DIGBY WELLS
ENVIRONMENTAL

Dagsoom Twyfelaar Coal Mining Project near Ermelo, Mpumalanga

Soils, Land Capability and Land Use Assessment Report

Project Number:

DAG5603

Prepared for:

Dagsoom Coal Mining (Pty) Ltd

October 2019

Digby Wells and Associates (South Africa) (Pty) Ltd
Co. Reg. No. 2010/008577/07. Turnberry Office Park, 48 Grosvenor Road, Bryanston, 2191. Private Bag X10046, Randburg, 2125, South Africa
Tel: +27 11 789 9495, Fax: +27 11 069 6801, info@digbywells.com, www.digbywells.com

DIGBY WELLS
ENVIRONMENTAL

This document has been prepared by Digby Wells Environmental.

Report Type:	**Soils, Land Capability and Land Use Assessment Report**
Project Name:	**Dagsoom Twyfelaar Coal Mining Project near Ermelo, Mpumalanga**
Project Code:	**DAG5603**

Name	**Responsibility**	**Signature**	**Date**
Report Compiler	Lungile Lembede	Lembede	October 2019
Report Review	Daniel Fundisi		October 2019

EXECUTIVE SUMMARY

Introduction

Digby Wells Environmental (hereafter Digby Wells) was appointed by Dagsoom Coal Mining (Pty) Ltd (hereafter Dagsoom) to conduct a soils, land capability and land suitability assessment for the proposed underground mining and related infrastructure within the proposed Twyfelaar Coal Mine development footprint area (Project Area). To identify soils accurately, it was necessary to undertake a soil survey. The aim was to provide an accurate record of the soil resources of the Project Area. Land capability, land use and land suitability were then determined from these results. The relevant project components included the following:

- Reviewing of all the existing information;
- The description of soil forms found in the Project Area;
- Determining the existing land capability and suitability;
- Soil chemical and physical properties; and
- Impact assessment associated with mining on soils.

Soil Survey and Classification

The land type data indicated that the dominant land types were Fa162 (Shallow soils, no lime); Bb35 (Yellow, highly weathered structureless soils with plinthic subsoils) and Ba51 (red, highly weathered structureless soils with plinthic subsoils).

The land capability consists of predominantly Class II (Intensive cultivation) and Classes VII and VIII, which can only sustain wildlife.

The fertility status of the soils is generally moderate with some requirement for lime (to counteract acidity) to achieve full cropping potential. Exchangeable base cations (potassium, calcium, magnesium) are present in sufficient levels and there is neither a sodium nor salinity hazard identified in the analysed soils. Texture is variable, with the occurrence of sandy clay loam, sandy loam and silty loam occurring within the Project Area. The most dominant soil texture within the Project Area is the sandy loam.

Impact Assessment

During the establishment phase, site clearing is necessary for the preparation of surface infrastructure development where vegetation and topsoil will be removed. When soil is removed, the physical properties are changed, and the soils’ chemical properties will deteriorate unless properly managed. Vehicles will drive on the soil surface during the establishment phase, thereby causing compaction of the soils.

During the Operational Phase, potential impacts may arise from chemical pollution of soils due to hydrocarbon waste and the deterioration of topsoil stored in topsoil stockpiles.

During the Rehabilitation and Decommissioning Phase, the potential impacts associated are the risk of hydrocarbon spills, erosion and compaction. The mitigation measures to manage and minimize the above-mentioned potential impacts are detailed for each phase in Section 12.

Recommendations

The following actions apply to minimise adverse effects of mining on the soil resources:

- Runoff must be controlled and managed by use of proper stormwater management measures to minimise or prevent soil erosion;
- Re-fuelling must take place on impervious and bunded surfaces to prevent seepage of hydrocarbons into the soil;
- Establishment of effective soil cover around constructed infrastructure for adequate protection from wind and water erosion;
- Soil erosion monitoring must be conducted regularly during construction phase to detect occurrence and implement corrective actions to minimise or stop any further erosion from taking place especially after rainfall events;
- Restriction of vehicle movement over sensitive areas to reduce soil compaction must be implemented;
- Minimise unnecessary removal of the natural vegetation cover outside the development footprint;
- All vehicles and machines must be parked within hard park areas and must be checked daily for fluid leaks;
- Place drip trays where there are vehicles or machinery leaks occurring;
- Fuel, grease and oil spills should be remediated using commercially available emergency clean up kits;
- For major spills (>5L), if soils are contaminated, they must be stripped and disposed of at a licensed waste disposal site;
- Any contractors on site must ensure that all employees are aware of the procedure for dealing with spills and leaks and undergo training on site; and
- Soil pollution monitoring should be conducted at selected locations on the project site to detect any extreme levels of pollutants in order to effect corrective measures before the pollutants spread to other areas.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS & ACRONYMS

