SOIL, LAND USE AND LAND CAPABILITY ASSESSMENT AS PART OF THE ENVIRONMENTAL IMPACT ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED KANAKIES GYPSUM MINE, NEAR LOERIESFONTEIN, NORTHERN CAPE

Prepared for

Cabanga Environmental

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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a soil, land use and land capability assessment as part of the environmental impact assessment and authorisation process for the proposed Kanakies mining of Gypsum over Portion 0 (the Remaining Extent), Kanakies 332, near Loeriesfontein, Northern Cape. Of the overall mining right area (MRA), approximately 700 Ha will be affected by mining and related activities, henceforth referred to as the "focus area".

From this assessment, it was found that grazing is the dominant land use within the focus area, with no cultivated agricultural production occurring in the surrounding areas. The proposed mining areas and associated infrastructure are largely dominated by soils such as Kimberly (Ky)/ Plooysburg (Py) with an average effective rooting depth of 300 mm due to the layer of refusal as a result of limited weathering of parent material attributable to rainfall constraints. Glenrosa (Gs) and Mispah (Ms) also occur in the south western corner of the focus area associated with water flow paths. Witbank (Wb) soil forms (anthrosols) were also observed within the focus area, and these included railways, tar roads/gravel roads with highly disturbed topsoil material. The areal extent of disturbed soils is 41.21 ha which is 3.08% of the total investigated focus area. The table below summarises the soils occurring within the focus area and their respective land capability.

Land capability classes for soil forms identified with the proposed mining sites

Land Capability	Soil Forms	Areal Extent (ha)	Percentage (%)
Grazing - Class VI	Kimberly, Plooysburg	1268.86	94.76
Grazing – Class VII	Glenrosa (Gs) and Mispah (Ms)	28.50	2.13
Wildlife/Wilderness (class VIII)	Witbank (Wb)	41.21	3.08
Other	Property	0.43	0.03

***The percentages were rounded off to two (2) decimal places**

From a land capability point of view, the focus area is comprised of soils with low agricultural potential. At best, the soils within the focus area are suitable for grazing. The very low rainfall in the area infers that the only means of cultivation would be by irrigation. However, based on observation and digital satellite imagery of the area there are no signs of irrigation infrastructure, only water reservoirs for wildlife and limited livestock were observed. In addition to that, high temperatures occurring in this area are also likely to cause crop wilting, thus affecting crop yield. Given these constraints the extent of the high productivity soils is not considered sufficient for viable commercial crop farming. The climatic restrictions and shallowness of the soil mean that the area where the Mining Right Area occurs is best suited for grazing and grazing capacity is low, where the proposed mining is to occur. Commercial farming is considered to be low for the proposed area extent to be affected by mining activities, due to the grazing capacity mentioned above. Therefore, although the proposed area is dominated by soils with a land capability suitable for grazing, it is not considered sufficient for viable small scale commercial farming. Below is the summary of the impact assessment for the proposed mining sites.

Impact 1: Soil erosion

Summary table of the overall impacts for the proposed mining

Phase	Unmanaged	Managed
Construction phase	Medium-low	Low
Operational phase	Medium-low	Low
Decommissioning Phase	Medium-low	Low

Impact 2: Soil compaction

Summary of impacts associated with soil compaction

Impact	Unmanaged	Managed
Construction phase	Medium-low	Low
Operational phase	Medium-low	Low
Decommissioning Phase	Medium-low	Low

Impact 3: Potential Soil Contamination

Summary of impacts associated with potential soil contamination

Phase	Unmanaged	Managed
Construction phase	Medium-low	Low
Operational phase	Medium-low	Low
Decommissioning Phase	Medium-low	Low

Impact 4: Loss of agricultural land capability

Summary table of the overall impacts for the proposed mining

Impact	Unmanaged	Managed
Construction phase	Medium low	Low
Operational phase	Medium low	Low
Decommissioning Phase	Medium-low	Low

From the findings of this assessment and the proposed mitigation measures outlined in this report, it can be concluded that the anticipated impacts of the proposed mining project on the soil resources and the associated land capability can be reduced to a low level with appropriate mitigation. The proposed mining project is not considered to have significant negative impacts from the soil, land capability and agricultural potential point of view, however it will have a positive impact for the agricultural sector of the region, since the project will ensure that there is adequate supply of gypsum material to ameliorate acidic soils. It must however be noted that the proposed mitigation measures must be integrated in the project execution and implemented accordingly, to minimise cumulative impacts on the soils, and to maintain their current land capability for future land use. It is the opinion of the specialist that this study provides the relevant information required for the Environmental Impact Assessment phase of the project to ensure that the best long-term use of the agricultural resources in the focus area will be made in support of the principle of sustainable development.

DOCUMENT GUIDE

The table below provides the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA) Regulations 2017 (as amended in 2014) for Specialist Reports and also the relevant sections in the reports where these requirements are addressed.

NEMA Regulations (2017) - Appendix 6	Relevant section in report
(1) A specialist report prepared in terms of these Regulations must contain -	
(a) details of -	
(i) the specialist who prepared the report; and	Appendix B
(ii) the expertise of that specialist to compile a specialist report, including a curriculum vitae;	Appendix B
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix B
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.1
(cA) an indication of the quality and age of base data used for the specialist report;	Section 3
(cB) a description of existing impacts on site, cumulative impacts of the proposed development and levels of acceptable change;	Section 5
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 2.3
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 2
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying alternatives;	Section 4
(g) an identification of any areas to be avoided, including buffers;	Section 4.3
(h) a map superimposing the activity, including the associated structures and infrastructure on the environmental sensitivities of the site, including areas to be avoided, including buffers;	Section 4.3
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.3
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment or activities;	Section 4, 5, and 6
(k) any mitigation measures for inclusion in the EMPr;	Section 5.1
(l) any conditions for inclusion in the environmental authorisation;	None
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	None
(n) a reasoned opinion -	
(i) as to whether the proposed activity, activities or portions thereof should be authorised;	Section 5 and 6
(iA) regarding the acceptability of the proposed activity or activities; and	Section 6
(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 5 and 6
(o) a description of any consultation process that was undertaken during the course of preparing the specialist report	Section 5.2
(p) a summary and copies, if any, comments received during any consultation process and, where applicable all responses thereto; and	Section 5.2.1
(q) any other information requested by the competent authority.	No other information requested

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GLOSSARY OF TERMS

Chromic:	Having within ≤150 cm of the soil surface, a subsurface layer ≥30 cm thick, that has a Munsell colour hue redder than 7.5YR, moist.
Ferralic:	Having a ferralic horizon starting ≤150 cm of the soil surface.
Ferralic horizon:	A subsurface horizon resulting from long and intense weathering, with a clay fraction that is dominated by low-activity clays and contains various amounts of resistant minerals such as Fe, Al, and/or Mn hydroxides.
Lithic:	Having continuous rock or technic hard material starting ≤10 cm from the soil surface.
Salinity:	High Sodium Adsorption Ratio (SAR) above 15% are indicative of saline soils. The dominance of Sodium (Na) cations in relation to other cations tends to cause soil dispersion (deflocculation), which increases susceptibility to erosion under intense rainfall events.
Sodicity:	High exchangeable sodium Percentage (ESP) values above 15% are indicative of sodic soils. Similarly, the soil dispersion.

1. INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to conduct a soil, land use and land capability assessment as part of the environmental impact assessment and authorisation process for the proposed Kanakies Mining Project over Portion 0 (the Remaining Extent), Kanakies 332, near Loeriesfontein, Northern Cape. The proposed mining right area comprises a total area of 7,456.70 hectares. Of the overall Mining Right Area, approximately 689 ha will be earmarked for mining, whilst a further 9 ha will be affected by surface infrastructure. Thus, a boundary was created around these areas, and this was henceforth referred to as the “focus area” (Figure 1 and 2).

The proposed mining area is located approximately 45km east-south-east of the town of Loeriesfontein and 40km north-north-west of the town of Nieuwoudtville, within the Northern Cape Province.

Agricultural potential is directly correlated to Land Capability Class (LCC), measured on a scale of I to VIII, with classes I to III considered as prime agricultural land, and classes V to VIII not suitable for cultivation. High potential agricultural land is defined as having “*the soil and terrain quality, growing season and adequate available moisture supply to sustain crop production when treated and managed according to best possible farming practices*” (Land Capability report, ARC, 2006). High agricultural potential land is a scarce non-renewable resource, which necessitates an Agricultural Potential assessment prior to land development, particularly for purposes other than agricultural land use which will affect extensive tracts of land, as per Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983).

A soil and land capability survey was conducted from 31 January to 02 February 2018. This date of assessment is acceptable since seasonality has no bearing on the accuracy of land use and land capability assessments. The assessment entailed evaluating physical soil properties and current limitations to various land use purposes. Subsurface soil observations were made using a manual hand auger to assess individual soil profiles.

1.1 Project Overview

Below is a summary description of what the proposed project will entail:

Mineral: Gypsum

Mining Method: Surface trench mining

Depth of Mining: 1.4 – 2.5 metres

Life of Mine: 30 years plus

Product: Agricultural and Industrial Markets

The deposit consists of 2 layers of gypsum i.e. a powder layer and nodular crystalline (clay) layer of gypsum.

1.2 Terms of Reference and Scope of Work

The EIA phase of the soil and land capability assessment entailed the following aspects:

- A desktop review of existing land type maps, to establish broad baseline conditions and areas of environmental sensitivity and sensitive agricultural areas;
- Assess spatial distribution of various soil types within the focus area;
- Identify restrictive soil properties on land capability under prevailing conditions;
- Compile various maps depicting the on-site conditions, soil types and land capability based on desktop review of existing data;
- A soil classification survey will be conducted within the focus area;
- Subsurface soil observations and sampling undertaken by means of a manual bucket hand auger;
- Classify the dominant soil types according to the South African Soil Classification System (Soil Classification Working Group, 1991);
- Compile a report presenting the results of the desktop study and a description of the findings during the field assessment; and
- Provide recommended mitigation measures and management practices to implement in order to comply with applicable legislations.

1.3 Assumptions and Limitations

For the purpose of this assessment, the following assumptions and limitations are applicable:

- The soil survey conducted as part of the land capability assessment was confined within the focus area, which is considered adequate for the purpose of this investigation;
- Sampling by definition means that not all areas are assessed, and therefore some aspects of soil and land capability may have been overlooked in this assessment. However, it is the opinion of the specialist that this assessment was carried out with sufficient sampling and in sufficient detail to enable the proponent, the Environmental Assessment Practitioner (EAP) and the regulating authorities to make an informed decision regarding the proposed mining activities;
- Land Capability was classified according to current soil restrictions, with respect to prevailing climatic conditions on site; however, it is virtually impossible to achieve 100%

purity in soil mapping, the delineated soil map units could include other soil type(s) as the boundaries between the mapped soils are not absolute but rather form a continuum and gradually change from one type to another. Soil mapping and the findings of this assessment were therefore inferred from extrapolations from individual observation points;

- Since soils occur in a continuum with infinite variances, it is often problematic to classify any given soils as one form, or another. for this reason, the classifications presented in this report are based on the "best fit" to the soil classification system of South Africa; and
- Soil fertility status was not considered a limitation, seeing as inherent nutrient deficiencies and/or toxicities would be rectified by appropriate liming and/or fertilization prior to cultivation.

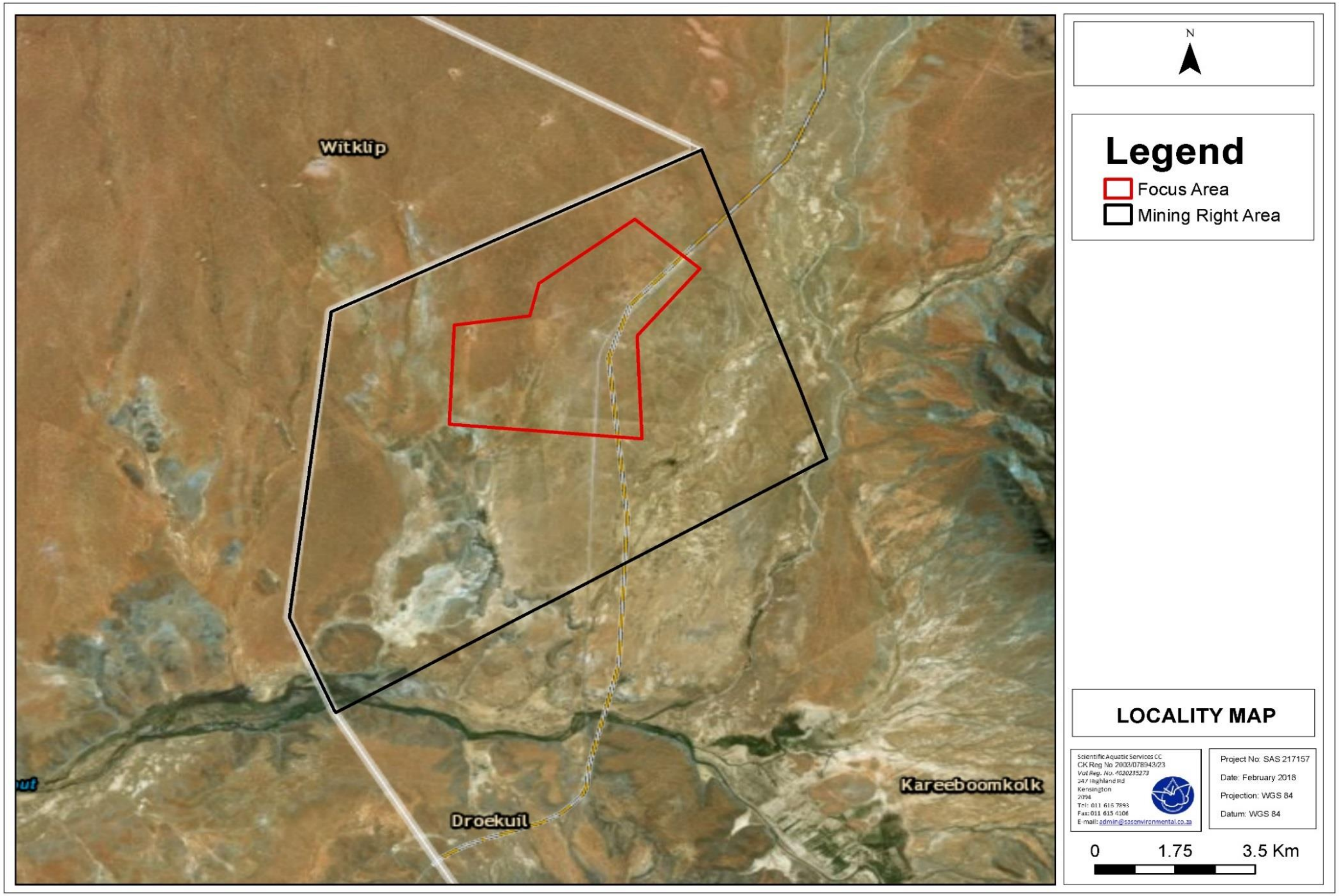

Figure 1: Digital satellite imagery depicting the locality of the focus area in relation to the surrounding areas.

