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Soil, Land Use, Land Capability and Agricultural Potential Assessment for the Proposed Matai Mining Project

Submitted by TerraAfrica Consult cc
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DEFINITIONS AND ACRONYMS

Base status: A qualitative expression of base saturation. See base saturation percentage. Base saturation refers to the proportion of the cation exchange sites in the soil that are occupied by the various cations (hydrogen, calcium, magnesium, potassium). The surfaces of soil minerals and organic matter have negative charges that attract and hold the positively charged cations. Cations with one positive charge (hydrogen, potassium, sodium) will occupy one negatively charged site. Cations with two positive charges (calcium, magnesium) will occupy two sites.

Calcareous: Containing calcium carbonate or magnesium carbonate.

Cutan: Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clayskin, clay film, argillan.

Erosion: The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Fertilizer: An organic or inorganic material, natural or synthetic, which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.

Fine sand: (1) A soil separate consisting of particles 0,25-0,1mm in diameter. (2) A soil texture class (see texture) with fine sand plus very fine sand (i.e. 0,25-0,05mm in diameter) more than 60% of the sand fraction.

Gleying: The process whereby the iron in soils and sediments is bacterially reduced under anaerobic conditions and concentrated in a restricted horizon within the soil profile. Gleying usually occurs where there is a high water table or where an iron pan forms low down in the soil profile and prevents run-off, with the result that the upper horizons remain wet. Gleyed soils are typically green, blue, or grey in colour.

Land capability: The ability of land to meet the needs of one or more uses under defined conditions of management.

Land type: (1) A class of land with specified characteristics. (2) In South Africa it has been used as a map unit denoting land, map able at 1:250000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use: The use to which land is put.

Orthic A horizon: A surface horizon that does not qualify as organic, humic, vertic or melanic topsoil although it may have been darkened by organic matter.

Ped: Individual natural soil aggregate (e.g. block, prism) as contrasted with a clod produced by artificial disturbance.

Pedology: The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution.

Saline, soil: Soils that have an electrical conductivity of the saturation soil extract of more than 400 mS/m at 25°C.

Slickensides: In soils, these are polished or grooved surfaces within the soil resulting from part of the soil mass sliding against adjacent material along a plane which defines the extent of the slickensides. They occur in clayey materials with a high smectite content.

Swelling clay: Clay minerals such as the smectites that exhibit interlayer swelling when wetted, or clayey soils which, on account of the presence of swelling clay minerals, swell when wetted and shrink with cracking when dried. The latter are also known as heaving soils.

Texture, soil: The relative proportions of the various size separates in the soil as described by the classes of soil texture shown in the soil texture chart (see diagram on next page). The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided (see diagram) according to the relative percentages of the coarse, medium and fine sand sub-separates.

Vertic, diagnostic A-horizon: A-horizons that have both, high clay content and a predominance of smectitic clay minerals possess the capacity to shrink and swell markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet.

Declaration of EAP

Details of practitioner

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Declaration of Independence

I, Mariné Pienaar, hereby declare that TerraAfrica Consult, an independent consulting firm, has no interest or personal gains in this project whatsoever, except receiving fair payment for rendering an independent professional service.

I further declare that I was responsible for collecting data and compiling this report. All assumptions, assessments and recommendations are made in good faith and are considered to be correct to the best of my knowledge and the information available at this stage.

TerraAfrica Consult cc represented by M Pienaar
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1. Introduction

Kimopax (Pty) Ltd appointed Terra Africa Consult to conduct the soil, land use, land capability and agricultural potential study as part of the Environmental Impact Assessment process for the proposed Matai Project. Matai Mining (Pty) Ltd has applied for the mining right for vanadium, titanium and iron ore on several portions of land which where there is currently a prospecting right in place.

The proposed mining right is located on portions of the following farms:

- Magazynskraal 3 JQ
- Haakdoorn 6 JQ
- Wildebeeskuil 7 JQ
- Syferkuil 9 JQ
- Middelkuil 8 JQ

The Matai Mining Project is located in the Moses Kotane Municipality of Bojanala Platinum District Municipality in North West Province. It lies about 10km south from the closest town Northam and 80km north east of Rustenburg (Figure **1**). It is in a larger area of mining and conservation, situated between the Pilanesberg Nature Reserve in the south, Pilanesberg Mines in the west and Siyanda Resources Union Mine in the north (source: *Final Scoping Report, Kimopax, September 2018*)

The purpose of the study is to determine and describe the baseline soil properties and the land capabilities and land uses associated with it within the proposed project's direct and indirect areas of influence from on-site investigations and data currently available. This report complies with the requirements of the NEMA and environmental impact assessment (EIA) regulations (GNR 326 of 2014 as amended).

2. Objective of the study

The objective of the Soil, Land Use and Land Capability study is to fulfill the requirements of the most recent South African Environmental Legislation with reference to the assessment and management of these natural resource aspects (stipulated in Section 3 below). The key components of assessment are to determine and describe the baseline soil properties and the land capabilities and land uses associated with it within the proposed project's direct and indirect areas of influence from on-site investigations and data currently available. It also assists with the identification of gaps in information. Once these conditions have been established, the anticipated impacts of the project on these properties can be determined. Mitigation and management measures can be recommended to minimise negative impacts and maximise land rehabilitation success towards successful closure at the end of the project life.

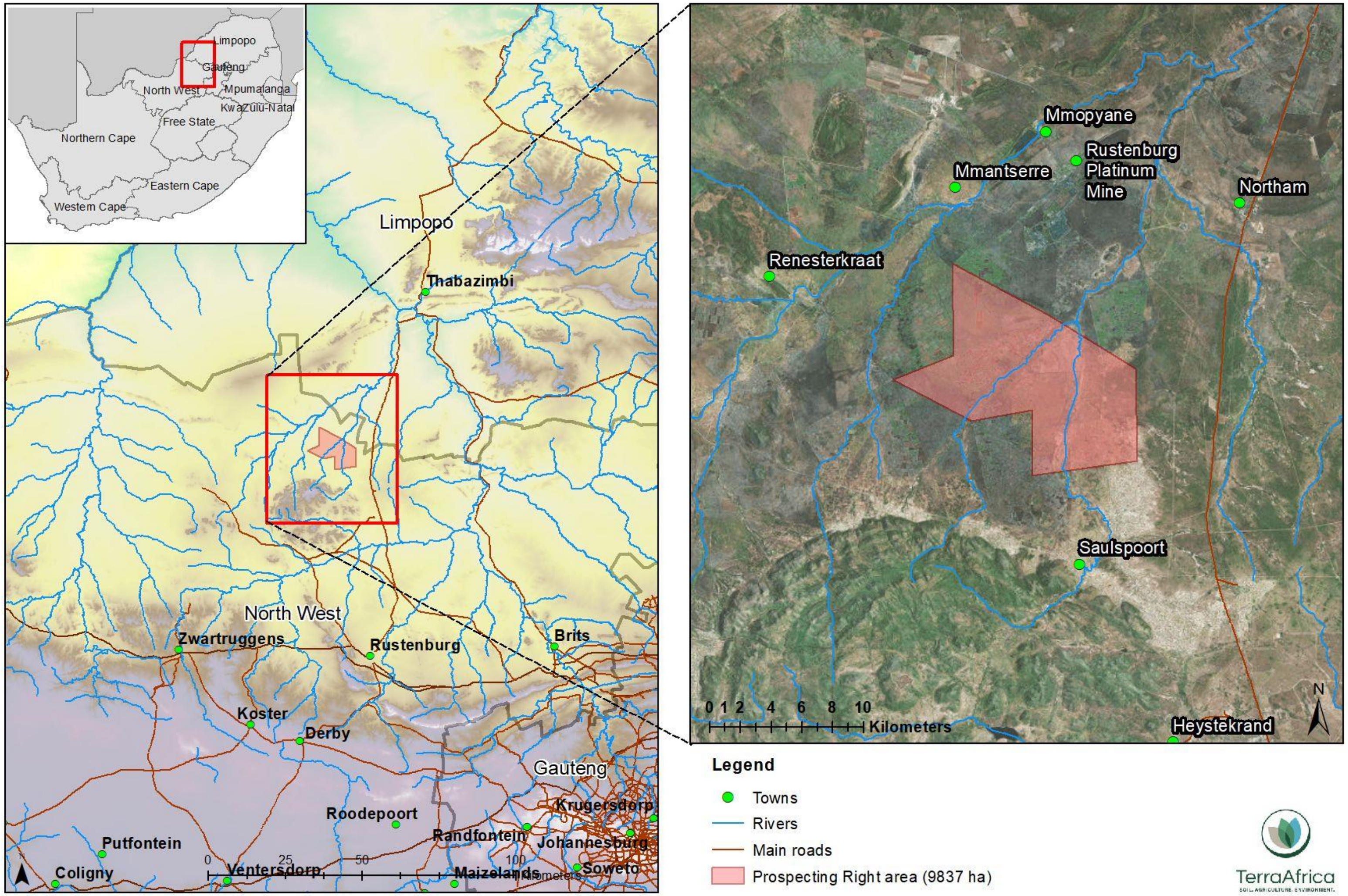

Figure 1: Locality map of the Matai Prospecting Right Area within which the Matai Mining Project is located

3. Environmental legislation applicable to study

The following South African Environmental Legislation needs to be considered for any new or expanding developments with reference to the management of soil and land use:

- The Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal. This act requires the protection of land against soil erosion and the prevention of water logging and salinisation of soils by means of suitable soil conservation works to be constructed and maintained. The utilisation of marshes, water sponges and watercourses are also addressed.
- In addition to this, the National Water Act (Act 36 of 1998) deals with the protection of wetlands. This Act defines wetlands as "land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil." This Act therefore makes it necessary to also assess soil for its hydropedological properties.
- Section 3 of the National Environmental Management Act, the EIA Regulations, 2014 (as amended) and the Subdivision of Agricultural Land Act is also relevant to the development.

4. Terms of reference

The following Terms of Reference as stipulated by Kimopax (Pty) Ltd applies to the soil, land use and land capability study:

- Investigate and study the soils (survey, mapping including profiling and interpretation) and use the taxonomic soil classification system to characterise and classify the soils of the overall area on a comprehensive grid base for the study of the opencast mining and roadway;
- Assess and rate the land capability (mapping and interpretation) using the SA Chamber of Mines methodology for assessing land capability;
- Assess the sensitivity of the soils and land to disturbance as part of an impact assessment process;
- Develop a dominant soils/land form map and land capability plan for the areas that will be affected with specific emphasis on areas of high biodiversity sensitivity
- Propose mitigation measures to reduce or mitigate potential impacts; and
- Compile a specialist report based on the results of the study.

5. Assumptions

It is assumed that the project surface footprint where direct impacts will occur will consist of the open pit area, the mining area, the plant area and the ROM pad. While the blasting buffer zone was also assessed, it is assumed that soil profiles here will remain in situ and their functionality will not be affected.

6. Uncertainties, limitations and gaps

The following uncertainties, limitations and gaps exists with regards to the study methodology followed and conclusions derived from it:

- Soil profiles were observed using a 1.5m hand-held soil auger. A description of the soil characteristics deeper than 1.5m cannot be given.
- Eight samples were collected to depict the baseline soil chemical conditions of the two major modal soil profiles. This number of samples is not sufficient to do detailed soil chemical mapping of the area assessed.
- The study does not include a land contamination assessment to determine pre-mining soil pollution levels (should there be any present).

7. Response to concerns raised by I&APs

Thus far, no concerns were raised by I & APs during the Public Participation Process pertaining to the continuation of existing land uses in the surrounding area. Should any comments be received during the public review period, it will be adequately addressed in this report.

8. Methodology

8.1 Desktop study

The following data was obtained and studied for the desktop study:

- Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC) (Land Type Survey Staff, 1972 – 2006). The land type data is presented at a scale of 1:250 000 and entails the division of land into 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 newly released National Land Capability Evaluation Raster Data Layer was obtained from the Department of Agriculture, Forestry and Fisheries (DAFF) to determine the land capability classes of the larger Prospecting Right area according to this system. The new data was developed using a spatial evaluation modelling approach (DAFF, 2017).
- The most recent aerial photography of the area available from Google Earth was obtained. The aerial photography analysis was used to determine areas of existing impact, land uses within the project area as well as the larger landscape.

