APPENDIX I: SOIL, LAND USE, LAND CAPABILITY AND AGRICULTURAL POTENTIAL ASSESSMENT

Reg No. 2019/317777/07
VAT Reg No. TBC
PO Box 751779
Gardenview
2047
Tel: 011 616 7893
Fax: 086 724 3132
Email: admin@sasenvgroup.co.za
www.sasenvironmental.co.za

SOIL, LAND USE, LAND CAPABILITY AND AGRICULTURAL POTENTIAL ASSESSMENT AS PART OF THE ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND AUTHORISATION PROCESS FOR THE PROPOSED VENTILATION SHAFTS AND ASSOCIATED INFRASTRUCTURE AT MARULA PLATINUM MINE, LIMPOPO PROVINCE.

Prepared for

SLR Consulting (Africa) (Pty) Ltd

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Prepared by: Zimpande Research Collaborative
Report author : T. Setsipane
Report reviewers: S. van Staden (Pr.Sci.Nat)
B. Mzila
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SAS Environmental Group of Companies

EXECUTIVE SUMMARY

The Zimpande Research Collaborative (ZRC) was appointed to conduct a soil, land use, land capability and agricultural potential assessment as part of the environmental impact assessment and authorisation process for the proposed ventilation shafts, ore stockpile, power transmission lines and water pipeline. The proposed development footprint area will hereafter be collectively referred to as the "study area" unless referring to individual infrastructure (i.e., ventilation shaft, stockpile area, power transmission lines and water pipelines etc.).

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, as per the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983). High potential agricultural land is defined as land 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). Land Capability Classification is measured on a scale of I to VIII, with the classes of I to III considered as prime agricultural soils and classes V to VIII not suitable for cultivation.

Based on the observations during the site assessment, the dominant land uses within the study area and the surroundings are mining related activities, with residential areas and wilderness/wildlife being the subdominant land uses. No agricultural activities were observed in the immediate vicinity of the study area.

A total of four (4) soil forms were identified within the study area and these include Spionberg/Valsrivier, Brandvlei, Mispah and Witbank. The agricultural potential of these soil forms ranges from restricted to very low, thus rendering the study area to marginally suitable for cultivated agriculture and under intensive management. The poor agricultural potential of these soil forms can be attributed to their inherent characteristics which include but not limited to:

- Poor drainage characteristics;
- Shallow rooting depth due to high clay content in the B horizon;
- Inadequate moisture;
- Bleached topsoils which lack nutrient retention capacity to support optimum growth and production; and
- Disturbed soils due to anthropogenic influences.

The soils of the Spionberg/Valsrivier are associated with poor physical properties induced by high clay content and very strong structure. The high clay content may effectively reduce water infiltration and thus these soils are more prone to waterlogging conditions as well as intensified runoff during high intensity rainfall. This intensified runoff makes the soils more prone to erosion and thus the formation of gullies which are not favourable for most cultivated crops. The strongly developed structure of the soils may impede root growth and thus limit the area to mostly grazing and/or forestry capability. Nutrient uptake by plants may be limited as these soils tend to hold nutrients tightly to the soil colloids due to the high cation exchange capacity (CEC) caused by high clay content, meaning that more nutrients are held on the soil and are not readily available for plant uptake. Nonetheless, should the soils be cultivated, intensive management practices will have to be implemented.

Brandvlei soil types are associated with the accumulation of calcium carbonate over a long period of time. The pH of these soils increases with depth, typically approaching 8 to 8.5 in the sub-soil. This can potentially induce high capacity for metal cations retention, in so doing potentially reducing agricultural productivity through the deficiency of phosphorus and certain trace elements. Calcic soils are typically low in organic matter due to spatially scattered vegetation in the landscape and rapid decomposition of organic matter in arid areas in which they occur.

Mispah soil types are soils associated with poor physical properties for plant root system penetration and water infiltration, due to the limiting impeding layer of the underlying parent material. These Mispah soils are also highly susceptible to erosion due to their poor hydraulic conductivity, thus not suitable for commercial agricultural cultivation.

Witbank soils are considered of very low agricultural potential due to the soils having been subjected to physical disturbance because of human interventions. Such interventions include transportation and deposition of the earth material containing soil. As a result, these soils are unable to support agricultural production unless significant amelioration and rehabilitation takes place .

Table A below represents the soil forms identified within the study area as well as their diagnostic horizons, respectively.

Table A: Identified soil forms within the study area and their respective land capability and land potential.

Soil Form	Land capability	Land Potential	Area (ha)	Percentage
Alluvial Watercourse	Class V	Restricted Potential (L6)	1.51	1.8
Spionsberg/Valsrivier	Class VI	Restricted Potential (L5)	69.21	80.4
Brandvlei	Class VI	Restricted Potential (L5)	3.19	1.4
Mispah	Class VIII	Very Low Potential (L8)	14.64	16.5
Total enclosed			**86.12**	**100**

The findings of this assessment suggest that the relevant soil and climatic limiting factors within the study area for land capability and land use potential for agriculture include the following:

- Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss according to the Climate Capability Classification by Scotney *et al*., 1987;
- High clay content of the Spionberg/Valsrivier soil forms affecting rooting depth and moisture content and low nutrient content of Brandvlei soil form;
- Shallow effective rooting depth due to shallow indurated bedrock of the Mispah and Brandvlei soil forms. As such, these soils are not considered able to contribute significantly to agricultural production on a national or provincial scale;
- Susceptibility to erosion of Mispah soils form; and
- Lack of soil medium for plants and crop growth in rocky soils, areas associated with mine infrastructure and no production within surface water areas.

The cumulative loss from a soil and land capability point of view is not anticipated to be significant as the dominant soils within the project footprint area are not considered ideal for cultivation. In addition, the impact on the soils from each footprint area will be localised as each ventilation shaft has a possible footprint area of less than 0.5 hectare, with the longest distance for the proposed water pipelines and power transmission lines being 5.2 km. It should also be noted that large portions of proposed linear infrastructure (i.e. water pipelines) are located within the road reserves where some impact as a result of edge effects has occurred. The stockpile area is already located under the existing infrastructural area and thus not anticipated to cause any significant impact. The study area is surrounded by residential areas as well as wilderness and is isolated from any large-scale agricultural activities in the area. The development of this area is not anticipated to cause a significant cumulative impact since this area is not under current cultivation and the extent of the area to be impacted is limited. The cumulative impact on the local and regional scale is considered medium-low as the dominant soils are not of high importance from a soil and land capability point of view. However, soil is a scarce, non-renewable resource which need to be protected, conserved and managed in compliance with the CARA, 1983 (Act No. 43 of 1983).

The screening tool analysis was conducted, which presented the findings as the impact on agricultural resources being of a High sensitivity rating. However, the screening tool analysis was found to be in contrast with the filed assessment results. The field assessment results indicated that the soils within the footprint areas to be of low agricultural potential, with no prior cultivation for the past 5 years.

Key mitigation measures to minimise impacts on the soil regime include but are not limited to:

- ➢ The project operations be kept within the demarcated footprint areas which must be well defined;
- ➢ Bare soils within the access roads should be regularly dampened with water to suppress dust during the construction phase, especially when strong wind conditions are predicted according to the local weather forecast;

- A soil monitoring programme should be initiated within the access roads and adjacent areas to ascertain whether the dust suppression has an impact on the soil chemistry; and
- Soil Compaction is usually greatest when soils are moist. Therefore, soils should be stripped when moisture content is as low as possible. If soil must be moved when wet, truck and shovel should be used as bowlscrapers create excessive compaction when moving wet soils.

From a soil and land capability point of view, this project is not regarded as being fatally flawed due to various inherent soil constraints for commercial agricultural production, however mitigation measures and recommendations outlined in this document need to be strongly considered and implemented accordingly in efforts to conserve soil resources.

DOCUMENT GUIDE

Table A: Document guide according to the amended 2017 EIA Regulations (No. R. 326)

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	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	Appendix B
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 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 the site, cumulative impacts of the proposed development and levels of acceptable change	Section 4 and 5
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 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 3
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternative	Section 4
g)	An identification of any areas to be avoided, including buffers	Section 4
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 4
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 1.1
j)	A description of the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 4 and 5
k)	Any mitigation measures for inclusion in the EMPr	Section 5.2
l)	Any conditions for inclusion in the environmental authorisation	Section 4.1
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	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 4 and 5
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	None
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None
q)	Any other information requested by the competent authority	None

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GLOSSARY OF TERMS

Albic	Grey colours, apedal to weak structure, few mottles (<10 %)
Alluvial soil:	A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.
Catena	A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic condition, but having different characteristics due to variation in relief and drainage.
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.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Hard Plinthic	Accumulative of vesicular Fe/Mn mottles, cemented
Hydrophytes:	Plants that are adaptable to waterlogged soils
Lithic	Dominantly weathering rock material, some soil will be present.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the “background colour” referred to as the matrix and the spots or blotches of colour referred to as mottles.
Plinthic Catena	South African plinthic catena is characterised by a grading of soils from red through yellow to grey (bleached) soils down a slope. The colour sequence is ascribed to different Fe-minerals stable at increasing degrees of wetness
Red Apedal	Uniform red colouring, apedal to weak structure, no calcareous
Runoff	Surface runoff is defined as the water that finds its way into a surface stream channel without infiltration into the soil and may include overland flow, interflow and base flow.
Orthic	Maybe dark, chromic or bleached
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.
Soil Map Unit	A description that defines the soil composition of a land, identified by a symbol and a boundary on a map
Soft Plinthic	Accumulation of vesicular Fe/Mn mottles (>10%), grey colours in or below horizon, apedal to weak structure

ACRONYMS

AGIS	Agricultural Geo-Referenced Information Systems
°C	Degrees Celsius.
CARA	Conservation of Agricultural Resources Act
CEC	Cation Exchange Capacity
DEA	Department of Environmental Affairs
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
ET	Evapotranspiration
IUSS	International Union of Soil Sciences
FAO	Food and Agriculture Organization
GIS	Geographic Information System
GPS	Global Positioning System
m	Meter
MAP	Mean Annual Precipitation
NWA	National Water Act
PSD	Particle Size Distribution
SACNASP	South African Council for Natural Scientific Professions
SAS	Scientific Aquatic Services
SOTER	Soil and Terrain
ZRC	Zimpande Research Collaborative

1. INTRODUCTION

The Zimpande Research Collaborative (ZRC) was appointed to conduct a soil, land use, land capability and agricultural potential assessment as part of the environmental impact assessment and authorisation process for the proposed ventilation shafts, ore stockpile, power transmission lines and water pipeline. The proposed development footprint area will hereafter be collectively referred to as the "study area" unless referring to individual infrastructure (i.e., ventilation shaft, stockpile area, power transmission lines and water pipelines etc.). A 50 m zone of influence was applied around the proposed ventilation shafts, power transmission lines and water pipeline to account for the edge effects that will likely occur during all phases of development.

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, as per Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983). High potential agricultural land is defined as land 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*).* Land Capability Classes (LCC) are used to determine the agricultural potential of soils within the study area due to the positive correlation between the agricultural potential and Land Capability Classification. Land Capability Classification is measured on a scale of I to VIII, with the classes of I to III considered as prime agricultural soils and classes V to VIII not suitable for cultivation. Furthermore, the climate capability is also measured on a scale of 1 to 8, as illustrated in Appendix A.

1.1 Project Description

The study area is located approximately 10 km north of the Driekop town and east of the R37 road. The nearest towns from the study area include Mohlaletsi, Madiseng and Tubatse located approximately 17 km east, 16.5 km south and 23 km west respectively. Refer to Figures 1 and 2 indicating the locality of the study area.

Marula now proposes to change their approved layout by establishing additional surface infrastructure, which will require an amendment to Marulas' approved EMPr. The proposed additional surface infrastructure comprises the following:

- The establishment of two additional ventilation shafts;
- The upgrade to refrigeration and ventilation infrastructure at existing ventilation shafts;

- The establishment of additional water pipelines to support the additional ventilation shafts;
- The expansion and establishment of additional power supply and distribution infrastructure in support of the establishment of additional ventilation shaft and upgrades to existing ventilation shafts);
- The establishment of a product stockpile within the existing footprint of the Concentrator Plant;
- The establishment of an additional pipeline to the approved Tailings Storage Facility (TSF); and
- Structural upgrades of the existing change house and compressed airline at the Clapham Shaft Complex.

a. Ventilation shafts and upgrades to refrigeration infrastructure

Marula proposes to establish two new additional ventilation shafts within their existing MRA. An upcast and downcast shaft is proposed. The downcast shafts are used to draw clean air into the underground mine workings, whilst the upcast shaft will vent the “dirty/used” air to the surface. There are also existing ventilation shafts on Driekop 253 KT (Ventilation Shaft 6) and Winnarshoek 250 KT (Ventilation Shaft 5). Ventilation Shaft 7 (located on Winnarshoek 250 KT) was approved as part of the Merensky Reef project but is not constructed to date. An overview of these activities is summarised in Table 1 and Table 2 below.