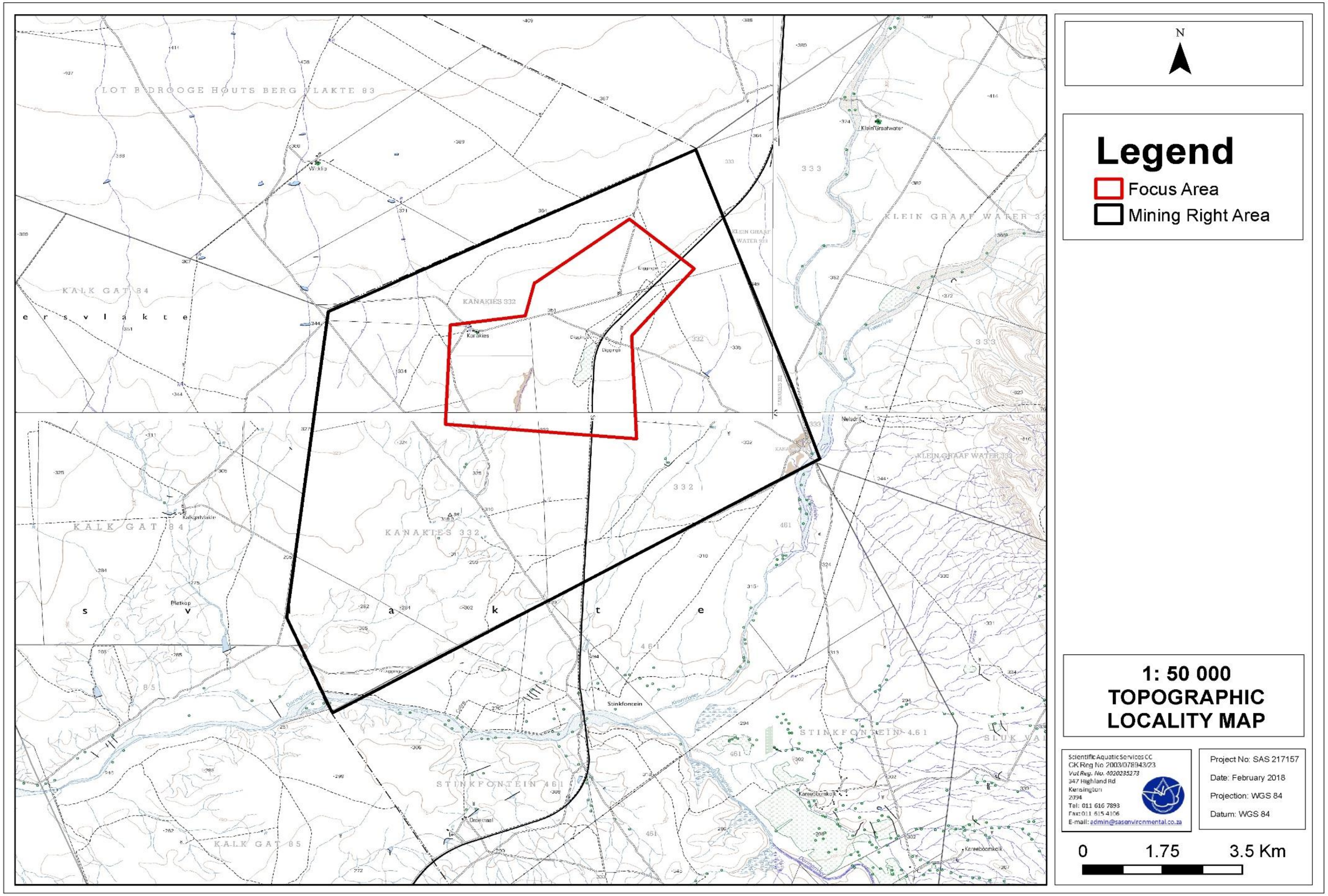

Figure 2: Location of the focus area depicted on a 1:50 000 topographical map in relation to surrounding area.

2. METHOD OF ASSESSMENT

2.1 Literature and Database Review

A desktop study was compiled from various data sources including but not limited to the Agricultural Geo-Referenced Information System (AGIS) and other sources as listed under references.

2.2 Desktop Screening

A background study, including a literature review, was conducted prior to commencement of the field assessment, in order to collect the pre-determined soil and land capability data in the vicinity of the investigated focus area. Soil patterns as well as land capability data within the proposed focus area was reviewed on the Agricultural Geo-Referenced Information System (AGIS) and/or Agricultural Research Council Institute for Soil Climate and Water (ARC-ISCW) databases.

2.3 Soil Classification and Sampling

A soil survey was conducted between 31 January and 02 February 2018 by a qualified soil specialist [Braveman N. Mzila], at which time the identified soils within the proposed infrastructure areas were classified into soil forms according to the Taxonomic Soil Classification System for South Africa (1991):

- Subsurface soil observations and sampling were made by means of a manual bucket hand auger;
- Dominant soil types were classified according to the South African Soil Classification System (Soil Classification Working Group, 1991);
- Assessed survey and sampling points were recorded on a Global Positioning System (GPS);
- Physical soil properties were described including the following parameters:
  - Terrain morphological unit (landscape position) description;
  - Diagnostic soil horizons and their respective sequence;
  - Depth of identified soil horizons;
  - Soil form classification name(s);
  - Observed land capability limitations of the identified soil forms; and
  - Depth to saturation (water table), if encountered.
- Uniform soil patterns were grouped into map units, according to observed limitations; and

- Soil data was analysed to assess the impacts of the proposed mining project under current conditions.

It was also the objective of the assessment to provide recommended mitigation measures and management practices to implement in order to comply with applicable articles of legislation.

Table 1: Typical Arrangement of Master Horizons in Soil Profile

<table>
<tr><th rowspan="6">Soil</th><th rowspan="6">Zone in which soil processes are maximally expressed</th><th colspan="5">Arrangement of master horizons</th></tr>
<tr><th rowspan="5">O-Organic</th><th rowspan="3">C- Regic sand (c), Stratified alluvium, (c), Man -Made Soil Deposits</th><th rowspan="2">A</th><td colspan="2">Humic, Vertic, Melanic, Orthic</td></tr>
<tr><th colspan="2">E</th></tr>
<tr><th>B</th><td>Red Apedal, yellow Brown Apedal, Soft Plinthic, Hard Plinthic, Prismacutanic, Pedocutanic, Lithocutanic, Neocutanic, Neocarbonate, Podzol, Podzol with placic pan</td><th rowspan="3">G - Horizon</th></tr>
<tr><th>C</th><td colspan="2">Dorbank, Soft Carbonate horizon, Hard Carbonate horizon, Saprolite, Unconsolidated without signs of wetness, Unconsolidated with signs of wetness, Unspecified material with signs of wetness</td></tr>
<tr><th colspan="3">R-Hard Rock</th></tr>
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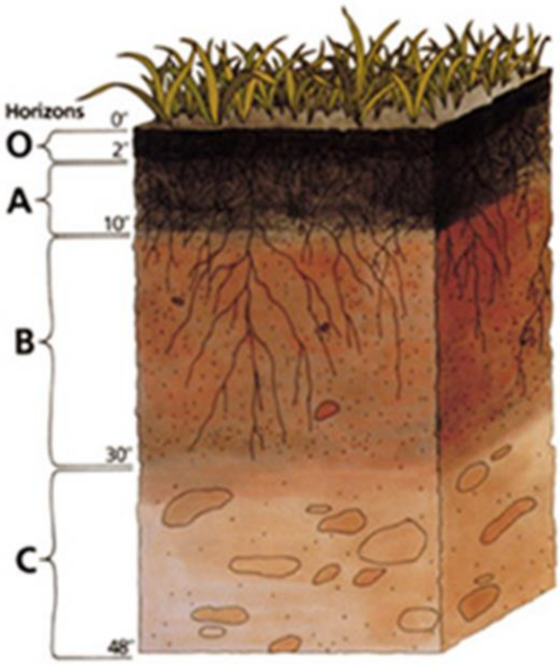


Figure 3: Schematic diagram depicting a conceptual presentation of a typical soil profile

2.4 Land Capability Classification

Agricultural potential is directly related to Land Capability, as measured on a scale of I to VIII, as presented in Table 1 below; with Classes I to III classified as prime agricultural land that is well suitable for annual cultivated crops. Whereas, Class IV soils may be cultivated under certain circumstances and management practices, whereas Land Classes V to VIII are not suitable to cultivation. Furthermore, the climate capability is also measured on a scale of 1 to 8, as illustrated in Table 2 below. The land capability rating is therefore adjusted accordingly, depending on the prevailing climatic conditions as indicated by the respective climate capability rating. The anticipated impacts of the proposed land use on soil and land capability were assessed in order to inform the necessary mitigation measures.

Table 2: Land Capability Classification (Scotney et al., 1987)

Land Capability Group	Land Capability Class	Increased intensity of use									Limitations
Arable	I	W	F	LG	MG	IG	LC	MC	IC	VIC	No or few limitations. Very high arable potential. Very low erosion hazard
	II	W	F	LG	MG	IG	LC	MC	IC	-	Slight limitations. High arable potential. Low erosion hazard
	III	W	F	LG	MG	IG	LC	MC	-	-	Moderate limitations. Some erosion hazards
	IV	W	F	LG	MG	IG	LC	-	-	-	Severe limitations. Low arable potential. High erosion hazard.
Grazing	V	W	-	LG	MG	-	-	-	-	-	Water course and land with wetness limitations
	VI	W	F	LG	MG	-	-	-	-	-	Limitations preclude cultivation. Suitable for perennial vegetation
	VII	W	F	LG	-	-	-	-	-	-	Very severe limitations. Suitable only for natural vegetation
Wildlife	VIII	W	-	-	-	-	-	-	-	-	Extremely severe limitations. Not suitable for grazing or afforestation.

W - Wildlife F - Forestry LG - Light grazing
MG – Moderate grazing IG - Intensive grazing LC - Light cultivation
MC - Moderate cultivation IC - Intensive cultivation. VIC – Very intensive cultivation

Table 3: Climate Capability Classification (Scotney et al., 1987)

Climate Capability Class	Limitation Rating	Description
C1	None to slight	Local climate is favourable for good yield for a wide range of adapted crops throughout the year.
C2	Slight	Local climate is favourable for good yield for a wide range of adapted crops and a year round growing season. Moisture stress and lower temperatures increase risk and decrease yields relative to C1.
C3	Slight to moderate	Slightly restricted growing season due to the occurrence of low temperatures and frost. Good yield potential for a moderate range of adapted crops.
C4	Moderate	Moderately restricted growing season due to low temperatures and severe frost. Good yield potential for a moderate range of adapted crops but planting date options more limited than C3.
C5	Moderate to severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss.
C6	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops for which frequently experience yield loss.
C7	Severe to very severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	Very severe	Very severely restricted choice of crops due to heat and moisture stress. Suitable crops at high risk of yield loss.

3. DESKTOP ASSESSMENT RESULTS

The following data is applicable to the focus area, according to various data sources including but not limited to the Agricultural Geo-Referenced Information System (AGIS) and the Northern Cape Critical Biodiversity Areas Database (2016):

- The Mean Annual Rainfall (MAR) is estimated to range between 100 and 200mm per annum for the northern and eastern portion of the MRA, whilst the south and western portion ranges between 200 and 30mm per annum;
- Evaporation is estimated to range between 1500 to 1600mm in the northern portion of the MRA, whereas the south portion ranges between 1600 and 1700mm per annum;
- A significant portion of the MRA according to the SOTER database is classified as a plain land form, with only a small portion to the southeast associated with drainage line is classified as a valley floor land reform, as presented in Figure 4;
- According to the soil-terrain (SOTER) database and the 1:250 000 geological map of South Africa, the majority of the MRA is underlain by shale geological formation while a small portion located to the is underlain by sedimentary rock formation, as presented in Figure 5;
- According to the ENPAT database, the entire MRA has a slope percentage ranging between 0 and 9 percent;
- According to the Geology 2001 layer, a significant portion of the MRA underlain by tilite (sedimentary rock that consists of consolidated masses of unweathered material),

while a small section located to the north is underlain by tilite and sedimentary rock (Figure 6);

- According to the Soils 2001 Layer, the majority of the MRA is situated within an area where the soils are classified as red apedal freely drained soils with a high base status and < 300mm deep. The remaining portions of the MRA are situated within Glenrosa and/or Mispah forms (other soils may occur) with lime generally present in the entire landscape, and miscellaneous land classes, undifferentiated deep deposits (Figure 7);
- The natural soil pH is estimated to be greater than 8.4, indicating soils are anticipated to be basic, as interpolated from topsoil pH values obtained from the National Soil Profile Database (AGIS database);
- Predicted soil loss is classified as low for a significant portion of the MRA, particularly where mining activities and associated infrastructure is to occur, whereas a portion to the south is classified as high risk for soil loss, as depicted in Figure 1 (AGIS database);
- According to the AGIS database, susceptibility to wind erosion of the soils within the broader MRA range from susceptible to highly susceptible, however the soils within the focus area are classified as being susceptible to wind erosion, refer to Figure 9. Furthermore, the majority of the MRA is classified as being low to moderate susceptible to water erosion, with only the portion associated with the drainage lines classified as being highly susceptible to water erosion, refer to Figure 10;
- The desktop assessment results extracted from the AGIS database indicates that the land capability of the entire MRA is described as non-arable, classified as Class VII. In addition, the entire MRA is considered suitable for grazing, woodland or wildlife;
- According to the AGIS database, a significant portion of the MRA has an estimated grazing capacity potential of approximately 39 hectares per large animal unit, whilst a portion along the western border has an estimated grazing capacity of approximately 72 hectares per large animal unit, as presented in Figure 11 (Morgenthal *et al.*, 2005); and
- According to the South African Journal of animal science (2013), the grazing capacity within the focus area ranges between 35 and 40 ha/LSU (hectares per livestock unit).