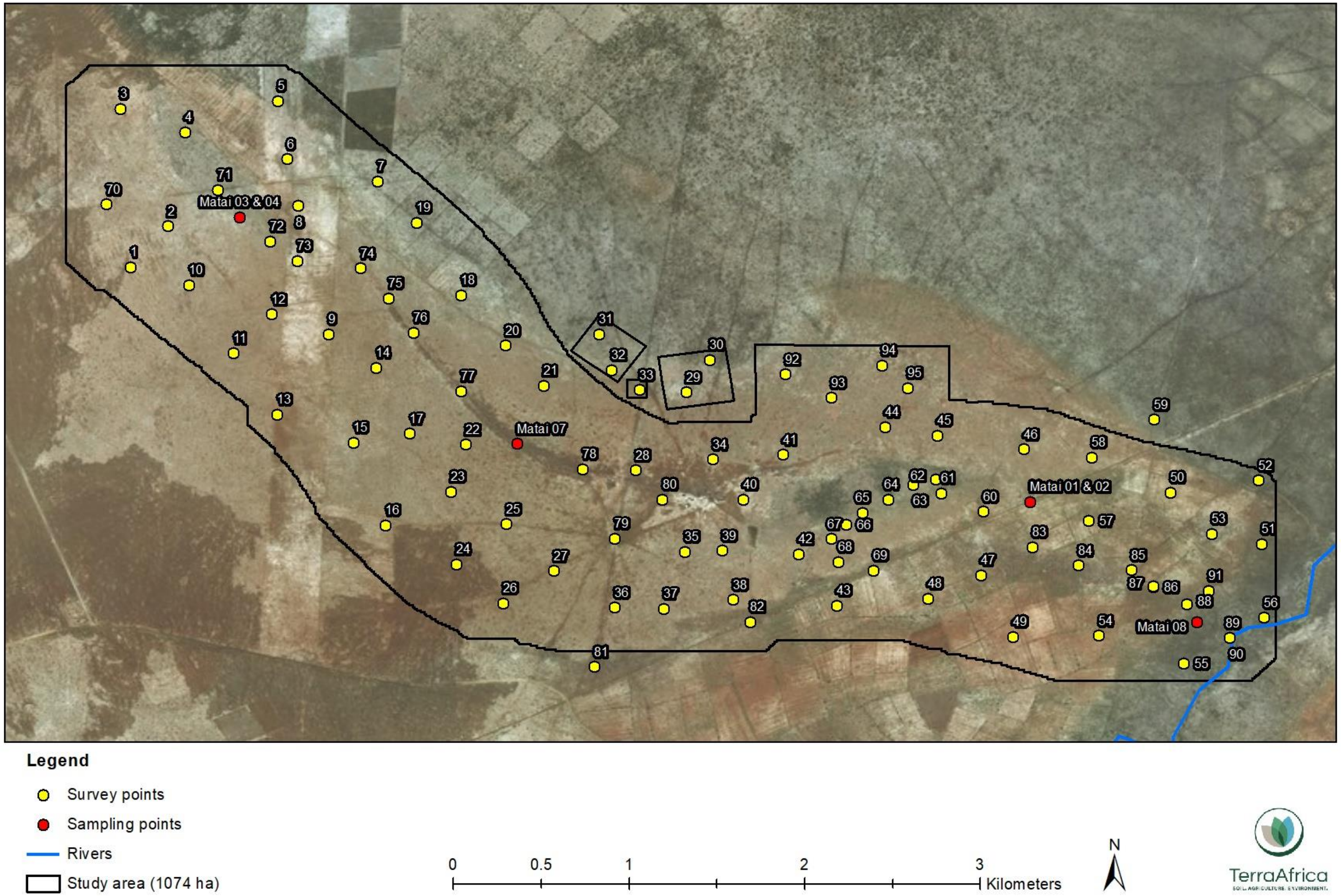

Figure 2: Location of survey and sampling points of the soil survey for the surface footprint of the proposed Matai Mining Project

8.2 Study area survey

A systematic soil survey was undertaken on 10 and 11 December 2018. The season in which the site visit took place has no influence on the results of the survey. The soil profiles were examined to a maximum depth of 1.5m or refuse, using a hand-held soil auger. Ninety soil profiles were classified at the project site (Figure **2**). Observations were made regarding soil texture, structure, colour and soil depth at each survey point. A cold 10% hydrochloric acid solution was used on site to test for the presence of carbonates in the soil. Soil samples were collected at four of these survey points. The soils are described using the S.A. Soil Classification Taxonomic System (Soil Classification Working Group, 1991) published as memoirs on the Agricultural Natural Resources of South Africa No.15. For soil mapping, the soils were grouped into classes with relatively similar soil characteristics.

8.3 Analysis of samples at soil laboratory

Eight soil samples (five topsoil and three subsoil samples) were collected from modal profiles of the two main soil forms (Hutton and Arcadia forms) within the surface footprint area. The samples were sealed in soil sampling plastic bags and sent to Eco Analytica Laboratory that is part of North West University for analyses. Samples taken to determine baseline soil fertility were analysed for pH(KCl), plant-available phosphorus (Bray1), exchangeable cations (calcium, magnesium, potassium, sodium), organic carbon (Walkley-Black) and texture classes (relative fractions of sand, silt and clay).

8.4 Land capability classification

Land capability classes were determined using the guidelines outlined in Section 7 of The Chamber of Mines Handbook of Guidelines for Environmental Protection (Volume 3, 1981). The Chamber of Mines pre-mining land capability system was utilised, given that this is the dominant capability classification system used for the mining industry. Table 2 indicates the set of criteria as stipulated by the Chamber of Mines to group soil forms into different land capability classes.

Table 1: Pre-Mining Land Capability Requirements

Criteria for Wetland	• Land with organic soils or • A horizon that is gleyed throughout more than 50 % of its volume and is significantly thick, occurring within 750mm of the surface.
Criteria for Arable Land	• Land, which does not qualify as a wetland, • The soil is readily permeable to the roots of common cultivated plants to a depth of 750mm, • The soil has a pH value of between 4,0 and 8.4, • The soil has a low salinity and SAR, • The soil has a permeability of at least 1,5-mm per hour in the upper 500-mm of soil • The soil has less than 10 % (by volume) rocks or pedocrete fragments larger than 100-mm in diameter in the upper 750-mm, • Has a slope (in %) and erodibility factor (K) such that their product is <2.0,

	• Occurs under a climatic regime, which facilitates crop yields that are at least equal to the current national average for these crops, or is currently being irrigated successfully.
Criteria for Grazing Land	• Land, which does not qualify as wetland or arable land, • Has soil, or soil-like material, permeable to roots of native plants, that is more than 250-mm thick and contains less than 50 % by volume of rocks or pedocrete fragments larger than 100-mm, • Supports, or is capable of supporting, a stand of native or introduced grass species, or other forage plants, utilizable by domesticated livestock or game animals on a commercial basis.
Criteria for Wilderness Land	• Land, which does not qualify as wetland, arable land or grazing land.

8.5 Impact assessment methodology

In order for the EAP to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An activity is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructures that are possessed by an organisation.
- An environmental aspect is an 'element of an organizations activities, products and services which can interact with the environment'[1]. The interaction of an aspect with the environment may result in an impact.
- Environmental risks/impacts are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or well-being, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.
- Receptors can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems.
- Resources include components of the biophysical environment.
- Frequency of activity refers to how often the proposed activity will take place.
- Frequency of impact refers to the frequency with which a stressor (aspect) will impact on the receptor.

[1] The definition has been aligned with that used in the ISO 14001 Standard.

- Severity refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- Spatial extent refers to the geographical scale of the impact.
- Duration refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria. Refer to the table below. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary[2].

The assessment of significance is undertaken twice. Initial significance is based on only natural and existing mitigation measures (including built-in engineering designs). The subsequent assessment takes into account the recommended management measures required to mitigate the impacts. Measures such as demolishing infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

The impact assessment model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information to be in line with international best practice guidelines in instances of uncertainty or lack of information by increasing assigned ratings or adjusting final model outcomes. In certain instances, where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

Table 2: Likelihood descriptors for impact assessment

Probability of impact	**RATING**
Highly unlikely	1
Possible	2
Likely	3
Highly likely	4
Definite	5
Sensitivity of receiving environment	**RATING**
Ecology not sensitive/important	1
Ecology with limited sensitivity/importance	2
Ecology moderately sensitive/ /important	3
Ecology highly sensitive /important	4
Ecology critically sensitive /important	5

Table 3: Consequence descriptors

Severity of impact	**RATING**

[2] Some risks/impacts that have low significance will however still require mitigation

Insignificant / ecosystem structure and function unchanged	1
Small / ecosystem structure and function largely unchanged	2
Significant / ecosystem structure and function moderately altered	3
Great / harmful/ ecosystem structure and function largely altered	4
Disastrous / ecosystem structure and function seriously to critically altered	5
Spatial scope of impact	**RATING**
Activity specific/ < 5 ha impacted / Linear features affected < 100m	1
Development specific/ within the site boundary / < 100ha impacted / Linear features affected	2
Local area/ within 1 km of the site boundary / < 2000ha impacted / Linear features affected <	3
Regional within 5 km of the site boundary / < 5000ha impacted / Linear features affected < 10	4
Entire habitat unit / Entire system/ > 5000ha impacted / Linear features affected > 10 000m	5
Duration of impact	**RATING**
One day to one month	1
One month to one year	2
One year to five years	3
Life of operation or less than 20 years	4
Permanent	5

Table 4: Likelihood descriptors

LIKELIHOOD (Frequency of activity + Frequency of impact)	CONSEQUENCE (Severity + Spatial Scope + Duration)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
	9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Table 5: Positive/Negative Mitigation Ratings

Significance Rating	Value	Negative Impact Management Recommendation	Positive Impact Management Recommendation
Very high	126-150	Improve current management	Maintain current management
High	101-125	Improve current management	Maintain current management
Medium-high	76-100	Improve current management	Maintain current management
Medium-low	51-75	Maintain current management	Improve current management
Low	26-50	Maintain current management	Improve current management
Very low	1-25	Maintain current management	Improve current management

9. Baseline conditions

9.1 Land types

Following the consideration of the Land Type classification data, the entire Prospecting Right area is dominated by Land Type Ae64 with a few smaller pockets of Land Type Ea70 in between (Figure **5**). Below is a description of each of the land types and the dominant soil forms that are present within them.

9.1.1 Land Type Ae64

The mid-slope (slope between 4% and 25%) and flat plain positions (slope between 0% and 4%) are represented by number 3 and 4 in Figure **3**. These terrain units are dominated by deep soil of the Hutton form interspersed with smaller areas of the Arcadia form. The soil profiles in these areas are between 60 and 120 cm deep and the clay content ranges between 15% and 35%.

The rest of this land type consists of rocky outcrops on the hilltops (Terrain unit 1) and Valsrivier and Arcadia forms at the depressions in the landscape (Terrain unit 5). Both Terrain Units 1 and 5 only has slight slope (not more than 4%).

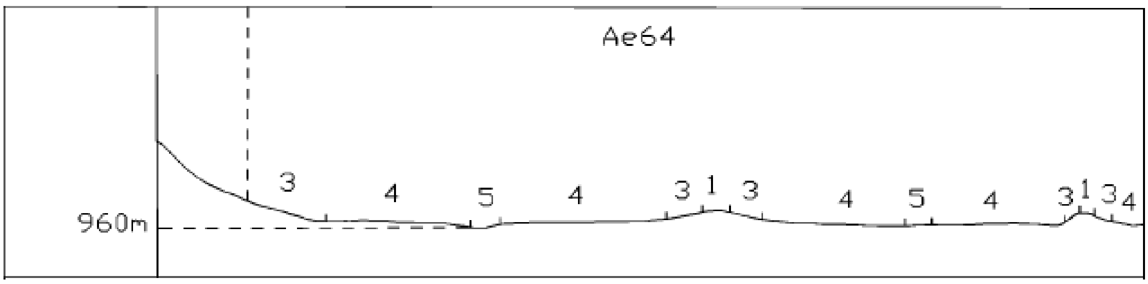

Figure 3: Illustration of the terrain units of Land Type Ae64

9.1.2 Land Type Ea70

The entire land type is dominated by the Arcadia form with only Terrain Unit 5 (Figure 4) having equal possibility to have the hydromorphic Rensburg form. As this landscape position represents the lowest point in the landscape, water accumulates here more easily that can lead to the development of hydromorphic (wetland) properties such as mottling. Small areas of the apedal Hutton form or the red structured Shortlands form may also occur within this land type.

