SOIL, LAND USE AND LAND CAPABILITY REPORT FOR THE PROPOSED MOKALA MANGANESE MINE

For and on behalf of TerraAfrica Consult Approved by: Mariné Pienaar Position: Principal consultant Date: July 2015

terraafrica
environmentalconsultants

DEFINITIONS AND ACRONYMS

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

Buffer capacity: The ability of soil to resist an induced change in pH.

Calcareous: Containing calcium carbonate or magnesium carbonate.

Catena: A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic conditions, but having different characteristics due to variation in relief and drainage.

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

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

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

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

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

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

Land type: (1) A class of land with specified characteristics. (2) In South Africa it has been used as a map unit denoting land, mapable at 1:250,000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use: The use to which land is put.

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

Overburden: Material that overlies another material difference in a specified respect, but mainly referred to in this document as materials overlying weathered rock.

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

Pedocutanic, diagnostic B-horizon: The concept embraces B-horizons that have become enriched in clay, presumably by illuviation (an important pedogenic process which involves downward movement of fine materials by, and deposition from, water to give rise to cutanic character) and that have developed moderate or strong blocky structure. In the case of a red pedocutanic B-horizon, the transition to the overlying A-horizon is clear or abrupt.

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

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

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

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

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

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

This report has been compiled taking into consideration the requirements as set out in the National Environmental Management Act No 107 of 1998, Regulations GNR. 982 (Appendix 6) as outlined in the table below.

NEMA Regs (2014) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report	Page vi
The expertise of that person to compile a specialist report including a curriculum vitae	Page vi
A declaration that the person is independent in a form as may be specified by the competent authority	Page v
An indication of the scope of, and the purpose for which, the report was prepared	Page 1
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	Page 5, Paragraph 8.2, Site survey. The season has no relevance.
A description of the methodology adopted in preparing the report or carrying out the specialised process	Page 5 – 7, Paragraph 8, Methodology.
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Page 16. Paragraph 9.7. The Ga-Mogara drainage channel
An identification of any areas to be avoided, including buffers	No buffers or areas to be avoided have been identified
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;	See Figures 3 (pg 13) and 5 (pg 17)
A description of any assumptions made and any uncertainties or gaps in knowledge;	Page 4, Paragraphs 5 & 6
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Page 22 – 27. Impact Assessment as per project phase.
Any mitigation measures for inclusion in the EMPr	Page 27 – 34. Mitigation measures in soil management plan.
Any conditions for inclusion in the environmental authorisation	The management measures as outlined in this report and included in the EIA and EMP report need to form part of the conditions of the environmental authorisation.
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Page 27 – 34. Monitoring described in Soil Management Plan where applicable.
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and	Page 34. Paragraph 13. Reasoned opinion.
If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures	Page 27 – 33. Management and mitigation measures addressed in Soil Management Plan.

NEMA Regs (2014) - Appendix 6	Relevant section in report
that should be included in the EMPr, and where applicable, the closure plan	
A description of any consultation process that was undertaken during the course of carrying out the study	No specific consultation process was undertaken as part of the study. A consultation process was undertaken as part of the EIA and EMP process. Comments received by interested and affected parties as part of the EIA process including a response thereto is included in Section 7, page 5.
A summary and copies if any comments that were received during any consultation process	
Any other information requested by the competent authority.	No additional information was requested

Declaration of EAP

Details of practitioner

Report author: M Pienaar

Contact number: 082 828 3587

Email address: mpienaar@terraafrica.co.za

Declaration of Independence

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

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

TerraAfrica Consult cc represented by M Pienaar

July 2015

CURRICULUM VITAE (CV) OF MARINÉ PIENAAR

PERSONAL DETAILS

Email address:	mpienaar@terraafrica.co.za
Contact number:	+27828283587
Skype address:	marine.pienaar
Date of Birth:	25 July 1982
Nationality:	South African
Professional registration:	SACNASP Reg No: 400274/10

Language proficiency:

English – Native speaker
Afrikaans – Native speaker
French - Conversant

EDUCATION

1. University Degrees

2001-2004:

Institution: University of Pretoria, South Africa
Degree: BSc.(Agric) Plant Production and Soil Science

2010-2014 (graduation July 2015):

Institution: University of Witwatersrand, South Africa
Degree: MSc. Environmental Science
Topic of dissertation: The effect of alluvial diamond prospecting on agricultural production in Northwest Province, South Africa.

2. University Special Programs and Short Courses

2008:

Institution: Centre for Environmental Management, University of Potchefstroom, South Africa
Courses completed:

- Environmental Impact Assessment
- Environmental Management Systems – ISO 14001:2004
- Environmental Law

2009:

Institution: University of Pretoria, South Africa
Course completed:

- Wetland Rehabilitation

2010:

Institution: University of KwaZulu-Natal, South Africa
Course completed: Hydrus Modeling of soil-water-leachate movement

2011:

Institution: Property and Environment Research Centre (PERC), Montana, U.S.A
Course completed: Enviropreneurship Institute

Institution: ACTIS Education (official spin-off of ETH Zürich), Switzerland
Course: Youth Encounter on Sustainability

2012:

Institution: Institute for Advanced Sustainable Studies, Potsdam, Germany
Course completed: Global Sustainability Summer School 2012

CAREER HISTORY

1 January 2005 – 30 June 2006

- Horticulturist and extension specialist at Omnia Fertilizer (Pty) Ltd

1 July 2006 – 31 October 2008

- Junior land-use consultant at Integrated Development Expertise

Present (since 3 December 2008):

- Owner and principal consultant of Terra-Africa Consult

PROJECT EXPERIENCE

Below follows a short description of a few of the projects Mariné has completed. A comprehensive project list is available on request.

2014:

- Soil, land use and land capability assessment for the proposed Italthai Railway and Macuse Port Projects in the Tete and Zambezia Provinces of Mozambique.
- Assessment of soil, agricultural potential and land capability properties of portions of the Northern Cape and Free State Provinces of South Africa for Eskom's Kimberley Strengthening Phase 4 Project.
- Natural resource and agricultural potential assessment (including soil, water and vegetation) for the Richards Bay Integrated Development Zone project that will develop an additional 1500 ha of land into industrial areas on the fringes of Richards Bay.
- Soil and agricultural impact assessment study for a proposed Integrated Development Zone as part of the TFM mining operations in a mining concession between Tenke en Fungurume in the Katanga Province of DRC.
- Soil, land capability and agricultural potential assessment for Exxaro Belfast Coal Mine's proposed infrastructure development projects including linear projects (road and railway upgrade) as well as site-specific coal loading facilities.
- Soil, land capability and land use assessment for the Marikana In-Pit Rehabilitation Project of Aquarius Platinum South Africa.

2013:

- Soil, land capability and agricultural potential assessment for the proposed upgrades at Eskom's Bighorn Substation.
- Consolidation of all existing soil and agricultural potential data Exxaro Leeuwpan Coal Mining Right Area. Where gaps in historic data sets were identified, new surveys were conducted to update existing data.
- Soil, land use and land capability study for the proposed WCL development projects in Liberia.

- Soil, land use and land capability assessment as part of the ESIA for the proposed Musonoi Mine in the Kolwezi area of Katanga Province, DRC.

- Land use and agricultural assessment of the Camutue Mining Concession, Angola.

- Soil, land use and agricultural assessment for the Manica Mining Project, Mozambique.

- Consolidation of the AQPSA Marikana Mine's soil, land use and land capability data as part of the EMP consolidation process.