Table 1: Proposed ventilation infrastructure.

Aspect	Detail	
Proposed establishment of new ventilation shafts - Driekop Shaft	Name	Ventilation Shaft 9.
	Location	Driekop 253 KT (Portion 0)
	Footprint	Within approved footprint of Driekop Shaft 6.
	Technology	Upcast shaft.
	Refrigeration or ventilation infrastructure	Establishment of a new ventilation shaft with surface main fans and electrical rooms.
Proposed establishment of new ventilation shafts - Clapham Shaft	Name	Ventilation Shaft 8.
	Location	Winnarshoek 250 KT (Portion 0)
	Footprint	Approximately 0.5 ha.
	Technology	Downcast shaft.
	Refrigeration or ventilation infrastructure	Establishment of a new bulk air cooler. Establishment of refrigeration plant and condenser cooling towers.

Table 2: Proposed upgrades of ventilation and refrigeration infrastructure.

Aspect	Detail	
Proposed changes and upgrades at existing infrastructure - Driekop Shaft	Name	Ventilation Shaft 6
	Refrigeration or ventilation infrastructure	Establishment of a new bulk air cooler. Establishment of a refrigeration plant and condenser cooling towers.
	Location of infrastructure	Driekop 253 KT (Portion 0)
	Footprint	Within the existing, approved footprint of the Driekop VS 6 shaft area.
Proposed changes and upgrades at existing infrastructure - Clapham Shaft	Name	Ventilation Shaft 5
	Refrigeration or ventilation infrastructure	Establishment of a new bulk air cooler.
	Location of infrastructure	Winnarshoek 250 KT (Portion 0)
	Footprint	Within the existing, approved footprint of the Clapham VS 5 shaft area.
	Name	Ventilation Shaft 7 (Approved but not constructed)
	Refrigeration or ventilation infrastructure	Establishment of surface main fans and electrical rooms.
	Location of infrastructure	Winnarshoek 250 KT (Portion 0)
	Footprint	Approximately 1.8 ha.

b. Upgrades of existing services and infrastructure

Water supply and distribution

Water supply: Raw water required for the proposed project will be sourced from the existing on-site Lebalelo Raw Water Dam (Plant Dam). Marula has sufficient capacity and volume to accommodate the proposed project water requirements and as such no changes are anticipated to the existing water reticulation storage capacities (Plant Dam) or supply demand.

Distribution: The proposed project will require the establishment of pipelines from the Plant Dam to the new ventilation shafts (Driekop Ventilation Shaft 9 and Clapham Ventilation Shaft 8). The proposed HDPE pipelines will have a diameter of approximately 150 mm (0.15 cm) and will be below ground. The proposed pipeline to the Clapham Ventilation Shaft 8 will be approximately 2.1 km in length with a throughput of 24 l/s. The proposed Driekop Ventilation Shaft 9 pipeline will be approximately 5.2 km in length with a throughput of 24 l/s. The water supply pipeline will be fed into the plant room and subsequently through to the cooling tower. The establishment of the proposed Driekop water supply pipeline will have a total area of disturbance of 5 250 m^2/ 0.525 Ha. The establishment of the proposed Clapham water supply pipeline will have a total area of disturbance of 13 000 m^2 / 1.3 Ha.

Wastewater: Wastewater which contains an elevated salt concentration will emanate from the refrigeration process. This wastewater will be pumped into a surface sump (with approximate dimension of 2 m by 2 m). A return pipeline of approximately 50 mm will carry this wastewater back to the Concentrator Plant. The return pipeline will be located within the same below ground trench as the water supply pipeline to the ventilation shafts and will thus not result in any additional land clearance.

Power supply and transmission

Supply: Power is currently supplied to the mine by a consumer Eskom substation which is comprised of 2 x 20 MVA transformers. The power demand is expected to exceed the output from the 2 x 20 MVA transformer in 2025. In addition, the power requirements for the establishment of the new Clapham Ventilation Shaft 8 will need to be accommodated. Marula therefore proposes to increase the existing Eskom yard capacity to 60 MVA by the addition of a 40 MVA transformer. The running load will be 54 MVA. Existing power supply infrastructure is sufficient to support the project components at the remaining ventilation shafts.

Distribution: A new 33 kV overhead transmission line will be established from the on-site Eskom yard to the Clapham Ventilation Shaft 8. A new 33 kV overhead transmission line will also be established from the Driekop Shaft Complex to the new Driekop Ventilation Shaft 9, to supply the new ventilation shaft with power. The new 33 kV overhead transmission line will then be fed into a new step-down transformer located at the Clapham and Driekop ventilation shafts. The 33 kV will be stepped down to 11 kV and then fed into the plant room and ventilation fans. The lengths of the Clapham Ventilation Shaft 8 and the Driekop Ventilation Shaft 9 will be 3.8 km and 3.3 km, respectively.

Disturbance to watercourses: Watercourses within the proposed project area include the Tshwenyane, Mogompane, Motse Rivers and an unnamed tributary of the Moopetsi River (with riparian vegetation), as well as numerous non-perennial and ephemeral drainage lines. The proposed power distribution lines and tower bases will be located within 32 m the existing watercourses. A water use license (WUL) will need to be applied for due to this disturbance, however this will be undertaken separately from this Basic Assessment process.

c. Establishment of a product stockpile

In order to alleviate storage capacity constraints experienced with their current operations, Marula proposes the establishment of an additional product stockpile. The additional product stockpile will reach a maximum capacity of 200 000 tons and will be located within the existing, disturbed footprint of the Concentrator Plant. The proposed location of the product stockpile is disturbed but unlined. The product material is similar to the mine’s existing tailings and is considered low grade ore. The 2015 geochemical waste assessment undertaken by Golder

(Golder, 2015) detailed that the tailings material is classified as a Type 3 waste. The results of the assessment indicated that NO_3 leachate concentrations exceeded the TCT0 threshold in two of the tailing composites. The material was reported to require a Class C liner. Marula will further investigate the liner requirements for the proposed stockpile as part of their WUL application which will be undertaken as a separate process.

Figure 1: Conceptual design of the proposed product stockpile.

d. TSF pipeline

To increase the operational efficiency at the mine, an additional tailings conveyance pipeline is proposed. The proposed additional pipeline will follow the existing overland pipeline route which runs from the Concentrator Plant to the Phase 2 TSF. The additional pipeline will be 4 km in length with an internal diameter of 243 mm and comprised of HDPE lined steel.

Table 3: Locality of the TSF pipeline

Start point	S24° 30' 3.762" E30° 4' 21.895"
Middle point	S24° 30' 30.037" E30° 5' 16.393"
End point	S24° 30' 32.641" E30° 6' 12.020"

e. Upgrade to existing change house (including lamp room) and compressed airline

The current change house and lamp room at the Clapham Shaft Complex has reached its current capacity. An upgrade of the change house (and lamp rooms) is now proposed to accommodate an increase of the labour force for 600 people. The actual construction timeline is expected to begin in 2024 / 2025.. In addition to the upgrade of the Clapham change house, the existing 400 NB compressed air ring main from compressor house to Clapham UG mine will be upgraded from 400 NB to 600 NB. No change to the pipeline pressure is anticipated. The structural upgrades of the change house and compressed air ring main will be undertaken within the existing and disturbed Clapham Shaft Complex footprint and no additional land clearance will be required.

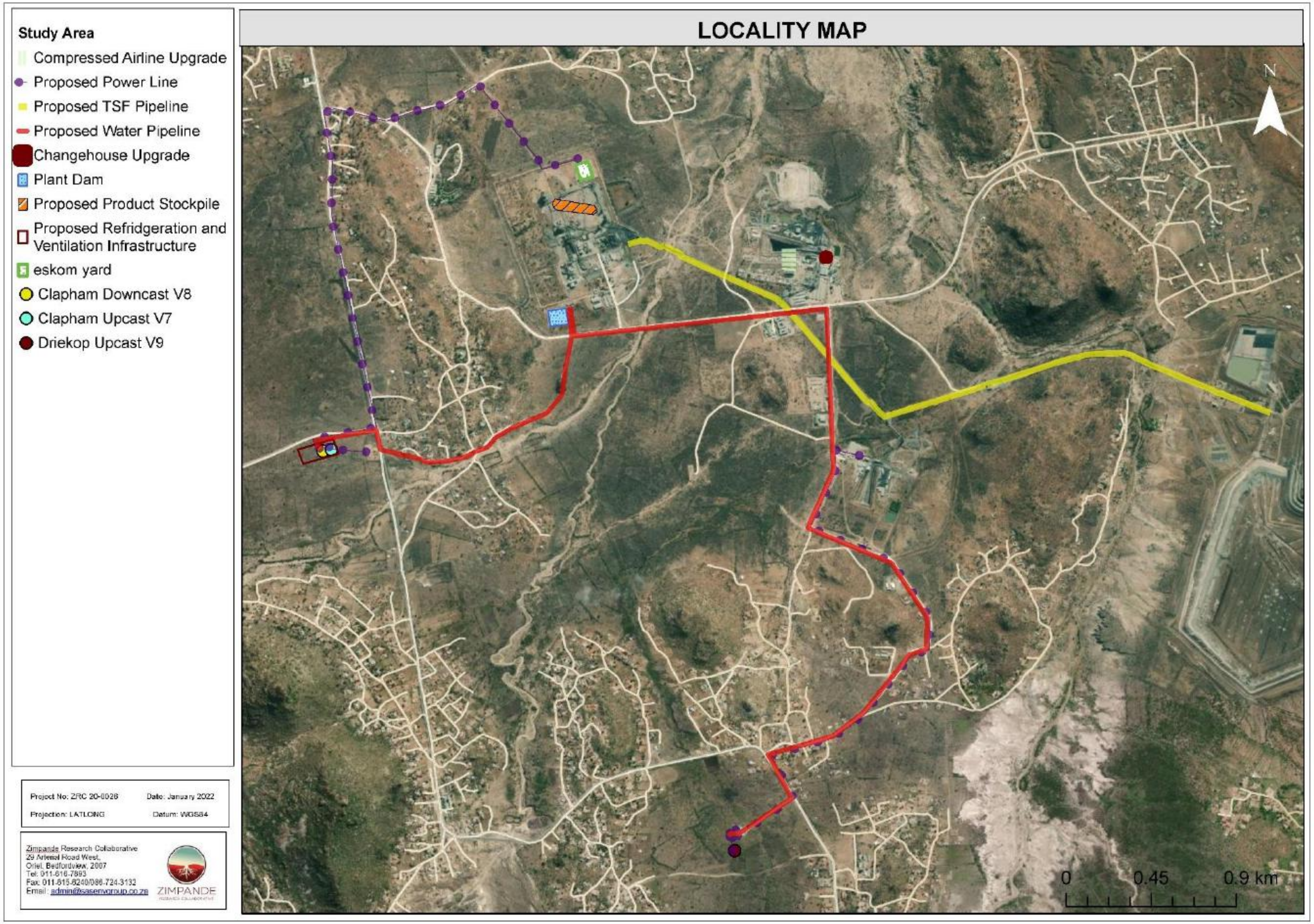


Figure 2: Digital satellite imagery depicting the locality of the study area in relation to the surrounding area.