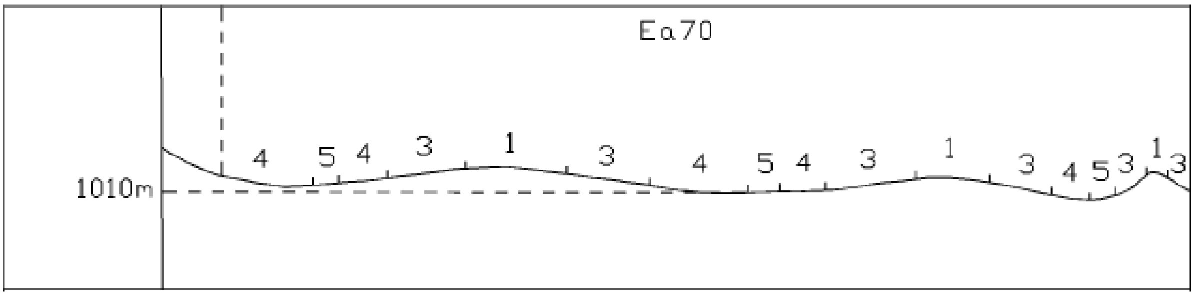

Figure 4 Depiction of the terrain forms of Land Type Ea70

9.2 Soil forms present within the project site

Five different soil forms were identified within the area assessed for the Matai Mining Project. The soil profiles are mostly deep (between 80 and 150 cm) with the only exception the Glenrosa form and a small pocket of shallow Hutton soil just south-east of the middle of the area assessed. No significant anthropogenic disturbance of soil profiles was observed. The area around the river in the south-eastern corner of the area assessed, consists of soil of the Arcadia and Valsrivier forms. Although the soil was moist during the assessment, there were no strong indicators of wetlands soil properties such as gleyed horizons and mottling. It was observed that the river has carved a path through the landscape and that the river bottom consists of mainly of rock or weather rock. The high clay content of the Arcadia form stabilises the soils around this area and prevent excessive erosion as a result of the water movement during times of peak rainfall.

9.2.1 Hutton (Hu) form (854 ha)

The Hutton soil form dominates the entire area assessed and consists of an orthic A horizon on a red apedal B horizon overlying unspecified material. The red apedal soils B1-horizon has more or less uniform "red" soil colours in both the moist and dry states and has weak structure or is structureless in the moist state (Soil Classification Working Group Book, 199). The red colours on site are mostly dark red.

Soil depths of the Hutton profiles surveyed on site ranged mostly between 120cm and 150cm and deeper with restrictive layers of unspecified material without signs of wetness. A small area of shallower Hutton soils (40 to 75 cm deep) were identified just south-east of the proposed mining pit area. All Hutton profiles are structureless or have very weakly developed structure.

Hutton soils with no restrictions shallower than 50cm are generally good for crop production (Fey, 2010). The high quality orthic A and red apedal B-horizons makes it highly suitable soil form for annual crop production (good rooting medium) and use as ‘topsoil’, having favourable structure (weak blocky to apedal) and consistence (slightly firm to friable). These topsoils are ideal for stripping and stockpiling for rehabilitation purposes for they are deep and have a favourable structure.

Soil samples Mat01, Mat05 and Mat 07 is representative of the topsoil chemical properties of the site while samples Mat02 and Mat06 representative is of the subsoil chemical conditions of the Hutton soil form.

9.2.2 Arcadia (Ar) form (99 ha)

Five different areas consisting of the Arcadia soil form has been classified within the project footprint. This includes two pockets in the pit area, sections of the plant and mining areas as well as directly around the river in the south-east. These dark brown to black vertic soils have deep A-horizons (60 to 120 cm deep on site) and are high in clay content with swelling-shrinking properties under conditions of water content changes. These expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet. The swell-shrink potential is manifested typically by the formation of conspicuous vertical cracks in the dry state and the presence, at some depth, of slickensides (polished or grooved glide planes produced by internal movement).

The Arcadia soils on site have arable agricultural potential and is used for sunflower and cotton production in the larger area around the site. In addition to arable land capability, it also has high grazing potential as very palatable, nutritious (sweet) grass grows on these soils.

9.2.3 Oakleaf (Oa) form (46 ha)

The Oakleaf soil form is present in two pockets in the proposed open pit area of the Matai project. This soil form consists of an orthic A horizon of 30 cm deep, overlying a neocutanic B horizon (50 cm thick) on unspecified material. The neocutanic horizon has non-uniform colouring and cutans and channel infillings area visible. Oakleaf soils have high agricultural production potential and are rather well-drained permitting that the rainfall and slope allows crop production. The fine sandy loam will be prone to both wind and water erosion when vegetation cover is removed or when stripped and stockpiled during mining activities. The Oakleaf soil on site has arable land capability.

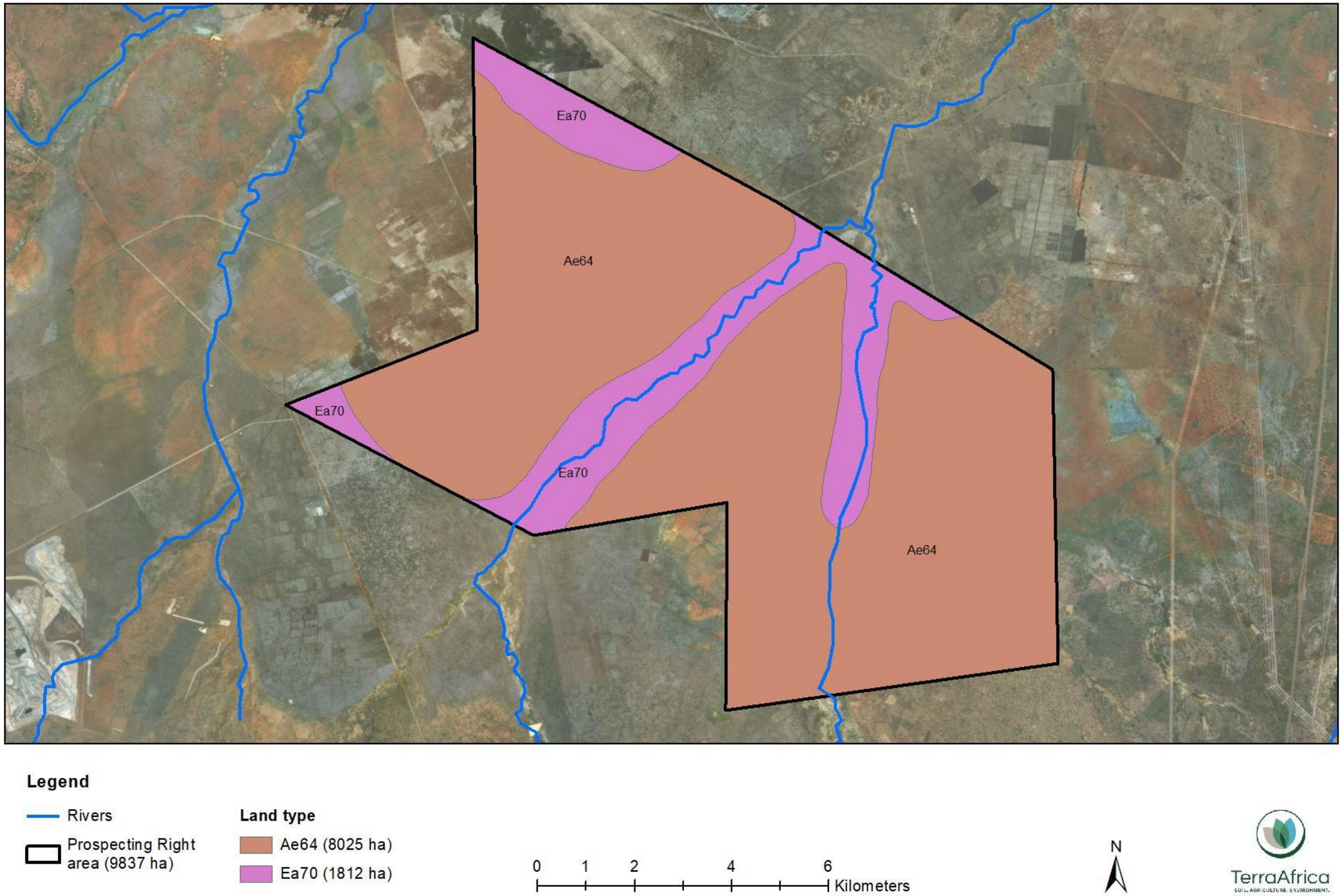

Figure 5: Land type map of the Matai (Pty) Ltd Prospecting Right area

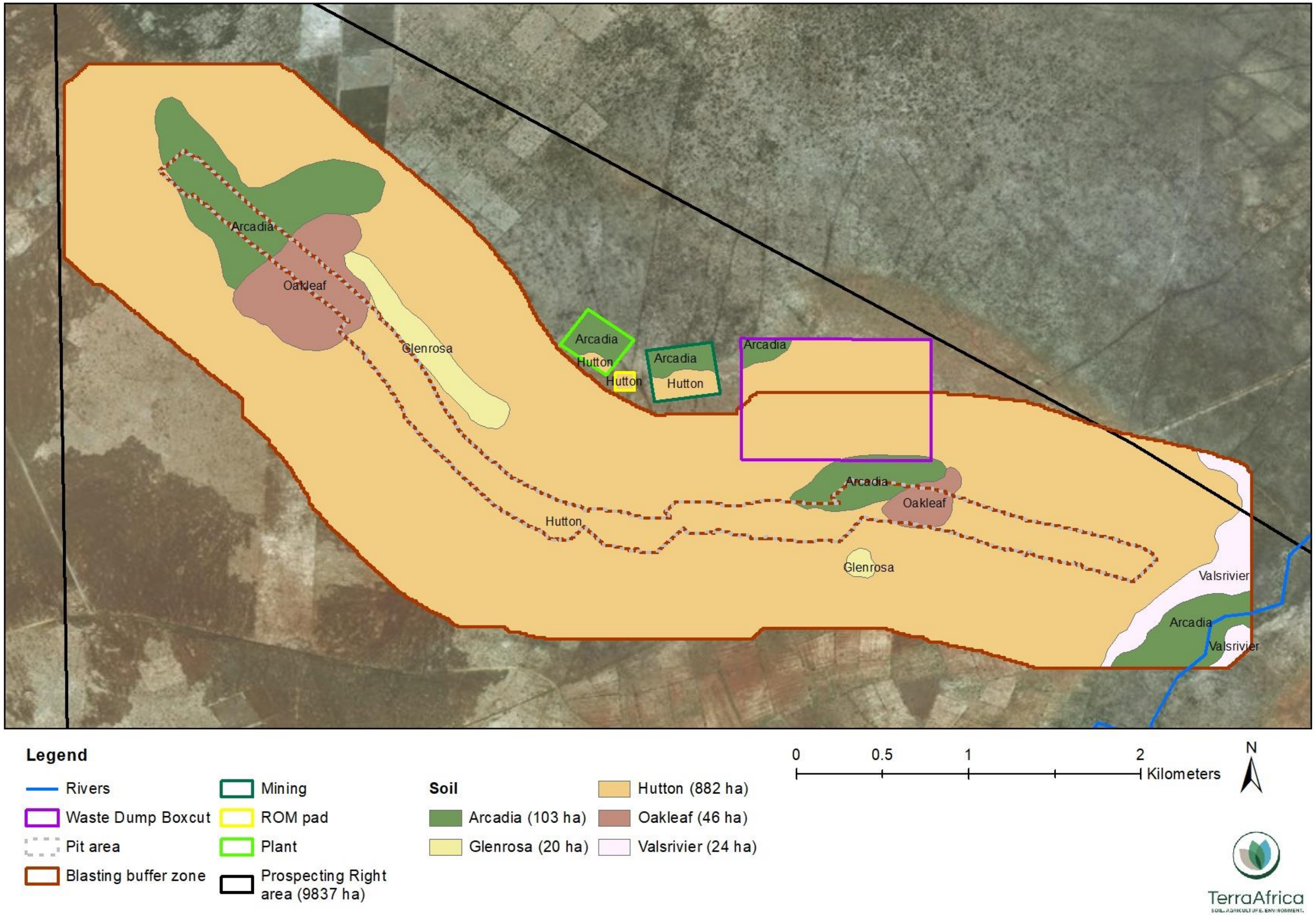

Figure 6: Soil map of the areas of proposed infrastructure and impact of the Matai Mining Project

9.2.4 Valsrivier (Va) form (24 ha)

The Valsrivier soil form is present on the eastern side of the area assessed. It is a duplex soil that consists of an orthic A horizon, overlying a pedocutanic B horizon which is underlain by unconsolidated material without signs of wetness. This profile consists of a clay loam (60 to 100 cm in the study area), formed in gneissic colluvium, containing nodules of secondary lime in the B horizon and showing no evidence of wetness at depth. The B-horizon have become enriched in clay by illuviation (a pedogenic process which involves downward movement of fine materials by, and deposition from, water to give rise to cutanic character) and that have developed moderate or strong blocky character.

