SOIL, LAND USE AND LAND CAPABILITY REPORT FOR THE PROPOSED ALEXANDER PROJECT

For and on behalf of TerraAfrica Consult

Approved by: Mariné Pienaar

Position: Soil scientist

Date: 25 April 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 1:250,000 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.

Declaration of EAP

Details of practitioner

Report author: M Pienaar
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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
April 2016

CURRICULUM VITAE

A. Personal Details

Last name: **Pienaar**

First name: **Mariné**

Nationality: **South African**

Employment: **Self employed (Consultant)**

B. Contact Details

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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]

Table of Contents

List of Figures

1. Introduction

Synergistics Environmental Services (Synergistics), an SLR Group Company, 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 Environmental Authorisation of the proposed development of the Alexander Project with all supporting infrastructure.

The proposed mining right area includes several portions of the farms Aangewys 81 IS, Alexander 102 IS, Dorstfontein 71 IS, Kafferstad 79 IS, Onverwacht 70 IS, Rensburgshoop 74 IS, Witbank 80 IS, Witrand 103 IS as well as Caley 77 IS RE, Witbank 576 IS RE and Portion 2 of Elandsfontein 75 IS. The proposed overland Run of Mine (ROM) conveyer will pass over portions of the farms Elandsfontein 75 IS, Legdaar 78 IS, Rensburgshoop 74 IS, portion 3 of Middelkraal 50 IS, portion 2 of Schoonvlei 52 IS and Valkkuiken 76 IS RE. The project area is located directly adjacent to Kriel (south and south-east of Kriel) and approximately 12 km northwest of Bethal (**Figure 1**). The Project is located in the Emalahleni Local Municipality within the Nkangala District Municipality and the Govan Mbeki Local Municipality within the Gert Sibande District Municipality in the Mpumalanga Province of South Africa.

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 Alexander 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.

The baseline soil chemistry determined during this study will serve as a measure during future soil and land quality monitoring procedures.