CARA	Conservation of Agricultural Resources Act
CEC	Cation Exchange Capacity
Digby Wells	Digby Wells Environmental
EA	Environmental Assessment
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
GIS	Geographic Information System
ha	Hectare
km	Kilometre
LM	Local Municipality
m	Metre
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NWA	National Water Act, 1998 (Act No. 36 of 1998)
OC	Organic Carbon
Project Area	Proposed Twyfelaar Coal Mine Development Footprint Area
SANAS	South African National Accreditation System
SANS	South African National Standards
WUL	Water Use License
WRC	Water Research Commission

1 Introduction

Digby Wells Environmental (hereinafter Digby Wells) was appointed by Dagsoom Coal Mining (Pty) Ltd (hereinafter Dagsoom) to undertake a soil, land capability and suitability assessment for the proposed Twyfelaar Coal Mine development footprint area (Project Area). The assessment was required to determine the baseline conditions and dominant soil forms on site. The findings of the study were used to determine the land capability and suitability of the proposed Project Area.

This specialist soil, land capability and suitability impact assessment report has been compiled in terms of Appendix 6 of the National Environmental Management Act, 1998 (Act No.107 of 1998) (NEMA) Environmental Impact Assessment (EIA) Regulations, 2014, (as amended) in support of the Scoping and EIA process.

2 Details of Specialists

Full Name of Specialist	Lungile Lembede
Designation	Hydrology and Soil Scientist
Responsibility	Report Writer
Highest Qualification	Master of Science (MSc) Degree
Years of experience in specialist field	2

Full Name of Specialist	Daniel Fundisi
Designation	Hydrology and Soil Scientist
Responsibility	Reviewer
Highest Qualification	Master of Science (MSc) Degree
Years of experience in specialist field	8
Registration(s):	Pr.Sci.Nat. (SACNASP); Reg. Number: 400034/17

3 Project Background

Dagsoom was the holder of a Prospecting Right for coal on the Farm Twyfelaar 298IT which is situated on the eastern escarpment of the Mpumalanga Highveld in the Ermelo Coalfield. Dagsoom has applied for a Mining Right in terms of the Minerals and Petroleum Resources Development Act, 2002 (Act 28 of 2002) (MPRDA).

There are numerous wetlands and hillside seepage areas (environmental no-go areas) around the Twyfelaar hill and in terms of the mining work programme, no opencast mining is envisaged on Twyfelaar (de Villiers, 2014). Bord and pillar mining with continuous miners (or conventional drill and blast) was therefore considered as the only practical mechanised mining method that can be used. A safety factor was applied in the mine layout and design to allow a stable roof, but with the vision in mind to do stooping (extraction of pillars) to fully utilise the coal resource. The Life of Mine (LoM) schedule allows between four and five years pending the decision whether to stoop the main development (de Villiers, 2014).

Activities listed for each project phase are presented in Table 3-1 below.

Table 3-1: Planned Activities for Mining within the Project Area

Project Phase	Project Activity
Construction Phase	Site/vegetation clearance
	Access and haul road construction
	Infrastructure construction
	Power line construction
	Diesel storage and explosives magazine
	Topsoil stockpiling
Operational Phase	Removal of rock (blasting)
	Stockpiling (rock dumps, soils, ROM, discard dump) establishment and operation
	Diesel storage and explosives magazine
	Operation of the underground workings
	Operating processing plant
	Operating sewage treatment plant
	Water use and storage on-site – during the operation water will be required for various domestic and industrial uses. Dams will be constructed that capture water from the mining area which will be stored and used accordingly
	Storage, handling and treatment of hazardous products (including fuel, explosives and oil) and waste
	Maintenance activities – through the operations maintenance will need to be undertaken to ensure that all infrastructure in operating optimally and does not pose a threat to human or environmental health. Maintenance will

Project Phase	Project Activity
	include haul roads, pipelines, processing plant, machinery, water and stormwater management infrastructure, stockpile areas
Decommissioning Phase	Demolition and removal of infrastructure – once mining activities have been concluded infrastructure will be demolished in preparation of the final land rehabilitation.
	Rehabilitation – rehabilitation mainly consists of spreading of the preserved subsoil and topsoil, profiling of the land and re-vegetation
	Post-closure monitoring and rehabilitation

4 Environmental Law Applicable to Study

The South African Environmental Legislation needs to be considered with reference to the management of soil and land use which includes:

- Soils and land capability are protected under the NEMA. The NEMA requires that pollution and degradation of the environment be avoided, or, where it cannot be avoided be minimised and treated; and
- The Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) (CARA). The CARA requires that protection of land against soil erosion, the prevention of water logging and salinization of soils by means of suitable soil conservation works to be constructed and maintained.

5 Project Locality

The proposed Project Area will be located on the farm Twyfelaar 298 IT, within the Msukaligwa Local Municipality (MP302), situated in the Gert Sibande District Municipality in the Highveld sub-region of Mpumalanga. The closest town is Sheepmoor which is situated approximately 4 km from the Project Area (Figure 5-1).

