering phase to allow for the micro-sitting of the associated infrastructure.

2.3.4. OPERATIONAL ALTERNATIVES

No operational alternatives are assessed as none are available for solar PV installations.

2.3.5. NO PROJECT ALTERNATIVE

The no project alternative is the option of not fulfilling the proposed project. This alternative would result in no environmental impacts from the proposed project on the site or surrounding local area. It provides the baseline against which other alternatives are compared and will be considered throughout the report. Implementing the no project alternative would entail no development. A no-go option is a feasible option; however, this would prevent the Lephalale

PV facility from contributing to the environmental, social and economic benefits associated with the development of the renewables sector.

2.4. PROJECT MOTIVATION

With Eskom unable to deliver a secure electricity supply, private electricity generation options have become viable options. This option was reinforced when, on 10 June 2021, President Cyril Ramaphosa announced that government will lift the threshold for embedded generating electricity capacity from 1 MW to 100 MW, allowing households and businesses to privately build much bigger self-generating power facilities. This opportunity utilizes the potential cost savings of such supplementary supply, while taking advantage of the reduced carbon footprint of rapidly developing renewable energy technology.

3. APPLICABLE POLICY AND LEGISLATION

Legislation and policy serve to guide the authorities in undertaking and agreeing on projects that are in the interest of the country as a whole. Consequently, the fit of the project with the relevant national, provincial and municipal legislation and policy is an important consideration. In this respect, the following legislation and policy are applicable to the project.

International

- Climate Change Action Plan, 2016-2020, World Bank Group (2016)
- Renewable Energy Vision 2030 – South Africa; World Wildlife Fund for Nature-SA (formerly World Wildlife Fund-SA) (2014)
- REthinking Energy 2017: Accelerating the global energy transformation. International Renewable Energy Agency, (2017)
- Renewable Energy Policies in a Time of Transition. International Renewable Energy Agency (2018)
- Global Warming of 1.5 °C. An IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Summary for Policymakers. Subject to copy-edit: Intergovernmental Panel on Climate Change (2018).

National

- White Paper on the Energy Policy of the Republic of South Africa (2003)
- White Paper on Renewable Energy (2003)
- The Constitution of South Africa (1996)
- A National Climate Change Response Strategy for South Africa (2004)
- National Energy Act (2008)
- Integrated Resource Plan (IRP) for South Africa (2010-2030)
- The Environmental Impact Assessment and Management Strategy for South Africa (2014)
- Government Gazette No. 43734; 25 September 2020, Notice No. 1015; Determination Under Section 34(1) of the Electricity Regulation Act, 2006 (Act No. 4 of 2006)
- Government Gazette Vol. 632; 16 February 2018 No. 41445. Department of Environmental Affairs, No. 114, Page No. 92 (2018)
- Department of Mineral Resources and Energy – Integrated Resource Plan 2019 (2019)
- Department of Mineral Resources and Energy's Independent Power Producers Procurement Programme (2020)
- New Growth Path Framework (2011)
- The National Development Plan (2011)
- National Infrastructure Plan (2012).

Provincial

- Limpopo Development Plan (2015)

District and local

- Waterberg District Municipality Integrated Development Plan 2021/2022-2025/2026 (2021).
- Lephalale Local Municipality Draft Integrated Development Plan (2021).

3.1. POLICY AND LEGISLATION FIT

Considering the nature and location of the project, there is a clear fit with international, national, provincial and local, at both district and municipal levels, policy and legislation. For instance, the World Wide Fund for Nature (WWF)

> "*…calls for a more ambitious plan, suggesting that the IRP* [Integrated Resource Plan for Electricity] *should provide for an 11-19% share of electricity*

> *capacity by 2030, depending on the country's growth rate over the next fifteen years*" (Sager, 2014, p. 5).

The issue of climate change is high on the agenda of all levels of government in South Africa with the Department of Environmental Affairs and Tourism (DEAT) indicating that;

> "*The efforts of all stakeholders will be harnessed to achieve the objectives of the Government's White Paper on Renewable Energy (2003) and the Energy Efficiency Strategy, promoting a sustainable development path through coordinated government policy* (Department of Environmental Affairs and Tourism, 2004, p. 23) "

DEAT goes further in specifically listing renewable energy sources, including wind power, solar power and biomass, as a tool in promoting mitigation against climate change.

In terms of the capacity determinations of the Minister of Energy, in consultation with the National Energy Regulator (NERSA), it has been established that South Africa required;

> "*The technological composition of additional new capacity to be added between 2019 and 2030 is as follows:*
> *Wind: 14400 MW (45.7%);*
> ***Solar photovoltaic (PV):*** *6000 MW (19.1%);*
> ***Gas and/or diesel:*** *3000 MW (9.5%);*
> *Hydroelectricity: 2500 MW (7.9%);*
> ***Energy storage:*** *2088 MW (6.6%);*
> ***Coal:*** *1500 MW (4.8%); and*
> ***Range of energy technologies to fill the short-term capacity gap:*** *2000 MW (6.4%)"* (Independent Power Producer Office, 2020a, p. 5).

With the Limpopo Province contributing 118 MW to the National Grid through 3 operational projects. (Independent Power Producers Procurement Office, 2020a, pp. 7, 14-17).

Of great significance regarding the proposed project is the Presidential announcement on 10 June 2021, regarding Schedule 2 of the Electricity Regulation Act, which is to be amended to increase the National Energy Regulator of South Africa (Nersa) licensing threshold for embedded generation projects from 1MW to 100MW. This initiative will provide impetus for the proposed project.

The Limpopo Provincial Government has indicated its intension to procure "…*about 20 000 MW of renewable electricity by 2030*". With one of the 10 priority infrastructure projects listed by the Limpopo Provincial Government being solar photovoltaic electricity generation. The Limpopo Provincial Government also indicates that.

> "*Green Economy Unit in the Department will use the 2013 Provincial Green Economy Plan to compile detailed implementation action plans for these priorities. The Green Economy Unit will also be responsible to drive the provincial electricity risk mitigation strategy by way of new solar photovoltaic projects as mentioned above, as well the promotion of co-generation and a provincial electricity conservation campaign*"
> (Limpopo Provincial Government, 2015, pp. 7, 22 & 35).

At a municipal level, support is also evident across both the district and local municipalities. Waterberg District Municipality has identified Lephalale, Mogalakwena and Thabazimbi as high priority emission zones, due to mining and industrial activities in the areas and less conservation zones for carbon control basins (Waterberg District Municipality, 2021, p. 148 & 151).

In committing to a transition to a low carbon economy the Lephalale Local Municipality has prioritised green economy goals and interventions pointing out that;

> "*Lephalale has the potential to be the national pioneer in the Green Economy.*
> *The advantages of the municipal area are:*
> - *Perfect geographic situation to develop renewable energy industry and economies of scale"* (Lephalale Local Municipality , 2021, p. 173).

Considering the policy and legislation referred to above, the project fits at an international, national, provincial and municipal level.

4. Description of the Affected Environment

The project is located on the farms Appelvlakte and Nelsonskop, in Ward 2 of the Lephalale Local Municipality, approximately 20 km west of the town of Lephalale, in the Waterberg District Municipality, Limpopo Province. The demographics pertaining to the provincial and municipal areas, as sourced from Statistics South Africa, are described below.

4.1. Provincial

Limpopo, which is the northern-most province in South Africa, shares international borders with Mozambique, Zimbabwe and Botswana in the north and provincial borders with Mpumalanga, Gauteng and North West provinces in the south. The province covers a geographical area of 125 806.1 km² and, with a population of 5 779 090, had a population density of 46.1/km^2 in 2016. The estimated population of Limpopo was 5 404 553 in 2020 ranking the province 5th in terms of both surface area and population in South Africa.

At an administrative and political level, Limpopo is divided into five district municipalities, which are subdivided into 22 local municipalities, as follows.

- **Capricorn District**
    - Blouberg Local Municipality
    - Lepelle-Nkumpi Local Municipality
    - Molemole Local Municipality
    - Polokwane Local Municipality
- **Mopani District**
    - Ba-Phalaborwa Local Municipality
    - Greater Giyani Local Municipality
    - Greater Letaba Local Municipality
    - Greater Tzaneen Local Municipality
    - Maruleng Local
- **Sekhukhune District**
    - Elias Motsoaledi Local Municipality
    - Ephraim Mogale Local Municipality
    - Fetakgomo Tubatse Local Municipality
    - Makhuduthamaga Local Municipality
- **Vhembe District**
    - Collins Chabane Local Municipality
    - Makhado Local Municipality
    - Musina Local Municipality
    - Thulamela Local Municipality
- **Waterberg District**
    - Bela-Bela Local Municipality
    - Lephalale Local Municipality
    - Modimolle-Mookgophong Local Municipality
    - Mogalakwena Local Municipality
    - Thabazimbi Local Municipality.

The following major cities are also located within the province.

- Polokwane (Pietersburg) the provincial capital
- Bela-Bela (Warmbad)
- Lephalale (Ellisras)
- Makhado (Louis Trichardt)
- Musina (Messina)
- Thabazimbi and
- Tzaneen.

The economy of the province is largely based on mining, agriculture and tourism with mineral deposits including.

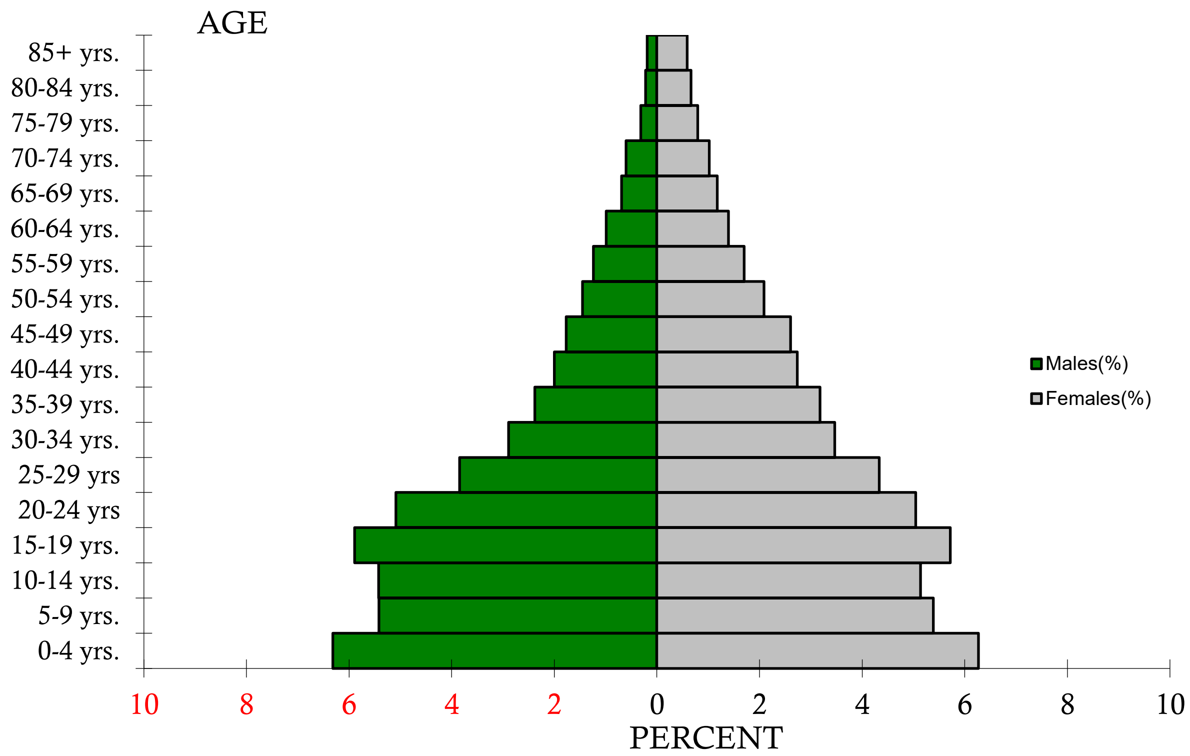
- Antimony
- Chromium
- Coking coal high & middle-grade
- Copper
- Diamonds
- Emeralds
- Gold
- Iron ore
- Magnetite
- Mica
- Phosphate
- Platinum-group metals
- Scheelite
- Silicon
- Vermiculite.