2012:

- Soil, land use and agricultural scientist for field survey and reporting of the soil potential, current land use activities and the existing soil pollution levels at the Banro Namoya Mining Operation as well as for the proposed extension areas of this project. The project included a progressive soil and land use rehabilitation plan.

- Soil, land use and agricultural scientist for field survey and reporting of the soil potential, current land use activities and the existing soil pollution levels for the Bomi Hills Mining project in Liberia as well as associated infrastructure upgrades of the port, road and railway.

- Soil, land use and agricultural scientist for Kumba Iron Ore's Sishen Mine. Soil, land use and agricultural potential assessment for the proposed new Western Waste Rock Dumps project. Included recommendations regarding stripping and stockpiling as well as alternative uses for the large calcrete resources available. Northern Cape Province.

- Soil, land use and agricultural scientist for Vetlaagte Solar Development Project. Soil, land use and agricultural potential assessment for a proposed new solar development project on 1500 ha near De Aar. Included a soil management plan.

- Land restoration specialist for the assessment of current soil environmental issues on an existing kimberlite diamond mining operation in the province of Luanda Norte. Development of agricultural plans for mine closure and social contribution. Design of sediment control measures and bamboo plantations for land restoration purposes.

Table of Contents

1 Introduction **1**

2 Objective of the study **1**

3 Applicable environmental legislation **3**

4 Terms of reference **3**

5 Assumptions **4**

6 Uncertainties, limitations and gaps **4**

7 Response to concerns raised by I&APs **5**

8 Methodology **5**

8.1 Desktop study and literature review *5*

8.2 Site survey *5*

8.3 Analysis of samples at soil laboratory *6*

8.4 Land capability classification *6*

9 Baseline conditions **9**

9.1 Climate data *9*

9.2 General geological description and topography *9*

9.3 Soil forms in the study area *9*

9.4 Soil chemical properties *11*

9.5 Agricultural potential *15*

9.6 Land use *15*

9.7 Land capability *16*

10 Impact assessment **18**

10.1 Assessment methodology *18*

10.2 Project layout and description *20*

10.3 Impact assessment per project phase *22*

10.3.1 Construction phase 22

10.3.2 Operational phase 24

10.3.3 Decommissioning phase 25

10.3.4 Closure phase 27

11 Soil Management Plan **27**

11.1 Soil management during the construction phase *28*

11.1.1 Minimise mining infrastructure footprint 28

11.1.2 Management and supervision of construction teams 28

11.1.3 Location of stockpiles 28

11.1.4 Topsoil stripping 29

11.1.5 Stockpiling of topsoil ... 29
11.1.6 Demarcation of topsoil stockpiles ... 29
11.1.7 Prevention of stockpile contamination ... 29
11.1.8 Terrain stability to minimise erosion potential ... 29
11.1.9 Management of access and haulage roads ... 30
11.1.10 Prevention of soil contamination ... 30
11.2 Soil management during the operational phase ... 31
11.2.1 Managing potential soil contamination during the operational phase ... 31
11.3 Soil management during the decommissioning phase ... 32
11.3.1 Management and supervision of decommissioning teams ... 32
11.3.2 Infrastructure removal ... 32
11.3.3 Site preparation ... 33
11.3.4 Seeding and re-vegetation ... 33
11.3.5 Prevention of soil contamination ... 33
11.4 Soil management during the closure phase ... 33
12 Environmental Impact Statement ... 34
13 A reasoned opinion as to whether the activity should or should not be authorised ... 34
14 Reference list ... 35

List of Tables

Table 1: Pre-Mining Land Capability Requirements ... 6
Table 2: Rating of unmitigated impacts for the construction phase ... 23
Table 3: Rating of mitigated impacts for the construction phase ... 23
Table 4: Rating of unmitigated impacts for the operational phase ... 25
Table 5: Rating of mitigated impacts for the operational phase ... 25
Table 6: Rating of unmitigated impacts for the decommissioning phase ... 26
Table 7 Rating of mitigated impacts for the decommissioning phase ... 26

List of Figures

Figure 1: Locality map of the Mokala Manganese Project ... 3
Figure 2: Survey points map of the Mokala Manganese Project ... 8
Figure 3: Soil map of the Mokala Manganese Project ... 13

Figure 4: Soil analysis results for the Mokala Manganese Project 14

Figure 5: Land capability map of the Mokala Manganese Project 17

Figure 6: Layout map of the proposed Mokala Manganese Project 21

1 Introduction

SLR Consulting (South Africa) Pty Ltd appointed TerraAfrica Consult to conduct the soil, land use and land capability study as part of the Environmental Impact Assessment (EIA) process for the proposed Mokala Manganese Mine Project. The proposed project is located on the farms Gloria 266, Kipling 271 and Umtu 281 situated approximately 4 km northwest of Hotazel in the Joe Morolong Local Municipality in the Northern Cape Province. In broad terms the proposed Mokala Manganese project will comprise open cast activities, a dry crushing and screening plant, waste overburden dumps, product and run-of mine stockpiles, topsoil stockpiles, mine related facilities such as workshops, stores and various support infrastructure and services. Further to this, the proposed project will require:

- The realignment of the R380 road on the farm Kipling 271 as this road currently traverses the proposed project site
- Upgrading of the intersection on portion 1 of the farm Gloria 266
- The realignment of a section of the Ga-Mogara River. This realignment will extend onto the farm Umtu 281.

The study site that formed part of the survey was 290.7 ha in extent (**Figure 1**).

2 Objective of the study

The objective of the Soil, Land Use and Land Capability is to fulfill the requirements of the most recent South African Environmental Legislation with reference to the assessment and management of these natural resource aspects (stipulated in Section 3 below). The key components of assessment including determining the current baseline soil properties and the associated agricultural potential as well as current land uses. From this baseline data, the anticipated future impacts of the proposed mining developments at the proposed Mokala Manganese Mine can be predicted and mitigation and management measures can be recommended to minimise negative impacts and maximise land rehabilitation success towards successful mine closure at the end of the project life.

A further objective of the study was to determine current soil metal levels present in soil and to measure it against for threshold levels in order to establish pollution risk for timely management. The baseline soil chemistry determined during this study will serve as a measure during future soil and land quality monitoring procedures.

