***SOIL, LAND USE AND LAND CAPABILITY REPORT FOR THE PROPOSED DEVELOPMENT OF THE SIYANDA FERROCHROME SMELTER***


For and on behalf of TerraAfrica Consult

Approved by: Mariné Pienaar

Position: Soil scientist


Date: 31 March 2016

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, map able at 1:250000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

**Land use:** The use to which land is put.

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

**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.

# Declaration of EAP

## Details of practitioner

Report author: M Pienaar

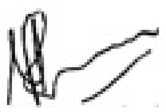
Contact number: 082 828 3587

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

March 2016

# CURRICULUM VITAE

## A. Personal Details

*Last name:* **Pienaar**

*First name:* **Mariné**

*Nationality:* **South African**

*Employment:* **Self employed (Consultant)**

## B. Contact Details

*Email address:* mpienaar@terraafrica.co.za

*Mailing address:* **PO Box 433, Ottosdal, 2610**

*Telephone:* **+27828283587**

*Address:* **Nr 8, 10th Street, Linden, Johannesburg, Republic of South Africa**

*Current Job:* **Lead Consultant and Owner of Terra Africa Consult**

## C. Concise biography

Mariné Pienaar is a professionally registered agricultural scientist who has consulted extensively in the fields of soil, agriculture and land use in several African countries. These countries include South Africa, Liberia, Ghana, DRC, Mozambique, Botswana, Angola, Malawi and Swaziland. She is currently part of a team of specialist scientists selected by the South African Government to conduct a strategic assessment on the impact of shale gas development on the Karoo (specifically soil quality and agricultural production).

She is a guest lecturer at the University of the Witwatersrand, Johannesburg on the topic of "Soil and the Extractive Industries" as well as a contributing author on issues of soil quality and food security to the Bureau for Food and Agricultural Policy (BFAP) report. Mariné presented at the First Global Soil Week and organised sessions at the Second and Third Global Soil Weeks in Berlin, Germany. Mariné has also attended several international conferences and courses including the World Resources Forum in Davos, Switzerland and Conference on Environmental Toxicology and Chemistry, Barcelona.

## D. Areas of expertise

- **Strategic assessment of land quality, soil properties and agricultural production as part of a multi-disciplinary team for large development projects**

- **Classification of soils according to their properties, genesis, use and environmental significance**
- **Sustainable land use and soil management**
- **Restoration of degraded soils**
- **Soil contamination assessment and remediation methods**
- **Agricultural potential assessment**
- **Resettlement planning**
- **Food production systems**
- **Assessment of ecosystem services and natural capital**

## E. Qualifications

**Academic Qualifications:**

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

**Courses Completed:**

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

## F. Language ability

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

## G. Professional Experience

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

**Successful Project Summary:**

*[Comprehensive project dossier available on request]*

**2015:**

- *Buffelsfontein Gold Mine, Northwest Province, South Africa:* Soil and land contamination risk assessment for as part of a mine closure application. Propose soil restoration strategies.
- *Bauba A Hlabirwa Moeijelik Platinum mine [proposed] project, Mpumalanga, South Africa:* soil, land use and land capability assessment and impact on agricultural potential of soil.
- *Commissiekraal Coal Mine [proposed] project, KwaZulu-*Natal, South Africa: sustainable soil management plans, assessment of natural resource and agricultural potential and study of the possible impacts of the proposed project on current land use. Soil conservation strategies included in soil management plan.
- *Cronimet Chrome Mine [proposed] project, Limpopo Province, South Africa:* soil, land use and land capability of project area and assessment of the impacts of the proposed project.
- *Grasvally Chrome (Pty) Ltd Sylvania Platinum [proposed] Project, Limpopo Province, South Africa:* Soil, land use and agricultural potential assessment.
- *Jeanette Gold mine project [reviving of historical mine], Free State, South Africa:* Soil, land use and agricultural potential assessment.
- *Kangra Coal Project, Mpumalanga, South Africa:* Soil conservation strategies proposed to mitigate the impact of the project on the soil and agricultural potential.
- *Mocuba Solar Photovoltaic Power Plant, Zambezia, Mozambique:* soil, land use and land capability studies.

**2014:**

- *Italthai Railway & Macuse Port [proposed] Projects, Tete & Zambezia, Mozambique:* soil, land use and land capability assessments.
- *Eskom Kimberley Strengthening Phase 4 Project, Northern Cape & Free State, South Africa:* soil, agricultural potential and land capability assessment.
- *Richards Bay Integrated Development Zone Project, South Africa* [future development includes an additional 1500 ha of land into industrial areas on the fringes of Richards Bay]: natural resource and agricultural potential assessment, including soil, water and vegetation.
- *TFM Mining Operations [proposed] Integrated Development Zone, Katanga, DRC* [part of mining concession between Tenke and Fungurume]: soil and agricultural impact assessment study.
- *Exxaro Belfast Coal Mine [proposed] infrastructure development projects* [linear: road and railway upgrade | site-specific coal loading facilities]: soil, land capability and agricultural potential assessment.
- *Marikana In-Pit Rehabilitation Project of Aquarius Platinum, South Africa:* soil, land capability and land use assessment.

**2013:**

- *Eskom Bighorn Substation proposed upgrades, South Africa:* soil, land capability and agricultural potential assessment.

- *Exxaro Leeuwpan Coal Mining Right Area, South Africa:* consolidation of all existing soil and agricultural potential data. Conducted new surveys and identified and updated gaps in historic data sets.
- *WCL [proposed] development projects, Liberia:* Soil, land use and land capability study.
- *ESIA for [proposed] Musonoi Mine, Kolwezi area, Katanga, DRC:* soil, land use and land capability assessment.
- *Camutue Mining Concession, Angola:* Land use and agricultural assessment.
- *Manica Mining Project, Mozambique:* soil, land use and agricultural assessment.
- *AQPSA Marikana Mine, South Africa:* soil, land use and land capability data consolidation as part of the EMP consolidation process.

**2012:**

- *Banro Namoya Mining Operation, DRC:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, including proposed project extension areas and progressive soil and land use rehabilitation plan.
- *Bomi Hills Mining Project, Liberia:* soil, land use and agricultural scientist for field survey and reporting of soil potential, current land use activities and existing soil pollution levels, as well as associated infrastructure upgrades of the port, road and railway.
- *Kumba Iron Ore's Sishen Mine, Northern Cape, South Africa: soil, land use and agricultural scientist | Western Waste Rock Dumps [proposed] Project:* soil, land use and agricultural potential assessment, including recommendations regarding stripping/stockpiling and alternative uses for the large calcrete resources available.
- *Vetlaagte Solar Development Project, De Aar, South Africa:* soil, land use and agricultural scientist. Soil, land use and agricultural potential assessment for proposed new 1500 ha solar development project, including soil management plan.
- *Lunda Norte kimberlite diamond mining operation, Angola:* land restoration specialist for the assessment of current soil environmental issues. Development of agricultural plans for mine closure and social contribution. Design of sediment control measures and bamboo plantations for land restoration purposes.

## H. Prior Tenures

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

## I. Professional Affiliations

- South African Council for Natural Scientific Professions [SACNASP]
- Society for Environmental Toxicology and Chemistry [SETAC]
- International Society for Sustainability Professionals [ISSP]
- Soil Science Society of South Africa [SSSA]
- South African Soil Surveyors' Organisation [SASSO]
- South African Society for Crop Production [SASCP]

- International Association for Impact Assessment, South Africa [IAIAsa]
- Environmental Law Association [ELA]
- Soil Science Society of America [SSSA]

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## List of Figures

# 1. Introduction

SLR Consulting (Africa) Pty Ltd appointed Terra Africa Consult to conduct the soil, land use and land capability study as part of the Environmental Impact Assessment (EIA) process for the proposed development of the Siyanda Ferrochrome Smelter with all supporting infrastructure.