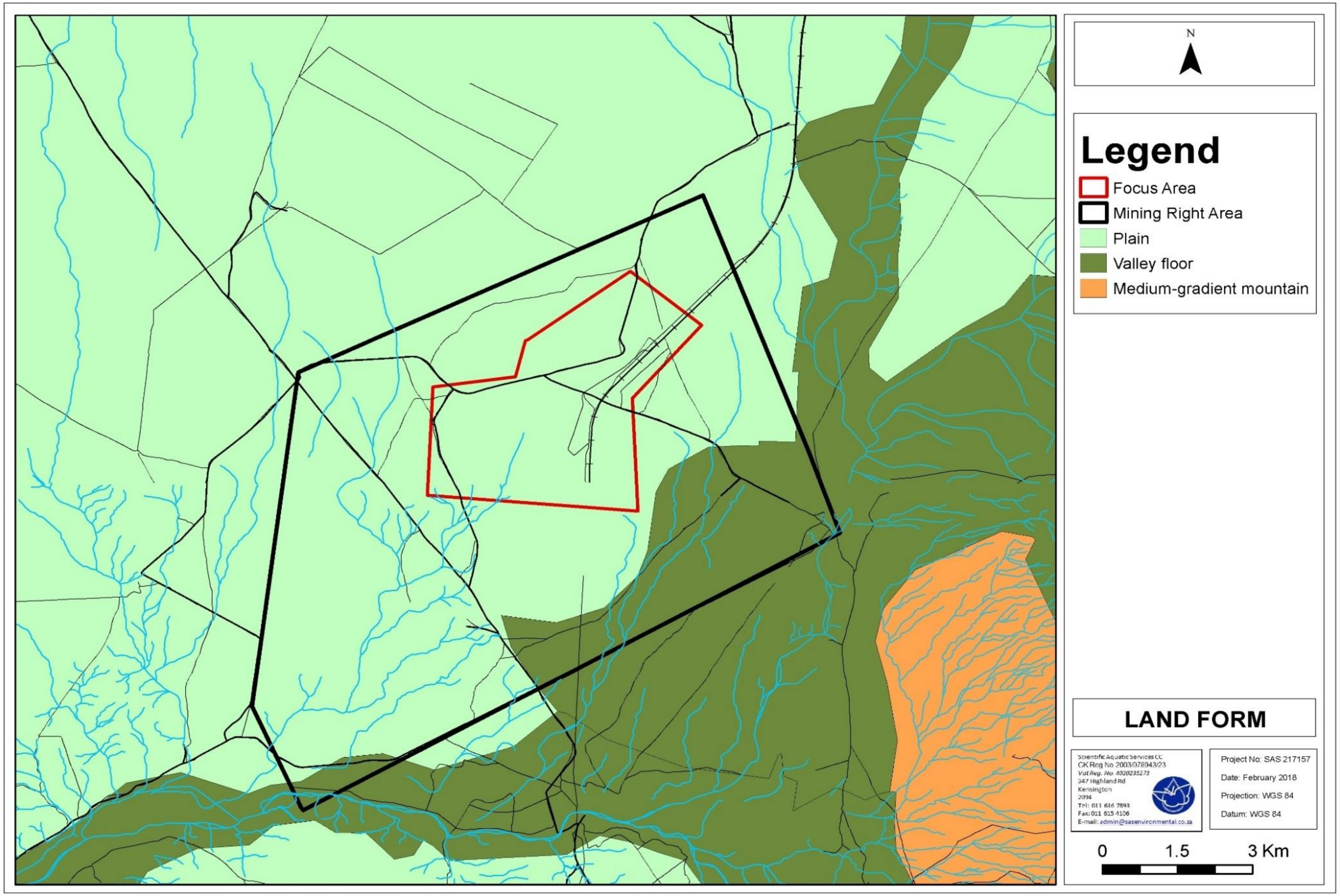


Figure 4: Simplified geology associated with the MRA and surrounding areas.

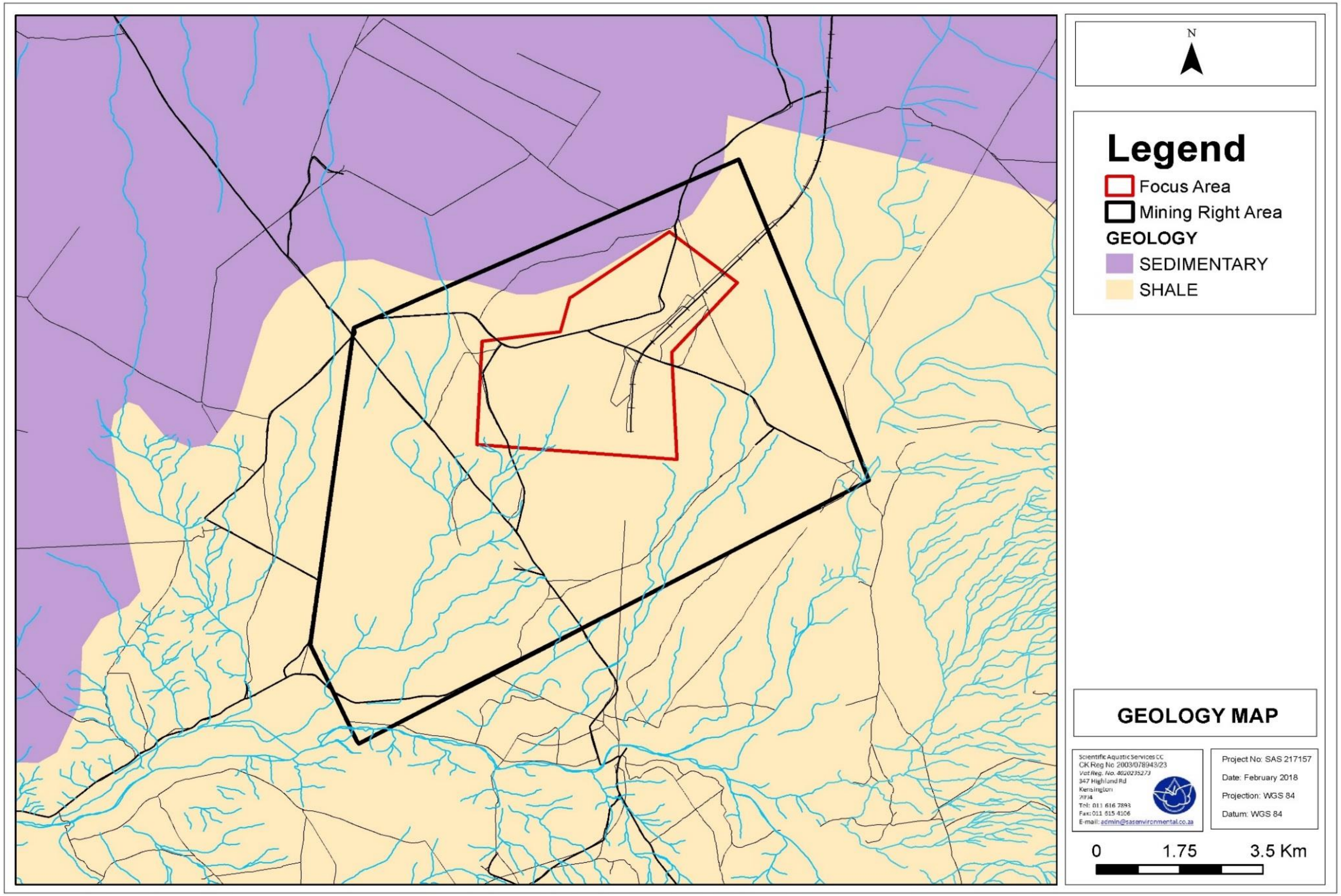


Figure 5: Geology (2001) associated with the MRA and surrounding areas.

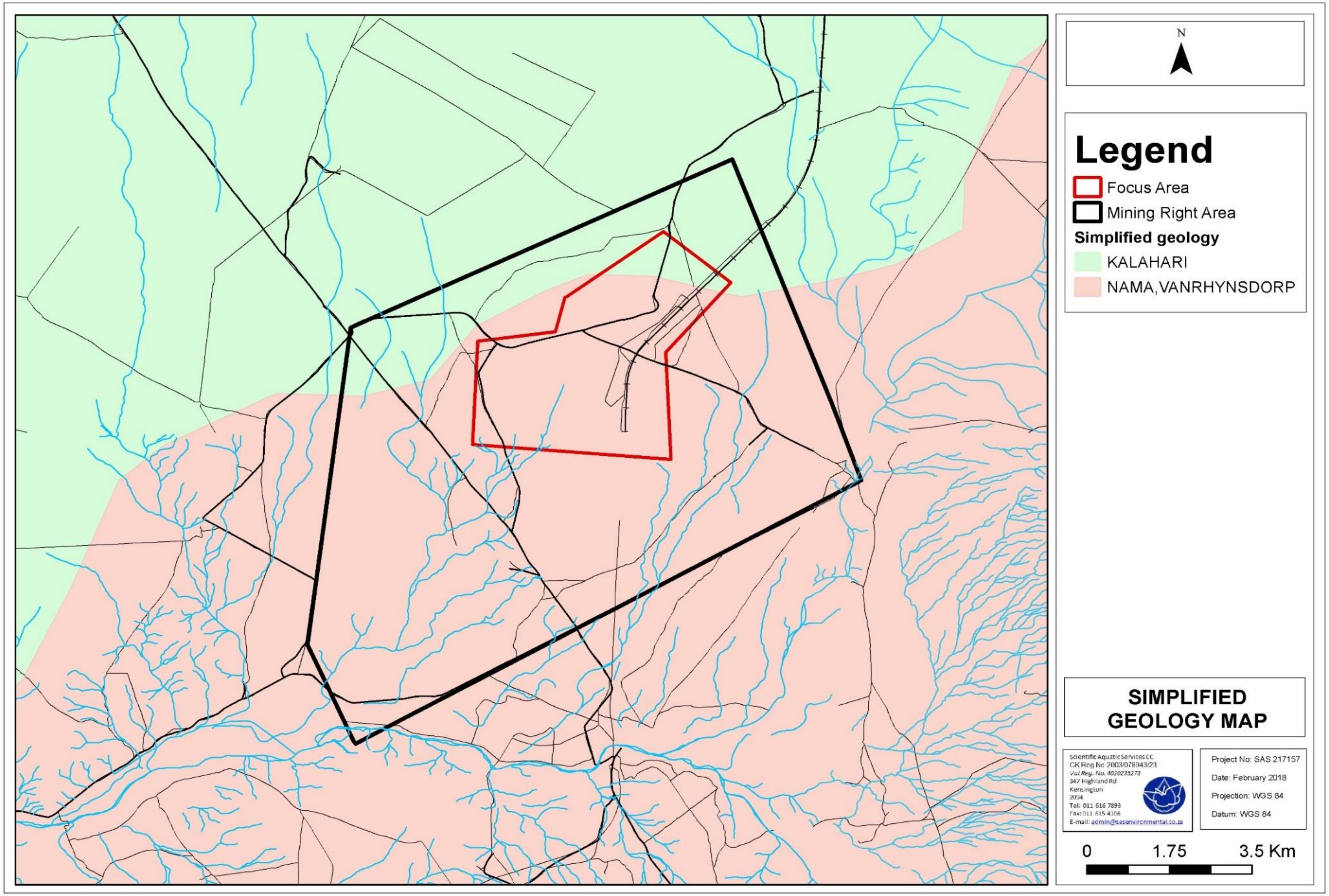


Figure 6: Simplified geology associated with the MRA and surrounding areas.

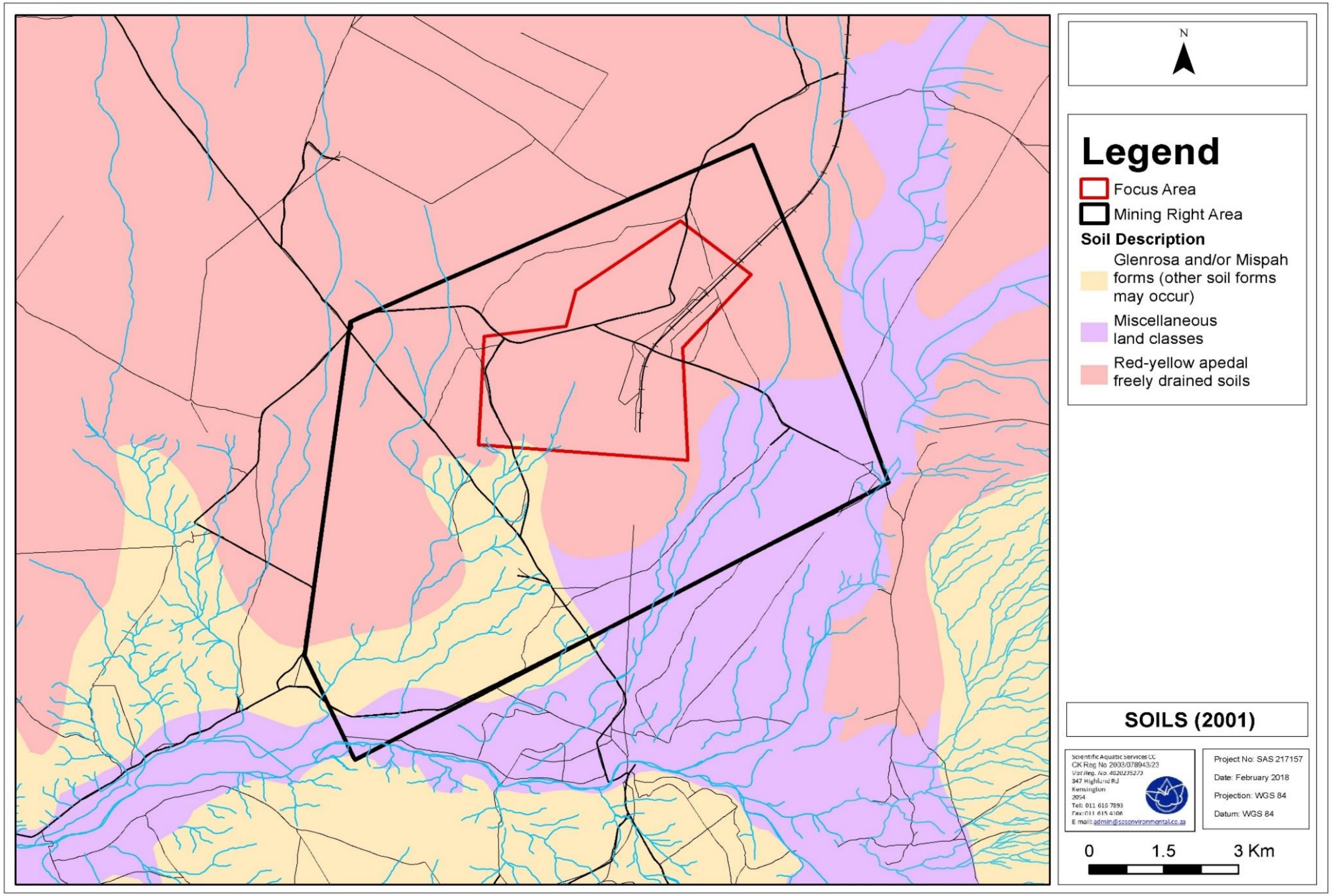


Figure 7: Soils (2001) associated with the Mining Right Area (MRA) and surrounding areas.

