SOIL, LAND USE AND LAND CAPABILITY ASSESSMENT FOR THE PROPOSED WEST WITS MINING PROJECT

Prepared for

SLR Consulting (South Africa) (Pty) Ltd

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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a soil, land use, land capability and agricultural potential assessment as part of the Environmental Impact Assessment process for the proposed Mining Right Application Area (MRA) for opencast and underground mining for the West Wits Project.

Based on observations during the site assessment and scrutiny of satellite imagery, land uses associated with the MRA and surroundings include residential, industrial, commercial areas, manufacturing and distribution facilities, schools, hospitals as well as small scale subsistence agriculture (maize and pastures at the time of field assessment). Historical mine infrastructure (tailings facilities, shafts, abandoned buildings and water facilities), powerlines and road infrastructure as well as ongoing illegal small-scale gold and sand mining operations were also evident within the MRA.

The current status of the soil resources where the majority of the proposed infrastructure as well as mining and related activities would occur already requires rehabilitation, owing to historic mining disturbances which led to the creation of Anthrosols such that the soil is unsuitable for cultivation or grazing but rather wildlife/wilderness. Even though the soils occurring within the MRA are suitable for wildlife/wildness, it is not practical in this area since the surrounding areas are largely urbanised. Some of the disturbed areas can still be used for light grazing, however, this would require intensive management practices. Arable soils of Hutton and Clovelly occupy approximately 39.79 ha of the total investigated MRA which is 1.87% of the total investigated area and is not considered adequate for commercial unirrigated agriculture. Arable land capability classification of the identified soils and their respective areal extent are presented on the table below.

Land Capability classes for soil forms identified within the MRA

Soil Form	Land Capability	Total Area (Ha)	% Areal Extent
Hutton/Clovelly	Arable (Class II)	39.79	1.87
Westleigh/Avalon	Arable (Class IV)	16.54	0.78
Kroonstad/Longlands	Grazing (Class V)	47.43	2.29
Mispah/Glenrosa		348.58	16.39
Witbank/Industria/Johannesburg (Anthrosols))	Wildlife/Wilderness (Class VIII)	1198.2	56.32
Artificial Water Features	Non-Arable	5.40	0.25
Built-up areas (Residential, Industrial, Commercial areas and Access Roads)		471.73	22.17
Total Area Investigated	2127.40		100

***Values rounded off to two (2) decimal place**

The chemical soil analyses indicate that the pH of the surrounding soils ranges between 3.0 and 7.5, whereas the electrical conductivity (EC) ranges between 2.4 and 12.9 milli siemens per meter (mS/m). The majority of the soil samples fell outside the optimum pH range (5.5 < pH <7.5) and based on the low pH these soils are considered to be acidic. Strongly acidic soils were sampled in close proximity to an old tailings facility within the Vogelstuisfontein area. However, based on the Soil and Terrain database (SOTER) the natural pH of these soils ranges from 5.5 to 6.4 and they are considered to be slightly acidic. The acidity of these soils is likely attributed to the historical mining activities occurring within the surrounding areas. The cyanide, CN, concentrations of the sampled soils was obtained by leaching the soil with distilled water. The detection limit was set at 0.02 mg/l in line with the Environmental Protection Agency requirements, and for all the sampled areas the cyanide levels fell below the detection limit. According to the Environmental Protection Agency (EPA), the Maximum Contaminant Level Goals (MCLG) for cyanide is 0.2 mg/l, thus from the analysis of the laboratory results, cyanide levels of the surrounding soils falls within acceptable levels. Refer to section 3.2 for a full discussion of the chemical analysis.

The findings of this assessment suggest that the relevant soil limiting factors within the MRA for agriculture include the following:

- Shallow effective rooting depth due to shallow indurated bedrock of the Mispah, Glenrosa. As such, these soils are not considered to contribute significantly to agricultural productivity;
- Limited root growth as a result of anoxic conditions due to periodic waterlogging of the Kroonstad/Longlands soil forms associated with the water courses. Preservation of these soils for conservation purposes takes precedence, according to the National Water Act, 1998 (Act No. 36 of 1998); and
- Lack of soil medium for plants and crop growth as a result of historic mine infrastructure, residential, commercial and industrial areas, and Anthrosols not suited for cultivation.

A large portion of the soils that fall within the Mining Right Application area would not be affected by the open cast and below-surface mining operations. Open cast mining, infrastructure complexes and waste rock dumps would affect soils, however, as these soils are deemed to be unsuitable for cultivation or grazing, the impact significance is considered to be low.

Key mitigation measures include:

- The footprint of the proposed infrastructure area should be clearly demarcated to restrict vegetation clearing activities within the infrastructure footprint as far as practically possible;
- Concurrent rehabilitation should strongly be considered to ensure that the duration that any pit or extent thereof is left unrehabilitated is minimised;
- Restrict the amount of mechanical handling of soils, as each excise increase the compaction level;
- Stockpile height should be restricted to that which can deposited without additional traversing by construction equipment. A Maximum height of 2-3 m is therefore proposed, and the stockpile should be treated with temporary soil stabilisation methods;
- Restrict the amount of mechanical handling, as each handling event increases that compaction level and the changes to the soil structure;
- At rehabilitation replace soil to appropriately and cover areas to achieve an appropriate topographic aspect and elevation profile so as to achieve a free draining landscape that is as close as possible the pre-mining conditions to allow for planned post closure land uses.

It is therefore the opinion of the land capability specialist that the proposed mining and related activities as well as the associated infrastructure will have an impact of relatively low impact significance on the prevailing soils and their inherent land capability, provided that the recommended mitigation and management measures will be implemented accordingly.

DOCUMENT GUIDE

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

NEMA Regulations (2017) - Appendix 6	Relevant section in report
(1) A specialist report prepared in terms of these Regulations must contain -	
(a) details of -	
(i) the specialist who prepared the report; and	Appendix D
(ii) the expertise of that specialist to compile a specialist report, including a curriculum vitae;	Appendix D
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix D
(c) an indication of the scope of, and the purpose for which, the report was prepared;	Section 1.3
(cA) an indication of the quality and age of base data used for the specialist report;	Section 2
(cB) a description of existing impacts on site, cumulative impacts of the proposed development and levels of acceptable change;	Section 4
(d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 2.1
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 2
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying alternatives;	Section 3 and 4
(g) an identification of any areas to be avoided, including buffers;	Section 4
(h) a map superimposing the activity, including the associated structures and infrastructure on the environmental sensitivities of the site, including areas to be avoided, including buffers;	Section 4
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 1.2
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment or activities;	Section 4 and 6
(k) any mitigation measures for inclusion in the EMPr;	Section 4
(l) any conditions for inclusion in the environmental authorisation;	Section 4 and 6
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 3.2
(n) a reasoned opinion -	
(i) as to whether the proposed activity, activities or portions thereof should be authorised;	Section 6
(iA) regarding the acceptability of the proposed activity or activities; and	Section 6
(ii) if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 6
(o) a description of any consultation process that was undertaken during the course of preparing the specialist report	Section 6
(p) a summary and copies, if any, comments received during any consultation process and, where applicable all responses thereto; and	Section 6
(q) any other information requested by the competent authority.	None during the scoping phase

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GLOSSARY OF TERMS

<table>
<tr><td>Albic</td><td>Grey colours, apedal to weak structure, few mottles (<10 %)</td></tr>
<tr><td>Alluvial soil:</td><td>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.</td></tr>
<tr><td>Catena</td><td>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.</td></tr>
<tr><td>Gleying:</td><td>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.</td></tr>
<tr><td>Hard Plinthic</td><td>Accumulative of vesicular Fe/Mn mottles, cemented</td></tr>
<tr><td>Hydrophytes:</td><td>Plants that are adaptable to waterlogged soils</td></tr>
<tr><td>Lithic</td><td>Dominantly weathering rock material, some soil will be present.</td></tr>
<tr><td>Mottles:</td><td>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.</td></tr>
<tr><td>Plinthic Catena</td><td>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</td></tr>
<tr><td>Red Apedal</td><td>Uniform red colouring, apedal to weak structure, no calcareous</td></tr>
<tr><td>Runoff</td><td>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.</td></tr>
<tr><td>Orthic</td><td>Maybe dark, chromic or bleached</td></tr>
<tr><td>Soil Map Unit</td><td>A description that defines the soil composition of a land, identified by a symbol and a boundary on a map</td></tr>
<tr><td>Soft Plinthic</td><td>Accumulation of vesicular Fe/Mn mottles (>10%), grey colours in or below horizon, apedal to weak structure</td></tr>
<tr><td>Watercourse:</td><td>In terms of the definition contained within the National Water Act, a watercourse means:
• A river or spring;
• A natural channel in which water flows regularly or intermittently;
• A wetland, dam or lake into which, or from which, water flows; and
• Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse;
• and a reference to a watercourse includes, where relevant, its bed and banks</td></tr>
<tr><td>Witbank</td><td>Man-made soil deposit with no recognisable diagnostic soil horizons, including soil materials which have not undergone paedogenesis (soil formation) to an extent that would qualify them for inclusion in another diagnostic horizon</td></tr>
<tr><td>Yellow-brown Apedal</td><td>Uniform yellow and brown colouring, apedal to weak structure, non-calcareous</td></tr>
</table>

ACRONYMS

AGIS	Agricultural Geo-Referenced Information Systems
ARC-ISCW	Agricultural Research Council Institute for Soil Climate and Water
Bgs	Below ground surface
CPC	Contaminants of Potential Concern
°C	Degrees Celsius.
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

1. INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a soil, land use, land capability and agricultural potential assessment as part of the Environmental Impact Assessment process for an application for a proposed Mining Right for opencast and underground mining for the West Wits Project, located north of Soweto, Gauteng Province.

The proposed Mining Right Area (MRA) is located in the City of Johannesburg Metropolitan Municipality and can be accessed via the R41 and the M77, with the R558 immediately to the west of the proposed MRA (Figure 1 & 2). The MRA partly falls within Roodepoort (northern section) and partly within Soweto (southern section). A description of the project is provided in Section 1.2 below, which includes the locality of the proposed MRA relative to the surrounding areas (Figure 1 and 2).

1.2 Project Description

In broad terms the proposed project entails:

- The development of five open pit mining areas, referred to as:
  - Mona Lisa Bird Reef Pit;
  - Roodepoort Main Reef Pit
  - Rugby Club Main Reef Pit
  - 11 Shaft Main Reef Pit; and
  - Kimberley Reef East Pit
- The refurbishment of two existing infrastructure complexes (to access the existing underground mine workings), namely:
  - Bird Reef Central Infrastructure Complex; and
  - Kimberley Reef East Infrastructure Complex

The project would also include the establishment of run of mine (ROM) ore stockpiles, topsoil stockpiles and waste rock dumps (WRD) as well as supporting infrastructure including material storage and handling facilities (for fuel, lubricants, general and hazardous substances), general and hazardous waste management facilities, sewage management facilities, water management infrastructure, communication and lighting facilities, centralised and satellite offices, workshops, washbays, stores, change houses, lamprooms, vent fans and security facilities.

The expected life of mine for the open pit operations (inclusive of rehabilitation) is three (3) to five (5) years and 20 years for the Kimberley Reef East underground workings, and 10 years for the Bird Reef Central underground workings. The pits would be mined in a phased approach with each pit taking between six (6) and 16 months to be mined and rehabilitated. The proposed location for the open pit mining areas and surface infrastructure complexes forming part of this project are depicted in Figure 1 and 2, with their approximate extent, presented in Table 1.

Table 1: Extent of the proposed infrastructure and open cast areas investigated pertaining to the MRA.

Mining Right Area	*Area (ha)*
MRA	2 076
Proposed Infrastructure Complexes Investigated	
Bird Reef Central	± 2.19
Kimberley Reef East	± 4.74
West Wits Opencast Areas Investigated (including open cast, topsoil stockpile and WRD footprint areas)	
11 Shaft Main Reef Pit	14
Kimberley Reef East Pit	9.92
Mona Liza Bird Reef Pit	19.2
Roodepoort Main Reef Pit	26.4
Rugby Club Reef East Pit	2.5

1.3 Scope of work

Specific outcomes in terms of this report are outlined below:

- A desktop assessment within the proposed Mining areas was undertaken using digital satellite imagery and other suitable digital aids;
- A review and interpretation of existing Soil Maps, Land Capability data, and other relevant database(s) such as the Agricultural Geo-referenced Information Service (AGIS) in order to establish broad baseline conditions and areas of environmental sensitivity and sensitive agricultural areas.
- A detailed soil classification survey was conducted within the proposed mining and infrastructural areas;
- Dominant soil types were classified and soil boundaries established according to the New Soil Classification: A Natural and Anthropogenic System for South Africa (2018);
- Soil properties of survey points were recorded using a Global Positioning System (GPS);
- Uniform soil patterns were grouped into map units, according to observed limitations and land capability of the demarcated map units were evaluated;

- Land use impacts of the proposed mining and related activities on the receiving environment were evaluated in relation to the land capability of the identified soils using the SLR Consulting (South Africa) Pty (Ltd) method; and
- Recommendations for mitigation measures were provided to implement in order to manage the anticipated impacts and to comply with the applicable legislation.

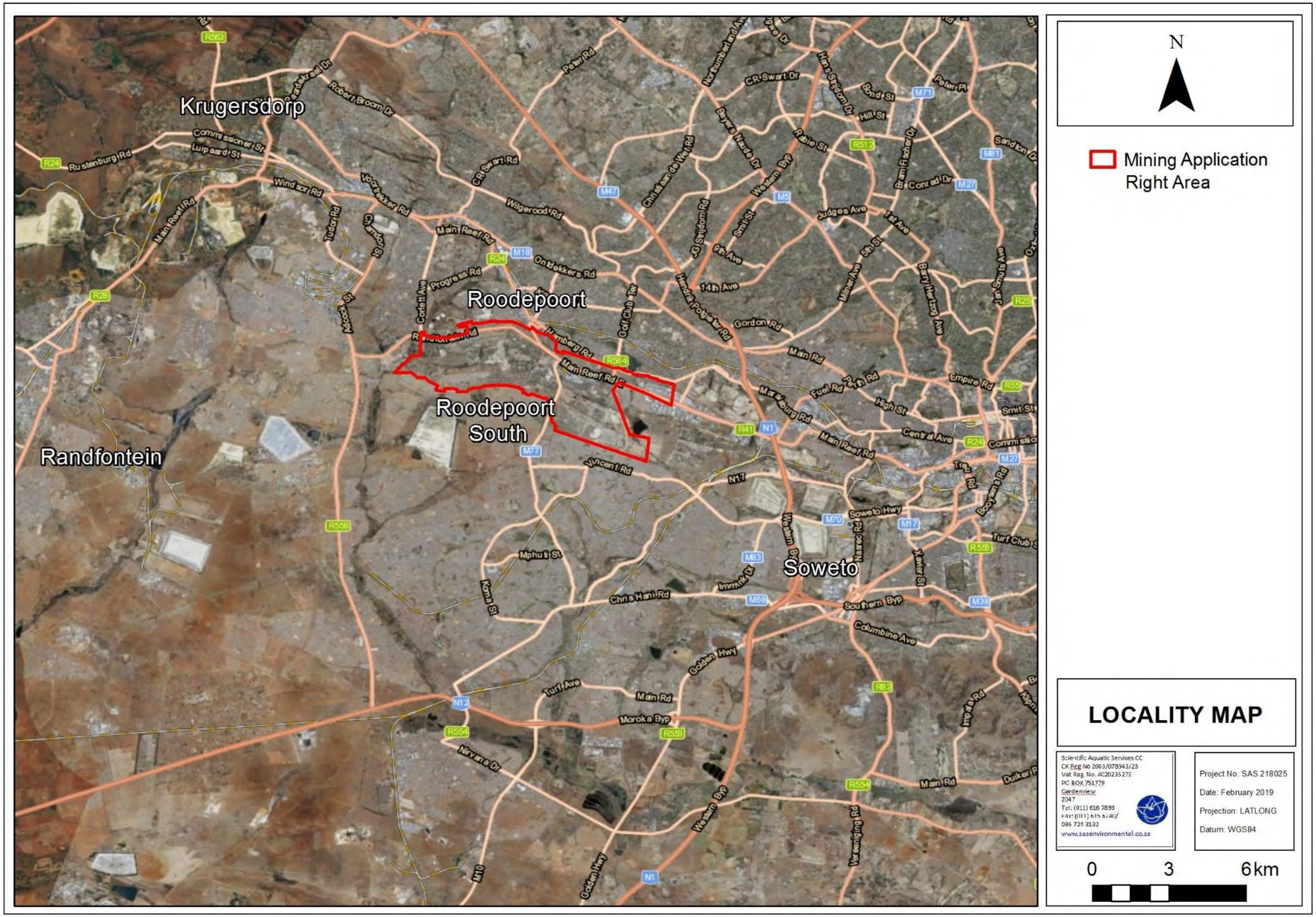

Figure 1: Digital satellite image depicting the MRA in relation to the surrounding areas.