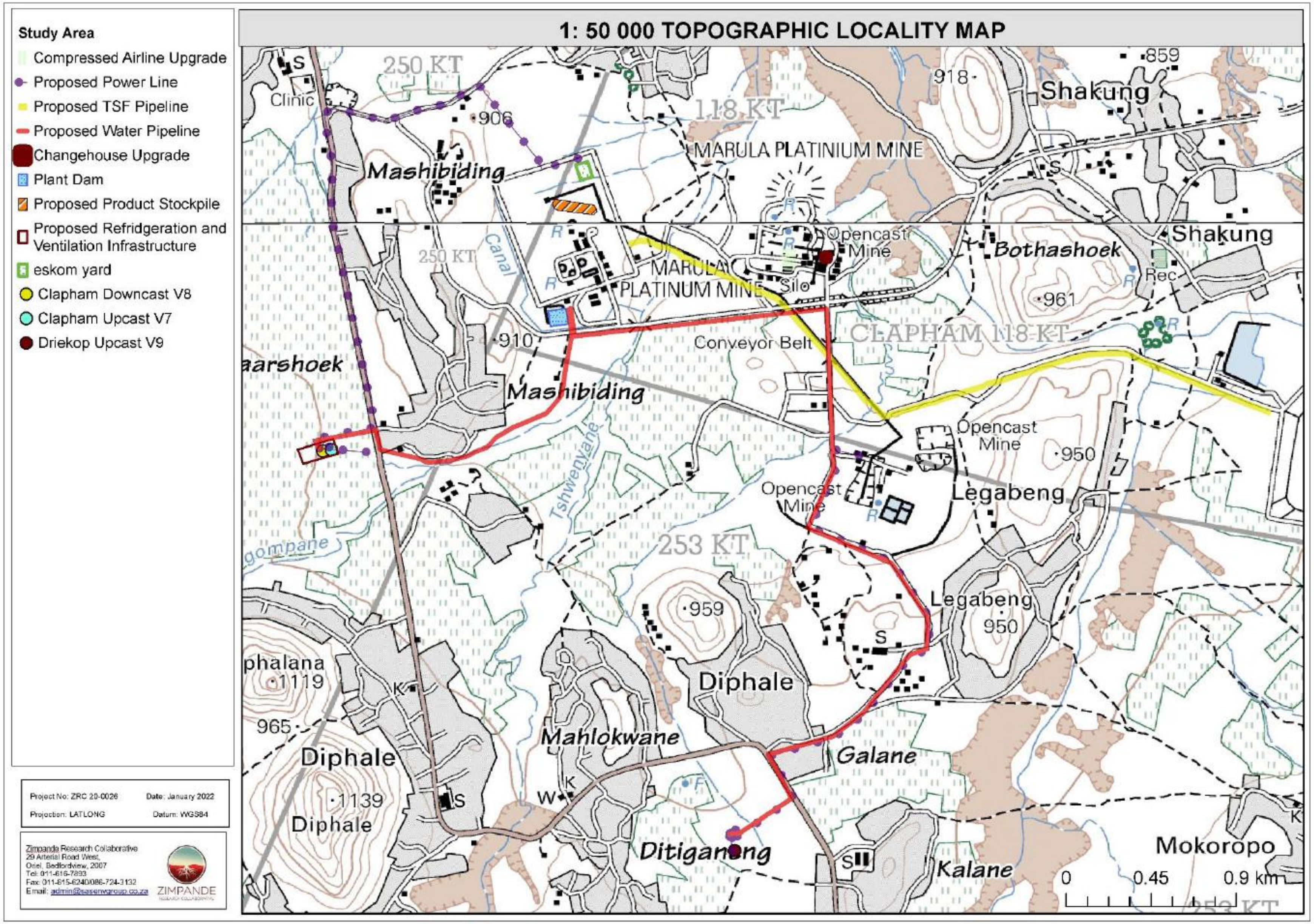


Figure 3: Location of the study area depicted on a 1:50 000 topographical map in relation to surrounding area.

1.2 Terms of Reference and Scope of Work

The soil, land use, land capability and agricultural potential assessment which formed part of the Environmental Authorisation process entailed the following aspects:

- As part of the desktop study various data sets were consulted which includes but not limited to Soil and Terrain dataset (SOTER) to review the geology, landform and land capability to establish broad baseline conditions and sensitivity of study area both on environmental and agricultural perspective;
- Compile various maps depicting the on-site conditions based on desktop review of existing data;
- Classification of the climatic conditions occurring within the study area;
- Conduct a soil classification survey within the proposed development footprint;
- Assess the spatial distribution of various soil types within the study area and classify the dominant soil types according to the South African Soil Classification System: A Natural and Anthropogenic System for South Africa (Soil Classification Working Group, 2018);
- Identify restrictive soil properties on land capability under prevailing conditions;
- Identify and assess the potential impacts in relation to the proposed development using pre-defined impact assessment methodology; and
- Compile soil, land use and land capability report under current on-site conditions based on the field finding data.

1.3 Assumptions and Limitations

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

- The soil survey conducted as part of the land capability assessment was confined within the study area outline. This includes linear and surface infrastructure; and
- Land capability was classified according to the 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.

2. METHOD OF ASSESSMENT

2.1 Literature and Database Review

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

2.2 Soil Classification and Sampling

A soil survey was conducted in November 2020, at which time the identified soils within the study area classified into soil forms according to the Soil Classification System: A Natural and Anthropogenic System for South Africa Soil Classification System (2018). This survey period is deemed appropriate since seasonality does not have an effect on the soil characteristics. 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.

2.3 Land Capability Classification

Agricultural potential is directly related to Land Capability, as measured on a scale of I to VIII, as presented in Table 4 below; with Classes I to III classified as prime agricultural land that is well suited for annual cultivated crops, whereas, Class IV soils may be cultivated under certain circumstances and specific or intensive management practices, and Land Classes V to VIII are not suitable to cultivation. Furthermore, the climate capability is also measured on a scale of C1 to C8, as illustrated in Table 5 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 4: Land Capability Classification (Smith, 2006).

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

VI	W	F	LG	MG						
VII	W	F	LG							
VIII	W									**Wildlife**

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

Table 5: 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.

The land potential assessment entails the combination of climatic, slope and soil condition characteristics to determine the agricultural land potential of the investigated area. The classification of agricultural land potential and knowledge of the geographical distribution of agricultural viable land within an area of interest. This is of importance for making an informed decision about land use. Table 6 below presents the land potential classes, whilst Table 7 presents a description thereof, according to Guy and Smith (1998).

Table 6: Table of Land Potential Classes (Guy and Smith, 1998).

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

Table 7: The Land Capability Classes Description (Guy and Smith, 1998).

Land Potential	Description of Land Potential Class
L1	**Very high potential:** No limitations. Appropriate contour protection must be implemented and inspected.
L2	**High potential:** Very infrequent and/or minor limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L3	**Good potential:** Infrequent and/or moderate limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L4	**Moderate potential:** Moderately regular and/or severe to moderate limitations due to soil, slope, temperature or rainfall. Appropriate permission is required before ploughing virgin land.
L5	**Restricted potential:** Regular and/or moderate to severe limitations due to soil, slope, temperature or rainfall.
L6	**Very restricted potential:** Regular and/or severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L7	**Low potential:** Severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L8	**Very low potential:** Very severe limitations due to soil, slope, temperature or rainfall. Non-arable.

3. DESKTOP ASSESSMENT RESULTS

**It should be noted that some of the database used in this assessment are not the most recent available, thus inaccuracies may exist in the data presented. However, the data presented gives useful background information of the surroundings in terms of the prevailing soil and climatic conditions.*

The following data is applicable to the study area, according to various data sources including but not limited to the Agricultural Geo-referenced Information System (AGIS).

- The Mean Annual Precipitation (MAP) in the vicinity of the study area is estimated to range between 401 and 600 mm per annum. These conditions have a low yield potential for a moderate range of adapted crops but planting date options are limited for supporting rain fed agriculture;
- The Mean Annual Evaporation for the majority of the study area ranges between 2201 and 2200 mm per annum. The high evaporation rates pose risks to plant yield due possible plant permanent wilting resulting in plant desiccation and lack of adequate soil moisture;
- According to the Geology 2001 and the 1:250 000 geological map of South Africa the study area is predominantly underlain by the Rustenburg, Lebowa and Rashoop geological types;
- The dominant parent material for the majority of the study area is the Gabbro;
- The dominant Landform type occurring within the study area is Plain. which means the terrain is suitable to allow agricultural activities;
- The Soil and Terrain (SOTER) database indicates that the majority of the study area is comprised of Calcic Vertisols. These soils are suitable for agricultural cultivation under intensive management;

- The predicted soil loss for the majority of the study area is considered very high;
- The majority of the study area is non-susceptible to wind erosion;
- According to the AGIS database, livestock grazing capacity potential for the majority of the study area is estimated to be approximately 14 - 17 hectares per large animal, the south-western portions of the study area have a potential livestock grazing capacity of 11 - 13 and the north-eastern portion a potential grazing capacity of 18–21 (Figure 4);
- Beneficial water retaining characteristics are scarce or absent;
- According to the AGIS database, the soil medium occurring within the study area is not considered to be saline or sodic; and
- The pH of the most soils occurring within the study area are alkaline with pH range of 7.5 - 8.4. This pH range is suitable for majority of cultivated crops.

Department of Environmental Affairs (DEA) screening tool:

The screening tool was compiled as required by the Environmental Impact Assessment (EIA) Regulations 2014. The findings of the screening tool indicated a high sensitivity to agriculture for the footprint areas, however this analysis was not consistent with the field assessment results as detailed by the site verification (Section 6).

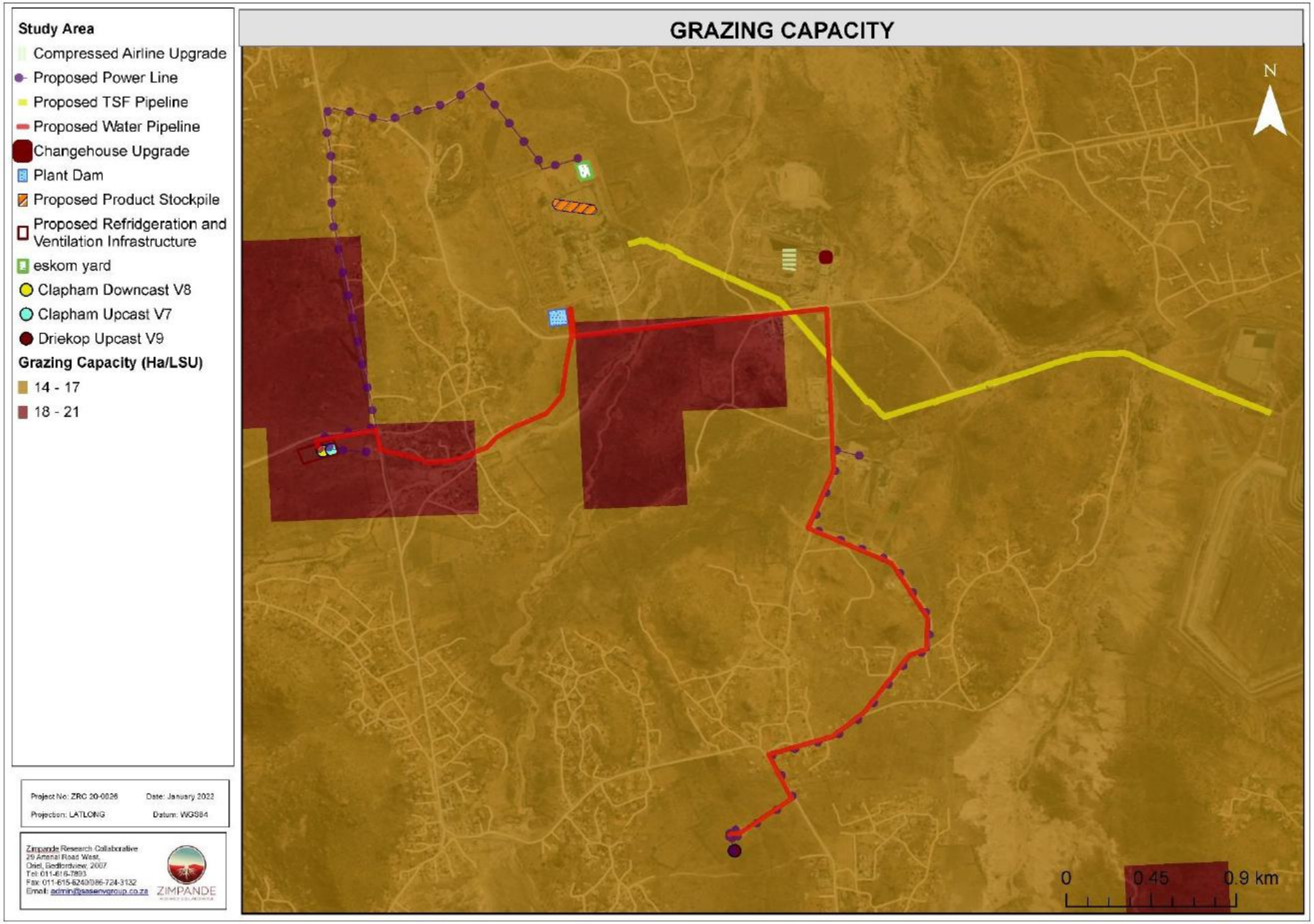


Figure 4: Map depicting the grazing capacity (Ha/LSU) associated with the study area.

4. ASSESSMENT RESULTS

4.1 Current Land Use

Based on the observations during the site assessment, the dominant land uses within the study area are mining related activities, with the sub-dominant uses being residential areas and wilderness/wildlife. No agricultural activities were observed in the immediate vicinity of the study area. Refer to Figure 5 for examples of the current land uses associated with the study area.

Figure 5: Photographs illustrating the dominant land use associated with the study area.

4.2 Dominant Soil Forms

The study area is dominated by marginal to low agricultural potential soils (Spionberg/Valsrivier and Brandvlei). In total, four (4) soil forms were identified within the study area and these include Spionberg/Valsrivier, Brandvlei, Mispah and Witbank. In addition, some rocky outcrops were identified along the study area and transformed soils being used as roads and recreational areas.