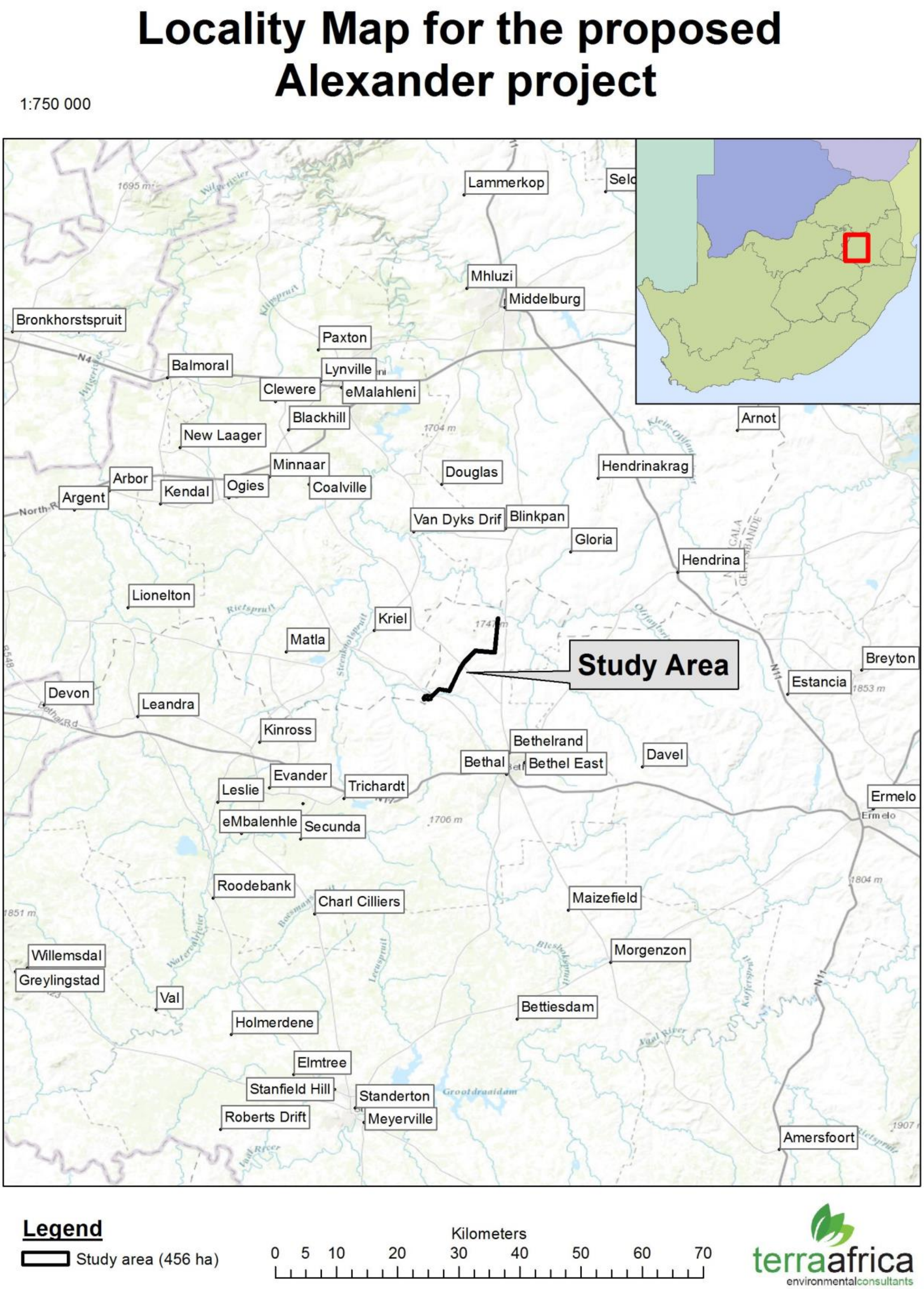

Figure 1: Locality map of the proposed Alexander Project

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 those activities.

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 1.1: 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 11 and 14
The date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 8.2, page 18

A description of the methodology adopted in preparing the report or carrying out the specialised process	Section 8, page 16
The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure	Sections 9 & 10, page 31
An identification of any areas to be avoided, including buffers	Section 9.5, page 29
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 34
A description of any assumptions made and any uncertainties or gaps in knowledge;	Sections 5 & 6, page 15
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 40
Any conditions for inclusion in the environmental authorisation	Section 11, page 40
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 11, page 40
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and	Section 13, page 48
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 48
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

4. Terms of reference

The following Terms of Reference as stipulated by Synergistics 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 Alexander 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;
- 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 proposed Alexander Project will comprise the following:

- an underground mine with an aerial extent of approximately 7 300 ha,
- a waste rock dump, topsoil stockpiles, mine related facilities such as workshops, stores and various support infrastructure and services which will cover an area of 120 ha.
- an overland conveyor to transport run-of-mine coal from the proposed Alexander incline shaft to the stockpile area at the Elders Colliery which will affect an area of 100 ha.

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.
- Access were denied to the largest part of the conveyor route and only broad soil description classes obtained from the Environmental Potential Atlas (ENPAT) of South Africa could be used to classify the soils of this area.

7. Response to concerns raised by I&APs

Mr Dirk Grobler raised a concern on behalf of the farmers about the overall impact of the Alexander Project on the maize farming industry.
The actual mine footprint around the shaft area where infrastructure will be erected (120 ha) and the conveyor with associated service road (100 ha) will directly affect these areas.
It is anticipated that the land capability of these areas will be reduced from arable (pre-mining) to grazing (post-mining) even with successful rehabilitation.

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 site 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.

Figure 2: Alexander Survey and Chemical Sampling Points Map

8.2 Site survey

A systematic soil survey was undertaken in April 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

Twelve soil samples (six topsoil samples and six subsoil samples) were collected at the subject property as follows: one topsoil and one subsoil at each sampling point. 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 H2O), 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.

9. Baseline conditions

9.1 *Soil forms present in the study area*

Ten different soil forms were identified within the study area (**Figure 3**). Below follows a description of each of these soil forms:

Avalon form (Av) (53.6 ha or 9.82 % of the total study area)

The Avalon soil form consists of an orthic A horizon (20 to 45 cm deep on study site) on a yellow-brown apedal B horizon overlying a red-mottled, soft plinthic B at a depth of 70 to 140 cm deep at different survey points on the study site. The yellow-brown apedal B horizon has structure that is weaker than moderate blocky or prismatic in the moist state.
Avalon soil has usually a loamy texture with moderate organic matter status and is well drained. It is usually acidic and extremely low in bases. Phosphate status is low and P sorption capacity is moderate to high. Dolomitic lime would be needed to achieve good crop yields and fertilizer containing Zn would also be advisable. The soil is highly suited to dry land crop production, subject to appropriate chemical amelioration.