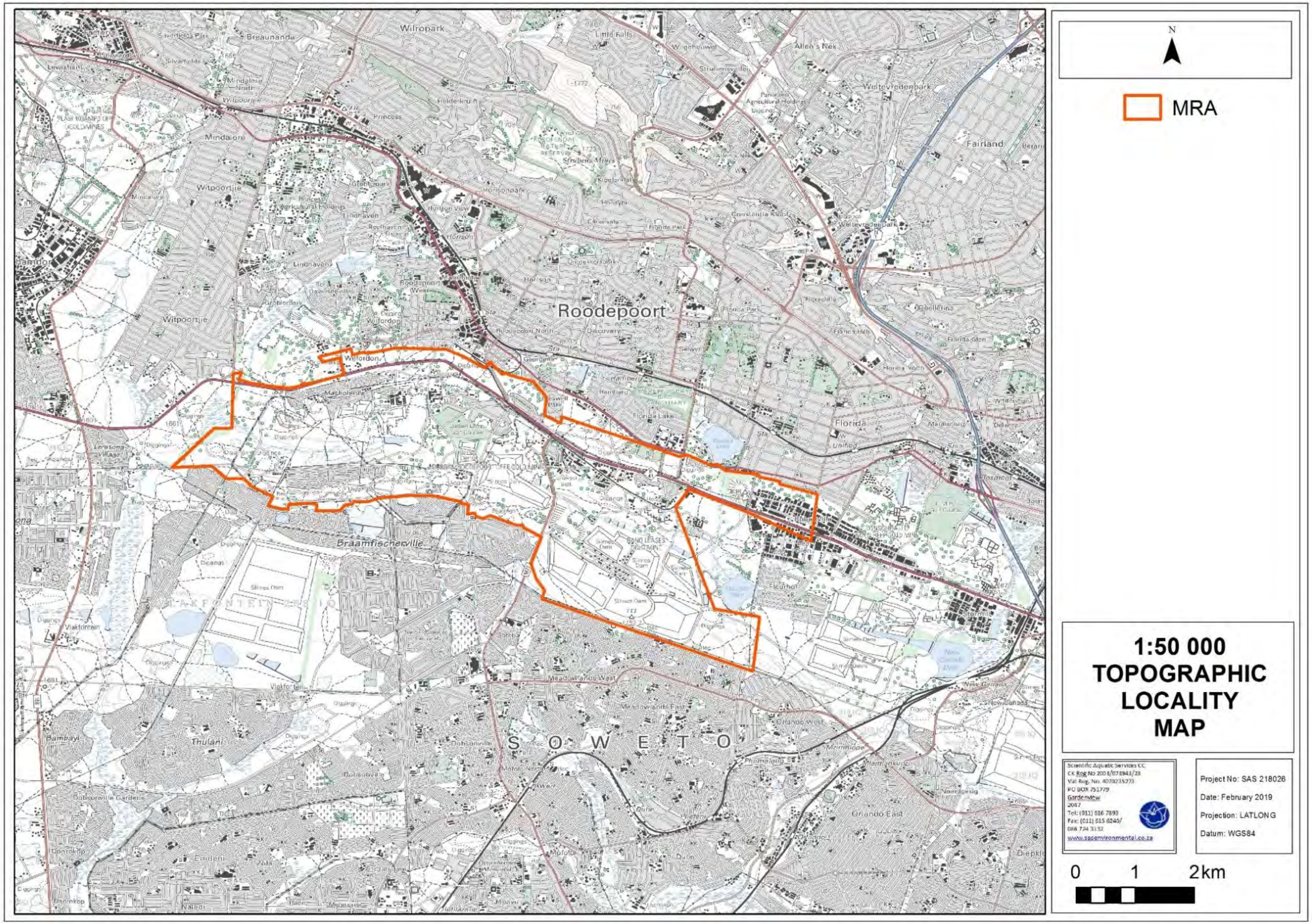

Figure 2: Location of the MRA depicted on a 1:50 000 topographical map in relation to surrounding areas.

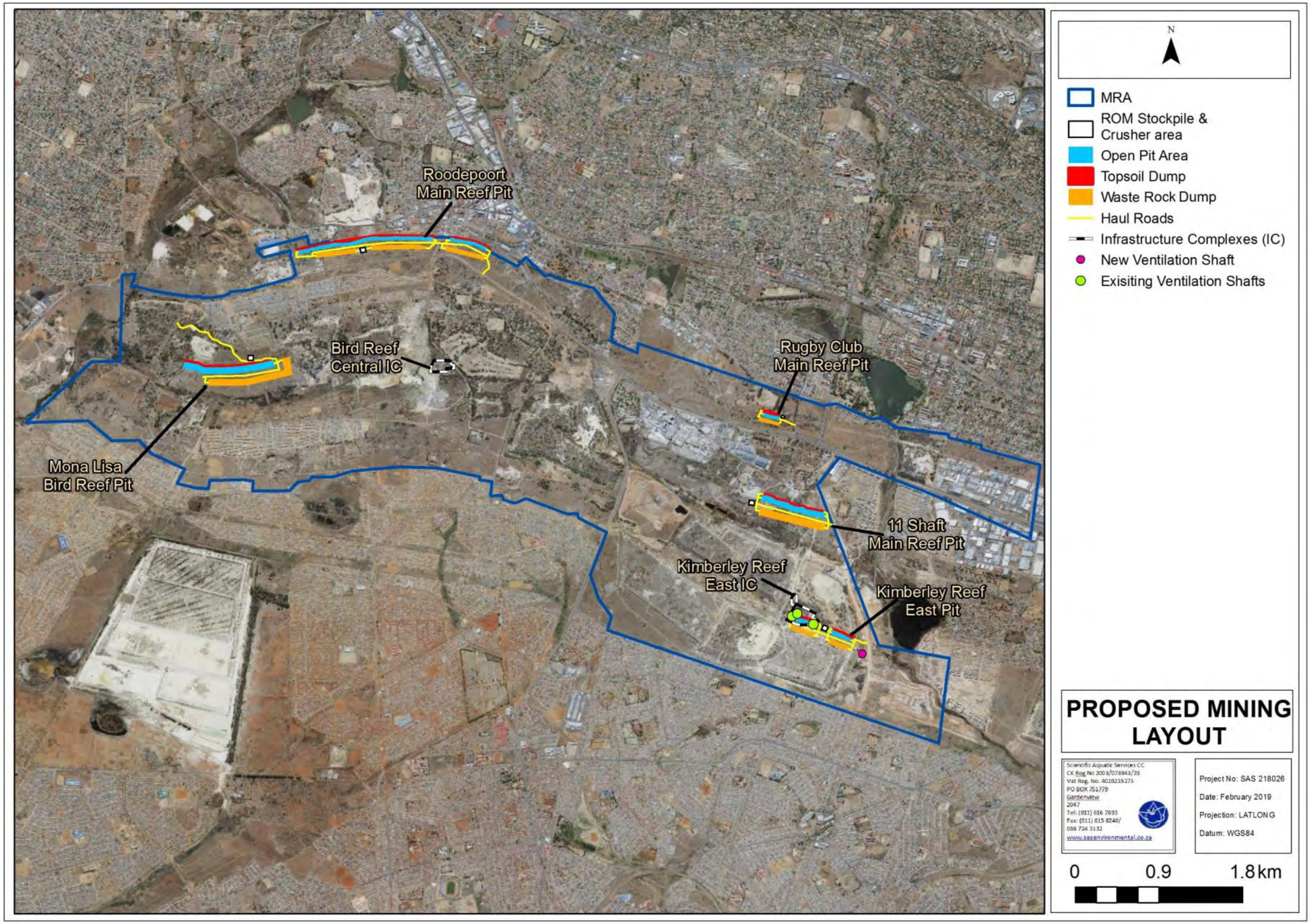

Figure 3: Proposed infrastructure layout

1.4 Assumptions and Limitations

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

- The soil survey conducted as part of the land capability and agricultural potential assessment was restricted to the proposed Mining Right Area (MRA);
- The areas where development is to occur were assessed in detail and the rest of the MRA on a high-level basis;
- Sampling by definition means that not all areas are assessed, and therefore some aspects of soil and land capability may have been overlooked in this assessment. However, it is the opinion of the professional specialist that this assessment was carried out with sufficient sampling and in sufficient detail to enable the proponent, the Environmental Assessment Practitioner and the regulating authorities to make an informed decision regarding the proposed activity; and
- Land Capability was classified according to current soil restrictions (limiting soil factors to cultivation), 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 point.

2. METHOD OF ASSESSMENT

2.1 Literature and Database Review

A background study, including a literature review, was conducted prior to the commencement of the field assessment in order to ascertain the anticipated land and soil capability of the MRA. Various data sources such as the Agricultural Geo-referenced Information System (AGIS) and other sources as listed under references were used for the assessment.

2.2 Soil Classification and Sampling

A soil survey was conducted on 6 and 7 March 2018, at which time the identified soils within the MRA were classified into soil forms according to the Soil Classification System for South Africa. This period of site investigation is deemed acceptable since seasonality does not have a bearing on soil and land capability:

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

It was also the objective of the assessment to provide recommended mitigation measures and management practices to implement in order to comply with applicable articles of legislation. Table 2 and Figure 4 depict a typical arrangement of master horizons in a soil profile.

Table 2: Typical Arrangement of Master Horizons in a Soil Profile

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

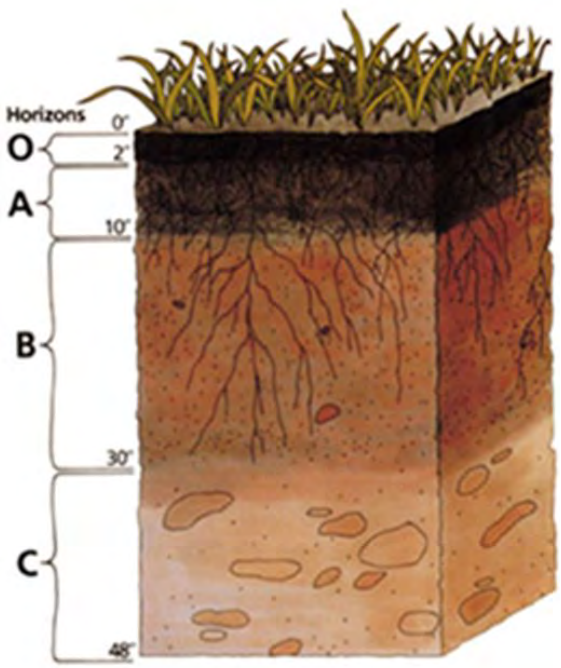

Figure 4: Schematic diagram depicting a conceptual presentation of a typical soil profile

2.3 Land Capability Classification

Agricultural potential is directly correlated to Land Capability, as measured on a scale of I to VIII, as presented in Table 3 below; with Classes I to III classified as prime agricultural land that is well suitable for annual cultivated crops. Class IV soils may be cultivated under certain circumstances and management practices, while Land Classes V to VIII are not suitable to cultivation. Additionally, the climate capability is also measured on a scale of 1 to

8, as illustrated in Table 4 below. The land capability rating is therefore adjusted accordingly, depending on the prevailing climatic conditions as indicated by the respective climate capability rating.

The expected impacts of the proposed land use on soil and land capability were assessed in order to inform the necessary mitigation measures.

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

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

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

Table 4: 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.

2.4 Laboratory Analyses

All sampled soils were sent to the WaterLab, a South African National Accreditation System (SANAS) accredited laboratory, for selected soil and water chemical analyses. The samples were prioritised for selected analyses of specific contaminants of potential concern (CPCs) according to the conceptual source-pathway-receptor linkages. The chemical analyses included the following selected constituents and contaminants of potential concern (CPCs):

- pH;
- Electrical conductivity (EC);
- Alkalinity;
- Anions; and
- Inorganic heavy metals and metalloids.

2.5 Soil Data Analysis and Interpretation

Analytical data was interpreted quantitatively, as mass of contaminant per mass of dry weight (DW) of soil (mg/kg), pH values and/or milli-Siemens per meter (mS/m) for electrical conductivity (EC). Table 5 below was used as reference guide to interpret pH results in terms of acidity.

Table 5: pH classification with reference of common foods and other substances

pH range	Description	pH range of common foods and other substances	
<4,5	Extremely acid	Battery acid	<2.0
4,5 – 5,0	Very strongly acid	Lemon juice	2.0-2.6
5,1 – 5,5	Strongly acid	Vinegar	2.4-3.4
5,6 – 6,0	Medium acid	Wine	4-5
6,1 – 6,5	Slightly acid	Normal rain	5-6
6,6 – 7,3	Neutral	Distilled water	7
7,4 – 7,8	Mildly alkaline	Baking soda	8-9
7,9 – 8,4	Moderately alkaline	Soap	9-10
8,5 – 9,0	Strongly alkaline	Ammonia	10-12
>9,0	Very strongly alkaline	Lye	12-14

Note: pH Values of Common Foods and Ingredients obtained from (Anon, 1962), and (Bridges and Mattice 1939).

2.6 Impact Assessment

The impacts of the proposed mining operation on the identified soil resources and their respective land capability is assessed according to a pre-defined methodology, as detailed under section 4.

3. ASSESSMENT RESULTS

3.1 Desktop Assessment Results

The desktop assessment results were obtained from various data sources including, but not limited to, the Agricultural Geo-Referenced Information System (AGIS) and other sources as listed under references:

- The Mean Annual Precipitation (MAP) for the MRA ranges between 662-704 mm per annum;
- According to the 1:250 000 geological map of South Africa, the MRA comprises two (2) geological group formations (Figure 5):
  1. Meinhardskraal Granite, Sand River Gneiss; and
  2. Witwatersrand, Dominion, Pongola.
- The SOTER database indicates that the lithology of the entire MRA is comprised of Quartzite;
- According to the SOTER database, the entire MRA comprises Rhodic Lixisols (LXh) soil type;
- Mining and Biodiversity Guidelines (2013) database indicates that the MRA falls within areas of Moderate, High and Highest Biodiversity. Refer to Figure 6;
- The entire MRA is comprised of soils classified as sub-dominant sandy soils;
- According to the AGIS Land Capability Atlas, the entire MRA is classified as Moderate Potential Arable Land with a Class III land capability (Figure 8);
- According to the SOTER database (soils with beneficial water-retaining layers below the rooting zone layer), the entire MRAs is comprised of soils with an absent water retaining layer below the root zone;
- The SOTER database indicates that the soils within the entire MRA are classified as having moderate susceptibility to wind erosion and are on generally moderately sloping land;
- The natural soil pH is estimated to range between 5.5 and 6.4 within the entire MRA as interpolated from topsoil pH values obtained from the National Soil Profile Database (AGIS database). This indicates that the soils are anticipated to be slightly acidic within the MRA;
- The grazing capacity within the entire MRA is 3 ha per Large Animal Unit (ha/LAU);
- The GDARD database (2013) indicates that the MRA is comprised of built up areas ranging from residential, commercial to industrial areas, and vacant areas, as presented in Figure 7;

- According to the GDARD database (2013), there are no Agricultural Hubs (areas of future agricultural development focus) occurring within the MRA;
- The land capability of the soils resources within the MRA ranges between low to moderate and high to very high according to the GDARD database (2013), as presented in Figure 8;
- Small portions to the south of the MRA are under cultivation, and this can be best described as small-scale farming. Some of the crops under cultivation within the MRA include maize as well as pastures (GDARD, 2013). Refer to Figure 12 and 13; and
- The size of the cultivated portions ranges between 0.8 ha to 28 ha.