The proposed project is located on portion 3 the farm Grootkuil 409 KQ adjacent to the existing Union Section Mine, approximately 5 km northwest of the town of Northam (**Figure 1**). The Project is located in the Thabazimbi Local Municipality within the Waterberg District Municipality in the Limpopo Province of South Africa.

This report complies with the requirements of the NEMA and environmental impact assessment (EIA) regulations (GNR 982 of 2014). The table below provides a summary of the requirements, with cross references to the report sections where these requirements have been addressed.

**Table 1: Specialist report requirements in terms of Appendix 6 of the EIA Regulations (2014)**

| A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain: | Relevant section in report |
|---|---|
| Details of the specialist who prepared the report | Page iv – viii |
| The expertise of that person to compile a specialist report including a curriculum vitae | Pages iv - viii |
| A declaration that the person is independent in a form as may be specified by the competent authority | Page iii |
| An indication of the scope of, and the purpose for which, the report was prepared | Pages 12 |
| The date and season of the site investigation and the relevance of the season to the outcome of the assessment | Section 8.2, page 17 |
| A description of the methodology adopted in preparing the report or carrying out the specialised process | Section 8, page 16 - 18 |
| The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure | Sections 9 & 10, page 20 |
| An identification of any areas to be avoided, including buffers | Not 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; | Figure 5, page 38 |
| A description of any assumptions made and any uncertainties or gaps in knowledge; | Sections 5 & 6, page 15 & 16 |
| A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment | Section 9, page 20 |
| Any mitigation measures for inclusion in the EMPr | Section 11, page 44 |

| | |
|---|---|
| Any conditions for inclusion in the environmental authorisation | Section 11, page 44 |
| Any monitoring requirements for inclusion in the EMPr or environmental authorisation | Section 11, page 44 |
| A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and | Section 13, page 52 |
| If the opinion is that the proposed activity 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 13, page 52 |
| A description of any consultation process that was undertaken during the course of carrying out the study | Not applicable |
| A summary and copies if any comments that were received during any consultation process | Section 7, page 16 |

## 2. Objective of the study

The objective of the Soil, Land Use and Land Capability study is to fulfill the requirements of the most recent South African Environmental Legislation with reference to the assessment and management of these natural resource aspects (stipulated in Section 3 below). The key components of assessment include 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 developments at the Siyanda Ferrochrome Smelter Project Area can be predicted and mitigation and management measures can be recommended to minimise negative impacts and maximise land rehabilitation success towards successful closure at the end of the project life.

A further objective of the study was to determine current soil metal levels and to measure it against the IFC Performance Standards for threshold levels in order to establish a 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.

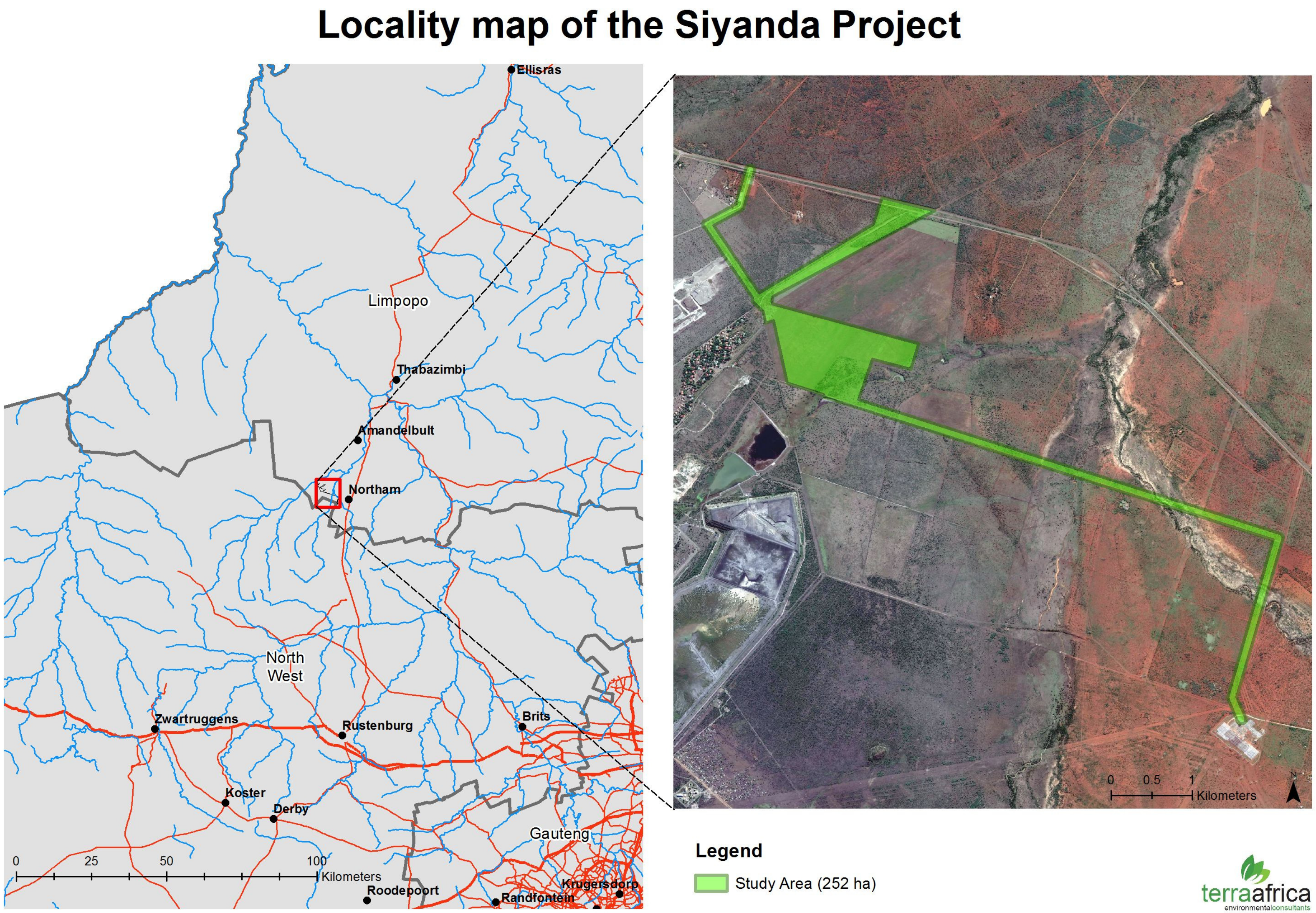



**Figure 1: Locality map of the Siyanda Ferrochrome Smelter Project**

# 3. Environmental legislation applicable to study

The most recent South African Environmental Legislation that needs to be considered for any new or expanding development with reference to 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. The purpose of this Notice is to identify activities that would require environmental authorisation prior to commencement of that activity.

In addition to South African Environmental Legislation, the study also aligns to fulfill the IFC Performance Standards on Environmental and Social Sustainability that became effective on 1 January, 2012. With regards to the Soil, Land Use and Land Capability assessment, the following standards and guidelines are of most relevance:

- IFC Performance Standard 3: Resource Efficiency and Pollution Prevention provides guidelines on project-level approach to resource efficiency and pollution prevention, in this case specifically for land management.
- IFC Guidelines for Mining which recommend practices for sustainable land use and topsoil management.
- IFC General Environmental, Health and Safety Guidelines: Contaminated Land for the detection, remediation and monitoring of contaminated land, should it be present.