Bloemdal soil form (Bd) (5.4 ha or 0.99 % of the total study area)

The Bloemdal soil form consists of an orthic A horizon overlying a red apedal B horizon that is underlain by unspecified material with signs of wetness. Red soil colours in both the moist and dry states dominate the colouration of this horizon. The depth of the orthic A horizons of the Bloemdal profiles surveyed on site was 35 cm and the restrictive layers of unspecified material with signs of wetness were found from 120 cm deep.

The oxides present in this soil form (it belongs to a larger group of oxidic soils) provide a micro-aggregating effect that reduces the dispersibility of fine particles and reduces erosion risk. This makes topsoil stripped from the Bloemdal soil form highly suitable for land rehabilitation purposes. Bloemdal soils with no restrictions shallower than 500mm are generally good for crop production.

Glencoe form (Gc) (51.2 ha or 9.38 % of the total study area)

The Glencoe soil form consists of an orthic A horizon, overlying a yellow brown apedal B horizon on a hard plinthic B. The Glencoe soil form differs from Avalon form only on the basis that the soft plinthic horizon of the Avalon form is replaced by a hard plinthic horizon. Glencoe soil has a moderately high degree of weathering, depletion of bases and no significant acidity, sandy loam structure and a morphology which indicates a fluctuating water table. Available phosphorous (P) is very low. The soil is suited to dryland crop production if the plinthic layer is deeper than 60 cm and appropriate fertilization is done. The depth of the hard plinthic horizon of the Glencoe soils surveyed on site ranges from 50 to 150 cm which makes it suitable for crop production. Only small patches have a depth of 40 cm and less.

Hutton form (Hu) (15.2 ha or 2.78 % 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. Some of the defining red soil colors identified on the sites are bleached (10R 3/6), while some are bright red. The clay content of Hutton soils identified is between 10% and 25%.

Soil depths of the Hutton profiles surveyed on site ranged between 130cm and 150cm and deeper with restrictive layers of unspecified material without signs of wetness. Hutton soils with no restrictions shallower than 50cm 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). These topsoils are ideal for stripping and stockpiling for rehabilitation purposes for they are deep and have a favourable structure.

Katspruit form (Ka) (22.5 ha or 4.12 % of the total study area)

The Katspruit soil form identified on the study site consists of an orthic A horizon overlying a non-calcareous G horizon and thus belonging to the Lammermoor family. The A horizon surveyed on site is non-calcareous and enriched with clay in the top 70 mm. It has a dark greyish-brown colour with medium faint grey mottles. The G horizon is saturated with water for long periods and is dominated by grey, low chroma matrix colours. This soil form is associated with wetland land capability and usually indicates the presence of seasonal or permanent wetlands.

<u>Lichtenburg form (Li</u>) (5.3 ha 0.79 % of the total study area)

The Lichtenburg soil form consists of an orthic A horizon on a red apedal B horizon overlying a hard plinthic horizon. The surface horizon is typically poorly structured and becomes easily degraded by cultivation. Low organic matter content and lack of iron oxides can lead to poor water infiltration and hard setting problems which call for judicious tillage and careful management of crop residues. The Lichtenburg soil form identified on site has a depth of 60cm overlying the hard plinthic horizon which makes the soil form suitable for summer crop production on the Highveld, because the upper solum drains freely while the plinthic horizon dams water within the lower part of the profile from where it can be tapped by crop roots during dry spells.

<u>Longlands form (Lo</u>) (38.8 ha or 7.1 % of the total study area)

The Longlands soil form consists of an orthic A horizon (15 cm to 30 cm on study site) overlying an E horizon that is underlain by a soft plinthic B horizon. A fluctuating water table has resulted in the accumulation of ferric oxides sufficient to form the soft plinthic B horizon in the lower part of what would otherwise have been a thick E horizon. Intermittent wetness may limit productivity in wetter seasons although in drier years the plinthic horizon could function as a reservoir for deep rooted crops. The soil on the Alexander Project study site belonging to the Longlands soil form has sufficient depth (60 cm to 150 cm) and will thus not present problems with rooting depth and periodic waterlogging for crops like maize. This soil form is therefore associated with arable land capability on the study site.

The Longlands soil form has a moderately high degree of weathering, depletion of bases and moderate acidity and a sandy loam texture. The soil needs lime and broad-spectrum fertilising for crop production but low buffer capacity will lead to rapid acidification if nitrogen is applied to generously. Groundwater vulnerability would be high in the case of pollution. Lateral discharge through the E and B horizons would result in the toe slope reception area being affected by a plume of polluted water.