With climatic conditions in the province allowing for a double harvesting seasons, the province is a producer of.

- A variety of nuts
- Bananas
- Coffee
- Cotton
- Litchis
- Maize
- Mangoes
- Papaws
- Peanuts
- Pineapples
- Sunflowers
- Tea.

The province also boasts cattle and game farming and has an extensive hunting tourism industry.

According to data gathered by Statistics South Africa during the Community Survey 2016, the median age of the population was 22 years, 43% of the population of Limpopo were below 18 years while 52% were between 18 and 64 years of age and 5% were above 64 years. At 53% there was a higher percentage of females in the province. The population pyramid of Limpopo Provinces is illustrated in **Figure 4**.



Source: (Statistics South Africa, 2011)

Figure 4: Population pyramid Limpopo Province

In respect of population grouping, the dominant population group in Limpopo is black African people at 97.1%, followed by white people at 2.3% with coloured and Indian or Asian people combined accounting for 0.6% of the population. The majority of the population, 54.7%, speak Sepedi at home, while 16.8% speak Tshivenda, 16.2% Xitsonga, 2.2% Afrikaans, 2% Setswana and 5.8% other languages.

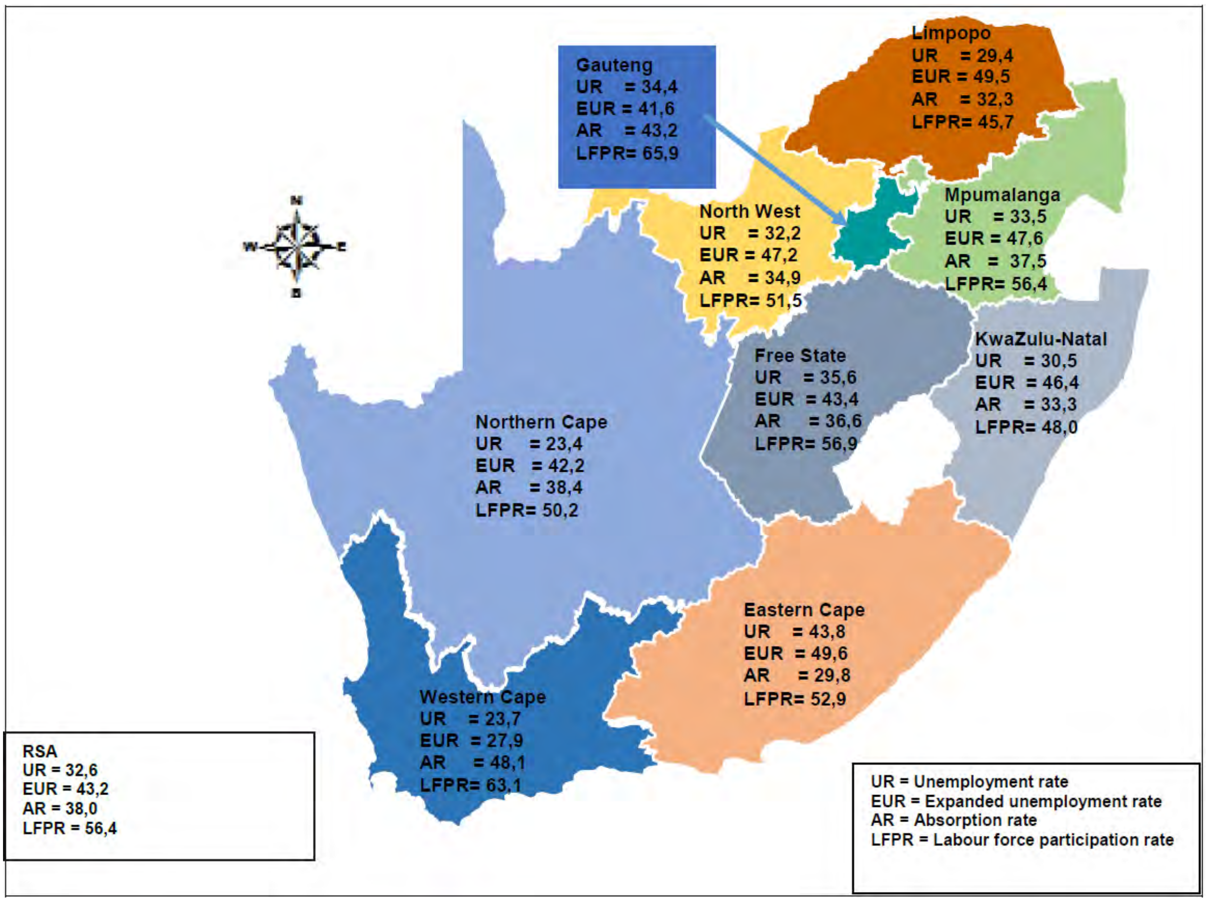
In 2011, 27.4% of the population of Limpopo was employed with 66.2% working in the formal sector and 18.1% in the informal sector. Official unemployment then stood at 17.5% with 48.4% being not economically active. The unofficial rate of unemployment, which included discouraged work-seekers was 31.4%. In the 1st Quarter of 2021, the official unemployment rate in the province was 29.4%. These figures must, however, be considered with caution as the official unemployment rate is defined by Stats SA as follows;

> "*Unemployed persons are those (aged 15–64 years) who:*
>
> *a) Were not employed in the reference week and;*
>
> *b) Actively looked for work or tried to start a business in the four weeks preceding the survey interview and;*

c) Were available for work, i.e. would have been able to start work or a business in the reference week or;

d) Had not actively looked for work in the past four weeks but had a job or business to start at a definite date in the future and were available.". (Statistics South Africa, 2021, p. 18)

In the first quarter of 2021, the expanded unemployment rate of Limpopo stood at 49.5%; the labour absorption rate at 32.3% and the labour force participation rate at 45.7%. A summary of the labour market indicators illustrated on a comparative basis across South Africa is provided in **Figure 5**.



Source: (Statistics South Africa, 2021, p. 10)

Figure 5: Labour market indicators 1st Quarter 2021

Regarding households, the 2016 Community Survey showed that there were 1 601 083 households in Limpopo. Of these households 48.9% were female-headed, 80% lived in formal houses and 64.8% owned and fully paid off their dwellings.

Regarding household services in 2016, 72.7% of households in Limpopo had pit toilets with 19.5% having flush toilets connected to the sewerage system, 19.2% had their refuse removed regularly, 11.5% had piped water delivered inside the dwelling and 87.5% had an in-house prepaid electricity meter.

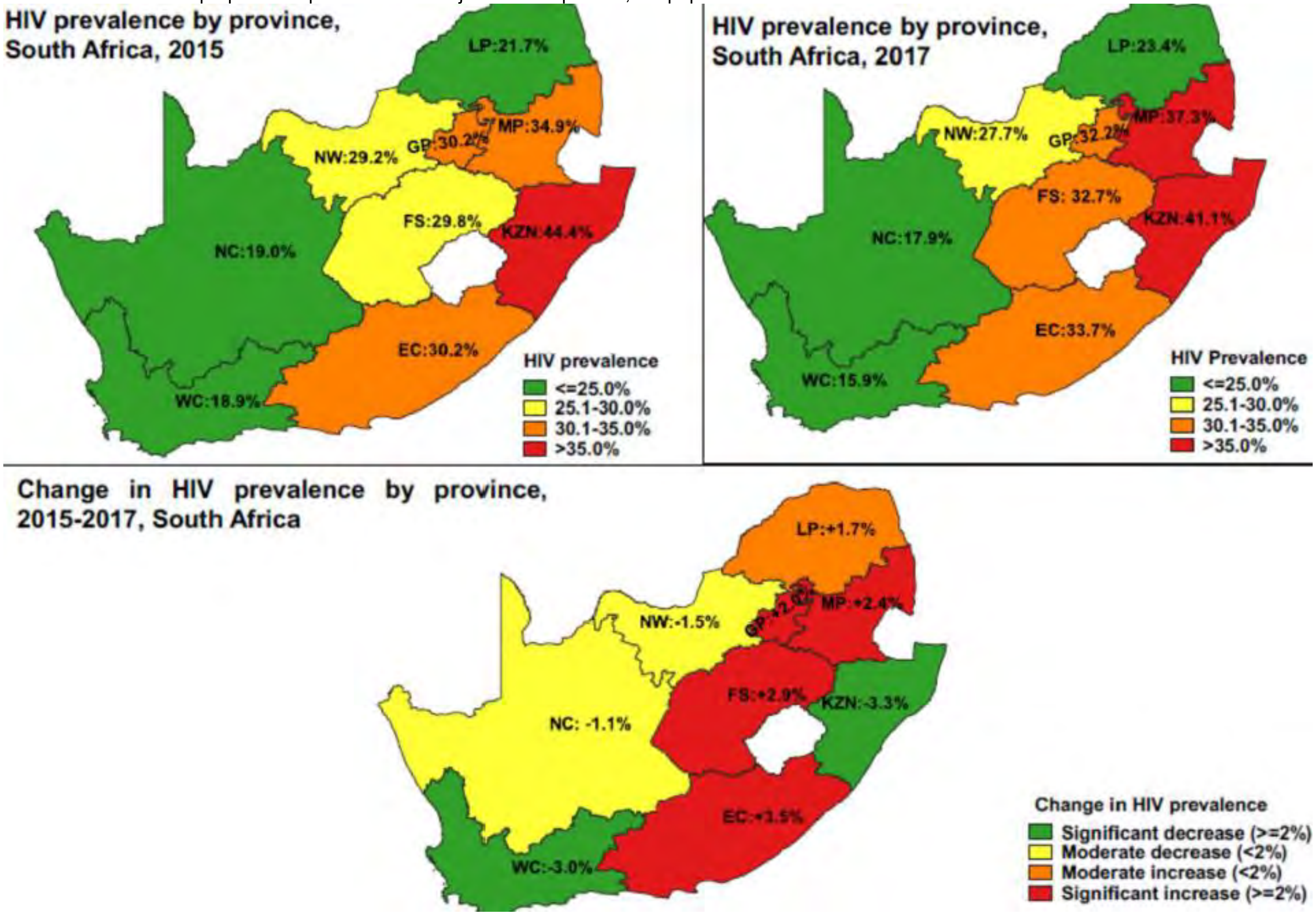
Concerning HIV prevalence, the Northern Cape had the lowest prevalence rate across South Africa at 8.3% in 2017 followed by the Western Cape with a prevalence rate of 8.9%. KwaZulu-Natal, with a prevalence rate of 41.1% had the highest rate with the national HIV prevalence rate at 30.7% in 2017. HIV prevalence rate between 2012 and 2017 as it stood across all South African provinces is illustrated in **Figure 6**.

The 2017 National HIV Prevalence Survey extended to the district level, which indicated that at the time the survey was undertaken, the HIV prevalence rate in Limpopo was 23.4%. The prevalence of HIV as it occurred across 5 district municipalities in 2017 is illustrated in **Table 3**Error! Reference source not found..