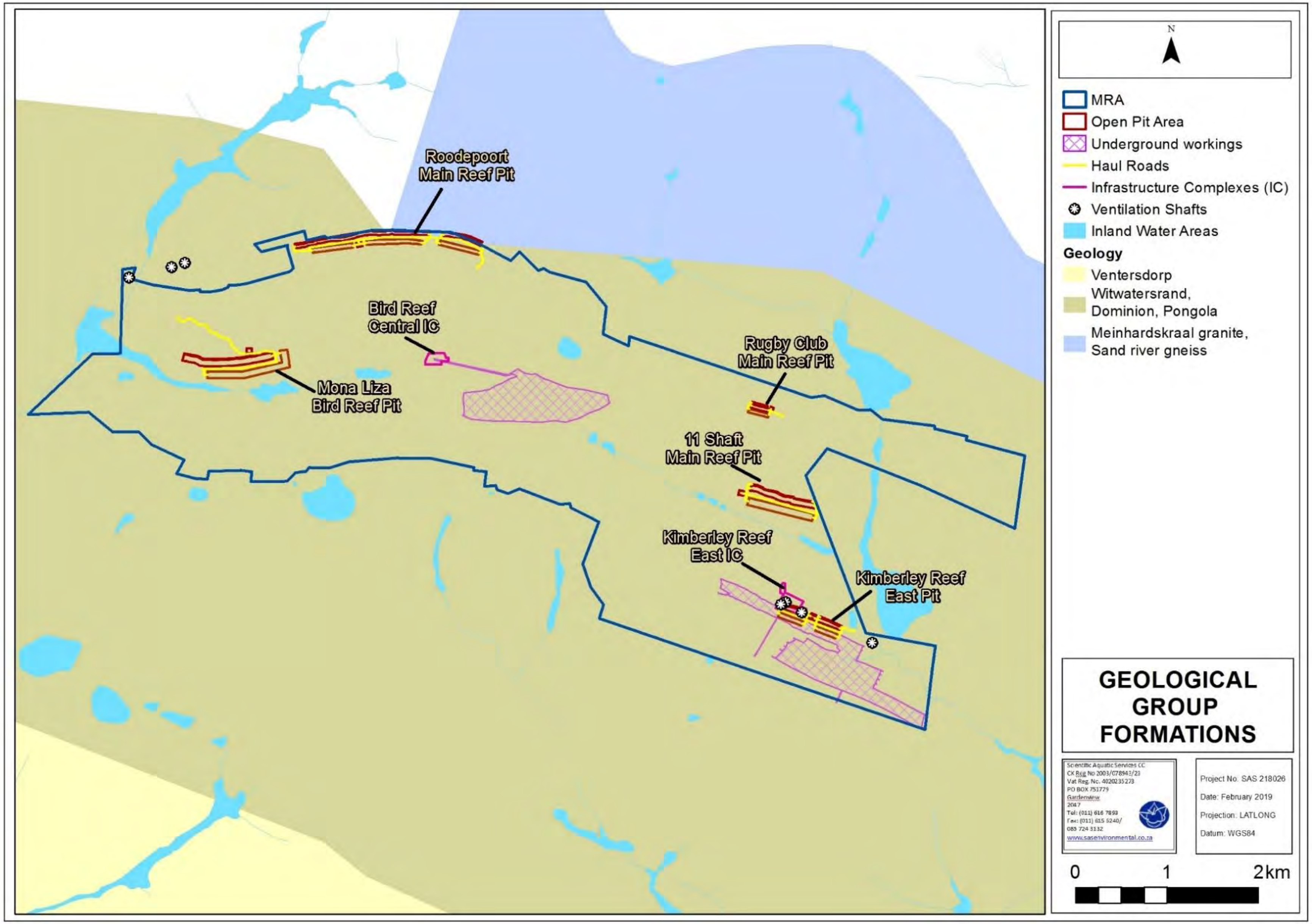

Figure 5: Presentation of the Geological Group Formations according to the 1:250 000 geological map of South Africa.

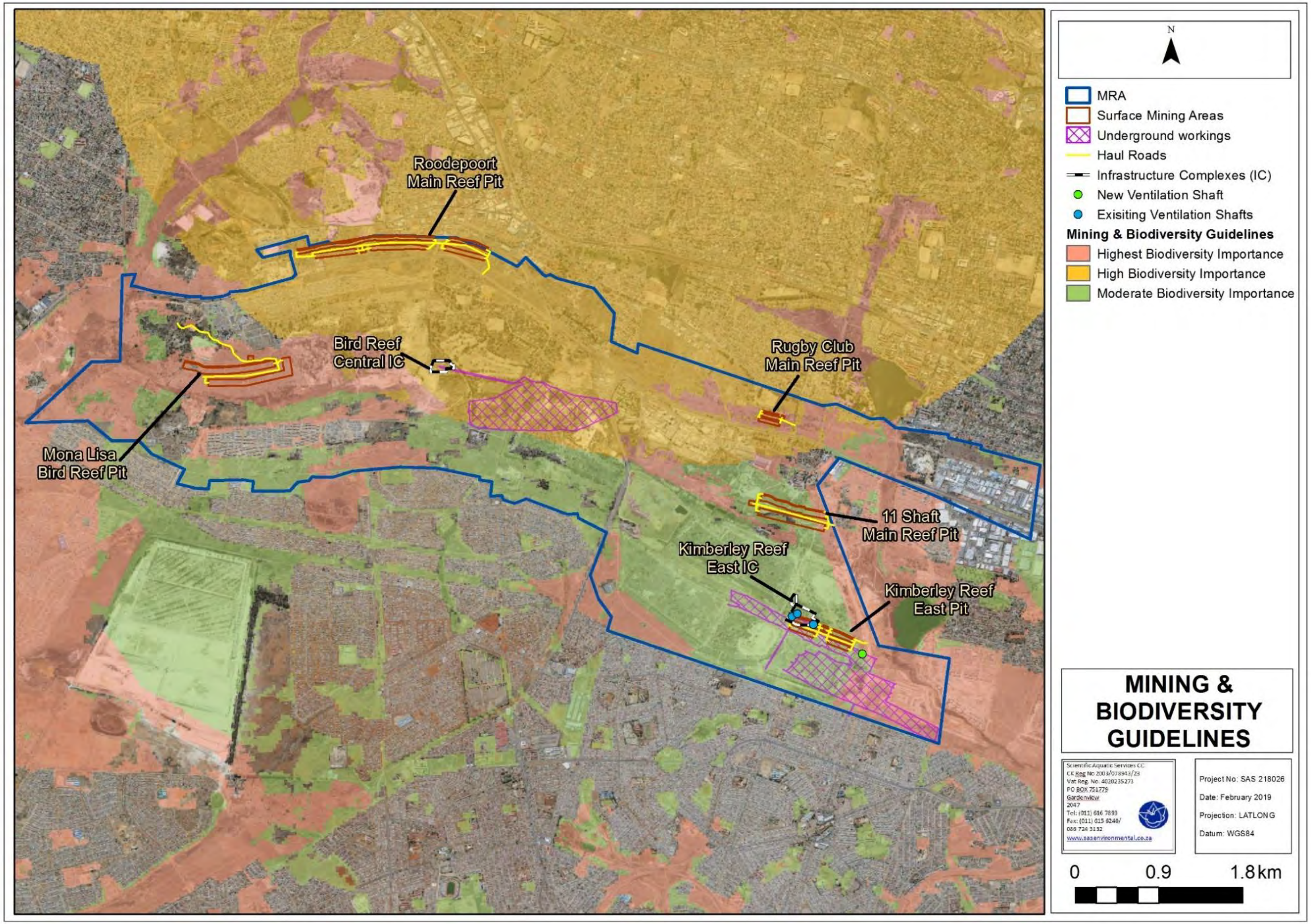

Figure 6: Presentation of the MRA as pertaining to the Mining and Biodiversity Guidelines (2013).

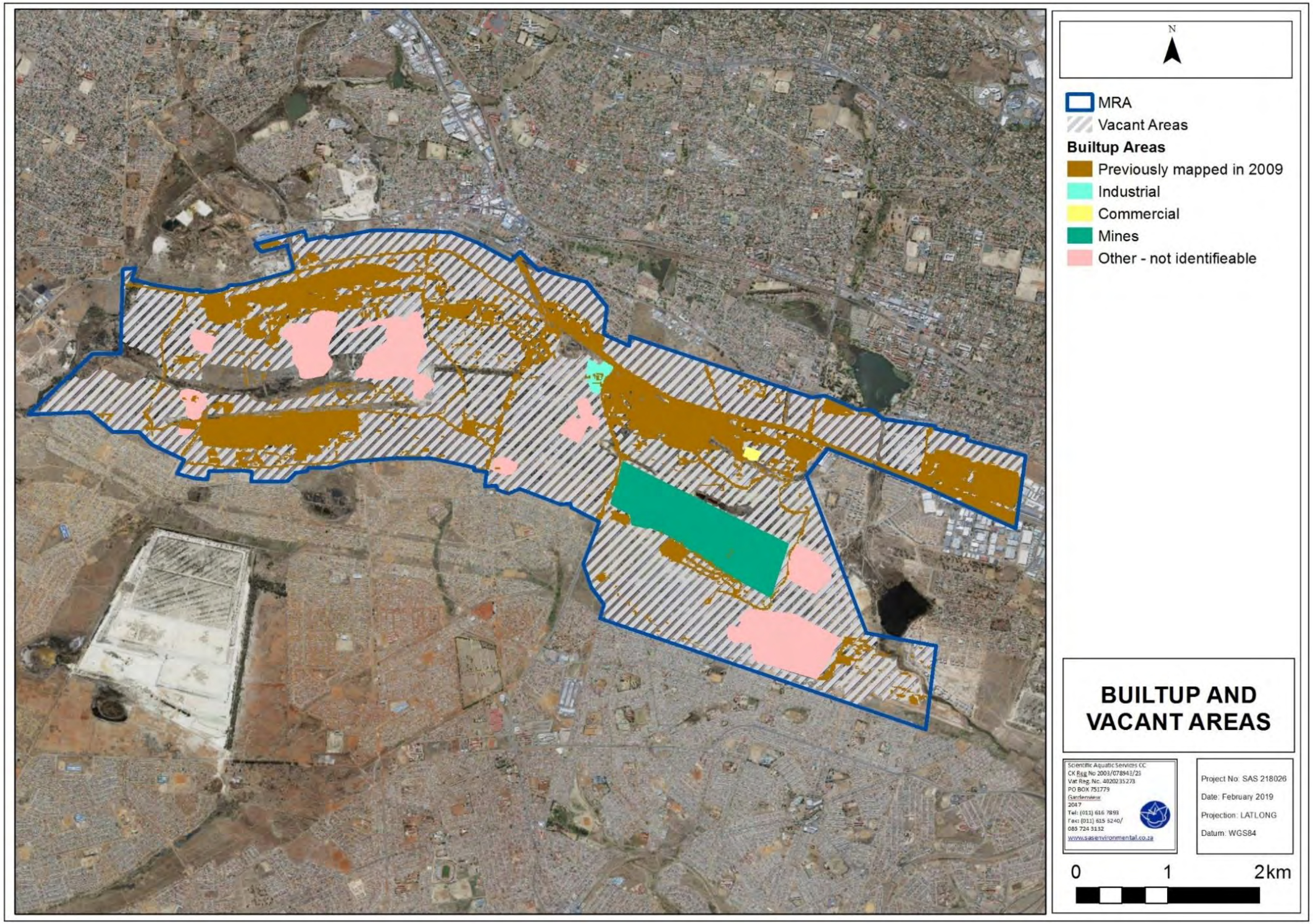

Figure 7: Presentation of built up and vacant areas within the MRA according to the GDARD (2013) database.

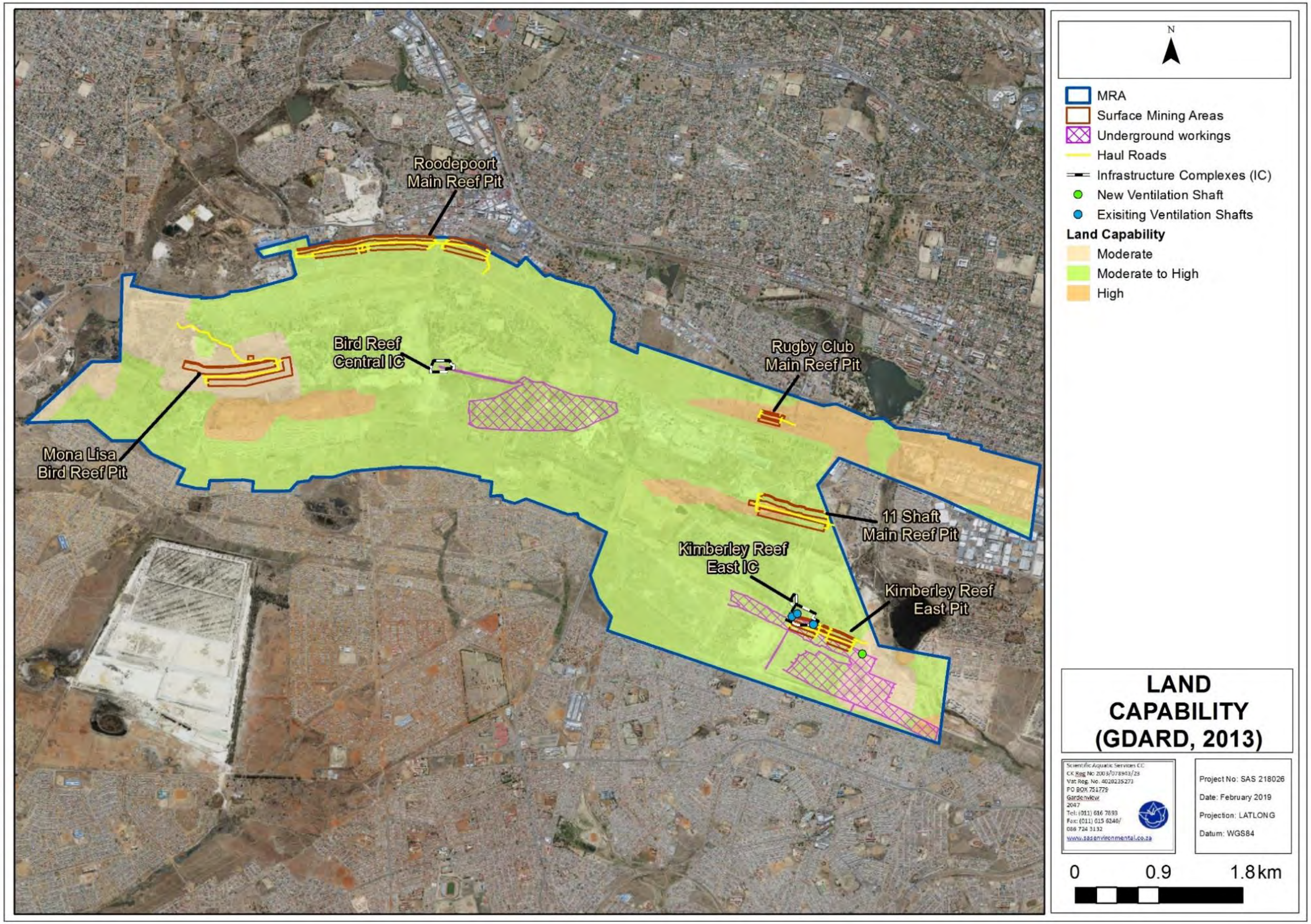

Figure 8: Presentation of land capability within the MRA according to the GDARD (2013) database.