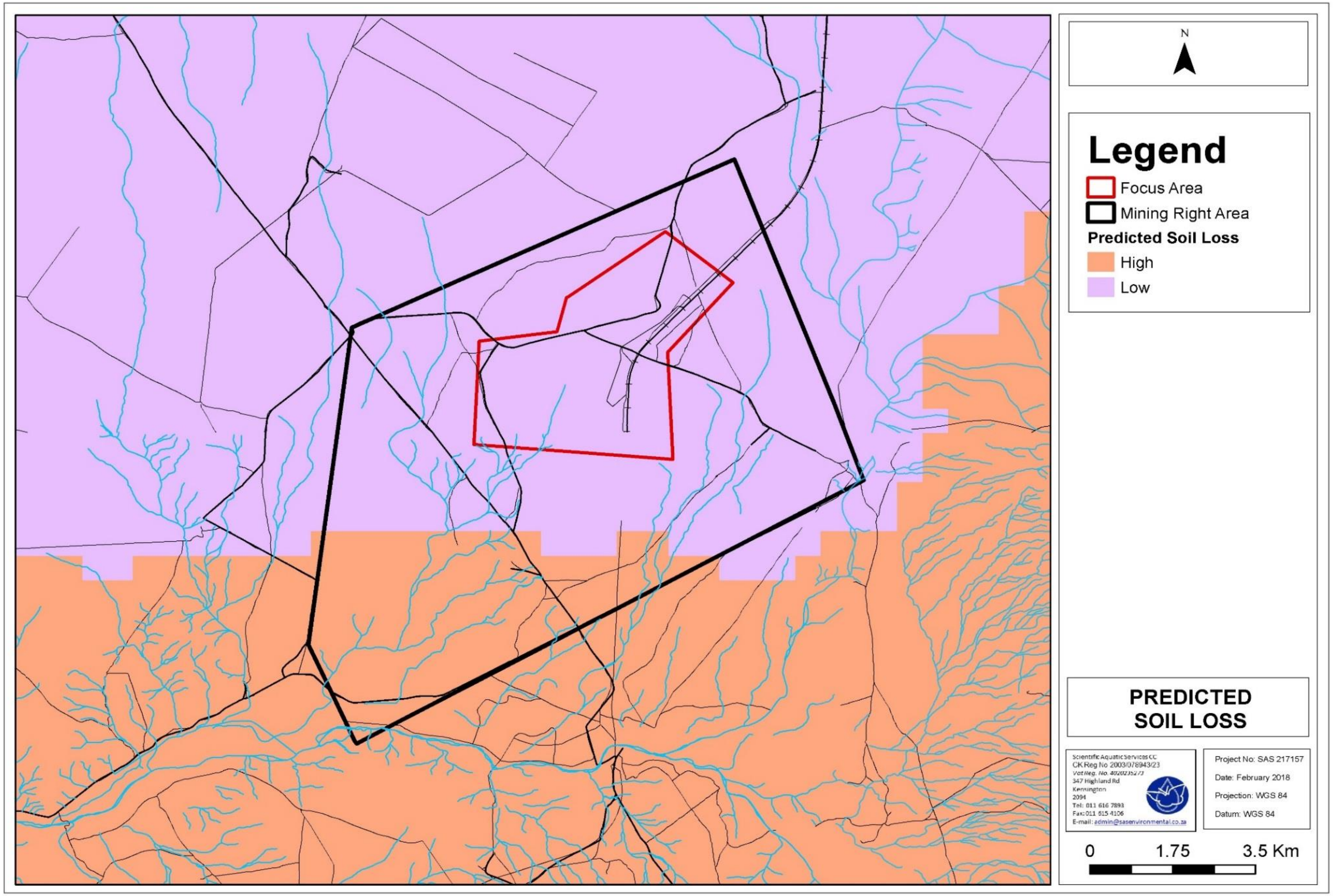


Figure 8: Predicted soil loss associated with the MRA and surrounding areas.

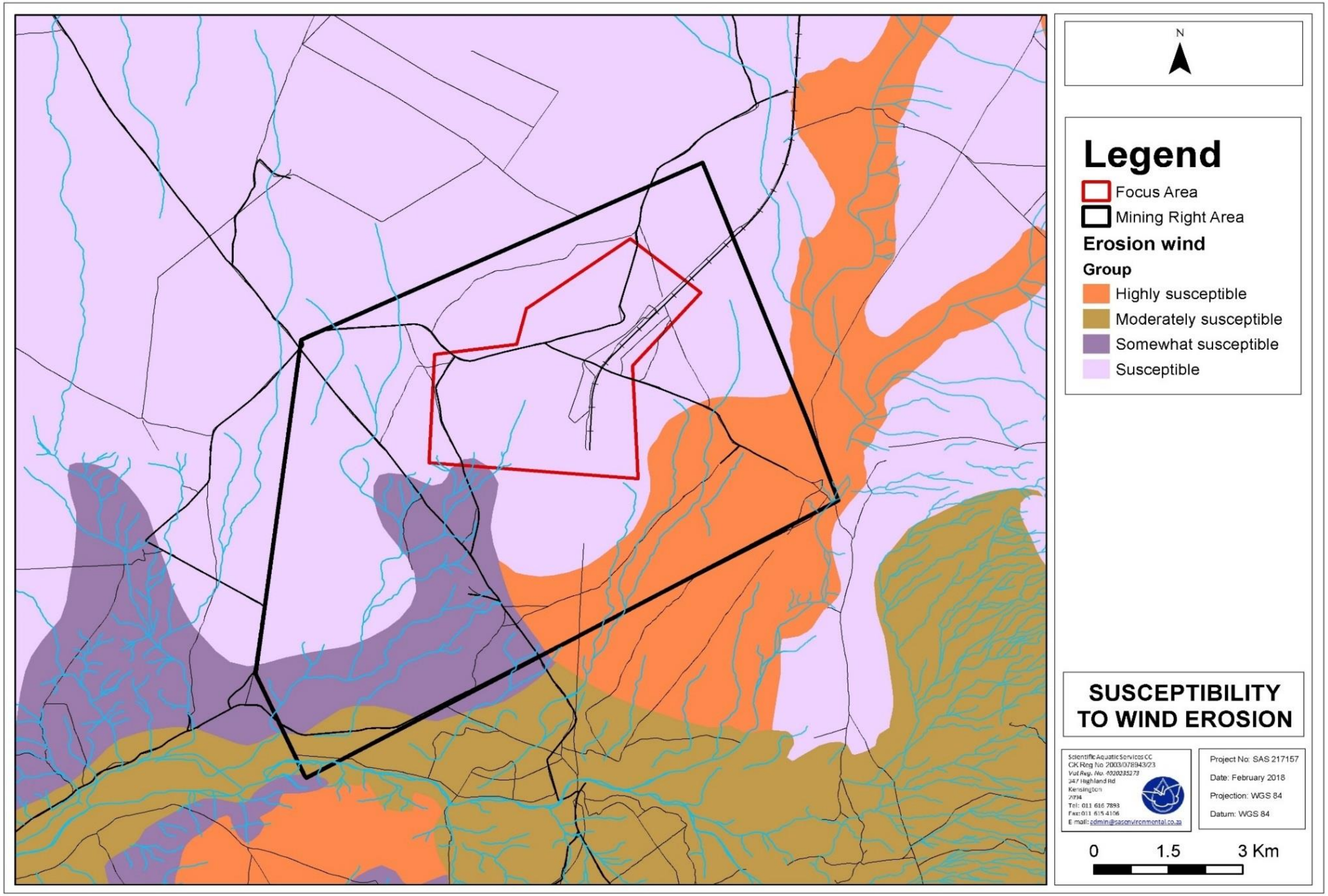


Figure 9: Soil susceptibility to wind erosion within the MRA and surrounding areas.

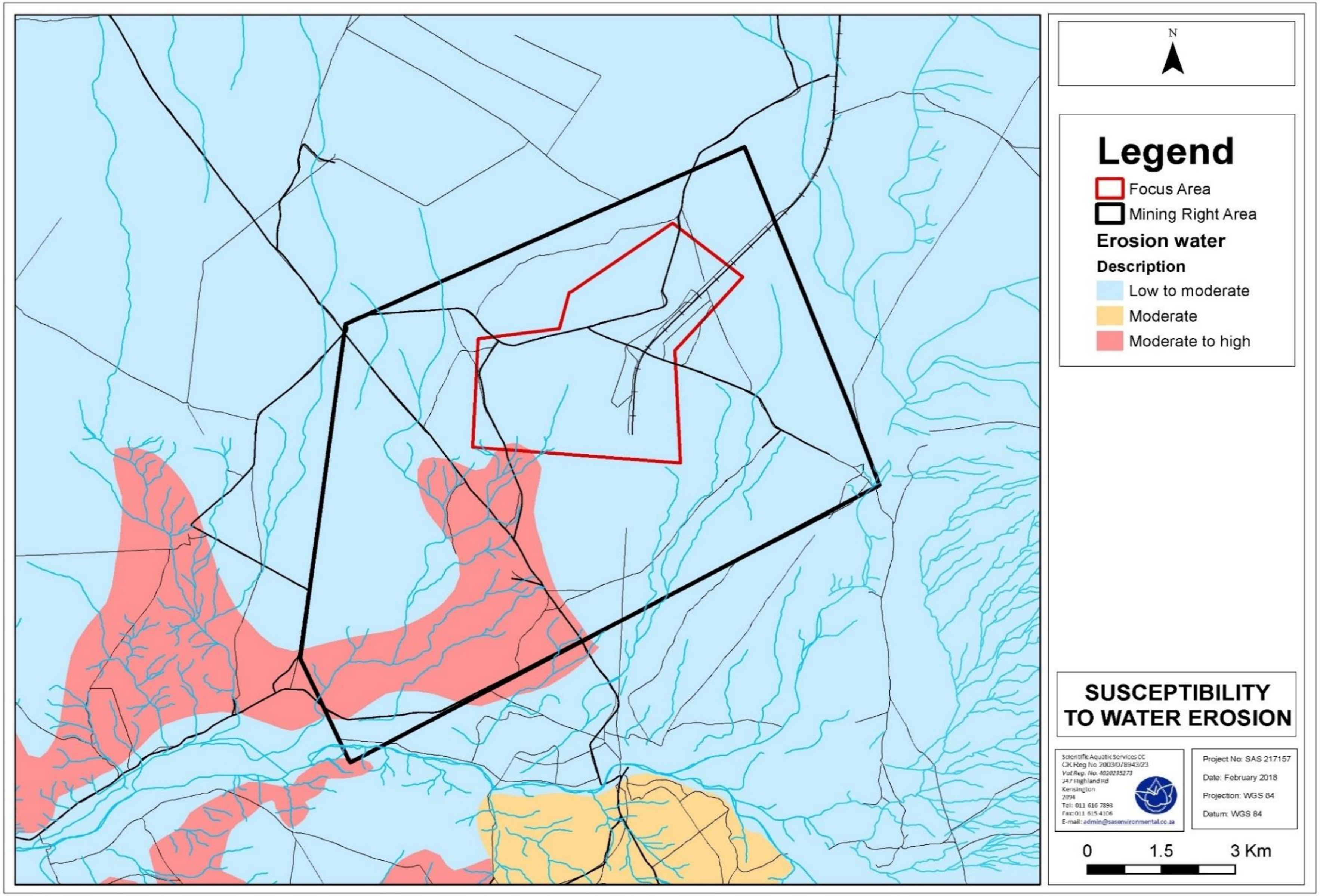


Figure 10: Soil susceptibility to water erosion within the MRA and surrounding areas.

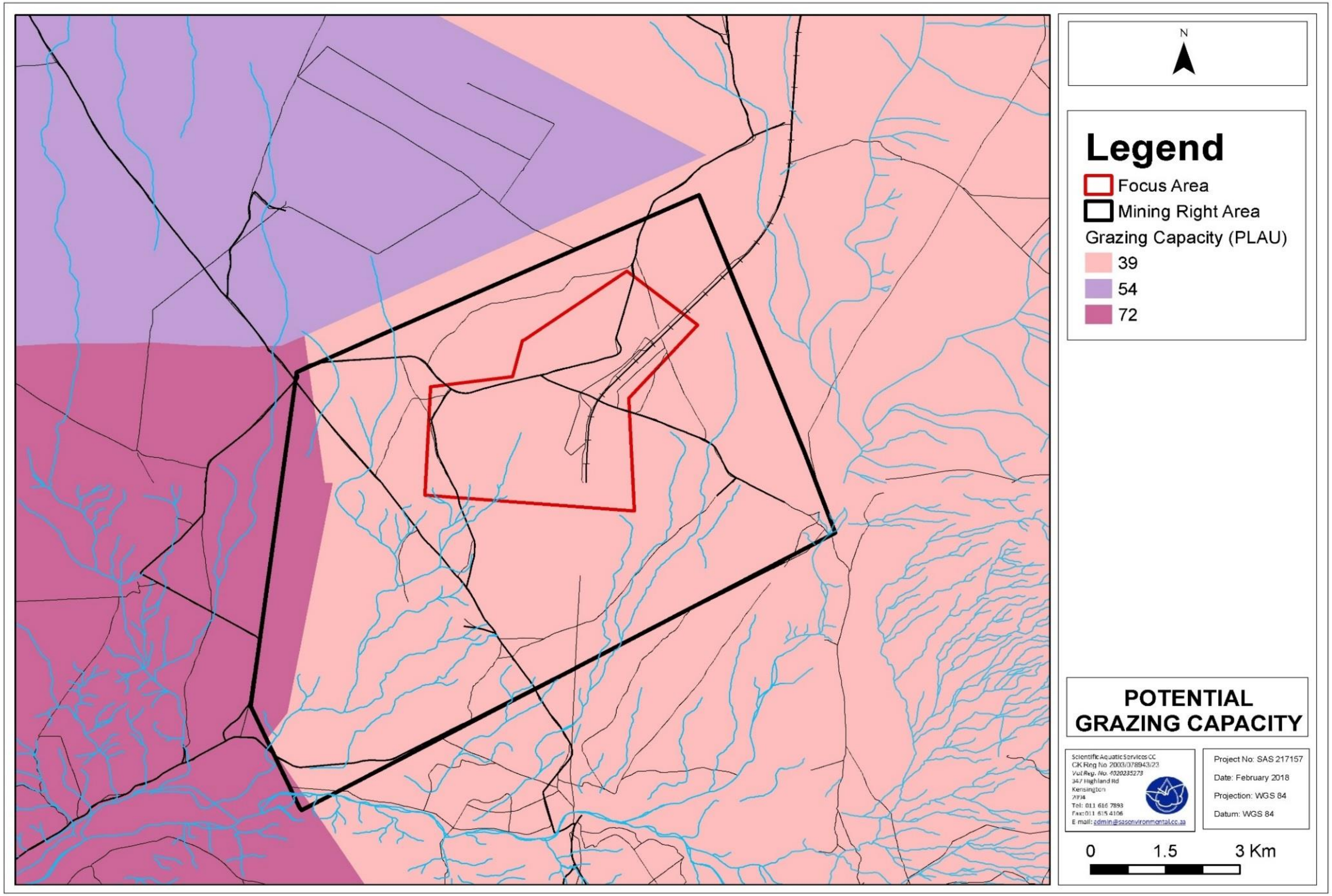


Figure 11: Potential grazing capacity associated with the MRA and surrounding areas.

4. FIELD ASSESSMENT RESULTS

4.1 Dominant Soil Types

The focus area is dominated by Kimberly/Plooysburg soil forms which are characterised by shallow effective rooting depth, underlined by carbonate horizon. These soils occurred on soil relatively flat areas. According to Fey (2010), calcic soils are youthful either because of limited rock weathering or on account of rejuvenation through natural erosion on steeper, convex slopes, ensuring intimate contact between a surface horizon is maintained by biological activity and the underlying rock or saprolite. The saprolitic material may have incipient features such as calcareous or softening due to weathering but these are insufficiently expressed to qualify for one of the other distinctive subsurface horizons. Witbank soil forms were also identified within the proposed focus areas, attributable to surface infrastructure such as roads and railway line. The Witbank soil form has been extensively disturbed such that no recognisable diagnostic soil morphological characteristics, particularly in the topsoil, could be identified, corresponding to *anthrosols* in the international soil classification terminology. The spatial distribution of all identified soil forms within the focus areas is presented in soil map in Figure **12 and 13** below.

