SOIL, LAND USE AND LAND CAPABILITY REPORT FOR THE PROPOSED TSHIPI BORWA WASTE ROCK DUMP EXTENSION PROJECT

For and on behalf of Terra Africa Consult Approved by: Mariné Pienaar Position: Soil scientist Date: 12 June 2018

terraafrica
environmentalconsultants

DEFINITIONS AND ACRONYMS

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

Calcareous: Containing calcium carbonate or magnesium carbonate.

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.

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.

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.

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.

Declaration of EAP

Details of practitioner

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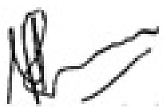
Declaration of Independence

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
June 2018

Executive Summary

TerraAfrica Consult cc was appointed by SLR Consulting (Africa) Pty Ltd to conduct the soil, land use and land capability study for the proposed Tshipi Borwa Waste Rock Dump Extension Project at the Tshipi Borwa Mine. The project includes for extension of the East Waste Rock Dump (WRD) as well as the construction of a new West WRD area, construction of a powerline and a conveyor route (further referred to as the study area). The objectives of the study are to determine the baseline soil properties and associated land capabilities in order to estimate and describe the anticipated impacts of the project on these components of the receiving environment.

The site survey of the West WRD area was conducted on 18 October 2017 as this was initially the only area to be included in the project. Four soil samples were collected from this area and submitted to Eco Analytica soil laboratory for chemical and textural analysis. As the project description changed, the additional areas were incorporated by means of a desktop study that included the use of aerial photography and land type data as soils in the region of the study area are extremely homogeneous. The report author has extensive soil survey experience in the study region (Hotazel and larger Kalahari area) and is familiar with the homogeneity of the soil. Land capability classification was done using the system developed by the South African Chamber of Mines.

The baseline study results showed that there are two main soil groups i.e. soil forms where the original soil profiles are present and undisturbed and areas already impacted upon by mining (within the mining right area). The in situ soil group consist of deep, structureless oxidic soil of very sandy texture. The only differentiation in this area is the soil colour (the red soil profiles are classified as Hutton and the yellow soil profiles as Clovelly). This colour differentiation has no impact on current land use or on the impact assessment of the proposed project and therefore the soil forms have been grouped together. The second type was the anthropogenically affected soils where differentiation was made between the Witbank form (physical altered by removal or covering of the surface) and Industria form (affected by the impacts of chemical pollution caused by opencast mining and processing). The Witbank form was delineated for areas with topsoil stockpiles, surfaced and haul roads and the Industria forms for areas of active mining and processing. The accuracy of this delineation may be improved with another site visit but the current delineation is deemed sufficient for the purpose of this study.

The soil forms support natural veld vegetation typical of the area with a grazing capacity of 21 – 30 hectares per Large Stock Unit (LSU) or head of cattle for undisturbed land. Although there are areas suitable for grazing within the mining rights area, it is not currently being grazed by cattle. Therefore, the proposed project will mainly result in the loss of potential grazing land in the West WRD area (suitable for grazing by four to seven head of cattle). Although the physical and chemical properties of the in situ profiles may have been suitable for arable agriculture, the low and erratic rainfall of the area makes this area unsuitable for dryland production. It could have been suitable for irrigated agriculture in the presence of a stable supply of good quality irrigation water and irrigation infrastructure.

The main and most significant impacts of the proposed project will occur during the construction phase. During this phase, topsoil will be stripped from the areas where the infrastructure will be

constructed (powerline, conveyor route and WRD areas) which results in horizon inversion and loss of topsoil fertility. Together with soil compaction, these are definite impacts that have limited mitigation measures (limiting the areas of impact is the main mitigation measure). While successful mine rehabilitation may result in revegetation of affected areas, soil horizons are never returned to their original positions and deep soil compaction is difficult to alleviate. Soil erosion and soil chemical pollution are other potential impacts on soil but these can both be prevented or successfully mitigated when implementing the Soil Management Plan diligently. Soil erosion and chemical pollution remains a risk through the operational phase and during the decommissioning phase but once the site has been successfully revegetated and vehicles and equipment are removed, these impacts become negligible. The most significant impact on land use and land capability also occur during this phase when the land use is changed from natural veld suitable for grazing to mining. This impact continues through the operational phase and is only mitigated or partially mitigated once the land has been rehabilitated.

It is the professional opinion of the report author that the activity may be allowed permitting that strict soil management measures and proper mine rehabilitation plans be implemented.

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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 extension of the Waste Rock Dump (WRD) of the Tshipi Borwa Mine. The proposed Tshipi Borwa Waste Rock Dump Extension Project (from here on referred to as “the Project”) will consist of the following key components:

- The extension of the existing East Waste Rock Dump (WRD) to the mining right boundary and towards the Mamatwan WRD and eventually filling the void between these dumps, to provide additional overburden storage capacity;
- The extension of the existing West WRD onto the remaining extent of Portion 8 of the farm Mamatwan 331, thereby including the remaining extent of Portion 8 into the mine’s surface use area;
- The erection of an 11kV overhead powerline and associated sub-station along the Portion 8 boundary onto the existing mining right area; and
- The construction of an overland conveyor system from the existing secondary crushing and screening plant to the existing manganese ore product stockpiles.

The proposed project is located near Hotazel on the remaining extent of portion 8 of the farm Mamatwan 331, portion 16 (previously a portion of portion 1) of the farm Mamatwan 331, portion 17 (previously a portion of portion 2) of the farm Mamatwan 331, portion 18 (previously a portion of portion 3) of the farm Mamatwan 331 and the remaining extent of the farm Moab 700. This land parcel is located in the Joe Morolong Local Municipality within the John Taolo Gaetsewe District Municipality in the Northern Cape Province of South Africa (Figure 1).

The purpose of the study is to describe the baseline soil properties, land capabilities and land uses associated with it within the project’s direct and indirect areas of influence, determine the impacts of the proposed project on these properties and then develop mitigation and management measures.

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 ii and Appendix 1
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix 1
A declaration that the person is independent in a form as may be specified	Page iii

A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	Relevant section in report
by the competent authority	
An indication of the scope of, and the purpose for which, the report was prepared	Pages 12
An indication of the quality and age of base data used for the specialist report;	Section 8, page 15
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 10, page 30
The duration, 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 inclusive of equipment and modelling used	Section 8, page 16 - 18
Details of an assessment of the specific identified sensitivities of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Sections 9 & 10, page 20
An identification of any areas to be avoided, including buffers	Evaluated but no areas to be avoided present
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;	Figures 7 and 8
A description of any assumptions made and any uncertainties or gaps in knowledge;	Sections 5 & 6, page 15 & 16
A specialist report prepared in terms of the Environmental Impact Regulations of 2014 must contain:	**Relevant section in report**
A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	Section 9, page 20
Any mitigation measures for inclusion in the EMPr	Section 11, page 30
Any conditions for inclusion in the environmental authorisation	Section 11, page 30
Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 11, page 30
A reasoned opinion as to whether the proposed activity, activities or portions thereof should be authorised	Section 13, page 36
Regarding the acceptability of the proposed activity or activities; and	Section 13, page 36
If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 13, page 36
A description of any consultation process that was undertaken during the course of carrying out the study	No comments have been received to date
A summary and copies if any comments that were received during any consultation process	Section 7, page 13

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 regarding the assessment and management of these natural resource aspects (stipulated in Section 3 below). The key components of assessment are to determine and describe the baseline soil properties and the land capabilities and land uses associated with it within the direct and indirect areas of the Project. The assessment is done through a combination of on-site investigations and a desktop data of existing soil data of the larger area. It also assists with the identification of gaps in information. Once these conditions were established, the anticipated impacts of the project on these properties were determined. Mitigation and management measures are recommended to minimise negative impacts and maximise land rehabilitation success towards successful closure at the end of the mine's life.