Table 3: HIV prevalence by district, in the Limpopo province, 2012-2017

District	2012		2013		2014		2015		2017	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Capricorn	22.4	19.1 – 26.1	21.1	18.0 – 24.6	23.8	20.6 – 27.3	21.6	18.5 – 25.0	22.5	19.8 – 25.5
Mopani	25.0	21.4 – 29.0	24.6	20.3 – 29.5	22.2	18.4 – 26.5	24.5	21.1 – 28.3	26.6	21.1 – 32.9
Sekhukhune	23.0	19.6 – 26.7	18.1	16.1 – 20.3	19.9	16.4 – 23.9	22.6	19.1 – 26.5	23.1	19.4 – 27.3
Vhembe	17.7	15.4 – 20.3	15.0	12.7 – 17.6	14.0	11.7 – 16.8	16.8	13.6 – 20.69	14.0	12.2 – 16.1
Waterberg	27.3	22.6 – 32.6	27.3	22.9 – 32.2	28.2	23.2 – 33.7	25.8	22.7 – 29.1	35.8	33.0 – 38.8
Limpopo province	22.3	20.7 – 23.9	20.3	18.9 – 21.9	20.9	19.2 – 22.6	21.7	20.1 – 23.3	23.4	21.8 – 25.1

Source: (Woldesenbet, et al., 2019, pp. 73-74)



Source: (Woldesenbet, et al., 2019, p. 73)

Figure 6: HIV by province – South Africa 2015 – 2017

Attention is now turned towards a demographic description of the municipalities, ward and small area affected by the project.

4.2. MUNICIPAL

Waterberg District Municipality DC36: The district, which covers an area of 45 315.6 km^2, incorporates the following local municipalities:

- Bela-Bela Local Municipality
- Lephalale Local Municipality
- Modimolle-Mookgophong Local Municipality
- Mogalakwena Local Municipality
- Thabazimbi Local Municipality.

The following towns are also located within the Waterberg district with Modimolle being the seat of the Waterberg DM:

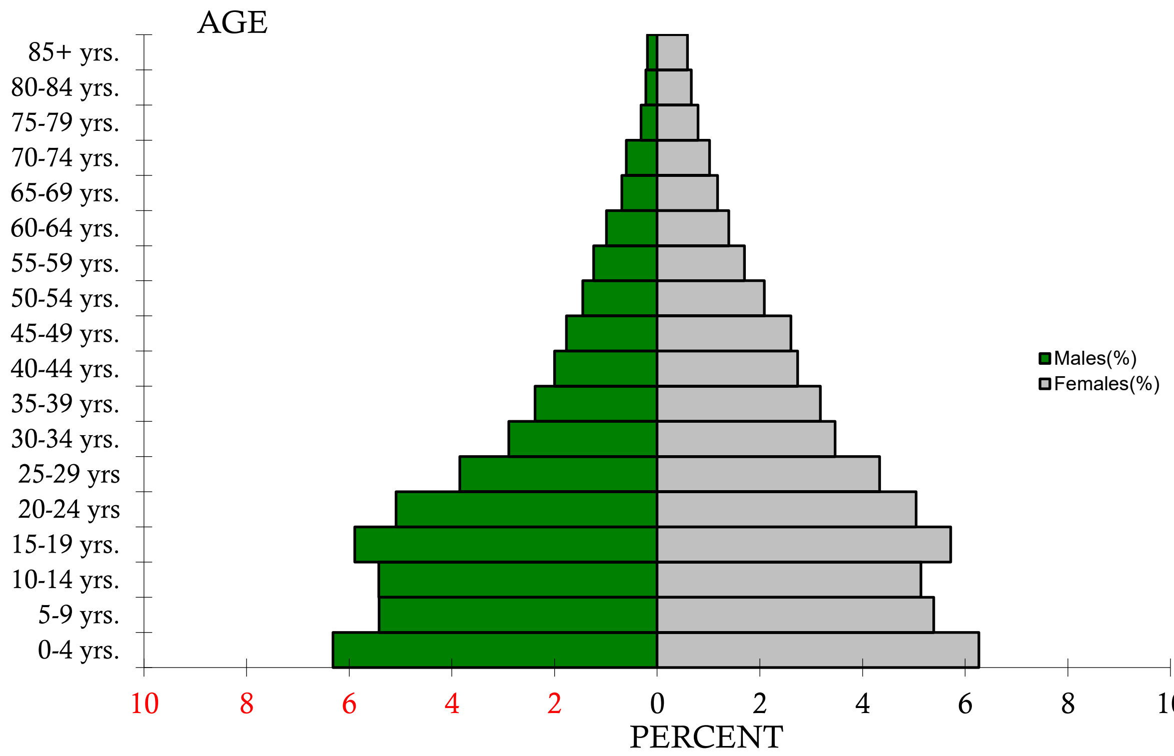
- Amandelbult Mine Town
- Bela-Bela
- Lephalale
- Modimolle
- Mokopane (Potgietersrus)
- Mookgophong (Naboomspruit)
- Pienaarsrivier
- Thabazimbi
- Vaalwater.

With the district containing much of the UNESCO designated Waterberg Biosphere, the area is considered a prime ecotourist destination with several game farms that attract international tourists. Economically, the following sectors contribute to the economy of the district:

- Mining
- Agriculture
- Tourism.

Consequently, the balance between mining and tourism is critical for the economic success of the district.

With a population of 745 758 people, the Waterberg DM has a population density of 16.5/km^2. According to Community Survey, 2016 the district has a sex ratio of 104.7 with 34.4% of the population being under 15 years; 60.5% being between 15 and 65 years and 5.1% being over 65 years of age. The population pyramid of Waterberg District Municipality is illustrated in Figure 7.



Source: (Statistics South Africa, 2011)

Figure 7: Population pyramid Waterberg District

The demographic data pertaining to Waterberg District Municipality, based on both Census 2011 and Community Survey 2016, is presented below.

	2016	**2011**
Population	745 758	679 336
Age Structure		
Population under 15	34.4%	29.9%
Population 15 to 64	60.5%	64.3%
Population over 65	5.1%	5.8%
Dependency Ratio		
Per 100 (15-64)	65.4	55.5
Sex Ratio		
Males per 100 females	104.7	102.1

	2016	2011
Population Growth		
Per annum	2.12%	n/a
Labour Market		
Unemployment rate (official)	n/a	28.1%
Youth unemployment rate (official) 15-34	n/a	35.5%
Education (aged 20 +)		
No schooling	7.1%	12.4%
Matric	27.6%	23.2%
Higher education	9.0%	9.0%
Household Dynamics		
Households	211 471	179 866
Average household size	3.5	3.4
Female headed households	40.9%	42.7%
Formal dwellings	85.0%	87.0%
Housing owned	63.6%	47.7%
Household Services		
Flush toilet connected to sewerage	43.8%	43.6%
Weekly refuse removal	44.4%	44.2%
Piped water inside dwelling	24.4%	30.7%
Electricity for lighting	86.1%	86.7%

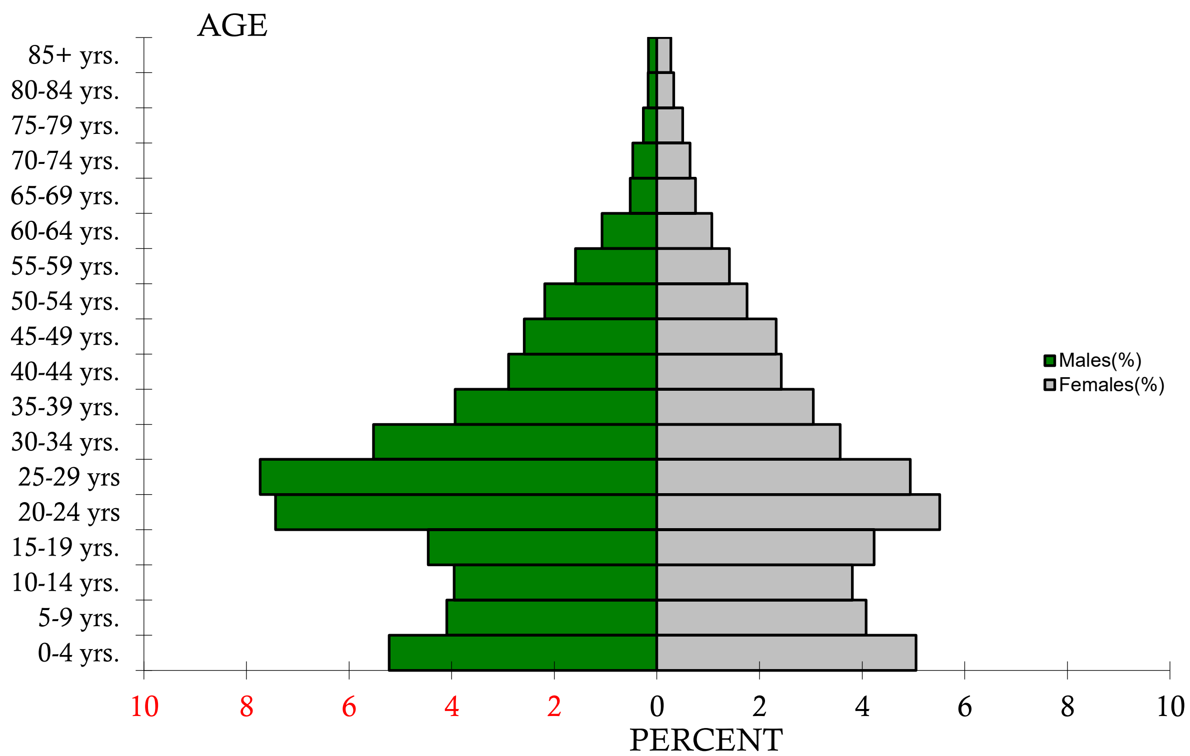
Lephalale Local Municipality: Situated some 280 km north-west of Pretoria and covering an area of 13 826.1 km^2 Lephalale is the largest of the local municipalities within the Waterberg district. The following main places are located within Lephalale:

- Bakenberg
- Ellisras (renamed Lephalale in 2002)
- Kwarriehoek
- Marapong
- Onverwacht
- Potgietersrus
- Seleka
- Shongoane
- St Catherina.

With the Waterberg Coal Fields containing 40% of South Africa's coal reserves, Lephalale has been identified as a national development node. The following economic sectors form the basis of the municipal economy:

- Mining and quarrying (71.4%)
- Finance, insurance, real estate and business services (5.2%)
- Wholesale and retail trade, catering and accommodation (4.4%)
- Transport, storage and communication (4.4%)
- General government (4.3%)
- Agriculture, forestry and fishing (3.9%)
- Electricity, gas and water (2.8%).

With a population of 140 240 people, the Lephalale LM has a population density of 10 1/km^2. According to Census, 2016 the district has a sex ratio of 126.5 with 28.8% of the population being under 15 years; 67.8% being between 15 and 65 years and 3.4% being over 65 years of age. The population pyramid of the Lephalale Local Municipality is illustrated in Figure 8.