Such soils can be productively used under irrigation but the duplex nature means that artificial drainage would have to be taken into consideration. Hard setting and erodibility are two physical conditions to be taken into consideration when stockpiling topsoil during mining activities. The Valsrivier soil form has grazing land capability and is considered highly sensitive to surface disturbance as a result of its ability to easily erode.

9.2.5 Glenrosa (Gs) form (20ha)

The Glenrosa soil form consists of an orthic A horizon underlain by a hard lithocutanic B horizon. The lithocutanic B horizon (distinguished from hard rock by not only consistence and degree of weathering but also tonguing and cutanic character) may itself be 'hard or not hard' (Soil Classification Working Group 1991). To be called hard, more than 70% must be parent rock, fresh or partly weathered with a hard consistence in the dry, moist and wet states. The cutanic character of the B horizon of the Glenrosa soil form as was visible in open profiles in the study area, take the form of tongues of topsoil extending into the partly weathered parent rock. The Glenrosa soil profiles on site are shallow to very shallow and occur in two pockets in the north-west and south of the pit area. Topsoil stripping for stockpiling will result in very little topsoil to be stored for rehabilitation purposes.

9.3 Soil chemical conditions

The purpose of establishing baseline chemical composition of soil on a site before development commences, is to determine whether there is any deterioration in soil fertility and what the nutrient status of the soil is associated with the natural vegetation. Should the chemical content of the soil be drastically different once rehabilitation commences, the chemical composition might have to be amended by the addition of fertilizers or organic matter. The analyses results obtained from the laboratory is attached as Appendix 2.

9.3.1 pH

The pH of the soil is measured potentiometrically in a supernatant suspension of a 1:2.5 soil to liquid mixture. For this assessment potassium chloride (KCl) was used. The pH levels will be described using the scale of general descriptive terminology as was defined by the United States Department of Agriculture Natural Resources Conservation Service (NRCS).

Table 6 - Descriptive terminology for pH ranges (NRCS, USDA)

Description/Denomination	pH range
Ultra-acidic	<3,5
Extremely acidic	3,5 – 4,4
Very strongly acidic	4,5 – 5,0
Strongly acidic	5,1 – 5,5
Moderately acidic	5,6 – 6,0
Slightly acidic	6,1 – 6,5
Neutral	6,6 – 7,3
Slightly alkaline	7,4 – 7,8
Moderately alkaline	7,9 – 8,4
Strongly alkaline	8,5 – 9,0
Very strongly alkaline	>9,0

The pH values of the samples range between 4,73 and 6,09 and are therefore very strongly acidic to slightly acidic. pH values below 5 result in high solubility of aluminium that results in aluminium toxicity symptoms such as stunted root growth and minimum lateral root development (Mengel and Kirkby, 2001). As only samples are below pH 5, the pH levels are not considered a hindrance to agricultural production.

9.3.2 Plant-available phosphorus (P)

Plant-available phosphorus is extracted with a Bray 1 solution for soils with a neutral to low pH value. The plant-available phosphorus levels are mostly high (the highest is 65,4 mg/kg at Mat01 [topsoil]) with only two points indicating low phosphorus levels (these points are representative of the Arcadia soil form). The high phosphorus levels in the soil indicate that the soil has previously been cultivated and that phosphorus fertilizer was added to the soil. Undisturbed in situ profiles in the warm, drier areas of the country such as the area of the proposed Mathai project, usually have much lower P levels.

9.3.3 Major cationic plant nutrients

The exchangeable complexed fraction of the major cationic plant nutrients (magnesium, calcium, potassium and sodium) were determined by percolation of the samples with ammonium acetate and measurement of bases in the percolate. The levels of all four cations are very high. The samples representing the Arcadia soil form showed extremely high levels of calcium and magnesium, high levels of potassium as well as rather high levels of sodium. Especially the Arcadia soil in close proximity to the river is very high in calcium as calcium nodules are also present in this area. The high magnesium and sodium levels can prove to be problematic for soil texture as deflocculation can occur.
The levels of each of the cations are indicated in the analysis results in Appendix 1.

The organic carbon content was measured with the Walkley-Black methodology. The organic carbon content is relatively high for the climatic conditions of the project area and can be attributed to the higher clay content of the soil forms there. The organic carbon content ranges between 1,44% and 3,42%.

9.3.4 Soil texture

Soil texture is a soil physical property but has been analysed by the laboratory with the three sieve-method. With this method, particles larger than 2mm are first removed and the soil mixture is then shaked through three sieves of different grid size to determine the percentage of each particle size group that remains on the sieves.

The textures range from sandy loam for the Hutton soil form where the sand fraction comprises 63 to 77% to much higher clay content being present in the vertic Arcadia soil (more than 40% clay). Soil with higher clay content has higher buffer capacity against possible soil pollution and has more slope stability against erosion when stockpiled.

9.4 Land capability

Land capability can be defined as “the extent to which land can meet the needs of one or more uses under defined conditions of management” (Schoeman, 2002). The land capability of an area is the combination of the inherent soil properties and the climatic conditions as well as other landscape properties such as slope and drainage patterns that may inhibit agricultural land use or result in the development of specific land functionality such as wetlands. Land capability affects the socio-economic aspects of human settlements and determine the livelihood possibilities of an area. Baseline land capabilities are also used as a benchmark for rehabilitation of land in the case of project decommissioning.

Following the land capability classification of the South African Chamber of Mines, the largest portion of the area assessed can be classified as having arable land capability. Although the vertic topsoil horizon of the Arcadia form is high in clay content, this soil form is successfully used in the larger region of the project area for the production of sunflowers and cotton. The area around the river as well as the two pockets of the shallow Glenrosa form, has grazing land capability. Especially the area around the river is not suitable for crop cultivation because of the excessively high cation content that can lead to erosion of the landscape should the in situ soil profiles be disturbed.

The larger prospecting right area within which the proposed project fall was also assessed using the newly launched land capability classification systems as released by DAFF (2017). This data set show that the prospecting right area is dominated by land with high and moderate high arable land capability (Figure **8**). This is in agreement with the findings of the soil survey and site assessment.

9.5 Agricultural potential

The largest portion of the area assessed has suitability for rain-fed agriculture. There are soil physical and chemical evidence that crop cultivation was previously practiced in this area. It is not evident why this has ceased and whether it is as a result of climatic constraints or as a result of a change in landownership. The site also has potential for irrigated agriculture although no irrigation infrastructure was observed during the site visit.

Livestock farming is also considered a viable option for the project site. The grazing capacity of a specified area for domestic herbivores is given either in large animal unit per hectare or in hectares per large animal unit. One large animal unit is regarded as a steer of 450kg whose weight increases by 500g per day on veld with a mean energy digestibility of 55%. The grazing capacity of the veld in the project site is 8 to 10 hectares per large animal unit or large stock unit (LSU) (Morgenthal et al., 2005).

9.6 Sensitivity analysis of the project site

Following the analysis of the baseline properties of the project site, it can be classified as having high, medium and low sensitivity to the proposed project from the perspective of soil, land capability and agricultural potential (Figure **9**). The area around the river has high sensitivity to disturbance but the current proposed surface footprint does not fall within this area. The largest parts of the areas to be disturbed has medium sensitivity to the proposed development as the soil has high arable potential although it is not currently cultivated. Areas which consist of the shallow Glenrosa soil form has low sensitivity to the proposed project.

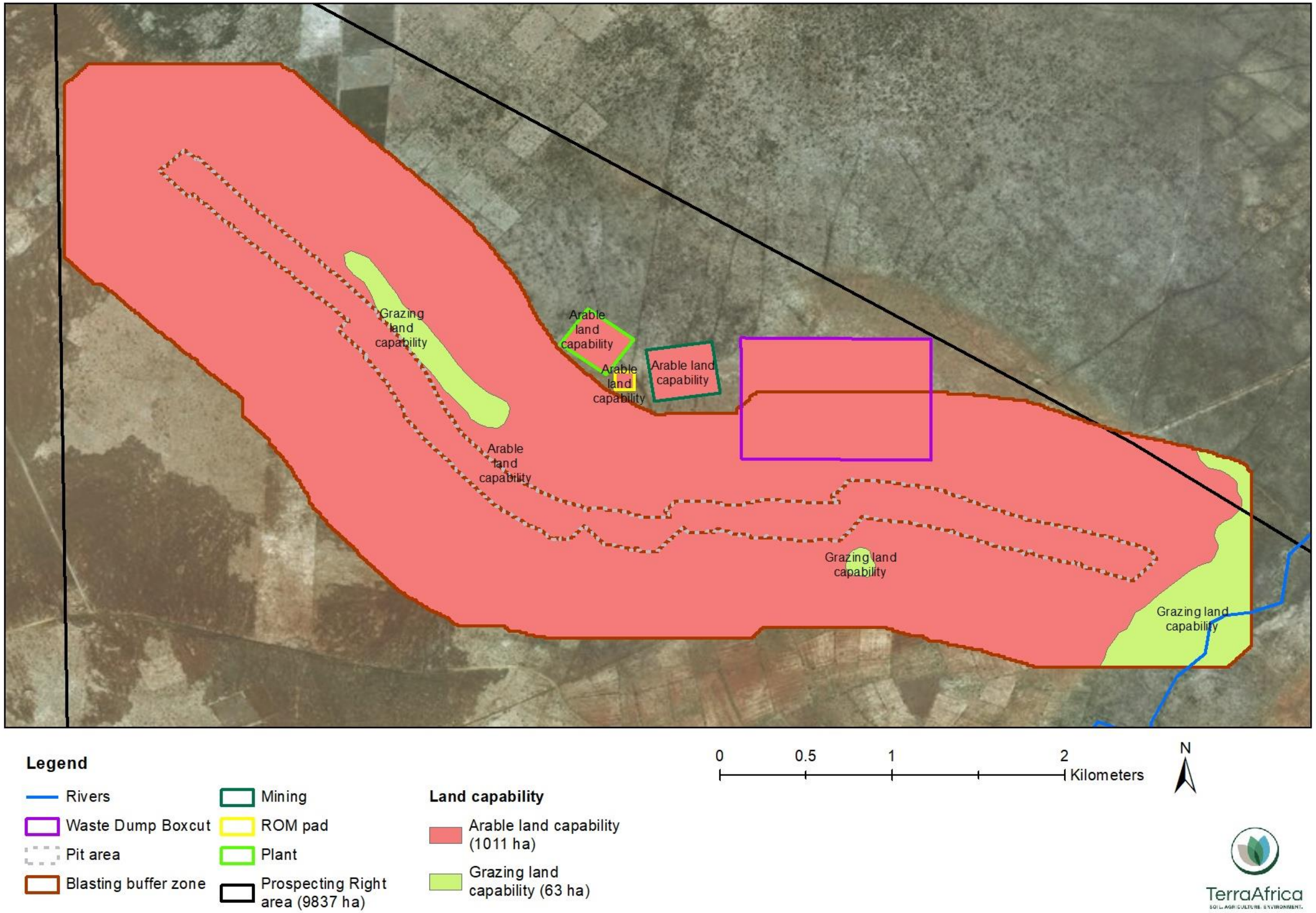

Figure 7: Land capability map of the areas of proposed infrastructure and impact of the Matai Mining Project