3. Delineation of the study area

For the purpose of soil mapping, the study area was delineated as the existing mining right area within which the proposed East WRD extension will located as well as the proposed West WRD area for which the site survey was conducted initially. That is the area considered to be the direct area of influence. Soil and land capability impacts are mostly localised.

4. Environmental legislation applicable to study

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

- Soils and land capability are protected under the National Environmental Management Act 107 of 1998, the Minerals and Petroleum Resources Development 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 utilization of marshes, water sponges and watercourses are also addressed.
- Government Notice R983 of 4 December 2014, as amended. The purpose of this Notice is to identify activities that would require environmental authorisation prior to commencement of that activity.

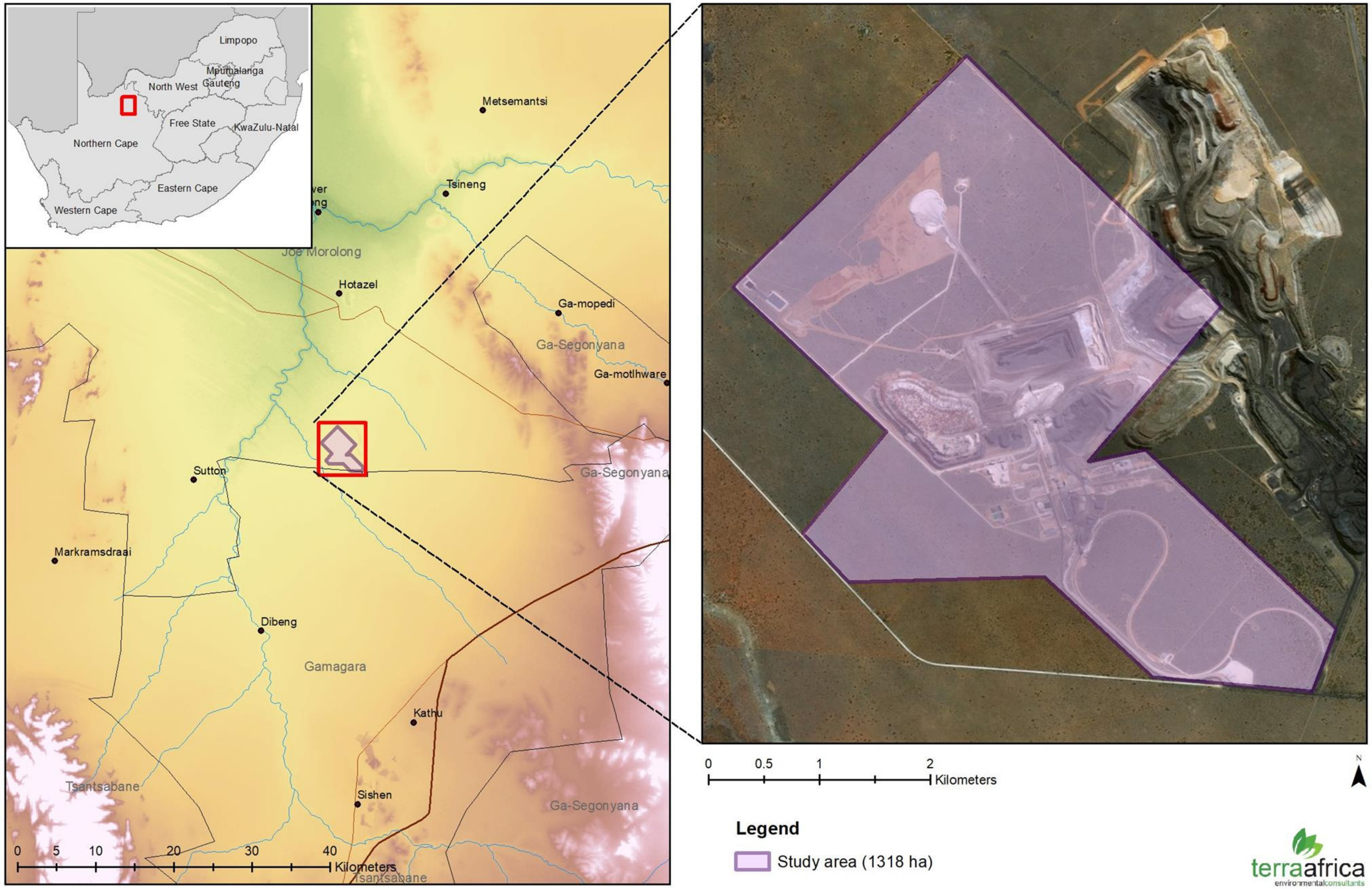

Figure 1: Locality map of the Tshipi Borwa Waste Rock Dump Extension Project

5. Terms of reference

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

- Undertake a desktop study to establish broad baseline soil conditions, land capability and areas of environmental sensitivity in the 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 associated with the construction, operation, decommissioning and post closure phases of the proposed infrastucture;
- Identify and describe potential cumulative soil, agricultural potential and land capability impacts resulting from the extension of the WRD as well as the construction of the overhead powerline and associated sub-station to the Tshipi Borwa Mine; and
- Recommend mitigation measures to minimise impacts and/or optimise benefits associated with the proposed project.

6. Assumptions

The delineation of the Wtibank and Industria soil forms were done using aerial photography analysis as these areas have been added after the initial site visit was conducted. The differentiation between the Witbank and Industria forms were based on the mining infrastructure layout as was visible on Google Earth. The current mining footprint may differ slightly from what was visible on Google Earth.

7. Uncertainties, limitations and gaps

No uncertainties, limitations and gaps exist in the study and study methodology.

8. Response to concerns raised by I&APs

Thus far, no concerns were raised by I & APs during the Public Participation Process pertaining to the continuation of existing land uses in the surrounding area. As soon as comment is received, it will be addressed in this report while still in the review process.

9. Methodology

9.1 Desktop study and literature review

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

- The report compiled by D.G. Patterson from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC) on the initial pre-mining soil properties (Report No GW/A/2008/68);
- 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. The aerial photography analysis was used to determine areas of existing impact, land uses within the project area as well as the larger landscape, wetland areas and preferential flow paths.

9.2 Study area survey

A systematic soil survey was undertaken with survey points between 100 and 150m apart in the proposed West WRD 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. After the site survey was conducted and initial maps compiled, the updated Soil Classification System for South Africa was released (Soil Classification Working Group, 2018). The maps were updated accordingly as this new system focuses on differentiating between different anthropogenic impacts on soil properties. It was not deemed necessary to conduct another site visit for the additional infrastructure that was added to the project (East WRD, powerline and conveyor route). The reason for this was that the site survey revealed that soil in the study area is extremely homogeneous and that interpretation of high level soil classification data such as the land type data, was considered sufficient (also see Section 9.4).

9.3 Analysis of samples at soil laboratory

Four soil samples (two topsoil samples and two subsoil samples) were collected in the proposed West WRD extension area as follows: one topsoil and one subsoil at each sampling point. All sampling and survey points are indicated in **Figure 3**. Soil samples were sealed in soil sampling plastic bags and sent to Eco Analytica Laboratory (part of North West University) in Potchefstroom 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).

9.4 Soil classification of new project areas using land type data and aerial photography

Land type data for the Project area was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC) (Land Type Survey Staff, 1972 – 2006). This data was used to confirm the homogeneity of the project area. Land type data divides the landscape into units where the likelihood of finding a number of soil forms within a typical terrain profile is provided together with the underlying geology of the terrain unit. The soil data provided in these data sheets were classified according to the Binomial System (MacVicar et al., 1977). The soil data was interpreted and re-classified according to the Taxonomic System (MacVicar, C.N. et al. 1991).

