Soils and Agricultural Potential Impact Assessment

FOR AN ENVIRONMENTAL IMPACT ASSESSMENT APPLICATION FOR THE ERGO MINING SOLAR PV FACILITY (PHASE 2), WITH A PLANT CAPACITY OF 40MW, WITHIN THE EKURHULENI LOCAL MUNICIPALITY, GAUTENG

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Declaration of Independence by Specialists

I, Rowena Harrison, hereby declare that I -

- Act as an independent soil consultant;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Have and will not have vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- Based on information provided to me by the project proponent and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional ability.

An abridged CV of the author is provided in Appendix C as per the 'Minimum Report Content Requirements' for Specialist Reports (as per GN 320 GG 43110, dated 20 March 2020).

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Rowena Harrison
SACNASP Reg. No. 400715/15
Date: 26th of August 2022

EXECUTIVE SUMMARY

Malachite Ecological Services was appointed by Environmental Management Assistance (Pty) Ltd to undertake a Soils and Agricultural Potential Impact Assessment for the proposed construction of a Solar Photovoltaic (PV) plant (phase 2), with a capacity of 40MW to supply power to the existing Ergo Mining (Pty) Ltd Brakpan Plant. The proposed project is situated off the R23 (Heidelberg Road), within the Ekurhuleni Local Municipality, Gauteng.

Two alternative layouts were assessed, with the preferred layout occurring on Portions 183 and 272 of the Farm Witpoortje No. 117IR, and the alternative layout occurring on Portion 183 of the Farm Witpoortje No. 117R and the Remainder of Portion 9 of the Farm Withok No. 131IR. The project infrastructure consists of the solar panels, a BES laydown area, a warehouse, an office, a switch room, internal roads to allow access to all the panels as well as a fence which will surround the entire infrastructural area. An additional access point to the northern portion of the preferred layout (Ptn 272 of the Farm Witpoortje No. 117IR) will also be utilised. This access point was approved as Phase 1 of the project and will utilise an existing road.

The terms of reference for the study were as follows:

- A desktop investigation of the land type associated with the study site. Land Type data is classified according to the Binomial System of 1977. Soil data was extracted from the land type information and re-classified as per the Soil Classification Working Group (2018).
- A field investigation to conduct a soil survey and mapping exercise of the study site to soil form level in order to ground truth the findings of the desktop assessment (Scoping Phase).
- Describe the physical properties of the soils sampled at each sampling location.
- Describe the slope, geology, topography, water resources and climate of the site.
- Describe the agricultural potential of the site based on the information attained from the desktop assessment as well as the field investigation of the two alternative layout sites.
- Identify current and possible negative impacts of the proposed project on the soils and agricultural potential of the site.
- Recommend mitigation measures to lessen these impacts within the study site.

Augur sample points were taken throughout the proposed PV facility site (taking into consideration both layout alternatives) during a field assessment conducted between the 30th of May and the 1st of June 2022. Soils were classified to form level and assessed in terms of their field texture, soil depth, subsoil permeability, slope, rockiness, surface crusting and wetness.

Taking into account the findings of the soil mapping exercise for both phase 1 and phase 2 of the Ergo Gold PV project, coupled with historic and current aerial imagery, the study site was divided into two separate soil types, the Natural Soils and the Anthrosols and Technosols.

The first group are naturally occurring with the soil morphological expression and sequence of soil horizons being formed without significant human intervention. Anthrosols and Technosols on the other hand, are soils which have been drastically altered by human intervention such that the natural

soil properties are no longer identifiable, and an anthropogenic classification is applied. The natural soils were classified as the Hutton/Nkonkoni soils, as well as the Katspruit and Tukulu soil forms. The Anthrosols and Technosols were classified as the Grabouw, Witbank, and Stilfontein soils forms.

Utilising the soil information, climatic information, and topography, the study site was assessed in terms of the agricultural potential. The study site has been categorised into the Class III, Class V, Class VI, and Class VIII categories. The Class III category is classified in areas that contain the natural Hutton/Nkonkoni soils. These soils are productive with regards to crop cultivation as they are well drained, generally rich in minerals and nutrients and have the depth required to sustain a number of crops. These soils occupy 22.2 % of the preferred layout site, and 5.7 % of the alternative layout site. The Class V category is reserved for saturated soils and was thus mapped where the anthropogenic Stilfontein and the natural Katspruit and Tukulu soils were identified in both the preferred and alternative layout sites. The soils are either anthropogenically modified, in the case of the Stilfontein soils or form part of wetland systems in the case of the Katspruit and Tukulu soil forms. Cropping in these areas would require intensive protection measures and special practices such as the drainage of the soil. Class V areas occupy 31.7 % of the preferred layout site and 22.9 % of the alternative layout site

The Grabouw or Physically Disturbed Anthrosol soils have been classified as Class VI soils. Class VI soils have severe restrictions to cropping and are therefore excluded from production under perennial vegetation. This is due to the anthropogenic disturbances to these soils and the use of the soils for human activity. Class VI areas occupy 40.8 % of the preferred layout site and 49.2 % of the alternative layout site. The remaining Witbank soils are categorised as Class VIII soils. These soils have been completely modified and are currently stockpiles. They are not productive for any agricultural activities, and they occupy 5.7 % of the preferred layout site 22.1 % of the alternative layout site.

Overall, the study site can therefore be considered to have a low agricultural potential with severe limitations to crop cultivation. The majority of the site is classified as Class V or Class VI (76.8%). This is as a result of a combination of factors including the significant long term anthropogenic modifications to the soils of the entire study site, the presence of saturated horizons, and the use of the surrounding landscape for mining and urban activities. Portions of the site are considered acceptable for crop production; however, these are small in comparison (22.2 %) to the non-suitable areas (77.8 %).

The project will involve the clearing of portions of the site for the establishment of the proposed 40MW power PV facility. The alternative layout is similar to the preferred layout, with Potion 183 of the Farm Witpoortje No. 117R forming both a part of the preferred and alternative layouts. Similar soils were identified in the Remainder of Portion 9 of the Farm Withok No. 131IR as in the preferred layout site. As such impacts to the agricultural potential of the study site were identified as being the same for both layouts (preferred and alternative) and are associated with

- the loss of agricultural land (this is a very limited to non-applicable impact as it only pertains to the loss of grazing land).
- soil compaction and exposure of topsoil potentially leading to erosion, and

- pollution of the soils as a result of construction related activities.

Several general and specific measures are proposed to mitigate these impacts.

In conclusion, the site (including both layout alternatives) can be considered to have a negligible to low agricultural production with regards to the cultivation of crops as a result of the majority of the site (including both layout alternatives) having been anthropogenically disturbed to such a level that the natural soil profile is not generally apparent. Cultivation of crops cannot take place in these areas. It is therefore the opinion of the author that, provided mitigation measures to reduce the impact of the project on the receiving environment are implemented as part of the construction and operational phases of the project, either the preferred or alternative layouts be approved from an agricultural perspective.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION AND BACKGROUND

1.1. Project Background and Locality

Malachite Ecological Services was appointed by Environmental Management Assistance (Pty) Ltd. to undertake a Soils and Agricultural Potential Assessment for the proposed construction of a Solar Photovoltaic (PV) plant (phase 2), with a capacity of 40MW to supply power to the existing Ergo Mining (Pty) Ltd Brakpan Plant and the Brakpan/Withok Tailings Dam facility. The proposed project is situated off the R23 (Heidelberg Road), within the Ekurhuleni Local Municipality, Gauteng. The project site is furthermore situated within the quarter degree square 2628AD (Figure 1).

Two alternative layouts were assessed, with the preferred layout occurring on Portions 183 and 272 of the Farm Witpoortje No. 117IR (Figure 2), and the alternative layout occurring on Portion 183 of the Farm Witpoortje No. 117R and the Remainder of Portion 9 of the Farm Withok No. 131IR (Figure 3). The project infrastructure consists of the solar panels, a BES laydown area, a warehouse, an office, a switch room, internal roads to allow access to all the panels as well as a fence which will surround the entire infrastructural area. An additional access point to the northern portion of the preferred layout (Ptn 272 of the Farm Witpoortje No. 117IR) will also be utilised. This access point was approved as Phase 1 of the project and will utilise an existing road.

The primary aim of the assessment is set out in the Natural Resources Survey Specifications document (2012) and is to determine the general soil types in the study area, their land capability and agricultural potential. This will be achieved through a desktop study and field investigation (conducted between the 30th of May and the 1st of June 2022) of the soils within the study site as well as through an investigation into historic and current aerial imagery; the climate of the area; the geology; the erosion hazard; and the water resources. Recommendations resulting from these findings will be aimed at ensuring soil resources are utilised in a sustainable manner.

Soil forms are the primary components creating the pedosphere and are integral in the sustainability of life on earth. They are formed through the integration of five key components, namely: parent material (geology); time; climate; microorganisms; and water. The primary attributes of soil forms include:

- Soils are the primary mediums on earth for biological processes and activity;
- They provide and sustain integral ecological processes including water retention, nutrient cycling, and the organic carbon cycle; and
- The soil characteristics of a particular area determine the botanical and faunal composition. Therefore, soils provide an important system in which the ecology of the area is founded upon.

South African soils can be classified into approximately 73 forms and further categorised into 14 groups (Fey, 2010). These numbers have been recently extended to 135 forms in 2018 (Soil Working Group, 2018). The classification and identification of these soil forms are based on the presence of defined diagnostic horizons or materials. Ineffective conservation efforts coupled with increased development within South Africa has exerted pressure on these vital soil resources. It is imperative that all developments employ techniques to ensure the conservation of soils forms.