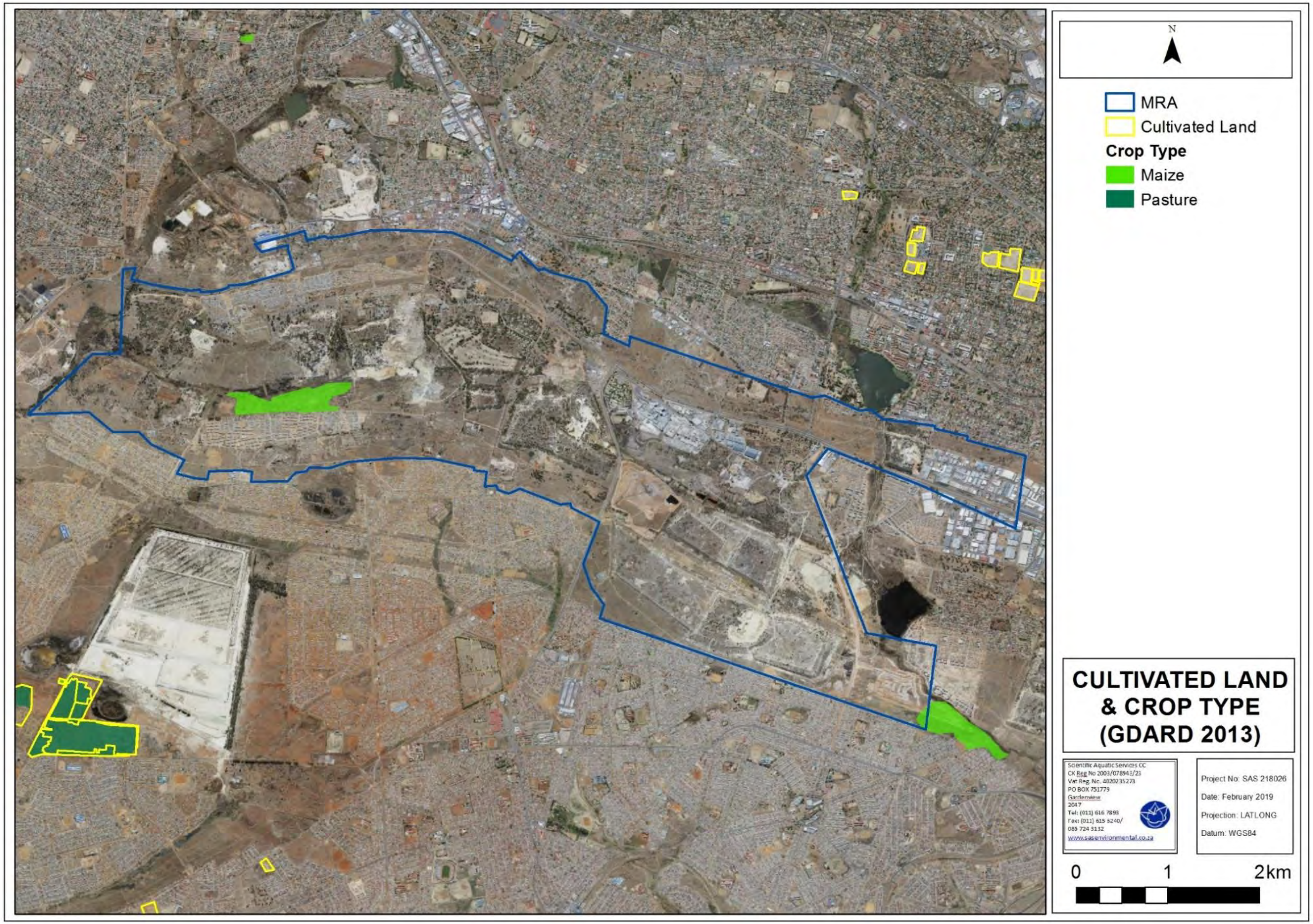

Figure 9: Presentation of cultivated areas and crop type within the MRA according to the GDARD (2013) database.

3.2 In-situ Assessment Results

3.2.1 Dominant Soil Types

Following the preliminary results of the dominant soils presented during the scoping phase, the EIA phase presents refined and detailed results of the dominant soils and are presented below.

The MRA is dominated by Anthrosols which under the South African Soil Classification Systems of 2018 are classified as Witbank, Industrial and Johannesburg, occupying approximately 56.32%. Built-up areas occupy approximately 22.17%, whilst the shallow soils of Mispah/Glenrosa forms collectively constitute of approximately 16.39% of the total investigated area. Arable soils of Hutton and Clovelly occupy approximately 1.87% of the total investigated MRA which is 39.79 ha which is not considered adequate in extent for commercial unirrigated agriculture. The spatial distribution of all identified soil forms within the MRA is presented in the soil map in Figure **10** below. Table 6 summarises all dominant soils as well as their respective land capability within the MRA.

Table 6: Dominant soil forms identified within the MRA

Soil Form	Land Capability	Total Area (Ha)	% Areal Extent
Hutton/Clovelly	Arable (Class II)	39.79	1.87
Westleigh/Avalon	Arable (Class IV)	16.54	0.78
Kroonstad/Longlands	Grazing (Class V)	47.43	2.29
Mispah/Glenrosa		348.58	16.39
Witbank/Industria/Johannesburg (Anthrosols))	Wildlife/Wilderness (Class VIII)	1198.2	56.32
Artificial Water Features	Non-Arable	5.40	0.25
Built-up areas (Residential, Industrial, Commercial areas and Access Roads)		471.73	22.17
Total Area Investigated	2127.40		100

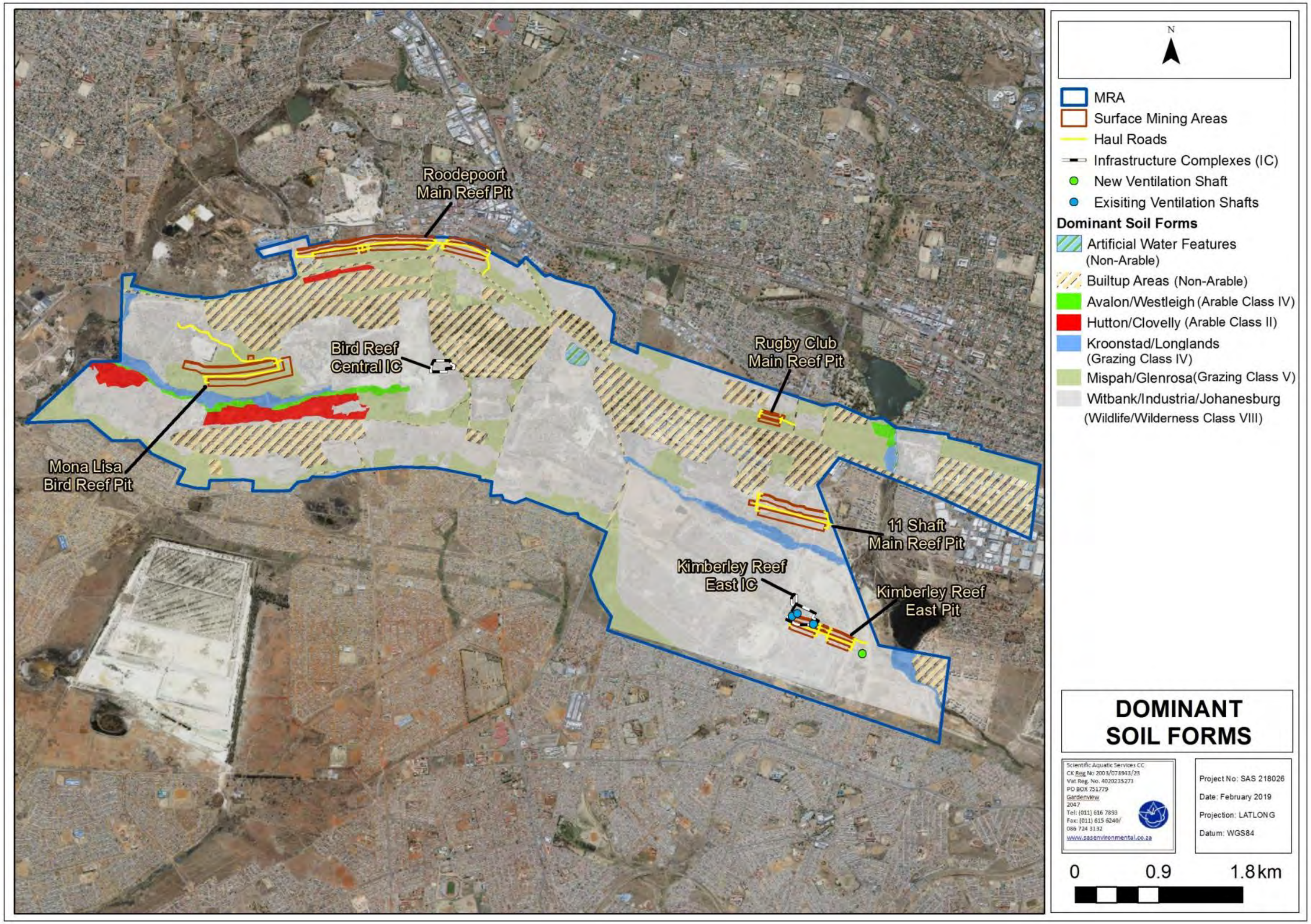

Figure 10: Soil map depicting identified soil forms with land capability classes within the MRA

3.2.2 Current Land Use

Based on observations during the site assessment and scrutiny of satellite imagery, land uses associated with the MRA include residential areas, industrial areas, commercial areas, manufacturing and distribution facilities, schools, clinics, small scale subsistence agriculture (maize and pastures at the time of field assessment), historical mine infrastructure (tailings facilities, shafts, abandoned buildings and water facilities), powerlines and road infrastructure as well as ongoing illegal small-scale gold and sand mining operations. Figure **11 and 12** depicts the current land uses within the investigated MRA.

Figure 11: Photos depicting some of the current land use within the MRA

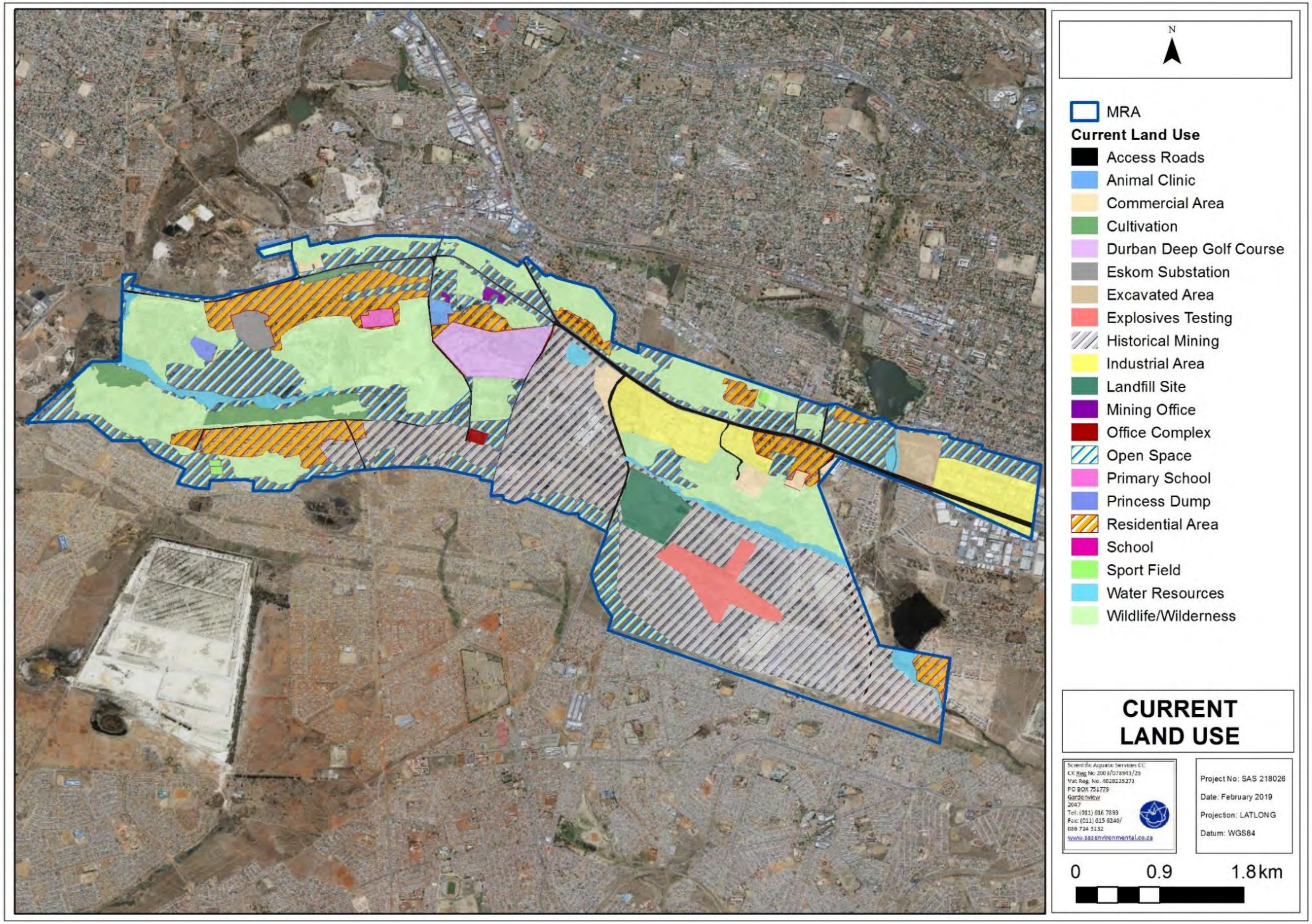

Figure 12: Current land use map pertaining to the MRA

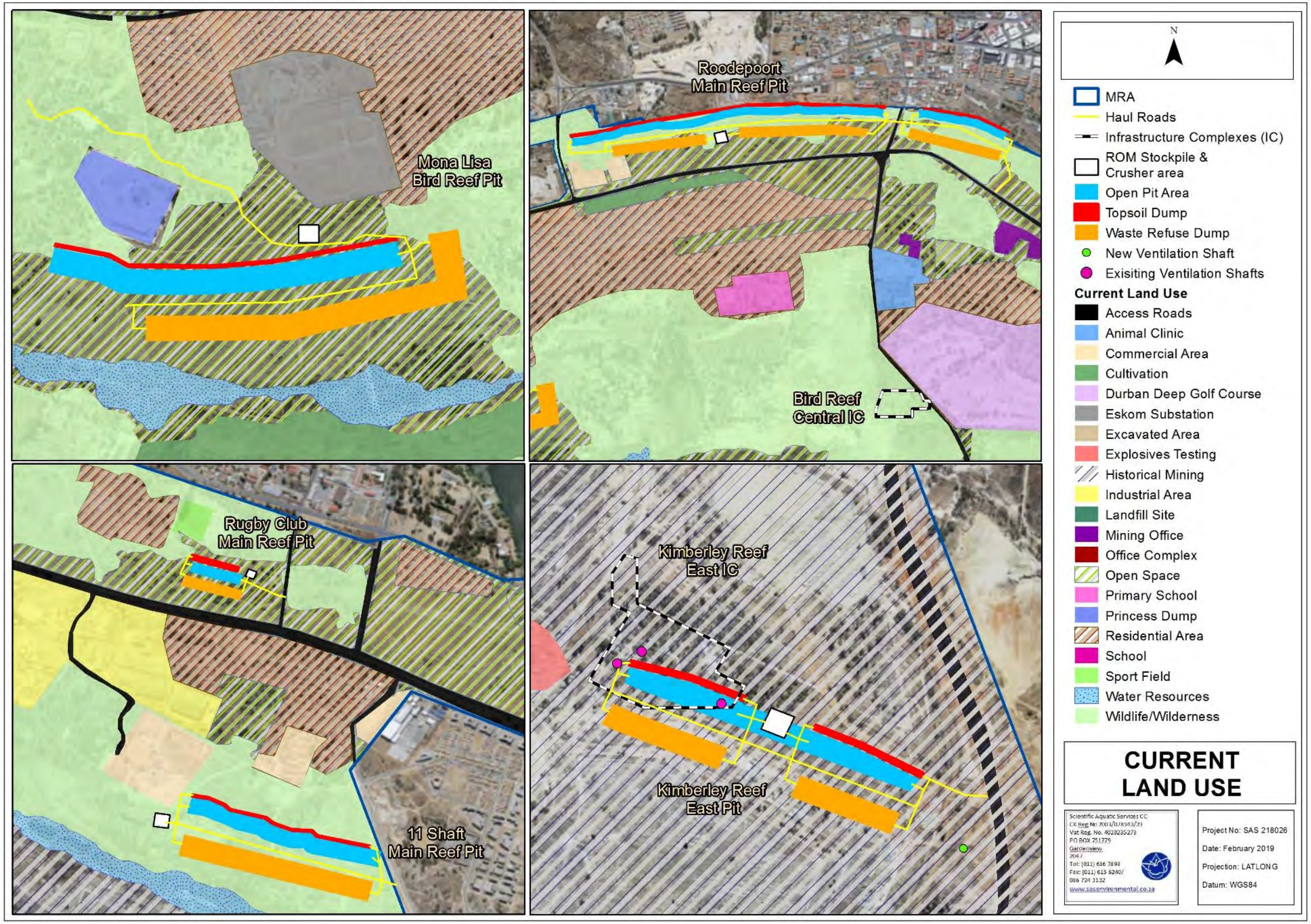

Figure 13: A Zoomed map depicting the current land use map pertaining to the MRA

3.2.3 Land Capability Classification

Agricultural land capability in South Africa, is generally restricted by climatic conditions, mainly water availability. However, even within similar climatic zones, different soil types typically have different land use capabilities attributed to their inherent characteristics.