# 4. Terms of reference

The following Terms of Reference as stipulated by SLR Consulting (Africa) Pty Ltd applies to the baseline soil and land capability study:

- Undertake a desktop study to establish broad baseline soil conditions, land capability and areas of environmental sensitivity in the proposed subject property;
- Undertake a soil survey of the proposed subject property area focusing on all landscape features including potentially wet areas;
- Describe soils in terms of soil texture, depth, structure, moisture content, organic matter content, slope and land capability of the area;
- Describe and categorise soils using the South African Soil Classification Taxonomic System;
- Identify and assess potential soil, agricultural potential and land capability impacts resulting from the proposed Siyanda Ferrochrome Smelter Development Project (including impacts associated with the construction, operation, decommissioning and post closure phases of the project), using the prescribed impact rating methodology;
- Identify and describe potential cumulative soil, agricultural potential and land capability impacts resulting from the proposed development in relation to proposed and existing developments in the surrounding area;
- Determine current metal levels in the soil to measure it against IFC Performance Standards and to use it as a measure during future soil and land quality monitoring procedures;
- Recommend mitigation measures to minimise impacts and/or optimise benefits associated with the proposed project.

# 5. Assumptions

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

- The project will include a railway siding, a raw materials offloading area, two 70 MW DC ferrochrome furnaces, crushing and screening plant, mineralized waste facility and related facilities such as material stockpiles, workshops, stores and various support infrastructure and services including power lines, access and internal roads and pipelines.

# 6. Uncertainties, limitations and gaps

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

- Soil profiles were observed using a 1.5m hand-held soil auger. A description of the soil characteristics deeper than 1.5m cannot be given.

# 7. Response to concerns raised by I&APs

Concerns were raised by I & APs during the Public Participation Process pertaining to the continuation of existing land uses in the surrounding area.

- Land uses on surrounding property can continue but will be influenced if air and surface water pollution occur beyond the site boundaries.
- Project related noise levels may also impact on the Anglo Platinum game farm adjacent to the proposed development.
- Comment by Sandy McGill and Mr. and Mrs. Schoeman that the quality of the soil is good for sunflower production, is relevant. The deep Arcadia and Bonheim soil form have arable land capability.
- Impact on current land uses on surrounding properties namely residential, eco-tourism and hunting is possible, refer to Economic Impact Assessment.
- The relevant specialists will address the issues in their reports.

# 8. Methodology

## 8.1 Desktop study and literature review

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

- Land type data for the study area was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC);
- 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;
- The most recent aerial photography of the area available from Google Earth was obtained.

## 8.2 Study area survey

A systematic soil survey was undertaken in February 2016 with survey points between 100 and 150m apart in the study area (Figure 2). The season in which the site visit took place has no influence on the results of the survey. The soil profiles were examined to a maximum depth of 1.5m 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

Seven soil samples (four topsoil samples and three subsoil samples) were collected at the study area as follows: one topsoil and one subsoil at each sampling point except at one sampling point where only a topsoil sample was taken. Six additional soil samples (three topsoil samples and three subsoil samples) were collected to determine possible heavy metal pollution for Equator Principles compliance. All sampling and survey points are indicated in **Figure 2**. Soil samples were sealed in soil sampling plastic bags and sent to Nvirotek Laboratories, Hartbeespoortdam for analyses. Samples taken to determine baseline soil fertility were analysed for electrical conductivity (EC), 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). A full metal scan was done on samples SY05 – SY10.

## *8.4 Land capability classification*

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

## Survey and Chemical sampling points map of Siyanda

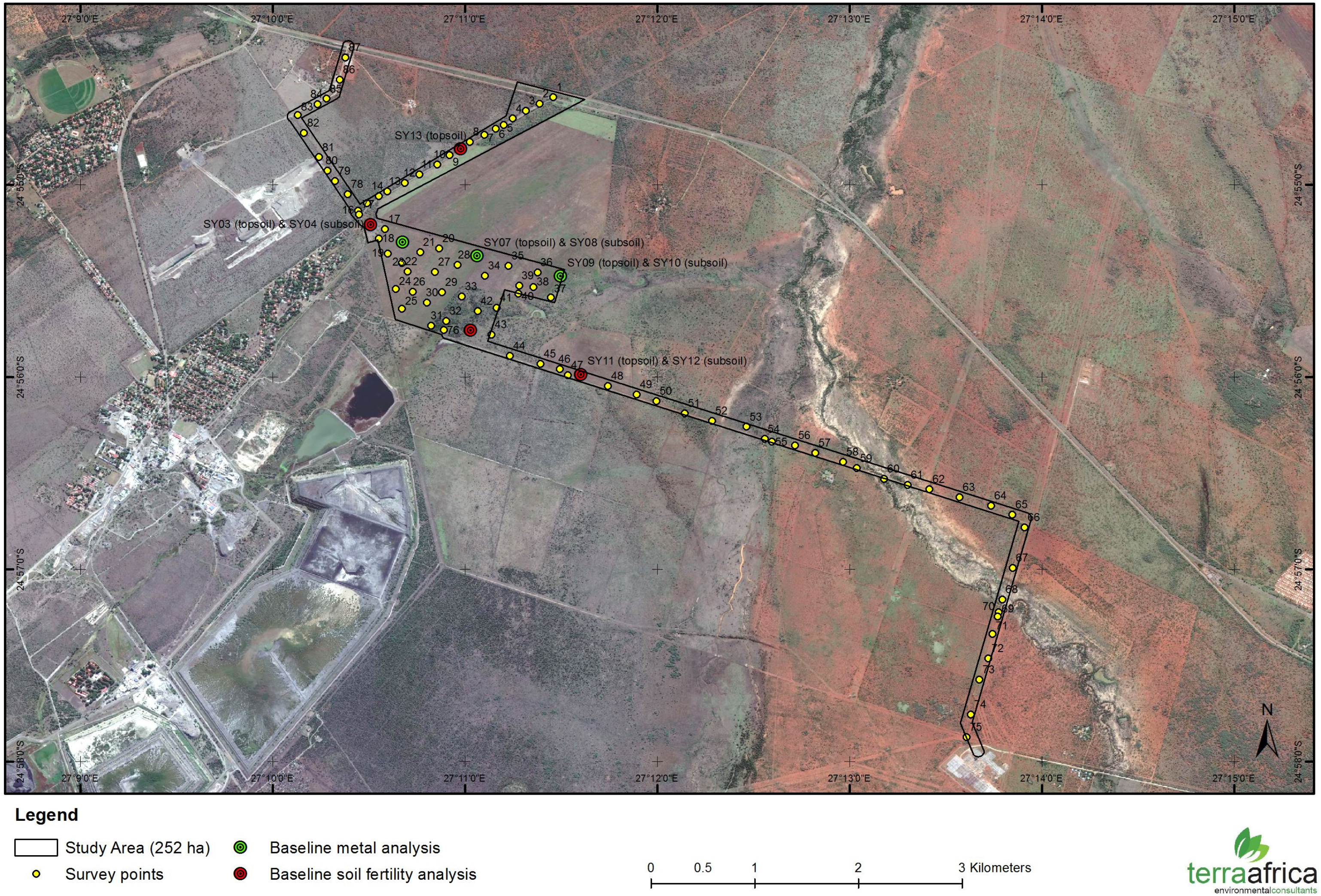



**Figure 2: Survey and Chemical sampling points map of the Siyanda Ferrochrome Smelter Project**

**Table 2: Pre-Mining Land Capability Requirements**

| | |
|---|---|
| Criteria for Wetland | ➢ Land with organic soils or<br>➢ 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,<br>➢ The soil is readily permeable to the roots of common cultivated plants to a depth of 750mm,<br>➢ The soil has a pH value of between 4,0 and 8.4,<br>➢ The soil has a low salinity and SAR,<br>➢ The soil has a permeability of at least 1,5-mm per hour in the upper 500-mm of soil<br>➢ The soil has less than 10 % (by volume) rocks or pedocrete fragments larger than 100-mm in diameter in the upper 750-mm,<br>➢ Has a slope (in %) and erodibility factor (K) such that their product is <2.0,<br>➢ 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,<br>➢ 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,<br>➢ 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. |

# 9. Baseline conditions

## 9.1 *Soil forms present in the study area*

Five different soil forms were identified within the study area (**Figure 3**) which included the preferred powerline and access road routing as well as the preferred location for the smelter infastructure. Below follows a description of each of these soil forms:

***<u>Arcadia soil form (Ar)</u> (134 ha or 53.1 % of the total study area)***

Soils of the Arcadia form occur on 93.7% of the study area. The vertic A-horizon is calcareous which makes it part of the Rustenburg soil family. These dark brown to black vertic soils have deep A-horizons (60 cm to 150 cm deep) and are high in clay content with swelling-shrinking properties under conditions of water content changes. These expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistency is highly plastic when moist and sticky when wet. The swell-shrink potential is manifested typically by the formation of conspicuous vertical cracks in the dry state and the presence, at some depth, of slickensides (polished or grooved glide planes produced by internal movement). The tendency of vertic soils to alternate from being either too dry and hard or excessively wet and sticky causes the workable period to be very short and in some years almost non-existent. Despite their problematic physical properties vertic soils are extremely fertile chemically.