Source: (Statistics South Africa, 2011)

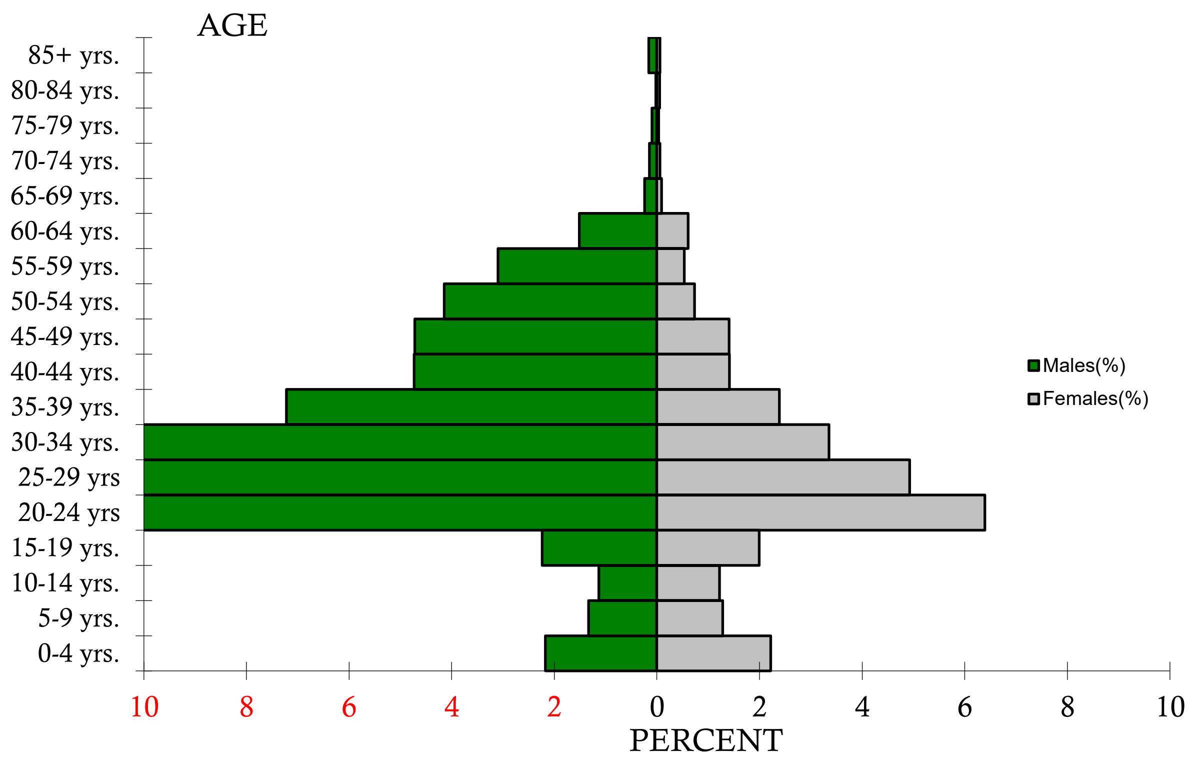
Figure 8: Population pyramid Lephalale Local Municipality

The demographic data pertaining to the Lephalale Local Municipality, based on both Census 2011 and Community Survey 2016, is presented below.

	2016	2011
Population	140 240	118 864
Age Structure		
Population under 15	28.8%	26.6%
Population 15 to 64	67.8%	69.4%
Population over 65	3.4%	4.0%
Dependency Ratio		
Per 100 (15-64)	47.5	44.2
Sex Ratio		
Males per 100 females	126.5	117.8
Population Growth		
Per annum	3.76%	n/a
Labour Market		
Unemployment rate (official)	n/a	n/a
Youth unemployment rate (official) 15-34	n/a	n/a
Education (aged 20 +)		
No schooling	6.0%	8.9%
Matric	27.9%	21.8%
Higher education	12.3%	9.4%
Household Dynamics		
Households	43 002	30 639
Average household size	3.3	3.4
Female headed households	33.7%	39.4%
Formal dwellings	76.4%	81.6%
Housing owned	41.6%	41.8%
Household Services		
Flush toilet connected to sewerage	40.4%	38.5%
Weekly refuse removal	44.5%	40.0%
Piped water inside dwelling	25.1%	30.7%
Electricity for lighting	83.1%	85.3%

Ward 2 Lephalale Local Municipality: Statistics SA data available for Ward 2 of Lephalale LM is only available in respect of Census 2011. On this basis, the Ward 2 covers an area of 75.2 km^2 and has a population of 11 728 people resulting in a population density of 155.9/km^2. The median age of the population is 29 years with 11.2% being under 18; 88.1%

being between 18 and 64 and 0.8% being 65 and over. With a sex ratio of 265.5, there are a far higher proportion of males to females across the ward. The population pyramid for Ward 2, reflecting the high number of males within the 24 to 34 year age category, is illustrated in Figure 9.



Source: (Statistics South Africa, 2011)

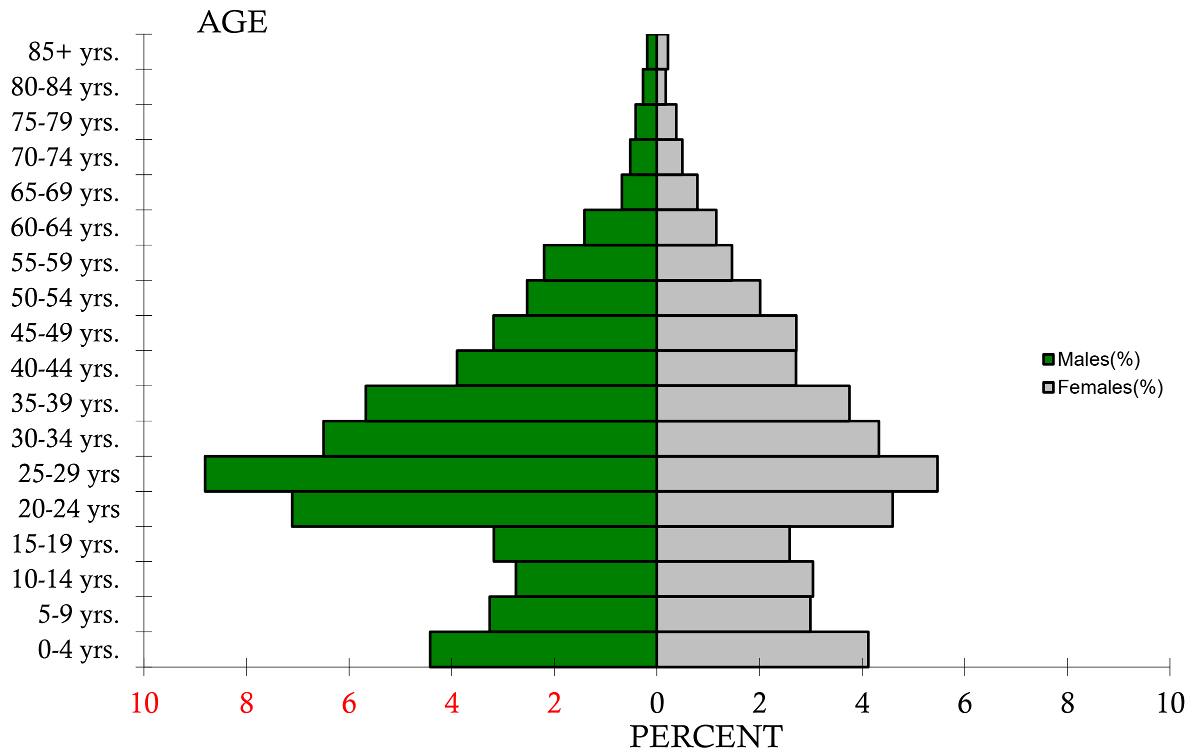
Figure 9: Population pyramid Ward 2 of Lephalale Local Municipality

In respect of population group, at 96.1% black African people are the most prevalent population group in the ward followed by coloured and white people at 2% and 1% respectively. At 34.6% Sepedi is the predominant home language spoken across the ward followed by Setswana at 9.4%. Concerning levels of education, 38.6% of the population has completed Grade 9 or higher and 19.5% have completed Matric or higher with 91.4% of school-aged children, between 5 and 17 years, attending school.

There are 2 515 households within Ward 2 of which 33.4% live within informal dwellings; 33.2% of dwellings are fully owned or are being paid off and 4.4% are occupied rent-free. The average annual household income of the ward is R57 300. Of these households 92.9% receive water from a regional or local service provider; 67.1% have access to flush or chemical toilets; 86.4% are receiving a refuse disposal service from a local authority or private company, while 7% utilise their own refuse dump.

In 2011 27.8% of the population was employed of which 86.8% was employed within the formal and 3.1% within the informal sectors.

Ward 3 Lephalale Local Municipality: Statistics SA data available for Ward 3 of Lephalale LM is only available in respect of Census 2011. On this basis, the Ward 3 covers an area of 4 509.0 km^2 and has a population of 10 836 people, resulting in a population density of 2.4/km^2. The median age of the population is 28 years with 21.5% being under 18; 74.7% being between 18 and 64 and 3.9% being 65 and over. With a sex ratio of 124.9, there is a higher proportion of males to females across the ward. The population pyramid for Ward 3 is illustrated in Figure 10.



Source: (Statistics South Africa, 2011)

Figure 10: Population pyramid Ward 3 of Lephalale Local Municipality

In respect of population group, at 68.4% black African people are the most prevalent population group in the ward followed by white and coloured people at 28.6% and 2% respectively. At 28.6% Afrikaans is the predominant home language spoken across the ward, followed by Setswana at 23% and Sepedi at 18.4%. Concerning levels of education, 68.9% of the population has completed Grade 9 or higher and 43.1% have completed Matric or higher with 85.2% of school-aged children, between 5 and 17 years, attending school.

There are 3 762 households within Ward 3 of which 8.6% live within informal dwellings; 21.2% of dwellings are fully owned or are being paid off and 16.7% are occupied rent-free. The average annual household income of the ward is R57 300. Of these households, 63.7% receive water from a regional or local service provider; 73.5% have access to flush or chemical toilets; 67.1% are receiving a refuse disposal service from a local authority or private company, while 27.7% utilise their own refuse dump.

In 2011, 65.1% of the population was employed, of which 72.1% was employed within the formal and 10.9% within the informal sectors.

4.3. PROJECT FOOTPRINT

The solar facility is to be located on the farm Appelvlakte approximately 20 km west of Lephalale, in the Limpopo Province and is surrounded by the following farms.

No	Farm	Farm/ Erf No	Portion	Latitude	Longitude
1	GROOTESTRYD	465	0	23°40'2.4S	27°36'26.99E
2	GROOTEGELUK	459	0	23°40'32.47S	27°30'45.38E
3	VOORUIT	449	0	23°36'55.83S	27°34'11.36E
4	Enkelbult	462	0	23°39'59.32S	27°33'6.49E
5	GOEDEHOOP	457	0	23°37'58.52S	27°31'20.9E
6	DAARBY	458	0	23°38'57.54S	27°32'7.1E
7	Turfvlakte	463	0	23°41'0.13S	27°33'50.67E
8	HIEROMTRENT	460	0	23°41'45.88S	27°30'55.75E
9	LEEUWDRIFT	312	0	23°39'39.06S	27°29'26.18E
10	APPELVLAKTE	448	0	23°37'59.48S	27°34'57.21E
11	NELSONSKOP	464	0	23°39'0.82S	27°35'48.01E
12	Enkelbult	462	0	23°39'59.32S	27°33'6.49E
13	Enkelbult	462	0	23°39'59.32S	27°33'6.49E
14	NELSONSKOP	464	1	23°39'23.3S	27°34'49.94E
15	LEEUWDRIFT	312	0	23°39'39.06S	27°29'26.18E
16	APPELVLAKTE	448	1	23°38'23.04S	27°33'55.47E
17	VOORUIT	449	0	23°36'55.83S	27°34'11.36E
18	Turfvlakte	463	0	23°41'0.13S	27°33'50.67E
19	DAARBY	458	0	23°38'57.54S	27°32'7.1E
20	HIEROMTRENT	460	0	23°41'45.88S	27°30'55.75E
21	APPELVLAKTE	448	0	23°37'52.8S	27°35'14.7E
22	GROOTEGELUK	459	0	23°40'51.05S	27°30'7.04E
23	HIEROMTRENT	460	0	23°41'45.88S	27°30'55.75E
24	GROOTESTRYD	465	3	23°40'27.02S	27°35'26.58E
25	GOEDEHOOP	457	0	23°37'58.52S	27°31'20.9E
26		463	0	23°41'0.13S	27°33'50.67E

On a broader basis the mine is surrounded by Lephalale Non-Urban, Main Place 978002 from Census 2011. This area is vast, coving 13 669.74 km^2 and with a population of 17 745 had a population density of 1.30 people per KM^2 in 2011. Of more relevance is Marapong, Main Place 978037, which is 1.5 km from boarder of the mine property and 12.14 km at its furthest.