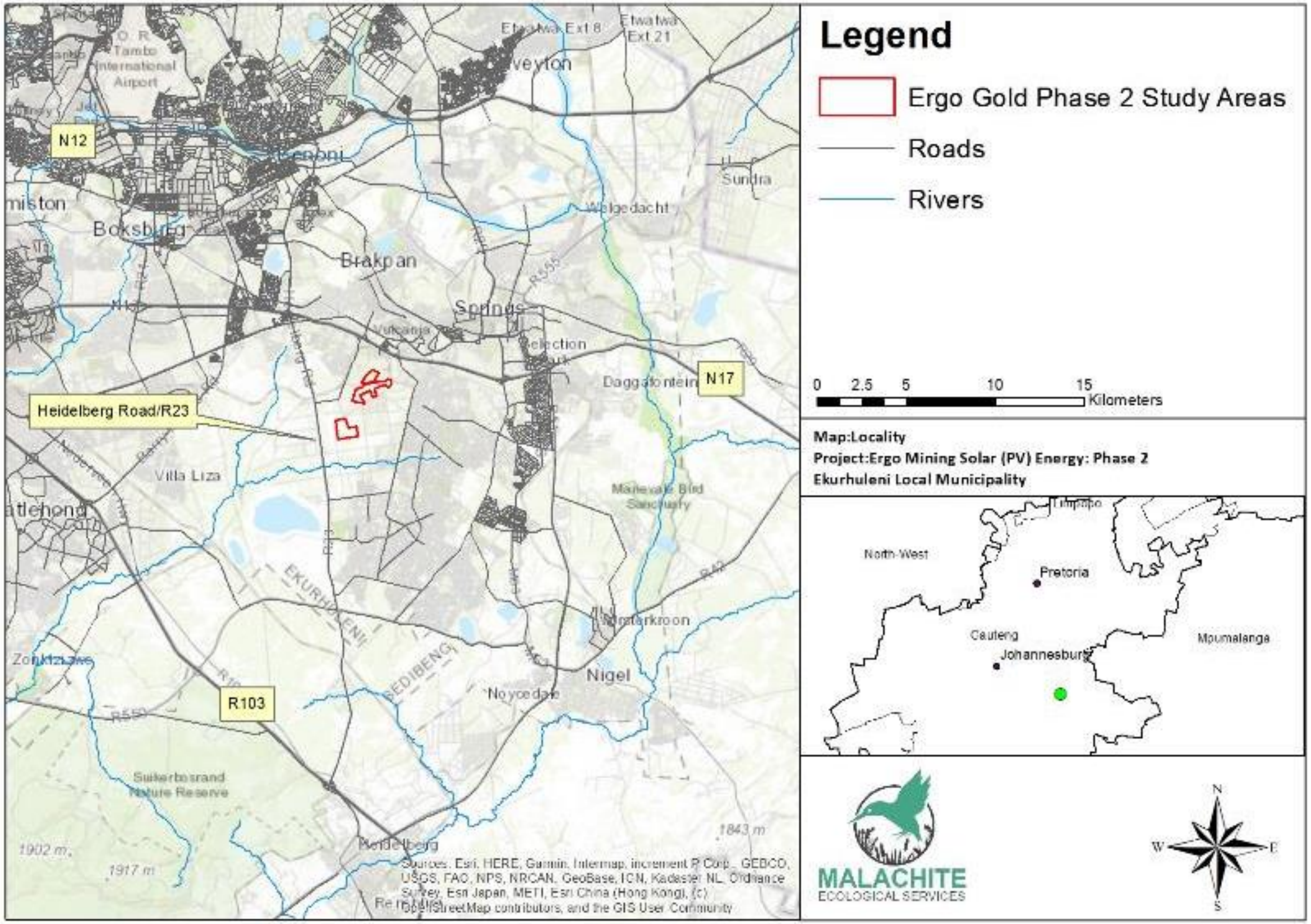

Figure 1: Locality of the entire study site

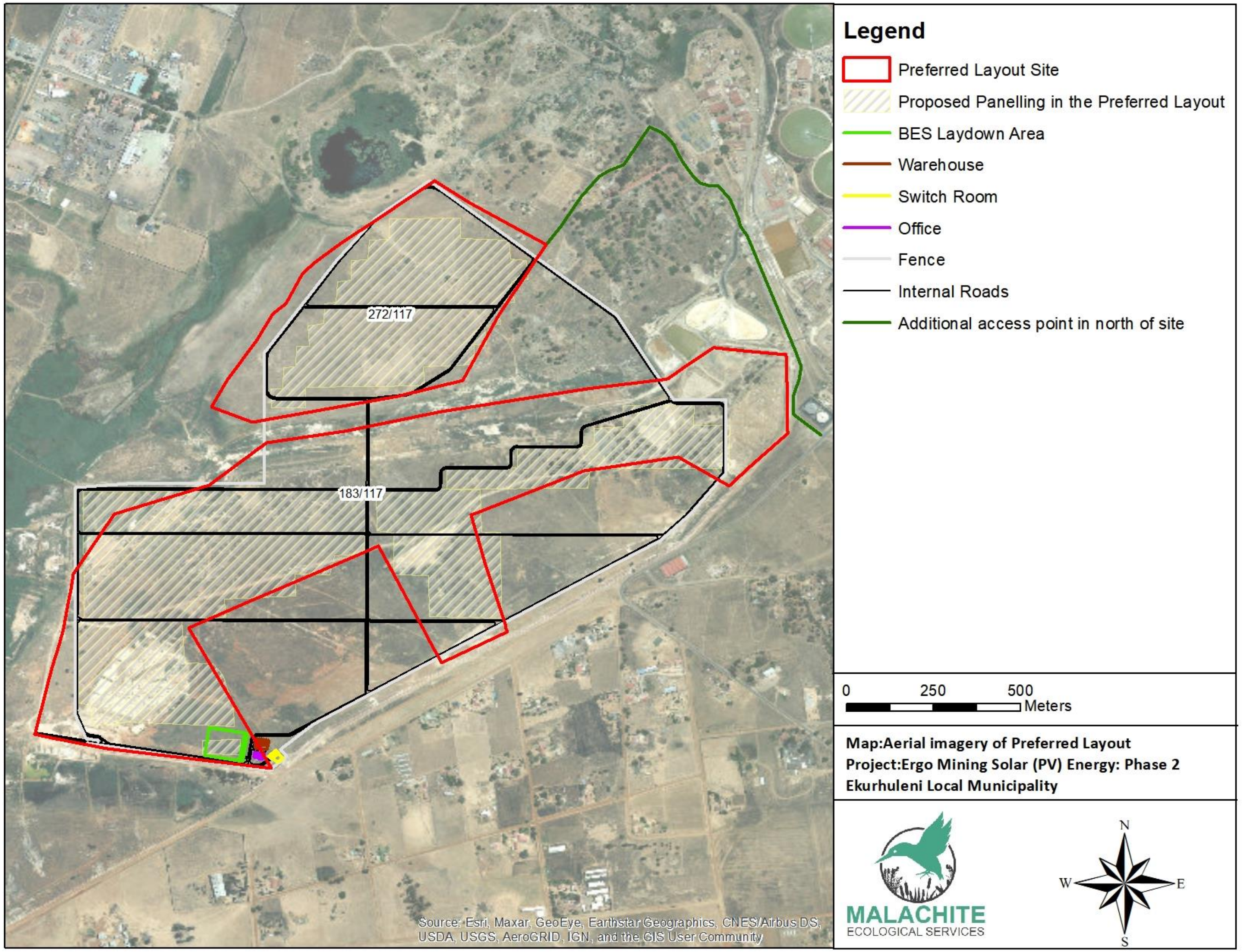

Figure 2: Aerial imagery showing the preferred layout site

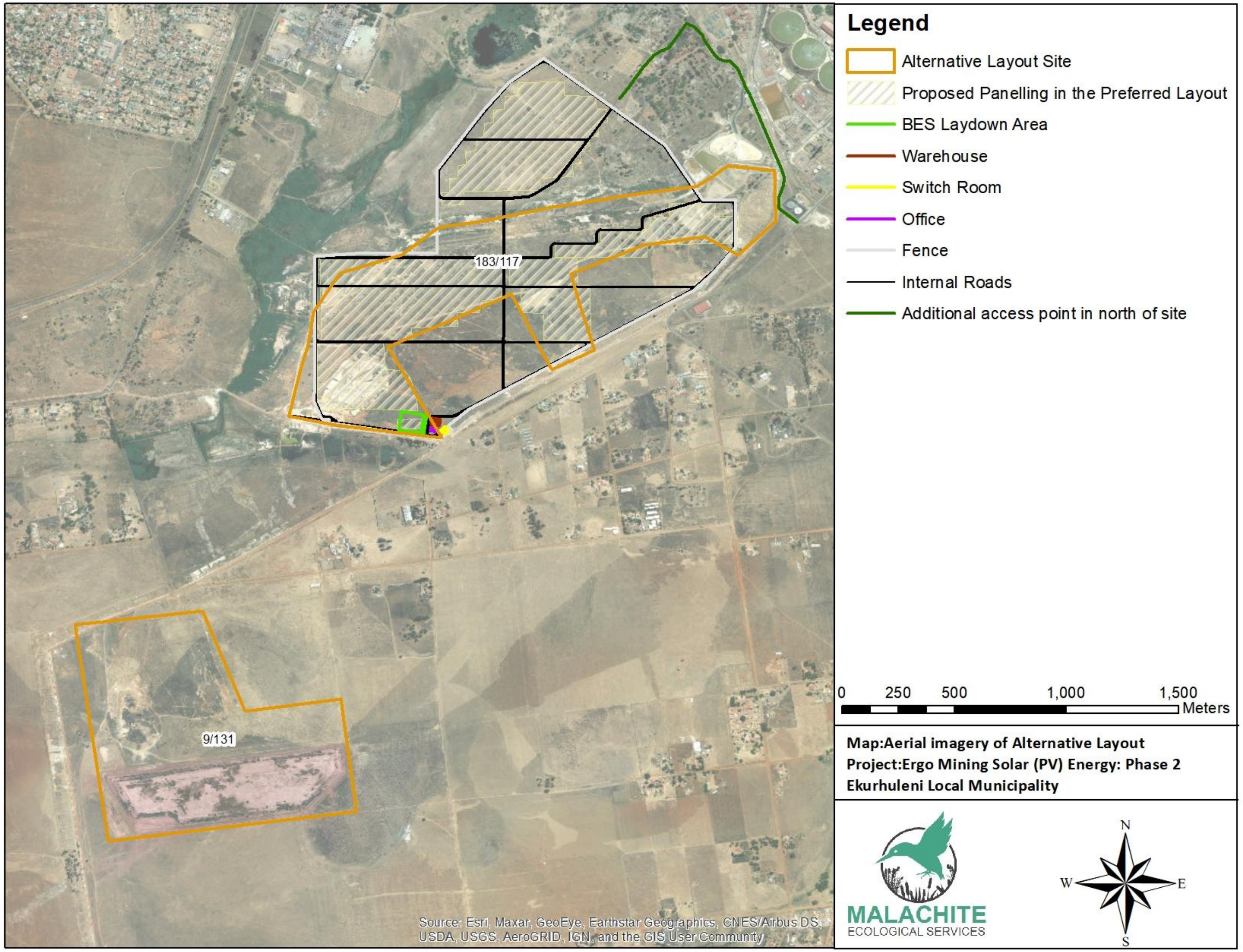

Figure 3: Aerial imagery showing the alternative layout site

1.2. Scope of the Assessment

The terms of reference for the study were as follows:

- A desktop investigation of the land type associated with the study site. Land Type data is classified according to the Binomial System of 1977. Soil data was extracted from the land type information and re-classified as per the Soil Classification Working Group (2018).
- A field investigation to conduct a soil survey and mapping exercise of the study site to soil form level in order to ground truth the findings of the desktop assessment (Scoping Phase).
- Describe the physical properties of the soils sampled at each sampling location.
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- Describe the agricultural potential of the site based on the information attained from the desktop assessment as well as the field investigation of the two alternative layout sites.
- Identify current and possible negative impacts of the proposed project on the soils and agricultural potential of the site.
- Recommend mitigation measures to lessen these impacts within the study site.

1.3. Assumptions and Limitations

It is difficult to apply pure scientific methods within a natural environment without limitations or assumptions. The following apply to this study:

i. Soil mapping was inferred from extrapolations from the auger sampling points, whose locations were recorded on GPS coordinate waypoints with an accuracy of 3 to 6m. The boundaries of the soil forms delineated within the site are based on these waypoint locations. It is impossible to achieve 100% purity in soil mapping, the delineated soil map units could include other soil types as the boundaries between the mapped soils are not sharp but rather gradual in reality.
ii. Soils classified as suitable to arable agriculture are also suited to other less intensive agricultural land uses, for instance pasture, natural grazing, and wildlife.
iii. Soil fertility status was not undertaken in this assessment.

1.4. Reporting Conditions

The findings, results, observations, conclusions, and recommendations provided in this report are based on the author’s best scientific and professional knowledge as well as information available at the time of compilation. The author, however, accept no liability for any actions, claims, demands, losses, liabilities, costs, damages, and expenses arising from or in connection with services rendered, and by the use of the information contained in this document. No form of this report may be amended without the prior written consent of the author.

2. METHODOLOGY

2.1. Assessment techniques and tools

The techniques and tools utilised for this assessment can be divided into baseline data and field investigations. Baseline data was utilised during the desktop component (Scoping Phase) (Malachite Ecological Services, 2022), to determine the biophysical context of the site as well as the potential agricultural capability of the site. These findings were then refined during the current assessment.

2.2. Desktop Study Methodology

The desktop study involved the examination of aerial photography and Geographical Information System (GIS) databases. The study made use of the following data sources:

- Google Earth™ satellite imagery was used at the desktop level.
- Relief dataset from the Surveyor General was used to calculate slope.
- Land type data was obtained from the Agricultural Research Council (ARC).
- Climatic data was obtained using a dataset from 1982 to 2012 on the climate-data.org website.
- Historical imagery was obtained from the Department of Rural Development and Land Reform and the National Geospatial Information website (http://cdngiportal.co.za/cdngiportal/).
- Geology dataset was obtained from AGIS[1].
- Vegetation type dataset from Mucina & Rutherford (2006), with amendments by SANBI (NBA, 2018) were used in determining the vegetation type of the study area.
- The National Wetland Map 5 dataset (NBA,2018) (Van Deventer et al., 2018) was used in determining any wetlands and watercourses within the study site.

2.3. Site Investigation

In field data collection was taken between the 30th of May and the 1st of June 2022. Soil sampling was conducted throughout the preferred and alternative sites using a standard hand-held auger with a depth of 1200 mm. At each sampling point the soil was described to form level according to Soil Classification: A Natural and Anthropogenic System for South Africa (Soil Classificatoin Working Group, 2018).

The following properties were recorded:

- Soil diagnostic horizons.
- Soil Form.
- Depth of the profile.
- Soil colour – as per the Munsell System.
- Soil texture including clay percentage.
- Permeability of the B horizon (wetness indicators).
- Effective rooting depth.

[1] Land type information was obtained from the Department of Agriculture's Global Information Service (AGIS) January 2014 – www.agis.agric.za

- Observations at the sampling point including any surface crusting, vegetation cover and rockiness.

The infield methods of determining soil texture and clay percentage are described in more detail in Appendix A.

Topography was also taken into account during this assessment, as together with soil form, it plays a large part in determining the land potential of the sites as well as any rehabilitation measures that may need to be taken as a result of the project. Climate is used as an important determinant in the agricultural potential of the site. Climate determines the volume of rainfall precipitation, the type of precipitation, the seasonal occurrence, soil moisture evaporation rate as well as the effect of sunshine hours, heat and chill units on crop yield and ground cover.

Information from the soil samples, the topography and land type information were utilised to produce the agricultural potential map.

3. BASELINE DESCRIPTION

3.1. Local Climatic Conditions

The Ergo Gold Mine is situated within an area characterised by summer rainfall patterns with sporadic rainfall events during the winter months. The mean annual precipitation is 692 mm, with the bulk of the rainfall occurring between September and March (summer months). These high intensity rainfall conditions are conducive to high levels of surface runoff and subsequent erosion where soils are shallow, occur on steep slopes or are overgrazed. The wettest time of the year is January with an average of 123 mm and the driest is June and July with 7 mm (Table 1). The seasonality of precipitation is a driving factor behind the hydrological cycles of water resources within the area. Typically, watercourses have a higher flow rate during the summer months.

Mean temperatures vary between 9.7 ^{O}C to 19.7 ^{O}C for the Brakpan region (Table 2). The area is coldest in July with average minimum temperatures of 2.8 ^{O}C and hottest in November and December with average maximum temperature of 25.2 ^{O}C on average (Climate-data.org; Mucina & Rutherford, 2006).

Table 1: Mean annual rainfall data for the Brakpan area

	January	February	March	April	May	June	July	August	September	October	November	December
Mean Rainfall (mm)	123	96	86	42	19	7	7	9	24	65	105	109

Table 2: Temperature data for the Brakpan area

	January	February	March	April	May	June	July	August	September	October	November	December
Mean Temperature (^{O}C)	19.7	19.6	18.4	15.7	12.8	10	9.7	13	16.8	18.5	18.9	19.7
Max Temperature (^{O}C)	25	24.9	23.9	21.5	19.6	17.3	17.4	20.9	24.6	25.7	25.2	25.2
Min Temp (^{O}C)	14.8	14.6	13.2	10.2	6.5	3.5	2.8	5.6	9.1	11.6	12.9	14.6

3.2. Geology

South Africa is a semi-arid country with differences in rainfall patterns, topography, and geology. The geological characteristic of an area influences the topography, soil types and textures, vegetation communities and faunal assemblages present.

The study area is underlain predominantly by the Ecca Group of the Madzaringwe Formation of the Karoo Supergroup. The geology of this region is primarily known to be sedimentary strata and is a very thick sequence of carbonaceous siltstone, mudstone, shale, sandstone, and coal (www.agis.agric.za).

3.3. Regional Vegetation structure and composition

The study area is located within the Grassland Biome. According to the latest regional vegetation classification for South Africa (Mucina & Rutherford, 2006; updated 2018), the study area falls within the Tsakane Clay Grassland vegetation type (Figure 4).

The Tsakane Clay Grassland unit is distributed throughout Gauteng and Mpumalanga in areas characterised by flat to slightly undulating plains and low hills. The community structure is comprised of short, dense grassland dominated by a mixture of common highveld grasses such as *Themeda triandra, Heteropogon contortus*, *Elionurus muticus* and a number of *Eragrostis* species. The dominant forbs are of the families Asteraceae, Rubiaceae, Malvaceae, Lamiaceae and Fabaceae. Disturbances within these grasslands changes the vegetation dynamics, with an increase in the abundance of *Hyparrhenia hirta* and *Eragrostis chloromelas* noted. Erosion is generally very low. This vegetation unit is classified as Endangered, with only 1.5% conserved in statutory reserves. The latter was confirmed in the NBA (2018) which indicates that the vegetation type is Poorly Protected, with an estimated over 60% transformed for cultivation, urbanisation, mining, dam-building, and roads.