Most Arcadia soils in the study area have medium to high agricultural potential. Crop production on these soils may require irrigation although cracks after the dry season make it possible for the soil to "tank up" with spring rain and sustain crops like sunflowers and cotton without irrigation. Some of the most palatable, nutritious (sweet) grazing that allows year-round grazing potential occurs on these soils.

**Bonheim soil form (Bo) (*71 ha or 28.1 % of the study area*)**

The Bonheim soil form identified consists of a melanic A horizon (20 cm to 80 cm deep), overlying a pedocutanic B horizon that is distinguished on the basis of an increase in clay as a result primarily of illuviation and accumulation and visually expressed as cutans. These soils are often found in similar topographic positions as vertic soils but commonly are slightly higher upslope. The B horizon of Bonheim soils may have a plasticity index that would qualify it as vertic if it was a topsoil horizon. The melanic A horizon lacks slickensides that are diagnostic of vertic horizons but has structure that is strong enough so that the major part of the horizon is not both massive and hard or very hard when dry. Absence of vertic properties is usually because of either a lower clay content, or a predominance of other clay minerals than the high expansive smectitic clay minerals which are predominant in vertic soils.

The Bonheim soil form is often one of the most productive soils within its climatic area. If irrigation is possible, arable crops, pastures and horticultural crops can be cultivated. The

strong structure of the melanic soils is able to withstand repeated cultivation though the low amount of organic matter may become problematic with continuous cultivation.
Natural veld on melanic soils provides sweet grazing and ecosystems dominated by melanic soils are highly productive.

**Glenrosa soil form (Gs) (6 ha or 2.3 % of the total study area)**

The Glenrosa soil form consists of an orthic A horizon underlain by a **hard** lithocutanic B horizon. The lithocutanic B horizon (distinguished from hard rock by not only consistence and degree of weathering but also tonguing and cutanic character) may itself be 'hard or not hard' (Soil Classification Working Group 1991). To be called hard more than 70% must be parent rock, fresh or partly weathered with a hard consistence in the dry, moist and wet states. The cutanic character of the B horizon of the Glenrosa soil form may take the form of tongues of topsoil extending into the partly weathered parent rock.

Lithic soils often have better quality and are far more useful than expected because of their shallow nature. Deciduous fruits and vines are often grown on lithic soils under irrigation and forest plantations in higher rainfall regions. Where there are better soils to choose from, Glenrosa soil form soils are avoided for intensive use and left as unimproved veld for grazing. A very shallow layer of topsoil is available for stockpiling for rehabilitation purposes in the study area. The part of access road option 3 where the Glenrosa soil form occurs, forms part of an existing road and is already compromised.

**Hutton soil form (Hu) (40 ha or 15.8 % of the total study area)**

The Hutton soil forms consist of an orthic A horizon on a red apedal B horizon overlying unspecified material. The red apedal soils' B1-horizon has more or less uniform "red" soil colours in both the moist and dry states and has weak structure or is structureless in the moist state. The range of red colors that is a key identification tool in differentiating between a red apedal and yellow-brown apedal is defined by the Soil Classification Working Group Book, 1991. The clay content of Hutton soils identified is between 10% and 25%.

Soil depths of the Hutton profiles surveyed in the study area ranged between 90 cm and 110 cm with restrictive layers of rock or unspecified material without signs of wetness. Hutton soils with no restrictions shallower than 500mm are generally good for crop production. All Hutton profiles are structureless or have very weakly developed structure. The high quality orthic A and red 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 will probably be limited by climatic factors like rainfall, temperature and evaporation rate. These topsoils are ideal for stripping and stockpiling for rehabilitation purposes for they are deep and have a favourable structure.

**Witbank form (Wb) (2 ha or 0.8 % of the total study area)**

In South Africa there is currently only one soil form that caters for the anthropic group of soils, namely the Witbank soil form. Anthropic 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 or has had insufficient time to express itself. The Witbank soil form encountered in the study area consists of old mining areas where backfilling was done but the topsoil is not yet replaced.

## 9.2 *Soil chemical conditions of the study area*

### 9.2.1 Soil fertility

The pH of the majority of the analyzed soil samples in the study area ranges from 6.0 (medium acid) to 6.5 (slightly acid). For successful crop production, a pH of between 5.8 and 7.5 is optimum and crops produced in soils with lower pH may suffer aluminium (Al) toxicities if toxic levels of Al are present. The danger of Al toxicity in maize only exists when the pH (KCl) is lower than 4.5. Typical of vertic soils the pH of the soils in the study area is mildly acid and there is no need for the pH to be improved by the addition of dolomitic lime or gypsum. The organic carbon is less than 2% as is usually the case with vertic soils.

Phosphorus levels are very low (ranging between 1 mg/kg and 15 mg/kg P). The clay plus silt content in the top 150 mm of the soil ranges between 78% and 91%. For crop production optimum extractable P levels in the soil according to Bray 1 are 14.6 mg/kg for soils with a clay plus silt content of 60% and more. The calcium and magnesium levels are higher than what is adequate for crop plants but is not considered as toxic. The potassium levels are higher than what is considered adequate at all sampling points. The balance between these three cations can be corrected with chemical fertilizer.

The soil chemistry of the samples analysed indicate that soil at the study area has the chemical suitability for crop production. Intensive annual crop production would however require proper fertilization as soil nutrients should be balanced and will get depleted.

No serious soil chemical issues such as soil salinity or sodicity occur on the study area. Where the sodium (Na) concentration is more than 15% of the sum of all cations, crop production may be impaired. However, the sodium concentration at all the sampling points ranges from 0.34% to 2.44% of the cations.

### 9.2.2 Soil metal content

The IFC General Environmental, Health and Safety Guidelines for Contaminated Land makes provision for the detection, remediation and monitoring of contaminated land while Performance Standard 3 deals with prevention and detection of land contamination.

South African legislation that ties in with this, is Government Notice No. 331 (GN R.331) that provides norms and standards for screening and assessing contaminated sites. Soil screening values (SSVs) are used to determine whether the concentration of constituents present in the soil is high enough to be a potential risk to receptors in the environment.

Soil screening values are defined as follows:

- "Soil Screening Value 1" means soil quality values that are protective of both human health and eco-toxicological risk for multi-exposure pathways, inclusive of contaminant migration to the water resource.
- "Soil Screening Value 2" means soil quality values that are protective of risk to human health in the absence of a water resource.

Since the study area is located within the quarternary catchment A24E with the Crocodile River as the main river downstream of the proposed site area, the SSV1 values are appropriate to assess potential soil contamination. When comparing the analysis results of the samples taken at the Siyanda Ferrochrome Smelter Project area with SSV1 values (**Table 2**) which are the strictest values prescribed by the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), it indicates high Copper and Manganese levels present in all the samples. This may be as a result of naturally occurring high metal levels in combination with historical agricultural practices on the land.