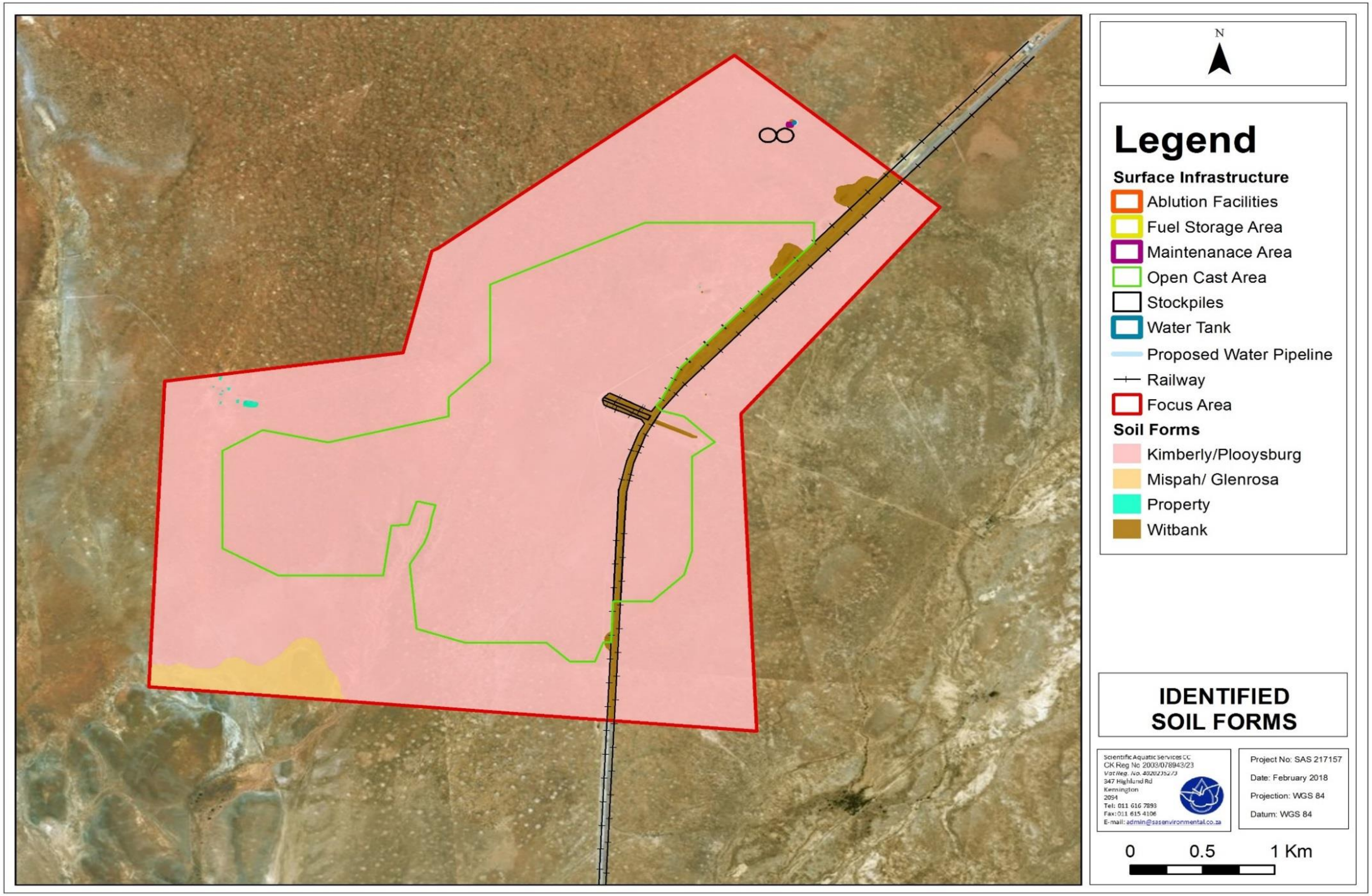


Figure 12: Soil map depicting identified soil forms within the proposed focus area

4.2 Current Land Use

Current land use activities associated with the focus areas are largely dominated by grazing and wildlife/wilderness, as depicted on the dominant land use maps on Figure **16 and 17**.

Figure 13: Photographic presentation of the dominant land uses within the focus area

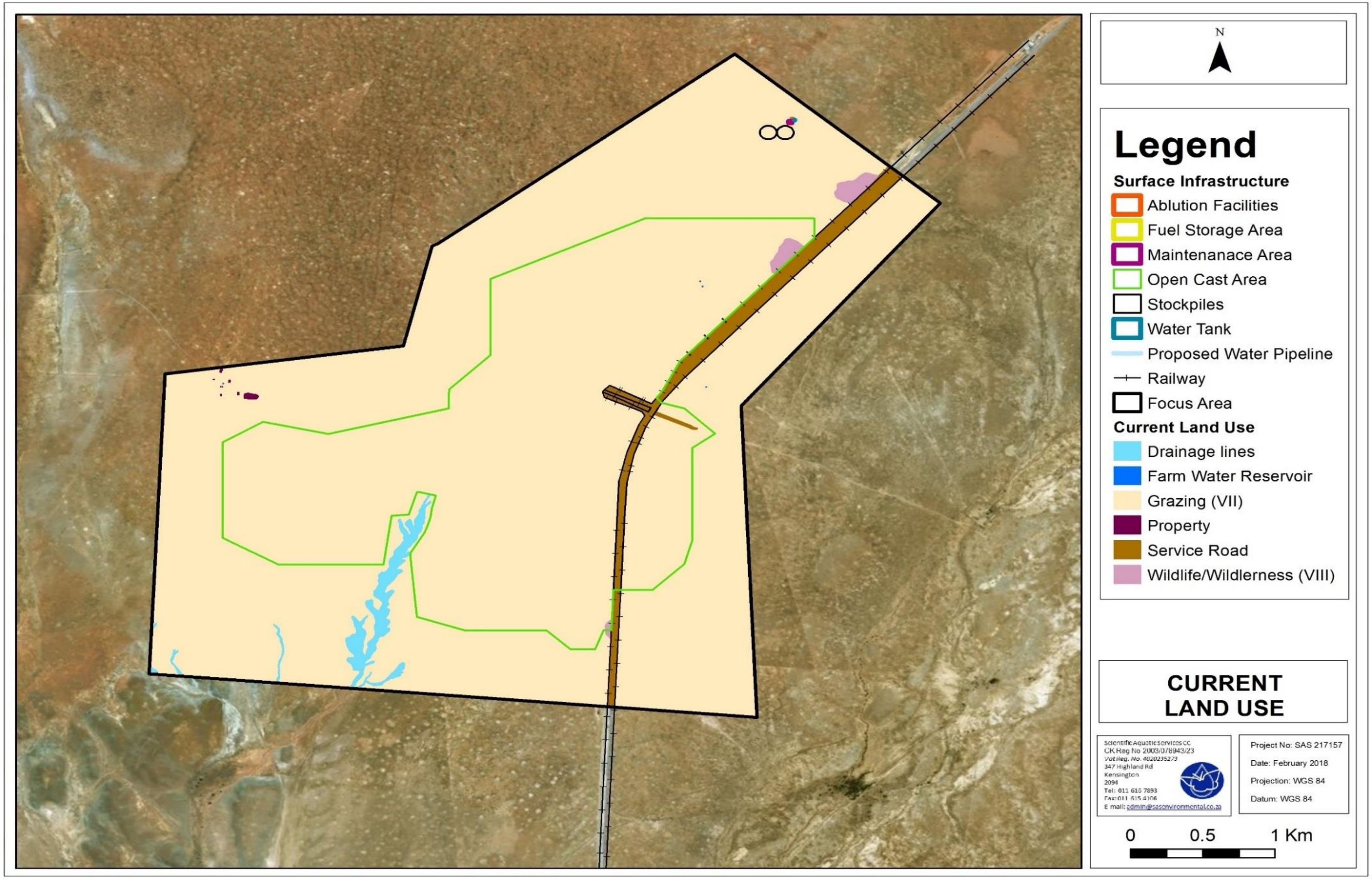


Figure 14: Map depicting identified land use within the focus area

4.3 Land Capability Classification

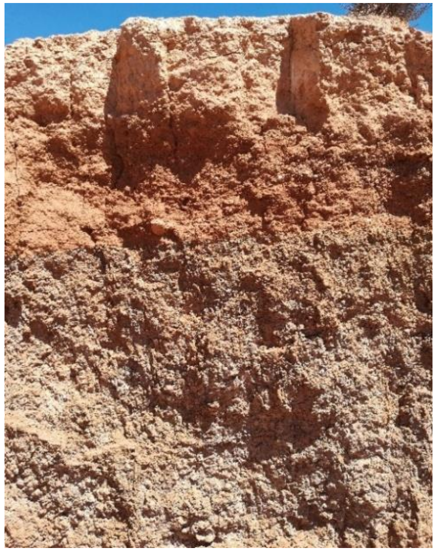
In South Africa, agricultural land capability is usually restricted by climatic conditions, with specific mention to water availability (Rainfall). Even within similar climatic zones, different soil types typically have different land use capabilities attributed to their inherent characteristics. High potential agricultural land is defined as having the soil and terrain quality, growing season and adequate available moisture supply needed to produce sustained economically high crops yields when treated and managed according to best possible farming practices (Scotney et al., 1987). For this assessment, land capability was inferred in consideration of observed limitations to land use due to physical soil properties and prevailing climatic conditions. Climate Capability (measured on a scale of 1 to 8) was therefore considered in the agricultural potential classification. The focus area falls into Climate Capability Class 7 due to high temperatures and moisture stress, with limited suitable crops which experience frequent yield loss throughout the year.

The identified soils were classified into land capability classes using the Scotney et. Al. Land Capability Classification system (Scotney et al., 1987), as presented from **Figure 15**. The identified land capability limitations for the identified soils are discussed in comprehensive "dashboard style" summary tables presented from Tables 4 to 6 below. The dashboard reports aim to present all the pertinent information in a concise and visually appealing fashion.

Table 4: Summary discussion of the Grazing (Class VII) land capability class

Land Capability: Grazing Class V

Occurrence within the focus areas
The land capability class in which these soils were assigned to is associated with water course or land with wetness limitations. Refer to land capability description below.



Terrain Morphological Unit (TMU)	Relatively flat to gently sloping landscape of < 2% slope gradient	**Photograph notes**	View of the morphology of the identified Kimberly/Plooysburg soil forms
Soil Form(s)	Kimberly/Plooysburg	**Area Extent**	1268.86 ha; which constitutes 94.76% of the total investigated focus area
Diagnostic Horizon Sequence	0-10 cm: Orthic A 10 30 cm: soft carbonation and hard carbonation	**Land Capability** The identified Kimberly/Plooysburg soil forms are of limited land capability and are not considered as prime agricultural soils. These soils, at best, are suited for grazing, however with climatic constraints of the area disqualify these soils for being suitable for commercial livestock/sheep farming.	
Physical Limitations	These soils were found to be somewhat shallow with an approximate effective rooting depth of 35 cm before reaching the layer of refusal		
Overall impact significance prior to mitigation — **M** **Overall impact significance post mitigation** — **L**	The overall impact of the proposed mining activity on the land capability of these soils is anticipated to be Medium (M) prior to mitigation due to sufficient soil depth for most cultivated crops. However, the impacts can be reduced to acceptable levels post mitigation	**Business case, Conclusion and Mitigation Requirements:** Should the proposed infrastructure encroach on the Kimberly/Plooysburg soils, rehabilitation would be a requirement for these soils as they can be of significant use from a commercial cattle farming point of view. These sites can be rehabilitated concurrently to ensure the soils and landscape setting is restored to a natural condition to allow for natural land uses to continue.	

Table 5: Summary discussion of the Grazing (Class VI) land capability class

<table>
<tr><td colspan="3">Land Capability: Grazing - Class VI

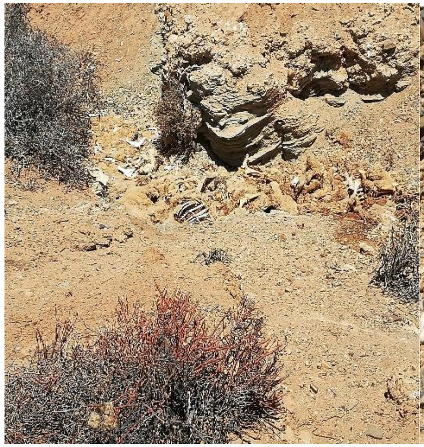
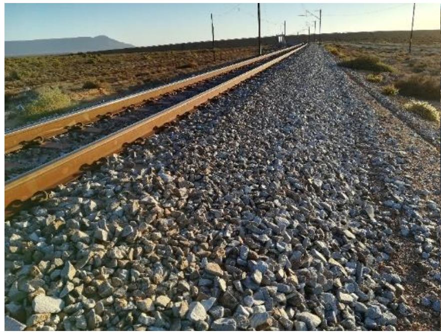
Occurrence within the focus areas
The shallow nature of these soils can be largely attributed to limited weathering due to limited rainfall.
</td><td colspan="2"></td></tr>
<tr><td colspan="2">Terrain Morphological Unit (TMU)</td><td>Relatively flat to gently sloping landscape of < 2% slope gradient</td><td>Photograph notes</td><td>View of the morphology of the identified Glenrosa/Mispah soil forms</td></tr>
<tr><td colspan="2">Soil Form(s)</td><td>Glenrosa/Mispah</td><td>Area Extent</td><td>28.5 ha; which constitutes 2.13 % of the total investigated area</td></tr>
<tr><td colspan="2">Diagnostic Horizon Sequence</td><td>0-35 cm: Orthic A
≥ 35 cm: Miscellaneous hard rocky material</td><td colspan="2" rowspan="2">Land Capability
The identified Glenrosa/Mispah soil forms are considered to be of poor (class VII) land capability and are not suitable for arable agricultural land use. Theses soils are, at best, suitable for natural pastures for light grazing. Therefore, these soils are considered to make a substantial contribution to extensive subsistence farming on a local scale.</td></tr>
<tr><td colspan="2">Physical Limitations</td><td>Shallow effective rooting depth is the primary limitation of the land capability of the Glenrosa/Mispah soil forms, which is due to the occurrence of a rocky layer at relatively shallow depth, which would hinder penetration of plant roots.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>ML</td><td rowspan="2">The overall impact of the proposed mining activities on the land capability of these soils is anticipated to be Medium Low (ML) due to the limited potential grazing opportunities. These soils are however not ideal for cultivated agriculture due to their shallowness and effective rooting depth.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
The identified Mispah soil form are, at best, suited for grazing and/or wilderness practices. This is due to the relatively shallow parent rock and lithocutanic material. The impact of the proposed mining activities on the land capability of these soils is anticipated to be low after mitigation. As much as these soils are not considered as prime agricultural soils, these soils are important for potential grazing opportunities. Therefore, implementation of rehabilitation and the proposed integrated mitigation measures is recommended to reinstate the natural topography of the area post mining.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>L</td></tr>
</table>

Table 6: Summary discussion of the Wildlife/Wilderness (Class VIII) land capability class

<table>
<tr><td colspan="3">Land Capability: Wildlife/Wilderness - Class VIII

These soils were observed within the focus area. Roads/gravel roads and railway lines with were also classified as Witbank (Anthrosols).</td><td colspan="2"> </td></tr>
<tr><td colspan="2">Terrain Morphological Unit (TMU)</td><td>Not applicable; highly disturbed areas</td><td>Photograph notes</td><td>View of the identified Witbank soil forms</td></tr>
<tr><td colspan="2">Soil Form(s)</td><td>Witbank (Anthrosols)</td><td>Area Extent</td><td>41.21 ha; which constitutes 3.08% of the total investigated area</td></tr>
<tr><td colspan="2">Diagnostic Horizon Sequence</td><td>Not applicable; highly disturbed soils</td><td colspan="2" rowspan="2">Land Capability
These identified Witbank soils have very poor (class VIII) land capability attributed to the potential leakages from vehicles and locomotives transporting material. In addition, some of these soils have been subjected to long term compaction and erosion. This land capability class also includes area where the original soil has been buried and/or extensively modified by anthropogenic activities. These soils are therefore not considered to make a significant contribution to agricultural productivity even on a local scale.</td></tr>
<tr><td colspan="2">Physical Limitations</td><td>Comprises of significantly disturbed areas due from anthropogenic activities to an extent that no recognisable diagnostic soil horizon properties could be identified. These soils included existing gravel/dirt roads as observed during the site assessment. These soils are characterised by various limitations, primarily the absence of soil as a growth medium for arable agriculture.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>L</td><td rowspan="2">The overall impact of the proposed development on the land capability of these soils is anticipated to be low due to their very poor land capability attributable to anthropogenic disturbances.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
The current state of these soils requires significant rehabilitation already. These areas can be rehabilitated concurrently or as part of the closure phase.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>L</td></tr>
</table>