In addition to this, aerial photography available on Google Earth was used to delineate areas already affected by the mining activities within the Project area as the properties in situ soil forms here have been altered through anthropogenic activities, thereby creating a new soil form.

9.5 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.

Table 2: 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.

9.6 Calculation of maximum stockpile height

The Wischmeier, Johnson and Cross (1971) nomograph was used to determine the maximum slope at which topsoil can be stockpiled in order to prevent erosion (**Figure 2**). This nomograph was developed using five parameters that have significant impact on the erodibility of soil. The five parameters are:

- The mass percentage of the fraction between 0.1 and 0.002 mm (very fine sand plus silt) of the topsoil.
- The mass percentage of the fraction between 0.1 and 2.0 mm diameter of the topsoil.
- Organic matter content of the topsoil. This "content" is obtained by multiplying the organic carbon content (as determined with the Walkley-Black methodology described above) by a factor of 1.724.
- A numerical index of soil structure.
- A numerical index of the soil permeability of the soil profile. The least permeable horizon is regarded as horizon that governs permeability.

These parameters are used to establish the K-value of the specific soil's erodibility on the nomograph. The erosion risk is based on the product of the slope (in percentage) and the K-value of erodibility. This product should not surpass a value of 2.0 in which case soil erosion becomes a major concern.

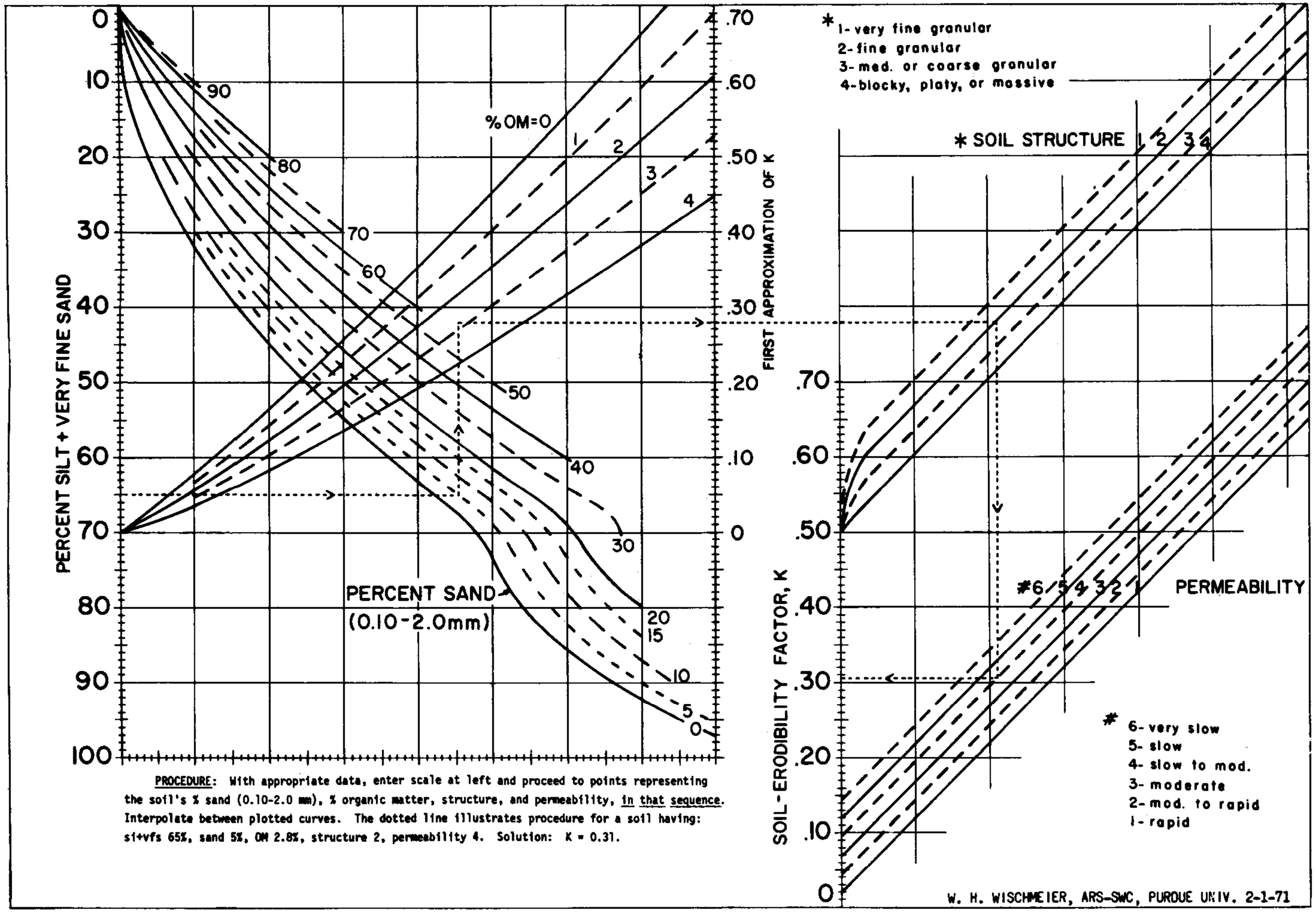

Figure 2: Erosion nomograph (developed by Wischmeier, Johnson and Cross, 1971)