Following Papenfus et al. (2015), the dissociation constant (Kd value) used to calculate the soil screening values for copper, lead and vanadium are not correctly representative of South African soil profiles. Their research focused on developing more accurate regression models which can be used for site specific soil Kd values.

For the purpose of site monitoring (should the Department of Environmental affairs request such) as well as during application for closure, a land contamination assessment will have to be conducted. The values presented in Table 3 below can then be used to measure any deviances that occurred as a result of site activities. It is therefore not recommended that any potential future site rehabilitation aim to lower the current copper and manganese levels to that indicated in the SSV1.

**Table 3: Metal analysis of soil samples as compared to Soil Screening Values (SSV 1) as prescribed in GN R.331**

| Parameter | Soil (mg/kg) | Siyanda Samples (mg/kg) | | | | | |
|---|---|---|---|---|---|---|---|
| | SSV 1 All land uses Protective of water resources | SY 5 | SY6 | SY7 | SY8 | SY9 | SY10 |
| Arsenic (As) | 5,8 | 1.50 | 1.30 | 1.40 | 1.30 | 1.40 | 1.30 |
| Cadmium (Cd) | 7.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Chromium (III) (Cr) | 46 000 | 160.00 | 164.00 | 170.00 | 173.00 | 169.00 | 160.00 |
| Chromium (IV) (Cr) | 6.5 | - | - | - | - | - | - |
| Cobalt (Co) | 300 | 38.2 | 34.00 | 37.70 | 37.20 | 47.50 | 48.90 |
| Copper (Cu) | 16 | 22.2 | 224.00 | 21.20 | 20.50 | 34.60 | 33.90 |
| Lead (Pb) | 20 | 8.4 | 8.00 | 8.10 | 8.30 | 8.30 | 7.90 |
| Manganese (Mn) | 740 | 1636.0 | 1340.0 | 1649.0 | 1627.0 | 1635.0 | 1656.0 |
| Mercury (Hg) | 0.93 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Nickel (Ni) | 91 | 83.00 | 77.50 | 81.30 | 80.80 | 60.50 | 55.40 |
| Vanadium (V) | 150 | 91.00 | 93.70 | 87.40 | 88.20 | 117.00 | 113.00 |
| Zinc (Zn) | 240 | 31.70 | 31.30 | 29.30 | 28.00 | 37.90 | 36.50 |

**Table 4 : Soil fertility analysis report**

| Lab No | Ref No | pH (KCl) | PBray1 | K | Na | Ca | Mg | EA.KCl | %Ca | %Mg | %K | %Na | ACID SAT | Ca:Mg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | cmol(c)/ | % | % | % | % | % | 1.5-4.5 |
| 64412 | SY 1 Top | 6.53 | 15 | 572 | 291 | 6154 | 2256 | 0.00 | 59.19 | 35.56 | 2.81 | 2.44 | 0.00 | 1.66 |
| 64413 | SY 2 Sub | 6.09 | 2 | 420 | 397 | 6483 | 2474 | 0.00 | 58.41 | 36.55 | 1.93 | 3.11 | 0.00 | 1.60 |
| 64414 | SY 3 Top | 5.98 | 1 | 384 | 38 | 5774 | 2129 | 0.00 | 60.82 | 36.76 | 2.07 | 0.34 | 0.00 | 1.65 |
| 64415 | SY 4 Sub | 6.17 | 2 | 186 | 192 | 6069 | 2515 | 0.00 | 58.06 | 39.44 | 0.91 | 1.60 | 0.00 | 1.47 |
| 64422 | SY 11 Top | 6.13 | 1 | 359 | 38 | 6963 | 1038 | 0.00 | 78.40 | 19.15 | 2.07 | 0.38 | 0.00 | 4.09 |
| 64423 | SY 12 Sub | 6.10 | 2 | 130 | 72 | 7098 | 1148 | 0.00 | 77.92 | 20.66 | 0.73 | 0.69 | 0.00 | 3.77 |
| 64424 | SY 13 Top | 6.02 | 1 | 234 | 108 | 4934 | 1415 | 0.00 | 66.08 | 31.06 | 1.60 | 1.25 | 0.00 | 2.13 |

| Lab No | Ref No | (Ca+Mg)/K | Mg:K | S-Value | Na:K | T | Density | S AmAc | EC | Clay | Silt | Sand | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 10.0-20.0 | 3.0-4.0 | cmol(+)/kg | | cmol(c)/kg | g/cm3 | mg/kg | mS/m | | | | % |
| 64412 | SY 1 Top | 33.67 | 12.64 | 51.99 | 0.87 | 51.99 | 1.08 | 4.32 | 31.1 | 64 | 27 | 9 | 1.40 |
| 64413 | SY 2 Sub | 49.08 | 18.89 | 55.49 | 1.61 | 55.49 | 1.11 | 26.44 | 43.4 | 58 | 29 | 13 | 1.22 |
| 64414 | SY 3 Top | 47.10 | 17.74 | 47.47 | 0.17 | 47.47 | 1.08 | 11.01 | 18.3 | 50 | 33 | 17 | 1.20 |
| 64415 | SY 4 Sub | 107.27 | 43.39 | 52.27 | 1.76 | 52.27 | 1.06 | 14.83 | 17.39 | 54 | 32 | 14 | 1.24 |
| 64422 | SY 11 Top | 47.16 | 9.26 | 44.41 | 0.18 | 44.41 | 1.08 | 10.48 | 42.6 | 52 | 26 | 22 | 1.38 |
| 64423 | SY 12 Sub | 135.13 | 28.33 | 45.55 | 0.94 | 45.55 | 1.10 | 2.38 | 16.52 | 56 | 27 | 17 | 1.43 |
| 64424 | SY 13 Top | 60.64 | 19.39 | 37.33 | 0.78 | 37.33 | 1.14 | 1.23 | 27.6 | 52 | 24 | 24 | 1.52 |

**Table 5: Soil metal content analysis report**

| Lab No | Ref No | Ag | Al | As | B | Ba | Cd | Co | Cr | Cu | Fe | Hg | Mg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mg/kg | g/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | g/kg | mg/kg | mg/kg |
| 64416 | SY 5 Top | <0.5 | 24.30 | 1.50 | 0.80 | 227 | <0.5 | 38.20 | 160.00 | 22.20 | 27.66 | <0.5 | 7039.00 |
| 64417 | SY 6 Sub | <0.5 | 25.36 | 1.30 | 0.70 | 199 | <0.5 | 34.00 | 164.00 | 224.00 | 26.12 | <0.5 | 7551.00 |
| 64418 | SY 7 Top | <0.5 | 22.54 | 1.40 | 0.60 | 206 | <0.5 | 37.70 | 170.00 | 21.20 | 26.77 | <0.5 | 5962.00 |
| 64419 | SY 8 Sub | <0.5 | 22.35 | 1.30 | 0.70 | 202 | <0.5 | 37.20 | 173.00 | 20.50 | 26.98 | <0.5 | 5914.00 |
| 64420 | SY 9 Top | <0.5 | 20.33 | 1.40 | 0.70 | 230 | <0.5 | 47.50 | 169.00 | 34.60 | 51.65 | <0.5 | 4389.00 |
| 64421 | SY 10 Sub | <0.5 | 20.31 | 1.30 | 0.70 | 221 | <0.5 | 48.90 | 160.00 | 33.90 | 54.19 | <0.5 | 4169.00 |

| Lab No | Ref No | Mn | Mo | Ni | P | Pb | Sb | Se | Sn | Ti | V | Zn | Zr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| 64416 | SY 5 Top | 1636.00 | <0.5 | 83.00 | 9.50 | 8.40 | <0.5 | <0.5 | <0.5 | 38.80 | 91.00 | 31.70 | 3.30 |
| 64417 | SY 6 Sub | 1340.00 | <0.5 | 77.50 | 5.20 | 8.00 | <0.5 | <0.5 | <0.5 | 43.60 | 93.70 | 31.30 | 4.00 |
| 64418 | SY 7 Top | 1649.00 | <0.5 | 81.30 | 11.40 | 8.10 | <0.5 | <0.5 | <0.5 | 31.50 | 87.40 | 29.30 | 2.50 |
| 64419 | SY 8 Sub | 1627.00 | <0.5 | 80.80 | 5.20 | 8.30 | <0.5 | <0.5 | <0.5 | 36.10 | 88.20 | 28.00 | 2.70 |
| 64420 | SY 9 Top | 1653.00 | <0.5 | 60.50 | 26.50 | 8.30 | <0.5 | <0.5 | 0.50 | 142.00 | 117.00 | 37.90 | 2.10 |
| 64421 | SY 10 Sub | 1656.00 | <0.5 | 55.40 | 24.40 | 7.90 | <0.5 | <0.5 | 0.50 | 167.00 | 113.00 | 36.50 | 2.40 |