Sterkspruit form (Ss) (14.1 ha or 2.58 % of the baseline study area):

The Sterkspruit soil form consists of an orthic A horizon overlying a prismacutanic B horizon. The clay content of the prismacutanic B horizon show an absolute increase of at least 20% higher clay content than the overlying layer. This horizon accommodates the classical concept of solodized solonetz B in which prismatic or columnar structure has developed under an abrupt transition and cutanic character (clay skins) is conspicuous. Certain chemical peculiarities, namely a high exchangeable sodium and/or magnesium percentage, are regularly associated with this morphology. The B horizon is commonly an impediment to root growth and water movement and duplex soils have thus a shallow effective depth. Because of the high erodibility of the topsoil which is caused by clay dispersion, it should best be used for grazing and natural vegetation be kept intact. When stockpiling during mining activities it should be kept in mind that the surface soil is prone to crusting and generally highly erodible.

Wasbank form (Wa) (16.1 ha or 2.95 % of the baseline study area):

The Wasbank soil form consists of an orthic A horizon on an E horizon overlying a hard plinthic B horizon. The E horizon is essentially a greyish horizon which is usually paler in colour than the overlying topsoil, is loose, friable and non-plastic in the moist state and has a very weakly developed structure. The genesis of this horizon has not been the same everywhere. In the case of the Wasbank soil form it lies abruptly on a B horizon which is considerably less permeable. Here a temporary build-up of water above the B horizon occurs after rain and discharge occurs in a predominantly lateral direction. This phenomenon can be very beneficial for crop production during drier seasons.

The profiles of the Wasbank soil form augered on site have depths of 40 cm to 80 cm before the hard plinthite horizon was reached. The suitability of the Wasbank soils on the study site ranges thus from marginally to highly suitable for crop production.

Westleigh form (We) (16.1 ha or 2.95 % of the baseline study area):

The Westleigh soil form consists of an orthic A horizon overlying a soft plinthic B horizon. The orthic A horizon on the study site has a depth of 25 cm and deeper. The soft plinthic horizon has clearly visible iron and manganese concretions. Accumulation of iron and frequently also manganese oxides and hydroxides, and localization in the form of high-chroma mottles and concretions is the predominating feature of this horizon. The formation of this horizon takes place in a zone of periodic saturation with water ,as in the case on the study site, between the limits of fluctuation of a water table.

As with all plinthic soils, the plinthic horizon should occur at sufficient depth beneath the orthic horizon or poor drainage will render the Westleigh soil form only marginal for the production of most crops, besides vegetables and pastures.

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 3.6 (extremely 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. Even under these low pH levels, Al toxicity may not prevail. The pH of the soil can be improved by the addition of dolomitic lime or gypsum. However, this process is costly and adds to production costs of crops.

Phosphorus levels are quite sufficient (ranging between 19 mg/kg and 114 mg/kg P in the topsoil, except in one of the samples). The clay plus silt content in the top 150 mm of the soil ranges between 20% and 44% in the majority of the topsoil samples taken. For crop production optimum extractable P levels in the soil according to Bray 1 are 25.1 mg/kg for soils with a clay plus silt content of 20% and 17.2 mg/kg P for soils with a clay plus silt content of 40%. 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 are 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 project site 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 site. 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 1.32% to 8.75% of the cations.