Marapong Main Place 978037: This area, which lies to the east of the mine and covers a geographical area of 3 99 km² has a population of 26 227 giving it a population density of 6 565.16 people per km². The demographic data regarding Marapong is:

Geographic area = 3.99 km²

Population = 26 227 people

Population density = 6 565.16/km²

Households = 6 625

Household density = 1 658.37 per km²

Gender	People	Percentage
Male	16,438	62.68%
Female	9,789	37.32%

Age	People	Percentage
0–4	2,077	7.92%
5–9	1,326	5.06%
10–14	1,170	4.46%
15–19	1,477	5.63%
20–24	4,309	16.43%
25–29	4,887	18.64%
30–34	3,503	13.36%
35–39	2,302	8.78%
40–44	1,542	5.88%
45–49	1,351	5.15%
50–54	982	3.74%
55–59	686	2.62%
60–64	401	1.53%
65–69	80	0.31%
70–74	46	0.18%
75–79	36	0.14%
80–84	13	0.05%
85+	36	0.14%

Population group	People	Percentage
Black African	25,603	97.62%
Coloured	282	1.08%
White	182	0.69%
Other	91	0.35%

Indian or Asian	69	0.26%
First language	**People**	**Percentage**
Sepedi	11,384	54.40%
Setswana	5,452	26.05%
Xitsonga	737	3.52%
Tshivenda	620	2.96%
isiZulu	558	2.67%
isiXhosa	451	2.16%
Other	443	2.12%
Sesotho	435	2.08%
isiNdebele	316	1.51%
English	291	1.39%
Afrikaans	99	0.47%
SiSwati	82	0.39%
Sign language	57	

The themes and sensitivities listed in **Table 4** were identified through the screening report for an environmental authorisation as required by the 2014 EIA regulations.

Table 4: Site environmental screening report sensitivities

Theme	Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
Agriculture Theme		X		
Animal Species Them			X	
Aquatic Biodiversity Theme	X			
Archaeological and Cultural Heritage Theme	X			
Avian Theme		X		
Bats Theme				X
Civil Aviation (Solar PV) Theme				X
Defence Theme				X
Landscape (Solar) Theme	X			
Theme	X			
Plant Species Theme			X	
RFI Theme			X	
Terrestrial Biodiversity Theme	X			

The full environmental sensitivities screening report for the proposed development area is attached as **Appendix 2**.

5. IDENTIFICATION OF POTENTIAL IMPACTS

The social impact variables considered across the project are in accordance with Vanclay's list of social impact variables clustered under the following main categories as adapted by Wong (Vanclay, 2002; Wong, 2013) and include:

1. Health and social well-being
2. Quality of the living environment (Liveability)
3. Economic
4. Cultural.

These categories are not exclusive and at times tend to overlap as certain processes may have an impact within more than one category.

5.1. Health and social wellbeing

The health and social wellbeing impacts related to the project include.

- Annoyance, air quality and noise
- Increase in crime
- Increased risk of HIV infections
- An influx of workers and job seekers
- Hazard exposure
- Glint and glare.

These impacts are separately addressed below.

5.1.1. Annoyance, air quality and noise

Annoyance, dust and noise will be more evident during the construction phase of the project, as construction activities will result in the generation of dust and noise from construction vehicles and equipment. The findings of the air quality specialist indicated that:

> "Construction of the Solar PV plant will result in minimal air quality impacts on nearby receptors. Given the low impacts on the receiving environment, based on the findings of this AQIA, it is recommended the proposed Solar PV facility be authorise" (WSP Group Africa (Pty) Ltd (WSP), 2021, p. 69).

5.1.2. Increase in crime

The Lephalale Solar PV Project and Grootegeluk Coal Mine both fall under the Lephalale Police Precinct which recorded 1 680 crimes across the precinct in 2020[1]. The precinct covers a wide area. It is often opportunistic crime, stock theft, the abuse of alcohol and relationship-

[1]According to Crime Stats SA as at 02 July 2021 https://www.crimestatssa.com/index.php

related crime that is associated with construction activities. With several game farms in the area, there is some concern regarding poaching.

Considering the relatively small nature of the project compared to various other activities in the area it is unlikely that the project will lead to any significant increase in crime levels in the area, however, it would be pertinent for the developers to ensure that processes are put in place through which any suspected criminal activities associated with the project can be easily communicated and swiftly addressed. The construction phase carries with it a higher risk of associated criminal activities than is likely to be associated with the operational phase of the project.

5.1.3. Increased risk of HIV infections

With the intensity of developmental activities in the area, the prevalence of HIV is relatively high. Waterberg covers a geographical area of 45 315.6 square kilometres and has a population density of 16.5 people per square kilometre but has the highest HIV prevalence rate in the province at 33.0% in 2017. It is likely that much of this is because of the high concentration of people around the town of Lephalale and settlement of Marapong, attracted to the area by the high rate of development in the region. It has been be noted that sexually transmitted diseases are spread by construction and transport workers (Singh & Malaviya, 1994; Ramjee & Gouws, 2002; Meintjes, Bowen, & Root, 2007; World Bank Group, 2016; Bowen, Dorrington, Distiller, Lake, & Besesar, 2008; Bowen P. , Govender, Edwards, & Cattell, 2016; Kikwasi & Lukwale, 2017; Bowen P. , Govender, Edwards, & Lake, 2018). This risk is likely to be at its highest during the construction phase of the project as the construction workforce increases and material and equipment are delivered to the site, and it is likely to subside during the operational phase.

5.1.4. An influx of workers and job seekers

It is estimated that over the construction period, which will stretch over a 9 to 15-month period, the peak construction workforce will reach approximately 350 workers. Of these, the majority will be recruited locally while some of the workforce will come from outside of the area and will be at a professional level. This will need to support the local procurement policies being implemented by Exxaro Grootegeluk. Any risk of additional community disruption associated with an influx of workers is likely to be low as the area has had a high influx of workers and work seekers over several years with projects such as expansion at Grootegeluk Coal Mine, the construction of the Medupi Power Station and the Mokolo and Crocodile River (West)

Water Augmentation Project, amongst others, having accelerated population growth and associated settlements and urban development.

During the operational phase of the project, the workforce will be comprised of 15 to 40 workers. Consequently, the risks associated with disruptions to social networks will be insignificant over the operation phase of the project.

5.1.5. HAZARD EXPOSURE

Using heavy equipment and vehicles and an increase in vehicle traffic within the vicinity of the construction sites will cause an increased risk to the personal safety of people and animals. Of particular concern are increased hazards faced by pedestrians, cyclists and motorists with emphasis on vulnerable groups such as children and the elderly.

Perimeter fencing, and internal security fencing and gates will be installed in accordance with the:

- Fencing Act (Act 31 of 1963) and
- Fencing Amendment Act, (Act 3 of 1971).

This will reduce any onsite risks to the public. The site will also be subject to health and safety compliance under the Mine Health and Safety Act, No. 29 of 1996 (“MHSA”) which will reduce health and safety risk to the workforce.

5.1.6. GLINT AND GLARE

The solar panels are likely to result in glint and glare being experienced by residents and passing motorists. Glint is a momentary reflection that can distract passing motorists and/or air traffic in the region. Glare, although less intense, can be more sustained over time and can be a source of annoyance for surrounding residents. Mitigation measures need to be introduced to ensure that the glint and glare emanating from the solar array does not cause travel hazards and/or impair the quality of life of the surrounding residences or buildings.

5.2. QUALITY OF THE LIVING ENVIRONMENT

The following quality of the living environment impacts are related to the project.

- Disruption of daily living patterns
- Disruptions to social and community infrastructure
- Transformation of the sense of place.

5.2.1. DISRUPTION OF DAILY LIVING PATTERNS

Disruptions are only likely to be associated with the delivery of materials and machinery to site and the transportation of workers to and from the site. In respect of traffic disruptions, it is stated in the Transport Study that:

> "*With reference to this report, associated assessment and the findings made within, it is SiVEST's opinion that the Lephalale Solar Project and associated infrastructure will have a nominal impact on the existing traffic network. The project is therefore deemed acceptable from a transport perspective, provided the recommendations and mitigations measures in this report are implemented, and hence the Environmental Authorisation (EA) should be granted for the EIA application* (SiVEST SA (Pty) Ltd, 2021b, p. 29).

5.2.2. DISRUPTION TO SOCIAL AND COMMUNITY INFRASTRUCTURE

With the workforce associated with the construction phase peaking at 350 workers, the majority of which being recruited locally in accordance with the local procurement policies implemented by Exxaro Grootegeluk, it is unlikely that the project will have any significant effect on social and community infrastructure in the area. Infrastructure in the area has expanded in response to the various developments that have occurred over a number of years.

5.2.3. TRANSFORMATION OF THE SENSE OF PLACE

The solar photovoltaic array will be visible and will result in the landscape being transformed. However, with various developments in the area; such as the Grootegeluk Coal Mine, the Matimba and Medupi power stations, and urban residential developments such as Marapong within close proximity and the suburb of Onverwacht further to the west, the area already assumes an industrialised urban character. In this regard, a visual impact assessment was undertaken which found that:

> "*Overall, the VIA demonstrates that the proposed Lephalale Solar project can be successfully accommodated and assimilated into the surrounding landscape without causing significant harm to the landscape character or visual amenity of the area, provided that the recommended mitigation measures are adhered to. Furthermore, the proposed project keeps in line with the development plan of the area which is to facilitate economic and mining development processes within the municipality and create the potential to be the national pioneers in the Green Economy*" (GCS Water & Environmental Consultants, 2021a, p. 65).

In respect of the soils, land capability, and land use, it was indicated that:

> "*The specialist opinion is that the proposed project be considered favourably as the DEA screening tool value of medium sensitivity was verified by confirming the project was not within any crop farming boundaries and that the proposed development of the Solar project was therefor within the allowable limits stated in GN 320. This was further strengthened by the detailed in-field survey confirming the land potential to have a restricted potential*" (Eco-Assist Environmental Consultants, 2021, p. 40).

5.3. ECONOMIC

The economic impacts related to the project include.

- Job creation and skills development
- Socio-economic stimulation

5.3.1. JOB CREATION AND SKILLS DEVELOPMENT

The project will lead to the creation of both direct and indirect job which will have a positive economic benefit within the region. In this regard, the workforce will be broken down as follows:

a. **Construction**
   i. Skilled = 10
   ii. Semi-skilled = 120
   iii. Low skilled = 220
   Total = 350.
b. **Operational**
   i. Skilled = 5
   ii. Semi-skilled = 10
   iii. Low skilled = 30
   Total = 45.