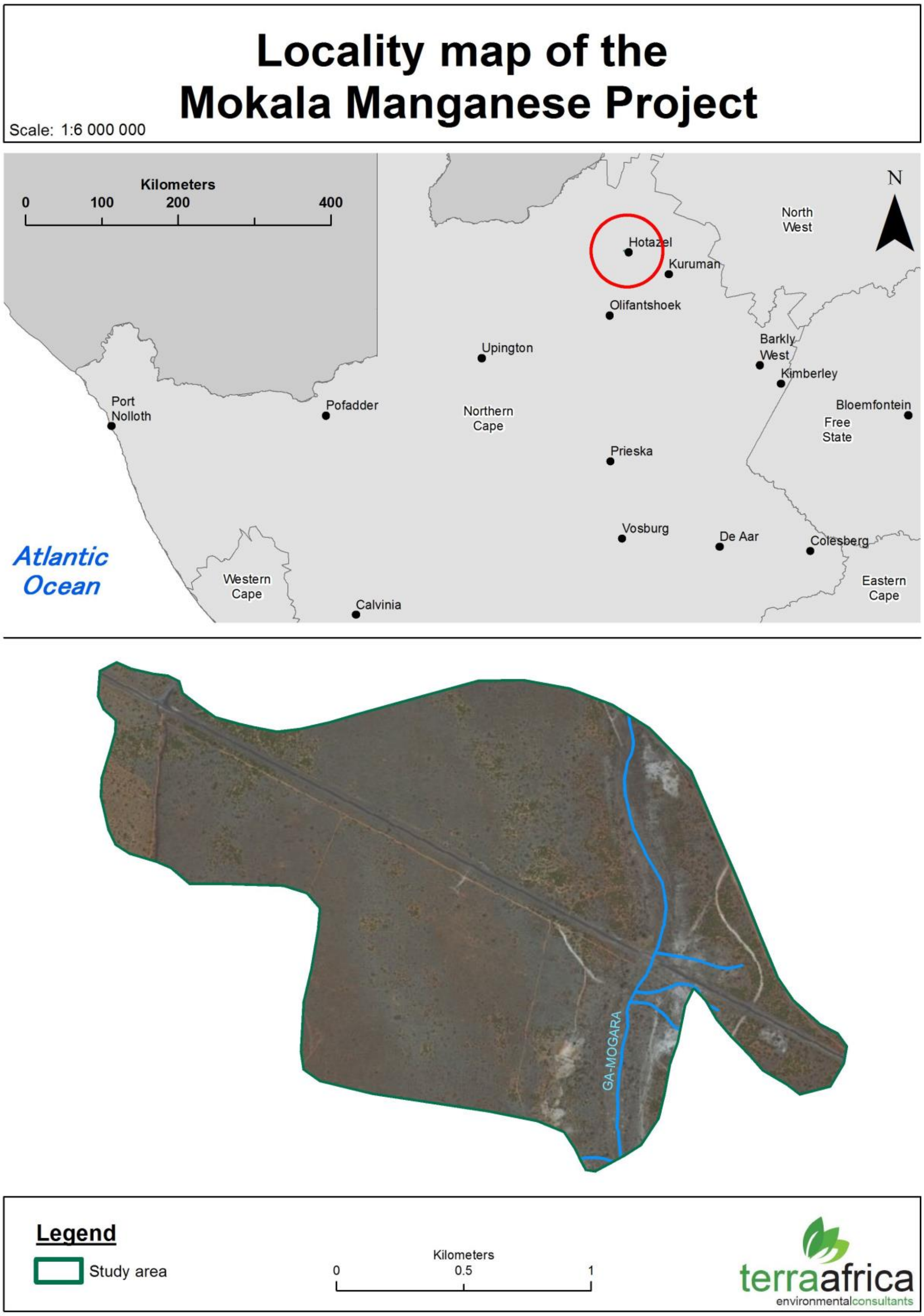

Figure 1: Locality map of the Mokala Manganese Project

3 Applicable environmental legislation

The most recent South African Environmental Legislation that needs to be considered for any new or expanding development with reference to assessment and management of soil and land use includes:

- Soils and land capability are protected under the National Environmental Management Act 107 of 1998, the Minerals Act 28 of 2002 and the Conservation of Agricultural Resources Act 43 of 1983.
- The National Environmental Management Act 107 of 1998 requires that pollution and degradation of the environment be avoided, or, where it cannot be avoided be minimised and remedied.
- The Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal.
- The Conservation of Agriculture Resources Act 43 of 1983 requires the protection of land against soil erosion and the prevention of water logging and salinization of soils by means of suitable soil conservation works to be constructed and maintained. The utilisation of marshes, water sponges and watercourses are also addressed.
- Government Notice R983 of 4 December 2014, Activity 21. The purpose of this notice is to identify activities that would require environmental authorisation prior to commencement of that activity.

4 Terms of reference

The terms of reference applicable to the Soils, Land Capability and Land Use Study include the following:

- A review of available desktop information about the project site and the different phases of the proposed project;
- Design and execution of a soil classification survey covering the proposed surface area as well as a small surrounding buffer area;
- Determination of the current (baseline) soil physical and chemical properties, land uses and surrounding land uses as well as the current land capabilities associated with the soil forms present in the survey area;

- Identification and assessment of the potential impacts of the different project phases on the baseline soil, land use and land capability properties as a result of the proposed project;
- Development of mitigation and management measures to minimise the negative effect of the anticipated impacts in an attempt towards successful mine rehabilitation.

5 Assumptions

The following assumptions were made during the assessment and reporting phases:

- The project will comprise open cast activities, a dry crushing and screening plant, waste overburden dumps, product and run-of mine stockpiles, topsoil stockpiles, mine related facilities such as workshops, stores and various support infrastructure and services.
- Further to this, the proposed project will require:
  - The realignment of the R380 road on the farm Kipling 271 as this road currently traverses the proposed project site
  - Upgrading of the intersection on portion 1 of the farm Gloria 266
  - The realignment of a section of the Ga-Mogara River. This realignment will extend onto the farm Umtu 281.

6 Uncertainties, limitations and gaps

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

- Soil profiles were observed using a 1.5m hand-held soil auger or open profiles where it was possible in old prospecting areas. A description of the soil characteristics deeper than 1.5m cannot be given.
- The study does not include land contamination assessment.

7 Response to concerns raised by I&APs

A consultation process was undertaken as part of the EIA and EMP process. In this regard, the following concern was raised during the public participation process:

"Please assess what impact the proposed project will have towards the agricultural potential of the project site (Raised by Moses Ramakulukusha on 15 April 2015 at the regulatory authorities meeting)?

In response to this, it can be said that the agricultural potential of the site for grazing of cattle and livestock will be temporarily lost in areas where the mining activities will disturb the surface area. Once mining has been completed in a certain area, it is expected that roll-over rehabilitation techniques will restore the land capability to grazing in the case of good rehabilitation practices. Should rehabilitation not be successful, the grazing potential of the area will be reduced or lost.

8 Methodology

8.1 Desktop study and literature review

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

- Background Information Document (BID) for the development of the proposed new Mokala Manganese Mine (February, 2015);
- Mokala Manganese Project Process Plant Design (October, 2014);
- Mokala Manganese Project Mine Services and Civil Design Report (October, 2014);
- Broad geological, soil depth and soil description classes were obtained from the Department of Environmental Affairs and studied. This data forms part of the Environmental Potential Atlas (ENPAT) of South Africa; and
- The most recent aerial photography of the area available from Google Earth was obtained.

8.2 Site survey

The field survey of the proposed project area was conducted during December 2014 by M. Pienaar of Terra-Africa Consult cc (a registered Professional Natural Scientist). A systematic soil survey was undertaken with sampling points between 100 and 250m apart in the study area (**Figure 2**). The soil profiles were examined to a maximum depth of 1.5m using an auger. Observations were made regarding soil texture, structure, colour and soil depth at each survey point. A cold 10% hydrochloric acid solution was used on site to test for the presence of carbonates in the soil. The soils are described using the S.A. Soil Classification Taxonomic System (Soil Classification Working Group, 1991) published as memoirs on the Agricultural Natural Resources of South Africa No.15. For soil mapping, the soils were grouped into classes with relatively similar soil characteristics.

8.3 Analysis of samples at soil laboratory

Six representative soil samples were collected (3 top- and subsoil samples each). Soil samples were sealed in soil sampling plastic bags and sent to Nvirotek Laboratories, Brits for analyses and were analysed for pH (KCl and H_2O), phosphorus (Bray1), exchangeable cations (calcium, magnesium, potassium, sodium), organic carbon (Walkley-Black) and texture classes (relative fractions of sand, silt and clay).

8.4 Land capability classification

Land capability classes were determined using the guidelines outlined in Section 7 of The Chamber of Mines Handbook of Guidelines for Environmental Protection (Volume 3, 1981). The Chamber of Mines pre-mining land capability system was utilised, given that this is the dominant capability classification system used for the mining industry. **Table 1** indicates the set of criteria as stipulated by the Chamber of Mines to group soil forms into different land capability classes.