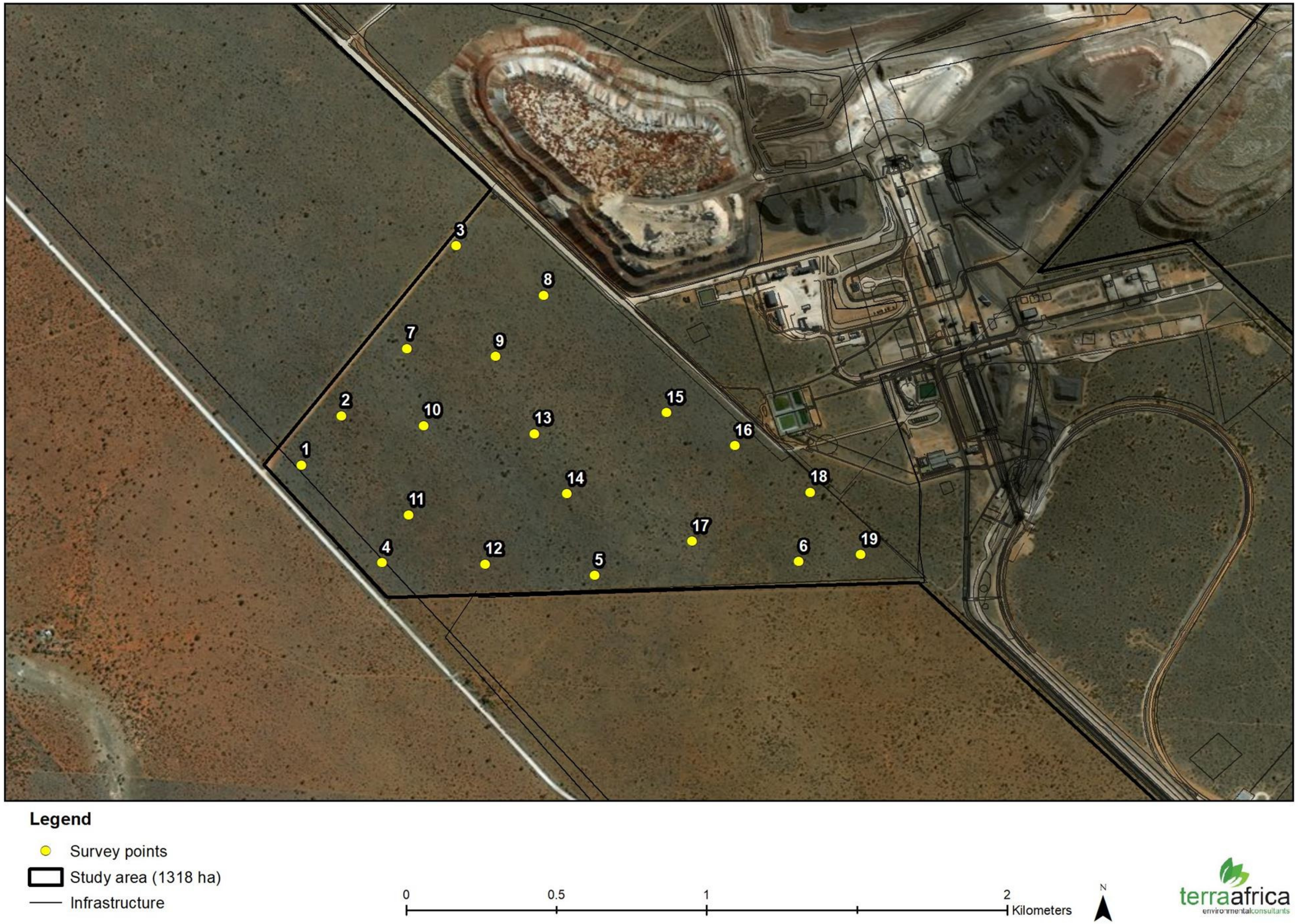

Figure 3: Locality of the survey points observed during the site survey

10. Baseline conditions

10.1 Land type

The entire study area consists of land type Ah9. The landscape is flat to very slightly undulating with slopes ranging between 0 and 3%. The soil formed from Aeolian sand of Recent age and the riverbeds in the larger area around the Project area formed on outcrops of Tertiary Kalahari beds (in most cases limestone layers can be seen where it has been exposed through sediment transport by water and wind). The texture of soil in this land type is dominated by sand with the clay fraction estimated as always less than 10%. Deep Hutton and Clovelly soil forms (deeper than 120cm) constitutes the largest portion of this land type with very limited possibility for finding shallow, rocky soils of the Mispah and Glenrosa forms over the entire land type area (an estimated 3.5%).

The homogeneity of soil properties in the Project area as well as the larger surrounding area was also confirmed by the description provided in the Soil Information for Proposed Mining Operation for Ntsimbintle Mining, near Hotazel (Paterson, D.G., 2008). In addition to this, the report author has extensive soil classification experience in the Hotazel area and larger Kalahari region and is familiar with the little differentiation there is in soil properties over large areas.

10.2 Soil classification

10.2.1 In situ soil forms

In situ soil forms refer to those where horizon organisation has not been disturbed by human activities. These soil forms have been the result of pedogenic processes over thousands of years and reflect the impact of a number of weathering processes (including climate) on the underlying geology. At the proposed project site, only one group of in situ soil forms were identified.

10.2.1.1 Hutton/Clovelly

The Hutton and Clovelly soil forms consist of an orthic A horizon on either a red apedal B (Hutton) or yellow-brown apedal (Clovelly) horizon overlying unspecified material. The range of red and yellow-brown colours that are a key identification tool in differentiating between a red apedal and yellow-brown apedal is defined by the Soil Classification Working Group Book (1991).

In the area surveyed during the site visit (West WRD extension), the defining red soil colours identified are highly bleached (5YR 5/8), thus borderline red. In situ soil profiles in the other project areas most likely also exhibit these borderline colour ranges which can either classify it as red or yellow-brown. The colour differentiation has no significance to the proposed project as all other properties are similar and it will not affect soil management and mitigation measures such as topsoil stripping guidelines. Soil texture is dominated by the sand fraction and all the samples analysed indicated a sand fraction of 96.9%.

Soil depths of the Hutton profiles surveyed on site are all beyond 150cm without signs of wetness. Hutton and Clovelly soils with no restrictions shallower than 50cm are generally good for crop production (Fey, 2010) permitting that the climate is suitable for crop production, especially rainfall in the absence of the availability of irrigation water. In the Kalahari region where the proposed project site is situated, the Hutton and Clovelly soil forms are preferred by *Vachellia erioloba* (camel thorn) as it allows the tap root of these trees to grow deeply in search of water stored below the surface.

Soil of the Hutton and Clovelly forms is highly suitable for stripping and stockpiling for rehabilitation purposes for they are deep and apedal (structureless). In addition, there is no horizon differentiation within the sub-surface horizons down to the level of refusal (hardpan and soft carbonate horizons at the proposed project site). The lack of differentiation indicates that there are no complex pedohydrological systems of water storage depending on the arrangement of soil horizons and therefore soil physical properties may be restored to a large extent with the proposed soil management and land rehabilitation measures.

Table 3: Texture analysis results of in situ soil profiles (Hutton form) in the Project area

Sample no.	> 2mm	Sand	Silt	Clay
	(%)	(% < 2mm)		
1	0,2	96,9	1,9	1,3
2	0,0	96,9	1,8	1,3
3	0,1	96,9	1,9	1,3
4	0,0	96,9	1,8	1,3

10.2.2 Anthropogenic soil forms

Whereas the previous soil classification system (Soil Classification Working Group, 1991) only had one anthropogenic soil form (Witbank), the updated system now differentiates between the severity and nature of the impact of human activities on soil forms. The definition provided for anthropogenic soils state that it is soil that have undergone physical, chemical and hydrological impacts to the extent that “land use options, as well as performance of vegetation that they support, are strongly and often permanently affected” (Soil Classification Working Group, 2018). The areas already impacted upon by the activities of the Tshipi Borwa Mine falls within the Technosols group with distinction made between those only physically affected through transport (topsoil stockpiles) and those where soil chemical pollution is most likely (active mining and processing areas).

10.2.2.1 Witbank

Through delineation using aerial photography, areas where soil has been transported as part of the topsoil stripping and stockpiling activities as well as existing roads and haul roads have been identified and delineated. Following the Soil Classification Working Group (2018), these areas be classified as the Witbank form. This form can be subdivided into a number of soil families that includes for ex-natural soils covering natural soils (topsoil stockpiles covering the in situ soil profiles in areas that were previously natural veld) and anthropogenic materials covering undisturbed natural soils and anthropogenic materials (in the cause of haul roads and surfaced roads, permitting that there is no soil chemical pollution).

10.2.2.2 Industria

This new soil form was identified in areas where active mining and processing is ongoing. Due to the fact that it is open cast mining (usually associated with adding pollutants, especially heavy metals to the environment), the areas of the open pits and associated infrastructure, has been classified as Industria. As it is outside of the scope of this report to determine current levels of possible pollutants present, the classification of these areas are not hinting at any current soil health risk but just serves to indicate that these areas are most likely to have a different chemical composition than topsoil that are stockpiled in other areas.

10.3 Soil chemical properties

The pH levels of soil in the study area ranges between 4.74 (strongly acid) and 6.21 (slightly acid). The soil pH levels do not pose a risk to plant growth and will not inhibit rehabilitation success. The phosphorus levels are as low as expected for natural veld conditions in South Africa. At lower pH levels, phosphorus becomes unavailable for uptake by plant roots. The cation levels (calcium, magnesium and potassium) indicate natural low soil fertility in the area as a result of the low cation exchange capacity. The cation complex is dominated by calcium, followed by magnesium and then potassium. Sodium levels are very low and do not pose a risk of causing sodic soils. The organic carbon content is very low and ranges between 0.22 and 0.26%.