Construction will stretch over a 9 to 15 month period with the operational phase lasting over 20 years.

5.3.2. SOCIO-ECONOMIC STIMULATION

Apart from these jobs, the project is also likely to stimulate the local economy, which is likely to be most significant at a cumulative level. Nevertheless, there will be a significant economic contribution attached to the Lephalale Solar PV Facility. This contribution will be in the form of disposable salaries and the purchases of services and supplies from the local communities in and around Lephalale. The capital expenditure (CAPEX) during construction is estimated at R1 billion with the operational phase estimated at 3% of CAPEX.

Apart from job creation and procurement spend, the project will also have broader positive socio-economic benefits, at a national level, regarding the potential to contribute towards the national grid requirements as part of the Government's vision to source 10.52% of the country's energy through solar power by 2030 (Department of Energy Republic of South Africa, 2019, p. 42).

5.4. CULTURAL IMPACTS

At a social level, it is likely that any cultural impacts would be associated with sensitive archaeological and/or heritage sites that may be found. The following extract was taken from the heritage report.

> "*A heritage survey was undertaken for the proposed Grootgeluk photovoltaic plant. Several heritage sites have been recorded outside of the study area and included historical buildings, Stone Age material and human graves. No heritage sites were recorded within the study area.*
> *A chance find protocol was suggested for the palaeontological aspect of the project.*
>
> *No further mitigation is required for the photovoltaic plant '* (Umlando: Archaeological Surveys and Heritage Management, 2021, pp. 22-23)

Consequently, cultural impacts will not be taken any further.

6. IMPACT ASSESSMENT

The impacts, as they apply to both the construction and operational phase of the project, will be assessed below and mitigation and optimisation measures will be suggested as is appropriate.

6.1. PLANNING AND DESIGN PHASE

An investigation was undertaken to assess the viability of the choice of site, and it was found that due to a range of issues such as;

- Solar energy potential
- Space availability
- Terrain

- EIA
- Ease of expansion
- Land and rights
- Water Use Licensing
- Dust
- Electrical connection costs
- Community risk during construction
- Risk of possible community expansion
- Re-zoning.

The site was best suited for a solar PV facility rather than any other type of renewable energy facility. Additionally, it is evident that the project fits with legislation and key planning and policy documentation. In this regard, renewable energy facilities are supported at a national, provincial and municipal level.

6.2. CONSTRUCTION PHASE

Most of the impacts discussed above apply over the short-term to the construction phase of the project, and include:

- Annoyance, air quality and noise
- Increase in crime
- Increased risk of HIV infections
- An influx of workers and job seekers
- Hazard exposure
- Disruption of daily living patterns
- Disruptions to social and community infrastructure
- Economic.

Each of these impacts is assessed below with mitigation and optimisation measures being suggested in **Table 5**Error! Reference source not found..

6.3. OPERATIONAL PHASE

The social impacts that apply to the operational phase of the project are:

- Health and wellbeing
  - Glare and glint.
- Quality of the living environment
  - Transformation of the sense of place and

- Economic
    - Job creation and skills development
    - Socio-economic stimulation.

These impacts are assessed below in Error! Reference source not found. with mitigation and with optimisation measures being suggested in each case.

Table 5: Construction phase impacts

		Before Mitigation												After Mitigation													Mitigation measures
Activity	Impact	Severity rating	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	+/-	Risk Rating	Severity rating	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	+/-	Risk Rating	Confidence level	
Social Impacts																											
Construction activities	Annoyance, air quality and noise	2	3	2	7	3	3	5	2	13	91	-	M	2	2	2	6	2	3	5	2	12	72	-	M	75%	Apply an appropriate dust suppression protocol to limit the generation of dust through construction activities and traffic on unsealed roads. Ensure that all construction vehicles are maintained to manufacturer's specifications.
Construction activities	Increase in crime	3	3	2	8	3	3	5	2	13	104	-	M	3	2	2	7	3	3	5	2	13	91	-	M	75%	Ensure that construction workers are clearly identifiable. All workers should carry identification cards and wear identifiable clothing; Fence off the construction site and control access to these sites; Appoint an independent security company to monitor the site; Encourage local people to report any suspicious activity associated with the construction sites through the establishment of a community liaison forum; Prevent loitering within the vicinity of the construction camp as well as construction sites.
Construction activities	Increased risk of HIV infections	4	4	2	10	4	4	1	3	12	120	-	M	4	4	2	10	4	4	1	3	12	120	-	M	75%	Ensure that an onsite HIV Infections Policy is in place and that construction workers have easy access to condoms; Expose workers to a health and HIV/AIDS awareness educational programme; Extend the HIV/AIDS program into the community with a specific focus on schools and youth clubs.

		Before Mitigation												After Mitigation													Mitigation measures
Activity	Impact	Severity rating	Spatial scale	Duration	Consequence	Frequency of	Frequency of	Legal Issues	Detection	Likelihood	Significance	+/-	Risk Rating	Severity rating	Spatial scale	Duration	Consequence	Frequency of	Frequency of	Legal Issues	Detection	Likelihood	Significance	+/-	Risk Rating	Confidence level	
Social Impacts																											
Construction activities	Influx of construction workers	2	3	2	7	2	2	1	2	7	49	-	L	2	2	2	6	2	2	1	2	7	42	-	L	75%	Communicate the limitation of opportunities created by the project through Community Leaders and Ward Councillors; Apply the existing Exxaro Procurement Policy as drawn up in consultation with community leaders and ward counsellors for the area.
Construction activities	Hazard exposure	3	3	2	8	3	3	5	2	13	104	-	M	2	3	2	7	3	3	5	2	13	91	-	M	75%	Ensure all construction equipment and vehicles are properly maintained at all times; Ensure that operators and drivers are properly trained and make them aware, through regular toolbox talks, of any risk they may pose to the community. Place specific emphasis on the vulnerable sector of the population such as children and the elderly; Ensure that fires lit by construction staff are only ignited in designated areas and that the appropriate safety precautions, such as not lighting fires in strong winds and completely extinguishing fires before leaving them unattended, are strictly adhered to; Make staff aware of the dangers of fire during regular toolbox talks.
Construction activities	Disruption of daily living patterns	2	3	2	7	3	3	1	3	10	70	-	M	2	2	2	6	2	2	1	3	8	48	-	L	75%	Ensure that, at all times, people have access to their properties as well as to social facilities.
Construction activities	Disruptions to social and community infrastructure	2	4	2	8	2	2	1	3	8	64	-	M	2	3	2	7	2	2	1	3	8	56	-	M	75%	Regularly monitor the effect that construction is having on infrastructure and immediately report any damage to infrastructure to the appropriate authority; Ensure that where communities' access is obstructed that this access is restored to an acceptable state.
Construction activities	Job creation and skills development	2	4	2	8	3	3	1	2	9	72	+	M	3	4	2	9	4	4	1	3	12	108	+	M	75%	Wherever feasible, local residents should be recruited to fill semi and unskilled jobs; women should be given equal employment opportunities and encouraged to apply for positions; a skills transfer plan should be put in place at an early stage and workers should be given the opportunity to develop skills which they can use to secure jobs elsewhere post-construction.
Construction activities	Positive economic impacts	3	4	2	9	4	4	1	2	11	99	+	M	4	4	2	10	4	4	1	3	12	120	+	M	75%	A procurement policy promoting the use of local business should, where possible, be put in place to be applied throughout the construction phase.

Table 6: Operational phase impacts

		Before Mitigation												After Mitigation													
Activity	**Impact**	**Severity rating**	**Spatial scale**	**Duration**	**Consequence**	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**+/-**	**Risk Rating**	**Severity rating**	**Spatial scale**	**Duration**	**Consequence**	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**+/-**	**Risk Rating**	**Confidence level**	**Mitigation measures**
Social Impacts																											
Operational activities	Glare & glint	2	3	4	9	2	3	1	2	6	72	-	M	2	3	4	9	2	3	1	2	8	72	-	M	75%	Follow the recommended mitigation measures suggested in the Traffic Impact Assessment.
Operational activities	Transformation of the sense of place	3	3	4	10	4	4	1	4	13	130	-	M	3	3	4	10	4	4	1	3	12	120	-	M	75%	Apply the mitigation measures suggested in the Visual Impact Assessment Report; Communicate the benefits associated with renewable energy to the broader community; Ensure that all affected landowners and tourist associations are regularly consulted; A Grievance Mechanism should be put in place and all grievances should be dealt with transparently; The mitigation measures recommended in the Heritage and Palaeontology Impact Assessment should be followed.
Operational activities	Positive economic impacts	4	4	4	12	5	5	1	3	14	168	+	M	4	4	4	12	5	5	1	3	14	168	+	M	75%	Implement a training and skills development programme for local employees/work seekers; Work closely with the appropriate municipal structures regarding establishing a social responsibility programme. Ensure that the procurement policy supports local enterprises; Establish a social responsibility programme either in line with the REIPPP BID guidelines or equivalent; Work closely with the appropriate municipal structures regarding establishing a social responsibility programme; Ensure that any trusts or funds are strictly managed in respect of outcomes and funds.

In the following section, attention will be focused on the decommissioning phase of the project.

6.4. DECOMMISSIONING PHASE

It is estimated that the project has a lifespan of approximately 20 years and there is the possibility that after this period the solar arrays would be dismantled and replaced with more up-to-date technology that would significantly extend the life of the facility. As social change is highly dynamic, over this time span, the variables that would need to be considered are most likely to be quite different to those currently in play. Consequently, the uncertainty of what would exactly occur, and the significance of the impact in isolation, makes it rather meaningless to attach assessment criteria to decommissioning at this point.

Apart from the loss of permanent jobs, if the project is decommissioned, decommissioning will also result in few temporary jobs being created over a short period as components are dismantled and the site is cleared. Although positive, this will be a rather insignificant benefit considering the size of the solar (PV) facility and the period attached to decommissioning. However, before decommissioning, the following mitigation measures are suggested.

Decommissioning mitigation measures

- Ensure that a retrenchment package is in place.
- Ensure that staff have been trained in a manner that would provide them with saleable skills within the job market.
- Ensure that the site is cleared responsibly and left in a safe condition.

The no project option will be considered next.

6.5. ASSESSMENT OF NO PROJECT ALTERNATIVE

The no project option would mean that the social environment is not affected as the status quo remains. On a negative front, it would also mean that all the positive aspects associated with the project would not materialise. Consequently, there would be no job creation, no revenue streams into the local economy and municipal coffers and a lost opportunity to enhance the national grid with a renewable source of energy. Considering that Eskom's coal-fired power stations are a huge contributor to carbon emissions, the loss of a chance to supplement the National Grid through renewable energy would be significant at a national, if not at a global level. The Intergovernmental Panel on Climate Change (6 October 2018, p. 15) has warned that Co^2 emissions need to be reduced by 45% from 2010 levels by 2030 and to zero by 2050, which means that coal must go in the immediate future. The no-project alternative is assessed in **Table 7**.

Table 7: No project alternative

		Before Mitigation												After Mitigation												
Activity	**Impact**	**Severity rating**	**Spatial scale**	**Duration**	**Consequence**	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**+/-**	**Risk Rating**	**Severity rating**	**Spatial scale**	**Duration**	**Consequence**	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**+/-**	**Risk Rating**	**Confidence level**
No project alternative	Project does not proceed	4	5	4	13	4	4	1	3	12	156	-	M	4	5	4	13	4	4	1	3	12	156	-	M	75%

Mitigation measures: The only mitigation measures attached to the ‘no project’ alternative would be to proceed with the project.