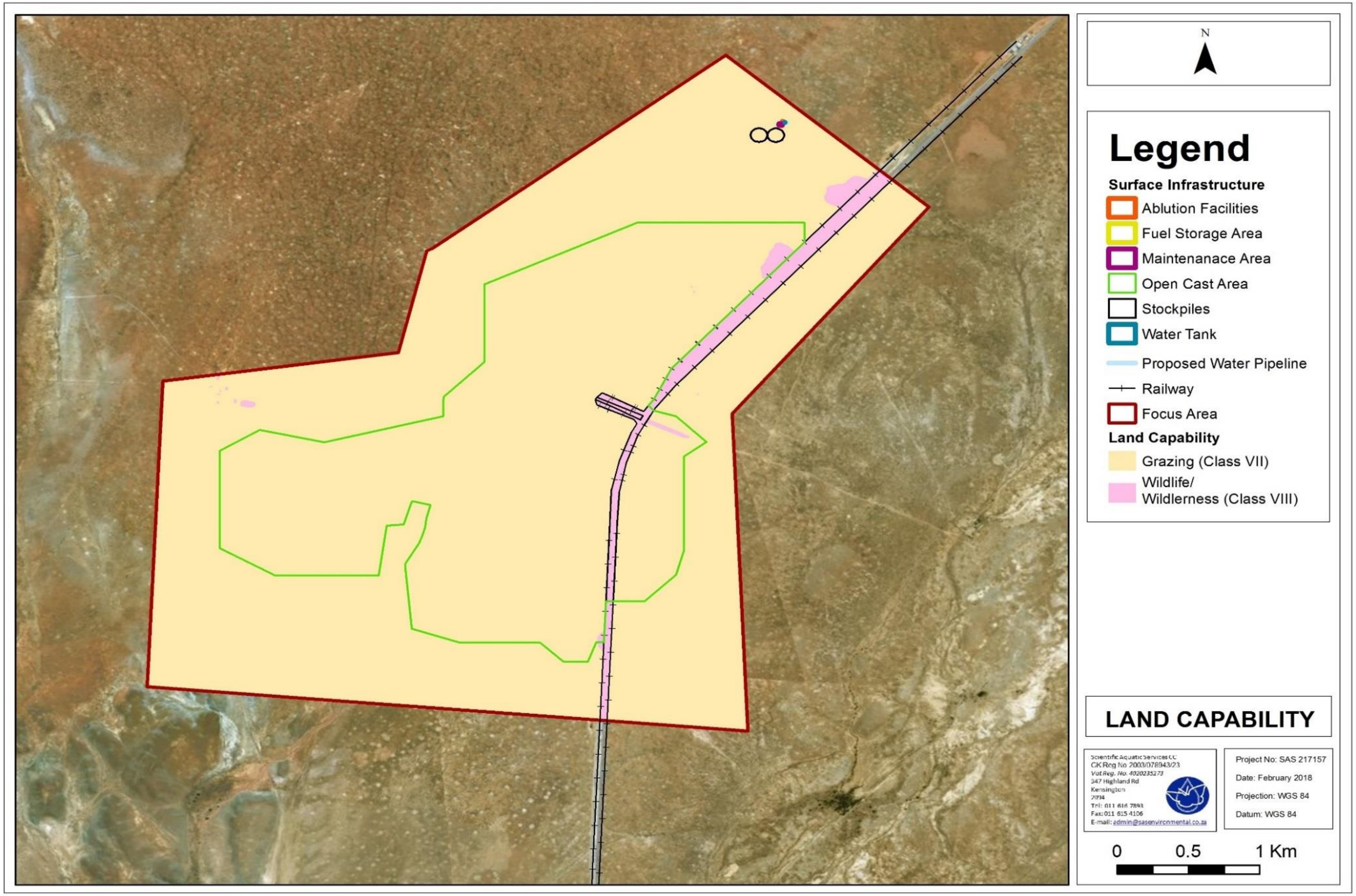


Figure 15: A map depicting land capability within the focus area

5. IMPACT ASSESSMENT AND MITIGATION MEASURES

The proposed focus area is currently used for sheep farming, with little to no crop agriculture due to climatic and soil constraints, with specific mention of soil depth and limited precipitation. This was evident during the site assessment, as sheep were observed in some portions of the proposed focus area. Furthermore, high temperatures occurring in this area are also likely to cause crop wilting, and thus affecting crop yield. Therefore, this area with this climate as well as lack of irrigation options renders the area largely unsuitable for gainful commercial agricultural purposes except for potential livestock farming. As the focus area is predominantly comprised of low potential agricultural soils, relatively low impact is foreseen on these soils from a land capability perspective. These soils have little bearing on agricultural productivity, with limited contribution to the local, regional, provincial as well as national food production. However, their protection, where feasible is deemed important to ensure that the area remains functional post closure. Witbank soils (Anthrosols) are not regarded as important for cultivated agricultural production, as these soils are affected by anthropogenic activities such that their genic character has either been largely destroyed or, in some cases, has had insufficient time to express itself. Thus, these soils could not be assigned to neither arable nor grazing land capability classes.

5.1 Mining Activities

The potential impact triggers at various phases of the proposed development are presented in Table 7 below.

Table 7: Summary of the anticipated Activities for the proposed development

Phase	Activities and associated impacts on soils and land capability
Preconstruction and construction	- Vegetation clearing within the proposed mining area; - Soil erosion on cleared areas; and - Soil compaction from frequent traffic of construction vehicles.
Operational	- Soil compaction from frequent traffic of mining machinery; - Expansion of waste rock dumps and pit areas; - Soil erosion from bare (un-vegetated) haul road areas; - Loss of potential grazing land; - Potential soil contamination, and - Additional production of waste rock.
Decommissioning and closure	- Demolishing and decommissioning of all surface infrastructure; - Removal of contaminated soils; - Reshaping of the landscape and reinstatement of the natural topography; and - Rehabilitation of the impacted areas near the mining footprint.
Post-closure	- Resumption of former land use activities; and - Potential latent impact on soil chemistry.

5.1.1 Impact: Soil erosion

Parameters determining the extent and severity of soil erosion are highly complex, with water and wind as the main geomorphic agents, and soil erosion is largely dependent on land use and soil management and is generally accelerated by human activities such as tillage practices.

The entire focus area is located on a relatively flat and gently sloping terrain of less than 3% slope gradient at most, consisting of shallow soils, thus erosion is considered moderate for this area.

Although the focus area consists of a sparse vegetation cover, the natural and undisturbed soils will become more vulnerable to erosion once the vegetation is cleared for construction activities, and the soils will inevitably be exposed to wind and some surface runoff during intensive rainfall events. The significance of this impact is anticipated to be medium low and will be reduced to low impact if mitigation measure outlined in this document are adhered to, as illustrated on the impact rating table below.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential poor planning leading to excessive or unnecessary clearing and removal of vegetation outside of the demarcated mining and infrastructure areas	Site clearing, the removal of vegetation, and associated disturbances to soils, leading to loss of land capability in cleared areas, increased runoff, erosion and consequent sedimentation of down gradient receiving environment.	Constant disturbances of soils, resulting in detachment of soil particles, reduced soil quality and risk of erosion, attributed to mining activities.	Ineffective rehabilitation may lead to further loosening and detachment of soil particles and risk of erosion.
	Stockpiling of topsoil and product (gypsum) material on sloping areas leading to increased runoff and erosion.	Ongoing disturbances to soils, resulting in increased sedimentation and risk of erosion, arising from mining activities.	Decommissioning activities may lead to habitat transformation and increased alien plant species proliferation, and potential for changing the nutrient status of the soils.

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	3	4	3	2	7	9	63 (Medium-low)
Operational phase	4	3	4	3	2	7	9	63 (Medium-low)

Decommissioning and Closure	5	3	4	3	1	8	8	64 (Medium-low)
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	4	1	2	5	8	40 (Low)
Operational phase	2	3	4	1	3	5	9	45 (Low)
Decommissioning and Closure	2	3	4	1	2	5	8	40 (Low)

Mitigation measures

Activity	*Vegetation clearing on proposed mining sites*
Project phase	*Pre-construction and construction phase*
Impact Summary	*Soils exposed to erosion following removal of the protective vegetation cover*
Management Measures	***Proposed mitigation and management measures:*** - *The footprint of the proposed mining area and associated infrastructure area should be clearly demarcated to restrict vegetation clearing activities within the infrastructure footprint as far as practically possible;* - *Infrastructure sites should be accessed through existing road network, if feasible;* - *Vegetation clearance and commencement of construction activities can be scheduled to coincide with low rainfall conditions when the erosive stormwater and wind are anticipated to be low;* - *The product can be stockpiled as needed according to the required process if adequate measures will be in place to protect the surrounding environmental receptors.* - *Stockpiled product material should not stand for too long to avoid erosion to the downgradient receiving environment* - *Recovered soils should be re-used to rehabilitate the mine footprint following mine closure;* - *Cleared vegetation should be nourished at a nursery for use during rehabilitation phase;* - *All disturbed areas can be re-vegetated with indigenous vegetation to re-establish a protective cover, to minimize soil erosion.*

5.1.2 Impact: Soil compaction

Heavy equipment traffic during construction activities is anticipated to cause soil compaction. The severity of this impact is anticipated to be moderate for soils such as Kimberly/ Plooysburg soils due to loamy sand texture. Whereas soils with a relatively shallow bedrock and lithocutanic character (partly weathered rock material) such as the Glenrosa/Mispah soil forms are anticipated to be less impaired due to the resistance offered by the underlying bedrock.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential poor planning leading to excessive mining and unnecessary placement of infrastructure outside of the demarcated project footprint	Potential movement of mining machinery leading to soil compaction.	Further movement of mining machinery leading to further soil compaction.	Disturbance of soils as part of demolition activities and backfilling.
	Unnecessary placement of construction material in soils which are prone to compaction.		Decommissioning activities may lead to further soil compaction and increased runoff.
			Ineffective rehabilitation may lead to significant soil compaction, resulting in lower infiltration rate, and consequently increased surface runoff.

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	2	5	2	4	5	11	55 Medium-low)
Operational phase	3	2	5	2	4	5	11	55 (Medium-low)
Decommissioning and Closure	2	2	5	1	3	4	9	36 (low)
Managed								
Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	1	5	1	3	3	9	36 (Low)
Operational phase	3	1	5	1	3	3	9	36 (Low)
Decommissioning and Closure	1	1	5	1	3	2	9	18 (Very Low)

Mitigation measures

Activity	*Vehicular traffic and construction activities*
Project phase	*Construction phase, operational and decommissioning phase*
Impact Summary	*Compression from mechanical construction implements and vehicle traffic may cause severe and potentially irreversible soil compaction particularly for wet based soils*
Management Measures	***Proposed mitigation and management measures:*** - *All vehicular traffic should be restricted to the existing service roads as far as practically possible;* - *Vegetation clearance and commencement of construction activities can be scheduled to coincide with low rainfall conditions when soil moisture is anticipated to be relatively low, such that the soils are less prone to compaction;* - *Unnecessary surface disturbance of the identified Kimberly/Plooysburg soil forms can be avoided where possible to minimise the intensity of compaction due to their loamy sand texture.*

5.1.3 Impact: Potential Soil Contamination

All the identified soils are considered equally predisposed to potential contamination, as contamination sources are generally unpredictable and often occur as incidental spills or leak for construction developments. The significance of soil contamination is considered to be medium-high for all identified soils, largely depending on the nature, volume and/or concentration of the contaminant of concern. Therefore, strict waste management protocols and activity specific Environmental Management Programme (EMP) guidelines should be adhered to during the construction activities.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential inadequate design of infrastructure leading to risks of contamination of soils.	Potential indiscriminate disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.	Potential leakages in mining machinery leading to contamination.	Contamination of soils during demolition activities and backfilling.
	Potential leakages in mining machinery leading to contamination.		Potential contamination from the decommissioning of mining infrastructure.

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	4	4	2	2	7	8	56 (Medium-low)

Unmanaged								
Operational phase	3	4	4	2	4	7	10	70 (Medium-low)
Decommissioning and Closure	3	4	4	2	2	7	8	56 (Medium-low
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	4	1	3	5	8	40 (Low)
Operational phase	2	3	4	1	4	5	9	45 (Low)
Decommissioning and Closure	2	3	4	1	3	5	8	40 (Low)

Mitigation measures

Activity	*Spills and/or leaks of potentially hazardous substances from mining machinery/equipment*
Project phase	*Construction phase*
Impact Summary	*Soil contact with potentially hazardous or toxic substances*
Management Measures	***Proposed mitigation and management measures:***
	- *Contamination prevention measures should be addressed in the Environmental Management Programme (EMP) for the proposed development, and this should be implemented and made available and accessible at all times to the contractors and construction crew conducting the works on site for reference;* - *A spill prevention and emergency spill response plan, as well as dust suppression, and fire prevention plans should also be compiled to guide the construction works;* - *An emergency response contingency plan should be put in place to address clean-up measures should a spill and/or a leak occur, as well as preventative measures to prevent ingress; and* - *Burying of any waste including rubble, domestic waste, empty containers on the site should be strictly prohibited and all construction rubble waste must be removed to an approved disposal site.*

5.1.4 Impact: Loss of Agricultural Land Capability

The proposed mining activities is not anticipated to result in significant loss of agricultural land capability since the majority of the soils where mining and associated infrastructure is to occur are not considered to contribute substantially to the provincial and national grid. Low crop yields are foreseen for this area due to climatic constraints and lack of irrigation options. The land capability loss is anticipated to range between medium and low for Kimberly/Plooysburg, Mispah and Glenrosa as these soils are not considered ideal for cultivation, attributable to their shallow nature and high erosion hazard. From a land capability perspective, Witbank (anthrosols) soils have no bearing on agricultural production, and as such the impacts on these soils is anticipation to be low.

Aspects and activities register

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential poor planning leading to risks of excessive soil contamination	Site clearing, the removal of vegetation, and associated disturbances to soils, leading to increased nutrient leaching, runoff and erosion and consequent sedimentation	Ongoing disturbance as a result of maintenance activities, leading to altered terrestrial vegetation community structures, and consequently altering the quality and nutrient status of the soil	Compaction and contamination of soils during demolition activities and backfilling.
	Potential indiscriminate disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.		Decommissioning activities may lead to soil transformation and increased alien plant species proliferation, which will ultimately alter the chemical composition and nutrient status of the soil.
			Disturbance of soils as part of closure as well as backfilling, which may lead to the formation of Witbank soils (Anthrosols) which reduce long term land capability.

Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	4	4	2	2	7	8	56 (Medium-low)
Operational phase	3	4	4	2	4	7	10	70 (Medium-low)
Decommissioning and Closure	3	4	3	2	4	7	9	63 (Medium-low)
Managed								
Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	2	4	1	2	5	7	35 (Low)
Operational phase	2	2	3	1	3	4	7	28 (Low)
Decommissioning and Closure	2	2	3	1	3	4	7	28 (Low)

Mitigation measures

Activity	*Vegetation clearance and associated physical construction activities*
Project phase	*All phases*
Impact Summary	*Loss of agricultural production and/or sheep grazing*
Management Measures	***Proposed mitigation and management measures:*** - *Aim to conduct all construction activities during the dry season to avoid unprecedented delays;* - *Disturbed soils can be lightly ripped to at least 25 cm, where feasible to alleviate soil compaction and subsequently re-vegetated with indigenous grass to alleviate soil compaction and minimize erosion.* - *The recommended ripping and re-vegetation, if necessary, can be implemented concurrently on the subsections where construction works are complete;* - *Project footprint should be minimised, where feasible, to ensure that there are sufficient soil resources for the duration of mining activities to support potential grazing*

5.1.5 Cumulative impacts

The surrounding areas within which the proposed mine is to occur are dominated grazing and wilderness land uses, and no cultivated agricultural activities were observed in the vicinity. This is largely attributable to the climatic constraints, particularly rainfall as well as limited irrigation options which further disqualifies the area from being ideal for agricultural production. Therefore, the proposed mining project is anticipated to insignificantly contribute to the cumulative loss of arable land and low cumulative loss of the herbaceous material for grazing after mitigation measures have been put in place. Therefore, from a soil and land capability point of view, the addition to the cumulative impact footprint of the region is considered relatively minor.

5.2 Public Consultation

The Scoping Phase Public Meeting was held on the 9th of February 2018, and the Scoping Report was made available for public review between the 27th of March – 29th of April 2018, whereby Interested and Affected Parties (I&APs) were allowed to comment on the proposed project. A second Public Meeting is scheduled for the 29th of August 2018 to summarise the findings from the specialist studies for I&APs, which will be held concurrently with the public review of the EIA EMP report. Any comments received during the second round of public review will be addressed accordingly.

5.2.1 Brief Summary of Concerns and Issues Raised By I&APs

The following table summarises the issues raised by I&AP's during the Scoping phase public consultation on the relevant specialist report.

Comment received by I&AP's during Scoping Phase	Response
Proximity of the Kalk Gat Reserve to the proposed operations. This is a protected area. Appropriate buffer zones must be recommended and established	With reference to the comments concerning the Kalk Gat Private Reserve, although the western portion of the MRA does border the reserve, the actual focus area is located approximately 6km north-east of this reserve, and as such mining activities, provided mitigation measure are suitable implemented, are unlikely to impact upon the reserve. According to the NEMA Regulations 2017, "buffer" means an area extending 5km from the proclaimed boundary of nature reserve or that defined as such for a biosphere.
Waste generation and management	Refer to Section 5.1.3 for mitigation on contamination management.

6. CONCLUSION

Scientific Aquatic Services (SAS) was appointed to conduct a soil, land use and land capability assessment as part of the environmental assessment and authorisation process for the proposed Kanakies Mining Project over Portion 0 (the Remaining Extent), Kanakies 332, near Loeriesfontein, Northern Cape.

From this assessment, it was found that grazing is the dominant land use within the focus area, with no cultivated agricultural production occurring in the surrounding areas. The proposed mining areas and associated infrastructure are largely dominated by soils such as Kimberly (Ky)/ Plooysburg (Py) with an average effective rooting depth of 300 mm at most due to the layer of refusal as a result of limited weathering of parent material attributable to rainfall constraints. Glenrosa (Gs) and Mispah (Ms) also occur in the south western corner of the focus area associated with water flow paths. Witbank (Wb) soil forms (anthrosols) were also observed within the focus area, and these included railways, tar roads/gravel roads with highly disturbed topsoil material. The areal extent of disturbed soils is 41.21 ha which is 3.08 % of the total investigated focus area. The table below summarises the soils occurring within the focus area and their respective land capability.

Land Capability classes for soil forms identified with the proposed mining sites

Land Capability	Soil Forms	Areal Extent (ha)	Percentage (%)
Grazing - Class VI	Kimberly, Plooysburg	1268.86	94.76
Grazing – Class VII	Glenrosa (Gs) and Mispah (Ms)	28.50	2.13
Wildlife/Wilderness (class VIII)	Witbank (Wb)	41.21	3.08
Other	Property	0.43	0.03

***The percentages were rounded off to two (2) decimal places**

From a land capability point of view, the focus area is comprised of soils with low agricultural potential. At best, the soils within the focus area are suitable for grazing. The very low rainfall in the area infers that the only means of cultivation would be by irrigation. However, based on observation and Google Earth image of the area there are no signs of irrigation infrastructure, only water reservoirs for wildlife was observed. In addition to that, high temperatures occurring in this area are also likely to cause crop wilting, thus affecting crop yield. Given these constraints the extent of the high productivity soils is not considered sufficient for viable cultivated commercial farming. The climatic restrictions and shallowness of the soil mean that the area where the Mining Right Area occurs is best suited for grazing and grazing capacity is low, where the proposed mining is to occur. Commercial farming is considered to be low for the proposed area extent to be affected by mining activities, due to the grazing capacity mentioned above. Therefore, although the proposed area is dominated by soils with a land capability suitable for grazing, it is not considered sufficient for viable small scale commercial farming. Below is the summary of the impact assessment for the proposed mining sites.

Impact 1: Soil erosion

Summary table of the overall impacts for the proposed mining

Phase	Unmanaged	Managed
Construction phase	Medium-low	Low
Operational phase	Medium-low	Low
Decommissioning Phase	Medium-low	Low

Impact 2: Soil compaction

Summary table of the overall impacts

Impact	Unmanaged	Managed
Construction phase	Medium-low	Low
Operational phase	Medium-low	Low
Decommissioning Phase	Medium-low	Very-low

Impact 3: Potential Soil Contamination

Summary table of the overall impacts for the proposed mining

Phase	Unmanaged	Managed
Construction phase	Medium-low	Low
Operational phase	Medium-low	Low
Decommissioning Phase	Medium-low	Low

Impact 4: Loss of agricultural land capability

Summary table of the overall impacts for the proposed mining

Impact	Unmanaged	Managed
Construction phase	Medium-low	Low
Operational phase	Medium-low	Low
Decommissioning Phase	Medium-low	Low

From the findings of this assessment and the proposed integrated mitigation measures, it can therefore be concluded that the anticipated impacts of the proposed mining project on the soil resources and the associated land capability can be reduced to a low level with appropriate mitigation. The proposed mining project is not considered to have significant negative impacts from the soil, land capability and agricultural potential point of view as the soils are of low arability, however it will have a positive impact for the agricultural sector of the region, since the project will ensure that there is adequate supply of gypsum material to ameliorate acidic soils. It must however be noted that the proposed mitigation measures must be integrated in the project execution and implemented accordingly, to minimise cumulative impacts on the soils, and to maintain their current land capability for future land use. It is the opinion of the specialist therefore that this study provides the relevant information required for the Environmental Impact Assessment phase of the project to ensure that the best long-term use of the agricultural resources in the focus area will be made in support of the principle of sustainable development.

7. REFERENCES

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APPENDIX A: METHOD OF ASSESSMENT

Desktop Screening

Prior to commencement of the field assessment, a background study, including a literature review, was conducted in order to collect the pre-determined soil and land capability data in the vicinity of the investigated focus area. Various data sources including but not limited to the Agricultural Geo-Referenced Information System (AGIS) and other sources as listed under references were used for the assessment.

Soil Classification and Sampling

A soil survey was conducted from 11 September to 14 September 2017 by a qualified soil specialist, at which time the identified soils within the infrastructure areas and associated access roads were classified into soil forms according to the Taxonomic Soil Classification System for South Africa (1991). Subsurface soil observations were made using a manual hand auger in order to assess individual soil profiles, which entailed evaluating physical soil properties and prevailing limitations to various land uses.

Land Capability Classification

Agricultural potential is directly related to Land Capability, as measured on a scale of I to VIII, as presented in Table 2 below; with Classes I to III classified as prime agricultural land that is well suitable for annual cultivated crops. Whereas, Class IV soils may be cultivated under certain circumstances and management practices, whereas Land Classes V to VIII are not suitable to cultivation. Furthermore, the climate capability is also measured on a scale of 1 to 8, as illustrated in Table 3 below. The land capability rating is therefore adjusted accordingly, depending on the prevailing climatic conditions as indicated by the respective climate capability rating. The anticipated impacts of the proposed land use on soil and land capability were assessed in order to inform the necessary mitigation measures.

Table A1: Land Capability Classification (Scotney et al., 1987)

Land Capability Group	Land Capability Class	Increased intensity of use									Limitations
Arable	I	W	F	LG	MG	IG	LC	MC	IC	VIC	No or few limitations. Very high arable potential. Very low erosion hazard
	II	W	F	LG	MG	IG	LC	MC	IC	-	Slight limitations. High arable potential. Low erosion hazard
	III	W	F	LG	MG	IG	LC	MC	-	-	Moderate limitations. Some erosion hazards
	IV	W	F	LG	MG	IG	LC	-	-	-	Severe limitations. Low arable potential. High erosion hazard.
Grazing	V	W	-	LG	MG	-	-	-	-	-	Water course and land with wetness limitations
	VI	W	F	LG	MG	-	-	-	-	-	Limitations preclude cultivation. Suitable for perennial vegetation
	VII	W	F	LG	-	-	-	-	-	-	Very severe limitations. Suitable only for natural vegetation
Wildlife	VIII	W	-	-	-	-	-	-	-	-	Extremely severe limitations. Not suitable for grazing or afforestation.

W - Wildlife; F - Forestry; LG - Light grazing
MG – Moderate grazing; IG - Intensive grazing; LC - Light cultivation
MC - Moderate cultivation; IC - Intensive cultivation.; VIC – Very intensive cultivation

Table A2: Climate Capability Classification (Scotney et al., 1987)

Climate Capability Class	Limitation Rating	Description
C1	None to slight	Local climate is favourable for good yield for a wide range of adapted crops throughout the year.
C2	Slight	Local climate is favourable for good yield for a wide range of adapted crops and a year round growing season. Moisture stress and lower temperatures increase risk and decrease yields relative to C1.
C3	Slight to moderate	Slightly restricted growing season due to the occurrence of low temperatures and frost. Good yield potential for a moderate range of adapted crops.
C4	Moderate	Moderately restricted growing season due to low temperatures and severe frost. Good yield potential for a moderate range of adapted crops but planting date options more limited than C3.
C5	Moderate to severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss.
C6	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops for which frequently experience yield loss.
C7	Severe to very severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	Very severe	Very severely restricted choice of crops due to heat and moisture stress. Suitable crops at high risk of yield loss.

Impact Assessment

The identified 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 wellbeing, 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.
- **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

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

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 necessary2.

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 model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act (No. 108 of 1997) 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.

LIKELIHOOD DESCRIPTORS

Table A3: Criteria for assessing significance of impacts

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

CONSEQUENCE DESCRIPTORS

Severity of impact	**RATING**
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

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

Development specific/ within the site boundary / < 100ha impacted / Linear features affected < 1000m	2
Local area/ within 1 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m	3
Regional within 5 km of the site boundary / < 5000ha impacted / Linear features affected < 10 000m	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 A4: Significance Rating Matrix.

	CONSEQUENCE (Severity + Spatial Scope + Duration)														
LIKELIHOOD (Frequency of activity + Frequency of impact)	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 A5: Positive/Negative Mitigation Ratings.

Significance Rating	Value	Negative Impact Management Recommendation	Positive Impact Management Recommendation
Very high	126-150	Critically consider the viability of proposed projects Improve current management of existing projects significantly and immediately	Maintain current management
High	101-125	Comprehensively consider the viability of proposed projects Improve current management of existing projects significantly	Maintain current management
Medium-high	76-100	Consider the viability of proposed projects Improve current management of existing projects	Maintain current management
Medium-low	51-75	Actively seek mechanisms to minimise impacts in line with the mitigation hierarchy	Maintain current management and/or proposed project criteria and strive for continuous improvement
Low	26-50	Where deemed necessary seek mechanisms to minimise impacts in line with the mitigation hierarchy	Maintain current management and/or proposed project criteria and strive for continuous improvement
Very low	1-25	Maintain current management and/or proposed project criteria and strive for continuous improvement	Maintain current management and/or proposed project criteria and strive for continuous improvement

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develop or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for prospecting activities and decommissioning and rehabilitation;
- If applicable, transboundary or global effects were assessed;
- Individuals or groups who may be differentially or disproportionately affected by the project because of their *disadvantaged* or *vulnerable* status were assessed.
- Particular attention was paid to describing any residual impacts that will occur after rehabilitation.

Mitigation measure development

According to the DEA *et al.,* (2013) "Rich biodiversity underpins the diverse ecosystems that deliver ecosystem services that are of benefit to people, including the provision of basic services and goods such as clean air, water, food, medicine and fibre; as well as more complex services that regulate and mitigate our climate, protect people and other life forms from natural disaster and provide people with a rich heritage of nature-based cultural traditions. Intact ecological infrastructure contributes significant savings through, for example, the regulation of natural hazards such as storm surges and flooding by which is attenuated by wetlands".

According to the DEA *et al.,* (2013) Ecosystem services can be divided into 4 main categories:

- Provisioning services are the harvestable goods or products obtained from ecosystems such as food, timber, fibre, medicine, and fresh water;
- Cultural services are the non-material benefits such as heritage landscapes and seascapes, recreation, ecotourism, spiritual values and aesthetic enjoyment;
- Regulating services are the benefits obtained from an ecosystem's control of natural processes, such as climate, disease, erosion, water flows, and pollination, as well as protection from natural hazards; and
- Supporting services are the natural processes such as nutrient cycling, soil formation and primary production that maintain the other services.

Loss of biodiversity puts aspects of the economy, wellbeing and quality of life at risk, and reduces socio-economic options for future generations. This is of particular concern for the poor in rural areas who have limited assets and are more dependent on common property resources for their livelihoods. The importance of maintaining biodiversity and intact ecosystems for ensuring on-going provision of ecosystem services, and the consequences of ecosystem change for human well-being, were detailed in a global assessment entitled the Millennium Ecosystem Assessment (MEA, 2005), which established a scientific basis for the need for action to enhance management and conservation of biodiversity.

Sustainable development is enshrined in South Africa's Constitution and laws. The need to sustain biodiversity is directly or indirectly referred to in a number of Acts, not least the National Environmental Management: Biodiversity Act (No. 10 of 2004) (hereafter referred to as the Biodiversity Act), and is fundamental to the notion of sustainable development. In addition International guidelines and commitments as well as national policies and strategies are important in creating a shared vision for sustainable development in South Africa (DEA *et al.,* 2013).

The primary environmental objective of the Mineral and Petroleum Resources Development Act (MPRDA) is to give effect to the environmental right contained in the South African Constitution. Furthermore, Section 37(2) of the MPRDA states that "any prospecting or mining operation must be conducted in accordance with generally accepted principles of sustainable development by integrating social, economic and environmental factors into the planning and implementation of prospecting and mining projects in order to ensure that exploitation of mineral resources serves present and future generations".

Pressures on biodiversity are numerous and increasing. According to the DEA *et al.,* (2013) Loss of natural habitat is the single biggest cause of biodiversity loss in South Africa and much of the world. The most severe transformation of habitat arises from the direct conversion of natural habitat for human requirements, including[3]:

- Cultivation and grazing activities;
- Rural and urban development;
- Industrial and mining activities, and
- Infrastructure development.