Table 4: Soil chemical analysis results

Sample no.	Ca	Mg	K	Na	P	pH(KCl)	Organic C
	(mg/kg)						%C
1	143,5	36,0	4,5	0,5	1,9	4,58	0,26
2	229,5	29,0	10,0	0,5	2,9	6,18	0,22
3	229,0	38,5	17,5	0,5	2,6	6,21	0,25
4	132,0	33,5	15,5	0,5	1,6	4,74	0,26

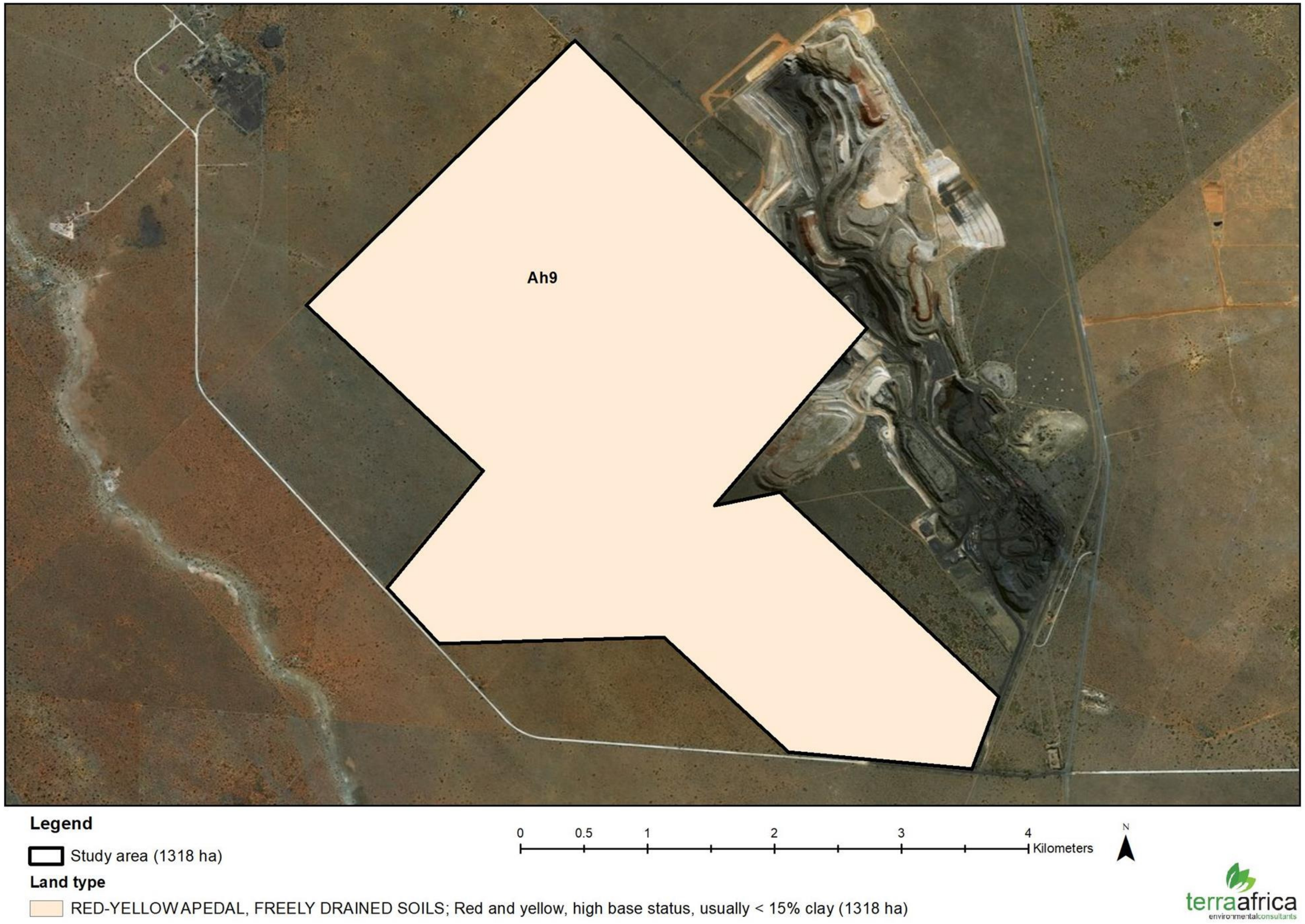

Figure 4: Land type map of the study area

Figure 5 Soil map of the study area

Figure 6: Land capability map of the study area

10.4 Agricultural potential

10.4.1 Dryland crop production

The Hutton and Clovelly soil forms are highly suitable for dryland crop production. Disadvantages are the well-drained nature which leads to insufficient moisture to sustain the crop during dry spells that sometimes occur in the latter parts of the growing season and their greater than normal requirement for phosphate (P) fertilizer to compensate for P sorption by iron oxides. According to du Plessis (2003) maize needs 450 – 600mm of water per season which is mainly acquired from the soil moisture reserves. Considering the facts that the study area receives an average of 460mm of rain annually, the soils are very well drained and the evaporation rate is high because of high temperatures, commercial crop production would be at high risk of suffering losses as a result of droughts.

10.4.2 Irrigated crop production

The Project area does 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 Hutton and Clovelly soil forms identified in the Project area is suitable for irrigated crop production if irrigation water is available. 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.

10.4.3 Cattle farming

The grazing capacity of a specified area for domestic herbivores is given either in large animal units 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 21 – 30 hectares per large animal unit or large stock unit (Morgenthal et al., 2005). These large stock units can further be converted to include small grazers and browsers such as Boer goats or sheep although the area is most suitable for cattle production. The proposed West WRD area therefore has the capacity for 4 to 7 head of cattle to graze on. While the areas within the boundaries of the existing mining right are not being grazed, the areas of the in situ profiles combined with that of the proposed West WRD has the capacity for 26 to 37 head of cattle to graze on.

10.5 Land use and surrounding land use

The entire study area and its immediate surrounds can be broadly defined as Eastern Kalahari Bushveld and more specifically as Kathu Bushveld which is characterised by slightly to moderately undulating plains, including some low hills and preferential flow paths for water. The vegetation consists of a medium-tall tree layer with *Vachellia erioloba* and *Boscia* *albitrunca* in places, a shrub layer with *Senegalia mellifera* and *Diospyros lycioides* and variable cover by the grass layer (Mucina and Rutherford, 2011)

Even though land use is intrinsically linked to soil and land capability of an area, it is also largely a function of the economic climate and availability of resources additional to productive land. This report focusses on the dependency of land users (including fauna) in the study area on the specific soil and land capability properties present and how project impacts may induce land use changes.

The land use in the study area can be defined as grazing, and mining activities. The land uses surrounding the proposed project is a combination of farming activities (livestock and game farming), mining activities (at Black Rock, Hotazel and Kathu), residential areas (Kuruman, Hotazel, Black Rock and Kathu as well as informal settlements and farmsteads), commercial and recreational activities in the above-mentioned towns and transport services. There was no evidence of cattle grazing in the study area during the site visit since it is already part of the mine's property and fenced off. Excretion of wild animals observed during the site visit (in the proposed West WRD area). Stock and/or game farming will be a viable post mining land use of the study area as long as the field quality is maintained by keeping within the grazing capacity of the land.

10.6 Land capability

Land capability is the inherent capacity of land to be productive under sustained use and specific management methods. The land capability of an area is the combination of the inherent soil properties and the climatic conditions as well as other landscape properties such as slope and drainage patterns that may have resulted in the development of wetlands as an example. Land capability has strong influence on socio-economic aspects of human settlements. Baseline land capabilities are also used as a benchmark for rehabilitation of land in the case of project decommissioning.

Following the classification system above in Section 8.4, the Project area could be divided into two land capability class and that is grazing and wilderness land capability (**Figure 6**). The deep soils of the Hutton and Clovelly soil form could have had arable land capability and could also be suitable for irrigated crop production. Due to unfavourable climatic conditions and lack of irrigation water the land capability of these parts of the study area is that of extensive grazing. The nutritional quality of natural veld on Hutton and Clovelly soils is expected to be good. Mine rehabilitation efforts should aim to restore the land capability back to grazing land capability with the same or improved grazing capacity that is currently present.