The dominant soils of Spionberg/Valsrivier, Brandvlei, Mispah and Witbank are not considered ideal for cultivation due to:

- Poor drainage characteristics;
- Shallow rooting depth due to high clay content in the B horizon;
- Inadequate moisture;
- Bleached topsoils which lack nutrient retention capacity to support optimum growth and production; and
- Disturbed soils due to anthropogenic influences.

The soils of the Spionberg/Valsrivier are associated with poor physical properties induced by high clay content and very strong structure. The high clay content may effectively reduce water infiltration and thus these soils are more prone to waterlogging conditions as well as intensified runoff during high intensity rainfall. This intensified runoff makes the soils more prone to erosion and thus the formation of gullies which are not favourable for most cultivated crops. The strongly developed structure of the soils may impede root growth and thus limit the area to mostly grazing and/or forestry capability. Nutrient uptake by plants may be limited as these soils tend to hold nutrients tightly to the soil colloids due to the high cation exchange capacity (CEC) caused by high clay content, meaning that more nutrients are held on the soil and are not readily available for plant uptake. Nonetheless, should the soils be cultivated, intensive management practices will have to be implemented.

Brandvlei soil types are associated with the accumulation of calcium carbonate over a long period. The pH of these soils increases with depth, typically approaching 8 to 8.5 in the sub-soil (Fey, 2010). This can potentially induce high capacity for metal cations retention, in so doing potentially reducing agricultural productivity through the deficiency of phosphorus and certain trace elements. Calcic soils are typically low in organic matter due to spatially scattered vegetation in the landscape and rapid decomposition of organic matter in arid areas in which they occur (Fey, 2010).

The Mispah soil type is associated with poor physical properties for plant root system penetration and water infiltration, due to the limiting impeding layer of the underlying parent material. The Mispah soil form is also highly susceptible to erosion due to the poor hydraulic conductivity of these soils and thus not suitable for commercial agricultural cultivation.

Witbank soils are considered of very low agricultural potential due to the soils having been subjected to physical disturbance because of human interventions. Such interventions include transportation and deposition of the earth material containing soil. As a result, these soils are unable to support agricultural production unless significant amelioration and rehabilitation takes place.

The soils within the study area can be broadly classified as not capable of supporting agricultural cultivation practices unless an intensive management practice is applied. However, grazing activities as well as wildlife/wilderness can be supported. Table 8 below represents the soil forms identified within the study area as well as their diagnostic horizons respectively. Figures 6, 7, 8 and 9 illustrates the dominant soil forms associated with the study area.

Table 8: Dominant soil forms within the study area.

Soil Form	Code	Diagnostic Horizon Sequence
Spionsberg/Valsrivier	Sb/Va	Orthic A/Pedocutanic or Hardrock
Brandvlei	Br	Orthic A/Soft Carbonate/Hardrock or Hard Carbonate
Mispah	Ms	Orthic A/Hard Rock
Witbank	Wt	Anthrosols

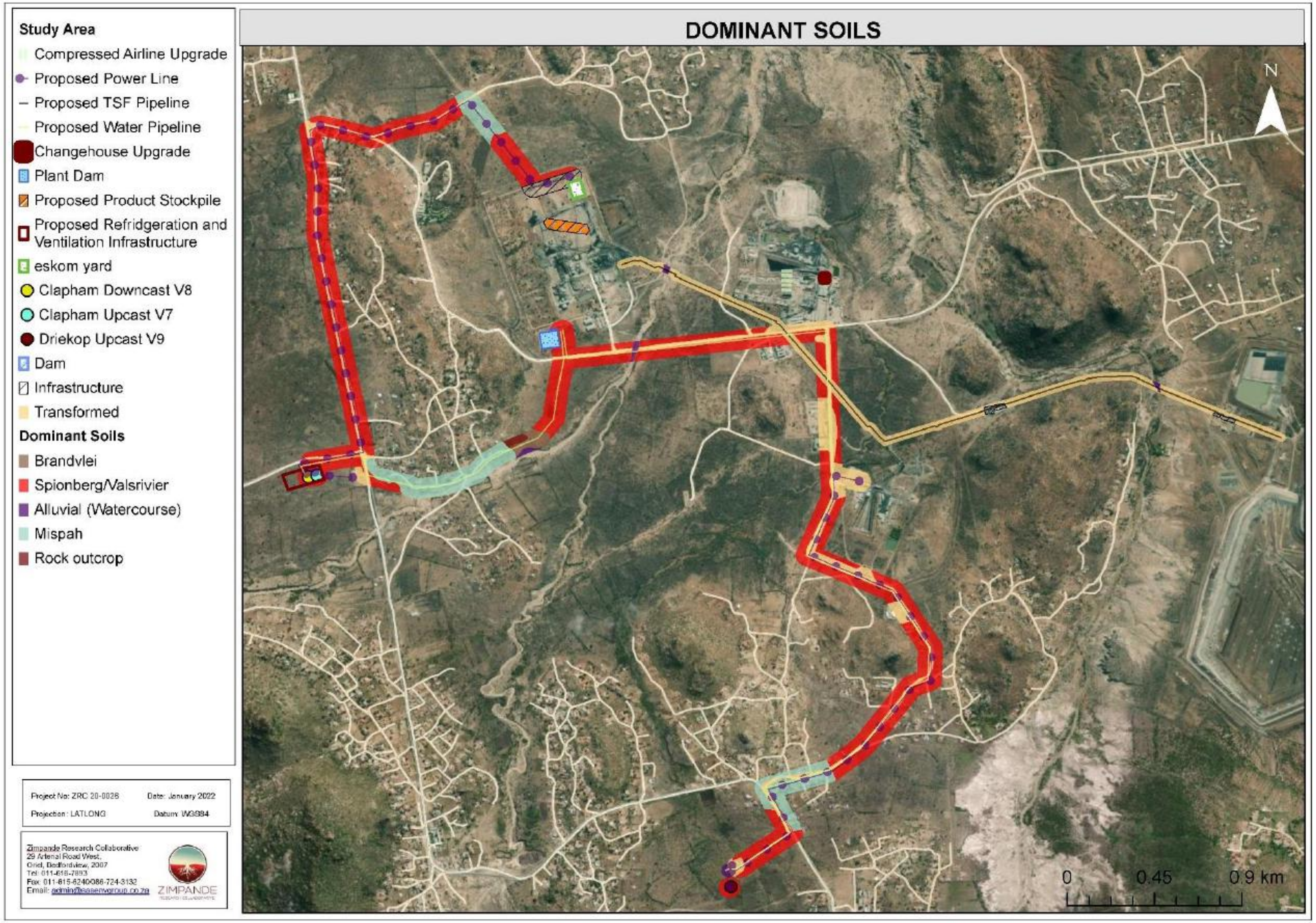


Figure 6: Dominant soils forms within the study area.

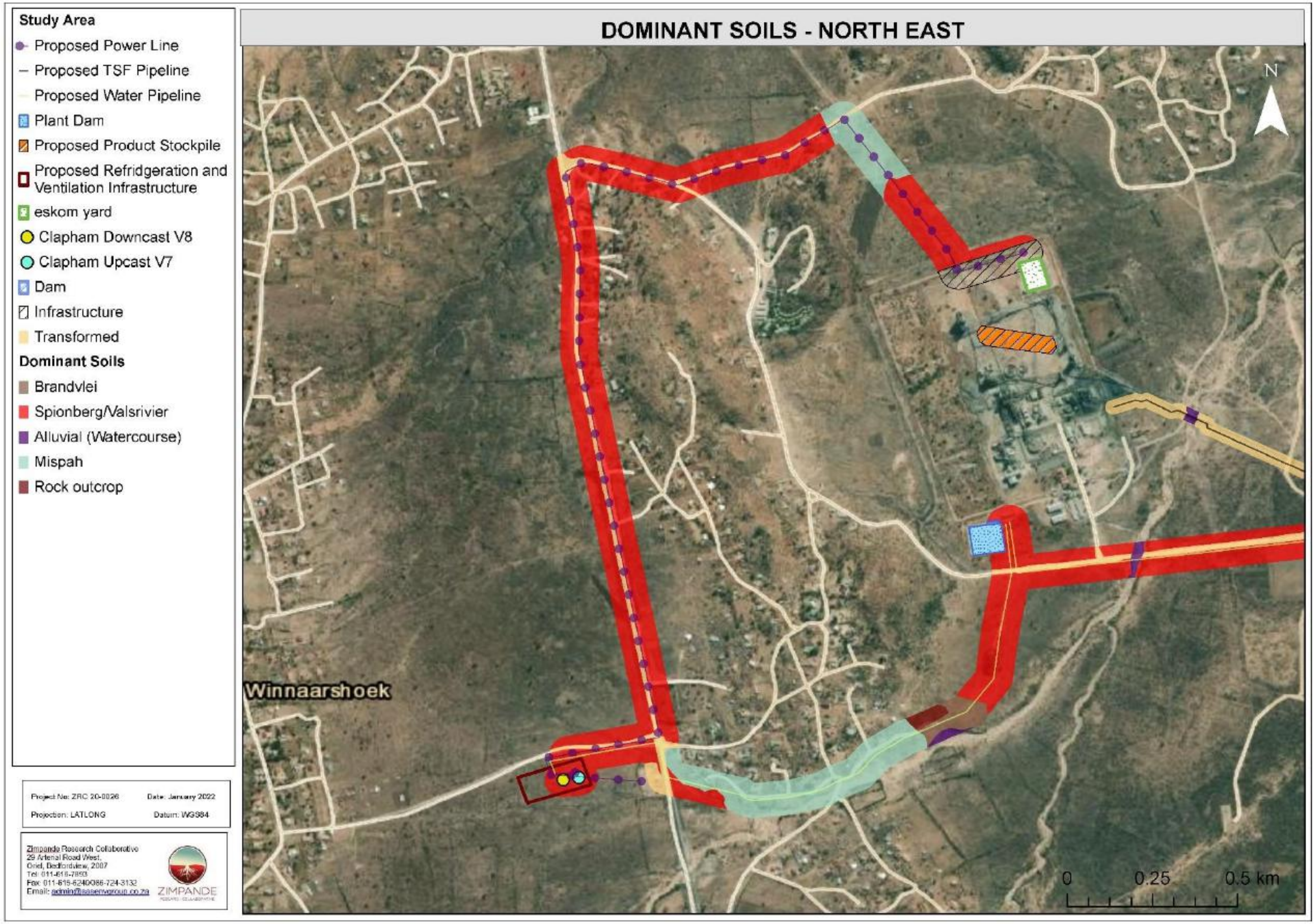


Figure 7: Dominant soils forms within the north-eastern portion of the study area.

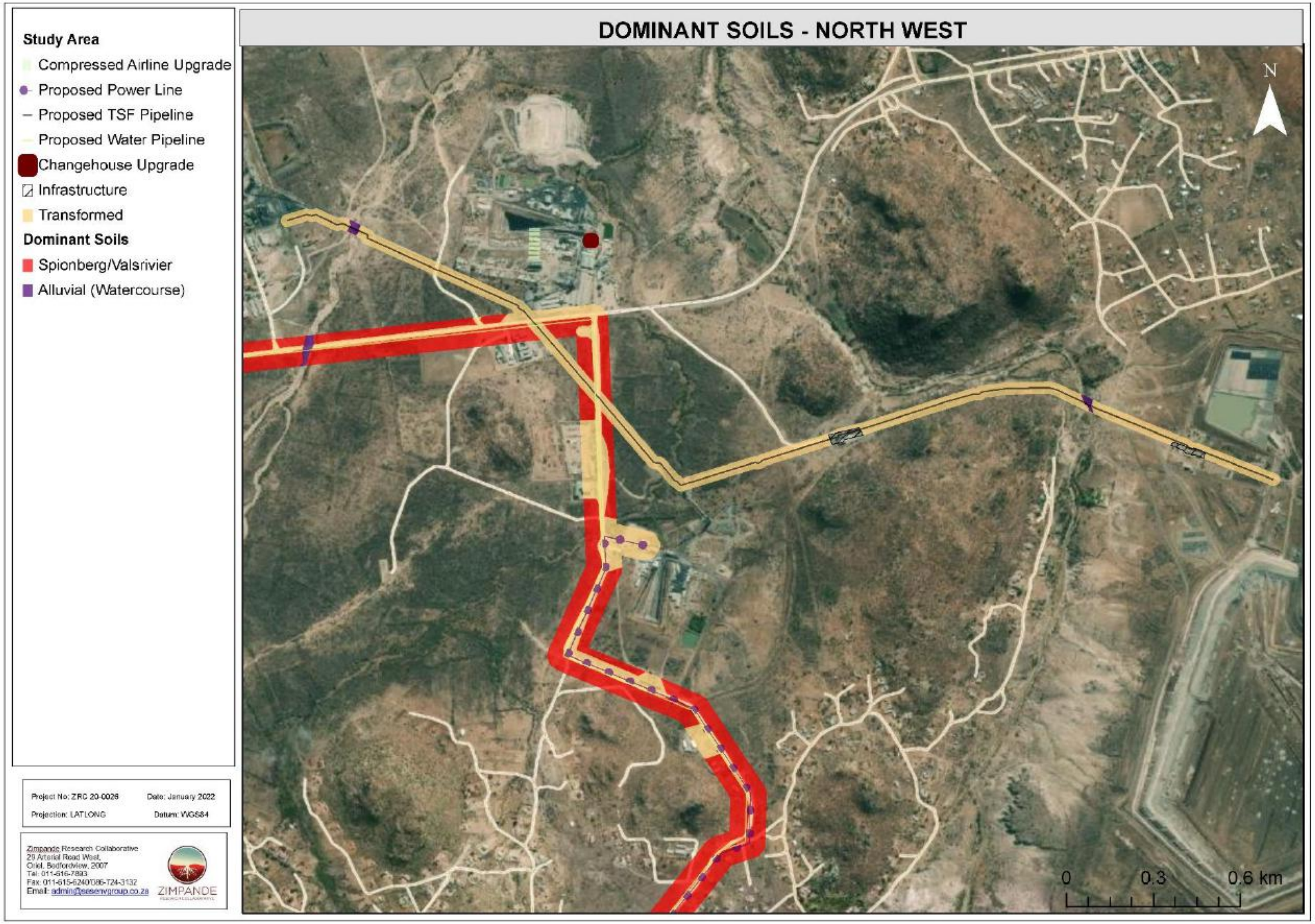


Figure 8: Dominant soils forms within the north-western portion of the study area.