Table 1: Pre-Mining Land Capability Requirements

Criteria for Wetland	➢ Land with organic soils or ➢ A horizon that is gleyed throughout more than 50 % of its volume and is significantly thick, occurring within 750mm of the surface.
Criteria for Arable Land	➢ Land, which does not qualify as a wetland, ➢ The soil is readily permeable to the roots of common cultivated plants to a depth of 750mm, ➢ The soil has a pH value of between 4,0 and 8.4, ➢ The soil has a low salinity and SAR, ➢ The soil has a permeability of at least 1,5-mm per hour in the upper 500-mm of soil

	➢ The soil has less than 10 % (by volume) rocks or pedocrete fragments larger than 100-mm in diameter in the upper 750-mm, ➢ Has a slope (in %) and erodibility factor (K) such that their product is <2.0, ➢ Occurs under a climatic regime, which facilitates crop yields that are at least equal to the current national average for these crops, or is currently being irrigated successfully.
Criteria for Grazing Land	➢ Land, which does not qualify as wetland or arable land, ➢ Has soil, or soil-like material, permeable to roots of native plants, that is more than 250-mm thick and contains less than 50 % by volume of rocks or pedocrete fragments larger than 100-mm, ➢ Supports, or is capable of supporting, a stand of native or introduced grass species, or other forage plants, utilizable by domesticated livestock or game animals on a commercial basis.
Criteria for Wilderness Land	➢ Land, which does not qualify as wetland, arable land or grazing land.

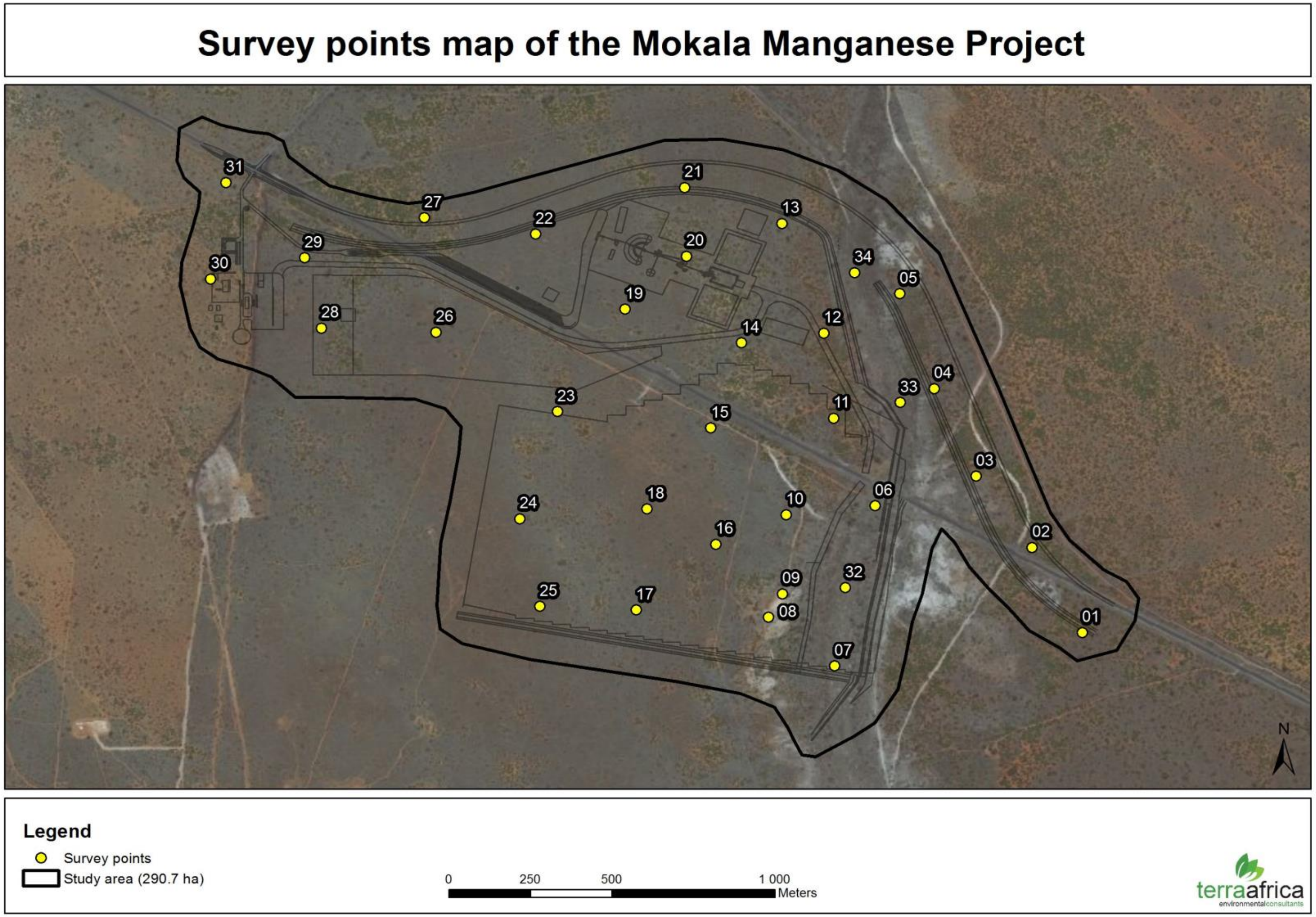

Figure 2: Survey points map of the Mokala Manganese Project

9 Baseline conditions

9.1 Climate data

The study area experiences hot summers and cold, dry winters with drought spells occurring quite often in the summer months. Mean monthly maximum temperatures range between 17°C and 30°C while mean monthly minimum temperatures can be anything between 1°C and 16°C. In summer months the average rainfall is between 24 mm and 81 mm per month while potential evapotranspiration will be between 115 mm to 140 mm per month. Rainfall during winter months is erratic (between 0 mm and 9 mm monthly) while evapotranspiration is never less than 80 mm per month. This implies that the area has a precipitation deficit and can therefore be classified as a dry area for agricultural purposes. (New Local Climate Estimator, Food and Agricultural Organisation of the United Nations, 2005).

9.2 General geological description and topography

The soil of the subject property is underlain by mainly the Hotazel Formation in the uppermost Paleoproterozoic (2.65–2.05 Ga) Transvaal Supergroup and comprises of three laminated manganese ore units interbedded with iron formation. The topography within the boundaries of the subject property is relatively flat with gentle undulations. The property slopes slightly to the southeast, with lower lying areas present with non-perennial drainage systems. The surrounding area is relatively flat with gentle undulations and with few distinct topographical features

9.3 Soil forms in the study area

Five different soil units were identified in the Mokala Manganese Project area. The area is dominated by yellow, apedal soil profiles underlain by carbonates.

Clovelly

The Clovelly soil forms consist of a sandy -loam orthic A horizon on a well-drained yellow-brown apedal B horizon overlying unspecified material where limited pedogenesis has taken place. Soil depths of the Clovelly profiles surveyed on site was deeper than 1.5m. Clovelly soils with no restrictions shallower than 500mm are generally good for crop production. The high quality orthic A and yellow-brown apedal B-horizons make it a suitable soil form for annual crop production (good rooting medium) and use as 'topsoil', having favourable structure (weak blocky to apedal) and consistence (slightly firm to friable). However, its suitability for crop production is limited by the climate where it is found and rainfall in the study area is often erratic and generally too low for successful dryland crop production.