The Witbank and Industria soil forms have either Wilderness or Industrial land capability depending on whether it is currently occupied by active mining and processing (Industrial) or used for stripping and stockpiling (Wilderness).

11 Impact assessment

11.1 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**

Figure 7 Impact of proposed project layout on soil forms

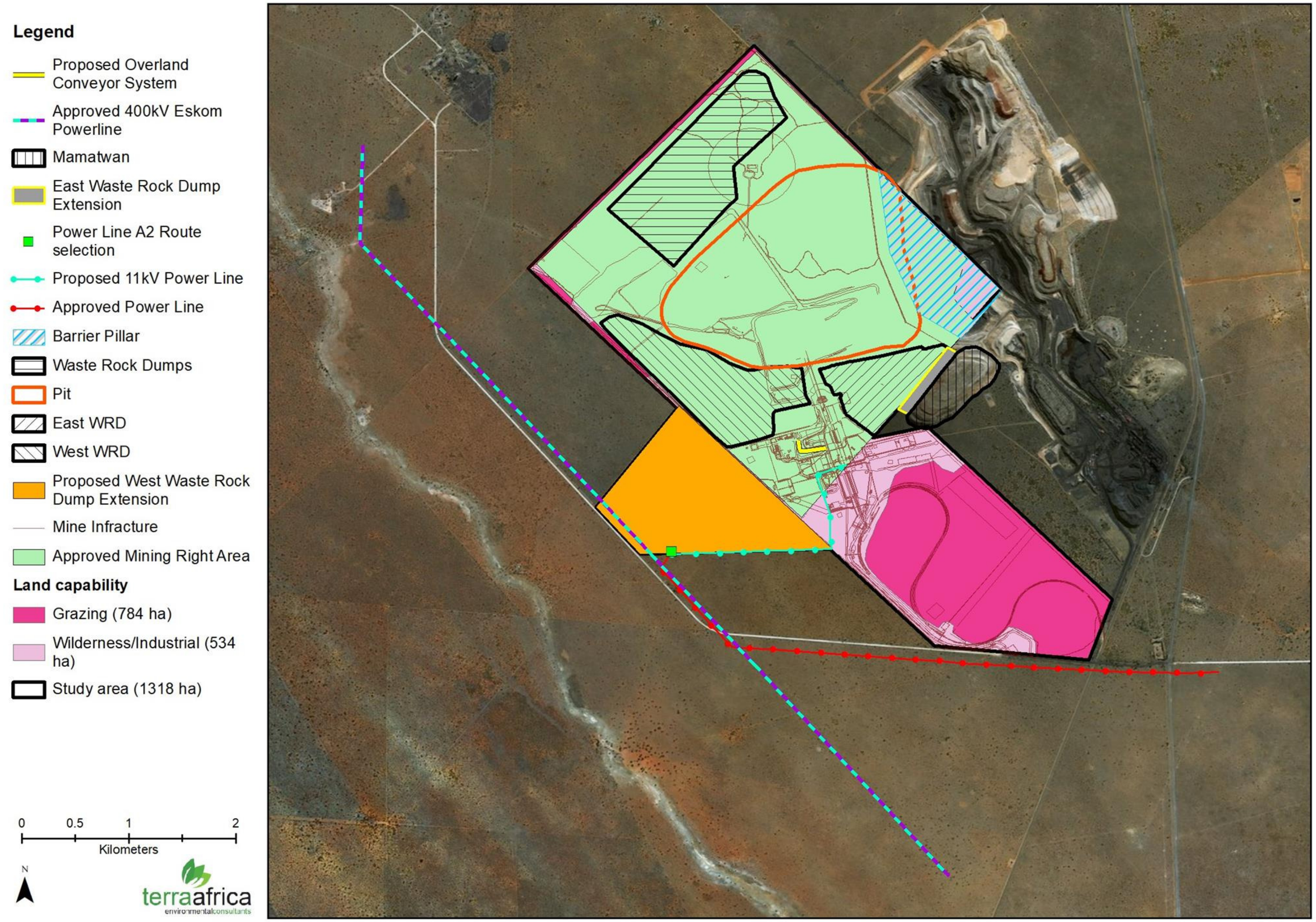

Figure 8 Impact of proposed layout on land capability properties

Note: Tshipi will extend the East WRD up to the mine property boundary, although the figures above show the full void between the Tshipi East WRD and the Mamatwan WRD.

11.2 Project layout and description

The Tshipi Borwa Waste Rock Dump Extension Project will involve the following (Figures 7 and 8):

- The extension of the existing East Waste Rock Dump (WRD) to the mining right boundary and towards the Mamatwan WRD and eventually filling the void between these dumps, to provide additional overburden storage capacity;
- The extension of the existing West WRD onto the remaining extent of Portion 8 of the farm Mamatwan 331, thereby including the remaining extent of Portion 8 into the mine's surface use area;
- The erection of an 11kV overhead powerline and associated sub-station along the Portion 8 boundary onto the existing mining right area; and
- The construction of an overland conveyor system from the existing secondary crushing and screening plant to the existing manganese ore product stockpiles.

A detailed description of activities to be undertaken can be found in the SLR environmental impact assessment and environmental management programme report.

11.3 Impact assessment per project phase

11.3.1 Construction phase

The Tshipi Borwa mine is currently in the operational phase of its development and requires additional waste rock dumping capacity. The components to be constructed include topsoil stockpile areas, the alignments along which the powerline and conveyor route will be constructed as well as the preparation of the areas for the extension of the West and East waste rock dumps.

The disturbance of original soil profiles and horizon sequences of these profiles during earthworks (stripping of topsoil) is a measurable deterioration. This impact is 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 with mitigation measures implemented as it is impossible to re-create the original soil profile distribution. Once rehabilitation of the pit area has commenced, the rehabilitated soil profiles will be a new soil with properties that may resemble some of the original soil properties but that may also be altered because of the mixing of soil horizons. The "new" soil can still be used for re-vegetation and successful rehabilitation practices will be able to restore the grazing capacity of the land over a period of time.

Soil chemical pollution because 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 will have medium significance on the soil resource when not managed.

However, with proper waste management and immediate clean-up as mitigation measures, the significance of this impact can be reduced to low (post-mitigation) (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 access and maintenance roads constructed for this project. Loading, hauling and transportation of the waste rock involve the use of heavy vehicles and will cause serious compaction of the soil resource. This is a permanent impact that will be localised within the site boundary with medium consequence and significance as subsurface soil compaction is difficult to alleviate.

The only areas where permanent change to land capability will occur is the areas where waste rock dumps are likely to remain on the soil surface post closure of the mine. In these areas the grazing land capability is permanently lost. This is considered a minor loss, permitting that all the other areas around it is sufficiently rehabilitated back to grazing land.

Table 5: 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	L	M	M
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 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

11.3.2 Operational phase

The operational phase includes all the processes associated with the daily management of the open pit mining and related activities. The main envisaged operational activities that will impact on soil, land use and land capability in the study area include the following:

- Surface infrastructure namely the waste rock dumps are disruptive to current land uses, land capability as well as agricultural potential of the soil.
- Other general activities include transport and loading and hauling of the waste rock on 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 continued disturbance of original soil profiles and horizon sequences of these profiles is considered to be a measurable deterioration. This impact is considered to be permanent but will be localised within the site boundary. This impact is possible and will have medium significance when unmanaged.