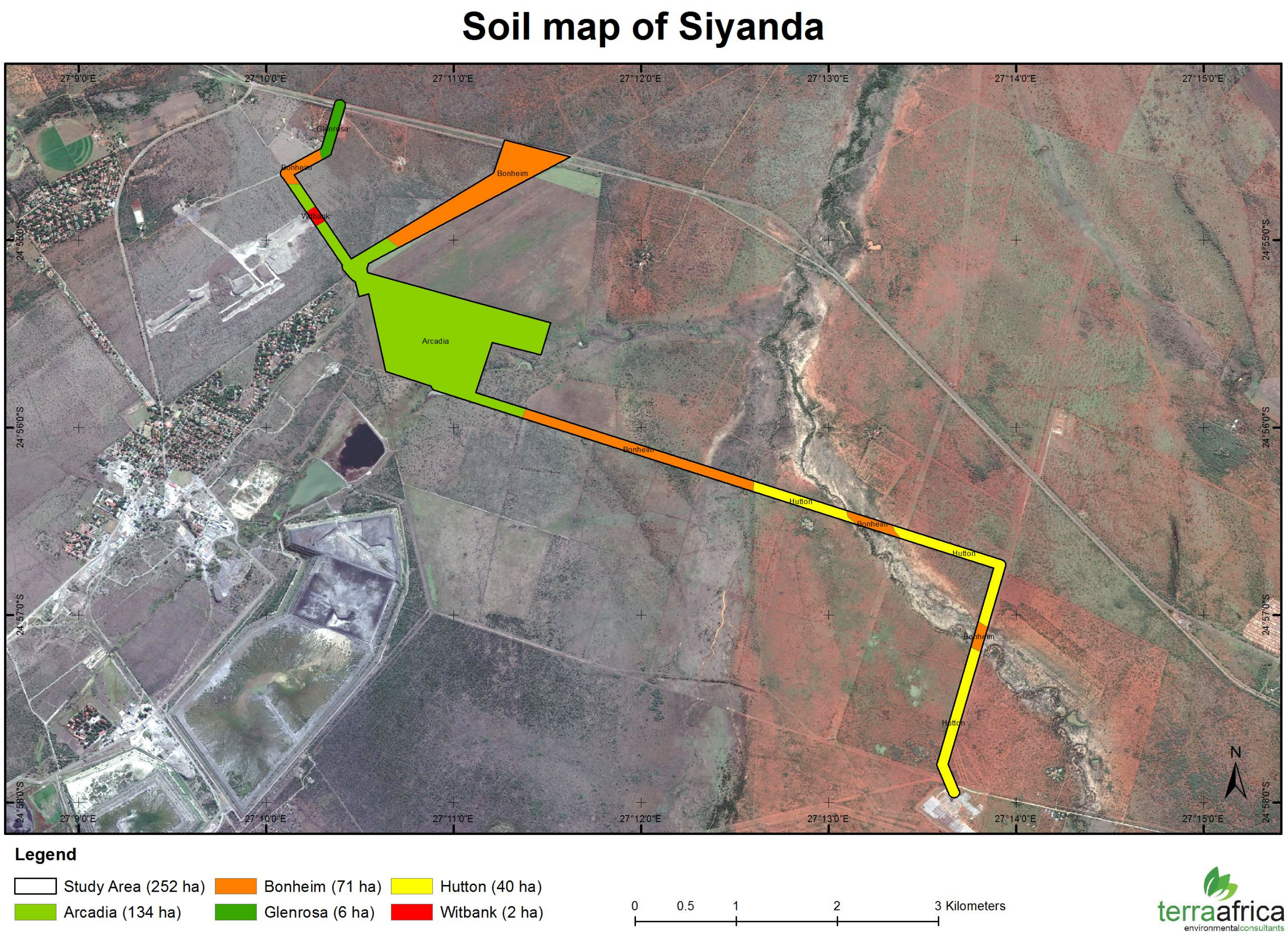



**Figure 3: Soil map of the Siyanda Ferrochrome Smelter Project**

## 9.3 *Agricultural potential*

### 9.3.1 Dryland crop production

The largest part of the study area is currently used for crop production however it is noted that cultivation within the project area forms part of a land use agreement between a land user and the previous landowner of portion 3 of Grootkuil. When Siyanda purchased the farm, this third party land use agreement lapsed. Soils of the Arcadia and Bonheim soil forms are suitable and highly suitable for crop production and the average annual rainfall of 570 mm is sufficient for successful maize production. The vertic Arcadia soil form is highly suitable for crops like cotton and sunflower, since the roots of these crops are not so sensitive to the swelling and shrinking movements within the soil.

### 9.3.2 Irrigated crop production

The Siyanda Ferrochrome Smelter study area did not have any current irrigation infrastructure that was being used for irrigation purposes. No large dams with irrigation potential have been observed on the study area. The Arcadia soil form identified on the study area has medium suitability for irrigated crop production since water management is of critical importance. These vertic soils alternate from being either too wet and sticky or too hard and dry to be cultivated. The Bonheim soil form is more suitable to irrigated crop production and although the establishment of irrigation infrastructure requires high initial capital investment, the site has potential for this production method should it ever become a future land use possibility.

### 9.3.3 Cattle farming

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 for the study area is 7 hectares per large animal unit or large stock unit. The proposed project area where infrastructure will be developed covers an area of approximately 135ha and can thus provide grazing for around 20 head of cattle or large stock units. These large stock units can further be converted to include small grazers and browsers such as Boer goats or antelope.