High potential agricultural land is defined as having the soil and terrain quality, growing season and adequate available moisture supply needed to produce sustained economically high crops yields when treated and managed according to best possible farming practices (Scotney et al., 1987). For 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 MRA falls into Climate Capability Class 3 at best, with slight limitations for arable crops.

The identified soils were classified into land capability classes using the Scotney *et. Al*. Land Capability Classification system (Scotney et al., 1987), as presented from **Figure 15**. The identified land capability limitations for the identified soils are discussed in comprehensive "dashboard style" summary tables presented from Tables 7 to 11 below. The dashboard reports aim to present all the pertinent information in a concise and visually manner**.** It should be noted that a dashboard table was not included for non-arable areas since they are developed and include residential, industrial and commercial infrastructure.

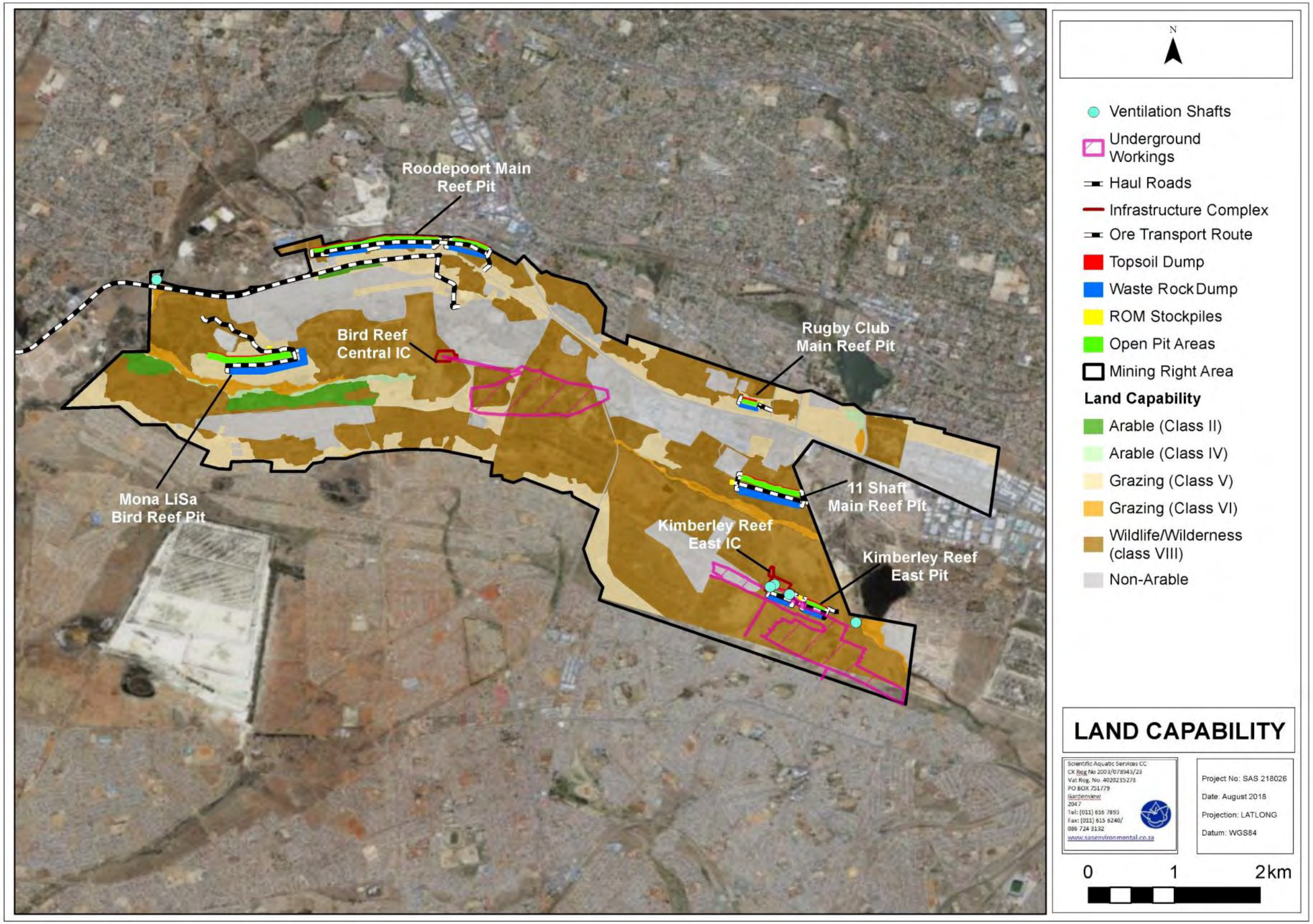

Figure 14: Land capability map depicting land capability classification of the identified soils within the MRA

Table 7: Summary discussion of the Arable (Class II) land capability class

<table>
<tr><td colspan="3">Land Capability: Arable - Class II</td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="3">View of the gently sloping terrain where Hutton/Clovelly soils were encountered
</td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Gently sloping landscape positions < 1 % slope gradient</td><td>Photograph notes</td><td>View of the identified Hutton/Clovelly soil forms</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Hutton/Clovelly</td><td>Areal Extent</td><td>39.79 ha which constitutes ≈1.87 % of the surveyed area</td></tr>
<tr><td>Diagnostic Horizon Sequence</td><td colspan="2">0 - 28 cm: Orthic A
28 – 60 cm: Red apedal B/Yellow brown apedal B
60cm - 90 cm: Unspecified</td><td colspan="2" rowspan="2">Land Capability
The identified Hutton and Clovelly soil forms are considered to be prime agricultural soils of high (class II) land capability, suitable to arable agricultural land use. Therefore, these soils are considered to contribute significantly to provincial and/or national agricultural productivity if used for crop cultivation, and are essentially also well-suited for other less intensive land uses such as grazing, forestry, etc. However, emphasis is directed to their agricultural crop productivity due to the scarcity of such soil resources on a national scale and food security concerns.</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">None; these soils have sufficient depth (more than one metre) for most cultivated crops and good drainage characteristics. These soils are inherently ideal for crop cultivation.</td></tr>
<tr><td>Overall impact significance prior and post mitigation</td><td>L</td><td>These soils were identified within the greater MRA, however these soils are not associated with the proposed mining and related activities. Thus the overall impact of the proposed mining and associated infrastructure is anticipated to be low (L) and very low post mitigation</td><td colspan="2">Business case, Conclusion and Mitigation Requirements:
The impact on these soils is regarded low since they are not located in close proximity to mining and related activities. The impact significance can further be reduced to very low significance, provided that the proposed integrated mitigation measures are implemented accordingly, as presented in section 4.</td></tr>
</table>

Table 8: Summary discussion of the Arable (Class IV) land capability class

<table>
<tr><td colspan="3">Land Capability: Arable - Class IV</td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="3">View of the identified Avalon/Westleigh soil forms
</td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Valley bottoms and gently sloping landscapes</td><td>Photograph notes</td><td>View of the identified Avalon/Westleigh soil form</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Avalon/Westleigh</td><td>Areal Extent</td><td>16.54 ha; which constitutes 0.78 % of the surveyed area</td></tr>
<tr><td>Diagnostic Horizon Sequence</td><td colspan="2">0-10 cm: Orthic A
10-35: Yellow Brown apedal B
35 – 70 cm Soft plinthic B horizon</td><td colspan="2" rowspan="2">Land Capability
The identified Avalon/Westleigh soil forms were classified as class IV land capability due to land use limitations related to prolonged waterlogging attributed to inherently poor internal drainage of the soft plinthite layer encountered at extremely shallow depth. The prolonged waterlogging of these soils limits their land use largely to wetland habitats for various wetland plant species that are inherently tolerant and/or obligate to anoxic conditions. These soils are therefore not considered to contribute significantly to provincial and/or national agricultural productivity.</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">Plant roots development of some crops, and water infiltration are largely impeded by the clayey, slowly permeable soft plinthite horizon occurring at shallow depths of less than 35 cm. Prolonged saturation of these soils are likely to create anoxic (oxygen deficiency) conditions which hamper root development of most arable crops.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>M</td><td rowspan="2">The overall impact of the proposed mining is anticipated to be of moderate significance on the land capability of these soils prior to mitigation, since these soils are located downgradient of the Mona Lisa open cast area, which will likely lead to seepage of contaminants. Although these soils are not considered high potential agricultural soils, these soils are suitable to crops with shallow rooting depth, thus the recommendations and management measures of this report should be considered.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
Although not considered to be of significant agricultural productivity, mainly due to the effective rooting depth, these soils are suitable to crops with shallow rooting depth; and as such, the recommendations and management measures outlined in this report conducted as part of the environmental assessment and authorisation process take precedence.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>L</td></tr>
</table>

Table 9: Summary discussion of the grazing (Class V) land capability class

Land Capability: Grazing - Class V

Occurrence of Mispah/Glenrosa soils within the MRA

Terrain Morphological Unit (TMU)	Relatively flat to gently sloping landscape of < 2% slope gradient	Photograph notes	View of the morphology of the identified Glenrosa/Mispah soil forms
Soil Form(s)	Glenrosa/Mispah	Area Extent	348.58 ha; which constitutes 16.39 % of the total investigated area

Diagnostic Horizon Sequence		0 - 5 cm: Orthic A 5 - 10 cm: Miscellaneous hard rocky material	Land Capability The identified Glenrosa/Mispah soil forms are considered to be of poor (class V) land capability and are not suitable for arable agricultural land use under normal circumstance. Theses soils are, at best, suitable for natural pastures for light livestock grazing. Therefore, these soils are not considered to make a contribution to regional and national agricultural food grid, but rather to subsistence farming on a local scale.
Physical Limitations		Shallow effective rooting depth is the primary limitation of the land capability of the Glenrosa/Mispah soil forms, which is due to the occurrence of a rocky layer at relatively shallow depth, which would hinder penetration of plant roots.	
Overall impact significance prior to mitigation	ML	The overall impact significance of the proposed mining activities on the land capability of these soils is anticipated to be Medium Low (ML) due to the limited potential grazing opportunities and wildlife/wilderness. These soils are however not ideal for cultivated agriculture due to their shallow nature.	Business case, Conclusion and Mitigation Requirements: The identified Mispah soil form are, at best, suited for grazing and/or wilderness practices. This is due to the relatively shallow parent rock and lithocutanic material. The impact of the proposed mining activities on the land capability of these soils is anticipated to be low. As much as these soils are not considered as prime agricultural soils, these soils are important for potential grazing opportunities. Therefore, implementation of rehabilitation and the proposed integrated mitigation measures is recommended to reinstate the natural topography of the area post mining.
Overall impact significance post mitigation	**L**		

Table 10: Summary discussion of the grazing (Class VI) land capability class

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

View of the valley bottom wetland where Kroonstad/Longlands soil forms were encountered
</td><td colspan="2"></td></tr>
<tr><td>Terrain Morphological Unit (TMU)</td><td colspan="2">Valley bottoms and gently sloping landscapes of < 0.5% slope gradient</td><td>Photograph notes</td><td>View of the identified Kroonstad/Longlands soil forms</td></tr>
<tr><td>Soil Form(s)</td><td colspan="2">Kroonstad/Longlands</td><td>Areal Extent</td><td>47.43 ha; which constitutes 2.29 % of the surveyed area</td></tr>
<tr><td>Diagnostic Horizon Sequence</td><td colspan="2">0 - 15 cm: Orthic
15 – 45 cm Soft plinthic B
≥ 45 cm: G horizon</td><td colspan="2" rowspan="2">Land Capability
The Kroonstad/Longlands soil forms were classified as class V land capability due to land use limitations related to prolonged waterlogging attributed to inherently poor internal drainage of the G-horizon encountered at extremely shallow depth. The prolonged waterlogging of these soils limits their land use largely to wetland habitats for various wetland plant species that are inherently tolerant and/or obligate to anoxic conditions. These soils are therefore not considered to contribute significantly to provincial and/or national agricultural productivity.</td></tr>
<tr><td>Physical Limitations</td><td colspan="2">Plant root development and water infiltration are largely impeded by the clayey, slowly permeable soft plinthite and/or G horizon occurring at extremely shallow depths. Prolonged saturation of these soils are typically induced anoxic (oxygen deficiency) conditions which hamper root development of most arable crops.</td></tr>
<tr><td>Overall impact significance prior to mitigation</td><td>L</td><td rowspan="2">The overall impact significance of the proposed infrastructure development on the land capability of these soils is anticipated to be low (L), due to their inherently poor land capability, and the alignment of the proposed haul roads with the existing mine service roads. Similarly, to the Westleigh soil forms, the ecological functionality of these soils as an essential medium for wetland habitats is considered to be highly significant, and therefore, the recommendations and management measures of the wetland assessment report should be considered and implemented.</td><td colspan="2" rowspan="2">Business case, Conclusion and Mitigation Requirements:
Although not considered to be of significant agricultural productivity, these soils are however considered to be of significant ecological conservation as they are characteristically unique to wetland habitats; and as such the recommendations and management measures of the wetland assessment report conducted as part of the environmental assessment and authorisation process take precedence. Furthermore, the susceptibility to prolonged waterlogging conditions (inundation), as implied by the occurrence of the G-horizon at relatively shallow depth, should be considered and avoided where possible for soil structural integrity.</td></tr>
<tr><td>Overall impact significance post mitigation</td><td>VL</td></tr>
</table>

Table 11: Summary discussion of the Wildlife/Wilderness land capability class

Land Capability: Wildlife/Wilderness (VIII)

Occurrence within the MRA

These soils include tailings material, spoil material that has undergone strong chemical alteration and urban waste dump showing soil mixed with refuse material




Terrain Morphological Unit (TMU)	Not applicable; highly disturbed areas	Photograph notes	View of the identified Witbank/Industria/Johannesburg soil forms
Soil Form(s)	Witbank/Industria/Johannesburg (Anthrosols)	Area Extent	1198.2 ha; which constitutes 56.32 % of the total investigated area
Diagnostic Horizon Sequence	Not applicable; highly disturbed soils	Land Capability These identified Witbank/Industria/Johannesburg soils have very poor land capability (class VIII) attributed to historical disturbances relating to mining, industrial and residential developments. In addition, some of these soils have been subjected to long term contamination, compaction and erosion. This land capability class also includes areas where the original soil has been buried and/or extensively modified by anthropogenic activities. These soils are therefore not considered to make a significant contribution to agricultural productivity even on a local scale.	
Physical Limitations	Comprises of significantly disturbed areas due to historical mining and related activities to an extent that no recognisable diagnostic soil horizon properties could be identified. These soils included old tailings facilities, old shaft complexes, explosive testing areas, as observed during the site assessment. These soils are characterised by various limitations, primarily the absence of natural soil as a growth medium for arable agriculture and grazing.		