Soil chemical pollution as a result of pollutants leaching into subsurface soil horizons where waste rock is stockpiled, 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 movement of vehicles on the soil surfaces and the weight of topsoil stored on the soil surface. This is a permanent impact that will be localised within the site boundary with medium consequence and significance. Hauling of rock and where topsoil will be stockpiled

The current land capability and land use of areas where permanent waste rock dumps are created will be lost permanently. However, the land capability and land use of areas where infrastructure will be decommissioned (topsoil stockpiles), can be restored through proper land rehabilitation techniques.

Table 7: 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	L	M	M
Loss of current land capability	H	H	L	H	H
Loss of current land use	M	H	L	M	M

Table 8: 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

11.3.3 Decommissioning phase

Decommissioning will only apply to the topsoil stockpiles since the WRDs may remain on surface afer closure. The topsoil will be used for the final rehabilitation of reclaimed areas as well as the WRDs.

- Transport of stockpiled topsoil to rehabilitation sites. 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 topsoil to rehabilitated areas and to be added to the soil surface. These activities will not result in further impacts on land use and land capability but may increase soil compaction.

Table 9: 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 10 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.

11.3.4 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 any permanent waste rock dumps will be stable and will have no further impacts on soil during the closure phase.

11.4 Cumulative impact assessment

The cumulative severity rating assessing the impact of the changes to the total operation the Tshipi Borwa Mine within the context of the approved mining operations is high in the unmitigated scenario. In the mitigated scenario (proper pollution control) the area of impact and the number of sources and number of pollution events should be significantly less which reduces the potential severity to medium to low.

The cumulative severity rating assessing the impact of the changes to the operations within the context of the approved mining operations is high in the unmitigated scenario. In the mitigated scenario (land rehabilitation and topsoil conservation) the soils can mostly be conserved and reused which reduces the severity to medium.

12 Soil Management Plan

The purpose of the Soil Management Plan (SMP) is to ensure the protection of soils and maintenance of the project area during the construction, operations, decommissioning and closure phases.

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; and
- Define monitoring procedures.

12.1 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 project are to minimise the area affected by the development, minimise potential future contact of toxic or polluting materials with the soil environment and to maximise the recovery and effective storage of soil material that will be most useful during the rehabilitation process after 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.

12.1.1 Minimise the development footprint

The layout and design of the project should aim to minimise the area to be occupied by waste rock and topsoil stockpiles to as small as practically possible. All footprint areas should also be clearly defined and demarcated and vehicles and equipment be limited to these areas. This measure will significantly reduce areas to be compacted by heavy construction vehicles and regular activities during both the construction and the operational phases.

12.1.2 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.

12.1.3 Location of stockpiles

Where possible, stripped soil should be stockpiled upslope of areas of mining activities to prevent contamination of stockpiled soil by dirty runoff or seepage. Locate all soil 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 development for cost saving only to have them relocated later during the life of the operation.

12.1.4 Topsoil stripping

Due to the extreme homogeneity of the soil profiles present on site and the almost undetectable differences between the A-horizon (top 30cm) and B1 (horizon) (30 – 150cm), soil can be stripped to a depth of 150cm. The B1-horizon is underlain by a combination of soft and hardpan carbonate horizons at depths greater than 150cm and at some places greater than 200 to 300 cm. It is important that the areas where soil stripping is conducted be constantly evaluated during the procedures to ensure these carbonate horizons are stripped and stockpiled separately and NOT mixed with the surface soil (A and B1 horizons).

Even though the Tshipi Borwa Mine is situated in a semi-arid area, soil stripping should not be started or continued directly after a rainfall event as this will drastically increase soil compaction. It is recommended that soil be allowed to dry out for a minimum of four days after the rainfall event has ended to ensure the soil had time to dry out.

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

All machines must be in efficient and safe working condition and only operated when ground conditions enable their maximum operating efficiency. Operation should be suspended before traction becomes a problem or the integrity of the basal layer and haul routes fail.

Stripping should be conducted a suitable distance ahead of the placement of waste rock 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.

12.1.5 Stockpiling of topsoil

There is currently no conclusive literature available on the correct or optimal height of topsoil stockpiles with a study by Mushia, Ramoela and Ayisi (2016) which concluded that any stockpiles higher than 1 m had shown a reduction in soil fertility. The issue of using such low stockpile heights is that very large areas of land (often previously undisturbed) are used for stockpiling. This generates a very large footprint, sterilizing all the soil underneath the topsoil stockpiles which will also require rehabilitation. This results in a much larger impact on the baseline soil properties, than the creation of higher stockpiles on smaller areas. The main design consideration for topsoil stockpiles should therefore be the prevention of soil erosion that will result in soil losses on site.

Using the results of the textural class analyses (Table 3) and the percentage of organic matter (Table 4) in the soil samples analysed, the maximum slope of the topsoil stockpiles could be calculated using the formula explained in Section 8.5. The final K-factor values were 0.6, resulting in a maximum slope angle of between 3 and 4%. This is as a result of the high sand and low organic carbon content of the soil.

The maximum topsoil stockpile side slopes can therefore range between 3 and 4% but not more than 4%. These maximum slopes should be used by the Tshipi's planning engineers to design the stockpiles with, especially because they plan to stockpile on existing topsoil stockpiles. Exceeding these maximum slopes will result in high erosion risk on the topsoil stockpiles.

In addition to maximum stockpile side slope, vegetation should be established on stockpiles as soon as possible to prevent soil erosion. The use of an annual species to stabilise the side slopes and create a micro- climate for seed germination of perennial grass species in natural succession should be considered. Vegetation on topsoil stockpiles will also activate the nutrient cycles and beneficial soil microbial life associated with plant roots that will aid mine rehabilitation processes when the topsoil is used.

12.1.6 Demarcation of topsoil stockpiles

All topsoil stockpiles should be 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.

12.1.7 Prevention of stockpile contamination

Topsoil stockpiles can be contaminated by dumping waste materials next to or on the stockpiles, contamination by dust from blasting, product stockpiles and waste rock 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.

12.1.8 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.

12.1.9 Management of access and haul 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 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.

12.1.10 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.

12.2 Soil management during the operational phase

Soil management should be an on-going strategy through the operational phase as soil disturbing activities will continue as new areas are developed to dump waste rock.

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.

Three months after new stockpiles have been created, they should be examined to determine whether vegetation has naturally established itself on the stockpiles. In the case of no or sparse vegetation establishment, it is recommended that geo-textiles be used on the topsoil stockpiles to prevent wind erosion. 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 monitored annually to determine what the current status of vegetation cover is. Areas where vegetation cover is sparse or absent, should either be covered with geotextiles to prevent erosion or the soil should be amended with fertilizers and indigenous grasses be established on these patches.
- Routine monitoring will be required in and around the sites.

12.2.1 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;
- General maintenance and safety precautions should be followed to prevent diesel and hydraulic fluids contaminating soil.

- Equipment, and vehicle maintenance to reduce the possibility of hydrocarbon pollution; and
- Avoid pollution of soils through dust suppression with contaminated water.

12.3 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:

12.3.1 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.

12.3.2 Site preparation

Once the site has been cleared of topsoil stockpiles and potential contamination, the slope must be re-graded (sloped) in order to approximate the pre-project aspect and contours. The previous topsoil stockpile footprint area must be ripped a number of times in order to reduce soil compaction. The project area to be affected has very deep soil profiles overlying the hardpan carbonate horizon and other sub-surface materials. Although closure plans traditionally refer to establishment of a minimum topsoil thickness of 300mm, this is not practical for an area where there will be large volumes of topsoil available. Thicker topsoil layers will aid vegetation establishment. The site preparation only refers to areas where topsoil stockpiles are removed.

12.3.3 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.

12.3.4 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.

12.4 Soil management during the closure phase

During the closure phase activities include the maintenance and aftercare of final rehabilitated land where topsoil stockpiles are removed and topsoil stockpiles that may be left behind permanently. 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.