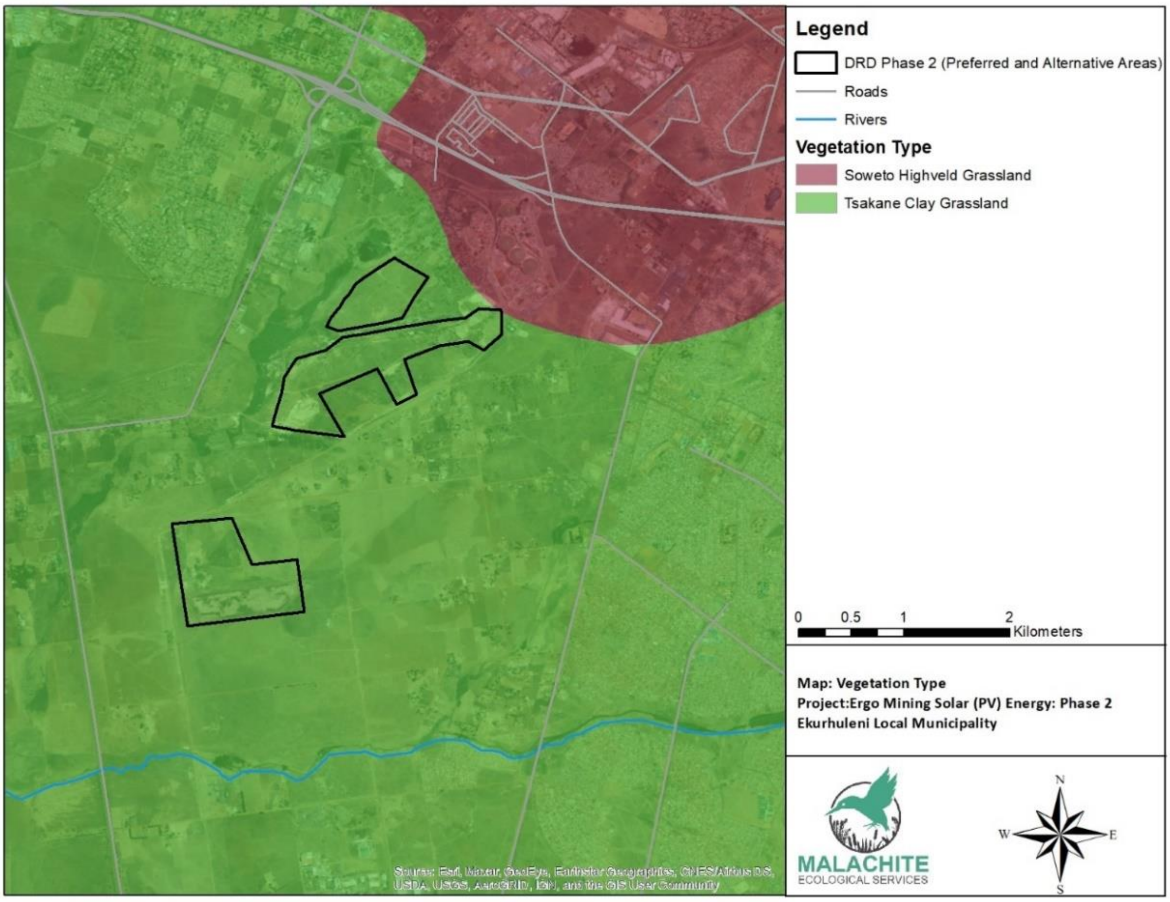

Figure 4: Regional vegetation associated with the study site

3.4. Wetland and watercourse systems

The project area is situated within the C22C Quaternary Catchment, with the Rietspruit River flowing approximately 2.7 km to the west of the study site. A tributary of this river flows approximately 1.5 km to the south of the study site. Non-perennial drainage channels are also located within the study site.

The NWM5 was utilised to assess the project area. The recent publication of the National Wetland Map 5 (Van Deventer et al, 2019) (NWM5) database forms part of the National Biodiversity Assessment (2018), within the category of the Inland Aquatic (Freshwater) Realm. This project is a multi-partner project through the CSIR and SANBI. The NWM5 has significantly improved the representation of inland wetland ecosystem types. The representation of the extent of inland wetlands has improved by 123%, whereas the incorrect representation of terrestrial ecosystems as wetlands has been reduced (Van Deventer et al, 2018).

As shown in Figure 5, an unchannelled valley bottom wetland flows along the western to northern boundary of the larger study site, and a depression/pan is located on the south-eastern boundary of the alternative layout site. According to the National Biodiversity Assessment (2018) the unchannelled valley bottom is classified as Critically Endangered, and not protected. The depression is classified as Least Concern and not protected. Both system types are at a high risk to loss within the catchment area. These systems are often utilised for agricultural production leading to negative impacts on their health and functional integrity. The protection of wetland systems forms part of the National Water Act (36 of 1998) and the delineation and assessment of these systems is detailed in the Wetland and Aquatic Assessment (Malachite Ecological Services and Ecology International, 2022).

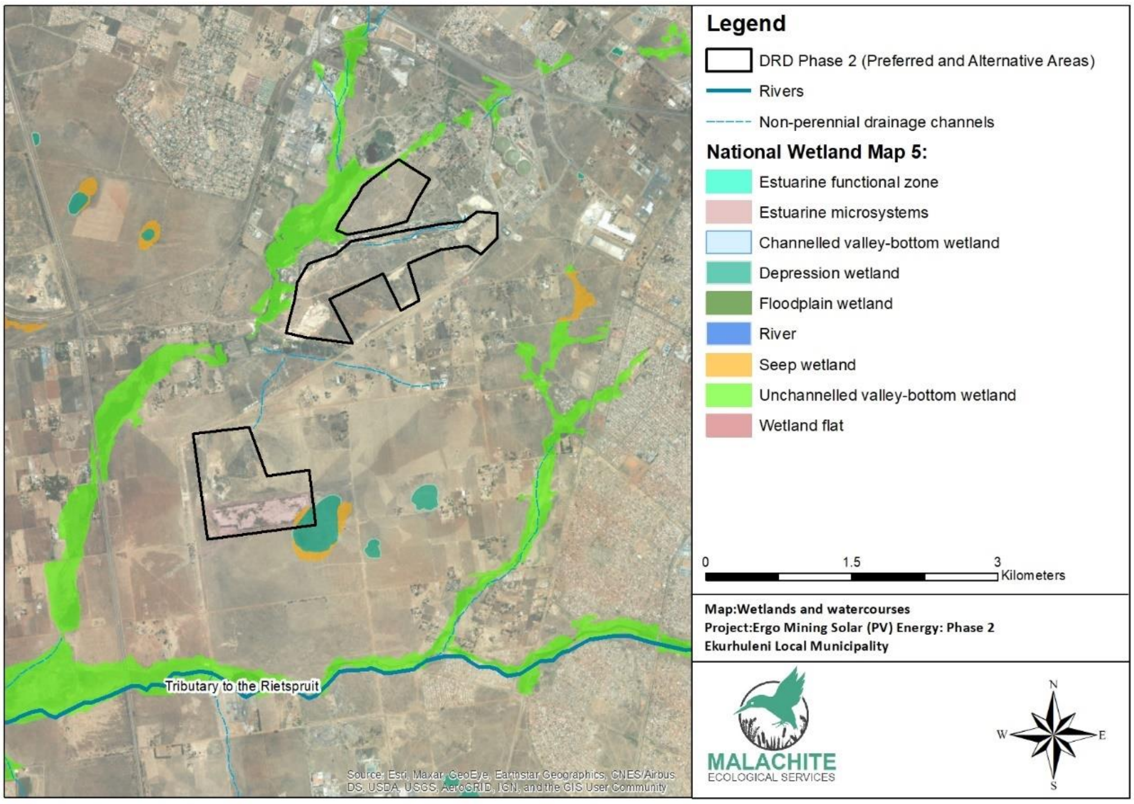

Figure 5: Wetland systems surrounding the site as per the National Wetland Map 5 (2018) database

3.5. Topography

The project area is situated on a gently undulating landscape. Average slopes are between 2 % to 2.5 % with maximum slopes of 11 % within the northern section of the study site, where the existing Ergo Gold Mine Brakpan Plant is located. The altitude ranges from 1583m above sea level (absl) in the south-eastern portion of the study site and rises to 1659m absl in the northern extent of the study site (Figure 6). Topography is not considered a limitation to agricultural production.

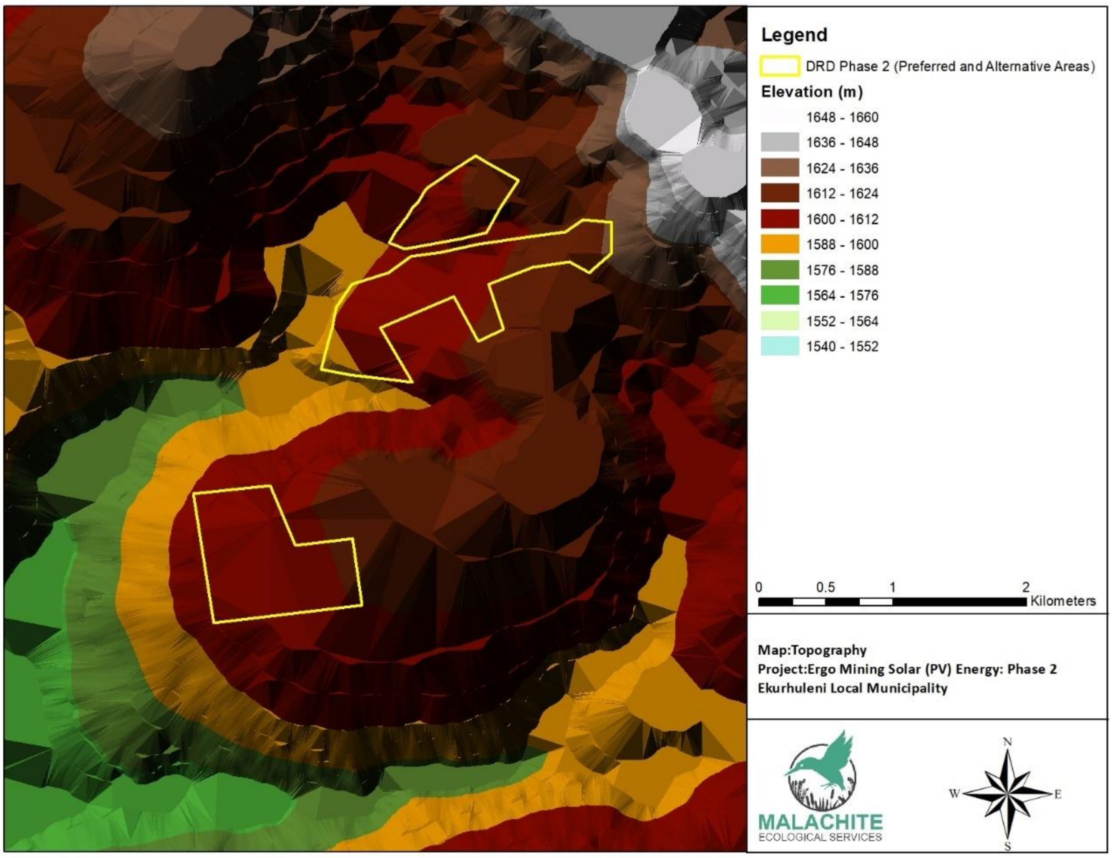

Figure 6: Topography of the site showing the range in altitude

3.6. Land Type Data

Land type data for the site was obtained from the Agricultural Research Council (ARC). The land type data is presented at a scale of 1:250 000 and entails the division of land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System. The soil data was interpreted and re-classified according to the Taxonomic System (Land Type Survey Staff, 1972-2006).

The study site is situated in the Bb3 land type (Figure 7). The B land types represent a large proportion of the interior of South Africa and is made up of plinthic soils. Plinthic soils indicate a fluctuating water table. Hillslope catenas within these land types are represented by the soil forms Hutton, Bainsvlei, Avalon, and Longlands. Valley bottoms consisting of a gley soils such as the Katspruit soil form or Willowbrook, Rensburg or Champagne. In the Bb land types the plinthic character of soils makes up more than 10% of the area.

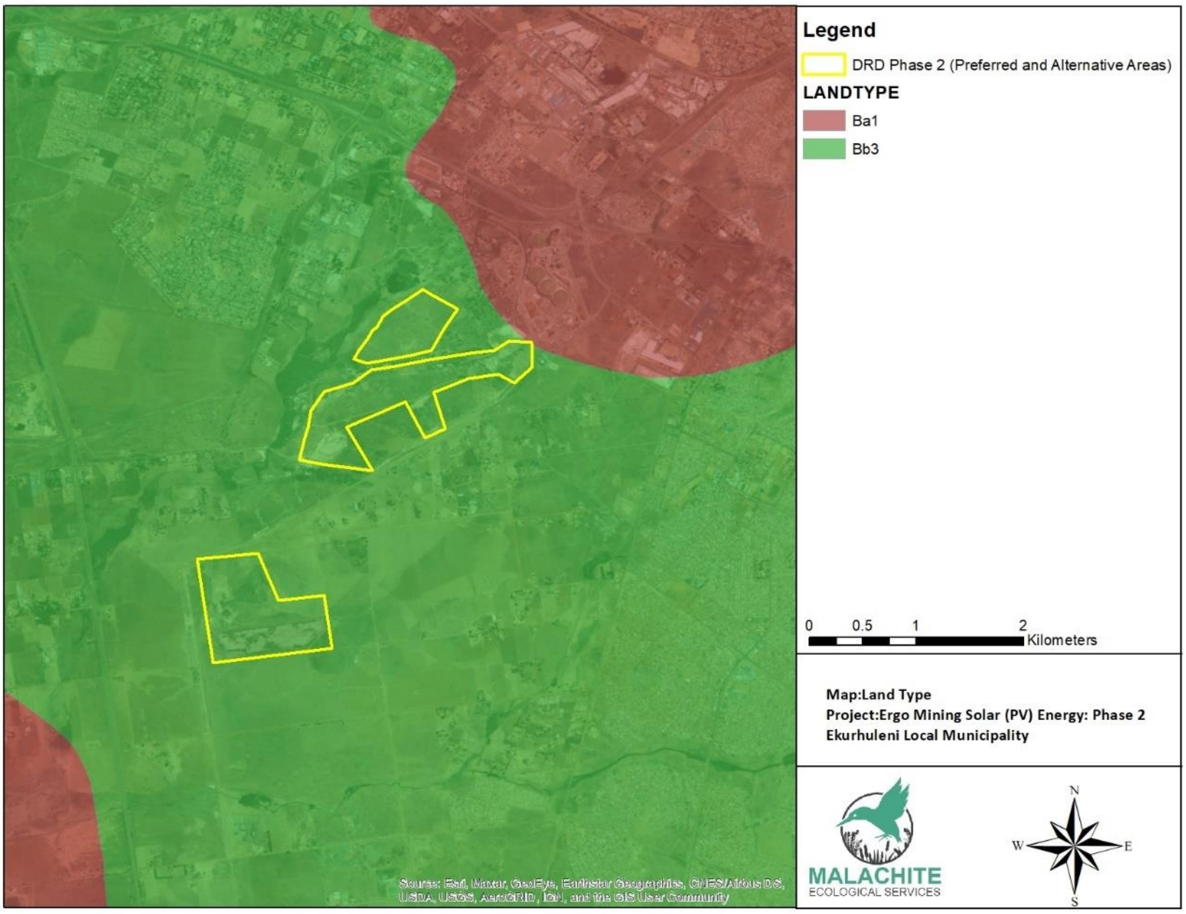

Figure 7: Land Type data associated with the study site

3.7. Historic and Current Land Use

An investigation into historic aerial imagery of the site was undertaken. Portions of the study site are visible in historical aerial imagery from 1938 (Figure 8). In this imagery, development within the area is apparent with mining operations underway at the current location of the Brakpan Plant. Development is furthermore noted in the form of roads and scattered residential buildings. Agricultural activities, particularly the cultivation of crops can be seen throughout the study site outside of and adjacent to water resources. The historic Tsakane Clay Grassland vegetation type is furthermore evident in the imagery, particulary in undisturbed portions of the site. These areas were most likely used for the grazing of livestock.