Molopo

The Molopo soil form consists of an orthic A horizon overlying a yellow-brown apedal B horizon that is underlain by a soft carbonate horizon. The topsoil is a fine sandy- loam. The yellow-brown apedal B horizon is usually eutrophic. Diagnostic eutrophic horizons are not calcareous. The soft carbonate horizon is nearer to the surface of the soil and more visible.

Witbank

In South Africa there is currently only one soil form that caters for the anthropogenic group according to the Soil Classification Working Group (1991), namely Witbank soil form. Anthropogenic soils are those soils that have been so profoundly affected by human disturbance that their natural genetic character (i.e. their link to the natural factors of soil formation) has largely been destroyed.

Brandvlei

The Brandvlei soil form identified consists of an orthic A horizon, overlying a soft carbonate horizon. The accumulation of secondary lime as a distinctive horizon consisting mainly of calcite is a widely observed feature of soils in arid climates. In the calcic soils either hardpan carbonate (calcrete) or a soft carbonate horizon (as in the case of Brandvlei soil form) dominates the morphology of the subsoil. The orthic A horizon consists of fine sandy loam which will be prone to both wind and water erosion when vegetation cover is removed or when stripped and stockpiled during mining activities.

Kinkelbos

The Kinkelbos soil form consists of an orthic A horizon overlying an E horizon that is underlain by a neocarbonate B horizon. The orthic A horizon is sandy and may have been darkened by organic matter but does not qualify as an organic, humic, vertic or melanic topsoil. The E horizon is greyish and paler in colour than the overlying topsoil as well as the underlying neocarbonate horizon. The neocarbonate horizon directly underlies the E horizon and contains within 1500mm of the surface sufficient calcium carbonate in the soil matrix to effervesce visible when treated with cold 10% hydrochloric acid. The vegetation on this soil form is denser than the surrounding areas. Even though the Kinkelbos soil form is present in the Ga-Mogara drainage channel of the landscape, some parts of it will be disturbed as part of a planned river channel realignment.

9.4 Soil chemical properties

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

The pH (measured in a KCl solution) of the analyzed soil samples in the study area ranges from 5.5 to 6.5 and can be described as moderately acid to neutral. Phoshorus levels are as low as expected for natural, unfertilized veld conditions in South Africa (1 to 2 mg/kg).

The rest of the soil chemical propertiest of the site can be classified into two main groups. The majority of the site consists of deep, well-drained soil where a thick sandy covering of yellow-brown apedal soil covering a carbonate horizon (represented by samples M01, M02, M05 and M06 in Figure 4). These soils are very sandy and the texture consists of more than 90% sand fraction. As a result of the well-drained soil horizons under dry climatic conditions, the organic carbon content of the topsoil is relatively low at 1.46%. The calcium, magnesium and potassium levels are within suitable range for the production of crop plants (which is not permitted by the climate).

The soil chemistry of soil in the Gamogara River (see Figure 3), has a clayey-sand texture consisting of 18 to 24% clay particles and 72 to 80% sand particles. This slows down the water infiltration rate resulting in higher organic carbon content in the topsoil layer (2.70%). As a result of slow, vertical soil-water movement in the riverbed soil profiles, cations of magnesium, calcium and potassium becomes mobile and accumulates in soil surface horizons, especially with the high evaporation rate experienced on the project site. Cations levels are extremely high (Mg at 223 mg/kg; Ca at 3663 mg/kg and K at 194mg/kg)

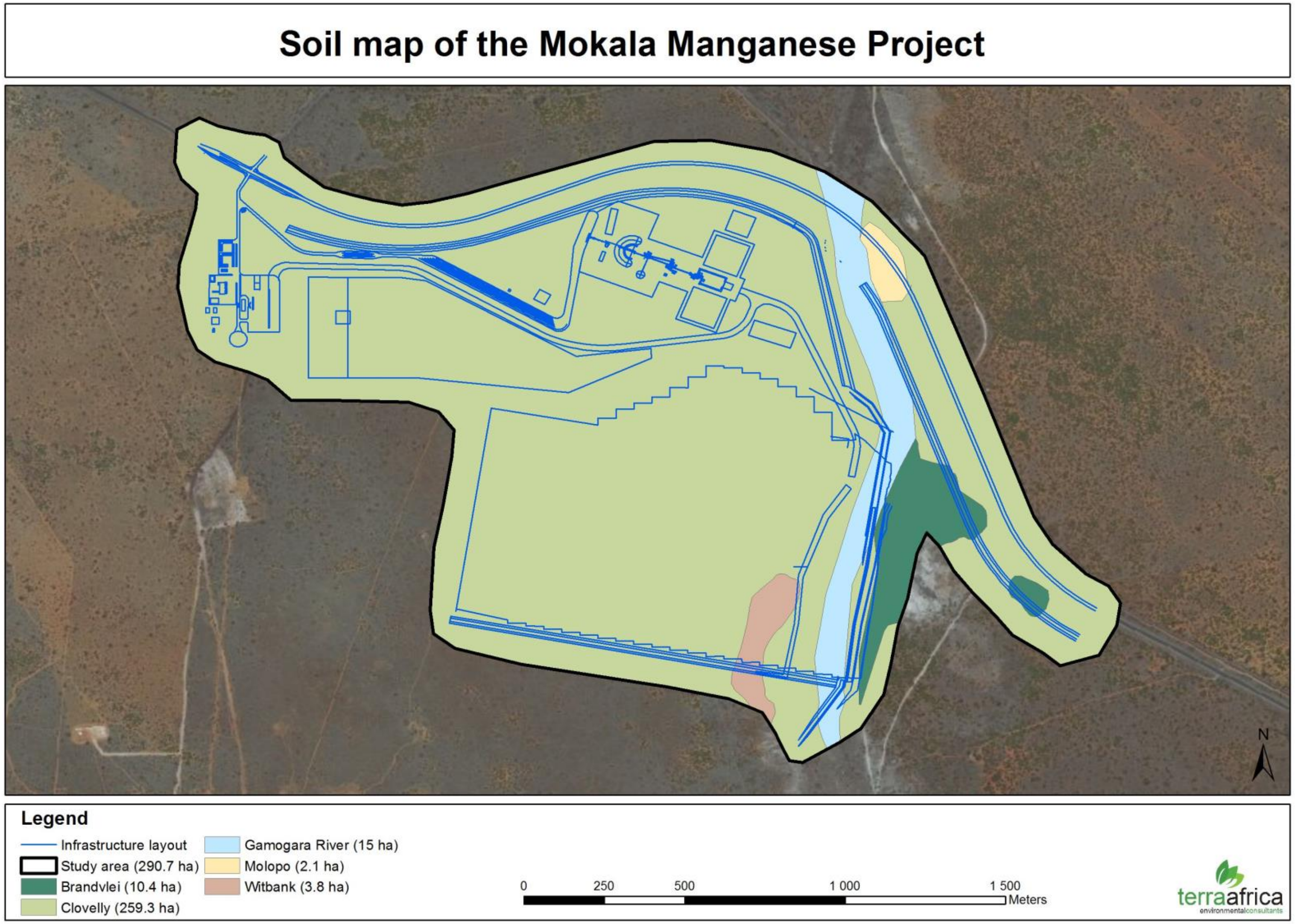

Figure 3: Soil map of the Mokala Manganese Project

TEL: 0828890133 / 0828890139 FAX: 086 683 7781

COMPANY: Terra-Africa Consult
ADDRESS: PO Box 433
Ottosdal
2610
TELEPHONE NO: 082 828 3587

DATE: 2014-09-11
PROJECT: MOKALA MANGANESE PROJECT
EMAIL: mpienaar@terraafrica.co.za