Overall impact significance prior to mitigation	L	The overall impact of the proposed development on the land capability of these soils is anticipated to be low due to their very poor land capability attributable to anthropogenic disturbances.	Business case, Conclusion and Mitigation Requirements: The current state of these soils requires significant rehabilitation already. These areas can be rehabilitated holistically at closure of the proposed mining and related activities to support grazing.
Overall impact significance post mitigation	L		

3.2.4 Chemical Characteristics of soil

Although soil functionality cannot be directly measured, physico-chemical parameters such as pH and EC are sensitive to disturbance and responsive to management. These parameters can be used as indicators of the response of the soil and ecosystem to current (and/or former) management practices. The baseline analysis results of physico-chemical parameters including soil pH, and EC under the conditions present at the time of the assessment are presented below in appendix. A. Refer to Figure **15** for soil sampling locality.

The chemical soil analyses indicate that the pH of the surrounding soils ranges between 3.0 and 7.5, whereas the electrical conductivity (EC) ranges between 2.4 and 12.9 mS/m. The majority of the soil samples fell outside the optimum pH range (5.5 < pH <7.5) and based on the low pH these soils are considered to be acidic and thus affected by mining. Strongly acidic soils were sampled in close proximity to an old tailings facility within the Vogelstuisfontein area. However, based on the Soil and Terrain database (SOTER) the natural pH of these soils ranges from 5.5 to 6.4 and they are considered to be slightly acidic. The acidity of these soils is likely attributed to the historical mining activities occurring within the surrounding areas. Low pH soils are said to have low agricultural value, this due to a release of aluminum that can stunt a plant's growth and alter nutrient intake. Some plants may also suffer with manganese and iron toxicity that causes yellow spots and leads to browning and leaf death. Refer to Appendix A.

The EC is a measure of the amount of soluble salts in the soil solution. However, there is no formally derived guideline value for EC. The laboratory analysis indicates that the EC of some areas are contaminated to some degree. However, none of the analysed samples exceeded the arbitrary threshold value. Refer to Appendix A.

The cyanide, CN, concentrations of the sampled soils was obtained by leaching the soil with distilled water. The detection limit was set at 0.02 mg/l, and for all the sampled areas the cyanide levels fell below the detection limit. Refer to Appendix A. According to the Environmental Protection Agency (EPA), the Maximum Contaminant Level Goals (MCLG) for cyanide is 0.2 mg/l, thus from the analysis of the laboratory results, cyanide levels of the surrounding soils falls within acceptable levels.

3.2.5 Macronutrients Analysis

For the purpose of this investigation, only selected essential macronutrients were selected for analysis, the comprehensive analysis results are presented in Appendix A.

Deficiency of a micronutrient can be just as yield limiting as the deficiency of a macronutrient. From the analysis of selected essential macronutrients such as Ca, Mg, K, Na, and P; most of the sampled soils showed significantly high concentrations of these macronutrients. Excessive nature of If these nutrients are available in excess, this will result in poor growth and development of plants. For instance, the higher levels of calcium are indicated on the results and they are mainly due to blockage of nutrients such as potassium, manganese and iron. Furthermore, the results indicate a deficiency in phosphorus, this results to a delayed maturity on plants, however the deficiency is likely to occur on lower pH soils. This imbalance tends to induce dispersion, which results in poor soil structure, which is susceptible to erosion during intense rainfall.

However, these soils are not considered to be saline or sodic, as the soils are distinctly acidic, and the total salt content is relatively low, as indicated by the EC values. According to the Food and Agriculture Organization (FAO) of the United Nations, the conductivity of the saturation extract of >120 mS/m (at 25 °C) and a pH of usually 8.5 or less in the water saturated soil is required for a soil to be classified as saline-sodic. Refer to Appendix A.

While there are no formally derived guideline values for essential macronutrients (Ca, Mg, Na, K, and P) in soil, these elements are typically regulated by pH and their availability for plant uptake is generally enhanced under favourable pH conditions in the range of 5.5 – 7.0 in order to avoid plant nutrient deficiencies.

3.2.6 Micronutrients Analysis

Micronutrients are essential elements that are required by plants in trace concentrations. Each essential element can only perform its role in plant nutrition properly when other necessary elements are available in balanced ratios for plant. For this report only, essential trace elements were selected for analysis and these include Manganese (Mn), Nickel (Ni), and Copper (Cu). Low pH levels tend to increase the concentration of these elements and they become toxic for plants if there is an excess in the soil. The results indicate that the majority of the elements are available in excess, which can be attributed to low pH levels of the soils within the investigated MRA.

Heavy metals such as Manganese (Mn), Iron (Fe), Copper (Cu) and Nickel (Ni) are essential elements with a wide range of common key roles in many plant functions. One of the well-known role is in the photosynthesis process, as it is a building block of the Chlorophyll. These elements are required in relatively low concentrations for them to be useful to plants.

However, the laboratory analysis indicates a significant higher concentration of these elements in relation to the recommended standard. This is highly likely to create toxic conditions in the soil, thus leading to the soils having low agricultural potential.

3.2.7 Further considerations

From the findings of this assessment it is anticipated that liming may be required within the worked areas to alleviate soil acidity at closure of the facility. The contaminants are anticipated to be more concentrated in a south-easterly direction from the Vogestruisfontein old tailings facility, as surface runoff and subsurface leaching are the most relevant mechanism for soil contaminant migration. However, the concentration of heavy metals is anticipated to be high under current low pH conditions since the bioavailability of heavy metals is directly linked to their solubility in soil solution, which is largely regulated by soil pH. For instance, Iron (Fe) is commonly known to become soluble at pH 3.5. It is therefore recommended that the soil pH be continuously monitored, particularly within rehabilitated open cast areas going forward in order to detect potential heavy metal contamination and that this information is used to guide closure and rehabilitation along with measure of EC and elemental analyses.

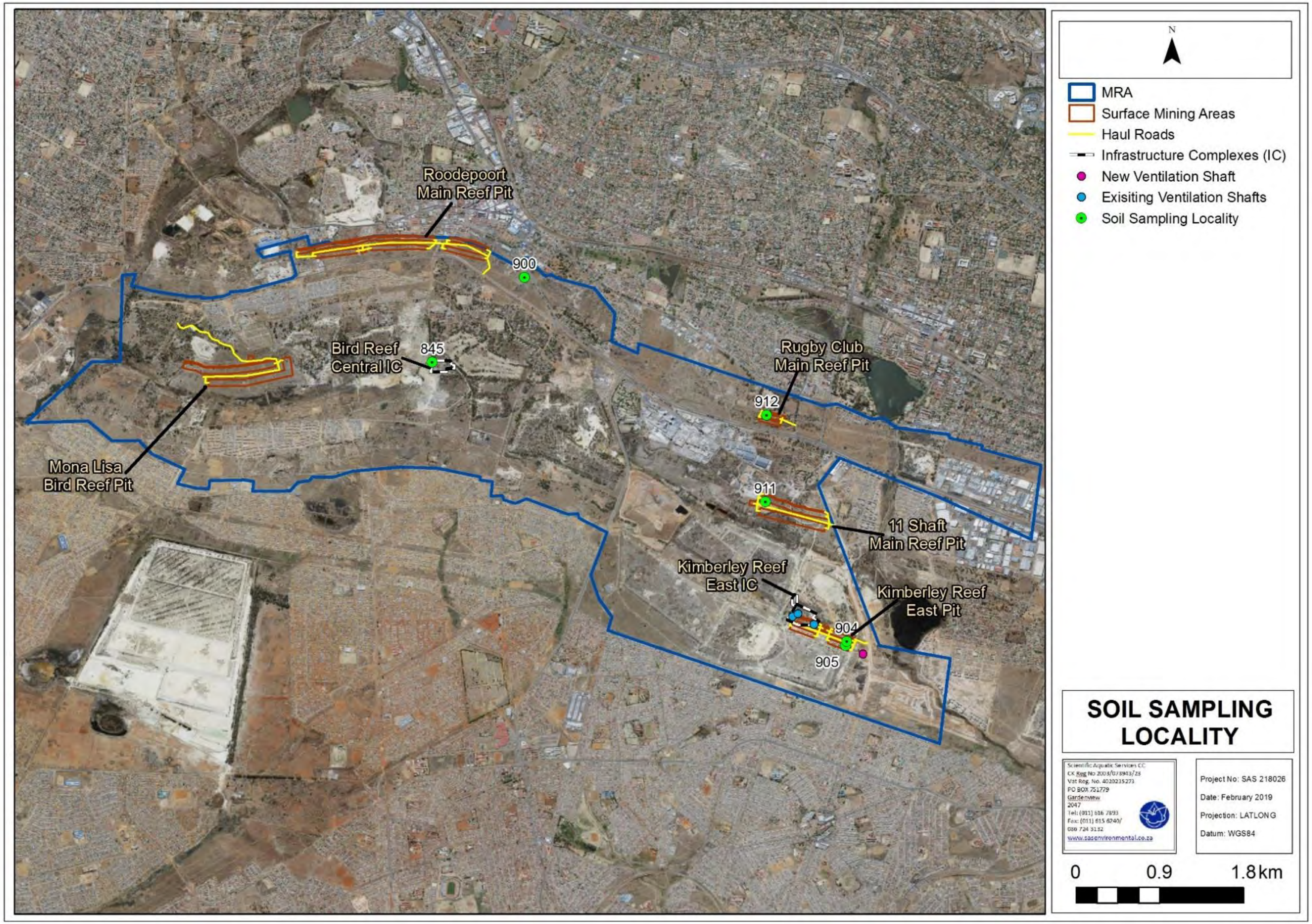

Figure 15: Map depicting the soil sampling locality in relation to the **proposed mining and related activities**

4. IMPACT ASSESSMENT AND MITIGATION MEASURES

The proposed mining activities and associated surface infrastructure will largely occur in areas which have previously been subjected to anthropogenic disturbances, some of which are related to historical mining activities. The current land capability of such areas ranges between wildlife/wilderness and non-arable. Thus, the anticipated impact from an agricultural point of view is low, particularly where the proposed mining and infrastructure is to occur. However, soil contamination within the worked areas is likely to be significant, resulting from various sources such as mining machinery (i.e. hydrocarbons). Based on the Geochemistry reports, the waste rock material contains no iron sulphide materials, is non-hazardous and therefore the risk of the formation of acid mine drainage conditions is negligible. Refer to Geochemistry reports for further details. Nonetheless it is imperative that the land capability impact assessment be undertaken on all aspects of soil and capability likely to be affected by the proposed project. The sections below present the results of the findings per identified impact for the proposed mining activities and associated surface infrastructure.

Activities which are likely to negatively affect the soil and land capability have been identified, and the impacts include, but are not limited to, the following:

- Soil erosion resulting from cleared and disturbed areas, leading to loss of soils;
- Soil compaction resulting from increased traffic of mining equipment;
- Loss of soil depth and volume due to excavation associated with mining activities;
- Contamination of soil resources resulting from accidental spillage of hydrocarbons and other hazardous material, leading to altered soil chemistry; and
- Loss of potential agricultural soils.

4.1 Vegetation clearing: *Impact on soil erosion*

The proposed mining project is located on a moderately sloping terrain and as such the erosion hazard is anticipated to be moderate. The identified soils will become more vulnerable to erosion once the vegetation is cleared for construction activities, and the soils will inevitably be exposed to wind and stormwater. As such, the significance of this impact is anticipated to be **moderate prior to mitigation** and **low post mitigation**, provided that mitigation is carefully implemented during all phases of development. Impact rating tables are presented below.

4.2 Mining vehicles: Impact on soil compaction

Heavy equipment traffic during construction and mining related activities is anticipated to cause some soil compaction, particularly for Kroonstad/Longlands/Westleigh and Avalon due to the clayey nature of these soils in the sub horizons (i.e. G horizon of Kroonstad and soft plinthic material of the Longlands and Westleigh). However, rocky outcrop and shallow soils of Mispah/Glenrosa are anticipated to be less impaired, attributable to the relatively shallow bedrock which offers resistance to compaction. The impact significance without mitigation is anticipated to be moderate without mitigation and low with mitigation.

4.3 Accidental Hazardous Chemicals spills/leaks and soil contamination

All the identified soils are considered to be equally predisposed to potential contamination, as contamination sources are generally unpredictable and often occur as incidental spills or leak during mining activities. The significance of soil contamination is considered to be moderate for all identified soils, largely depending on the nature, volume and/or concentration of the contaminant of concern. The impact significance without mitigation is anticipated to be moderate without mitigation and low with mitigation.

Therefore, strict spill management protocols and activity specific Environmental Management Programme (EMP) guidelines should be adhered to during the mining related activities.

4.4 Loss of soil depth and volume from Soil excavation

The open cast mining is anticipated to have a significant impact on soil depth and volume since during the operational phase, as most of the ore material will be transported off-site for processing and sold as product. The open cast areas will however be backfilled to mimic the natural topography to allow for post closure landuses, thus the impact significance is regarded as **high without mitigation** and **low with mitigation.**

4.5 Loss of agricultural land capability due to miscellaneous mining related activities

The proposed mining and the associated surface infrastructure are not anticipated to result in significant loss of agricultural land capability since the demarcated mining and surface infrastructural areas are predominantly underlain by anthropogenically transformed soil resources, corresponding to Witbank/Industria/Johannesburg soil forms in the South African Soil Classification system. The loss of agricultural land capability is anticipated to **moderate** without mitigation and **low** with mitigation. The majority of the soils likely to be affected by edge effect are not considered high potential agricultural soils but rather soils classified as being capable of supporting grazing and wildlife/wilderness (i.e. Mispah/Glenrosa). Of the total high agricultural potential soils (Hutton and Avalon) within the MRA area, none will be directly impacted by the proposed surface infrastructure complexes, open cast mining or haul roads. However, soil contamination resulting from leakages of hydrocarbons is anticipated to be **moderate** without mitigation, which could migrate to natural soils, thereby impacting on soils classified as grazing and wildlife/wilderness. The impact significance can be reduced to a **low** if mitigation measures as well as recommendations outlined in section 4 of this document are considered.