Figure 8: Historic aerial imagery from 1938 showing portions of the study site, with mining already underway, the creation of road networks and the cultivation of crops

In imagery from 1985 the use of large portions of both the preferred and alternative layout sites as both mining areas and/or tailings dams is clearly evident (Figure 9). These impacts are indications of the disturbed nature of the study site as a result of the use of this area for mining activities, with the soil profiles in these mined areas forever changed by these activities. These impacts on the soils within the study area reduce the likelihood of the use of these areas for crop cultivation in the future.

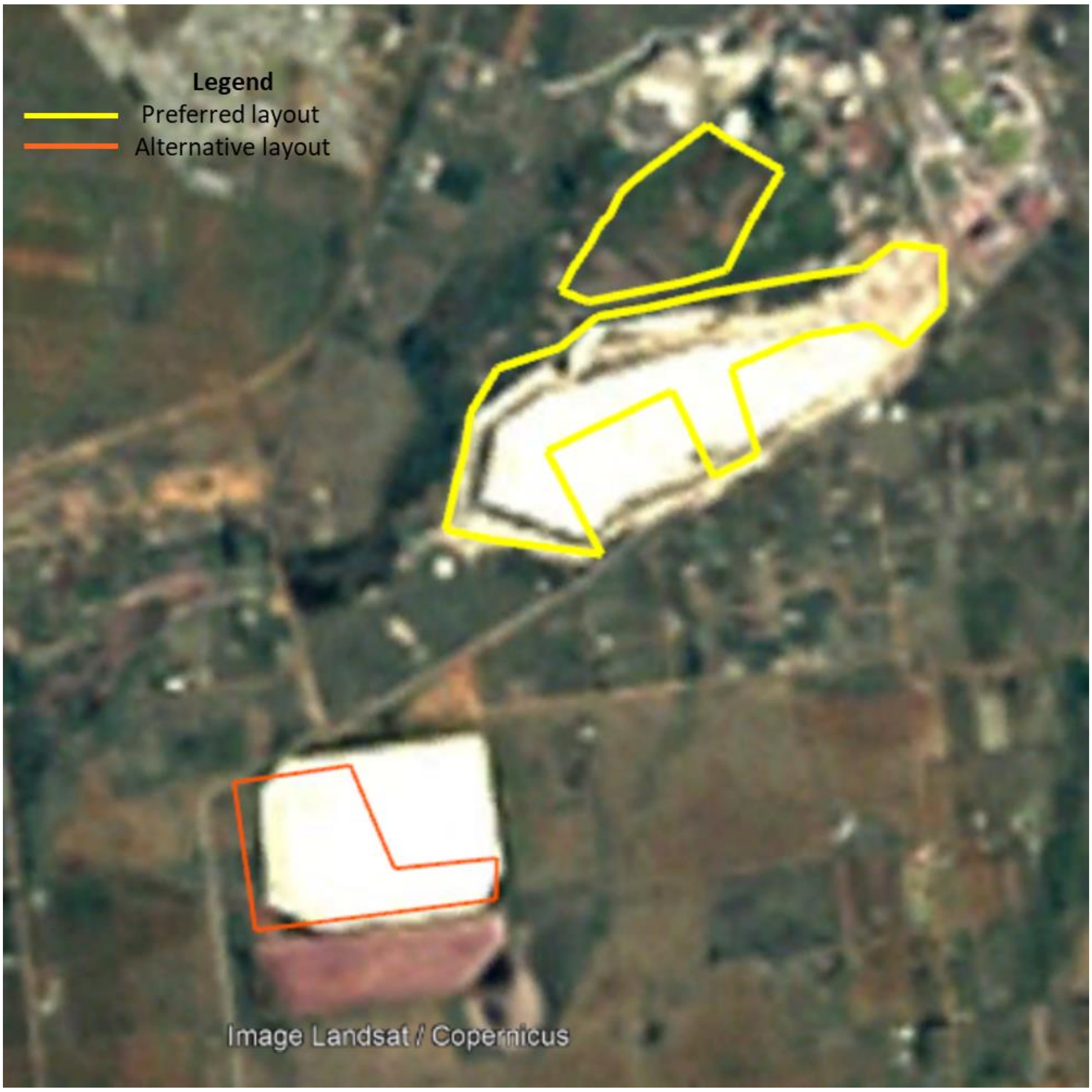

Figure 9: Historic aerial imagery from 1985

Aerial imagery from 2002 shows the mining and remining of both the preferred and alternative layout sites (Figure 10). Haul roads, mining operations, and the continued transformation of the site is apparent in the aerial imagery. Areas adjacent to the mining operations, are no longer utilised for the cultivation of crops, with agricultural practices largely abandoned within the area. Some small-scale cultivation is evident in Portion 272 of the Farm Witpoortjie 117 and the larger study area are utilised for livestock grazing.

Figure 10: Aerial imagery from 2002

Mining was then discontinued within the study site and the rehabilitation of the area undertaken, from approximately 2004/2005. Soil is seen to be deposited within the disturbed sites as well as the re-grassing of these areas. This is shown in aerial imagery from 2008 (Figure 11). Topsoil stockpiles are still evident in the southern portion of the study area. Furthermore Portion 272 of the Farm Witpoortjie 117 is no longer utilised for crop cultivation.

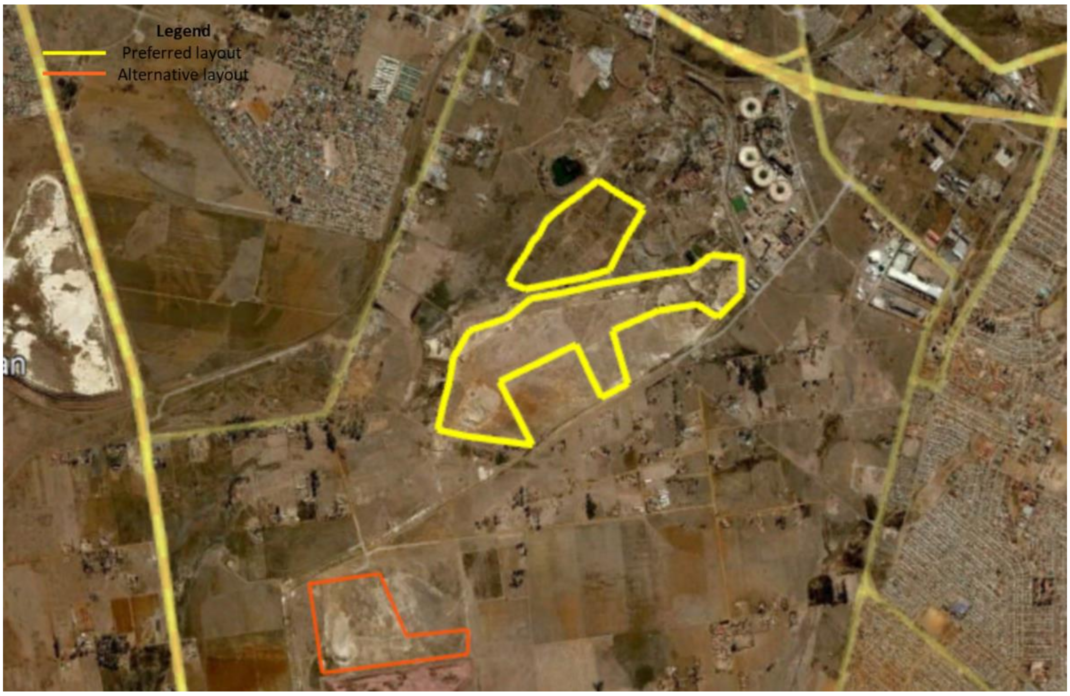

Figure 11: Aerial imagery from 2008

The most current aerial imagery available on Google Earth[Tm] is from March 2022 (Figure 12). This shows the completed rehabilitation process of the disturbed portions of the study site, with these areas now grassed and utilised for livestock grazing. The operations associated with historic and current mining activities however dominate the area and have had an impact on the quality of the soils within the study site. This is detailed further in the following sections.

Figure 12: Current aerial imagery (2022)

4. ASSESSMENT RESULTS – SOIL SURVEY

4.1. Soil Assessment

Taking into account the historic and current aerial imagery as well as the soil mapping exercise conducted for both phase 1 and phase 2 of the Ergo Gold PV project, the study site was divided into two separate soil types, the Natural Soils and the Anthrosols and Technosols (Figure 13). The locations of these soils within the study site are depicted in Figures 14, 15 and 16.

The first group are naturally occurring with the soil morphological expression and sequence of soil horizons being formed without significant human intervention. Anthrosols and Technosols on the other hand are soils which have been drastically altered by human intervention such that the natural soil properties are no longer identifiable, and an anthropogenic classification is applied.

According to the 2018 Soil Classification Working Group, Anthrosols are soils which have been drastically changed by intentional human activity to improve productivity of an area. Technosols are soils that comprise material from mining, industry, construction, or urban activities that often supply parent material for new anthropogenic soils. They may also be created from alteration of natural soils by physical, chemical, or hydrological processes resulting from mechanical working, water diversion, pollution, and/or extraneous additions of harmful solids or liquids. Table 3 shows the Anthrosols and Technosols identified within the site as well as their soil class as per Figures 14, 15 and 16.

Table 3: Anthropogenic soil materials and associated classes identified in the site

Type of Anthropogenic Material Identified in the site	Soil Class
Physically Disturbed Anthrosols	Grabouw
Transported Technosols	Witbank
Hydric Technosols	Stilfontein

The majority of Portions 183 of the Farm Witpoortje 117 and Portion 9 of the Farm Withok 131 I.R were classified as the Physically Disturbed Anthrosol, Grabouw. This soil form is physically disturbed as a result of historic and current activities and includes areas where the soils have been mixed, compacted, or excavated by human activity. Adjacent to the Grabouw soils, the Witbank soil, which is a Transported Technosol was identified. Transported Technosols include any relatively fine or crushed material which has been intentionally transported from a separate location and deposited on the land surface. The Witbank soil was identified in areas which serve as stockpile for historic mining operations.

The final Technosol encountered within the study site, the Hydric Technosol, Stilfontein, was classified in areas which have undergone saturation for an extended period of time. This classification is also applied to former wetland soils that have suffered altered soil properties resulting from direct human intervention. The classification was applied to areas which have undergone historic transformation to tailings dams, remined areas, rehabilitated areas, as well as areas currently used to convey water for mining operations and was identified in Portions 183 of the Farm Witpoortjie 117 and Portion 9 of the Farm Withok 131 I.R. The alteration to the natural topography and drainage of the majority of these areas has furthermore caused ponding of stormwater. These saturated areas display hydric properties both at the surface of the soil as well as within the lower reaches of the soil profile and include gleying of the soil matrix as well as distinct and a high concentration of mottles and concretions.

Scattered throughout the study area, between the Anthrosols and Technosols, natural soil profiles were also apparent. These were classified as Hutton/Nkonkoni soils, Pinedene soils, Tukulu soils or the Katspruit soils.

The Hutton/Nkonkoni soils were identified in the preferred layout site. The soils are categorised as belonging to the Oxidic soil class. Oxidic soils have a B horizon that is uniformly coloured with red and/or yellow oxides of iron. These soils exhibit a broad geographic distribution in South Africa and are considered mature soils, coupled with free drainage in the upper solum of the soil profile. The Nkonkoni soil form consists of an orthic A horizon overlying a red-apedal B horizon which overlies a lithic horizon. The Hutton form is the same as the Nkonkoni form, with the red-apedal horizon being much thicker in this soil form.

Within the seasonally and temporary saturated areas of an unchannelled valley bottom wetland system, which was delineated along the northern boundary of the preferred layout, the Tukulu soil form was identified. The Tukulu soil consists of a neocutanic (weakly structured) horizon overlying a gleyic horizon. The gleyic horizon indicates seasonal saturation and this soil form often forms the boundary of wetland systems.

Within the more permanently saturated sections of the unchannelled valley bottom wetland system, along the northern boundary of the preferred layout site, as well as in the depression system associated with the alternative layout site, the Katspruit soil form was mapped. This soil form belongs to the Gleyic soil class. Gley soils display reduction and are located within saturated environments. They are considered wetland soils and are generally identified in the low-lying parts of the landscape. The Katspruit soil form consists of an orthic A horizon overlying a gley horizon and this saturated horizon.