Lab No	Reference no	pH (KCl)	pH(H2O)	PBray1	K	Na	Ca	Mg	%Ca	%Mg	%K	%Na	C
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%	%	%
36916	MO1 Topsoil	5,50	6,50	2	44	6	196	44	66,08	24,61	7,61	1,69	1,46
36917	MO2 Subsoil	5,98	6,78	1	51	3	165	89	48,68	42,88	7,63	0,81	0,41
36918	MO3 Topsoil	5,57	6,40	2	289	11	3663	223	87,50	8,73	3,53	0,24	2,70
36919	MO4 Subsoil	6,13	6,93	1	194	8	2230	219	82,75	13,32	3,68	0,25	0,89
36920	MO5 Topsoil	6,51	7,31	1	43	2	147	36	63,82	25,76	9,50	0,93	0,12
36921	MO6 Subsoil	5,83	6,63	1	49	2	105	40	53,34	33,09	12,83	0,74	0,19

Lab No	Reference no	Ca:Mg	(Ca+Mg)/K	Mg:K	S-Value	Na:K	T	Density	S AmAc	Clay	Silt	Sand
		1.5-4.5	10.0-20.0	3.0-4.0	cmol(+)/kg		cmol(+)/kg	g/cm3	mg/kg	%	%	%
36916	MO1 Topsoil	2,69	11,91	3,23	1,48	0,22	1,48	1,42	5,94	6	1	93
36917	MO2 Subsoil	1,14	12,00	5,62	1,70	0,11	1,70	1,46	10,30	8	1	91
36918	MO3 Topsoil	10,03	27,24	2,47	20,93	0,07	20,93	0,98	7,91	24	4	72
36919	MO4 Subsoil	6,21	26,12	3,62	13,47	0,07	13,47	1,10	16,31	18	2	80
36920	MO5 Topsoil	2,48	9,43	2,71	1,15	0,10	1,15	1,45	5,38	6	1	93
36921	MO6 Subsoil	1,61	6,73	2,58	0,98	0,06	0,98	1,57	4,82	6	2	92

NF REEDERS

Figure 4: Soil analysis results for the Mokala Manganese Project

9.5 Agricultural potential

Although some of the soil groups identified would be moderately to highly suitable for crop production, the rainfall in the area is erratic and periods of drought do occur from time to time which restricts the profitability of large scale crop production.

The proposed Mokala Manganese Project study site did not have any current irrigation infrastructure that was being used for irrigation purposes. No large dams with irrigation potential have been observed on site. The high evaporation rate of the hot, dry climate will result in regular irrigation needed should crops be produced this way. The site currently has low to no irrigation potential.

The grazing capacity of a specified area for domestic herbivores is given either in large animal unit per hectare or in hectares per large animal unit. One large animal unit is regarded as a steer of 450kg whose weight increases by 500g per day on veld with a mean energy digestibility of 55%. The grazing capacity of the veld in the study area is 18 to 22 hectares per large animal unit or large stock unit (LSU) (ARC-ISCW). The entire study area will have grazing available for 18 head of cattle whilst maintaining the quality of the field.

Cattle farming is a viable long-term land use of the site as long as the field quality is maintained by never exceeding the grazing capacity. Post-mining land use should aim to re-establish the cattle farming potential of the land.

The study area is highly suited to game farming and the tourism components associated with game farming such as lodges and professional hunting. According to Van der Merwe and Saayman (2003), the Northern Cape Province has the second largest number of game farms per province in South Africa but needs the largest area per farm as a result of the lower grazing capacity of these farms. However, the area is ideal for a wide variety of small and large game that can be managed as a profitable land use.

9.6 Land use

The land use on entire subject property and its immediate surrounds can be broadly defined as livestock farming, game farming, prospecting and mining. Mining activities currently take place on portion 1 of the farm Gloria 266 (Gloria Mine owned by Assmang (Pty) Ltd) and Umtu 281 (Kalagadi Mine owned by Kalagadi Manganese (Pty) Ltd). Prospecting activities are currently being undertaken on the remaining extent of the farm Gloria 266 by Mokala. A small section to the west of the remaining extent of the farm Gloria has been fenced off by Kalagadi Manganese Mines and is currently used for game. The farm Kipling is owned by Assmang and is used for ad-hoc grazing.

9.7 Land capability

Different land capability classes have been identified for the Mokala Manganese Project area. Deeper soils of the Clovelly soil form have grazing land capability that could have been suitable for dryland crop production in an area with higher rainfall than is the case for the Mokala Manganese Project area. Because of the climate restrictions the land capability is mainly grazing (259.3 ha). The Brandvlei, Molopo and Witbank soil forms have wilderness land capability as a result of the shallow soil depth and existing soil due to the presence of historical borrow pit activities located on-site.

During the site survey, the Gamogara River had no water flow and the soil in the riverbed consists mainly of soil of the Kinkelbos form with visible hard carbonate outcrops where water erosion has removed the top sandy layer. Therefore, although the soil in this area does not indicate significant hydromorphic properties, it is a flow path of water in the landscape and disturbance to this might influence the pedohydrology of the riverbed.