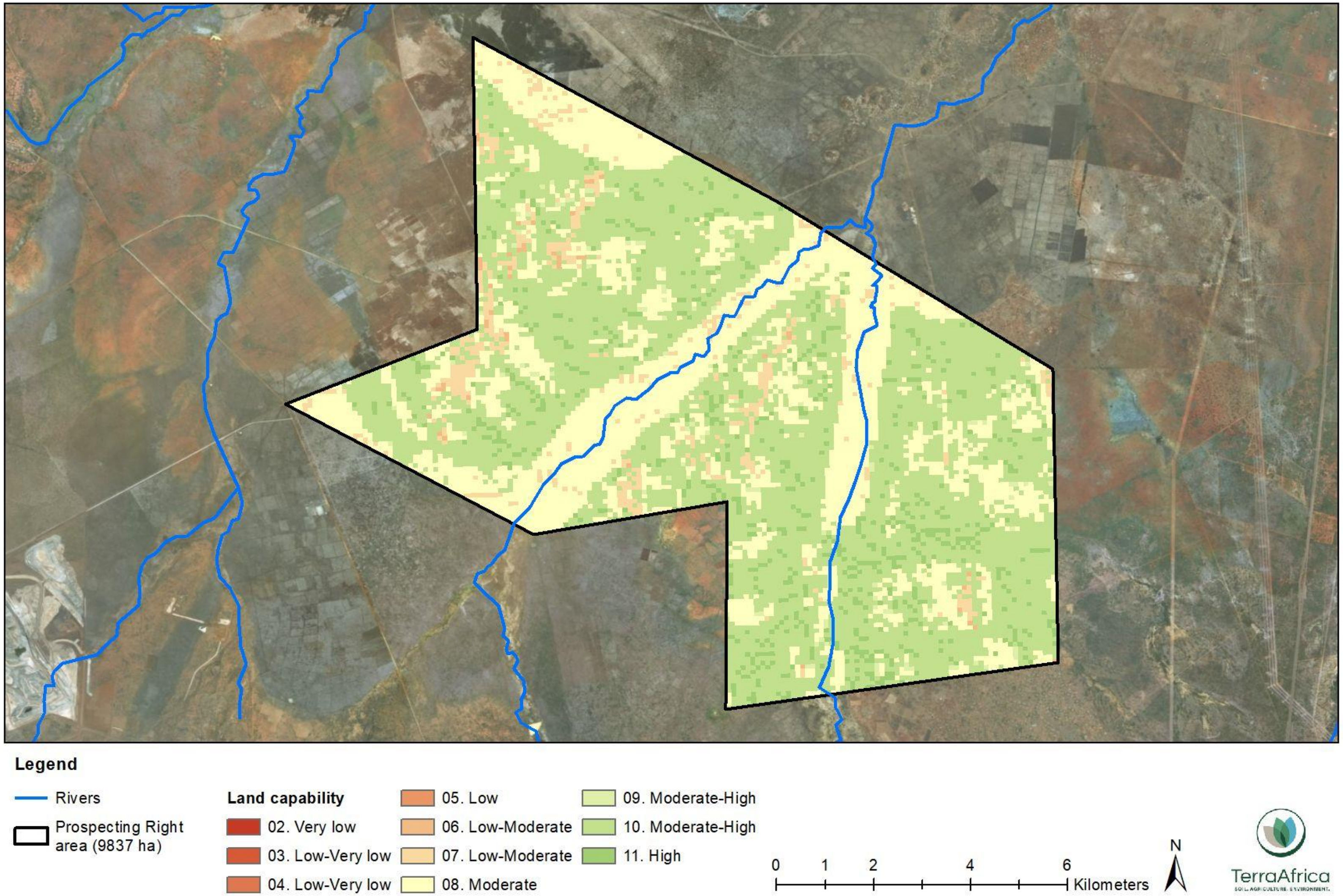

Figure 8: Land capability map of the Matai Mining (Pty) Ltd Prospecting Right area (data source: DAFF, 2017)

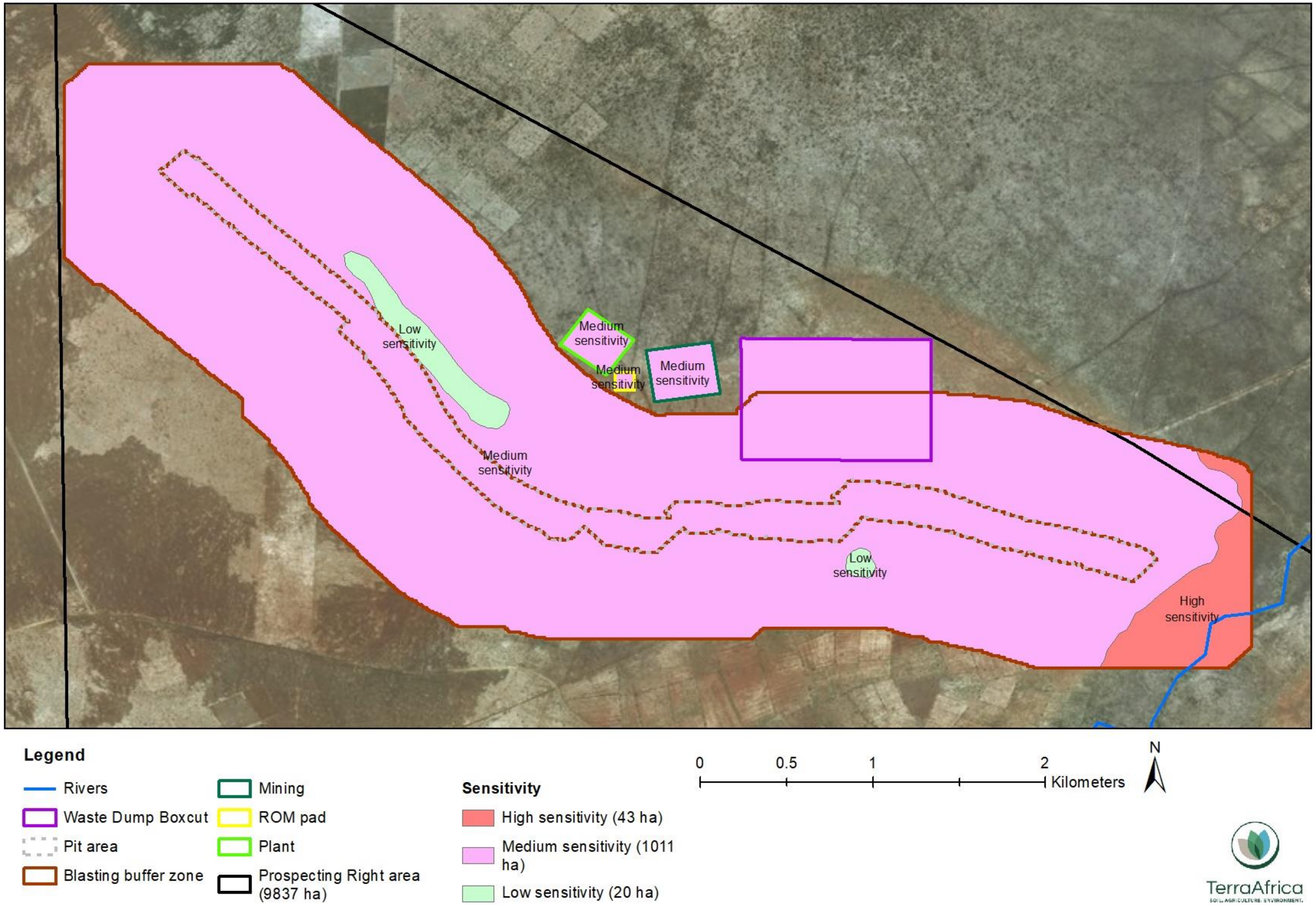

Figure 9: Sensitivity of the baseline environment to the proposed project layout

10. Impact Assessment

10.1 Project description

The proposed Matai Mining project will involve the construction of an opencast mine, processing plant, pollution control dams, material stockpiles, waste rock dump, storage area, gravel surface access roads and other site infrastructure. Topsoil, where available will be stripped and stockpiled separately. Waste rock will be stockpiled on a Waste Rock Dump (WRD). Site preparation will include the removal of vegetation, topsoil and subsoil and the construction of buildings and access and haul roads.

Site infrastructure will include inter alia the following:

- Office complex (carpark, meeting rooms, hall, training complex, security and first aid station)
- Workshops (vehicle workshops, tyre shops, wash bay, garages, fuel depots and explosives magazine)
- Sewerage treatment plan

10.2 Impact assessment for each of the project phases

10.2.1 Construction phase

During the construction phase, all infrastructure and activities required for the operational phase will be established. The main envisaged activities include the following:

- Transport of materials and labour with trucks and buses as well as other light vehicles using the existing access roads. This will compact the soil of the existing roads and fuel and oil spills from vehicles may result in soil chemical pollution.
- Earthworks will include clearing of vegetation from the surface, stripping topsoil (soil excavation) and stockpiling as well as drilling and blasting for the initial removal of overburden at the planned open cast pit as well as the construction of infrastructure like the Primary Crushing Facility, water management systems, contractors camp and sewage treatment plants. These activities are the most disruptive to natural soil horizon distribution and will impact on the current soil hydrological properties and functionality of soil. It will also change the current land use as well as land capability in areas where activities occur and infrastructure is constructed.
- Other activities in this phase that will impact on soil are the handling and storage of building materials and different kinds of waste. This will have the potential to result in soil pollution when not managed properly.

The disturbance of original soil profiles and horizon sequences of these profiles during earthworks is considered to be a measurable deterioration. This impact is considered to be permanent but will be localised within the site boundary. This impact is possible and will have medium-high significance. Even though topsoil management as described in the Soil

Management Plan (SMP) is adhered to, the impact will still have medium-high significance as it is impossible to re-create original soil profile distribution.

Soil chemical pollution as a result of potential oil and fuel spillages from vehicles, is considered to be a moderate deterioration of the soil resource. This impact will be localised within the site boundary and have medium-high significance on the soil resource when not managed. However, with proper waste management and immediate clean-up, the significance of this impact can be reduced to low (Soil Management Plan).

Soil compaction will be a measurable deterioration that will occur as a result of the heavy vehicles commuting on the existing roads as well as any new haul roads constructed for this project. This is a permanent impact that will be localised within the site boundary with medium-high consequence and significance.

Soil erosion is also anticipated due to vegetation clearance. The impacts of soil erosion are both direct and indirect. The direct impacts are the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil and the reduced water-holding capacity of severely eroded soils. The off-site indirect impacts of soil erosion include the disruption of riparian ecosystems and sedimentation. Soil erosion is a permanent impact for once the resource has been lost from the landscape it cannot be recovered. Although there are off-site indirect impacts associated with this, the impact is mainly considered to be local. The consequence and significance of the impact is considered as medium-high. With proper mitigation measures and the embedded controls as recommended in the Soil Management Plan, it is anticipated that the significance of this impact can be reduced to medium-low.

In areas of permanent changes such as road upgrades, the sinking of open pits and the erection of infrastructure and stockpiles, the current land capability and land use will be lost temporarily. However, the land capability and land use of areas where infrastructure will be decommissioned can be partially restored through mined land rehabilitation techniques.