Figure 13: Soils identified within the preferred and alternative layout sites including (A) Hutton, (B) Tukulu, (C) Katspruit, (D) Grabouw, (E) Stilfontein, and (F) Witbank

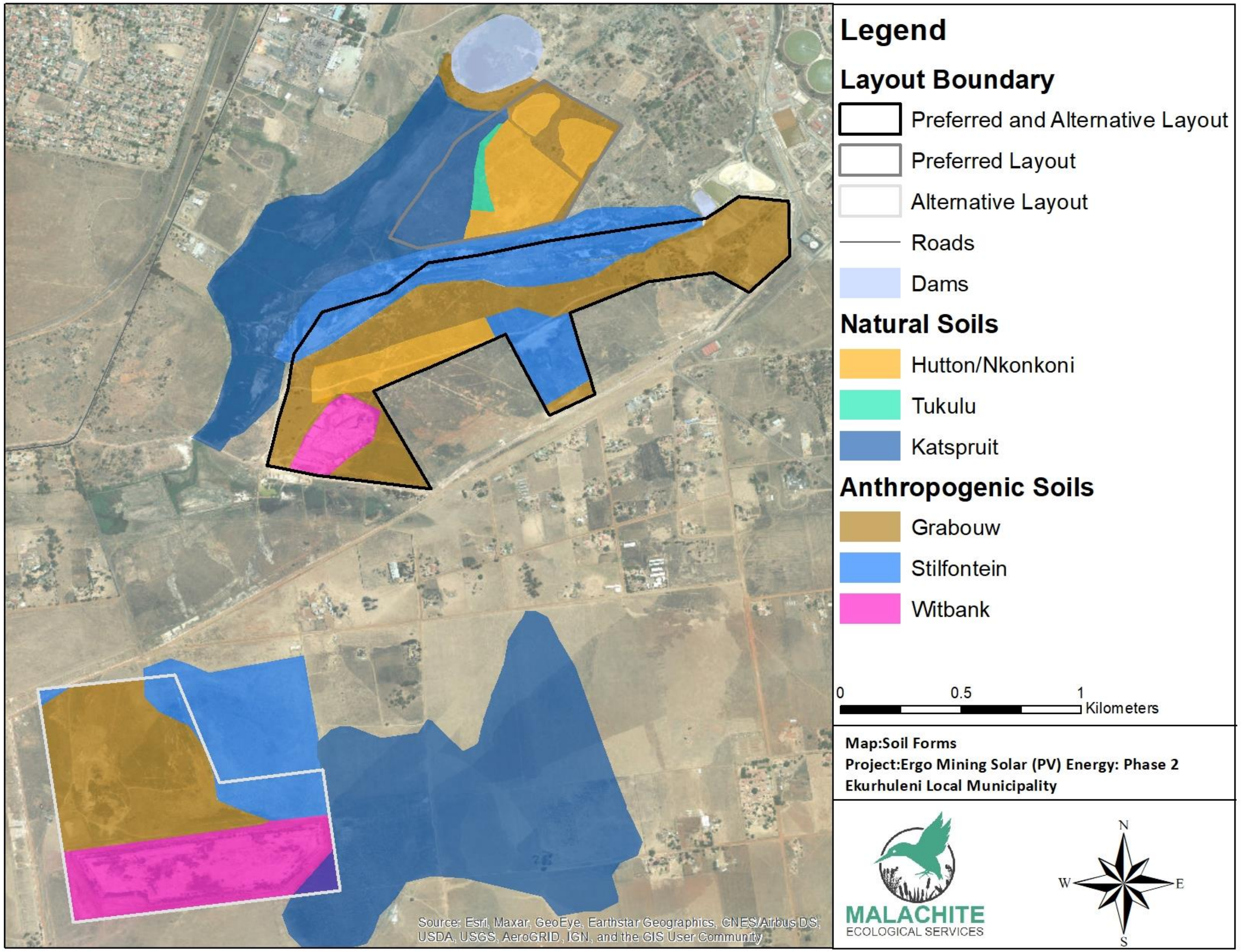

Figure 14: Soils associated with the preferred and alternative layout sites

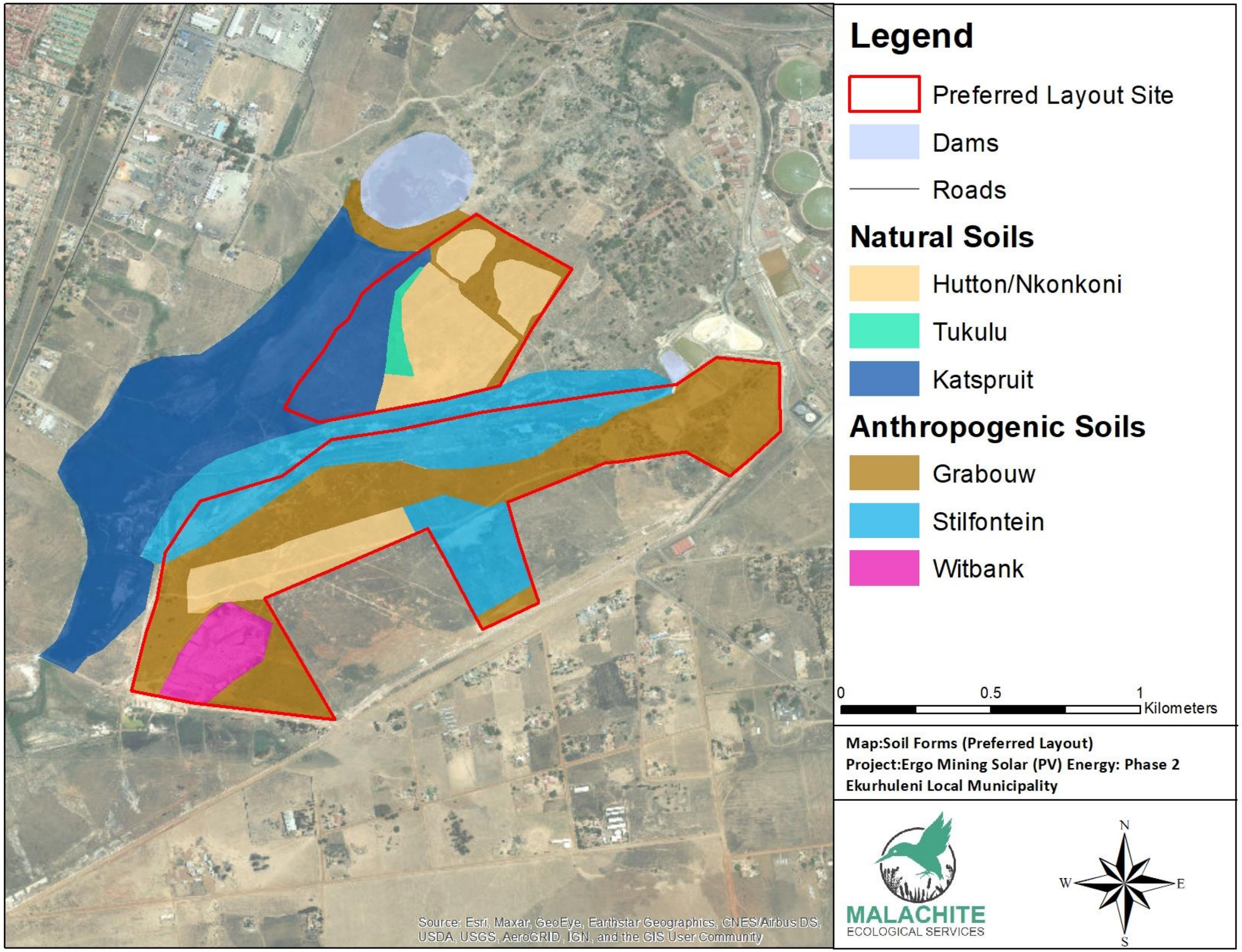

Figure 15: Closer view of the soils associated with the preferred layout

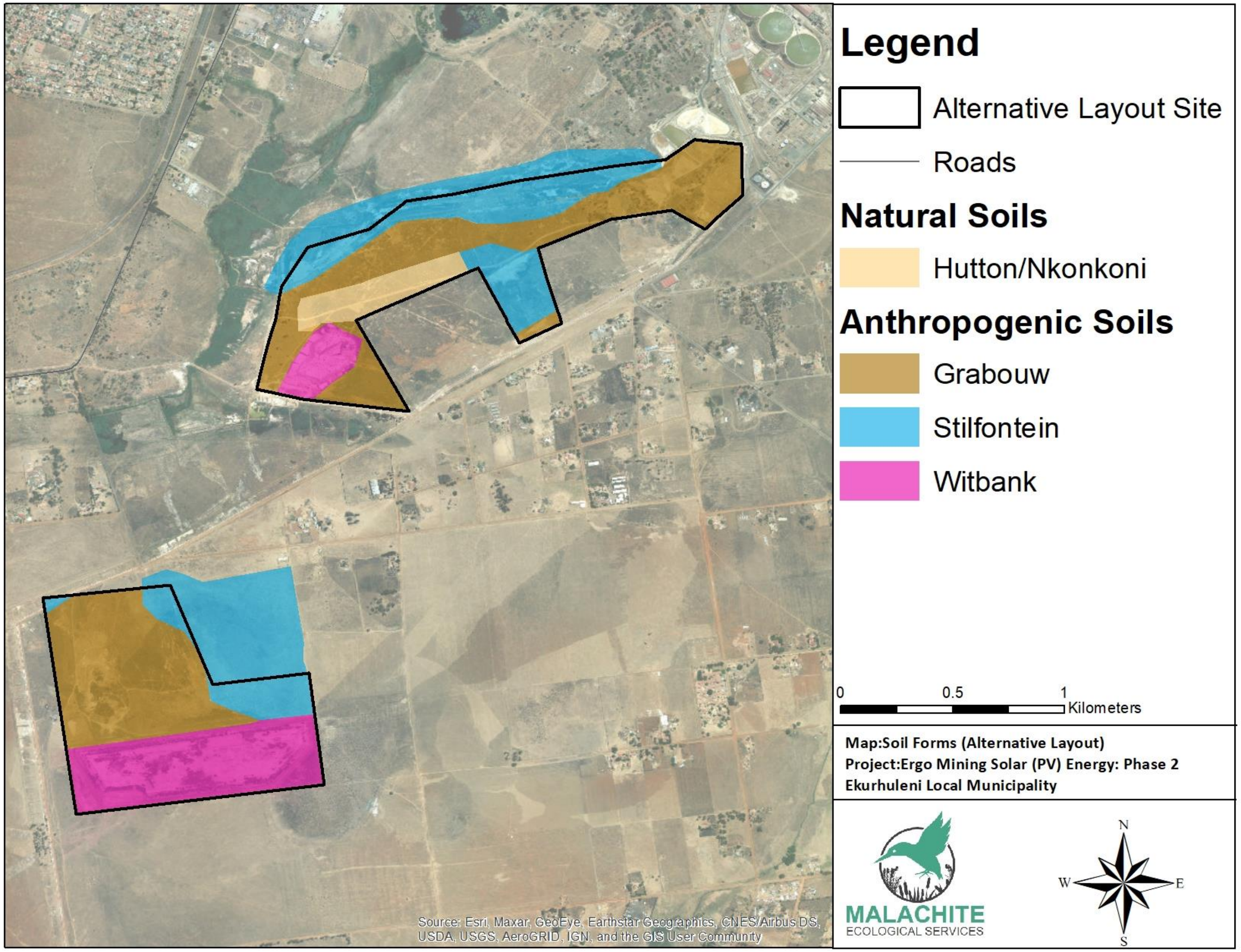

Figure 16: Closer view of the soils associated with the alternative layout

5. SOIL AGRICULTURAL POTENTIAL

Land evaluation is the process of estimating the production potential for alternative land uses. The physical data acquired from soil profiles is applied to a flow sheet adapted to South African conditions from the US Department of Agriculture standards and utilised by land usage authorities as the basic template for benchmarking soil quality throughout South Africa.

Land capability evaluation is an attempt to grade the potential of the land in terms of its best and worst uses in an arable situation. The land is classified according to its limitations, either on a permanent or temporary basis. The system is biased towards soil conservation and is based on the negative features of the land. The classification system is categorised on a scale of I to VIII so yield potential matrices can be easily formulated. LCC I to LCC III classes are suitable for arable crops. LCC IV can sometimes be cultivated for annual crops, but under carefully controlled conditions. LCC V are usually wetlands while LCC VI, VII and VIII soils are suited to domestic livestock and wild game only. Table 4 reflects the LCC of each Class. The flowsheets used to determine Land Capability Class are shown in Appendix A.

Table 4: Land capability classification descriptions (US Department of Agriculture, 1961)

Class	Description
I	Little to no limitations, high potential for intensive arable use.
II	Land subject to certain limitations or hazards. It is suitable for cropping with adequate protection measures, which may sometimes include special management practices and regular rotations.
III	Land subject to moderate limitations or risk of damage, which is suitable for cropping only with intensive protection measures and special practices, which may include long ley rotations with short cropping periods
IV	Land subject to severe permanent limitations or hazards. Suitable for occasional row cropping in long ley rotations, or for use under perennial vegetation. Limitations may include steep slopes, shallow soils, soils of very low water-retaining capacity, high erodibility, unfavourable characteristics in the surface soil, and severe, but correctable, wetness.
V	Watercourses and land subject to wetness limitations. These limitations include temporary, periodic and semi-permanent wetness. Cultivation is only permitted with very special practices and measures. Vleis and watercourses subject to severe wetness are best left under permanent vegetation.
VI	Land which has such severe soil and/or slope limitations that cropping must be excluded but which is productive under perennial vegetation but is susceptible to moderate erosion.
VII	Not suited for cultivation, severe limitations for grazing or farming.
VIII	Extremely rough, suited only for wildlife or recreation.

The primary function of land evaluation is to predict the possible effects, both detrimental and beneficial for a change in land use.

The most important soil and landscape characteristics when applying this system are texture (Clay %), soil depth, permeability, slope, rockiness, surface crusting and wetness. These characteristics of the soils associated with the study site were gathered from the field investigations of the preferred and alternative layout sites.

- **Soil texture:** Field based texture analysis was undertaken on the soils examined during the site investigation. The texture of the soils sampled revealed silty clay or silty clay loam soils, with the majority of soils falling into the latter classification. Clay percentage for these texture classes ranges from 25-40% for the silty clay loam soils and 40-60% for the silty clay soils. These clay percentages are not expected to be a limitation to crop production, with a slight restriction in the clayey soils associated with the silty clay texture class. The clay percentage increases for the Katspruit soils, and these soils will have a limitation to crop cultivation.
- **Soil depth:** Soil profile depths ranged from 50 mm to 1000 mm, however the majority of soils were identified to be within the 300 mm -700 mm depth class. The soils were generally shallow as a result of both historic and current anthropogenic activity causing compaction, soil mixing and saturation. These depths are considered a limitation to crop production, with the study site only really suitable for shallow rooted vegetables or grass pastures.
- **Soil permeability:** Due to the anthropogenic impacts to the majority of the study site, the permeability of the majority of the soils are likely to be restrictive for crop production. The Anthrosols and Technosols will be restrictive to crop production as a result of compaction, soil mixing, and the presence of artificial hydric soils and stormwater ponding. Within the areas classified as having more natural soils, the presence of the gleyed horizon associated with the Katspruit soils will have an impact on the permeability of the soils. The Hutton/Nkonkoni soils were identified as being more permeable compared to all other soil forms identified within the study site. This is as a result of the presence of the freely draining upper solumn of the soil profile. These soils are not restrictive for crop growth; however, they only occupy a small percentage (22%) of the preferred layout site.
- **Slope:** There is a wide range in slopes, which for the land capability classification, have been grouped as follows:
    - 0-8% - land, which depending on soil profile characteristics is potentially in Class II
    - 8-12% - land, which depending on soil profile characteristics is potentially in Class III
    - 12-20% - land, which depending on soil profile characteristics is potentially in Class IV
    - >20% - land, which is in Class VI or even VII, on slopes greater than 40%.