7. CUMULATIVE IMPACTS

The Waterberg Coalfield, which forms part of the Ellisras Basin, extends west of the town of Lephalale and, due to the dwindling Mpumalanga coal reserves, has become the most important coal resource in the country. This has resulted in two coal fired power stations being constructed in the area and extensive mining of this reserve for both export and local power production. In support of these activities, and the increase in mining in the area, a great deal of industrial development has occurred in and around the town of Lephalale. In addition to the various industrial developments in the region, a number of solar PV facilities are also planned and are being built in the area. On a more project-specific basis, the following projects listed in **Table 8** have been identified within a 35 km radius of the Lephalale Solar PV Facility and are illustrated in respect of this radius in the map in **Figure 11**.

Table 8: Renewable energy projects within a 30 km radius of Grootegeluk

DEA REF	Applicant	Project	Distance from proposed area km	Technology	Capacity	Status
14/12/16/3/3/2/304/AM2	Molifin (Pty) Ltd	Construction and Operation of a PV Facility near Lephalale in Limpopo	22 km	Solar (PV)	Not indicated	Approved
14/12/16/3/3/2/468	Solar Reserve South Africa (Pty) Ltd	Proposed 75 MW PV solar farm on the Farm Windsor Castle 493	29.3 km	Solar (PV)	75 MW	In progress
12/12/20/2508	Phaki Phakanani Environmental Consultants (Pty) Ltd (EAP)	Proposed establishment of a solar farm with an output of 75 MW on extent of Portion 3 of the farm Rietfontein 573 LQ	22.8 km	Solar (PV)	75 MW	In progress
12/12/20/2152	Sole Energy Pty Ltd	Proposed Establishment of Delta Renewable Energy Generation Project on Portion 1 of the farm Geelhoutskloof 395 LG	17.6 km	Solar (PV)	46 MW	Approved
14/12/16/3/3/2/444	Epembe Investments (Pty) Ltd and Piosol (Pty) Ltd Solar	Construction of 75 MW Solar Farm on the Remainder of the farm Vangpan 294 LQ	25 km	Solar (PV)	75 MW	Approved
12/12/20/2128	Main Stream 832 (Pty) Ltd	Proposed renewable energy facility on remainder and portions of the farm Vangpan 294-LQ and proposed new power line from Vangpan 294-LQ to Zandnek 358-LQ (new Eskom Delta substation)	27 km	Solar (PV)	Not indicated	Withdrawn/Lapsed

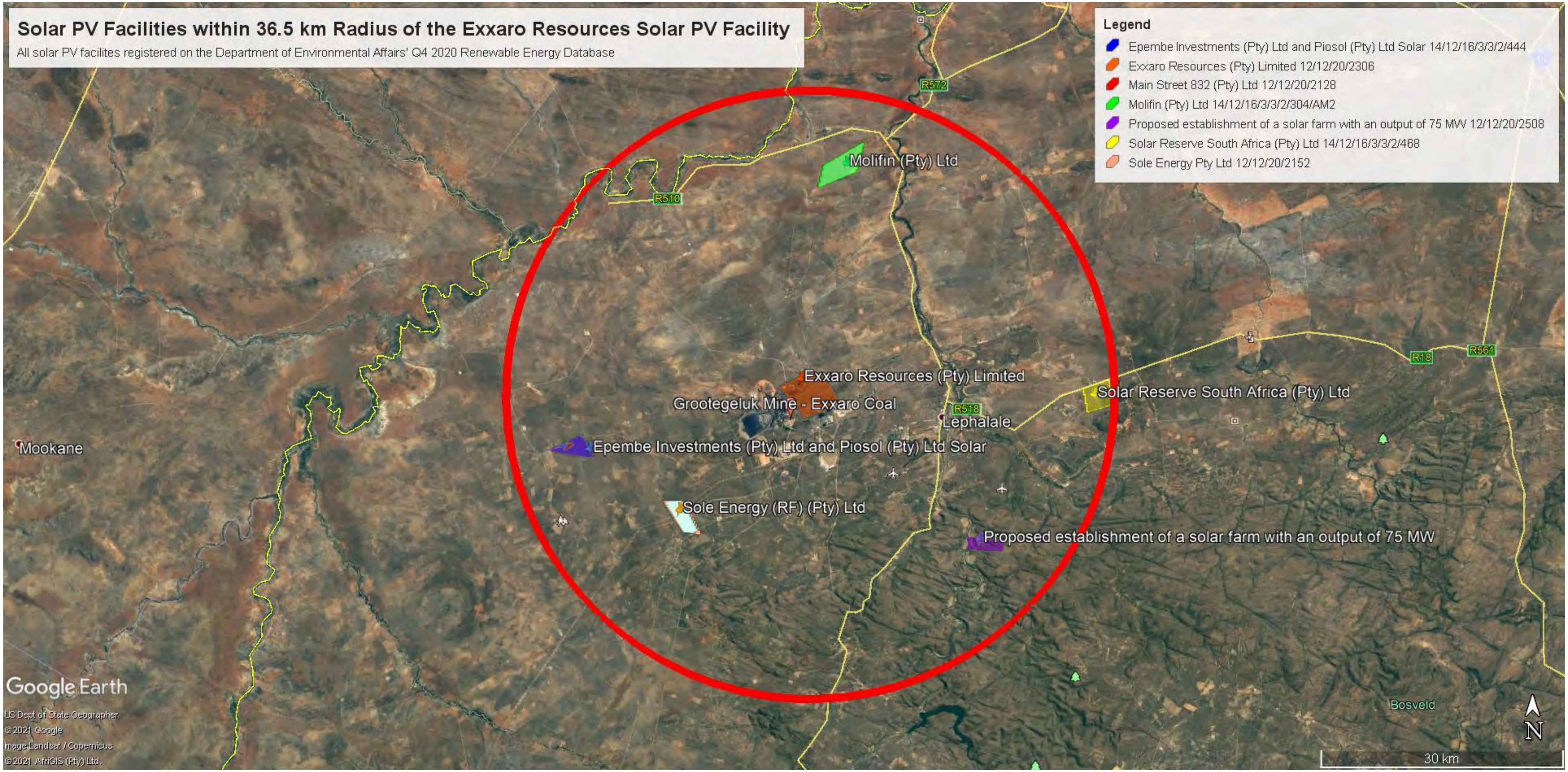


Figure 11: **Proposed renewable energy developments ~35 km radius from site**

The following social issues have been raised in the specialist reports pertaining to some of the developments in the area.

- **Positive impacts**
  - *Stimulation of economy*
  - *Job creation; Impacts associated with the construction phase are generally short-term*
  - *Increased demand for services*
  - *Increased government revenue*
  - *Skills development*
  - *Local upliftment initiatives*
  - *Sustainable household income*
  - *Establishment of renewable energy infrastructure.*
- ***Negative impacts***
  - *Potential increase in criminal activity*
  - *Impact on surrounding land uses*
  - *Sense of place*
  - *An influx of construction workers*
  - *Impact on family and community relations – STDs and HIV*
  - Risk of stock theft, poaching and damage to farm infrastructure.
- **Indirect impacts**
  - Skills and development – increased employability.
- **Decommissioning Phase**
  - Local economy stimulation
  - Temporary increase in employment and income.
- **Cumulative impacts**
  - Stimulation of economy
  - Impact associated with increases in traffic
  - Impact on family and community relations – STDs and HIV
  - Sense of place
  - Pressure on municipal and social services.
- **No-Go option**
  - Loss of development
  - Overall social impact.

The details of the reports from which these impacts have been sourced are provided in Table 9.

Table 9: List of some of the SIA reports for projects within a 35 km radius

Date	Title of report	Consultant responsible for the report
November 2005	Environmental Scoping Report for the proposed establishment of a New Coal-Fired Power Station in the Lephalale Area, Limpopo Province	Bohlweki Environmental (Pty) Ltd
April 2014	Social Impact Assessment for the Proposed Continuous Ash Disposal Facility at Matimba Power Station in Lephalale, Limpopo Province	Royal HaskoningDHV
May 2010	Mokolo and Crocodile River (West) Water Augmentation Project (MCWAP) Phase 1: Augment Supply from Mokolo Dam	Dr Neville Bews & Associates
September 2010	Proposed Construction of the Waterberg Photovoltaic Plant on a site near, Vaalwater, Limpopo	Batho Earth Soil and Environmental Consultants
October 2011	Basic Social Assessment as part of the Basic Assessment Process for the Proposed Construction of the Exxaro Photovoltaic Facility near Lephalale, Limpopo Province	Batho Earth Soil and Environmental Consultants
July 2017	Lephalale Coal and Power Project (LCPP)	KONGIWE Environmental (Pty)
June 2018	Environmental and Social Impact Assessment Summary for Medupi Flue Gas Desulphurisation (FGD) Retrofit Project Country – South Africa	African Development Bank Group
August 2018	Proposed Lephalale Railway Yard in Limpopo Province	Equispectives Research & Consulting Services
October 2020	Social Baseline and Impact Assessment for the proposed Turfvlakte Open Pit Mine Project at Grootegeluk Coal Mine near Lephalale, Limpopo Province. Exxaro Resources Limited	Golder Associates Africa (Pty) Ltd.

The more pertinent cumulative social impacts associated with the general development occurring across the region include.

- Risk of HIV and AIDS
- Population growth
- Sense of place
- Service supplies and infrastructure; and
- Economic.

7.1. RISK OF HIV INFECTIONS[2]

The area already has a relatively high prevalence of HIV with the province of Limpopo having a rate of 23.4% in 2017 and the Waterberg DM a prevalence rate of 33.0%, the highest rate compared to all other districts across the province.

With the influx of labour, particularly following the construction of the various projects within the region, the risk of HIV infections in the area is likely to continue to rise. It is well documented on both an international and local basis that the construction industry carries a high level of HIV (Meintjes, Bowen, & Root, 2007; Bowen, Dorrington, Distiller, Lake, & Besesar, 2008; Wasie, et al., 2015; Bowen P. , Govender, Edwards, & Cattell, 2016; Kikwasi & Lukwale, 2017; Bowen P. , Govender, Edwards, & Lake, 2018) which can be spread amongst the local communities, particularly through the spread of prostitution that follows the availability of disposable income. It is also well documented on both an international and local level that HIV is also spread by truck drivers (Singh & Malaviya, 1994; Ramjee & Gouws, 2002; Strauss, et al., 2018) and there is likely to be an increase in truck drivers in the area as equipment and material is delivered to the various construction sites.

These issues associated with the area being extremely poor and the associated disposable income that will follow the construction workers and truck drivers to the area will heighten the risk of the spread of HIV infections across what is a rather remote region. In this regard The World Bank (2009, pp. 367-368) had indicated a strong link between infrastructure projects and health as:

> "*Transport, mobility, and gender inequality increase the spread of HIV and AIDS, which along with other infectious diseases, follow transport and construction workers on transport networks and other infrastructure into rural areas, causing serious economic impacts.*"

7.2. SENSE OF PLACE

The Waterberg area boasts an enormous expanse of natural bush and several game farms, with economic activities based on game tourism, hunting and ecotourism. The industrial transformation in and around the town of Lephalale has, however, significantly changed the sense of place of the region, resulting in more of an industrial character. This change is accompanied by rapid growth in the human population, with new housing, retail and commercial outlets; all of which add to the change in the sense of place of the area.

[2] HIV prevalence rates are at 2013 figures based on The 2013 National Antenatal Sentinel HIV Prevalence Survey, South Africa.