## *9.4 Land use and surrounding land use*

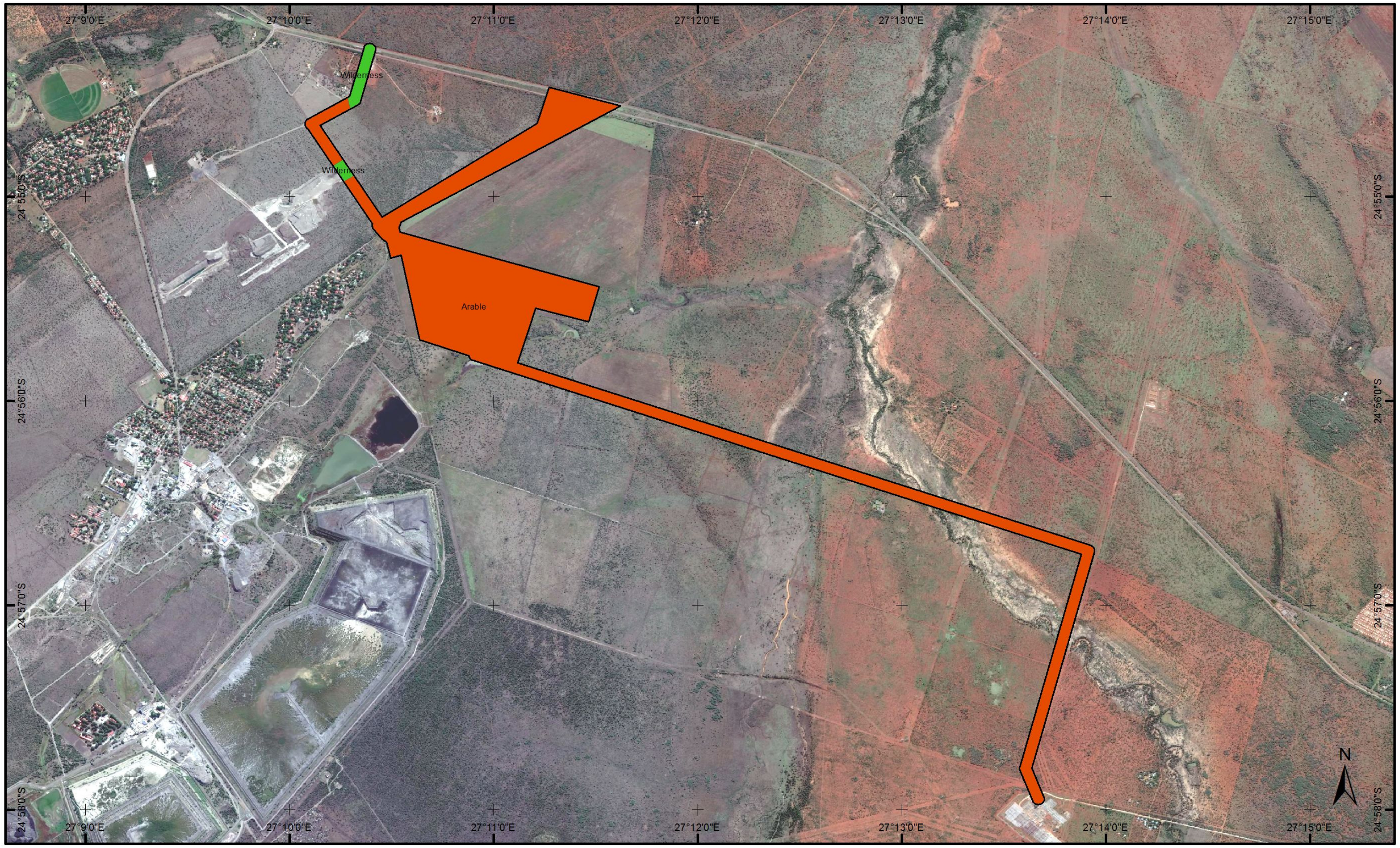
The entire study area and its immediate surrounds can be broadly defined as Waterberg Savannah which is an open tree savannah. The land use on the study area can be defined as crop production and a smaller part as livestock farming. The immediate surrounds can be broadly defined as livestock farming, game farming, eco-tourism and mining. There was evidence of cattle grazing on the subject property during the site visit. Extensive livestock ranching constitutes the largest percent of land use in Thabazimbi Local Municipality, contributing 49.6%, followed by game farming with 40%. Only 2% of the land is under irrigation and dry land crop production constitutes only 3% mainly because of erratic rainfall.

Cattle farming will be a viable post mining land use of the study area as long as the field quality is maintained by never exceeding the grazing capacity. Post-project land use should aim to re-establish the cattle farming potential of the land.

### 9.5 Land capability

Following the classification system above in Section 8.4, the soil and land types identified in the study area could all be classified into two land capability classes. Deeper soils of the Arcadia, Hutton and Bonheim soil forms have arable land capability which could also have been suitable for irrigated crop production should irrigation water be available. Because of difficulties in the agricultural management of the Arcadia soil form the land capability is also suitable to extensive grazing where the soil has year-round grazing potential but it is possible to be used for crop production. The area consisting of the Glenrosa soil form as well as the area already disturbed by construction activities (where the Witbank soil form occurs) have wilderness land capability. These areas are not currently suitable for grazing or arable crop production.

## Land capability map of Siyanda




**Legend**

- Study Area (252 ha)
- Arable land capability (245 ha)
- Wilderness land capability (7 ha)

0 0.5 1 2 3 Kilometers

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**Figure 4: Land capability map of the Siyanda Ferrochrome Smelter 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 |

| 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 smelter complex will comprise inter alia a railway siding, a raw materials offloading area, two 70 MW DC furnaces, crushing and screening plant, mineralized waste facility and related facilities such as material stockpiles, workshops, stores and various support infrastructure and services including power lines, roads and pipelines.

The construction phase facilities include:

- Contractor's laydown areas
- Workshops (instrumentation, electrical, mechanical, diesel)
- Stores for the storing and handling of fuel, lubricants, solvents, paints and construction materials
- Wash bay
- Laboratory
- Construction waste collection and storage facilities
- Store
- Parking area for cars and equipment
- Mobile site offices
- Portable ablution facilities
- Temporary electricity supply (diesel generators)
- Portable water supply (bowsers)
- Change houses and clinic
- Soil stockpiles
- Water management infrastructure
- Security and access control
- Main access road

Construction facilities will either be removed at the end of the construction phase or incorporated into the layout of the operational phase facilities.

The operational phase facilities include inter alia the following:

- Furnaces
- Crushing and screening plant
- Ingot cooling pad
- Service yard
- Operational store

- Instrumentation workshop
- Mechanical workshop
- Electrical workshop
- Diesel workshop
- Diesel, lubricants and propane gas storage
- Refractory and general store
- Laboratory
- Slag dump
- Baghouse slurry dam
- Substation
- Filter Yard
- Stormwater dam and associated stormwater management infrastructure
- Emergency fire water dam
- Change house
- Clinic
- HR/SHEQ office
- Main entrance/security
- Raw materials offloading area
- Railway siding
- Access road
- Internal roads
- Powerline
- Conveyors
- Pipelines
- Cooling water tank (and pumps)
- Topsoil stockpiles and berms
- Sewage treatment/containment facility (will be required on-site in the event that the Northam sewage treatment plant is not operational).