Figure 3: Soil map for the proposed Alexander Project areas

Table 2: Soil fertility analysis report

Lab No	Ref No	pH (KCl)	PBray1	K	Na	Ca	Mg	EA.KCl	%Ca	%Mg	%K	%Na	ACID SAT
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	cmol(c)/	%	%	%	%	%
70332	Alex 1 Top	3.60	114	190	14	360	60	1.31	43.48	11.79	11.71	1.50	31.52
70333	Alex 2 Sub	4.04	3	169	16	590	108	0.35	62.93	18.92	9.23	1.46	7.47
70334	Alex 3 Top	3.79	75	221	11	184	38	0.67	36.69	12.41	22.47	1.93	26.50
70335	Alex 4 Sub	4.97	1	81	13	721	68	0.00	81.39	12.63	4.65	1.32	0.00
70336	Alex 5 Top	5.46	2	163	199	1517	786	0.00	49.53	42.09	2.73	5.65	0.00
70337	Alex 6 Sub	6.52	1	234	575	2422	1631	0.00	42.37	46.79	2.10	8.75	0.00
70338	Alex 7 Top	4.36	19	348	16	363	107	0.44	44.34	21.37	21.74	1.71	10.85
70339	Alex 8 Sub	4.62	2	71	18	402	147	0.00	57.88	34.62	5.21	2.29	0.00
70340	Alex 9 Top	5.46	37	40	15	498	83	0.00	74.58	20.40	3.10	1.92	0.00
70341	Alex 10 Sub	4.19	1	39	14	426	126	0.12	61.91	30.02	2.91	1.73	3.43
70342	Alex 11 Top	6.27	43	126	21	1024	141	0.00	76.57	17.25	4.81	1.36	0.00
70343	Alex 12 Sub	4.51	1	28	21	318	80	0.00	66.01	27.29	2.97	3.73	0.00

Lab No	Ref No	Ca:Mg	(Ca+Mg)/K	Mg:K	S-Value	Na:K	T	Density	S AmAc	EC	Clay	Silt	Sand	C
		1.5-4.5	10.0-20.0	3.0-4.0	cmol(+)/kg		cmol(c)/kg	g/cm3	mg/kg	µS/m	%	%	%	%
70332	Alex 1 Top	3.69	4.72	1.01	2.84	0.13	4.14	1.19	15.10	106.6	19	6	75	0.15
70333	Alex 2 Sub	3.33	8.87	2.05	4.34	0.16	4.69	1.07	36.59	377.0	23	10	67	0.39
70334	Alex 3 Top	2.96	2.19	0.55	1.85	0.09	2.51	1.31	11.80	92.8	12	1	87	0.14
70335	Alex 4 Sub	6.45	20.20	2.71	4.43	0.28	4.43	1.15	18.20	108.0	27	5	68	0.27
70336	Alex 5 Top	1.18	33.61	15.44	15.31	2.07	15.31	1.26	20.95	338.0	33	11	56	0.16
70337	Alex 6 Sub	0.91	42.48	22.29	28.58	4.17	28.58	1.15	22.59	337.0	43	14	43	0.49
70338	Alex 7 Top	2.07	3.02	0.98	3.65	0.08	4.09	1.07	29.75	468.0	23	10	67	0.12
70339	Alex 8 Sub	1.67	17.74	6.64	3.48	0.44	3.48	1.07	60.70	160.4	25	14	61	0.54
70340	Alex 9 Top	3.66	30.62	6.58	3.34	0.62	3.34	1.24	7.89	58.5	19	1	80	0.29
70341	Alex 10 Sub	2.06	31.62	10.32	3.32	0.59	3.44	1.10	29.75	130.6	27	2	71	0.44
70342	Alex 11 Top	4.44	19.49	3.58	6.68	0.28	6.68	1.08	6.47	142.4	17	5	78	0.12
70343	Alex 12 Sub	2.42	31.42	9.19	2.41	1.26	2.41	1.45	13.54	85.5	15	3	82	0.44

9.2 Agricultural potential

9.3.1 Dryland crop production

The largest part of the study site is currently used for crop production. All the soil forms encountered at the study site are suitable and highly suitable for crop production with the exception of the Katspruit and Sterkspruit soil forms. The annual precipitation of 650 to 900 mm is sufficient for successful maize production. The plinthic soils such as Longlands, Avalon, Glencoe and Lichtenburg are prized by maize farmers on the Highveld because the plinthic layer dams water in the lower profile which can be used by maize roots during periods of drought.

9.3.2 Irrigated crop production

The Alexander 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 soil forms identified on the site have medium suitability for irrigated crop production as the presence of phreatic water in soil forms such as Avalon, Longlands, Westleigh and Glencoe may prove problematic during high rainfall years when dry land production methods will suffice. 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 around the study area is 5 to 6 hectares per large animal unit or large stock unit (LSU) according to Morgenthal *et al*. (2004) in a report to the Institute for Soil, Climate and Water of the ARC. Areas where the wetland soils are dominant (Katspruit soil form) and highly erodible duplex soils (Sterkspruit soil form) are more suitable for cattle farming than crop production.

Cattle farming is a viable long-term land use of certain parts of the site as long as the field quality is maintained by never exceeding the grazing capacity. Land use after decommissioning of the Alexander Project should aim to re-establish the cattle farming potential of the land.