Table 7: Environmental significance before mitigation for the construction phase

POTENTIAL IMPACT DESCRIPTION	CONSEQUENCE			LIKELYHOOD		SCORE	SIGNIFICANCE RATING
	Severity	Spatial	Duration	Frequency: Activity	Frequency: Impact		
Disturbance of original soil profiles	4	1	5	4	4	80	Medium-high
Soil compaction	4	2	5	4	4	88	Medium-high
Soil chemical pollution	4	2	4	4	4	80	Medium-high
Soil erosion	5	2	5	3	4	84	Medium-high
Loss of Land Capability	5	1	5	5	5	110	High
Change of Land Use	5	1	5	5	5	110	High

Table 8: Environmental significance after mitigation for the construction phase

POTENTIAL IMPACT	CONSEQUENCE	LIKELYHOOD	SCORE	SIGNIFICANCE

DESCRIPTION	Severity	Spatial	Duration	Frequency: Activity	Frequency: Impact		RATING
Disturbance of original soil profiles	4	1	5	4	4	80	Medium-high
Soil compaction	3	1	5	3	3	54	Medium-low
Soil chemical pollution	2	1	3	2	2	24	Low
Soil erosion	4	2	4	3	3	60	Medium-low
Loss of Land Capability	5	1	5	5	5	110	High
Change of Land Use	5	1	5	5	5	110	High

10.2.2 Operational phase

The operational phase includes all the processes associated with the mining of vanadium, titanium and iron ore as well as the daily management of the mine and related activities. The main envisaged operational activities that will impact on soil, land use and land capability include the following:

- Open pits and surface infrastructure will both lead to surface impacts on soil resources. Surface infrastructure like buildings, haul roads, waste rock dumps and product stockpiles are by far the most disruptive to current land uses, land capability as well as agricultural potential of the soil. Soil underneath buildings and stockpiles are subject to compaction and sterilization of the topsoil;
- Daily traffic on roads for inspection and maintenance of infrastructure;
- Daily mining activities in different areas of the proposed Matai mining project and
- Loading and hauling of ore at the open pit and transporting it to the product stockpile.

The disturbance of original soil profiles and horizon sequences of these profiles is considered to be a measurable deterioration. This impact is considered to be permanent but will be localised within the site boundary. This impact is possible and will have medium-high significance when unmanaged.

Soil chemical pollution as a result of spills of fuel and lubricants by vehicles and machinery as wells as the accumulation of domestic waste, is considered to be a moderate deterioration of the soil resource. This impact will be localised within the site boundary and have medium-high significance on the soil resource.
Vanadium and titanium are unlikely to cause toxic effects for soil microbes or plants due to dust from or soil stockpiles.

Soil compaction will be a measurable deterioration that will occur as a result of the weight of the topsoil and overburden stockpiles stored on the soil surface as well as the movement of vehicles on the soil surfaces (including access and haul roads). This is a permanent impact that will be localised within the site boundary with medium-low consequence and significance in the mitigated scenario.

During the operational phase, topsoil stockpiles as well as roads running down slopes will still be susceptible to erosion. Soil surfaces with infrastructure such as concrete slabs and buildings will not be exposed to erosion any longer. This is a permanent impact that will be localized within the site boundary with medium-high consequence and significance. With proper mitigation measures and the embedded controls as recommended in the Soil Management Plan, it is anticipated that the significance of this impact will be reduced to low. Although thunderstorms occur in the area, the slope of the terrain is quite level and it is unlikely that soil erosion will have more than a low significance.

The current land capability and land use of areas with active mining will be lost temporarily. However, the land capability and land use of areas where infrastructure will be decommissioned can be restored through mined land rehabilitation techniques.

Table 9: Environmental significance before mitigation for the operational phase

POTENTIAL IMPACT DESCRIPTION	CONSEQUENCE			LIKELYHOOD		SCORE	SIGNIFICANCE RATING
	Severity	Spatial	Duration	Frequency: Activity	Frequency: Impact		
Disturbance of original soil profiles and horizon sequences	4	1	5	4	4	80	Medium-high
Soil compaction	4	2	5	4	4	88	Medium-high
Soil chemical pollution	4	2	4	4	4	80	Medium-high
Soil erosion	5	2	5	3	4	84	Medium-high
Loss of Land Capability	5	1	5	5	5	110	High
Change of Land Use	5	1	5	5	5	110	High

Table 10: Environmental significance after mitigation for the operational phase

POTENTIAL IMPACT DESCRIPTION	CONSEQUENCE			LIKELYHOOD		SCORE	SIGNIFICANCE RATING
	Severity	Spatial	Duration	Frequency: Activity	Frequency: Impact		
Disturbance of original soil profiles	4	1	5	4	4	80	Medium-high
Soil compaction	3	1	5	3	3	54	Medium-low
Soil chemical pollution	2	1	3	2	2	24	Low
Soil erosion	4	2	4	3	3	60	Low
Loss of Land Capability	5	1	5	5	5	110	High
Change of Land Use	5	1	5	5	5	110	High

10.2.3 Decommissioning phase

Decommissioning and rehabilitation can be considered a reverse of the construction phase with the demolition and removal of the majority of infrastructure and activities very similar to those described with respect to the construction phase.

- Transport of materials away from site. This will compact the soil of the existing roads and fuel and oil spills from vehicles may result in soil chemical pollution.

- Earthworks will include redistribution of inert waste materials to fill the open pits as well as topsoil to add to the soil surface. These activities will not result in further impacts on land use and land capability but may increase soil compaction.
- With the decommissioning phase, soil surfaces are in the process of being replanted with indigenous vegetation and until vegetation cover has established successfully, all surfaces are still susceptible to potential soil erosion.
- Other activities in this phase that will impact on soil are the handling and storage of materials and different kinds of waste generated as well as accidental spills and leaks with decommissioning and rehabilitation activities. This will have the potential to result in soil pollution when not managed properly.

Soil chemical pollution as a result of potential oil and fuel spillages from vehicle, is considered to be a medium deterioration of the soil resource. This impact will be localised within the site boundary and have medium-high significance on the soil resource when not managed. However, proper waste management and immediate clean-up, the significance of this impact can be reduced to very low (**Soil Management Plan**).

Soil compaction will be a measurable deterioration that will occur as a result of the heavy vehicles. This is a long-term impact because soil ripping will only alleviate compaction in surface soil layers and have little to no effect on deeper soil compaction. Soil compaction will be localised within the site boundary with medium consequence and significance in the unmitigated scenario.

Successful re-vegetation of all denuded areas with indigenous vegetation can reduce the significance of erosion to very low.

Table 11: Environmental significance before mitigation for the decommissioning phase

POTENTIAL IMPACT DESCRIPTION	CONSEQUENCE			LIKELYHOOD		SCORE	SIGNIFICANCE RATING
	Severity	Spatial	Duration	Frequency: Activity	Frequency: Impact		
Soil compaction	4	2	5	4	4	88	Medium-high
Soil chemical pollution	4	2	4	4	4	80	Medium-high
Soil erosion	5	2	5	3	4	84	Medium-high

Table 12: Environmental significance after mitigation for the decommissioning phase

POTENTIAL IMPACT DESCRIPTION	CONSEQUENCE			LIKELYHOOD		SCORE	SIGNIFICANCE RATING
	Severity	Spatial	Duration	Frequency: Activity	Frequency: Impact		
Soil compaction	3	1	3	3	2	35	Low
Soil chemical pollution	3	1	2	2	1	18	Very low

Soil erosion	3	1	2	2	1	18	Very low

10.2.4 Closure phase

The closure phase occurs after the cessation of all decommissioning activities. Relevant closure activities are those related to the after care and maintenance of remaining structures. It is assumed that all operation activities and processing operations will have ceased by the closure phase of the Matai Mining project. The potential for impacts during this phase will depend on the extent of demolition and rehabilitation efforts during decommissioning and on the features that will remain, such as upgraded roads and buildings.

There will be no further impacts on soil during the closure phase.

11. Assessment of cumulative impacts

11.1 Assessment rationale

"Cumulative Impact", in relation to an activity, means the past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity that in itself may not be significant, but may become significant when added to existing and reasonably foreseeable impacts eventuating from similar or diverse activities[3].

The role of the cumulative assessment is to test if such impacts are relevant to the proposed project in the proposed location (i.e. whether the addition of the proposed project in the area will increase the impact). This section should address whether the construction of the proposed development will result in:

- Unacceptable risk
- Unacceptable loss
- Complete or whole-scale changes to the environment or sense of place
- Unacceptable increase in impact

[3] Unless otherwise stated, all definitions are from the 2014 EIA Regulations (GNR 326).

11.2 Other projects in the area

The larger area around the proposed project site already consists of a few mining developments, residential and human settlements.

The cumulative impacts associated with the Matai Mining project will be a reduction in the area with arable land capability. In addition to this, cumulative impacts will be an increased risk for soil erosion when vegetation is removed and possible pollution of soil resources. The areas of potentially compacted soil is also increasing.

12. Soil, land use and land capability management plan

The purpose of the Soil Management Plan (SMP) is to ensure the protection of soils and maintenance of the terrain of the Matai Mining Project footprint during the construction, operations, decommissioning and closure phases. The plan contains methods that will be used to prevent adverse effects as well as a monitoring plan to assess potential effects during construction, operation, decommissioning and closure.

The objectives of the SMP are to:

- Address the prevention, minimisation and management of erosion, compaction and chemical soil pollution during construction, operations, decommissioning and closure;
- Describe soil stripping and stockpiling methods that will reduce the loss of topsoil;
- Define requirements and procedures to guide the Project Management Team and other project contractors;
- Define monitoring procedures.

12.1 Soil management during the construction phase

From the perspective of conserving the soil properties that will aid rehabilitation during the closure phase, the key factors to consider during the preparation for the construction phase of the supporting infrastructure are to minimise the area affected by the development, minimise potential future contact of toxic or polluting materials with the soil environment and to maximise the recovery and effective storage of soil material that will be most useful during the rehabilitation process after operation of the opencast mine is completed. Some of these measures will minimise a combination of impacts simultaneously while other measures are specific to one impact.

12.1.1 Minimise the footprint of the Matai Mining Project

The existing pre-construction mine layout and design is aiming to minimise the area to be occupied by mine infrastructure (workshops, administration, product stockpile, etc.) to as small as practically possible. All footprint areas should also be clearly defined and demarcated and edge effects beyond these areas clearly defined. This measure will significantly reduce areas to be compacted by heavy construction vehicles and regular activities during the operational phase.

12.1.2 Management and supervision of construction teams

The activities of construction contractors or employees will be restricted to the planned areas. Instructions must be included in contracts that will restrict construction work and construction workers to the clearly defined limits of the construction site. In addition, compliance to these instructions must be monitored.

12.1.3 Location of stockpiles

Locate all soil stockpiles in areas where they will not have to be relocated prior to replacement for final rehabilitation. Refrain from locating stockpiles as close as possible to the development for cost saving only to have them relocated later during the life of the operation. The ideal is to place all overburden materials removed during construction in their final closure location, or as close as practicable to it.

12.1.4 Topsoil stripping

Wherever possible, stripping and replacing of soils should be done in a single action. This is both to reduce compaction and also to increase the viability of the seed bank contained in the stripped surface soil horizons.

Stripping should be conducted a suitable distance ahead of development of, for example the open pit, at all times to avoid loss and contamination. As a norm, soil stripping should be kept within 3-9 months of development, or between 50-100 metres ahead of the active operations.

12.1.5 Stockpiling of topsoil

To minimise compaction associated with stockpile creation, it is recommended that the height of stockpiles be restricted between of 4 – 5 metres maximum. For extra stability and erosion protection, the stockpiles may be benched. The clay content of the topsoil on the largest area of the Matai Mining project area is not sufficient for stockpiles to remain relatively stable without benching. The areas on the Arcadia soil form do have sufficient clay content.

12.1.6 Demarcation of topsoil stockpiles

Ensure all topsoil stockpiles are clearly and permanently demarcated and located in defined no-go areas. As the operations will last over several years it is important to have well defined maps of stockpile locations that correlate with these demarcated areas as re-vegetated stockpiles may easily be mistaken for something else. These areas should be maintained for rehabilitation purposes and topsoil should never be used as a filling material for ramps, etc.

12.1.7 Prevention of stockpile contamination

Topsoil stockpiles can be contaminated by dumping waste materials next to or on the stockpiles, contamination by dust from blasting and waste rock stockpiles and the dampening for dust control with contaminated water are all hazards faced by stockpiles. This should be avoided at all cost and if it occurs, should be cleaned up immediately.