  The site consisted of gentle terrain with all slope percentages recorded in the 0-8% category. Slope is therefore not a limitation to cultivation.
- **Rockiness:** Rockiness was not identified as a limitation to cultivation. Surface rocks were encountered during the field investigation, particularly in areas that have been classified as Anthrosols and Technosols as these were deposited in the area. However,

the rocks did not pose a major limitation to the site. The areas classified as the Witbank soil form will have a limitation to agricultural production as this is a transported soil and rock mixture.

- **Crusting:** Crusting was not found to be a major limitation to cultivation. It is unlikely that this will be a limitation within the study site.
- **Wetness:** Portions of both the preferred and alternative layout sites are categorised as either the Hydric Technosol, Stilfontein as a result of historic and current impacts to the soils, or the natural hydric soil, Katspruit, identified within wetland systems. The wetness of portions of the study site is therefore due to both natural and anthropogenic disturbances and these areas are not suitable for crop production.

Taking into account the above factors, the study site has been categorised into the Class III, Class V, Class VI, and Class VIII categories (Figure 17) as per Table 4.

The Class III category is classified in areas that contain the natural Hutton/Nkonkoni soils. The Hutton/Nkonkoni soils are productive with regards to crop cultivation as they are well drained, generally rich in minerals and nutrients and have the depth required to sustain a number of crops. These areas are classified as Class III and occupy 22.2 % of the preferred layout site and 5.7 % of the alternative layout site. They do not occupy any area in Portion 9 of the Farm Withok No. 131IR (part of the alternative layout site).

The Class V category is reserved for saturated soils and was thus mapped where the anthropogenic Stilfontein and the natural Katspruit and Tukulu soils were identified in both the preferred and alternative layout sites. These soils show a high degree of mottling and gleying and indicate a shallow water table for most of the year. The soils are either anthropogenically modified, in the case of the Stilfontein soils or form part of wetland systems in the case of the Katspruit and Tukulu soil forms. Cropping in these areas would require intensive protection measures and special practices such as the drainage of the soil. Class V areas occupy 31.7 % of the preferred layout site and 22.9 % of the alternative layout site.

The Grabouw or Physically Disturbed Anthrosol soils have been classified as Class VI soils. Class VI soils have severe restrictions to cropping and are therefore excluded from production under perennial vegetation. This is due to the anthropogenic disturbances to these soils and the use of the soils for human activity. Class VI areas occupy 40.8 % of the preferred layout site and 49.2 % of the alternative layout site.

The remaining Witbank soils are categorised as Class VIII soils. These soils have been completely modified and are currently stockpiles. They are not productive for any agricultural activities, and they occupy 5.7 % of the preferred layout site and 22.1 % of the alternative layout site.

Overall, the study site can therefore be considered to have a low agricultural potential with severe limitations to crop cultivation. The majority of the site is classified as Class V, or Class VI (76.8%) (as per Table 4). This is as a result of a combination of factors including the significant long term anthropogenic modifications to the soils of the entire study site, the presence of saturated horizons, and the use of the surrounding landscape for mining and urban activities. Portions of the site are considered acceptable for crop production; however, these are small in comparison (22.2 %) to the non-suitable areas (77.8 %).

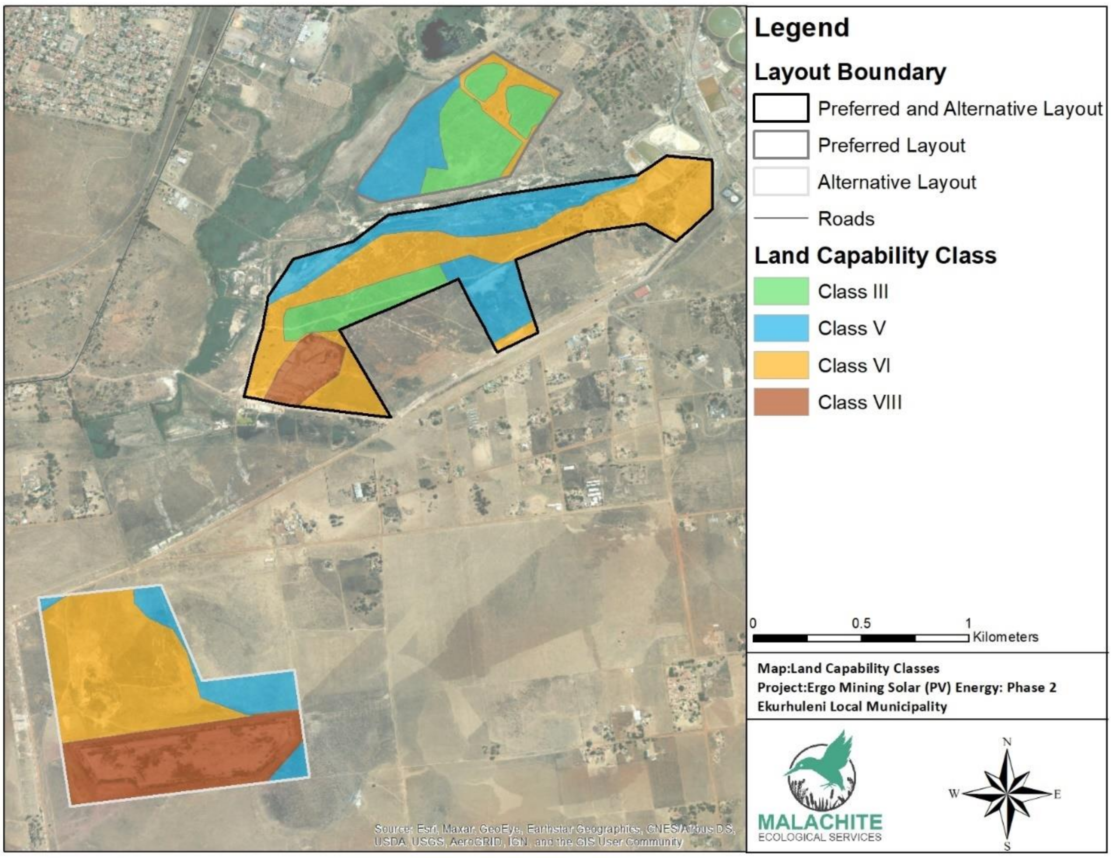

Figure 17: Land Capability Classes which guide the Agricultural Land Potential

6. IMPACT ASSESSMENT

Any development activity in a natural system will have an impact on the surrounding environment, usually in a negative way. The purpose of this phase of the study was to identify and assess the significance of the impacts caused by the proposed project on the soils as well as the agricultural potential of the site. Furthermore, mitigation measures are recommended to limit the identified negative impacts on the receiving environment.

The project will involve minimal grass clearing of portions of the site where the solar panels and internal roads will be positioned for the establishment of the 40MW power PV facility. The preferred location of the panels and associated infrastructure in relation to the soils is provided in Figures 18 and 19.

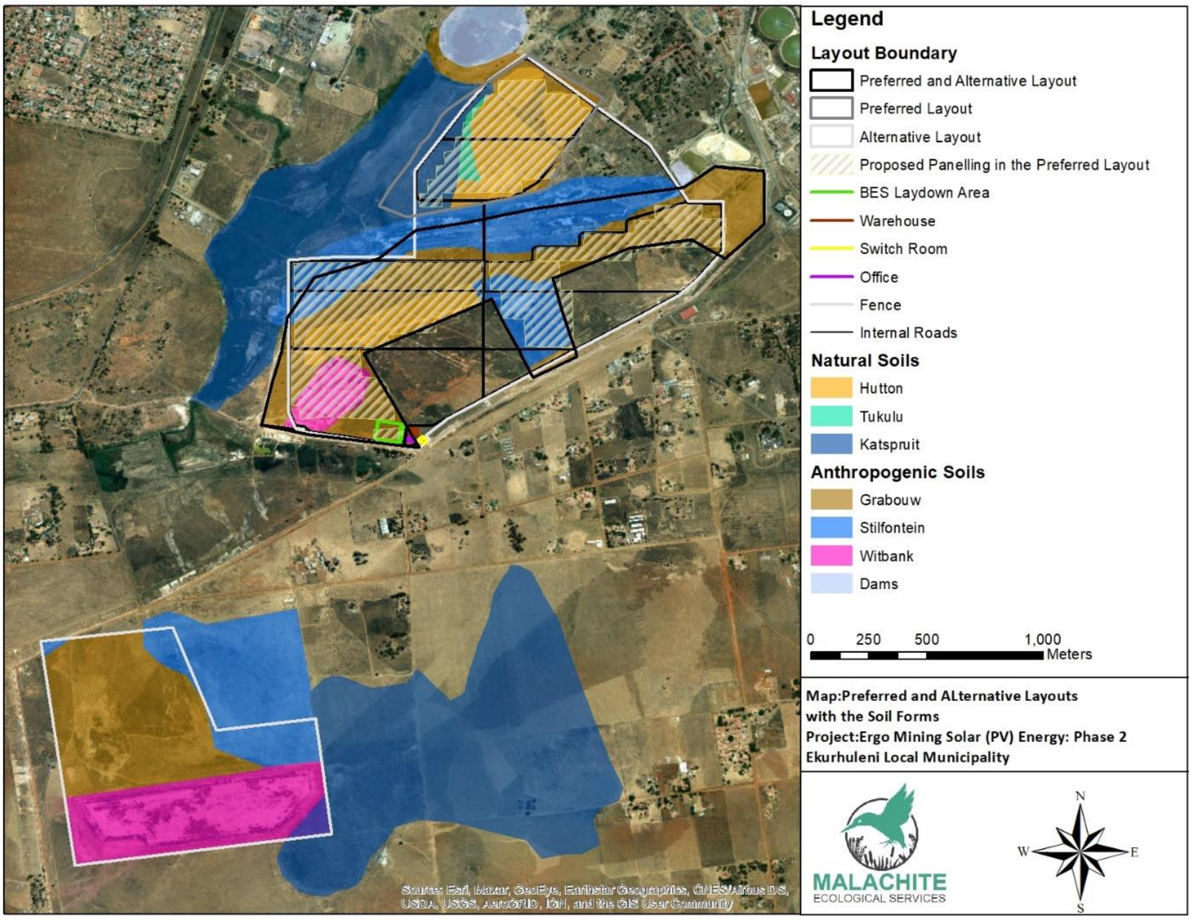

Figure 18: Soil forms of the study site in relation to preferred and alternative layout sites

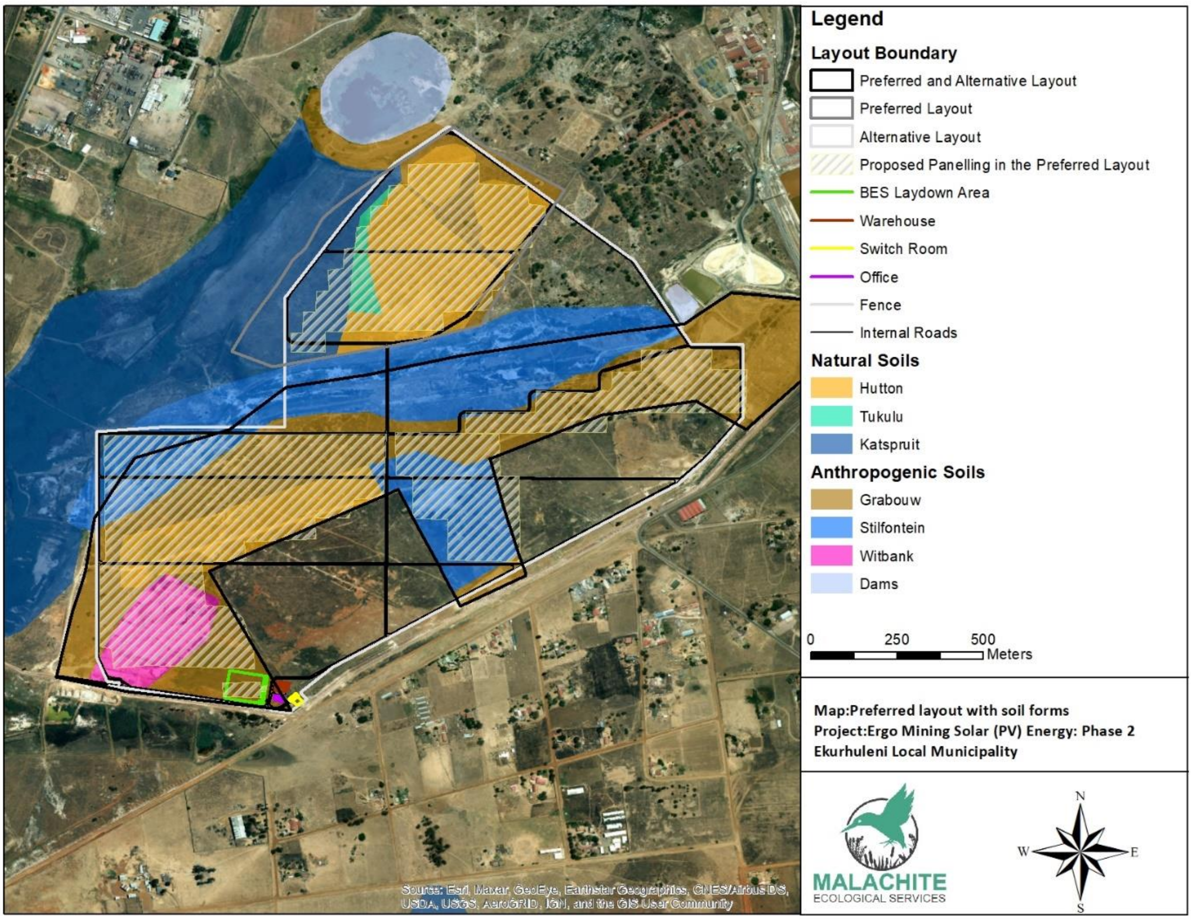

Figure 19: Soil forms of the study site in relation to preferred layout site

The alternative layout is similar to the preferred layout, with Portion 183 of the Farm Witpoortje No. 117R forming part of both the preferred and alternative layouts. Similar soils were identified in the Remainder of Portion 9 of the Farm Withok No. 131IR as in the preferred layout site. As such impacts to the agricultural potential of the study site were identified as being the same for both layouts (preferred and alternative) and are associated with (i) the loss of agricultural land; (ii) soil compaction and exposure of topsoil leading to erosion and (iii) pollution of the soils as a result of construction related activities. Several general and specific measures are proposed to mitigate these impacts.