Impacts on biodiversity can largely take place in four ways (DEA *et al.,* 2013):

- **Direct impacts:** are impacts directly related to the project including project aspects such as site clearing, water abstraction and discharge of water from riverine resources;
- **Indirect impacts:** are impacts associated with a project that may occur within the zone of influence in a project such as surrounding terrestrial areas and downstream areas on water courses;
- **Induced impacts:** are impacts directly attributable to the project but are expected to occur due to the activities of the project. Factors included here are urban sprawl and the development of associated industries; and
- **Cumulative impacts:** can be defined as the sum of the impact of a project as well as the impacts from past, existing and reasonably foreseeable future projects that would affect the same biodiversity resources. Examples include numerous mining operations within the same drainage catchment or numerous residential developments within the same habitat for faunal or floral species.

Given the limited resources available for biodiversity management and conservation, as well as the need for development, efforts to conserve biodiversity need to be strategic, focused and supportive of sustainable development. This is a fundamental principle underpinning South Africa's approach to the management and conservation of its biodiversity and has resulted the definition of a clear mitigation strategy for biodiversity impacts.

'Mitigation' is a broad term that covers all components of the 'mitigation hierarchy' defined hereunder. It involves selecting and implementing measures – amongst others – to conserve biodiversity and to protect, the users of biodiversity and other affected stakeholders from potentially adverse impacts as a result of mining or any other land use. The aim is to prevent adverse impacts from occurring or, where this is unavoidable, to limit their significance to an acceptable level. Offsetting of impacts is considered to be the last option in the mitigation hierarchy for any project.

The mitigation hierarchy in general consists of the following in order of which impacts should be mitigated (DEA *et al.,* 2013):

- **Avoid/prevent impact:** can be done through utilising alternative sites, technology and scale of projects to prevent impacts. In some cases if impacts are expected to be too high the "no project" option should also be considered, especially where it is expected that the lower levels of mitigation will not be adequate to limit environmental damage and eco-service provision to suitable levels;
- **Minimise impact:** can be done through utilisation of alternatives that will ensure that impacts on biodiversity and ecoservices provision are reduced. Impact minimisation is considered an essential part of any development project;
- **Rehabilitate impact:** is applicable to areas where impact avoidance and minimisation are unavoidable where an attempt to re-instate impacted areas and return them to conditions which are ecologically similar to the pre-project condition or an agreed post project land use, for example arable land. Rehabilitation can however not be considered as the primary mitigation tool as even with significant resources and effort rehabilitation that usually does not lead to adequate replication of the diversity and complexity of the natural system. Rehabilitation often only restores ecological function to some degree to avoid ongoing negative impacts and to minimise aesthetic damage to the setting of a project. Practical rehabilitation should consist of the following phases in best practice:

[3] Limpopo Province Environment Outlook. A Report on the State of the Environment, 2002. Chapter 4.

- **Structural rehabilitation** which includes physical rehabilitation of areas by means of earthworks, potential stabilisation of areas as well as any other activities required to develop a long terms sustainable ecological structure;
- **Functional rehabilitation** which focuses on ensuring that the ecological functionality of the ecological resources on the focus area supports the intended post closure land use. In this regard special mention is made of the need to ensure the continued functioning and integrity of wetland and riverine areas throughout and after the rehabilitation phase;
- **Biodiversity reinstatement** which focuses on ensuring that a reasonable level of biodiversity is re-instated to a level that supports the local post closure land uses. In this regard special mention is made of re-instating vegetation to levels which will allow the natural climax vegetation community of community suitable for supporting the intended post closure land use; and
- **Species reinstatement** which focuses on the re-introduction of any ecologically important species which may be important for socio-cultural reasons, ecosystem functioning reasons and for conservation reasons. Species re-instatement need only occur if deemed necessary.

➢ **Offset impact:** refers to compensating for latent or unavoidable negative impacts on biodiversity. Offsetting should take place to address any impacts deemed to be unacceptable which cannot be mitigated through the other mechanisms in the mitigation hierarchy. The objective of biodiversity offsets should be to ensure no net loss of biodiversity. Biodiversity offsets can be considered to be a last resort to compensate for residual negative impacts on biodiversity.

The significance of residual impacts should be identified on a regional as well as national scale when considering biodiversity conservation initiatives. If the residual impacts lead to irreversible loss or irreplaceable biodiversity the residual impacts should be considered to be of *very high significance* and when residual impacts are considered to be of *very high significance*, offset initiatives are not considered an appropriate way to deal with the magnitude and/or significance of the biodiversity loss. In the case of residual impacts determined to have *medium to high significance*, an offset initiative may be investigated. If the residual biodiversity impacts are considered of low significance no biodiversity offset is required.[4]

In light of the above discussion the following points present the key concepts considered in the development of mitigation measures for the proposed development.

➢ Mitigation and performance improvement measures and actions that address the risks and impacts[5] are identified and described in as much detail as possible.

➢ Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation.

➢ Desired outcomes are defined and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, with estimates of the resources (including human resource and training requirements) and responsibilities for implementation wherever possible.

Recommendations

Recommendations were developed to address and mitigate impacts associated with the proposed development. These recommendations also include general management measures which apply to the proposed development as a whole. Mitigation measures have been developed to address issues in all phases throughout the life of the operation from planning, through to construction and operation.

[4] Provincial Guideline on Biodiversity Offsets, Western Cape, 2007.

[5] Mitigation measures should address both positive and negative impacts

APPENDIX B: DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Braveman Mzila BSc (Hons) Environmental Hydrology (University of KwaZulu-Natal)

Stephen van Staden MSc (Environmental Management) (University of Johannesburg)

1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

1. (b) A declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

Signature of the Project Manager

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing member, Ecologist, Aquatic Ecologist
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO)
Member of the Gauteng Wetland Forum

EDUCATION

Qualifications

MSc (Environmental Management) (University of Johannesburg)	2002
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2000
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	1999

COUNTRIES OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe
Eastern Africa – Tanzania
West Africa – Ghana, Liberia, Angola, Guinea Bissau
Central Africa – Democratic Republic of the Congo

SELECTED PROJECT EXAMPLES

Development compliance studies

- Project co-leader for the development of the EMP for the use of the Wanderers stadium for the Ubuntu village for the World Summit on Sustainable Development (WSSD).
- Environmental Control Officer for Eskom for the construction of an 86Km 400KV power line in the Rustenburg Region.
- Numerous Environmental Impact Assessment (EIA) and EIA exemption applications for township developments and as part of the Development Facilitation Act requirements.
- EIA for the extension of mining rights for a Platinum mine in the Rustenburg area by Lonmin Platinum.
- EIA Exemption application for a proposed biodiesel refinery in Chamdor.
- Compilation of an EIA as part of the Bankable Feasibility Study process for proposed mining of a gold deposit in the Lofa province, Liberia.
- EIA for the development of a Chrome Recovery Plant at the Two Rivers Platinum Mine in the Limpopo province, South Africa.
- Compilation of an EIA as part of the Bankable Feasibility Study process for the Mooihoek Chrome Mine in the Limpopo province, South Africa.
- Mine Closure Plan for the Vlakfontein Nickel Mine in the North West Province.

Specialist studies and project management

- Development of a zero discharge strategy and associated risk, gap and cost benefit analyses for the Lonmin Platinum group.
- Development of a computerised water balance monitoring and management tool for the management of Lonmin Platinum process and purchased water.
- The compilation of the annual water monitoring and management program for the Lonmin Platinum group of mines.
- Analyses of ground water for potable use on a small diamond mine in the North West Province.
- Project management and overview of various soil and land capability studies for residential, industrial and mining developments.
- The design of a stream diversion of a tributary of the Olifants River for a proposed opencast coal mine.

- Waste rock dump design for a gold mine in the North West province.
- Numerous wetland delineation and function studies in the North West, Gauteng and Mpumalanga Kwa-Zulu Natal provinces, South Africa.
- Hartebeespoort Dam Littoral and Shoreline PES and rehabilitation plan.
- Development of rehabilitation principles and guidelines for the Crocodile West Marico Catchment, DWAF North West.

Aquatic and water quality monitoring and compliance reporting

- Development of the Resource Quality Objective framework for Water Use licensing in the Crocodile West Marico Water Management Area.
- Development of the Resource Quality Objectives for the Local Authorities in the Upper Crocodile West Marico Water Management Area.
- Development of the 2010 State of the Rivers Report for the City of Johannesburg.
- Development of an annual report detailing the results of the Lonmin Platinum groups water monitoring program.
- Development of an annual report detailing the results of the Everest Platinum Mine water monitoring program.
- Initiation and management of a physical, chemical and biological monitoring program, President Steyn Gold Mine Welkom.
- Aquatic biomonitoring programs for several Xstrata Alloys Mines and Smelters.
- Aquatic biomonitoring programs for several Anglo Platinum Mines.
- Aquatic biomonitoring programs for African Rainbow Minerals Mines.
- Aquatic biomonitoring programs for several Assmang Chrome Operations.
- Aquatic biomonitoring programs for Petra Diamonds.
- Aquatic biomonitoring programs for several coal mining operations.
- Aquatic biomonitoring programs for several Gold mining operations.
- Aquatic biomonitoring programs for several mining operations for various minerals including iron ore, and small platinum and chrome mining operations.
- Aquatic biomonitoring program for the Valpre bottled water plant (Coca Cola South Africa).
- Aquatic biomonitoring program for industrial clients in the paper production and energy generation industries.
- Aquatic biomonitoring programs for the City of Tshwane for all their Waste Water Treatment Works.
- Baseline aquatic ecological assessments for numerous mining developments.
- Baseline aquatic ecological assessments for numerous residential commercial and industrial developments.
- Baseline aquatic ecological assessments in southern, central and west Africa.
- Lalini Dam assessment with focus on aquatic fish community analysis.
- Musami Dam assessment with focus on the FRAI and MIRAI aquatic community assessment indices.

Wetland delineation and wetland function assessment

- Wetland biodiversity studies for three copper mines on the copper belt in the Democratic Republic of the Congo.
- Wetland biodiversity studies for proposed mining projects in Guinea Bissau, Liberia and Angola in West Africa.
- Terrestrial and wetland biodiversity studies for developments in the mining industry.
- Terrestrial and wetland biodiversity studies for developments in the residential commercial and industrial sectors.
- Development of wetland riparian resource protection measures for the Hartbeespoort Dam as part of the Harties Metsi A Me integrated biological remediation program.
- Priority wetland mammal species studies for numerous residential, commercial, industrial and mining developments throughout South Africa.

Terrestrial ecological studies and biodiversity studies

- Development of a biodiversity offset plan for Xstrata Alloys Rustenburg Operations.
- Biodiversity Action plans for numerous mining operations of Anglo Platinum throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plans for numerous mining operations of Assmang Chrome throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plans for numerous mining operations of Xstrata Alloys and Mining throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plan for the Nkomati Nickel and Chrome Mine Joint Venture.
- Terrestrial and wetland biodiversity studies for three copper mines on the copperbelt in the Democratic Republic of the Congo.
- Terrestrial and wetland biodiversity studies for proposed mining projects in Guinea Bissau, Liberia and Angola in West Africa.
- Numerous terrestrial ecological assessments for proposed platinum and coal mining projects.
- Numerous terrestrial ecological assessments for proposed residential and commercial property developments throughout most of South Africa.
- Specialist Giant bullfrog (*Pyxicephalus adspersus*) studies for several proposed residential and commercial development projects in Gauteng, South Africa.
- Specialist Marsh sylph (*Metisella meninx*) studies for several proposed residential and commercial development projects in Gauteng, South Africa.
- Project management of several Red Data Listed (RDL) bird studies with special mention of African grass owl (*Tyto capensis*).

- Project management of several studies for RDL Scorpions, spiders and beetles for proposed residential and commercial development projects in Gauteng, South Africa.
- Specialist assessments of terrestrial ecosystems for the potential occurrence of RDL spiders and owls.
- Project management and site specific assessment on numerous terrestrial ecological surveys including numerous studies in the Johannesburg-Pretoria area, Witbank area, and the Vredefort dome complex.
- Biodiversity assessments of estuarine areas in the Kwa-Zulu Natal and Eastern Cape provinces.
- Impact assessment of a spill event on a commercial maize farm including soil impact assessments.

Fisheries management studies

- Tamryn Manor (Pty.) Ltd. still water fishery initiation, enhancement and management.
- Verlorenkloof Estate fishery management strategising, fishery enhancement, financial planning and stocking strategy.
- Mooifontein fishery management strategising, fishery enhancement and stocking programs.
- Wickams retreat management strategising.
- Gregg Brackenridge management strategising and stream recalibration design and stocking strategy.
- Eljira Farm baseline fishery study compared against DWAF 1996 aquaculture and aquatic ecosystem guidelines.

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF BRAVEMAN MZILA

PERSONAL DETAILS

Position in Company	Wetland Ecologist and Soil Scientist
Date of Birth	03 January 1991
Nationality	South African
Languages	IsiZulu, English
Joined SAS	2017

EDUCATION

Qualifications

BSc (Hons) Environmental Hydrology (University of KwaZulu-Natal)	2013
BSc Hydrology and Soil Science (University of KwaZulu-Natal))	2012

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, KwaZulu-Natal, Eastern Cape

SELECTED PROJECT EXAMPLES

Freshwater Ecological Assessments

- Freshwater ecological assessment as part of the water use authorisation relating to stormwater damage of a tributary of the Sandspruit, Norwood, Gauteng province.
- Wetland verification as part of the environmental assessment and authorization process for the proposed development in Crowthorne extension 67, Gauteng province.
- Freshwater assessment as part of the section 24g rectification process for unauthorised construction related activities that took place on erf 411, Ruimsig extension 9, Gauteng province
- Baseline aquatic and freshwater assessment as part of the environmental assessment and authorisation process for the N11 Ring Road, Mokopane, Limpopo Province
- Wetland Resource Scoping Assessment as Part of the Environmental Assessment and Authorisation Process for the Kitwe TSF Reclamation Project, Kitwe, Zambia
- Wetland delineation as part of the environmental assessment and authorization process for the proposed development in Boden Road, Benoni, Ekurhuleni Metropolitan Municipality, Gauteng Province.

Soil, Land Use and Land Capability Assessments

- Soil, Land Use and Land Capability Assessment as part of the environmental assessment and authorisation process for the proposed Witfontein Railway Siding Project Near Bethal, Mpumalanga Province
- Soil, Land Use and Land Capability Assessment as part of the environmental assessment and authorisation process for the proposed Heuningkranz Mine, Postmasburg, Northern Cape Province

Hydropedological Wetland Impact Assessments

- Hydropedological Assessment as Part of the Environmental Assessment and Authorisation Process for the proposed Vandyksdrift Central Dewatering Project
- Hydropedological Assessment for the Proposed Evander Gold Elikhulu Tailings Storage Facility (TSF) Expansion, Mpumalanga Province
- Hydropedological Assessment as part of the environmental assessment and authorisation process for the proposed Palmietkuilen Mine, Springs, Gauteng Province
- Hydropedological Assessment as part of the environmental assessment and authorisation process for the proposed Uitkomst Colliery Mine expansion, Newcastle, KwaZulu-Natal Province

Soil Rehabilitation Assessments

Soil rehabilitation plan, a water resource assessment and develop a management plan in support of the water use license for the Driefontein operations, Carletonville, Gauteng