9.4 Land use and surrounding land use

The entire subject property and its immediate surrounds can be broadly defined as Eastern Highveld Grassland. The land use on the study area can be defined as crop production and a smaller part (along the conveyor) as livestock farming. Some 44% of the Eastern Highveld Grassland in which the study area falls is transformed primarily by cultivation, plantations, mines, urbanization and by building of dams. Cultivation may have had a more extensive impact, indicated by land-cover data.

Cattle farming will be a viable post mining 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.

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 three land capability classes. Deeper soils of the Bloemdal, Glencoe, Hutton, Lichtenburg, Longlands, Wasbank and Westleigh soil forms have arable land capability which could also have been suitable for irrigated crop production should irrigation water be available. Because of the high erodibility of the Sterkspruit soil form the land capability is more suitable to extensive grazing, while the Katspruit soil form has wetland land capability.

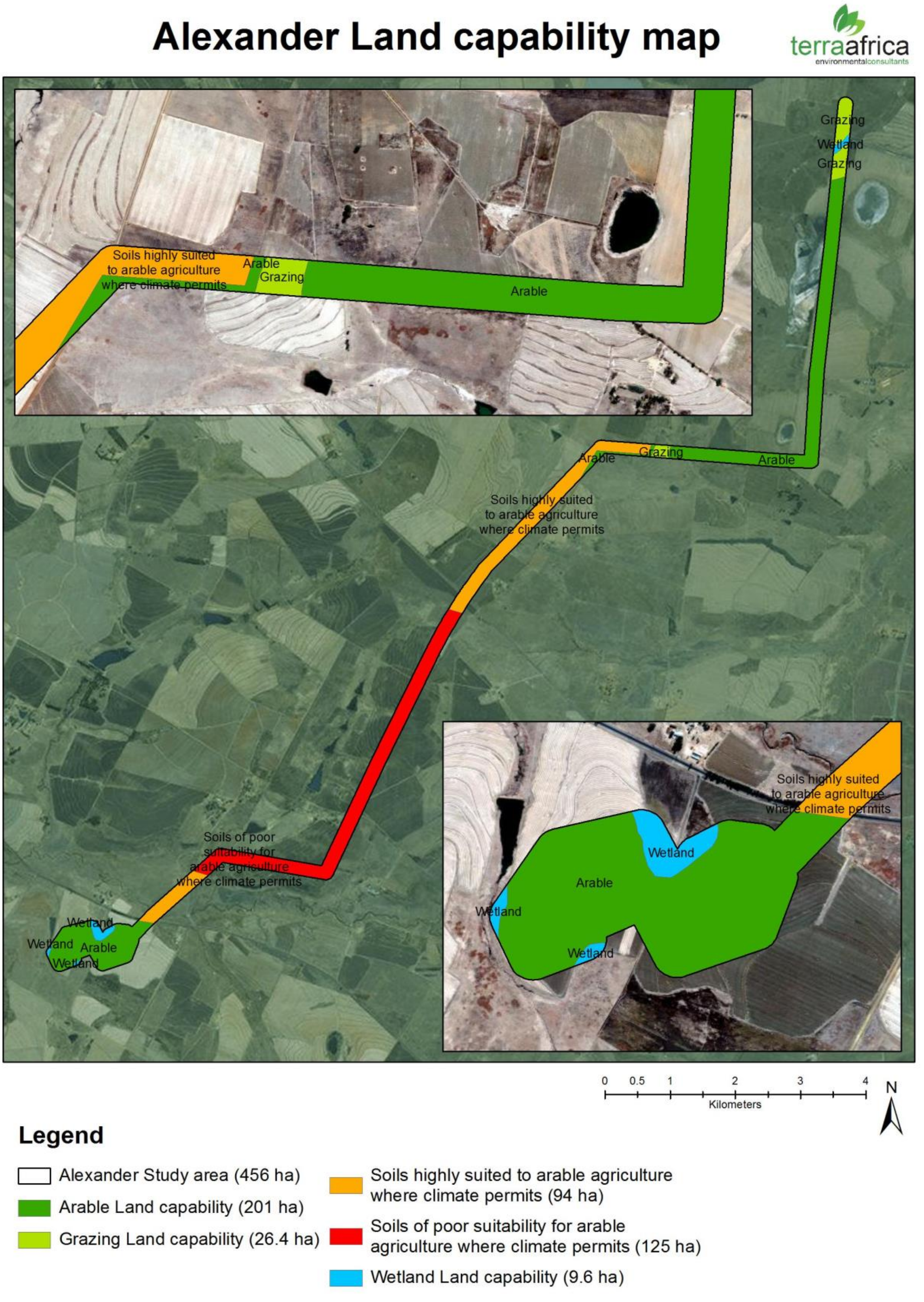

Figure 4: Land capability map of the proposed Alexander Project

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 area assessed during the site visit can be divided into an area of direct impact and indirect impact. The area of direct impact is the entire area where the footprint of the proposed mining infrastructure will disturb the current land use and surface activities. The indirect area of impact falls just outside of this and is considered as a buffer zone. No direct impacts are expected in this region but uncontrolled and unmanaged impacts may migrate out of the direct zone of impact into this area.

The following Construction Phase activities are expected at the proposed Alexander Project namely clearing of vegetation, stripping and stockpiling of soil resources, sourcing of construction material, establishment of storm water management facilities, establishment of water treatment plant and sewage treatment plant and building of an administrative block. Other construction activities include the installation of water tanks, construction of the overland conveyor and associated gravel service road which includes an underpass below the R545.

The main access road to the site will be through the upgraded and tarred gravel road that will link through a new intersection to the R545 provincial road. Other internal roads at the shaft complex will be gravel roads. A parking area and access control facilities will also be established.

Earthworks will include the excavation of the shaft, the formation of soil and overburden rock stockpiles and borrow pits.
Other infrastructure like mobile site offices and portable ablution facilities, waste collection and storage areas, store for hazardous material, pipelines and other essential infrastructure needed for the operation of the mine will be established.
See layout (**Figure 5**).

Figure 5: Layout map of the proposed Alexander 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 roads. 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 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 done as 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 of the main access road, the current land capability and land use will be lost permanently.

Table 3: 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 4: 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 workers, fuel, etc. as well as the daily management of the mine, conveyor and related activities. The main envisaged operational activities that will impact on soil, land use and land capability include the following:

- The shaft complex and associated surface infrastructure will lead to surface impacts on soil resources. Surface infrastructure like topsoil stockpiles and mineralized waste facilities (overburden stockpiles) 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. Dust and spillages from the overland conveyor can cause soil pollution 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 and overburden 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 mining 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 5: 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 6: 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 7: 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 8 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 mining activities and transporting operations will have ceased by the closure phase of the Alexander 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 Alexander 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 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 mine is completed. Some of these measures will minimise a combination of impacts simultaneously while other measures are specific to one impact.

11.1.1 Minimise Alexander Coal Mine's development footprint

The existing pre-construction shaft complex layout and design (**Figure 5**) is aiming to minimise the area to be occupied by infrastructure (workshops, administration, water treatment 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.

During construction of the conveyor and service road use should be made of existing routes to construction areas where possible. Approved vehicle turning areas should be constructed in areas that are not ecologically sensitive or prone to be easily compacted like wetland areas. Construction staff should only use authorised paths and roads. If two-way traffic movement is to take place, demarcated passing bays are to be used to prevent detours into the surrounding areas.

11.1.3 Location of stockpiles

Locate all topsoil 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 during shaft excavation 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 development of the shaft complex, conveyor and roads 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 should be benched since the clay content is not sufficient in the topsoil of the soil forms on the Alexander Project site for stockpiles to remain 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 coal dust from product stockpile and the pumping out of contaminated water from the underground mine 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, service 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 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, 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 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 layout of the operation. 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 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 it continues to redirect clean water away from the operating plants, and to convey any potentially polluted water to 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;
- Dirty water generating 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 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 shaft cavity will be completely 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 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 crop production activities. The land supports crop production and small areas with natural vegetation are suitable for cattle and small stock farming. The proposed development of the Alexander Project will consist of an underground mine with an aerial extent of approximately 7 300 ha, the shaft complex consisting of a waste rock dump, topsoil stockpiles, mine related facilities such as workshops, stores and various support infrastructure and services which will cover an area of 120 ha and an overland conveyor to transport run-of-mine coal from the proposed Alexander incline shaft to the stockpile area at the Elders Colliery which will affect an area of 100 ha.

The proposed project 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 Alexander Project developments falls within a larger area of mining projects intermixed with annual crop production, livestock farming and settlement (Kriel and Bethal). The land capability and soil quality of land affected by the surface footprint of mining 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 farming will be possible on rehabilitated land after the mining 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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