Table 12: Impact assessment rating of all the proposed mining and related activities

Impact	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Impact Assessment for all proposed activities							
CONSTRUCTION PHASE							
Activity: Site preparation prior to mining activities							
*Site clearing, removal of vegetation, and associated disturbances to soils leading to increased runoff, erosion and consequent loss of soil and sedimentation of down gradient receiving environment, and loss of land capability in cleared areas; *Earthworks, leading to the exposure of soils, and thus to increased runoff, erosion; *Stockpiling of topsoil material and waste rock on sloping areas leading to increased runoff and erosion and the consequent loss of soil; and *Proliferation of alien vegetation due to disturbances, thus causing alterations in the soil quality and chemistry	Unmanaged	M	M	L	M	H	M
	Managed	M	L	L	L	L	L
Activity: Construction of activities related to the construction of any of the proposed surface infrastructure and haul roads							
Construction of surface infrastructure increasing the potential risk of soil erosion.	Unmanaged	M	M	L	M	H	M
	Managed	M	L	L	L	L	L
Movement of heavy machinery / construction vehicles off existing/demarcated roads, leading to soil compaction	Unmanaged	M	M	L	M	H	M
	Managed	M	L	L	L	L	L
Potential leakages of hydrocarbons resulting from machinery / construction vehicles, and spillage of other heavy metals leading to soil contamination	Unmanaged	M	M	L	M	H	M
	Managed	M	L	L	L	L	L
Activity: Excavation and removal of soil during pit establishment							
Excavation and removal of topsoil from the proposed infrastructure areas, and stockpiling, leading to an increased risk of transportation of sediment from exposed soils in storm water runoff, leading to loss of natural topography, soil depth, soil volume and alteration of natural drainage pattern.	Unmanaged	M	M	L	M	H	M
	Managed	M	L	L	L	L	L

Mitigation Measures	*The footprint of the proposed infrastructure area should be clearly demarcated to restrict vegetation clearing activities within the infrastructure footprint as far as practically possible; *Bare soils 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 infrastructural and open cast areas should be re-vegetated with an indigenous grass mix, if necessary, to re-establish a protective cover, in order to minimise soil erosion and dust emission; *A spill prevention and emergency spill response plan, as well as dust suppression, and fire prevention plans should also be compiled to guide the construction works; *An emergency response contingency plan should be put in place to address clean-up measures should a spill and/or a leak occur, as well as preventative measures to prevent ingress; *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; *All vehicular traffic should be restricted to the existing service roads and the selected road servitude as far as practically possible; *Compacted soils adjacent to the infrastructure complexes and opencast mine pits and associated infrastructure footprints can be lightly ripped to at least 25 cm below ground surface to alleviate compaction prior to re-vegetation; *Excavation and long-term stockpiling of soil should be limited as far as practically possible; *Prevent mixing of high quality topsoil (A and B-horizons) with low quality underlying material to ensure sufficient volumes of high quality soil for rehabilitation; *Separate stockpiling of different soil type groups (to obtain the highest post-mining land capability; *Stockpiles should be revegetated to establish a vegetation cover as an erosion control measure. These stockpiles should also be kept free of alien vegetation at all times to prevent loss of soil quality; *Temporary berms should be installed, if necessary, around stockpile areas whilst vegetation cover has not established to avoid soil loss through erosion; *The recovered soils should be re-used to rehabilitate the mine footprint following mine closure; and *Soil resources of similar characteristics must be imported back to the site to compensate for soil loss that will occur during mining activities.

OPERATIONAL PHASE

Impact	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity: Establishment of the open cast pit areas							
*Operation of the open cast pit will highly likely result in a loss of soil depth and volume, since the ore material will be transported off-site and sold as product.	Unmanaged	H	H	M	H	H	H
	Managed	M	L	L	L	L	L
Potential leakages of hydrocarbons resulting from machinery / construction vehicles, and spillage of other heavy metals leading to soil contamination	Unmanaged	M	M	L	M	H	M
	Managed	M	L	L	L	L	L
Movement of heavy machinery / construction vehicles off existing/demarcated roads, leading to soil compaction	Unmanaged	M	M	L	M	H	M
	Managed	M	L	L	L	L	L
Activity: Development of waste facilities (i.e. Waste Rock Dump)							
*Stockpiling on Waste Rock Dump (WRD) areas alongside the open cast pit area. Waste rock will potentially result in soil compaction of underlying soil material.	Unmanaged	M	M	L	M	H	M

	Managed	M	L	L	L	L	L
Mitigation Measures	*An emergency response contingency plan should be put in place to address clean-up measures should a spill and/or a leak occur, as well as preventative measures to prevent ingress; *The footprint areas of the ore stockpiles as well waste rock dumps should be lined to prevent seepage of contaminants. The footprint areas should also be rehabilitated post closure to a manner that will allow for land use such as housing or industrial development. *Temporary berms and trenches should be installed around WRD areas as a measure to capture contaminated runoff water from contaminating surrounding soil resources; *Stockpiles should be revegetated to establish a vegetation cover as an erosion control measure. These stockpiles should also be kept alien vegetation free at all times to prevent loss of soil quality; and *Compacted soil associated footprint areas can be lightly ripped to at least 25 cm below ground surface to alleviate compaction prior to re-vegetation.							
CLOSURE AND DECOMMISIONING PHASE								
Impact	Management	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Activity: Backfilling of the open cast pit areas with material from the WRD and topsoil stockpiles							
*Demolition of structures such as shaft complexes and ripping of soil and hard surfaces, leading to further soil disturbances leading to compaction	Unmanaged	M	L	L	L	L	L
	Managed	M	L	L	L	L	L
re sloping, restoration of natural topography and revegetation leading to further soil erosion, compaction and contamination. Resurfacing may lead to water ponding if not done properly	Unmanaged	M	M	L	M	H	M
	Managed	M	L	L	L	L	L
Mitigation Measures	*The footprint should be ripped to alleviate compaction post closure before revegetation; *Stored topsoil should be replaced (if any) and the footprint graded to a smooth surface; *The landscape should be backfilled and re-profiled so as to mimic the natural topography (if possible) for potential post mining activities including housing and industrial development. If possible ensure a continuation of the pre-mining surface drainage pattern; *Slopes of the backfilled surface should therefore change gradually since abrupt changes in slope gradient increase the susceptibility for erosion initiation; *The topsoil should be ameliorated according to soil chemical analysis and monitoring data; *The soil fertility status should be determined by soil chemical analysis after levelling (before seeding/re-vegetation); *Soil amelioration should be done according to soil analyses as recommended by a soil specialist, in order to correct the pH and nutrition status before revegetation; *The footprint should be re-vegetated with a grass seed mixture as soon as possible, preferably in spring and early summer to stabilize the soil and prevent soil loss during the rainy season; and *The impact of the WRDs is regarded as permanent in the footprint, therefore efforts should be made to avoid placement of the WRD on natural soils, but rather on disturbed soils as they already require rehabilitation.							

4.6 Stockpile and Stripping Management

- Excavation and long-term stockpiling of soil should be limited to within the demarcated areas as far as practically possible;
- Ensure all stockpiles (especially topsoil) are clearly and permanently demarcated and located in defined no-go areas;
- Restrict the amount of mechanical handling, as each handling event increases compaction level and the changes to the soil structure. Wherever possible, the 'cut and cover' technique (where the stripped soils is immediately placed in an area already prepared for rehabilitation, thus avoiding stockpiling) should be used;
- The use of heavy machinery (for stockpiling) such as bulldozers should be avoided where feasible;
- Stockpile height should be restricted to that which can be stored without additional traversing by machinery. A maximum height of 2-3 m is therefore proposed, and the stockpile should be treated with temporary soil stabilisation methods; such as the application of organic matter to promote soil aggregate formation, leading to increased infiltration rate, thereby reducing soil erosion. Also, the use of lime to stabilise soil pH levels;
- Soil erosion should be controlled on stockpiles by measures in place to reduce erosion risk such as erosion control blankets, soil binders, revegetation, contours, diversion banks and spillways;
- Stockpiled soils should be stored for a maximum of 3-5 years. In addition, concurrent rehabilitation should strongly be considered to reduce the duration of stockpile storage in order to ensure that the quality of stored soil material does not deteriorate excessively, especially with regard to leaching and acidification;
- Stockpiles should be revegetated to establish a vegetation cover as an erosion control measure. These stockpiles should also be kept free of alien vegetation at all times to prevent loss of soil quality;
- Temporary berms should be installed, around stockpile areas whilst vegetation cover has not established to avoid soil loss through erosion;
- The recovered soils should be re-used to rehabilitate the mine footprint following mine closure; and
- During rehabilitation replace soil to appropriate soil depths in the correct order, and cover areas to achieve an appropriate topographic aspect and attitude so as to achieve a free draining landscape that is as close as possible to the pre-mining land capability rating as possible.

5. CONCLUSION

Scientific Aquatic Services (SAS) was appointed to conduct a soil, land use, land capability and agricultural potential assessment as part of the Environmental Impact Assessment process for the proposed Mining Right Application Area (MRA) for opencast and underground mining for the West Wits Project.

Based on observations during the site assessment and scrutiny of satellite imagery, land uses associated with the MRA and surroundings include residential, industrial, commercial areas, manufacturing and distribution facilities, schools, hospitals as well as small scale subsistence agriculture (maize and pastures at the time of field assessment). Historical mine infrastructure (tailings facilities, shafts, abandoned buildings and water facilities), powerlines and road infrastructure as well as ongoing illegal small-scale gold and sand mining operations were also evident within the MRA.

The current status of the soil resources where the majority of the proposed infrastructure as well as mining and related activities would occur already requires rehabilitation, owing to historic mining disturbances which led to the creation of Anthrosols such that the soil is unsuitable for cultivation or grazing but rather wildlife/wilderness. Even though the soils occurring within the MRA are suitable for wildlife/wildness, it is not practical in this area since the surrounding areas are largely urbanised. Some of the disturbed areas can still be used for light grazing, however, this would require intensive management practices. Arable soils of Hutton and Clovelly occupy approximately 39.79 ha of the total investigated MRA which is 1.87% of the total investigated area and is not considered adequate for commercial unirrigated agriculture. Arable land capability classification of the identified soils and their respective areal extent are presented on the table below

Land Capability classes for soil forms identified within the MRA

<table>
<tr><th>Soil Form</th><th>Land Capability</th><th>Total Area (Ha)</th><th>% Areal Extent</th></tr>
<tr><td>Hutton/Clovelly</td><td>Arable (Class II)</td><td>39.79</td><td>1.87</td></tr>
<tr><td>Westleigh/Avalon</td><td>Arable (Class IV)</td><td>16.54</td><td>0.78</td></tr>
<tr><td>Kroonstad/Longlands</td><td rowspan="2">Grazing (Class V)</td><td>47.43</td><td>2.29</td></tr>
<tr><td>Mispah/Glenrosa</td><td>348.58</td><td>16.39</td></tr>
<tr><td>Witbank/Industria/Johannesburg (Anthrosols))</td><td>Wildlife/Wilderness (Class VIII)</td><td>1198.2</td><td>56.32</td></tr>
<tr><td>Artificial Water Features</td><td rowspan="2">Non-Arable</td><td>5.40</td><td>0.25</td></tr>
<tr><td>Built-up areas (Residential, Industrial, Commercial areas and Access Roads)</td><td>471.73</td><td>22.17</td></tr>
<tr><td>Total Area Investigated</td><td colspan="2">2127.40</td><td>100</td></tr>
</table>

***Values rounded off to two (2) decimal place**

The chemical soil analyses indicate that the pH of the surrounding soils ranges between 3.0 and 7.5, whereas the electrical conductivity (EC) ranges between 2.4 and 12.9 milli siemens per meter (mS/m). The majority of the soil samples fell outside the optimum pH range (5.5 < pH <7.5) and based on the low pH these soils are considered to be acidic. Strongly acidic soils were sampled in close proximity to an old tailings facility within the Vogelstuisfontein area. However, based on the Soil and Terrain database (SOTER) the natural pH of these soils ranges from 5.5 to 6.4 and they are considered to be slightly acidic. The acidity of these soils is likely attributed to the historical mining activities occurring within the surrounding areas. The cyanide, CN, concentrations of the sampled soils was obtained by leaching the soil with distilled water. The detection limit was set at 0.02 mg/l in line with the Environmental Protection Agency requirements, and for all the sampled areas the cyanide levels fell below the detection limit. According to the Environmental Protection Agency (EPA), the Maximum Contaminant Level Goals (MCLG) for cyanide is 0.2 mg/l, thus from the analysis of the laboratory results, cyanide levels of the surrounding soils falls within acceptable levels. Refer to section 3.2 for a full discussion of the chemical analysis.

The findings of this assessment suggest that the relevant soil limiting factors within the MRA for agriculture include the following:

- Shallow effective rooting depth due to shallow indurated bedrock of the Mispah, Glenrosa. As such, these soils are not considered to contribute significantly to agricultural productivity;
- Limited root growth as a result of anoxic conditions due to periodic waterlogging of the Kroonstad/Longlands soil forms associated with the water courses. Preservation of these soils for conservation purposes takes precedence, according to the National Water Act, 1998 (Act No. 36 of 1998); and
- Lack of soil medium for plants and crop growth as a result of historic mine infrastructure, residential, commercial and industrial areas, and Anthrosols not suited for cultivation.

A large portion of the soils that fall within the Mining Right Application area would not be affected by the open cast and below-surface mining operations. Open cast mining, infrastructure complexes and waste rock dumps would affect soils, however, as these soils are deemed to be unsuitable for cultivation or grazing, the impact significance is considered to be low.

Key mitigation measures include:

- The footprint of the proposed infrastructure area should be clearly demarcated to restrict vegetation clearing activities within the infrastructure footprint as far as practically possible;
- Concurrent rehabilitation should strongly be considered to ensure that the duration that any pit or extent thereof is left unrehabilitated is minimised;
- Restrict the amount of mechanical handling of soils, as each excise increase the compaction level;
- Stockpile height should be restricted to that which can deposited without additional traversing by construction equipment. A Maximum height of 2-3 m is therefore proposed, and the stockpile should be treated with temporary soil stabilisation methods;
- Restrict the amount of mechanical handling, as each handling event increases that compaction level and the changes to the soil structure;
- At rehabilitation replace soil to appropriately and cover areas to achieve an appropriate topographic aspect and elevation profile so as to achieve a free draining landscape that is as close as possible the pre-mining conditions to allow for planned post closure land uses.

It is therefore the opinion of the land capability specialist that the proposed mining and related activities as well as the associated infrastructure will have an impact of relatively low impact significance on the prevailing soils and their inherent land capability, provided that the recommended mitigation and management measures will be implemented accordingly.

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APPENDIX A: Soil Chemistry Results

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CERTIFICATE OF ANALYSES

TCLP / ACID RAIN / DISTILLED WATER EXTRACTIONS

Date received:	**2018/03/12**			**Date completed:**	**2018/04/05**
Project number:	**244**	**Report number:**	**73061**	**Order number:**	**Soweto West Wits**
Client name:	**Scientific Aquatic Services**			**Contact person:**	**Braveman Mzila**
Address:	**347 Highland Road, Kensington, 2094**			**Email:**	**brave@sasenvgroup.co.za**
Telephone:	**011 616 7893**			**Cell:**	**078 152 6993**

Analyses	**854 Top soil 0-30cm**		**854 Subsoil 30-70cm**		**870 Top soil 0-35cm**		**870 Sub Soil 35-70cm**		**900 Top Soil 0-45cm**	
Sample Number	**25552**		**25553**		**25554**		**25555**		**25556**	
TCLP / Acid Rain / Distilled Water / H_2O_2	**Distilled Water**		**Distilled Water**		**Distilled Water**		**Distilled Water**		**Distilled Water**	
Dry Mass Used (g)	**250**		**250**		**250**		**250**		**250**	
Volume Used (mℓ)	**1000**		**1000**		**1000**		**1000**		**1000**	
pH Value at 25˚C	6,1		**Sample Cancelled**		**Sample Cancelled**		4,0		5,8	
Electrical Conductivity in mS/m at 25˚C	9,4						4,2		2,4	
Inorganic Anions	**mg/ℓ**	**mg/kg**					**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**
Nitrate as N	3,3	13					0,1	0,4	<0.1	<0.4
Ortho-Phosphate as P	1,6	6,4					<0.1	<0.4	<0.1	<0.4
Mercury as Hg	<0.001	<0.004					<0.001	<0.004	0,008	0,032
Total Cyanide as CN [s]	<0.02	<0.08					<0.02	<0.08	<0.02	<0.08
ICP-OES Full Quant	See tab ICP DW						See tab ICP DW		See tab ICP DW	

Analyses	**904 Sub Soil 0-45cm**		**905 Top Soil Tailings (Anthropic Soils)**		**911 Top Soil 0-35cm**		**911 Sub Soil 35-70cm**		**912 Top Soil 0-38cm**	
Sample Number	**25557**		**25558**		**25559**		**25560**		**25561**	
TCLP / Acid Rain / Distilled Water / H_2O_2	**Distilled Water**		**Distilled Water**		**Distilled Water**		**Distilled Water**		**Distilled Water**	
Dry Mass Used (g)	**250**		**250**		**250**		**250**		**250**	
Volume Used (mℓ)	**1000**		**1000**		**1000**		**1000**		**1000**	
pH Value at 25˚C	3,6		3,0		4,1		3,5		7,5	
Electrical Conductivity in mS/m at 25˚C	8,4		78,3		37,0		58,0		12,9	
Inorganic Anions	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**
Nitrate as N	0,1	0,4	1,9	7,6	0,6	2,4	0,3	1,2	0,3	1,2
Ortho-Phosphate as P	<0.1	<0.4	<0.1	<0.4	<0.1	<0.4	<0.1	<0.4	<0.1	<0.4
Mercury as Hg	<0.001	<0.004	<0.001	<0.004	<0.001	<0.004	<0.001	<0.004	<0.001	<0.004
Total Cyanide as CN [s]	<0.02	<0.08	<0.02	<0.08	<0.02	<0.08	<0.02	<0.08	<0.02	<0.08
ICP-OES Full Quant	See tab ICP DW		See tab ICP DW		See tab ICP DW		See tab ICP DW		See tab ICP DW	