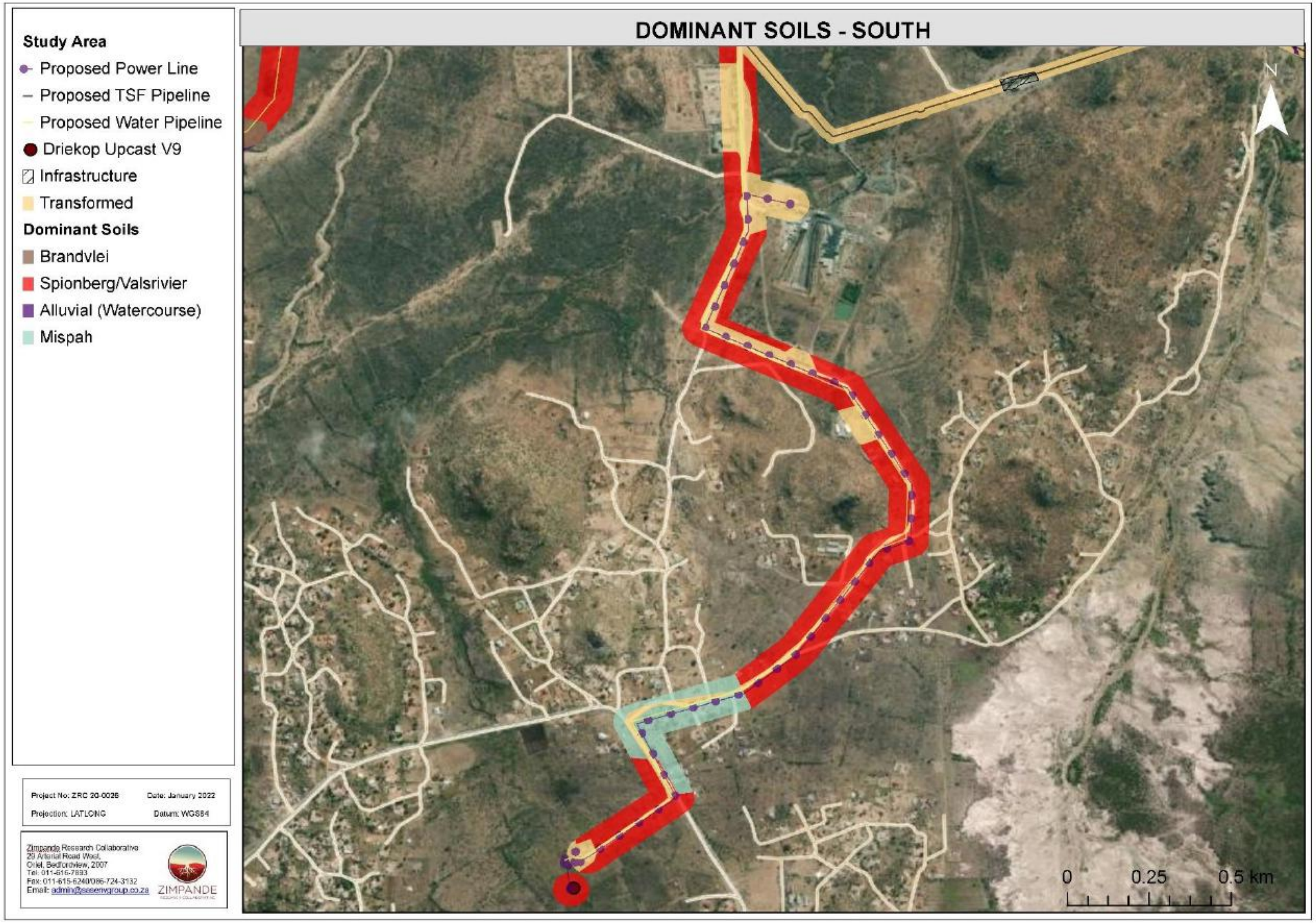


Figure 9: Dominant soils forms within the southern portion of the study area.

4.3 Land Capability Classification

Agricultural land capability in South Africa is generally 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 crop yields when treated and managed according to best possible farming practices (Scotney *et al*., 1987).

For the purpose of 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 study area falls into Climate Capability Class 5 due to low rainfall and high temperatures, with low yield potential for a limited range of adapted crops.

The identified soils were classified into land capability and land potential classes using the Camp *et. al*, and Guy and Smith Classification system (Camp *et al.,* 1987; Guy and Smith, 1998), as presented from Figure **10**. The identified land capability limitations for the identified soils are discussed in comprehensive "dashboard style" summary tables presented from Tables **10, 11** and **12** below. The dashboard reports aim to present all the pertinent information in a concise and visually appealing fashion. **Table 9** below presents the dominant soil forms and their respective land capability, land potential as well as areal extent expressed as hectares as well as percentages. Figure **11** depicts the land potential of the soils in terms of agriculture attributable to their cultivability. The agricultural land potential was found to be in contrast to the findings of the DEA screening tool.

Table 9: Identified soil forms within the study area and their respective land capability and land potential.

Soil Form	Land capability	Land Potential	Area (ha)	Percentage
Alluvial Watercourse	Class V	Restricted Potential (L6)	1.51	1.8
Spionsberg/Valsrivier	Class VI	Restricted Potential (L5)	69.21	80.4
Brandvlei	Class VI	Restricted Potential (L5)	3.19	1.4
Mispah	Class VIII	Very Low Potential (L8)	14.64	16.5
Total enclosed			**86.12**	**100**

***Infrastructural areas 6.4 ha (4.9%) and transformed 38.27 ha (23.3%) areas were not included in the table above since they not considered in the land capability ratings.**

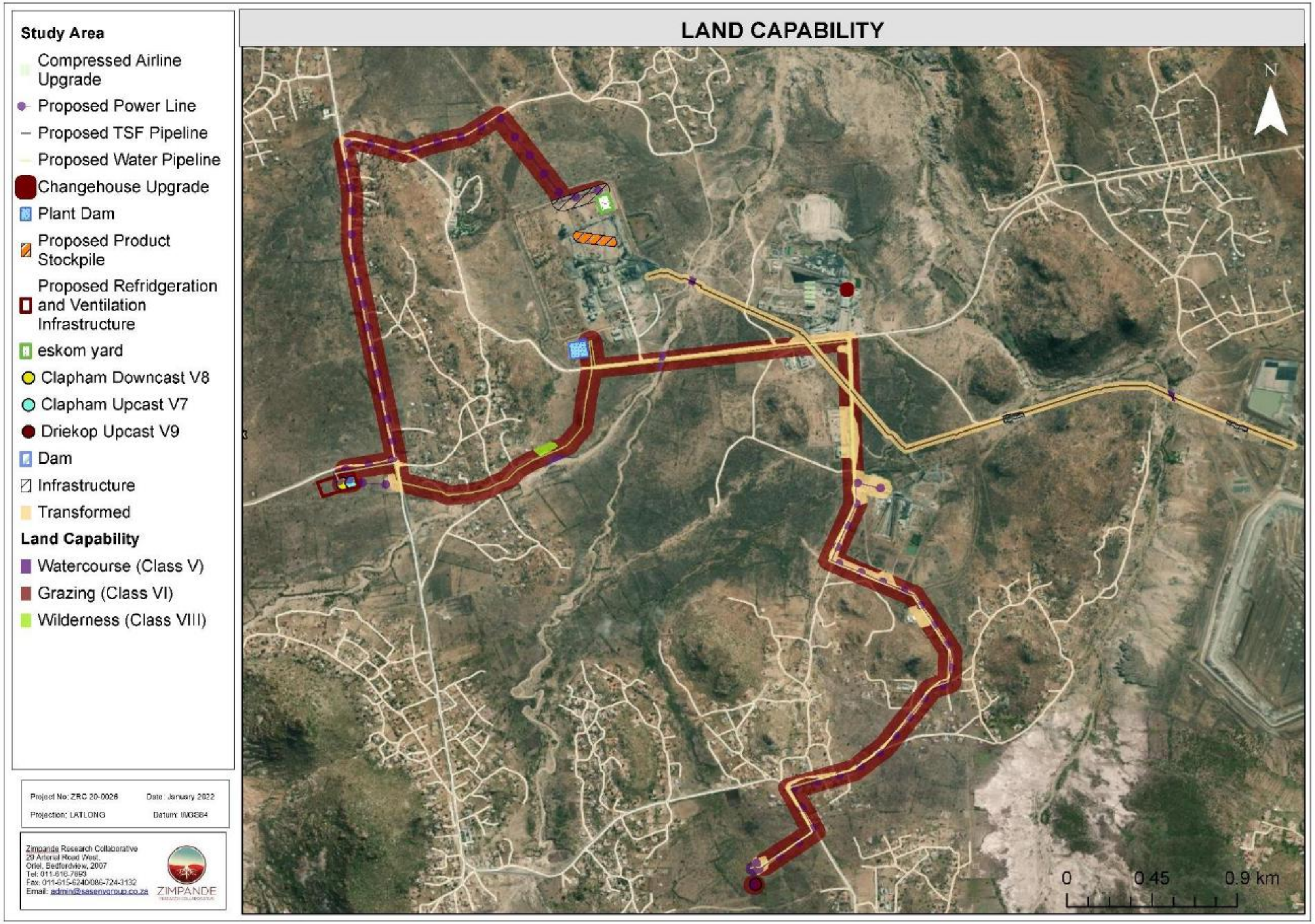


Figure 10: Map depicting Land capability of soils occurring within the study area.