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Except for the areas already compromised by mining activities, the study area is covered with natural veld and is suitable for cattle, game and small stock farming. The WRDs may become permanent features of the landscape. These activities 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 an 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.

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

The proposed changes at the Tshipi Borwa Mine falls within a larger area of mining projects intermixed with game and livestock farming and settlement (Hotazel, Black Rock, Kuruman and Kathu). The land capability and soil quality of land affected by the surface footprint of mining activities will be compromised; the proposed operation area will not impact on current farming activities because it is already part of the mine property.

Furthermore, 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, except for the area covered by waste rock dumps that may remain in perpetuity.

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 project.

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APPENDIX 1 – CURRICULUM VITAE OF REPORT AUTHORS

Mariné Pienaar

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
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Mailing address: **PO Box 433, Ottosdal, 2610**
Telephone: **+27828283587**
Address: **Strydpoort 01, Ottosdal, Republic of South Africa**
Current Job: **Lead Consultant and Owner of Terra Africa Consult**

C. Concise biography

Mariné Pienaar is a professionally registered soil- and agricultural scientist who has consulted extensively for the past eleven years in the fields of soil, land use and agriculture in several African countries. These countries include South Africa, Liberia, Ghana, DRC, Mozambique, Botswana, Angola, Swaziland and Malawi. She has worked with mining houses, environmental consulting companies, Eskom, government departments as well as legal and engineering firms. She conducted more than a hundred specialist studies that included baseline soil assessment and rehabilitation planning for new projects or expansion of existing projects, soil quality monitoring, land rehabilitation assessment and monitoring, natural resource assessment as part of agricultural project planning, evaluation and development of sustainable agriculture practices, land use assessment and livelihood restoration planning as part of resettlement projects and land contamination risk assessments.

She has attended a number of courses in Europe, the USA and Israel in addition to those attended in South Africa. She is currently finalising her MSc in Environmental Science at the University of the Witwatersrand where she also presents guests lectures on the importance of soil management on mining sites. Mariné is a contributing author of a report on the balance of natural resources between the mining industry and agriculture in South Africa (published by the Bureau for Food and Agricultural Policy, 2015).

D. Qualifications

Academic Qualifications:

- **MSc Environmental Science**; University of Witwatersrand, South Africa, 2017
- **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

E. Language ability

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

F. Professional Experience

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

G. Prior Tenures

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

H. Professional Affiliations

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

Summary of a selected number of projects completed successfully:

[Comprehensive project dossier available on request]

- *Lesotho Highlands Development Agency, development of Phase II (Polihali Dam and associated infrastructure)*: External review and editing of the initial Soil, Land Use and Land Capability Assessment as requested by ERM Southern Africa.

- *Tina Falls Hydropower Project, Eastern Cape , South Africa*: Soil, land use and land capability assessment as part of the ESIA for the construction of a hydropower plant at the Tina Falls.

- *Kingston Vale Waste Facility, Mpumalanga Province, South Africa*: Soil and vegetation monitoring to determine the risk of manganese pollution resulting from activities at the waste facility.

- *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.

- *Richards Bay Minerals, KwaZulu-Natal*: Contaminated land assessment of community vegetable gardens outside Richards Bay as a result of spillages from pipelines of Rio Tinto's Richards Bay Minerals Mine.

- *Keaton Mining's Vanggatfontein Colliery, Mpumalanga*: Assessment of soil contamination levels in the mining area, stockpiles as well as surrounding areas as part of a long-term monitoring strategy and rehabilitation plan.

- *Graveyard relocation as part of Exxaro Coal's Belfast Resettlement Action Plan*: Soil assessment to determine pedohydrological properties of the relocation area in order to minimise soil pollution caused by graveyards.

- *Rhino Oil Resources: Strategic high-level soil, land use and land capability assessment of five proposed regions to be explored for shale gas resources in the KwaZulu-Natal, Eastern Cape, North-West and Free State provinces of South Africa.*
- *Eskom Kimberley Strengthening Phase 4 Project, Northern Cape & Free State, South Africa:* soil, agricultural potential and land capability assessment.

- *Italthai Rail and Port Projects, Mozambique* – The study included a thorough assessment of the current land use practices in the proposed development areas including subsistence crop production and fishing as well as livestock farming and forestry activities. All the land uses were mapped and intrinsically linked to the different soil types and associated land capabilities. This study was used to develop Livelihood Restoration Planning from.

- *Mocuba Solar Project, Mozambique* – The study included a land use assessment together with that of the soil and land capabilities of the study area. All current land uses were documented and mapped and the land productivity was determined. This study advocated the resettlement and livelihood restoration planning.

- *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.

- *Botswana (Limpopo-Lipadi Game Reserve).*Soil research study on 36 000 ha on the banks of the Limpopo River. This soil study forms part of an environmental management plan for the Limpopo-Lipadi Game Reserve situated here as well as the basis for the Environmental Impact Assessment for the development of lodges and Land Use Management in this area.

- *TFM Mining Operations [proposed] Integrated Development Zone, Katanga, DRC* [part of mining concession between Tenke and Fungurume]: soil and agricultural impact assessment study.

- *Closure Strategy Development for Techmina Mining Company – Lucapa, Angola.* Conducted an analysis of the natural resources (soil, water) to determine the existing environmental conditions on an opencast diamond mine in Angola. The mine currently experience severe problems with kimberlite sediment flowing into the river. A plan is currently being developed to change the mining area into a sustainable bamboo farming operation.

- *Closure of sand mining operations, Zeerust District.* Succesfully conducted the closure application of the Roos Family Sand Mine in the Zeerust District. Land Use Management Plans for rehabilitated soil were developed. The mine has closed now and the financial provision has been paid out to the applicant.

- *ESIA for [proposed] Musonoi Mine, Kolwezi area, Katanga, DRC:* soil, land use and land capability assessment.

- *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.
- *Moonlight Iron Ore Land Use Assessment, South Africa* – Conducted a comprehensive land use assessment that included interviews with land users in the direct and indirect project zones of influence. The study considered all other anticipated social and environmental impacts such as water, air quality and noise and this was incorporated into a sensitivity analysis of all land users to the proposed project.

- *Project Fairway Land Use Assessment, South Africa* – The study included an analysis of all land users that will directly and indirectly be influenced by the project. It analysed the components of their land uses and how this components will be affected by the proposed project. Part of the study was to develop mitigation measures to reduce the impact on the land users.

- *Bekkersdal Urban Renewal Project – Farmer Support Programme,* Independent consultation on the farmer support programme that forms part of Bekkersdal Renewal Project. This entailed the production of short and long term business plans based on soil and water research conducted. Part of responsibilities were the evaluation of current irrigation systems and calculation of potential water needs, etc. as well as determining quantities and prices of all project items to facilitate the formalisation of tender documents.

- *Area-based agricultural business plans for municipalities in Dr. Kenneth Kaunda Municipal District.* Evaluation of the agricultural and environmental status of the total district as well as for each municipality within the district. This included the critical evaluation of current agricultural projects in the area. The writing of sustainable, executable agricultural business plans for different agricultural enterprises to form part of the land reform plans of each Municipality within the district.

- *Batsamaya Mmogo, Hartswater.* Conducted a soil and water assessment for the farm and compiled management and farming plans for boergoats grazing on *Sericea lespedeza* with pecan nuts and lucerne under irrigation.

- *Anglo Platinum Twickenham Mine – Irrigated Cotton Project.* Project management of an irrigated cotton production project for Twickenham Platinum Mine. This project will ensure that the community benefit from the excess water that is available from the mine activities.

- *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.

- *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.

- *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.
- *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.

- *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.

- *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.