7.3. POPULATION GROWTH

An influx of job seekers and the growth in the workforce will result in an increase in the population and demand for service delivery. Many of these work seekers arrive without employment offers and remain in the area in the hope of finding employment which results in the growth of informal settlements and an increase in crime, particularly petty crime driven by survival needs.

7.4. SERVICES, SUPPLIES AND INFRASTRUCTURE

With the proliferation of development in the area, it is quite likely that the local authorities, currently hard-pressed to deliver services, will find it difficult to keep up with the growth. The influx of construction workers is likely to place pressure on accommodation and the need for both services and supplies. On this basis market demands could inflate costs that may have a negative effect on local communities, particularly the poor, who may be forced to pay higher prices for essential supplies resulting in an escalation of the cost of living in the area. Social services, such as medical and educational facilities, could also be placed under pressure due to increased demand.

7.5. ECONOMIC

The cumulative economic impact of the project will be both positive and negative. The negative economic impacts, associated with a possible rise in living costs driven by market demand, are considered under the section above. In this section, the positive economic impacts will be addressed.

From a positive perspective, the proliferation of developments in the region is likely to result in significant and positive cumulative impacts in the area in terms of both direct and indirect job creation, skills development, training opportunities, and the creation of business opportunities for local businesses.

7.6. ASSESSMENT OF CUMULATIVE IMPACTS

The cumulative impacts discussed above are assessed in Table 10. It must, however, be noted that this assessment is at a superficial level as any in-depth investigation of the cumulative effects of the various developments being planned for the region are beyond the scope of this study as they would require a broad-based investigation on a far larger scale.

Table 10: Cumulative impacts

		Before Mitigation												After Mitigation													Mitigation measures
Activity	**Impact**	**Severity rating**	**Spatial scale**	**Duration**	**Consequence**	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**+/-**	**Risk Rating**	**Severity rating**	**Spatial scale**	**Duration**	**Consequence**	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**+/-**	**Risk Rating**	**Confidence level**	
Social Impacts																											
Cumulative impacts	Risk of HIV	5	5	4	14	5	5	1	3	14	196	-	H	5	5	4	14	5	5	1	3	14	196	-	H	75%	It remains beyond the scope of a single industrial enterprise to be able to address the cumulative impacts of developments in the area. Any meaningful attempt in addressing cumulative impacts would require an interdisciplinary and multi-agency approach. Following which, a strategy would need to be established to address, monitor and enforce appropriate interventions to ensure a healthy living environment for citizens, with emphasis on protecting vulnerable populations. Any mitigation and optimisation measures would need to be considered on a cumulative basis and applied across all developments in the area. They would also need to be based on a sound understanding of the current regional state of the environment and based on robust scientific grounds.
Cumulative impacts	Sense of place	4	4	5	13	5	5	1	3	14	182	-	H	4	4	5	13	5	5	1	3	14	182	-	H	75%	
Cumulative impacts	Population increase	4	4	5	13	5	5	1	3	14	182	-	H	4	4	5	13	5	5	1	3	14	182	-	H	75%	
Cumulative impacts	Service supplies and infrastructure	3	4	4	11	5	4	1	3	13	143	-	M	3	4	4	11	5	4	1	3	13	143	-	M	75%	
Cumulative impacts	Positive economic impacts	4	5	4	13	5	5	1	3	14	182	+	H	4	5	4	13	5	5	1	3	14	182	+	H	75%	

The assessment of the cumulative impacts takes into consideration the impacts associated with all developments in the area and on this basis; no fatal flaws associated with the cumulative impacts are evident at a social level. The impacts assessed above are summarised and a pre- and post-mitigation comparison is presented in **Table 11**.

Table 11: Impact summary

Construction Phase			
Environmental parameter	Issues	Rating prior to mitigation	Rating post-mitigation
Health & social wellbeing	Annoyance, air quality and noise	-91 M	-72 M
	Increase in crime	-104 M	-91 M
	Increased risk of HIV infections	-120 M	-120 M
	An influx of construction workers	-49 L	-42 L
	Hazard exposure.	-104 M	-91 M
Quality of the living environment	Disruption of daily living patterns	-70 M	-48 L
	Disruptions to social and community infrastructure	-164M	-56 M
Economic	Job creation and skills development	+72 M	-104 M
	Socio-economic stimulation	+ 99 M	-120 M
Operational Phase			
Health & Wellbeing	Glint & glare	-72 M	-72 M
Quality of the living environment	Transformation of the sense of place	-130 M	-120 M
Economic	Positive economic impacts	+168 M	+168 M
	Socio-economic stimulation	+99 M	+120 M
Decommissioning Phase			
Considering a time period of 20 years plus, prior to decommissioning and the dynamics of social variables, it would be rather meaningless to attach assessment criteria to decommissioning at this point due to the high level of uncertainty such assessment would be based upon.			
No Project Alternative			
No project	Project does not proceed	-156 M	No mitigation measures
Cumulative Impacts			
Health & social wellbeing	Risk of HIV	-196 H	-196 H
Quality of the living environment	Sense of place	-182 H	-182 H
	Population increase	-182 H	-182 H
	Services, supplies & infrastructure	-143 M	-143 M
Economic	Economic	+182 H	+182 H

8. COMPARATIVE ASSESSMENT OF LAYOUT ALTERNATIVES

Although it is necessary to consider viable alternatives regarding the project, the only viable alternatives that existed were two alternatives in respect of the access to roads and power lines. These alternatives were assessed during the basic assessment and it was found that.

> "*From a visual perspective the preferred alternatives for both the access road off the Stockpoort road and the proposed power line are supported by virtue of their shorter length. Furthermore, the preferred access road is located on the alignment of existing roads for the most part*" (Savannah Environmental, 2011, p. 86).

On a social basis, less of a visual intrusion would be preferred and therefore the shorter power line option and preferred access road would be supported.

The requirement to make minor adjustments to the associated infrastructure during the detailed engineering phase of the project, in order to avoid any social and/or environmental obstacles that may become apparent, is also supported. Apart from this no further social preferences have emerged in respect of any of the alternatives.

9. CONCLUSION

Regarding the negative impacts associated with the project, it was evident that most apply over the short-term construction phase of the project. Of these impacts, all can be mitigated to within acceptable ranges and there are no social fatal flaws associated with the construction or operation of the project. Although over the operational phase, the project will be visible and is likely to alter the sense of place of the area, this should be limited to the extent that the PV facility and infrastructure is placed within an industrialised setting.

On a cumulative basis, considering a range of developments that have occurred over an extended period in the area; Lephalale and surrounds have undergone extensive transformation. Although the project will contribute towards this transformation, this will be at an insignificant level, as the project falls within what is already an industrialised area with Grootegeluk Coal Mine, Matimba and Medupi power stations and associated infrastructure all within close proximity.

On the positive front the project clearly fits with policy and legislation and the Presidential announcement to increase the threshold for generation license exemptions for embedded generation projects from 1 MW to 100 MW. In this regard the project will not only ensure that the mine enjoys a more reliable, available and sustainable electricity supply but will also contribute towards reducing CO^2 emissions. On a cumulative basis, considering other renewable energy initiatives across the country and the opportunity of wheeling surplus energy to the grid, the project could also have a positive effect on the security of the National Electricity Grid.

9.1. IMPACT STATEMENT

Considering all social impacts associated with the project, it is evident that the positive elements outweigh the negative, and that the project carries with it a significant social benefit and as such is supported and should proceed. In addition, the project fits with the Government's requirement for the urgent generation of electricity by means of renewable energy initiatives.

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APPENDIX 1 – ENVIRONMENTAL IMPACT ASSESSMENT (EIA) METHODOLOGY

The assessment of potential impacts was addressed in a standard manner to ensure that a wide range of impacts were comparable. The ranking criteria and rating scales were applied to all specialist studies for this project. The following methodology was used to rank these impacts. Clearly defined rating and rankings scales (Error! Reference source not found. - Error! Reference source not found.) were used to assess the impacts associated with the proposed activities. The impacts identified by each specialist study and through public participation were combined into a single impact rating table for ease of assessment.

Each identified impact was assessed in terms of severity, spatial scale and duration (temporal scale). Consequence was then determined as follows:

Table 1: Severity or magnitude of impact

Insignificant/non-harmful (no loss of species / habitat)	1
Small/potentially harmful (replaceable loss with minimal effort)	2
Significant/slightly harmful (replaceable loss of species / habitat with great effort and investment)	3
Highly Significant/harmful (impact to human health or welfare / loss of species / habitat)	4
Extremely Significant /extremely harmful/within a regulated sensitive area (loss of human life / irreplaceable loss of Red Data species / conservation habitat)	5

Table 2: Spatial Scale – extent of area being impacting upon

Area specific (at impact site)	1
Whole site (entire surface right)	2
Local (within 5km)	3
Regional/neighbouring areas (5 km to 50 km)	4
National	5

Table 3: Duration of activity

One day to one month (immediate – immediately reversible with minimal effort)	1
One month to one year (Short term - reversible)	2
One year to 10 years (medium term - difficult to reverse with effort)	3
Life of the activity (long term – very difficult to reverse with extensive effort)	4
Beyond life of the activity (permanent – not reversible)	5

Table 4: Frequency of activity - how often activity is undertaken

Improbable / almost never / Annually or less	1
Low probability / Very seldom / 6 monthly	2
Medium probability / Infrequent / Temporary / Monthly	3
Highly probable / Often / semi-permanent / Weekly	4
Definite / Always / permanent / Daily	5

Table 5: Frequency of incident/impact - how often activity impacts environment

Almost never/almost impossible/>20%	1
Very seldom/highly unlikely/>40%	2
Infrequent/unlikely/seldom/>60%	3
Often/regularly/likely/possible/>80%	4
Daily/highly likely/definitely/>100%	5

Table 6: Legal Issues - governance of activity by legislation

No legislation	1
Fully covered by legislation	5

Table 7: Detection - how quickly/easily impacts/risks of activity on environment, people and property are detected

Immediately (easier to mitigate)	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered (more difficult to mitigate)	5

Consequence = Severity + Spatial Scale + Duration

The risk of the activity was then calculated based on frequencies of the activity and impact, whether the activity is governed by legislation and how easily it can be detected:

Likelihood = Frequency of Activity + Frequency of Impact + Legal issues + Detection

The risk of each identified impact was then based on the product of consequence and likelihood.

Risk = Consequence x Likelihood

Impacts were rated as either of high, moderate or low significance on the basis provided in **Error! Reference source not found.**. Each impact was also assessed in terms of the level to which there is an irreplaceable loss of resources and its degree of reversibility. The ratings as described in **Error! Reference source not found.** and **Error! Reference source not found.**.

Table 8: Impact Significance Ratings

SIGNIFICANCE RATING	CLASS (NEGATIVE IMPACT)	CLASS (POSITIVE IMPACT)
1 - 55	(L) Low Significance	(L) Low Significance
56 - 169	(M) Moderate Significance	(M) Moderate Significance
170 - 600	(H) High Significance	(H) High Significance

Table 9: Irreplaceability of resource caused by impacts

No irreplaceable resources will be impacted (the affected resource is easy to replace/rehabilitate)	**Low**
Resources that will be impacted can be replaced, with effort	**Medium**
Project will destroy unique resources that cannot be replaced	**High**

Table 10: Reversibility of impacts

Low reversibility to non-reversible	**Low**
Moderate reversibility of impacts	**Medium**
High reversibility of impacts	**High**

APPENDIX 2 – SCREENING REPORT FOR AN ENVIRONMENTAL AUTHORIZATION