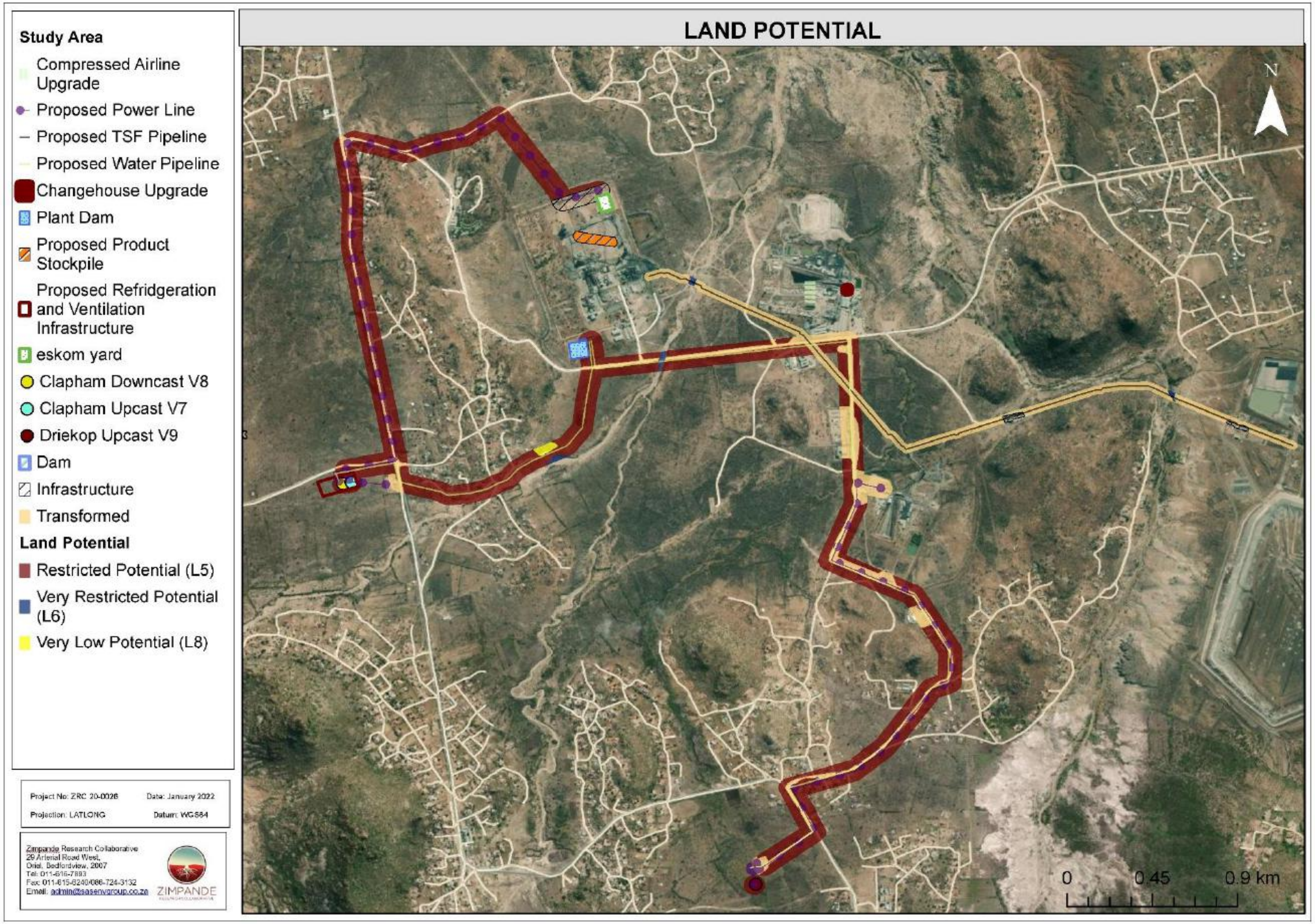


Figure 11: Map depicting agricultural sensitivity of soils occurring within the study area.

Table 10: Summary discussion of the watercourse (Class V) land capability class

<table>
<tr><th colspan="5">Land Capability: Watercourse (Class V)</th></tr>
<tr><td colspan="5"> </td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Relatively flat to moderately sloping land of <1.5% slope</td><td>Photograph notes</td><td>View of the bleached sandy alluvial soil material associated with the watercourse</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">alluvial</td><td>Areal Extent</td><td>1.51 ha which constitutes 1.8% of the study area</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">Soils are very sandy and subject to wind and water erosion and often shallow in depth.</td><td colspan="2" rowspan="2">Land Capability
The identified soils are of poor (Class V) land capability due to wetness limitations during the good rainy seasons. These soils are associated with watercourse features in the arid environments and cultivation on these soils would prove impractical.</td></tr>
<tr><td>Land Potential</td><td colspan="2">(L6) Very Restricted Potential: Due to association with the watercourse</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>M</td><td rowspan="2">The overall impact of the proposed activity/infrastructure changes on land capability and land potential is anticipated to be Moderate (M) without mitigation measures in place and Low (L) post mitigation. This is due to the inherently poor land capability of the identified dominant soil forms. The proposed proposed activity/infrastructure changes in areas with this soil type.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
While these soils are not considered prime agricultural production soils, they are crucial for freshwater systems in the area. Thus, avoidance of these soils is deemed imperative in line with the National Water Act No. 36 of 1998.</td></tr>
<tr><td>Overall impact significance post to mitigation</td><td>L</td></tr>
</table>

Table 11: Summary discussion of the Grazing (Class VI) land capability class

<table>
<tr><th colspan="5">Land Capability: Grazing (Class VI) and Restricted land potential</th></tr>
<tr><td colspan="5"></td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Relatively flat landscapes of < 0.2% slope gradient</td><td>Photograph notes</td><td>View of the sandy topsoil, pedocutanic and soft carbonate soil horizons associated with soil forms occurring within the soil profile of the identified soil forms.</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Spionberg/Valsrivier and Brandvlei</td><td>Area Extent</td><td>70.4 ha which constitutes 81% of the study area</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">Spionberg/Valsrivier are characterized by high clay content in the subsoil and strong structure and Brandvlei soils are characterized by limited rooting depth (<60 cm).</td><td colspan="2" rowspan="2">Land Capability and Land Potential
Land has very serious permanent limitations that restrict the choice of alternative crops or the intensity of crop production to a great extent.</td></tr>
<tr><td>Land Potential</td><td colspan="2">L5 (Restricted Potential): Regular and/or moderate to severe limitations due to soil, slope, temperature, or rainfall.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>M</td><td rowspan="2">The overall impact of the proposed development on land capability and land potential is anticipated to be Medium without mitigation measures and Low with mitigation measures in place. Due to the inherently low land capability of the identified dominant soil forms. The proposed developments will result in a permanent change of land use. If this area is clearly demarcated the impact could potentially be reduced to low since the adjacent area could potentially be used as grazing land by subsistence farmers in the neighbouring communities.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
The identified soils are generally not considered significant in terms of agricultural productivity. Should agricultural production be considered intense management practices have to be applied, which are usually costly and not economical based on the expected yields from these soils. This is exacerbated by the climate of the area. However, plant and animal species habitat is likely to be affected. These soils are best suited for grazing, rangeland and wildlife. The proposed developments are viable on these soils considering the agricultural potential of these soils. Mitigation measures should this put in place to minimise further disruption of other adjacent soils which can potentially be used for grazing, rangeland and wildlife.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>L</td></tr>
</table>

Table 12: Summary discussion of the Wilderness (Class VII) land capability class

<table>
<tr><th colspan="5">Land Capability: Grazing (Class VII) and Very Low land potential.</th></tr>
<tr><td colspan="5">  </td></tr>
<tr><td colspan="2">Terrain Morphological Unit (TMU)</td><td>Gently sloping landscapes of < 0.5% slope gradient</td><td>Photograph notes</td><td>View of the shallow soil horizon, rock outcrop and physically disturbed soils associated with the Mispah and Witbank soil forms.</td></tr>
<tr><td colspan="2">Soil Form(s)</td><td>Mispah (Lithic soil forms)</td><td>Area Extent</td><td>14 ha which constitutes 16.5% of the total study area.</td></tr>
<tr><td colspan="2">Physical Limitations</td><td>Lithic soils are normally referred to as young soils due to their shallow effective rooting depth (<20 cm) which is the primary limitation of this soil group of land capability.</td><td colspan="2" rowspan="2">Land Capability and Land Potential
The Lithic soils (Mispah) are also considered to be of poor (Class VI) land capability and are not suitable for arable agriculture. These soils are therefore considered to have low land potential. Low land potential has permanent limitations that exclude it from commercial plant production and the use thereof is limited to wildlife, recreation, water provision and aesthetic qualities.</td></tr>
<tr><td colspan="2">Land Potential</td><td>L8 (Very low potential): Very severe limitations due to soil, slope, temperature or rainfall. Non-arable.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>M</td><td rowspan="2">The overall impact of the proposed developments on the land capability of these soils is anticipated to be medium with mitigation due to their inherently poor land capability. If this area is clearly demarcated the impact could potentially be reduced to low since the adjacent area could potentially be used as grazing land by subsistence farmers in the neighbouring communities.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
The identified Mispah soils are generally not considered to be of significant agricultural productivity. These soils, at best are suited for grazing, recreation and wildlife. The proposed developments are viable on these soils considering the extent of the area that will be disturbed and agricultural potential of these soils. Mitigation measures should be put in place to minimise further disruption of other adjacent soils which can potentially be used for grazing and other activities.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>L</td></tr>
</table>

5. IMPACT ASSESSMENT AND MITIGATION MEASURES

This section presents the significance of potential impacts on the identified soil resources associated with the proposed developments. In addition, it also indicates the required mitigatory measures needed to minimise the perceived impacts associated with the proposed development and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures and assuming that they are fully implemented. The description of the impact significance and ratings are presented on Table 13 and Table 14.

Table 13: Description of the impact significance in relation to the to the proposed activities and developments within the study area.

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

Table 14: : Description of terms used in the impact assessment rating for the proposed activities and developments within the study area.

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.

	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	VL	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	VL	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

5.1 Activities

Proposed Activity Description:

The proposed additional surface infrastructure comprises the following:

- The establishment of two additional ventilation shafts;
- The upgrade to refrigeration and ventilation infrastructure at existing ventilation shafts.
- The establishment of additional water pipelines to support the additional ventilation shafts;
- The expansion and establishment of additional power supply and distribution infrastructure in support of the establishment of additional ventilation shaft and upgrades to existing ventilation shafts);
- The establishment of a product stockpile within the existing footprint of the Concentrator Plant;
- The establishment of an additional pipeline to the approved Tailings Storage Facility (TSF); and
- Structural upgrades of the existing change house and compressed airline at the Clapham Shaft Complex.

The impact assessment will be divided into line infrastructure (pipelines, powerlines and conveyor lines) and built infrastructure (ventilation shaft, change house, ventilation and refrigeration infrastructure.

The soils are anticipated to be exposed to erosion, dust emission, and potential soil contamination impacts during the construction phase of the study area; and these impacts may persist for the duration of the operational phase if not mitigated adequately. The activities associated with the proposed developments are presented on Table 15.

The impact assessment rating is applicable to the following activities:

Table 15: Activities associated with study area during different phases

Phase	Activities
Pre- Construction Phase	Planning and design of the footprint areas.
	Preparation for the construction activities
construction	Clearing of the footprint area associated for the proposed developments
	Soil striping
	Construction of various infrastructure
Operational	Operation of mining related activities

5.1.1 Soil Erosion

Soil erosion is largely dependent on land use and soil management and is generally accelerated by anthropogenic activities. In the absence of detailed South African guidelines on erosion classification, the erosion potential and interpretation are based on field observations as well as observed soil profile characteristics. In general, soils with high clay content have a high-water retention capacity, thus less prone to erosion in comparison to sandy textured soils, which in contrast are more susceptible to erosion.

The proposed development is located on a relatively flat to gently sloping terrain, which decreases the erosion hazard. However, the sandy nature of the topsoil with little organic carbon content and the sparse vegetation cover makes the identified soils highly susceptible to erosion. Their susceptibility to erosion is likely to increase once the land is cleared for excavation, and the soils will inevitably be exposed to wind and stormwater. The overall soil erosion impact is therefore anticipated to be Medium during the pre-construction, construction and operational phases. Hence mitigation measures will be required. Post mitigation measures the impact is anticipated to be Low during the pre-construction and construction phases and very low during the operational phases.

Refer to Table 16 and 18 for the different impact significance ratings on soil erosion before mitigation for the linear and surface infrastructure respectively and Table 17 and 19 for impact significance ratings on soil erosion post mitigation for the linear and surface infrastructure respectively.

Aspects and activities register

Pre-Construction	Construction	Operational
Potential poor planning leading to excessive erosion outside the study area demarcations.	Site clearing, removal of vegetation, and associated disturbances to soils, leading to, increased runoff, erosion and consequent loss of land capability in cleared areas.	Constant disturbances of soils, resulting in risk of erosion
	Potential frequent movement of digging machinery within lose and exposed soils, leading to excessive erosion	

Table 16: Summary of the impact significance on soil erosion for the line infrastructure.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	VH	M	L	L	**Medium**	**Medium**
Construction	VH	M	L	H	**Medium**	**Medium**
Operational	H	M	L	M	**Medium**	**Medium**

Table 17: Summary of the impact significance on soil erosion for the line infrastructure post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	L	L	**Low**	**Low**
Construction	H	L	L	M	**Low**	**Low**
Operational	M	L	L	L	**Low**	**Very Low**

Table 18: Summary of the impact significance on soil erosion for the surface infrastructure.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	VH	M	L	L	**Medium**	**Medium**
Construction	H	M	L	H	**Medium**	**Medium**
Operational	M	M	L	M	**Medium**	**Medium**

Table 19: Summary of the impact significance on soil erosion for the surface infrastructure post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	VL	L	**Low**	**Low**
Construction	H	L	VL	L	**Low**	**Low**
Operational	M	L	VL	M	**Low**	**Very Low**

5.1.2 Potential Soil Compaction

Heavy equipment traffic during construction and activities is anticipated to cause soil compaction. The severity of this impact is likely to be significant for most of the soils due to amount of disturbance that could occur due to the clayey texture of the subsoils. The impact significance can be reduced significantly, should the proposed activities be restricted to access roads, vehicle hard stand areas and equipment and machinery laydown areas. Soil compaction will potentially lead to:

- Increased bulk density and soil strength, reduced aeration and lower infiltration rate

- Destroyed soil structure, causing it to become more massive with fewer natural voids with a high possibility of soil crusting.
- Soil biodiversity is also influenced by reduced soil aeration. Severe soil compaction may cause reduced microbial biomass. Soil compaction may not influence the quantity, but the distribution of macro fauna that is vital for soil structure including earthworms due to reduction in large pores.