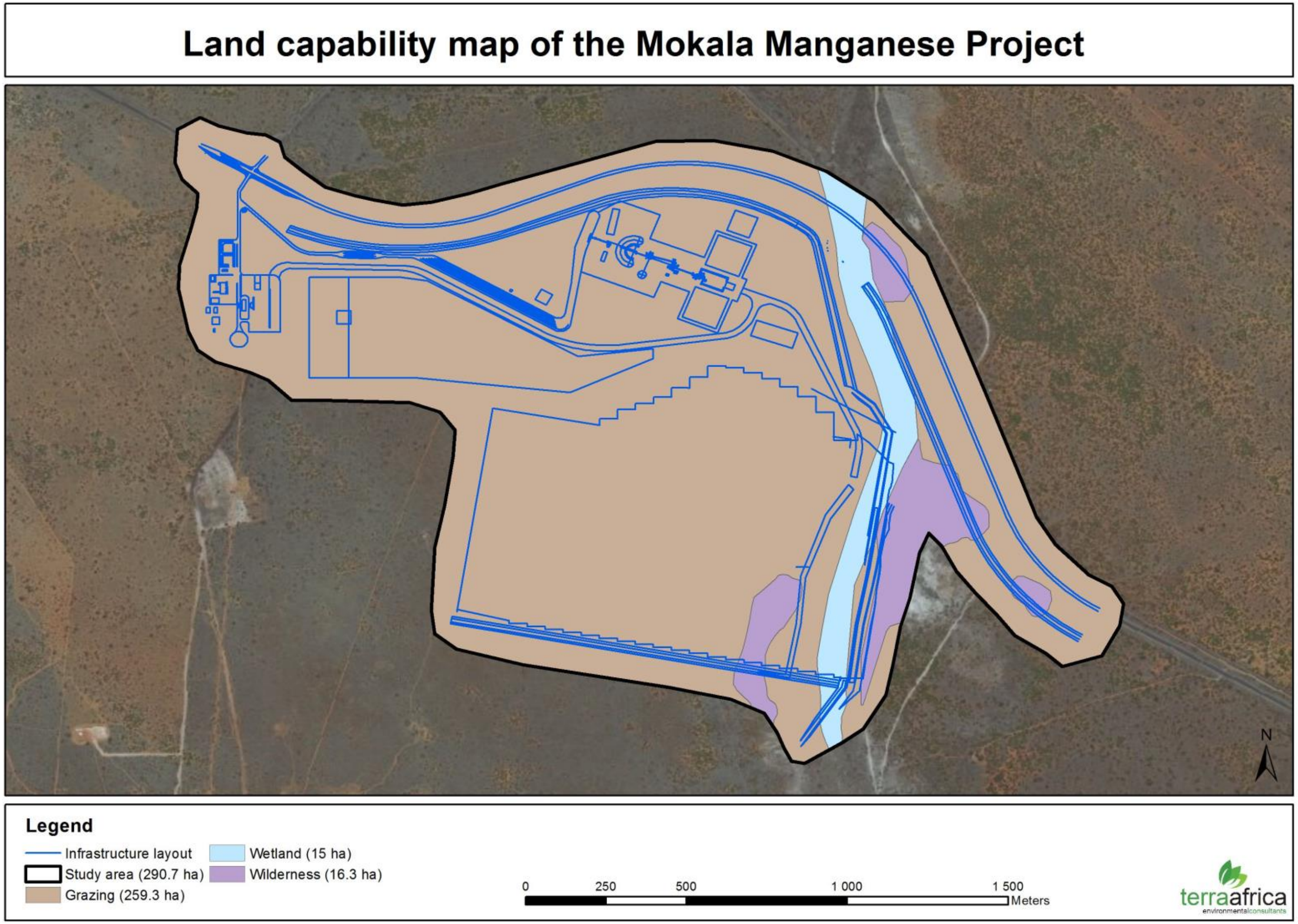

Figure 5: Land capability map of the Mokala Manganese Project

10 Impact assessment

10.1 Assessment methodology

The impact assessment methodology is based on the Hacking method of determination of the significance of impacts (Hacking, 1998). This method also complies with the method provided in the EIA guideline document. Part A provides the definition for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D.

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

terraafrica
environmentalconsultants

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		

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		

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.

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

10.2 Project layout and description

The proposed mine layout indicated areas of surface disturbance for opencast mining as well as areas where surface infrastructure will be constructed. The site infrastructure includes the realignment of the Main Provincial Road, (R380), site access roads and weighbridge, storm water drainage and recycle water systems and storage, potable water system and storage, parking areas, administration block, workshop and stores, refuelling depot, security and fencing, supporting civil works to the plant area and load-out flask, specifications for mine haul roads, civil works for a water processing plant and sewerage treatment plant, civil works for the electrical installation components that require foundations and general building work that may be required to support prefabricated office accommodation and off-the-shelf steel structures including civil work for the plant structures. The layout includes the pit area and areas for topsoil stockpiles (**Figure 5**).

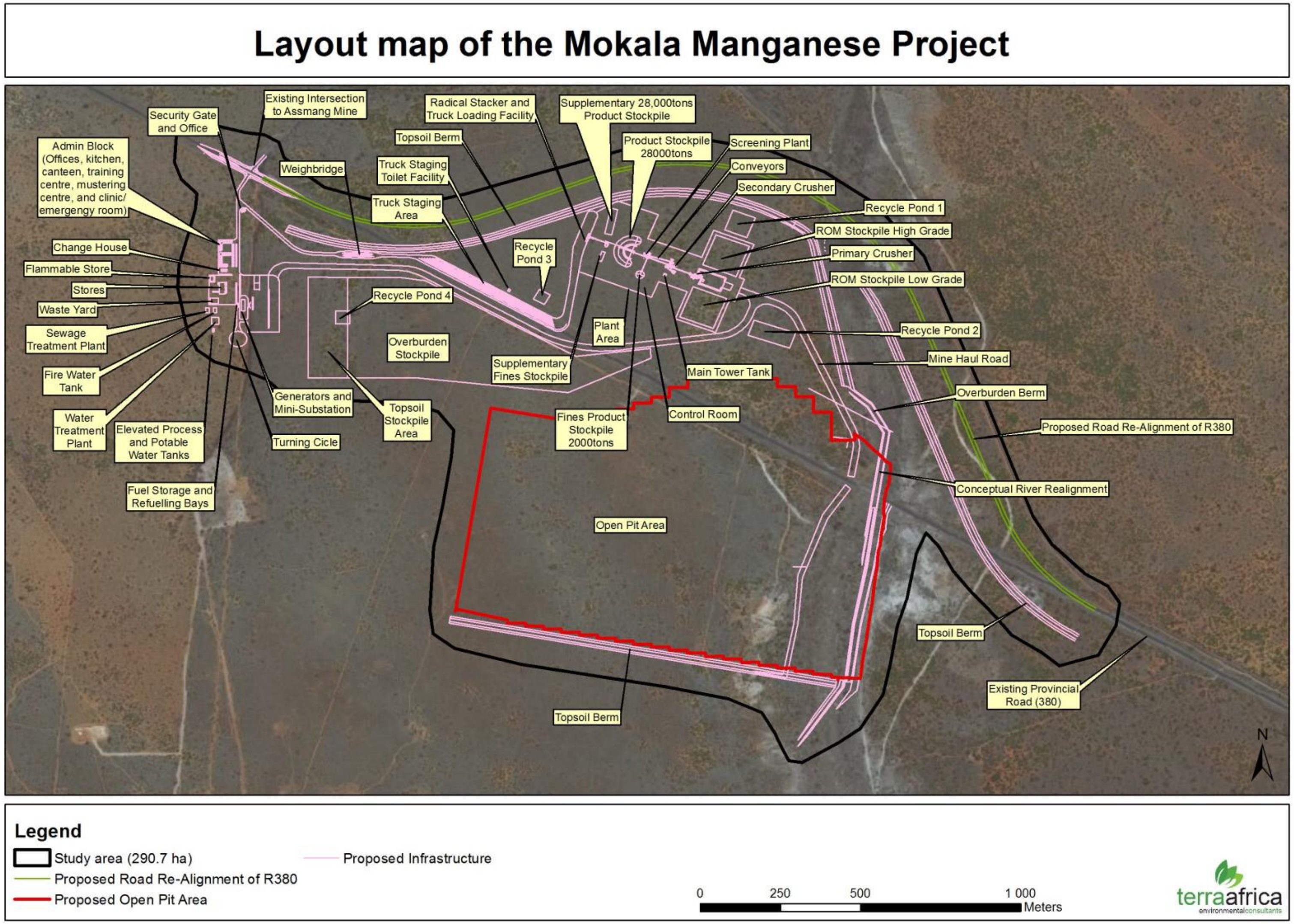

Figure 6: Layout map of the proposed Mokala Manganese Project

10.3 Impact assessment per project phase

10.3.1 Construction phase

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

- Transport of materials and labour with trucks and buses as well as other light vehicles using internal road. This will compact the soil of the existing roads and fuel and oil spills from vehicles may result in soil chemical pollution.
- Earthworks will include clearing of vegetation from the surface, stripping topsoil (soil excavation) and stockpiling as well as drilling and blasting for the initial box cut as well as the construction of new haul roads and the widening of existing haul roads. These activities are the most disruptive to natural soil horizon distribution and will impact on the current soil hydrological properties and functionality of soil. It will also change the current land use as well as land capability in areas where activities occur and infrastructure is constructed.
- Other activities in this phase that will impact on soil are the handling and storage of building materials and different kinds of waste. This will have the potential to result in soil pollution when not managed properly.

The disturbance of original soil profiles and horizon sequences of these profiles during earthworks is considered to be a measurable deterioration. This impact is considered to be permanent but will be localised within the site boundary. This impact is possible and will have medium significance. Even though topsoil management is described in the Soil Management Plan (SMP), the impact will still have medium significance as it is impossible to re-create origin soil profile distribution.

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

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

In areas of permanent changes such as the river realignment and road upgrades, the current land capability and land use will be lost permanently.