6.1. Methodology

Potential impacts of the proposed activity on the soils of the site were assessed utilising a standard method from Environmental Management Assistance (Pty) Ltd. Using this methodology, the impacts are described in terms of their characteristics, including the impact's spatial and temporal features (namely extent, duration, probability, and magnitude). While an impact assessment typically focuses on the negative impacts, an impact can also be positive. The definitions of the terms used in this assessment are described in Table 5 below.

Table 5: Impact Characteristics used in this assessment

Characteristic	Definition	Terms	Scoring
Duration	The time period over which a resource / receptor is affected.	**Temporary** - (period of less than 1 year - negligible/ pre-construction/ construction) **Short term** - period of less than 5 years ie commissioning/operational period **Medium term** - period of less than 15 years ie operational period **Long term** - period of less than 20 years ie life of project **Permanent** - a period that exceeds the life of project– ie irreversible.	Temporary – 1 Short term – 2 Medium term – 3 Long term – 4 Permanent – 5
Extent	The reach of the impact (ie physical distance an impact will extend to)	**On-site** - impacts that are limited to the Project site. **Local** - impacts that are limited to the Project site and adjacent properties. **Regional** - impacts that are experienced at a regional scale, ie Gauteng. **National** - impacts that are experienced at a national scale. **Trans-boundary/International** - impacts that are experienced outside of South Africa.	On-site – 1 Local – 2 Regional – 3 National – 4 International – 5
Probability	Measure of the probability with which the impact is expected to occur	**Unlikely -** probably will not happen **Improbable -** some possibility, but low likelihood **Probable -** distinct possibility) **Highly probable -** most likely **Definite -** impact will occur regardless of any prevention measures	Unlikely – 1 Improbable – 2 Probable – 3 Highly probable – 4 Definite – 5
Magnitude	A measure of the damage that the impact will cause if it does occur	**No effect** - will have no effect on the environment **Minor** – minor and will not result in an impact on processes **Low** – low and will cause a slight impact on processes **Moderate** – moderate and will result in processes continuing but in a modified way	No effect – 0 Minor – 2 Low – 4 Moderate – 6 High – 8 Very high – 10

Characteristic	Definition	Terms	Scoring
		High - processes are altered to the extent that they temporarily cease **Very high** - results in complete destruction of patterns and permanent cessation of processes	

The significance (quantification) of potential environmental impacts identified during the assessment have been determined using a ranking scale, based on the following (terminology has been taken from the Guideline Documentation on EIA Regulations, of the Department of Environmental Affairs and Tourism, April 1998):

Occurrence

- Probability of occurrence (how likely is it that the impact may occur?)
- Duration of occurrence (how long may it last?)

Severity

- Magnitude (severity) of impact (will the impact be of high, moderate or low severity?)
- Scale/extent of impact (will the impact affect the national, regional or local environment, or only that of the site?)

The environmental significance of each potential impact is assessed using the following formula:

Significance Points (SP) = (Magnitude + Duration + Extent) x Probability

The maximum value is 100 Significance Points (SP). Potential environmental impacts were rated as high, moderate, or low significance on the following basis:

- < 30 significance points = **LOW** environmental significance.
- 30- 60 significance points = **MODERATE** environmental significance
- >60 significance points = **HIGH** environmental significance

The significance of an impact gives one an indication of the level of mitigation measures required in order to minimise negative impacts and reduce environmental damage during the construction, operational and decommissioning / closure phases. Suitable and appropriate mitigation measures were identified for each of the potential impacts.

6.2. Significance rating tables for the Construction Phase

Activity:	**Loss of agricultural productive land within the study area during construction phases (Both layout alternatives are considered).**				
Impact:	Loss of agricultural land was assessed with regards to the loss of arable land within the site and within adjacent properties. The identified agricultural limitations within the study site as a result of the significant anthropogenic modifications to the soils as well as the saturation of the soil reduces the likelihood of the use of this area for the cultivation of crops. The preferred layout site has only 22% of soils that are agriculturally viable for crop cultivation, while the alternative layout has only 5.7% of these soils. These soils (Hutton/Nkonkoni soils) are scattered within the preferred and alternative layout site and are located adjacent to non-agricultural soils as a result of anthropogenic impacts to the site. The southern portion (Ptn 9/131) of the alternative layout has no agriculturally viable soils. Given the limited area of agriculturally viable soils in both layout alternatives, the loss of agriculturally productive land is low/not applicable and mitigation measures are aimed at limiting impacts to any adjacent properties. The site could however be utilised for grazing; with pasture grasses the current scenario on site. Given that the study site is owned by Ergo Mining and the area utilised for mining operation mitigation measures are aimed at limiting impacts to any adjacent properties.				
Significance rating:	**Duration**	**Extent**	**Magnitude**	**Probability**	**Significance**
Pre-Mitigation	1	1	1	1	**4 (Low)**
Post-Mitigation	1	1	1	1	**4 (Low)**
Is the Impact Reversible?	• There is no loss of agricultural land as a result of this project. The land is owned by Ergo Mining and the area utilised for mining operations. As such the impact is considered not applicable.				
Mitigation Measures:	• During construction, workers must remain within the site and must not affect adjacent properties. • Dust monitoring during construction must form part of the Environmental Management Programme as dust will affect vegetation growth. • Management of waste so that it does not impact adjacent properties must take place as per the Environmental Management Programme (EMPr) particularly during the operational phase. • The implementation of an alien invasive control plan must form part of the EMPr. Alien species will quickly establish on disturbed soils, potentially spread to adjacent properties. Their growth must be monitored, and alien control implemented when necessary.				
Cumulative impacts:	• Portions of the preferred and alternative layout (particularly Ptn 183/117) are currently used for grazing. Given the low agricultural potential of the				

	site this is the only agricultural activity that will be lost as a result of the area. Areas surrounding the project site will however still offer grazing land, thus limiting the cumulative impact of the loss of agricultural land in the area.
Residual impacts:	• Not applicable as the only agricultural activity which occurs within the project area, grazing, can still continue in adjacent areas during the construction and operational phases of the project.
Climate Change:	• Not applicable.

Activity:	**Soil Compaction leading to erosion and sedimentation. (Both layout alternatives are considered)**				
Impact:	The clearing of vegetation for the establishment of the PV facility including all infrastructure (internal roads, fencing, warehouse, office, BES lay down area and the panels) will result in the exposure of the topsoil to environmental factors including rainfall and wind. Furthermore, the use of heavy machinery or vehicles during construction, will lead to the compaction of these disturbed soils. This will increase the soil bulk density, reduce the porosity further and the hydraulic conductivity, leading to a greater potential for the formation of erosion gullies. This is particularly so for construction related activities on the Stilfontein soils, which are saturated, and are thus more susceptible to erosion. In the long-term, the existence of the PV facility can lead to the formation of erosion gullies, particularly if there is inadequate stormwater control within this site. Given the disturbed nature of the soils in this area this impact is expected to be low.				
Significance rating:	**Duration**	**Extent**	**Magnitude**	**Probability**	**Significance**
Pre-Mitigation	2	2	6	3	**30 (Moderate)**
Post-Mitigation	1	1	4	2	**12 (Low)**
Is the Impact Reversible?	• This impact is reversible should the mitigation measures recommended below be implemented. Rehabilitation of compacted areas, outside of the footprint of the PV facility must occur once construction is complete.				
Mitigation Measures:	• Erosion control measures must be implemented in areas sensitive to erosion such as near water supply points, edges of slopes, etc. These measures include but are not limited to - sand bags, hessian sheets, silt fences, retention or replacement of vegetation and geotextiles such as soil cells which must be used in the protection of slopes. • Do not allow surface water or stormwater to be concentrated, or to flow down any cut or fill slopes without erosion protection measures being in place.				

	• Vegetation clearing must be undertaken only in the areas to be affected and must not extend outside of the PV facility footprint. • Demarcate all/any sensitive ecological areas (i.e. wetlands) within the site and ensure that these areas remain off-limits during construction.
Cumulative impacts:	• Cumulative impacts are associated with continued development within the larger landscape. This ever-increasing development of the urban environment leads to a decrease in infiltration rates of stormwater and the increased likelihood of erosion gully formation. Given the limited footprint of the project the cumulative impact is expected to be low.
Residual impacts:	• Residual impacts from the construction phase are associated with the formation of erosion gullies from compacted soils that are not remediated. Over time this will increase in size and will impact areas downstream of the project site.
Climate Change:	• Soil erosion leads to the disturbance and loss of predominantly the topsoil, which is the most productive horizon of a soil profile and the loss of the ecosystem which forms the topsoil has an impact on nutrient and carbon cycles, leading to an impact on climate change in the long-term.

Activity:	**Soil Pollution (Both layout alternatives are considered)**				
Impact:	Sediment releases (particularly contaminated sediments) from a construction site into the downstream aquatic environment is one of the most common forms of waterborne pollution. Furthermore, mismanagement of waste and pollutants including hydrocarbons, construction waste and other hazardous chemicals will result in these substances entering and polluting the soil profile. These pollutants can quickly be transferred to nearby water resources situated within the vicinity of PV facility site in both the preferred and alternative layouts.				
Significance rating:	**Duration**	**Extent**	**Magnitude**	**Probability**	**Significance**
Pre-Mitigation	2	2	6	3	**30 (Moderate)**
Post-Mitigation	1	1	4	2	**12 (Low)**
Is the Impact Reversible?	• Impacts regarding potential soil pollution as a result of leakage from chemicals can be reversed. Soils that have been contaminated would need to be remediated either on site or removed to a secure location. A spill team would need to be contacted to conduct the remediation exercise.				
Mitigation Measures:	• All waste generated during construction is to be disposed of as per the EMPr. • Management and disposal of construction waste as per the Environmental Management Plan must occur during the construction of the development. • Waste disposal during the construction phase must ensure no litter or other contaminants particularly chemicals stored on site are deposited into the unchannelled valley bottom system (located in close proximity to both layout sites) as well as the depression system (located in close proximity to the alternative layout site).				

	• Do not locate chemical storage areas associated with the construction camp or construction site on any of the hydric soils (whether natural or artificially saturated), without ensuring that these chemicals cannot leak or spill into these soil profiles. • No release of any substance i.e., cements, oil, or any other substance that could be toxic into the soil profiles. Check vehicles and equipment entering the site for oil and fuel leaks and inspect site for possible spillages. • Spillages of fuels, oils and other potentially harmful chemicals must be contained and cleaned up immediately. Contaminants must be properly drained and disposed of using proper solid/hazardous waste facilities (never to be disposed of within the natural environment). Any contaminated soil must be removed, and the affected area rehabilitated immediately.
Cumulative impacts:	• Cumulative impacts relating to soil pollution are associated with the continued development of the larger area. As development occurs soils can and are contaminated with chemicals, hydrocarbons, and sediments from a variety of sources such as the existing mine, existing roads and leakage and spillage from construction activities. These soils are not remediated and are therefore changed from their natural state, making it difficult to utilise them in the future. Given the low agricultural potential of the site as well as the limited footprint of the project area, cumulative impacts of this project are low.
Residual impacts:	• Residual impacts occur if leakage or spillage of chemicals occur during the construction phase, and these soils are not remediated. These soils will continue to release these chemicals into the environment after construction has ended. Provided the recommendations of this report are adhered to this impact is expected to be low.
Climate Change:	• Soil pollution leads to a decrease in soil health and changes to the microbial populations of soil ecosystems. This can affect nutrient and carbon cycling leading to an effect on climate change in the long term.

6.3. Significance rating tables for the Operational Phase

Activity:	**Soil Compaction leading to erosion and sedimentation. (Both layout alternatives are considered)**				
Impact:	In the long-term, the existence of the PV facility can lead to the formation of erosion gullies, particularly if there is inadequate stormwater control within this site. Given the disturbed nature of the soils in this area this impact is expected to be low.				
Significance rating:	**Duration**	**Extent**	**Magnitude**	**Probability**	**Significance**
Pre-Mitigation	5	2	4	3	**33 (Moderate)**
Post-Mitigation	5	1	2	2	**16 (Low)**
Is the Impact Reversible?	• This is reversible should the mitigation measures recommended below be implemented. Rehabilitation of compacted areas, outside of the footprint of the PV facility as well as the powerline must occur once construction is complete, and the project enters the operational phase. Should compaction of soils occur during the operational phase these must be remediated as soon as possible.				
Mitigation Measures:	• It is recommended that areas that are not in use be planted with an indigenous grass cover to limit the exposure time of soils. • Outflow points of the drainage channels created as part of the stormwater management of the site must be protected by erosion control measures as described below. • Erosion control measures must be implemented in areas sensitive to erosion such as near water supply points, edges of slopes, etc. These measures include but are not limited to - sand bags, hessian sheets, silt fences, retention or replacement of vegetation and geotextiles such as soil cells which must be used in the protection of slopes.				
Cumulative impacts:	• Cumulative impacts are associated with continued development within the larger landscape. This ever-increasing development of the urban environment leads to an increase in soil compaction, a decrease in stormwater management, and therefore an increase in the likelihood for erosion gully formation. Mitigation measures recommended in this report will decrease the cumulative impacts of this project on the larger landscape.				
Residual impacts:	• Residual impacts are associated with the formation of erosion gullies from compacted soils that are not remediated. Over time this will increase in size and will impact areas downstream of the project site.				
Climate Change:	• Soil erosion leads to the disturbance and loss of predominantly the top soil, which is the most productive horizon of a soil profile and the loss of the ecosystem which forms the topsoil has an impact on nutrient and carbon cycles, leading to an impact on climate change in the long-term.				

Activity:	Soil Pollution (Both layout alternatives are considered).				
Impact:	During the operational phase, any maintenance of the PV facility can lead to the release of substances into the soil profile, polluting the area. Internal roads may be contaminated with pollutants such as petroleum residues, oil, metals from brake linings, rubber particles from tires, nitrous oxide from car exhausts, and grease. The internal roads are however proposed to be utilised by only pedestrians, cycles or golf carts, and/or quad bike type vehicles, and thus this impact is expected to be low.				
Significance rating:	Duration	Extent	Magnitude	Probability	Significance
Pre-Mitigation	5	2	4	3	33 (Moderate)
Post-Mitigation	5	1	2	2	16 (Low)
Is the Impact Reversible?	• Impacts regarding potential soil pollution as a result of leakage from chemicals can be reversed. Soils that have been contaminated would need to be remediated either on site or removed to a secure location. A spill team would need to be contacted to conduct the remediation exercise.				
Mitigation Measures:	• Waste disposal during the operational phase must ensure no litter or other chemicals used for maintenance activities are spilled or deposited into the soils. • No release of any substance i.e., cements, oil, or any other substance that could be toxic into the soil profiles. Check vehicles and equipment entering the site for oil and fuel leaks and inspect site for possible spillages. • Spillages of fuels, oils and other potentially harmful chemicals must be contained and cleaned up immediately. Contaminants must be properly drained and disposed of using proper solid/hazardous waste facilities (never to be disposed of within the natural environment). Any contaminated soil must be removed, and the affected area rehabilitated immediately.				
Cumulative impacts:	• Cumulative impacts relating to soil pollution are associated with the continued development of the larger area. As development occurs soils can and are contaminated with chemicals, hydrocarbons, and sediments from a variety of sources such as the existing mine, existing roads and leakage and spillage from maintenance activities. These soils are not remediated and are therefore changed from their natural state, making it difficult to utilise them in the future. Given the low agricultural potential of the site as well as the limited footprint of the project area, cumulative impacts of this project are low.				
Residual impacts:	• Residual impacts occur if leakage or spillage of chemicals occur during the operational phase, and these soils are not remediated. These soils will continue to release these chemicals into the environment. Provided the recommendations of this report are adhered to this impact is expected to be low.				