The overall soil compaction impact is therefore anticipated to be Medium during the pre-construction construction and operational phases. Hence it should have an influence on the decision and mitigation measures will be required. Post mitigation measures the significant impacts are anticipated to be Low during the pre-construction and construction phases and Very Low during the operational phase.

Refer to Table 20 and 22 for the different impact significance ratings on potential soil compaction before mitigation for the linear and surface infrastructure respectively and Table 21 and 23 for impact significance ratings on potential soil compaction post mitigation for the linear and surface infrastructure respectively.

Aspects and activities register

Pre-Construction	Construction	Operational
Potential poor planning leading to excessive or unnecessary placement of infrastructure outside the study area or the demarcated infrastructure areas leading to increased soils compaction.	Site clearing and associated disturbances to soils, leading to, increased runoff, soil compaction and consequent loss of land capability in cleared areas.	Constant disturbances of soils, resulting in risk of compaction
	Potential frequent movement of digging machinery and construction vehicles within lose and exposed soils, leading to excessive soil compaction	

Table 20: Summary of the impact significance on soil compaction for the line infrastructure.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	VH	M	M	L	**Medium**	**Medium**
Construction	VH	M	L	M	**Medium**	**Medium**
Operational	H	M	L	M	**Medium**	**Medium**

Table 21: Summary of the impact significance on soil compaction for the line infrastructure post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	L	L	**Low**	**Low**
Construction	H	L	L	M	**Low**	**Low**
Operational	M	L	L	L	**Low**	**Very Low**

Table 22: Summary of the impact significance on soil compaction for the surface infrastructure

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance

Pre-Construction	H	M	L	L	**Medium**	**Medium**
Construction	H	H	L	M	**Medium**	**Medium**
Operational	H	M	L	M	**Medium**	**Medium**

Table 23: Summary of the impact significance on soil compaction for the surface infrastructure post mitigation.

Activity	**Probability**	**Intensity**	**Spatial extent**	**Duration**	**Consequence**	**Significance**
Pre-Construction	H	L	VL	L	**Low**	**Low**
Construction	M	M	VL	M	**Low**	**Low**
Operational	M	L	VL	M	**Low**	**Very Low**

5.1.3 Potential Soil Contamination

Contamination sources are mostly unpredictable and often occur as incidental spills or leaks during both the construction and operational phase. Thus, all the identified soils are considered equally predisposed to potential contamination. The significance of contamination is largely dependent on the nature, volume and/or concentration of the contaminant of concern as well as the rate at which contaminants are transported by water in the soil. Therefore, strict waste management protocols as well as product stockpile management and activity specific Environmental Management Programme (EMP) and monitoring guidelines should be adhered to during the construction and operational activities. If the management protocols are not well managed this will more likely lead to:

- Contaminants leaching into the soil and thus potentially rendering the soil sterile. reducing the yield potential of soils.
- Potential reduction of water quality used for irrigation and for livestock use.

The overall soil contamination impact is therefore anticipated to be Medium during the pre-construction, construction and operational phases. Hence it should have an influence on the decision and mitigation measures will be required. Post mitigation measures the significant impacts are anticipated to be Very Low during the pre-construction, construction and operational phases.

Refer to Table 24 and 26 for the different impact significance ratings before on potential soil contamination mitigation for the linear and surface infrastructure respectively and Table 25 and 27 for impact significance ratings on potential soil contamination post mitigation for the linear and surface infrastructure respectively.

Aspects and activities register

Pre-Construction	Construction	Operational
Potential poor planning leading to excessive or unnecessary pollution of soils outside the study area demarcations.	Spillage of petroleum hydrocarbons during construction of associated infrastructure	Leaching of hydrocarbons chemicals into the soils, leading to alteration of the soil chemical status as well as contamination of ground water

Pre-Construction	Construction	Operational
	Disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.	Disposal of hazardous and non-hazardous waste, including waste material spills and refuse deposits into the soil.

Table 24: Summary of the impact significance for soil contamination for the line infrastructure.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	M	M	Medium	Medium
Construction	H	M	M	M	Medium	Medium
Operational	M	M	M	M	Medium	Medium

Table 25: Summary of the impact significance for soil contamination for the line infrastructure post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	M	VL	L	L	Very Low	Very Low
Construction	M	L	L	L	Low	Very Low
Operational	M	VL	L	L	Very Low	Very Low

Table 26: Summary of the impact significance for soil contamination for the built infrastructure.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	M	M	Medium	Medium
Construction	H	M	M	M	Medium	Medium
Operational	M	M	M	M	Medium	Medium

Table 27: Summary of the impact significance for soil contamination for the built infrastructure post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	M	VL	L	L	Very Low	Very Low
Construction	M	L	L	L	Low	Very Low
Operational	M	VL	L	L	Very Low	Very Low

5.1.4 Loss of Agricultural Land Capability

The impact on soil land capability is therefore anticipated to be Low during the pre-construction, construction and Very Low during the operational phase. Hence limited mitigation is likely to be required. This is because the dominant soils are not considered ideal for cultivation due to their inherent poor drainage characteristics, shallow rooting depth and limited nutrient retention due to the bleached topsoils. Post mitigation measures the impact significance ratings are anticipated to be Very Low during the pre-construction phase, Low during the construction phase and Insignificant during the operational phase. Refer to Table 28 for the different impact significance ratings on loss of agricultural land capability before mitigation and Table 29 for impact significance ratings on loss of agricultural land capability post mitigation.

Table 28: Summary of the impact significance for soil land capability.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	H	L	L	L	Low	Low
Construction	VH	L	L	L	Low	Low
Operational	M	L	L	L	Low	Very Low

Table 29: Summary of the impact significance for soil land capability post mitigation.

Activity	Probability	Intensity	Spatial extent	Duration	Consequence	Significance
Pre-Construction	M	VL	L	L	Very Low	Very Low
Construction	H	L	L	L	Low	Low
Operational	L	VL	L	L	Very Low	Insignificant

5.1.5 Cumulative Impact

The cumulative loss from a soil and land capability point of view is not anticipated to be significant as the dominant soils within each footprint area are not considered ideal for cultivation. In addition, the impact on the soils from each footprint area will be localised because each ventilation shaft has a possible footprint area of less than 0.5 hectare, with the longest distance for water pipelines and power transmission lines being 5.2 km. It should also be noted that large portions of proposed line infrastructure (i.e., water pipeline) are located within the road reserves where some impact has occurred as a result of edge effects. The stockpile area is already located under the infrastructural area and thus not anticipated to cause any significant impact.

The study area is surrounded by mining related activities, residential areas, as well as wilderness areas and is isolated from any big scale agricultural activities in the area. The mining related activities dominate a large portion of the study area and thus has caused significant impact on the soils. Hence, the development of this area is not anticipated to cause a significant cumulative impact since this area is not under current cultivation and the extent of the area to be impacted is limited. The cumulative impact on the local and regional scale is considered medium as the dominant soils are not sensitive from a soil and land capability point of view. However, soils are scarce non-renewable resources which need to be protected, conserved and managed in compliance with the CARA, 1983 (Act No. 43 of 1983).

5.2 Integrated Mitigation Measures

Based on the findings of the soil, land use and land capability assessment, mitigation measures have been developed to minimise the impact on the soil resources of the area, should the proposed project proceed:

5.2.1 Soil Erosion

- The footprint of the proposed development and construction activities should be clearly demarcated to restrict vegetation clearing activities within the infrastructure footprint as far as practically possible;
- Bare soils within the access roads can be regularly dampened with water to suppress dust during the construction phase, especially when strong wind conditions are predicted according to the local weather forecast;
- All disturbed areas adjacent to the proposed development areas should be re-vegetated with an indigenous grass mix, if necessary, to re-establish a protective cover, to minimise soil erosion and dust emission;

5.2.2 Soil compaction Management

- Compacted soils adjacent to the proposed developments during construction should be lightly ripped to at least 25 cm below ground surface to alleviate compaction;
- Soil Compaction is usually greatest when soils are moist, so soils should be stripped when moisture content is as low as possible. If they have to be moved when wet, truck and shovel should be used as bowlscrapers create excessive compaction when moving wet soils.

5.2.3 Soil Contamination Management

- 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;
- 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;
- 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; and
- 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 contamination.

5.2.4 Loss of Land Capability Management

- Close supervision and monitoring of the stripping process is required to ensure that soils are stripped correctly and backfilled after the laying down of water pipelines.
- Revegetate the disturbed soils with an indigenous grass mix, to re-establish a protective cover, in order to minimise soil erosion and dust emissions; and
- The footprint areas should be lightly ripped to alleviate compaction.

6. CONCLUSION

The Zimpande Research Collaborative (ZRC) was appointed to conduct a soil, land use, land capability and agricultural potential assessment as part of the environmental impact assessment and authorisation process for the proposed ventilation shafts, ore stockpile, power transmission lines and water pipeline. The proposed development footprint area will hereafter be collectively referred to as the “study area” unless referring to individual infrastructure (i.e., ventilation shaft, stockpile area, power transmission lines and water pipelines etc.).

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, as per the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983). High potential agricultural land is defined as land 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). Land Capability Classification is measured on a scale of I to VIII, with the classes of I to III considered as prime agricultural soils and classes V to VIII not suitable for cultivation.

Based on the observations during the site assessment, the dominant land uses within the study area and the surroundings are mining related activities, with residential areas and wilderness/wildlife being the subdominant land uses. No agricultural activities were observed in the immediate vicinity of the study area.

A total of four (4) soil forms were identified within the study area and these include Spionberg/Valsrivier, Brandvlei, Mispah and Witbank. The agricultural potential of these soil forms ranges from restricted to very low, thus rendering the study area to marginally suitable for cultivated agriculture and under intensive management. The poor agricultural potential of these soil forms can be attributed to their inherent characteristics which include but not limited to:

- Poor drainage characteristics;
- Shallow rooting depth due to high clay content in the B horizon;
- Inadequate moisture;
- Bleached topsoils which lack nutrient retention capacity to support optimum growth and production; and
- Disturbed soils due to anthropogenic influences.

The soils of the Spionberg/Valsrivier are associated with poor physical properties induced by high clay content and very strong structure. The high clay content may effectively reduce water infiltration and thus these soils are more prone to waterlogging conditions as well as intensified runoff during high intensity rainfall. This intensified runoff makes the soils more prone to erosion and thus the formation of gullies which are not favourable for most cultivated crops. The strongly developed structure of the soils may impede root growth and thus limit the area to mostly grazing and/or forestry capability. Nutrient uptake by plants may be limited as these soils tend to hold nutrients tightly to the soil colloids due to the high cation exchange capacity (CEC) caused by high clay content, meaning that more nutrients are held on the soil and are not readily available for plant uptake. Nonetheless, should the soils be cultivated, intensive management practices will have to be implemented.

Brandvlei soil types are associated with the accumulation of calcium carbonate over a long period of time. The pH of these soils increases with depth, typically approaching 8 to 8.5 in the sub-soil. This can potentially induce high capacity for metal cations retention, in so doing potentially reducing agricultural productivity through the deficiency of phosphorus and certain trace elements. Calcic soils are typically low in organic matter due to spatially scattered vegetation in the landscape and rapid decomposition of organic matter in arid areas in which they occur.

Mispah soil types are soils associated with poor physical properties for plant root system penetration and water infiltration, due to the limiting impeding layer of the underlying parent material. These Mispah soils are also highly susceptible to erosion due to their poor hydraulic conductivity, thus not suitable for commercial agricultural cultivation.

Witbank soils are considered of very low agricultural potential due to the soils having been subjected to physical disturbance because of human interventions. Such interventions include transportation and deposition of the earth material containing soil. As a result, these soils are unable to support agricultural production unless significant amelioration and rehabilitation takes place .

Table A below represents the soil forms identified within the study area as well as their diagnostic horizons, respectively.

Table A: Identified soil forms within the study area and their respective land capability and land potential.

Soil Form	Land capability	Land Potential	Area (ha)	Percentage
Alluvial Watercourse	Class V	Restricted Potential (L6)	1.51	1.8
Spionsberg/Valsrivier	Class VI	Restricted Potential (L5)	69.21	80.4
Brandvlei	Class VI	Restricted Potential (L5)	3.19	1.4
Mispah	Class VIII	Very Low Potential (L8)	14.64	16.5
Total enclosed			**86.12**	**100**

The findings of this assessment suggest that the relevant soil and climatic limiting factors within the study area for land capability and land use potential for agriculture include the following:

- Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops may be grown at risk of some yield loss according to the Climate Capability Classification by Scotney *et al*., 1987;
- High clay content of the Spionberg/Valsrivier soil forms affecting rooting depth and moisture content and low nutrient content of Brandvlei soil form;
- Shallow effective rooting depth due to shallow indurated bedrock of the Mispah and Brandvlei soil forms. As such, these soils are not considered able to contribute significantly to agricultural production on a national or provincial scale;
- Susceptibility to erosion of Mispah soils form; and
- Lack of soil medium for plants and crop growth in rocky soils, areas associated with mine infrastructure and no production within surface water areas.