Table 2: Rating of unmitigated impacts for the construction phase

Impact	Severity	Duration	Spatial scale	Consequence	Significance
Disturbance of original soil profiles and horizon sequences	M	H	L	M	M
Soil chemical pollution by petroleum hydrocarbons and other waste	M	H	L	M	M
Soil compaction	M	H	M	H	H
Loss of current land capability	H	H	L	H	H
Loss of current land use	M	H	L	M	M

Table 3: Rating of mitigated impacts for the construction phase

Impact	Severity	Duration	Spatial scale	Consequence	Significance
Disturbance of original soil profiles and horizon sequences	M	M	L	M	M
Soil chemical pollution by petroleum hydrocarbons and other waste	L	L	L	L	L
Soil compaction	M	H	L	M	M
Loss of current land capability	M	H	L	M	M
Loss of current land use	M	H	L	M	M

10.3.2 Operational phase

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

- Open pit and surface infrastructure will both lead to surface impacts on soil resources. Surface mining are by far the most disruptive to current land uses, land capability as well as agricultural potential of the soil.
- Other general activities include transport on haul roads that will result in soil compaction while waste generation (non-mineral waste) and accidental spills and leaks may result in soil chemical pollution when unmanaged.

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

Soil chemical pollution as a result of pollutants leaching into subsurface soil horizons where waste overburden is stored, is considered to be a moderate deterioration of the soil resource. This impact will be localised within the site boundary and have medium significance on the soil resource.

Soil compaction will be a measurable deterioration that will occur as a result of the weight of the topsoil stockpiles stored on the soil surface as well as the movement of vehicles on the soil surfaces (including haul roads and around the open cast areas). This is a permanent impact that will be localised within the site boundary with medium consequence and significance.

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

Table 4: Rating of unmitigated impacts for the operational phase

Impact	Severity	Duration	Spatial scale	Consequence	Significance
Disturbance of original soil profiles and horizon sequences	M	H	L	M	M
Soil chemical pollution into subsurface soil profiles	M	H	L	M	M
Soil compaction	M	H	M	H	H
Loss of current land capability	H	H	L	H	H
Loss of current land use	M	H	L	M	M

Table 5: Rating of mitigated impacts for the operational phase

Impact	Severity	Duration	Spatial scale	Consequence	Significance
Disturbance of original soil profiles and horizon sequences	M	L	L	L	M
Soil chemical pollution by petroleum hydrocarbons and other waste	L	L	L	L	L
Soil compaction	M	H	L	M	M
Loss of current land capability	M	M	L	M	M
Loss of current land use	M	M	L	M	M

10.3.3 Decommissioning phase

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

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

- Earthworks will include redistribution of inert waste materials to fill the open pit as well as topsoil to add to the soil surface. These activities will not result in further impacts on land use and land capability but may increase soil compaction.
- Other activities in this phase that will impact on soil are the handling and storage of materials and different kinds of waste generated as well as accidental spills and leaks with decommissioning activities. This will have the potential to result in soil pollution when not managed properly.

Table 6: Rating of unmitigated impacts for the decommissioning phase

Impact	Severity	Duration	Spatial scale	Consequence	Significance
Soil chemical pollution by petroleum hydrocarbons and other waste	M	H	L	M	M
Soil compaction	M	H	L	M	M

Table 7 Rating of mitigated impacts for the decommissioning phase

Impact	Severity	Duration	Spatial scale	Consequence	Significance
Soil chemical pollution by petroleum hydrocarbons and other waste	L	L	L	L	L
Soil compaction	M	L	L	L	M

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

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

10.3.4 Closure phase

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

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

11 Soil Management Plan

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

The objectives of the SMP are to:

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

11.1 Soil management during the construction phase

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

11.1.1 Minimise mining infrastructure footprint

The existing pre-construction mine layout and design (**Figure 5**) is aiming minimise the area to be occupied by mine infrastructure (workshops, administration, processing plants, etc.) to as small as practically possible. All footprint areas should also be clearly defined and demarcated and edge effects beyond these areas clearly defined. This measure will significantly reduce areas to be compacted by heavy construction vehicles and regular activities during the operational phase.

11.1.2 Management and supervision of construction teams

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

11.1.3 Location of stockpiles

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

11.1.4 Topsoil stripping

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

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

11.1.5 Stockpiling of topsoil

To minimise compaction associated with stockpile creation, it is recommended that the height of stockpiles be restricted between of 4 – 5 metres maximum. For extra stability and erosion protection, the stockpiles may be benched although the clay content is sufficient for stockpiles to remain relatively stable without benching.

11.1.6 Demarcation of topsoil stockpiles

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

11.1.7 Prevention of stockpile contamination

Topsoil stockpiles can be contaminated by dumping waste materials next to or on the stockpiles, contamination by fly-rock from blasting and the pumping out of contaminated water from the pit are all hazards faced by stockpiles. This should be avoided at all cost and if it occurs, should be cleaned up immediately.

11.1.8 Terrain stability to minimise erosion potential

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

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

11.1.9 Management of access and haulage roads

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

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

11.1.10 Prevention of soil contamination

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

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

11.2 Soil management during the operational phase

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

It is recommended that concurrent rehabilitation techniques be followed to prevent topsoil from being stockpiled too long and losing its inherent fertility but opportunities may be limited by the geometry of the ore body. Historical borrow pits and other disturbed sites must be rehabilitated as soon as they have reached the end of their life. During operations, soil will continue to be removed from the open pit and stockpiled for later use. Topsoil stripping and stockpiling should follow the guidelines as stipulated under the construction phase above.

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

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

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

11.2.1 Managing potential soil contamination during the operational phase

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

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

11.3 Soil management during the decommissioning phase

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

11.3.1 Management and supervision of decommissioning teams

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

11.3.2 Infrastructure removal

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

11.3.3 Site preparation

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

11.3.4 Seeding and re-vegetation

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

11.3.5 Prevention of soil contamination

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

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

11.4 Soil management during the closure phase

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

12 Environmental Impact Statement

A small portion of the proposed project site by previous prospecting activities that resulted in erosion of those areas. The rest of the land supports natural vegetation suitable for cattle and game farming. The proposed new Mokala Manganese Mine consisting of an open pit, new haul roads and associated plant and infrastructure, will impact upon soil and land capability properties in the areas where the footprint will cause surface disturbance. Cumulative impacts are also related to increase in the surface footprint. These impacts can be reduced by keeping the footprint minimised where possible and strictly following soil management measures pertaining to topsoil stripping, stockpiling and conservation of the soil quality of topsoil stockpiles.

13 A reasoned opinion as to whether the activity should or should not be authorised

The proposed Mokala Manganese mining developments falls within a larger area of mining projects intermixed with cattle and game farming and settlement (Hotazel). Although the land capability and soil quality of land affected by the surface footprint of mining activities will be compromised, the proposed mining area will not impact on any current crop production and will therefore not affect primary grain production. Livestock and game farming activities will be influenced due to mining activities, however if soil management measures are followed as outlined in this report and the land be rehabilitated to the highest standard possible, it is of my opinion that the activity should be authorised. It follows that the recommendations and monitoring requirements as set out in this report should form part of the conditions of the environmental authorisation for the proposed project.

14 Reference list

1. Department of Environmental Affairs, Pretoria. Environmental Potential Atlas of South Africa.
2. **MacVicar, C.N. Et Al. (1991).** Soil Classification. A taxonomic system for South Africa. Mem. Agric. Nat. Resources. S.Afr. No.15. Pretoria.
3. **Van der Merwe, P. and M. Saayman. (2003)**. Determining the economic value of game farm tourism. *Koedoe* 46(2): 103–112. Pretoria