Climate Change:	• Soil pollution leads to a decrease in soil health and changes to the microbial populations of soil ecosystems. This can affect nutrient and carbon cycling leading to an effect on climate change in the long term.

7. CONCLUSION

Taking into account the findings of the soil mapping exercise for both phase 1 and phase 2 of the Ergo Gold PV project, coupled with historic and current aerial imagery, the study site was divided into two separate soil types, the Natural Soils and the Anthrosols and Technosols.

Utilising the soil information, climatic information, and topography, the study site was assessed in terms of the agricultural potential. The study site has been categorised into the Class III, Class V, Class VI, and Class VIII categories. As such, the study site can be considered as having a low agricultural potential with severe limitations to crop cultivation. The majority of the site is classified as Class V or Class VI (76.8%). This is as a result of a combination of factors including the significant long term anthropogenic modifications to the soils of the entire study site, the presence of saturated horizons, and the use of the surrounding landscape for mining and urban activities. Portions of the site are considered acceptable for crop production; however, these are small in comparison (22.2 %) to the non-suitable areas (77.8 %).

The project will involve the clearing of portions of the site for the establishment of the 40MW power PV facility. The alternative layout is similar to the preferred layout, with Potion 183 of the Farm Witpoortje No. 117R forming both part of the preferred and alternative layouts. Similar soils were identified in the Remainder of Portion 9 of the Farm Withok No. 131IR as in the preferred layout site. As such impacts to the agricultural potential of the study site were identified as being the same for both layouts (preferred and alternative) and are associated with

- the loss of agricultural land (this is a very limited to non-applicable impact as it only pertains to the loss of grazing land).
- soil compaction and exposure of topsoil leading to erosion, and
- pollution of the soils as a result of construction related activities.

Several general and specific measures are proposed to mitigate these impacts.

In conclusion, the site (including both layout alternatives) can be considered to have a negligible to low agricultural production with regards to cultivation of crops as a result of the majority of the site (including both layout alternatives) having been anthropogenically disturbed to such a level that the natural soil profile is not generally apparent. Cultivation of crops cannot take place in these areas. It is therefore the opinion of the author that, provided mitigation measures to reduce the impact of the project on the receiving environment are implemented as part of the construction and operational phases of the project, either the preferred or alternative layouts be approved from an agricultural perspective.

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Brakpan climate: Average Temperature, weather by month, Brakpan weather averages - Climate-Data.org

9. APPENDICES

9.1. APPENDIX A – Agricultural potential and land capability classes

All factors regarding the assessment of the agricultural potential and land capability of the site were undertaken including an assessment of the:

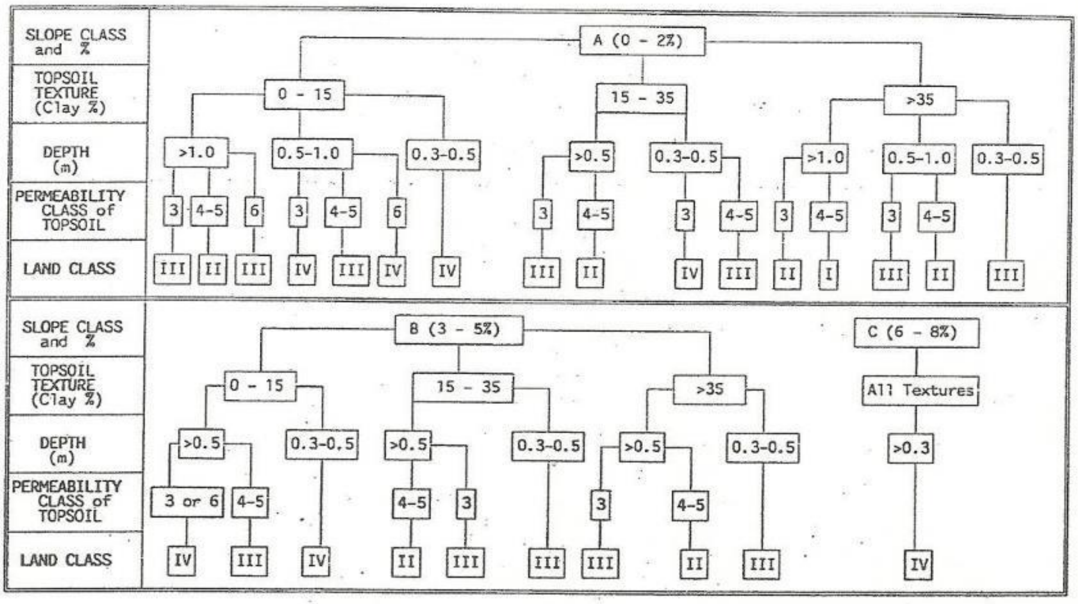
- Topography
- Climate
- Soil texture
- Soil depth
- Subsoil permeability
- Rockiness and Surface Crusting

Using the information gathered at the site as well as during the literature review, a soil form map was produced. Information was also gathered from the Land type information. This information was utilised in conjunction with the soil data recorded on site (i.e. soil form, depth, permeability, wetness) to produce the Land Capability Map.

9.2. Land capability classes – flow sheet

CAPABILITY CLASS DETERMINATION GUIDELINE for BRGs:
Dry Zululand Thornveld (20), Valley Bushveld (21), Lowveld (22), Sandy Bushveld (23) (Average annual rainfall 587-830 mm)

Use the following flow chart to determine the land capability classes for land to be cropped in the above Bioresource Groups.



PERMEABILITY CLASS DESCRIPTION*			
Class	Rate (seconds)	Description	Texture
7	<1	Extremely rapid	Gravel and Coarse Sand. 0 to 10 % clay.
6	1-3	Rapid	5% to 10% clay.
5	4-8	Good	> 10% clay.
4	9-20	Slightly restricted	
3	21-40	Restricted	Strong structure, grey colours, mottles. > 35% clay.
2	41-60	Severely restricted	Strong structure, weathered rock. > 35% clay.
1	>60	Impermeable	Rock and very strong structure. > 35% clay.

* If roots can penetrate the subsoil, test permeability of upper subsoil.
If roots cannot penetrate the subsoil, test the permeability of the mid-topsoil.
Dark structured clay topsoil (vertic & melanic) with a Class 2 permeability should be assessed in the chart as if it has a Class 3 permeability. If permeability is Class 7, downgrade to Land Class IV.

Now refer to the opposite page to make adjustments for wetness, rockiness, crusting or permeability.

32

USE THE FOLLOWING LAND CHARACTERISTICS TO MODIFY THE LAND CLASS OBTAINED OPPOSITE, IF NECESSARY: The land capability class determined using the "flowchart" cannot be upgraded through consideration of wetness, rockiness, surface crusting or permeability classes given below, but it may be downgraded as indicated.

WETNESS		
Class	Definition	Land Class
W0	Well drained - no grey colour with mottling within 1.5 m of the surface. Grey colour without mottling is acceptable.	No change
W1	There is no evidence of wetness within the top 0.5 m. Occasionally wet - grey colours and mottling begin between 0.5 m and 1.5 m from the surface.	Downgrade Class I to Class II, otherwise no change
W2	Temporarily wet during the wet season. No mottling in the top 0.2 m but grey colours and mottling occur between 0.2 m and 0.5 m from the surface. Included are: soils with G horizons (highly gleyed and often clayey) at depths deeper than 0.5 m; soils with an E horizon overlying a B horizon with a strong structure; soils with an E horizon over G horizons where the depth to the G horizon is more than 0.5 m.	Downgrade to Class IV
W3	Periodically wet. Mottling occurs in the top 0.2 m, and includes soils with a heavily gleyed or G horizon at a depth of less than 0.5 m. Found in bottomlands.	Downgrade to Class Va
W4	Semi-permanently / permanently wet at or above soil surface throughout the wet season. Usually an organic topsoil or an undrained vlei. Found in bottomlands.	Downgrade to Class Vb

PERMEABILITY	
Permeability Class	Adjustment to be made
1 - 2	If in sub-soil, rooting is likely to be limited: Use the permeability of the topsoil in the flow chart. If this is the permeability of the topsoil, then the topsoil is probably a dark structured clay, in which case a permeability Class 3 can be used in the flow chart.
3 - 5	Classify as indicated in the flow chart.
6	Topsoil should have < 15% clay - use the flow chart.
7	Downgrade Land Classes I to III to Land Class IV.

ROCKINESS		
Class	Definition	Land Class
R0	No rockiness	No change
R1	2 - 10% rockiness	Downgrade Classes I to II, otherwise no change
R2	10 - 20% rockiness	Downgrade Classes I to II, otherwise no change
R3	20 - 30% rockiness	Downgrade to Class IV
R4	> 30% rockiness	Downgrade Classes I, II, III & IV to Class VI

SOIL SURFACE CRUSTING		
Class	Definition	Land Class
t0	No surface crusting when dry	No change
t1	Slight surface crusting when dry	Downgrade Class I to Class II, otherwise no change
t2	Unfavourable surface crusting when dry	Downgrade Classes I & II to Class III, otherwise no change

NB **Any land not meeting the minimum requirements shown is considered non-arable (Class V, VI, VII or VIII).**
Non-arable land in BRGs 2, 4, 6, 9, 12, 14, 15, 16, 17, 18 & 19 includes:
* all land with W3, W4 or R4,
* all land with slope exceeding 20%,
* land with slope 13-20%, if clay < 15% or depth < 0.4m,
* land with slope 8-12% and clay > 15%, if depth < 0.25m,
* land with slope 8-12% and clay < 15%, if depth < 0.5m, and
* land with slope 0-7%, if depth < 0.25m.

20 March 1996

9.3. Appendix B: CV of the Author

PERSONAL DETAILS

Name	Rowena Harrison
Date of Birth	21 April 1982
Identity Number	8204210320081
Nationality	South African
Current Position	Director (Wetland Specialist and Soil Scientist)
Office Location	Durban, KwaZulu-Natal
Tel	+27 (0)78 023 0532
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ACADEMIC QUALIFICATIONS

2019 – present	PhD Soil Science (University of Free State and the University of Burgundy, France)
2015	Certificate in Wetland Rehabilitation – University of the Free State
2009	MSc (Soil Science) – University of KwaZulu-Natal
2008	Certificate course in Wetland Delineation, Legislation and Rehabilitation, University of Pretoria
2006	BSc (Environmental Science) – University of KwaZulu-Natal
2005	BSc (Applied Environmental Science) – University of KwaZulu-Natal

PROFESSIONAL AFFILIATIONS

- South African Council for Natural Scientific Professions – SACNASP (Pr. Sci.Nat 400715/15: Soil Science)
- International Association for Impact Assessments – IAIAsa
- South African Wetland Society

PUBLICATIONS

- Harrison, R.L., van Tol, J., and Toucher, M.L. (2022). Using hydropedological characteristics to improve modelling accuracy in Afromontane catchments. Journal of Hydrology: Regional Studies. 39. https://doi.org/10.1016/j.ejrh.2021.100986.
- Harrison, R., and van Tol, J. (2022). Digital Soil Mapping for hydropedological purposes of the Cathedral Peak research catchments, South Africa. In Remote Sensing of African Mountains. Springer. (in publication)

CONFERENCES ATTENDED AND PRESENTED

NAME	DATE
South African Mountain Conference – Presenter on digital soils mapping as well as using hydropedological methods to improve hydrological models.	March 2022
SAEON Science Seminars – Presenter on gaining insights into hydropedological characteristics of catchment hydrology.	February 2022
Biodiversity Symposium – Presenter on Hydropedology and Carbon Dynamics	November 2019
IAIAsa – KZN Branch – Presenter on wetland offsets from a soil's perspective	October 2019
Zoological Society of Southern Africa Conference	July 2019
Grass Identification Course hosted by African Land-Use Training	March 2019
Groundwater Modelling Course hosted by the Nelson Mandela Metropolitan University	February 2019
Hydropedology Course hosted by TerraSoil Science and the Water Business Academy	November 2018
Wetland National Indaba	October 2018
Wetland National Indaba	October 2017
Wetland Vegetation training course	February 2017
National Biodiversity and Business Network (NBBN). Biodiversity Indaba	March 2017

Certificate course in Wetland Rehabilitation and Management, University of the Free State	March 2015
Gauteng Wetland Forum: Basic Wetland Delineation course	February 2013
EIA Training Course: Real World EIA, Metamorphosis Environmental Consultants	November 2008
Certificate course in Wetland Delineation, Legislation and Rehabilitation, University of Pretoria	May 2008

EMPLOYEMENT RECORD

- April 2016 – Present Malachite Ecological Services – Director (Soil Scientist)
- March 2014 - 2016 Afzelia Environmental Consultants (Pty) Ltd (Soil Scientist March and Wetland Specialist)
- September 2012 - February 2014 Strategic Environmental Focus (Pty) Ltd (Junior Wetland Specialist)
- February 2008 - 2009 Afzelia Environmental Consultants cc (Soil Scientist/Junior December Wetlands Specialist and Environmental Assessment Practitioner)

PROJECT EXPERIENCE

Rowena has obtained a MSc. In Soil Science from the University of KwaZulu Natal, Pietermaritzburg. She is professionally affiliated to the South African Council for Natural Scientific Professions (Pr. Sci. Nat) and has 13 years consulting experience in the wetland and soil science field. She has conducted numerous wetland, hydropedology and soil assessments for a variety of development types across South Africa, Swaziland, Cameroon, and the Democratic Republic of Congo.

She is a member of the International Association for Impact Assessment (IAIA) as well as a founding member of the South African Wetland Society. She is currently a joint PhD candidate at the University of the Free State and the University of Burgundy in France. Her research is focused on the interactions of dissolved organic carbon and hydropedology at a catchment scale.