The cumulative loss from a soil and land capability point of view is not anticipated to be significant as the dominant soils within the project footprint area are not considered ideal for cultivation. In addition, the impact on the soils from each footprint area will be localised as each ventilation shaft has a possible footprint area of less than 0.5 hectare, with the longest distance for the proposed water pipelines and power transmission lines being 5.2 km. It should also be noted that large portions of proposed linear infrastructure (i.e. water pipelines) are located within the road reserves where some impact as a result of edge effects has occurred. The stockpile area is already located under the existing infrastructural area and thus not anticipated to cause any significant impact. The study area is surrounded by residential areas as well as wilderness and is isolated from any large-scale agricultural activities in the area. The development of this area is not anticipated to cause a significant cumulative impact since this area is not under current cultivation and the extent of the area to be impacted is limited. The cumulative impact on the local and regional scale is considered medium-low as the dominant soils are not of high importance from a soil and land capability point of view. However, soil is a scarce, non-renewable resource which need to be protected, conserved and managed in compliance with the CARA, 1983 (Act No. 43 of 1983).

The screening tool analysis was conducted, which presented the findings as the impact on agricultural resources being of a High sensitivity rating. However, the screening tool analysis was found to be in contrast with the filed assessment results. The field assessment results indicated that the soils within the footprint areas to be of low agricultural potential, with no prior cultivation for the past 5 years.

Key mitigation measures to minimise impacts on the soil regime include but are not limited to:

- The project operations be kept within the demarcated footprint areas which must be well defined;
- Bare soils within the access roads should be regularly dampened with water to suppress dust during the construction phase, especially when strong wind conditions are predicted according to the local weather forecast;
- A soil monitoring programme should be initiated within the access roads and adjacent areas to ascertain whether the dust suppression has an impact on the soil chemistry; and
- Soil Compaction is usually greatest when soils are moist. Therefore, soils should be stripped when moisture content is as low as possible. If soil must be moved when wet, truck and shovel should be used as bowlscrapers create excessive compaction when moving wet soils.

From a soil and land capability point of view, this project is not regarded as being fatally flawed due to various inherent soil constraints for commercial agricultural production, however mitigation measures and recommendations outlined in this document need to be strongly considered and implemented accordingly in efforts to conserve soil resources.

7. REFERENCES

Agricultural Geo-referenced Information System (AGIS) database. www.agis.agric.za

Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983).

Department of Agriculture, Forestry and Fisheries. Agricultural Geo-referenced Information system (AGIS). Grazing Capacity Maps (1993).

Department of Mines (1970). 1:250 000 Geological Map Series (sheet no. 2730) of the Republic of South Africa (RSA) and the Kingdoms of Lesotho and Swaziland. Department of Mines (1970).

Fey, M. 2010. Soils of South Africa: Their distribution, properties, classification, genesis, use and environmental significance.

International Union of Soil Sciences (IUSS) Working Group (2014). World Reference Base (WRB) for Soil Resources 2014. International soil classification system for naming soils and creating legends for soil maps. World Soil Resources Reports No. 106. FAO, Rome

Morgenthal, T.L., Newby, T., Smith, H.J.C., and Pretorius, D.J. (2004*). Developing and refinement of a grazing capacity map for South Africa using NOAA (AVHRR) satellite derived data*. Report GW/A/2004/66. ARC Institute for Soil, Climate and Water, Pretoria.

National Department of Agriculture, 2002. Development and Application of a Land Capability Classification System for South Africa

Soil Classification Working Group, 2018. Soil classification. A Natural and Anthropogenic System for South Africa. Mem. agric. nat. Resource. S. Afr. No. 15. Dept. Agric. Dev., Pretoria.

APPENDIX A: ASSESSMENT METHODOLOGY

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 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 in November 2020 by a qualified soil specialist, at which time the identified soils within the study area were classified into soil forms according to the Soil Classification Working Group for South Africa (2018). 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 **A1** 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 **A2** 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 (Smith, 2006)

Land Capability Class	Increased Intensity of Use									Land Capability Groups
I	W	F	LG	MG	IG	LC	MC	IC	VIC	**Arable land**
II	W	F	LG	MG	IG	LC	MC	IC		
III	W	F	LG	MG	IG	LC	MC	IC		
IV	W	F	LG	MG	IG	LC				
V	W		LG	MG						**Grazing land**
VI	W	F	LG	MG						
VII	W	F	LG							
VIII	W									**Wildlife**

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

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.

The land potential assessment entails the combination of climatic, slope and soil condition characteristics to determine the agricultural land potential of the investigated area. The classification of land potential and knowledge of the geographical distribution within an area of interest. This is of importance for making an informed decision about land use. **Table A3** below presents the land potential classes, whilst Table A4 presents description thereof, according to Guy and Smith (1998).

Table A3: Land Potential Classes (Guy and Smith, 1998)

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

Table A4: The Land Capability Classes Description (Guy and Smith, 1998)

Land Potential	Description of Land Potential Class
L1	**Very high potential:** No limitations. Appropriate contour protection must be implemented and inspected.
L2	**High potential:** Very infrequent and/or minor limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L3	**Good potential:** Infrequent and/or moderate limitations due to soil, slope, temperatures or rainfall. Appropriate contour protection must be implemented and inspected.
L4	**Moderate potential:** Moderately regular and/or severe to moderate limitations due to soil, slope, temperature or rainfall. Appropriate permission is required before ploughing virgin land.
L5	**Restricted potential:** Regular and/or moderate to severe limitations due to soil, slope, temperature or rainfall.
L6	**Very restricted potential:** Regular and/or severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L7	**Low potential:** Severe limitations due to soil, slope, temperature or rainfall. Non-arable.
L8	**Very low potential:** Very severe limitations due to soil, slope, temperature or rainfall. Non-arable.

Impact Assessment Methodology

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

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

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is 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 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 according to the defined criteria. Refer to the Table A1. The purpose of the rating is to develop a clear understanding of influences and

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

processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance-rating matrix and are used to determine whether mitigation is necessary[2].

The assessment of significance is undertaken twice. Initial, significance is based on only natural and existing mitigation measures (including built-in engineering designs). The subsequent assessment considers 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 1998 (Act No. 108 of 1998) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

Table A1: Criteria and definitions for assessing significance of impacts

LIKELIHOOD DESCRIPTORS

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.

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

	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	VL	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	VL	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

CONSEQUENCE DESCRIPTORS

Table A2: Determining Consequence and Significance

PART B: DETERMINING CONSEQUENCE							
INTENSITY = VL							
DURATION	Very long	VH	Low	Low	Medium	Medium	High
	Long term	H	Low	Low	Low	Medium	Medium
	Medium term	M	Very Low	Low	Low	Low	Medium
	Short term	L	Very low	Very Low	Low	Low	Low
	Very short	VL	Very low	Very Low	Very Low	Low	Low
INTENSITY = L							
DURATION	Very long	VH	Medium	Medium	Medium	High	High
	Long term	H	Low	Medium	Medium	Medium	High
	Medium term	M	Low	Low	Medium	Medium	Medium
	Short term	L	Low	Low	Low	Medium	Medium
	Very short	VL	Very low	Low	Low	Low	Medium
INTENSITY = M							
DURATION	Very long	VH	Medium	High	High	High	Very High
	Long term	H	Medium	Medium	Medium	High	High
	Medium term	M	Medium	Medium	Medium	High	High
	Short term	L	Low	Medium	Medium	Medium	High
	Very short	VL	Low	Low	Low	Medium	Medium
INTENSITY = H							
DURATION	Very long	VH	High	High	High	Very High	Very High
	Long term	H	Medium	High	High	High	Very High
	Medium term	M	Medium	Medium	High	High	High
	Short term	L	Medium	Medium	Medium	High	High
	Very short	VL	Low	Medium	Medium	Medium	High
INTENSITY = VH							
DURATION	Very long	VH	High	High	Very High	Very High	Very High
	Long term	H	High	High	High	Very High	Very High
	Medium term	M	Medium	High	High	High	Very High
	Short term	L	Medium	Medium	High	High	High
	Very short	VL	Low	Medium	Medium	High	High

			VL	L	M	H	VH
			A part of the site/ property	Whole site	Beyond the site, affecting neighbours	Extending far beyond site but localised	Regional/ National
			EXTENT				
PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	VH	Very Low	Low	Medium	High	Very High
	Probable	H	Very Low	Low	Medium	High	Very High
	Possible/ frequent	M	Very Low	Very Low	Low	Medium	High
	Conceivable	L	Insignificant	Very Low	Low	Medium	High
	Unlikely/ improbable	VL	Insignificant	Insignificant	Very Low	Low	Medium
			VL	L	M	H	VVH
			CONSEQUENCE				

Table A3: Significance Rating and Interpretation

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

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 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 all stages of the project cycle including:
  - Pre-construction;
  - Construction; and
  - Operation.
- 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

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[3] 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.

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.

[3] *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

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

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

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

Company of Specialist:	Zimpande Research Collaborative		
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

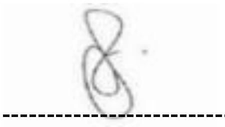
----

Signature of the Specialist

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

I, Braveman Mzila, 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 Specialist

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

I, Tshiamo Setsipane, 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 Specialist

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Group CEO, Water Resource discipline lead, Managing member, Ecologist, Aquatic Ecologist
Joined SAS Environmental Group of Companies	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
Member of the Gauteng Wetland Forum;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications	
MSc Environmental Management (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for wetland assessment short course Rhodes University	2016
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2013
Short Courses	
Certificate – Department of Environmental Science in Legal context of Environmental Management, Compliance and Enforcement (UNISA)	2009
Introduction to Project Management - Online course by the University of Adelaide	2016
Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017

AREAS OF WORK EXPERIENCE

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

KEY SPECIALIST DISCIPLINES

Biodiversity Assessments

- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Protected Tree and Floral Marking and Reporting
- Biodiversity Offset Plan

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant species and Landscape Plan
- Freshwater Offset Plan
- Hydropedological Assessment
- Pit Closure Analysis

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Assemblage Integrity Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Screening Test
- Riverine Rehabilitation Plans

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Soil Monitoring
- Soil Mapping

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments
- View Shed Analyses
- Visual Modelling

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Environmental and Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

SAS ENVIRONMENTAL GROUP OF COMPANIES – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF BRAVEMAN MZILA

PERSONAL DETAILS

Position in Company	Wetland Ecologist and Soil Scientist
Joined SAS Environmental Group of Companies	2017

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the South African Soil Science Society (SASSO)

Member of the Gauteng Wetland Forum (GWF)

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, Free State, North West, Limpopo, Northern Cape, Eastern Cape, KwaZulu-Natal

KEY SPECIALIST DISCIPLINES

Hydropedological Assessments:

- Soil Survey
- Soil Delineation
- Hydrological hillslope classification
- Hydropedological loss Quantification
- Hydropedological impact assessment
- Scientific buffer determination

Soil, Land use, Land Capability and Agricultural Potential Studies

- Soil Desktop assessment
- Soil classification
- Agricultural potential
- Agricultural Impact Assessments

SAS ENVIRONMENTAL GROUP OF COMPANIES (SEGC) –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF TSHIAMO SETSIPANE

PERSONAL DETAILS

Position in Company	Soil Scientist/ Hydropedologist
Joined SAS Environmental Group of Companies	2020

MEMBERSHIP IN PROFESSIONAL SOCIETIES

South African Council for Natural Scientist Professions (SACNASP)

EDUCATION

Qualifications

M.Sc. (Agric) Soil Science (*Cum Laude*)	(University of the Free State)	2019
B.Sc. (Agric) Honours Soil Science	(University of the Free State)	2014
B.Sc. (Agric) Soil Science & Agrometeorology	(University of the Free State)	2013

COUNTRIES OF WORK EXPERIENCE

South Africa – Kwa-Zulu Natal, Northern Cape, Mpumalanga and Free State

KEY SPECIALIST DISCIPLINES

Hydropedological Assessments:

- Soil Survey
- Soil Delineation
- Hydrological hillslope classification
- Hydropedological loss Quantification
- Hydropedological impact assessment
- Scientific buffer determination

Soil, Land use, Land Capability and Agricultural Potential Studies

- Soil Desktop assessment
- Soil classification
- Agricultural potential
- Agricultural Impact Assessments