12.1.8 Terrain stability to minimise erosion potential

Management of the terrain for stability by using the following measures will reduce the risk of erosion significantly:

- Using appropriate methods of excavating that are in accordance with regulatory requirements and industrial best practices procedures;
- Reducing slope gradients as far as possible along road cuts and disturbed areas to gradients at or below the angle of repose of those disturbed surfaces; and
- Using drainage control measures and culverts to manage the natural flow of surface runoff.

12.1.9 Management of access and service roads

Existing established roads should be used wherever possible. Where possible, roads that will carry heavy-duty traffic should be designed in areas previously disturbed rather than clearing new areas, where possible. The moisture content of access road surface layers must be maintained through routine spraying or the use of an appropriate dust suppressant.

Access roads should be designed with a camber to avoid ponding and to encourage drainage to side drains; where necessary, culverts will be installed to permit free drainage of existing water courses. The side drains on the roads can be protected with sediment traps and/or gabions to reduce the erosive velocity of water during storm events and where necessary geo-membrane lining can be used.

12.1.10 Prevention of soil contamination

During the construction phase, chemical soil pollution should be minimised as follows:

- Losses of fuel and lubricants from the oil sumps and steering racks of vehicles and equipment should be contained by using a drip tray with plastic sheeting filled with absorbent material;
- Using biodegradable hydraulic fluids, using lined sumps for collection of hydraulic fluids, recovering contaminated soils and treating them off-site, and securely storing dried waste mud by burying it in a purpose-built containment area;
- Avoiding waste disposal at the site wherever possible, by segregating, trucking out, and recycling waste;
- Containing potentially contaminating fluids and other wastes; and
- Cleaning up areas of spillage of potentially contaminating liquids and solids.

12.2 Soil management during the operational phase

Soil management should be an on-going strategy through the operational phase as soil disturbing activities will continue in areas where operation of the mine continues and new areas are developed through operation activities.

It is recommended that concurrent rehabilitation techniques be followed to prevent topsoil from being stockpiled too long and losing its inherent fertility but opportunities may be limited by the layout of the operation. Disturbed sites must be rehabilitated as soon as they have reached the end of their life. During operations, soil will continue to be removed from newly developed areas and stockpiled for later use. Topsoil stripping and stockpiling should follow the guidelines as stipulated under the construction phase above.

As new stockpiles are created, they should be re-vegetated immediately to prevent erosion and resulting soil losses from these stockpiles. It is recommended that vegetation removed during land clearance be composted during the operational phase and that this compost be used as a soil ameliorant for soil rehabilitation purposes.

All above soil management measures explained under the Construction Phase should be maintained for similar activities during the Operational Phase. In addition to this, the following Soil Management Measures are recommended:

- The vegetative (grass) cover on the soil stockpiles (berms) must be continually monitored in order to maintain a high basal cover. Such maintenance will limit soil erosion by both the mediums of water (runoff) and wind (dust).
- Drains and intercept drains must be maintained so that they continue to redirect clean water away from the operating areas, and to convey any potentially polluted water to pollution control dams.
- Routine monitoring will be required in and around the sites.

12.2.1 Management of potential soil contamination during the operational phase

The following management measures will either prevent or significantly reduce the impact of soil chemical pollution on site during the operation phase:

- Stockpiles are managed so they do not become contaminated and then need additional handling or disposal;
- A low process or storage inventory must be held to reduce the potential volume of material that could be accidentally released or spilled;
- Processing areas should be contained and systems designed to effectively manage and dispose of contained storm water, effluent and solids;
- Storage tanks of fuels, oils or other chemicals stored are above ground, preferably with inspectable bottoms, or with bases designed to minimise corrosion. Above-ground (rather than in-ground) piping systems should be provided. Containment bunds should be sealed to prevent spills contaminating the soil and groundwater;
- Equipment, and vehicle maintenance and washdown areas, are contained and appropriate means provided for treating and disposing of liquids and solids;
- Air pollution control systems avoid release of fines to the ground (such as dust from dust collectors or slurry from scrubbing systems);

- Solids and slurries are disposed of in a manner consistent with the nature of the material and avoids contamination; and
- Effluent and processing drainage systems avoid leakage to ground.

12.3 Soil management during the decommissioning phase

At decommissioning any excavated areas will be backfilled and covered with a layer of topsoil. Some re-grading and re-contouring will be carried out. Soil management in the decommissioning phase will include the following:

12.3.1 Management and supervision of decommissioning teams

The activities of decommissioning contractors or employees will be restricted to the planned areas. Instructions must be included in contracts that will restrict decommissioning workers to the areas demarcated for decommissioning. In addition, compliance to these instructions must be monitored.

12.3.2 Infrastructure removal

All buildings, structures and foundations not part of the post-closure land use plan must be demolished and removed from site.

12.3.3 Site preparation

Once the site has been cleared of infrastructure and potential contamination, the slope must be re-graded (sloped) in order to approximate the pre-project aspect and contours. The previous infrastructure footprint area must be ripped a number of times in order to reduce soil compaction. The area must then be covered with topsoil material from the stockpiles.

12.3.4 Seeding and re-vegetation

Once the land has been prepared, seeding and re-vegetation will contribute to establishing a vegetative cover on disturbed soil as a means to control erosion and to restore disturbed areas to beneficial uses as quickly as possible. The vegetative cover reduces erosion potential, slows down runoff velocities, physically binds soil with roots and reduces water loss through evapotranspiration. Indigenous species will be used for the re-vegetation, the exact species will be chosen based on research available and then experience as the further areas are re-vegetated.

12.3.5 Prevention of soil contamination

During the decommissioning phase, chemical soil pollution should be minimised as follows:

Losses of fuel and lubricants from the oil sumps of vehicles and equipment should be contained using a drip tray with plastic sheeting and filled with absorbent material;

- Using biodegradable hydraulic fluids, using lined sumps for collection of hydraulic fluids and recovering contaminated soils and treating them off-site;
- Avoiding waste disposal at the site wherever possible, by segregating, trucking out, and recycling waste;
- Containing potentially contaminating fluids and other wastes; and
- Cleaning up areas of spillage of potentially contaminating liquids and solids.

12.4 Soil management during the closure phase

During the closure phase activities include the maintenance and aftercare of final rehabilitated land. In this regard, frequent visual observations should be undertaken to confirm if vegetation has re-established and if any erosion gullies have developed. In the event that vegetation has not re-established and erosion gullies have developed, remedial action should be taken.

13 Consideration of alternatives

A project alternative that is mentioned in the Scoping Report (September 2018) indicates that underground mining is considered an alternative. Underground mining of the mineral resources will result in significantly fewer and less severe impacts associated with soil, land capability and agricultural potential. Underground mining is considered a much less intrusive disturbance to the current soil properties and the associated functionality and therefore the preferred alternative.

14 Reasoned opinion

The proposed Matai Mining Project surface infrastructure and open pit will be located on a combination of deep red Hutton soil and vertic Arcadia soil. These soil forms have arable agricultural potential and portions of this land has previously been cultivated. Currently, it is covered in natural vegetation and used for cattle grazing.

The proposed project will have a range of soil and land capability impacts that ranges from low to high. Cumulative impacts are related to an increase in the loss of land with arable land capability as well as increased areas of soil compaction, soil pollution risk and soil erosion risk. These impacts can be reduced by keeping the footprints minimised where possible and strictly following soil management measures pertaining to erosion control and management and monitoring of any possible soil pollution sources such as vehicles traversing over the sites. No layout alternatives were provided for consideration.

The proposed Matai Mining Project falls within a larger area where there are existing mining developments, power lines and human settlements in between agricultural areas. The proposed project will cause land disturbance in order to be able to get access to the mineral resources and create employment opportunities as such.

It is therefore of my opinion that the proposed project is acceptable permitting that soil management guidelines be followed strictly and that the land be rehabilitated to a state as close as possible to pre-mining conditions. It follows that the recommendations and monitoring requirements as set out in this report should form part of the conditions of the environmental authorisation for the proposed project.

15 Reference list

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Appendix 1 – Laboratory analyses sheet

NOORDWES UNIVERSITEIT
ECO-ANALYTICA

Eco Analytica
Posbus 19140
NOORDBRUG 2522
Tel: 018-285 2732/3/4

TERRA AFRICA (MATAI PROJECT)

17/1/2019 **Nutritional status**

Sample no.	Ca	Mg	K	Na	P	pH(KCl)
	(mg/kg)					
1 Top	1614,9	326,3	265,3	8,2	65,4	5,08
2 Sub	2053,2	397,4	85,6	9,6	27,5	5,00
3 Top	10502,8	949,0	199,6	17,7	13,1	5,60
4 Sub	16652,6	1102,5	149,5	114,6	8,4	5,97
5 Top	1305,0	237,3	135,2	5,9	56,6	5,30
6 Sub	1534,5	285,8	62,4	10,6	55,0	4,91
7 Top	1134,4	241,7	80,1	8,3	23,6	4,73
8 Top	22408,3	983,3	222,7	204,0	6,0	6,09

Exchangeable cations

Sample no.	Ca	Mg	K	Na	S-value	LOI
	(cmol(+)/kg)					%C
1 Top	8,06	2,69	0,68	0,04	11,46	1,58
2 Sub	10,25	3,27	0,22	0,04	13,78	1,81
3 Top	52,41	7,81	0,51	0,08	60,81	2,57
4 Sub	83,10	9,07	0,38	0,50	93,05	2,62
5 Top	6,51	1,95	0,35	0,03	8,84	1,50
6 Sub	7,66	2,35	0,16	0,05	10,22	1,64
7 Top	5,66	1,99	0,21	0,04	7,89	1,44
8 Top	111,82	8,09	0,57	0,89	121,37	3,42

Cation ratios

Sample	Ca:Mg	Mg:K	Ca+Mg:K	K%	Ca%	Mg%	Na%
1 Top	3,00	3,95	15,79	5,94	70,32	23,43	0,31
2 Sub	3,13	14,90	61,59	1,59	74,37	23,74	0,30
3 Top	6,71	15,26	117,66	0,84	86,19	12,84	0,13
4 Sub	9,16	23,67	240,41	0,41	89,30	9,75	0,54
5 Top	3,33	5,63	24,41	3,92	73,68	22,10	0,29
6 Sub	3,26	14,71	62,60	1,57	74,96	23,02	0,45
7 Top	2,85	9,69	37,27	2,60	71,73	25,21	0,46
8 Top	13,82	14,17	209,99	0,47	92,13	6,67	0,73

"HANDBOOK OF STANDARD SOIL TESTING METHODS FOR ADVISORY PURPOSE

UITRUILBARE KATIONE:	1 M NH_4-asetaat pH=7	FOSFAAT:	Bray 1 - Ek
KUK:	1 M NH_4-asetaat pH=7	pH H_2O/KCl:	1:2,5 - Ekst
		EG:	Versadigde

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TERRA AFRICA (MATAI)

17/1/2019

Particle Size Distribution

Sample no.	> 2mm (%)	Sand	Silt	Clay
		(% < 2mm)		
1 Top	1,6	66,9	14,1	19,1
2 Sub	1,6	53,5	10,0	36,5
3 Top	0,4	40,9	16,6	42,5
4 Sub	1,1	33,5	17,0	49,5
5 Top	1,1	72,9	13,5	13,6
6 Sub	2,6	63,1	9,5	27,4
7 Top	3,9	77,1	6,6	16,3
8 Top	5,8	44,5	23,2	32,3

Ten einde betroubaarheid van analises te verseker, neem Eco-Analytica deel aan die volgende instansies se kontroleske

International Soil-Analytical Exchange (ISE), Wageningen, Nederland

Geen verantwoordelikheid word egter deur Noordwes Universiteit aanvaar vir enige verliese wat uit die gebruik van hierdie data ma

APPENDIX 2 - CURRICULUM VITAE OF SPECIALIST (Mariné Pienaar)

- **Personal Details**

  Last name: **Pienaar**
  First name: **Mariné**
  Nationality: **South African**
  Employment: **Self-employed (Consultant)**

- **Contact Details**

  Email address: mpienaar@terraafrica.co.za
  Website: **www.terraafrica.co.za**
  Mailing address: **PO Box 433, Ottosdal, 2610**
  Telephone: **+27828283587**
  Address: **57 Kruger Street, Wolmaransstad, 2630, Republic of South Africa**
  Current Job: **Lead Consultant and Owner of Terra Africa Consult**

- **Concise biography**

Mariné Pienaar is a professionally registered soil- and agricultural scientist (SACNASP) who has consulted extensively for the past eleven years in the fields of soil, land use and agriculture in several African countries. These countries include South Africa, Liberia, Ghana, DRC, Mozambique, Botswana, Angola, Swaziland and Malawi. She has worked with mining houses, environmental consulting companies, Eskom, government departments as well as legal and engineering firms. She conducted more than three hundred specialist studies that included baseline soil assessment and rehabilitation planning for new projects or expansion of existing projects, soil quality monitoring, land rehabilitation assessment and monitoring, natural resource assessment as part of agricultural project planning, evaluation and development of sustainable agriculture practices, land use assessment and livelihood restoration planning as part of resettlement projects and land contamination risk assessments. She holds a BSc. Agriculture degree with specialisation in Plant Production and Soil Science from the University of Pretoria and a MSc in Environmental Science from the University of the Witwatersrand. In addition to this, she has attended a number of courses in Europe, the USA and Israel in addition to those attended in South Africa. Mariné is a contributing author of a report on the balance of natural resources between the mining industry and agriculture in South Africa (published by the Bureau for Food and Agricultural Policy, 2015).