See layout **(Figure 5)**

## Layout map of Siyanda

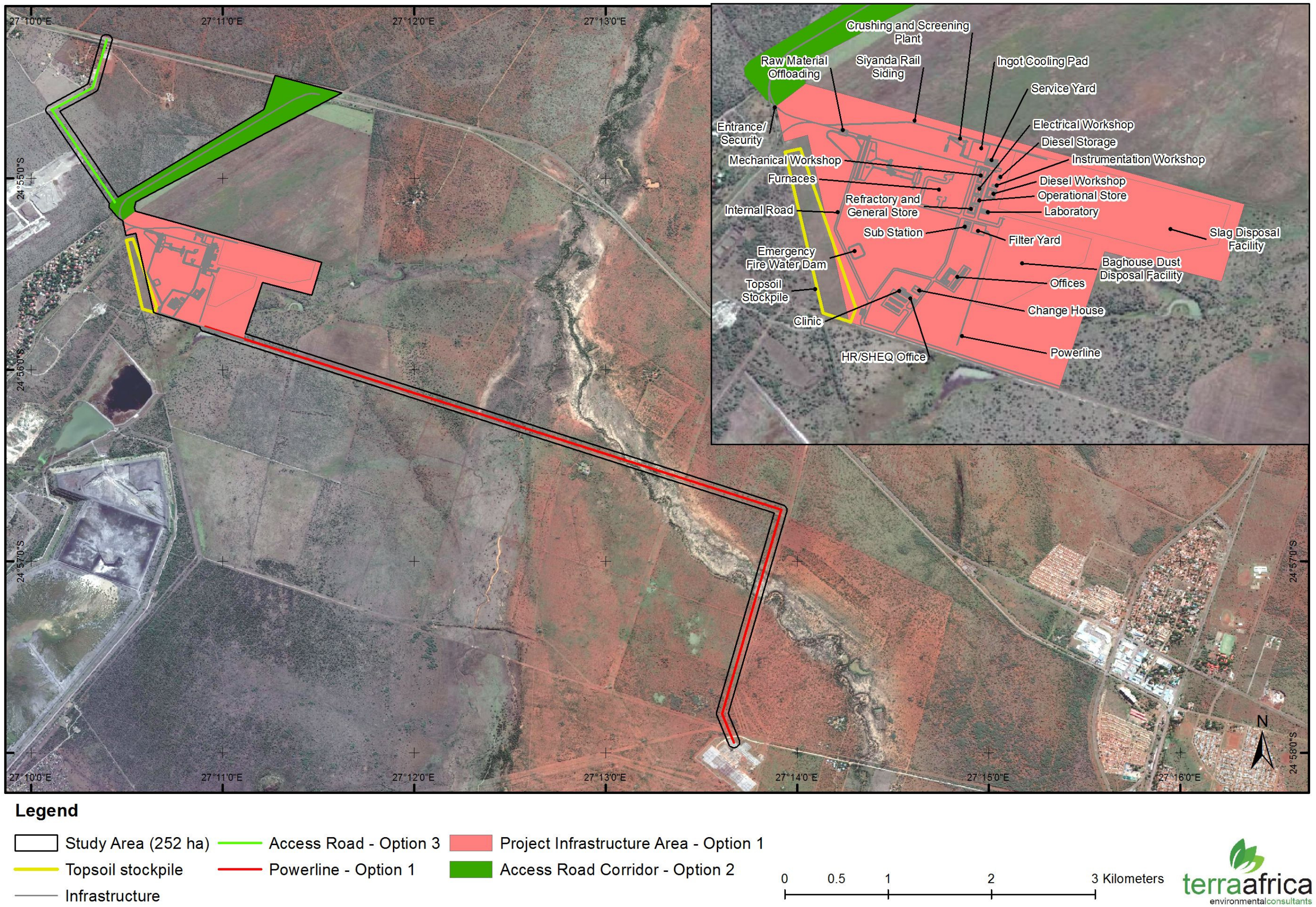


**Figure 5: Layout map of the Siyanda Ferrochrome Smelter Project**

## 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, the construction of buildings and infrastructure such 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 original soil profile distribution.

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

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

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

**Table 6: 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 7: 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 transport of the raw material as well as the daily management of the smelter and related activities. The main envisaged operational activities that will impact on soil, land use and land capability include the following:

- The furnaces and associated surface infrastructure will lead to surface impacts on soil resources. Surface infrastructure like material stockpiles and mineralized waste facilities 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 mineralized waste 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. 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 smelter operation activities will be lost temporarily. However, the land capability and land use of areas where infrastructure will be decommissioned can be restored through land rehabilitation techniques.

**Table 8: 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 9: 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 excavated areas 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 10: 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 11 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 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, with proper waste management and immediate clean-up, the significance of this impact can be reduced to low (**Soil Management Plan**).

Soil compaction will be a measurable deterioration that will occur as a result of the heavy vehicles. 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 operation activities and processing operations will have ceased by the closure phase of the smelter 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 Siyanda Ferrochrome Smelter 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 rehabilitation during the closure phase, the key factors to consider during the preparation for the construction phase of the smelter development are to minimise the area affected by the development, minimise potential future contact of toxic or polluting materials with the soil environment and to maximise the recovery and effective storage of soil material that will be most useful during the rehabilitation process after operation of the smelter 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 ferrochrome smelter development footprint

The conceptual smelter development layout and design (**Figure 5**) aims to minimise the area to be occupied by 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

The topsoil stockpile is located to the west of the project infrastructure where it will also serve as noise impact reducing measure as well as to mitigate air quality impacts. Topsoil stockpiles should not be located elsewhere than in this demarcated area.

### 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 development at all times, to avoid loss and contamination. As a norm, soil stripping should be kept within 3-9 months of development, or between 50-100 metres ahead of the active operations.

### 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 operations will last over several years it is important to have well defined maps of stockpile locations that correlate with these demarcated areas as re-vegetated stockpiles may easily be mistaken for something else. These areas should be maintained for rehabilitation purposes and topsoil should never be used as a filling material for ramps, etc.

### 11.1.7 Prevention of stockpile contamination

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

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

### *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 sumps and steering racks of vehicles and equipment should be contained using a drip tray with plastic sheeting filled with absorbent material;
- Using biodegradable hydraulic fluids, using lined sumps for collection of hydraulic fluids, recovering contaminated soils and treating them off-site, and securely storing dried waste mud by burying it in a purpose-built containment area;

- Avoiding waste disposal at the site wherever possible, by segregating, trucking out, and recycling waste;
- Containing potentially contaminating fluids and other wastes; and
- Cleaning up areas of spillage of potentially contaminating liquids and solids.

## *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 operation of the smelter continues and new areas are developed through operation activities.

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

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

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

- The vegetative (grass) cover on the soil stockpiles (berms) must be continually monitored in order to maintain a high basal cover. Such maintenance will limit soil erosion by both the mediums of water (runoff) and wind (dust).
- Drains and intercept drains must be maintained so that they continue to redirect clean water away from the operating areas, and to convey any potentially polluted water to 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 be released or spilled;
- Processing areas should be contained and systems designed to effectively manage and dispose of contained storm water, effluent and solids;
- Storage tanks of fuels, oils or other chemicals stored are above ground, preferably with inspectable bottoms, or with bases designed to minimise corrosion. Above-ground (rather than in-ground) piping systems should be provided. Containment bunds should be sealed to prevent spills contaminating the soil and groundwater;
- Equipment, and vehicle maintenance and washdown areas, are contained and appropriate means provided for treating and disposing of liquids and solids;
- Air pollution control systems avoid release of fines to the ground (such as dust from dust collectors or slurry from scrubbing systems);
- Solids and slurries are disposed of in a manner consistent with the nature of the material and avoids contamination; and
- Effluent and processing drainage systems avoid leakage to ground.

## 11.3 Soil management during the decommissioning phase

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

### 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 (sloped) in order to approximate the pre-project aspect and contours. The previous infrastructure footprint area must be ripped a number of times in order to reduce soil compaction.  The area must then be covered with topsoil material from the stockpiles.

### *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 loss through evapotranspiration.  Indigenous species will be used for the re-vegetation, the exact species will be chosen based on research available and then experience as the further areas are re-vegetated.

### *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 sumps of vehicles and equipment should be contained using a drip tray with plastic sheeting and filled with absorbent material;
- Using biodegradable hydraulic fluids, using lined sumps for collection of hydraulic fluids and recovering contaminated soils and treating them off-site;
- Avoiding waste disposal at the site wherever possible, by segregating, trucking out, and recycling waste;

- Containing potentially contaminating fluids and other wastes; and
- Cleaning up areas of spillage of potentially contaminating liquids and solids.

## 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 gullies have developed. In the event that vegetation has not re-established and erosion gullies have developed, remedial action should be taken.

# 12 Environmental Impact Statement

A large portion of the proposed project site is already cleared of natural vegetation by previous crop production activities. The land supports crop production and small areas with natural vegetation are suitable for cattle and game farming. The area where the proposed access road will be built is inside an existing game farm. The proposed development of the Siyanda Ferrochrome Smelter consisting of furnaces, new access road and haul roads, a railway siding and associated plant and infrastructure, will impact upon soil and land capability properties as well as current land uses 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 Siyanda Ferrochrome Smelter developments falls within a larger area of mining projects intermixed with annual crop production, livestock and game farming and settlement (Northam). The land capability and soil quality of land affected by the surface footprint of smelter operation activities will be compromised; the proposed operation area will impact on current crop production and will therefore affect primary grain production.

However, if soil management measures are followed as outlined in this report and the land be rehabilitated to the highest standard possible, livestock and game farming will be possible on rehabilitated land after the smelting activities have ceased. It is therefore 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.

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