[s]=subcontracted

E. Botha

Geochemistry Project Manager

WATERLAB (PTY) LTD

CERTIFICATE OF ANALYSES
ICP-OES QUANTITATIVE ANALYSIS

Date received:	**3/12/2018**	**Date Completed:**	**4/5/2018**
Project number:	**244**	**Report number:**	**73061**
Client name:	**Scientific Aquatic Services**	**Contact person:**	**Braveman Mzila**
Address:	**347 Highland Road, Kensington, 2094**	**Email:**	**brave@sasenvgroup.co.za**
Telephone:	**0116167893**	**Cell:**	**078 152 6993**

Extract	Sample Dry Mass	Volume	Mass (g/l)	Factor
Distilled Water	250	1000	250	4

Sample Id	Sample number	Ag	Ag	Al	Al	As	As
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.100	<0.400	<0.010	<0.040
854 Top soil 0-30cm	25552	<0.025	<0.100	8.54	34	<0.010	<0.040
870 Sub Soil 35-70cm	25555	<0.025	<0.100	<0.100	<0.400	<0.010	<0.040
900 Top Soil 0-45cm	25556	<0.025	<0.100	5.00	20	0.010	0.040
904 Sub Soil 0-45cm	25557	<0.025	<0.100	0.976	3.90	<0.010	<0.040
905 Top Soil Tailings	25558	<0.025	<0.100	28	112	<0.010	<0.040
911 Top Soil 0-35cm	25559	<0.025	<0.100	0.129	0.516	<0.010	<0.040
911 Sub Soil 35-70cm	25560	<0.025	<0.100	0.752	3.01	<0.010	<0.040
912 Top Soil 0-38cm	25561	<0.025	<0.100	3.66	15	<0.010	<0.040

Sample Id	Sample number	B	B	Ba	Ba	Be	Be
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.025	<0.100	<0.025	<0.100
854 Top soil 0-30cm	25552	0.068	0.272	0.043	0.172	<0.025	<0.100

870 Sub Soil 35-70cm	25555	<0.025	<0.100	0.050	0.200	<0.025	<0.100
900 Top Soil 0-45cm	25556	0.029	0.116	0.027	0.108	<0.025	<0.100
904 Sub Soil 0-45cm	25557	<0.025	<0.100	0.085	0.340	<0.025	<0.100
905 Top Soil Tailings	25558	<0.025	<0.100	<0.025	<0.100	<0.025	<0.100
911 Top Soil 0-35cm	25559	<0.025	<0.100	0.043	0.172	<0.025	<0.100
911 Sub Soil 35-70cm	25560	<0.025	<0.100	<0.025	<0.100	<0.025	<0.100
912 Top Soil 0-38cm	25561	<0.025	<0.100	0.026	0.104	<0.025	<0.100

Sample Id	Sample number	Bi	Bi	Ca	Ca	Cd	Cd
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<1	<4	<0.003	<0.012
854 Top soil 0-30cm	25552	<0.025	<0.100	9	36	<0.003	<0.012
870 Sub Soil 35-70cm	25555	<0.025	<0.100	3	12	<0.003	<0.012
900 Top Soil 0-45cm	25556	<0.025	<0.100	3	12	<0.003	<0.012
904 Sub Soil 0-45cm	25557	<0.025	<0.100	5	20	<0.003	<0.012
905 Top Soil Tailings	25558	<0.025	<0.100	21	84	<0.003	<0.012
911 Top Soil 0-35cm	25559	<0.025	<0.100	57	228	<0.003	<0.012
911 Sub Soil 35-70cm	25560	<0.025	<0.100	96	384	<0.003	<0.012
912 Top Soil 0-38cm	25561	<0.025	<0.100	26	104	<0.003	<0.012

Sample Id	Sample number	Co	Co	Cr	Cr	Cu	Cu
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.025	<0.100	<0.010	<0.040
854 Top soil 0-30cm	25552	<0.025	<0.100	<0.025	<0.100	0.023	0.092
870 Sub Soil 35-70cm	25555	<0.025	<0.100	<0.025	<0.100	<0.010	<0.040
900 Top Soil 0-45cm	25556	<0.025	<0.100	<0.025	<0.100	0.037	0.148
904 Sub Soil 0-45cm	25557	<0.025	<0.100	<0.025	<0.100	<0.010	<0.040
905 Top Soil Tailings	25558	0.181	0.724	0.069	0.276	0.055	0.220
911 Top Soil 0-35cm	25559	0.134	0.536	<0.025	<0.100	<0.010	<0.040

911 Sub Soil 35-70cm	25560	0.051	0.204	<0.025	<0.100	0.037	0.148
912 Top Soil 0-38cm	25561	<0.025	<0.100	<0.025	<0.100	0.010	0.040

Sample Id	Sample number	Fe	Fe	K	K	Li	Li
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.5	<2.0	<0.025	<0.100
854 Top soil 0-30cm	25552	11	44	6.0	24	<0.025	<0.100
870 Sub Soil 35-70cm	25555	<0.025	<0.100	<0.5	<2.0	<0.025	<0.100
900 Top Soil 0-45cm	25556	3.13	13	1.2	4.8	<0.025	<0.100
904 Sub Soil 0-45cm	25557	0.679	2.72	1.8	7.3	<0.025	<0.100
905 Top Soil Tailings	25558	0.160	0.640	<0.5	<2.0	<0.025	<0.100
911 Top Soil 0-35cm	25559	<0.025	<0.100	5.5	22	<0.025	<0.100
911 Sub Soil 35-70cm	25560	0.046	0.184	0.9	3.4	<0.025	<0.100
912 Top Soil 0-38cm	25561	2.36	9.43	<0.5	<2.0	<0.025	<0.100

Sample Id	Sample number	Mg	Mg	Mn	Mn	Mo	Mo
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<1	<4	<0.025	<0.100	<0.025	<0.100
854 Top soil 0-30cm	25552	2	8	0.031	0.124	<0.025	<0.100
870 Sub Soil 35-70cm	25555	<1	<4	0.039	0.156	<0.025	<0.100
900 Top Soil 0-45cm	25556	<1	<4	<0.025	<0.100	<0.025	<0.100
904 Sub Soil 0-45cm	25557	1	4	0.641	2.56	<0.025	<0.100
905 Top Soil Tailings	25558	23	92	4.29	17	<0.025	<0.100
911 Top Soil 0-35cm	25559	3	12	0.533	2.13	<0.025	<0.100
911 Sub Soil 35-70cm	25560	<1	<4	0.262	1.05	<0.025	<0.100
912 Top Soil 0-38cm	25561	<1	<4	0.039	0.156	<0.025	<0.100

Sample Id	Sample number	Na	Na	Ni	Ni	P	P

		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<1	<4	<0.025	<0.100	<0.025	<0.100
854 Top soil 0-30cm	25552	2	8	<0.025	<0.100	1.63	6.50
870 Sub Soil 35-70cm	25555	<1	<4	<0.025	<0.100	<0.025	<0.100
900 Top Soil 0-45cm	25556	<1	<4	0.075	0.300	0.045	0.180
904 Sub Soil 0-45cm	25557	<1	<4	<0.025	<0.100	<0.025	<0.100
905 Top Soil Tailings	25558	18	72	0.133	0.532	<0.025	<0.100
911 Top Soil 0-35cm	25559	1	4	0.178	0.712	<0.025	<0.100
911 Sub Soil 35-70cm	25560	1	4	0.061	0.244	<0.025	<0.100
912 Top Soil 0-38cm	25561	<1	<4	0.022	0.088	<0.025	<0.100

Sample Id	Sample number	Pb	Pb	Sb	Sb	Se	Se
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.010	<0.040	<0.020	<0.080	<0.010	<0.040
854 Top soil 0-30cm	25552	0.010	0.040	<0.020	<0.080	<0.010	<0.040
870 Sub Soil 35-70cm	25555	<0.010	<0.040	<0.020	<0.080	<0.010	<0.040
900 Top Soil 0-45cm	25556	0.026	0.104	<0.020	<0.080	<0.010	<0.040
904 Sub Soil 0-45cm	25557	<0.010	<0.040	<0.020	<0.080	<0.010	<0.040
905 Top Soil Tailings	25558	<0.010	<0.040	<0.020	<0.080	<0.010	<0.040
911 Top Soil 0-35cm	25559	<0.010	<0.040	<0.020	<0.080	<0.010	<0.040
911 Sub Soil 35-70cm	25560	<0.010	<0.040	<0.020	<0.080	<0.010	<0.040
912 Top Soil 0-38cm	25561	<0.010	<0.040	<0.020	<0.080	<0.010	<0.040

Sample Id	Sample number	Si	Si	Sr	Sr	Ti	Ti
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.2	<0.8	<0.025	<0.100	<0.025	<0.100
854 Top soil 0-30cm	25552	14.1	56	0.029	0.116	0.177	0.708
870 Sub Soil 35-70cm	25555	3.3	13	0.032	0.128	<0.025	<0.100

900 Top Soil 0-45cm	25556	9.7	39	<0.025	<0.100	0.057	0.228
904 Sub Soil 0-45cm	25557	2.9	12	<0.025	<0.100	0.030	0.120
905 Top Soil Tailings	25558	1.7	6.7	<0.025	<0.100	<0.025	<0.100
911 Top Soil 0-35cm	25559	4.1	16	0.108	0.432	<0.025	<0.100
911 Sub Soil 35-70cm	25560	4.3	17	0.052	0.208	<0.025	<0.100
912 Top Soil 0-38cm	25561	5.8	23	0.030	0.120	0.083	0.332

Sample Id	Sample number	Tl	Tl	V	V	Zn	Zn
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<0.100	<0.025	<0.100	<0.025	<0.100
854 Top soil 0-30cm	25552	<0.025	<0.100	<0.025	<0.100	0.048	0.192
870 Sub Soil 35-70cm	25555	<0.025	<0.100	<0.025	<0.100	<0.025	<0.100
900 Top Soil 0-45cm	25556	<0.025	<0.100	<0.025	<0.100	0.124	0.496
904 Sub Soil 0-45cm	25557	<0.025	<0.100	<0.025	<0.100	0.062	0.248
905 Top Soil Tailings	25558	<0.025	<0.100	<0.025	<0.100	0.108	0.432
911 Top Soil 0-35cm	25559	<0.025	<0.100	<0.025	<0.100	0.519	2.08
911 Sub Soil 35-70cm	25560	<0.025	<0.100	<0.025	<0.100	0.169	0.676
912 Top Soil 0-38cm	25561	<0.025	<0.100	<0.025	<0.100	<0.025	<0.100

APPENDIX B: Terms of Use

INDEMNITY AND TERMS OF USE OF THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and SAS CC and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation. Although SAS CC exercises due care and diligence in rendering services and preparing documents, SAS CC accepts no liability and the client, by receiving this document, indemnifies SAS CC and its directors, managers, agents and employees against all actions, claims, demands, losses, liabilities, coSAS, damages and expensed arising from or in connection with services rendered, directly or indirectly by SAS CC and by the use of the information contained in this document.

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APPENDIX C: Impact Assessment Methodology

Impacts are assessed based on consideration of the impact severity, spatial scale and duration of impacts, which together determine the impact consequence. The impact consequence together with the probability of the impact occurring determine the overall impact significance.

The criteria for determining the severity, spatial scale and duration of potential impacts are presented in Table 1. The criteria are based on the criteria detailed in *DEAT (2002) Specialist Studies, Integrated Environmental Management Information Series 4, Department of Environmental Affairs and Tourism (DEAT), Pretoria*; *DEAT (2002) Impact Significance, Integrated Environmental Management Information Series 5, Department of Environmental Affairs and Tourism (DEAT)* and the criteria and methodology developed by Theo Hacking[1]. Table D1 also provides the definition for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact).

Table D1: Criteria for the assessment of impacts

PART A: DEFINITION AND CRITERIA*		
Definition of SIGNIFICANCE		Significance = consequence x probability
Definition of CONSEQUENCE		Consequence is a function of severity, spatial extent and duration
Criteria for ranking of the SEVERITY of environmental impacts	H	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	L	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	L	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national

Impact consequence and significance are determined from Table D2 and Table D3. The interpretation of the impact significance is presented in Table D4.

[1] Hacking, Theo (1999) An innovative approach to structuring environmental impact assessment reports. Anglo American Corporation-Envirolink. Unpublished.

Table D2: Method of determining impact consequence

PART B: DETERMINING CONSEQUENCE					
SEVERITY = L					
DURATION	Long term	H	Medium	Medium	Medium
	Medium term	M	Low	Low	Medium
	Short term	L	Low	Low	Medium
SEVERITY = M					
DURATION	Long term	H	Medium	High	High
	Medium term	M	Medium	Medium	High
	Short term	L	Low	Medium	Medium
SEVERITY = H					
DURATION	Long term	H	High	High	High
	Medium term	M	Medium	Medium	High
	Short term	L	Medium	Medium	High
			L	M	H
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		

Table D3: Method of determining impact and significance

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	H	Medium	Medium	High
	Possible/ frequent	M	Medium	Medium	High
	Unlikely/ seldom	L	Low	Low	Medium
			L	M	H
			CONSEQUENCE		

Table D4: Interpretation impact significance

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	Decision guideline
High	Influences the decision regardless of any possible mitigation.
Medium	Should have an influence on the decision unless it is mitigated.
Low	Will not have an influence on the decision.

***H = high, M= medium and L= low and + denotes a positive impact.**

Control Measure Development

The following points present the key concepts considered in the development of mitigation measures for the proposed mine:

- Mitigation and performance improvement measures and actions that address the risks and impacts[2] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - Minimisation of impact;
  - Rehabilitation; and
  - Offsetting.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and
- Desired outcomes are defined, and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

Recommendations

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

Recommendations were developed to address and mitigate potential impacts on the land use and land capability of the resources traversed by or in close proximity of the proposed infrastructure.

APPENDIX D: Specialist Information

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

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

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

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

I, Stephen van Staden, declare that -

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

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Signature of the Specialist

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION
CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing member, Ecologist with focus on Freshwater Ecology
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)
Other Business	Trustee of the Serenity Property Trust and emerald Management Trust

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 International Association of Impact Assessors (IAIA) South Africa;
Member pf 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

COUNTRIES 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 Leone
Central Africa – Democratic Republic of the Congo

PROJECT EXPERIENCE (Over 2500 projects executed with varying degrees of involvement)

1. Mining Coal, Chrome, PGM's, Mineral Sands, Gold, Phosphate, river sand, clay, fluorspar
2. Linear developments
3. Energy Transmission, telecommunication, pipelines, roads
4. Minerals beneficiation
5. Renewable energy (wind and solar)
6. Commercial development
7. Residential development
8. Agriculture
9. Industrial/chemical

REFERENCES

- Terry Calmeyer (Former Chairperson of IAIA SA)
  Director: ILISO Consulting Environmental Management (Pty) Ltd
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  Managing Director: Jacana Environmental
  Tel: 015 291 4015

Yours faithfully

STEPHEN VAN STADEN

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF BRAVEMAN MZILA

PERSONAL DETAILS

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

EDUCATION

Qualifications

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

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, KwaZulu-Natal, Eastern Cape

SELECTED PROJECT EXAMPLES

Freshwater Ecological Assessments

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

Soil, Land Use and Land Capability Assessments

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

Hydropedological Wetland Impact Assessments

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

Soil Rehabilitation Assessments

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