- **Qualifications**

  Academic Qualifications:

  - **MSc Environmental Science**; University of Witwatersrand, South Africa, 2017
  - **BSc (Agric) Plant Production and Soil Science;** University of Pretoria, South Africa, 2004
  - **Senior Certificate / Matric;** Wolmaransstad High School, South Africa, 2000

  Courses Completed:

- **World Soils and their Assessment;** ISRIC – World Soil Information, Wageningen, 2015
- **Intensive Agriculture in Arid- and Semi-Arid Environments** – Gilat Research Centre, Israel, 2015
- **Hydrus Modelling of Soil-Water-Leachate Movement;** University of KwaZulu-Natal, South Africa, 2010
- **Global Sustainability Summer School 2012;** Institute for Advanced Sustainability Studies, Potsdam, Germany, 2012
- **Wetland Rehabilitation;** University of Pretoria, South Africa, 2008
- **Enviropreneurship Institute;** Property and Environment Research Centre [PERC], Montana, U.S.A., 2011
- **Youth Encounter on Sustainability;** ACTIS Education [official spin-off of ETH Zürich], Switzerland, 2011
- **Environmental Impact Assessment │Environmental Management Systems – ISO 14001:2004 │Environmental Law;** University of Potchefstroom, South Africa, 2008
- **Carbon Footprint Analyst Level 1;** Global Carbon Exchange Assessed, 2011
- **Negotiation of Financial Transactions;** United Nations Institute for Training and Research, 2011
- **Food Security: Can Trade and Investment Improve it?** United Nations Institute for Training and Research, 2011

- **Language ability**

Perfectly fluent in English and Afrikaans (native speaker of both) and conversant in French.

- **Professional Experience**

Name of firm	Terra Africa Environmental Consultants
Designation	Owner | Principal Consultant
Period of work	December 2008 to Date

- **Prior Tenures**

Integrated Development Expertise (Pty) Ltd; **Junior Land Use Consultant** [July 2006 to October 2008]
Omnia Fertilizer (Pty) Ltd; **Horticulturist and Extension Specialist** [January 2005 to June 2006]

- **Professional Affiliations**

- South African Council for Natural Scientific Professions [SACNASP]
- Soil Science Society of South Africa [SSSA]
- Soil Science Society of America
- South African Soil Surveyors' Organisation [SASSO]
- International Society for Sustainability Professionals [ISSP]

Summary of a selected number of projects completed successfully:

[Comprehensive project dossier available on request]

1. *Sekoko Railway Alignment and Siding Soil, Land Use and Capability Study* in close proximity to the Medupi Power Station in the Lephalale area, Limpopo Province.

2. *Italthai Rail and Port Projects, Mozambique* – The study included a thorough assessment of the current land use practices in the proposed development areas

including subsistence crop production and fishing as well as livestock farming and forestry activities. All the land uses were mapped and intrinsically linked to the different soil types and associated land capabilities. This study was used to develop Livelihood Restoration Planning from.

3. *Bomi Hills Railway Alignment Project, Liberia:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, as well as associated infrastructure upgrades of the port, road and railway.

4. *Kingston Vale Waste Facility, Mpumalanga Province, South Africa*: Soil and vegetation monitoring to determine the risk of manganese pollution resulting from activities at the waste facility.

5. *Keaton Mining's Vanggatfontein Colliery, Mpumalanga*: Assessment of soil contamination levels in the mining area, stockpiles as well as surrounding areas as part of a long-term monitoring strategy and rehabilitation plan.

6. *Richards Bay Minerals, KwaZulu-Natal*: Contaminated land assessment of community vegetable gardens outside Richards Bay as a result of spillages from pipelines of Rio Tinto's Richards Bay Minerals Mine.

7. *Buffelsfontein Gold Mine, Northwest Province, South Africa:* Soil and land contamination risk assessment for as part of a mine closure application. Propose soil restoration strategies.

8. Glenover Phosphate Mining Project near Steenbokpan in the Lephalale area – Soil, Land Use and Land Capability Study as part of the environmental authorisation process.

9. *Waterberg Coal 3 and 4 Soil, Land Use and Land Capability Study* on 23 000 ha of land around Steenbokpan in the Lephalale area.

10. *Lesotho Highlands Development Agency, development of Phase II (Polihali Dam and associated infrastructure)*: External review and editing of the initial Soil, Land Use and Land Capability Assessment as requested by ERM Southern Africa.

11. *Tina Falls Hydropower Project, Eastern Cape , South Africa*: Soil, land use and land capability assessment as part of the ESIA for the construction of a hydropower plant at the Tina Falls.
12. *Graveyard relocation as part of Exxaro Coal's Belfast Resettlement Action Plan*: Soil assessment to determine pedohydrological properties of the relocation area in order to minimise soil pollution caused by graveyards.

13. *Rhino Oil Resources: Strategic high-level soil, land use and land capability assessment of five proposed regions to be explored for shale gas resources in the KwaZulu-Natal, Eastern Cape, North-West and Free State provinces of South Africa.*

14. *Eskom Kimberley Strengthening Phase 4 Projec*t, Northern Cape & Free State, South Africa: soil, agricultural potential and land capability assessment.

15. *Mocuba Solar Project, Mozambique* – The study included a land use assessment together with that of the soil and land capabilities of the study area. All current land uses were documented and mapped and the land productivity was determined. This study advocated the resettlement and livelihood restoration planning.

16. *Botswana (Limpopo-Lipadi Game Reserve).* Soil research study on 36 000 ha on the banks of the Limpopo River. This soil study forms part of an environmental management plan for the Limpopo-Lipadi Game Reserve situated here as well as the basis for the Environmental Impact Assessment for the development of lodges and Land Use Management in this area.

17. *TFM Mining Operations [proposed] Integrated Development Zone, Katanga, DRC* [part of mining concession between Tenke and Fungurume]: soil and agricultural impact assessment study.

18. *Closure Strategy Development for Techmina Mining Company – Lucapa, Angola.* Conducted an analysis of the natural resources (soil, water) to determine the existing environmental conditions on an opencast diamond mine in Angola. The mine currently experience severe problems with kimberlite sediment flowing into the river. A plan is currently being developed to change the mining area into a sustainable bamboo farming operation.

19. *Closure of sand mining operations, Zeerust District.* Succesfully conducted the closure application of the Roos Family Sand Mine in the Zeerust District. Land Use Management Plans for rehabilitated soil were developed. The mine has closed now and the financial provision has been paid out to the applicant.

20. *ESIA for [proposed] Musonoi Mine, Kolwezi area, Katanga, DRC:* soil, land use and land capability assessment.

21. *Bauba A Hlabirwa Moeijelik Platinum mine [proposed] project, Mpumalanga, South Africa:* soil, land use and land capability assessment and impact on agricultural potential of soil.

22. *Commissiekraal Coal Mine [proposed] project, KwaZulu*-Natal, South Africa: sustainable soil management plans, assessment of natural resource and agricultural potential and study of the possible impacts of the proposed project on current land use. Soil conservation strategies included in soil management plan.

23. *Cronimet Chrome Mine [proposed] project, Limpopo Province, South Africa:* soil, land use and land capability of project area and assessment of the impacts of the proposed project.
24. *Moonlight Iron Ore Land Use Assessment, South Africa* – Conducted a comprehensive land use assessment that included interviews with land users in the direct and indirect project zones of influence. The study considered all other anticipated social and environmental impacts such as water, air quality and noise and

this was incorporated into a sensitivity analysis of all land users to the proposed project.

25. *Project Fairway Land Use Assessment, South Africa* – The study included an analysis of all land users that will directly and indirectly be influenced by the project. It analysed the components of their land uses and how this components will be affected by the proposed project. Part of the study was to develop mitigation measures to reduce the impact on the land users.

26. *Bekkersdal Urban Renewal Project – Farmer Support Programme,* Independent consultation on the farmer support programme that forms part of Bekkersdal Renewal Project. This entailed the production of short and long term business plans based on soil and water research conducted. Part of responsibilities were the evaluation of current irrigation systems and calculation of potential water needs, etc. as well as determining quantities and prices of all project items to facilitate the formalisation of tender documents.

27. *Area-based agricultural business plans for municipalities in Dr. Kenneth Kaunda Municipal District.* Evaluation of the agricultural and environmental status of the total district as well as for each municipality within the district. This included the critical evaluation of current agricultural projects in the area. The writing of sustainable, executable agricultural business plans for different agricultural enterprises to form part of the land reform plans of each Municipality within the district.

28. *Batsamaya Mmogo, Hartswater.* Conducted a soil and water assessment for the farm and compiled management and farming plans for boergoats grazing on *Sericea lespedeza* with pecan nuts and lucerne under irrigation.

29. *Anglo Platinum Twickenham Mine – Irrigated Cotton Project.* Project management of an irrigated cotton production project for Twickenham Platinum Mine. This project will ensure that the community benefit from the excess water that is available from the mine activities.

30. *Grasvally Chrome (Pty) Ltd Sylvania Platinum [proposed] Project, Limpopo Province, South Africa:* Soil, land use and agricultural potential assessment.

31. *Jeanette Gold mine project [reviving of historical mine], Free State, South Africa:* Soil, land use and agricultural potential assessment.

32. *Kangra Coal Project, Mpumalanga, South Africa:* Soil conservation strategies proposed to mitigate the impact of the project on the soil and agricultural potential.

33. *Richards Bay Integrated Development Zone Project, South Africa* [future development includes an additional 1500 ha of land into industrial areas on the fringes of Richards Bay]: natural resource and agricultural potential assessment, including soil, water and vegetation.

34. *Exxaro Belfast Coal Mine [proposed] infrastructure development projects* [linear: road and railway upgrade | site-specific coal loading facilities]: soil, land capability and agricultural potential assessment.

35. *Marikana In-Pit Rehabilitation Project of Aquarius Platinum, South Africa:* soil, land capability and land use assessment.
36. *Eskom Bighorn Substation proposed upgrades, South Africa:* soil, land capability and agricultural potential assessment.

37. *Exxaro Leeuwpan Coal Mining Right Area, South Africa:* consolidation of all existing soil and agricultural potential data. Conducted new surveys and identified and updated gaps in historic data sets.

38. *Banro Namoya Mining Operation, DRC:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, including proposed project extension areas and progressive soil and land use rehabilitation plan.

39. *Kumba Iron Ore's Sishen Mine, Northern Cape, South Africa: soil, land use and agricultural scientist | Western Waste Rock Dumps [proposed] Project:* soil, land use and agricultural potential assessment, including recommendations regarding stripping/stockpiling and alternative uses for the large calcrete resources available.

40. *Vetlaagte Solar Development Project, De Aar, South Africa:* soil, land use and agricultural scientist. Soil, land use and agricultural potential assessment for proposed new 1500 ha solar development project, including soil management plan.