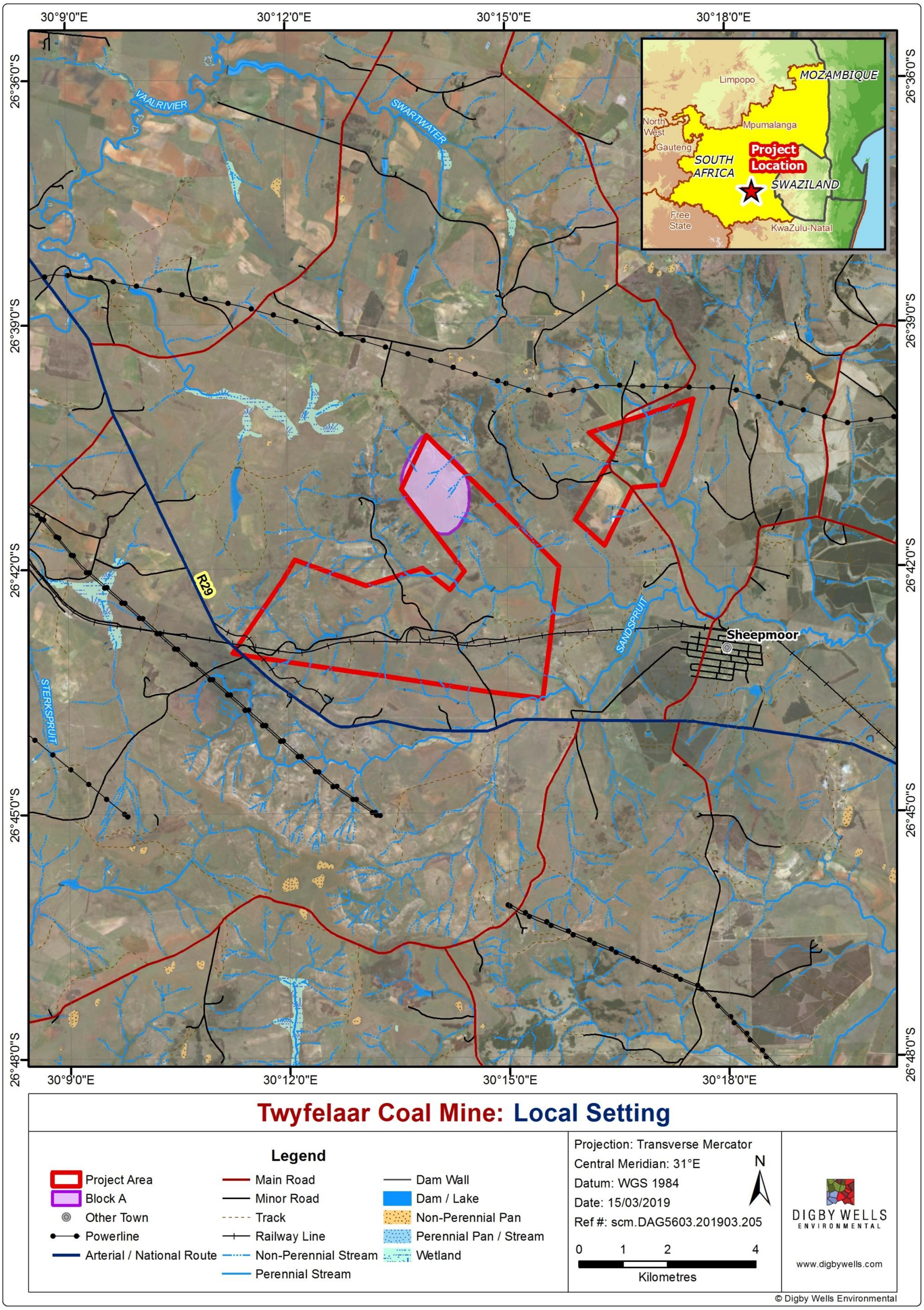

Figure 5-1: Local Setting of the Project Area

6 Scope and Purpose of this Report

The following tasks were undertaken as part of the soils, land capability and suitability assessment study:

- Review of available existing information and literature;
- Baseline environmental assessment;
- Site visit, soil survey and sampling;
- Land use/cover: present land use/cover was mapped;
- Soil classification;
- Soil laboratory analysis and interpretation;
- Soil capability and suitability /Agricultural Potential; and
- Identification of potential impacts on soils resulting from the project using the prescribed impact rating methodology.

7 Methodology

7.1 Review of Literature and Relevant Information

Digby Wells conducted a desktop review of the baseline data and findings related to the soil surveys and other relevant existing documentation. Existing Land Type data was used to obtain generalised soil patterns and terrain types for the project site. Land Type data exists in the form of published 1:250 000 maps. These maps indicate delineated areas of relatively uniform terrain, soil pattern and climate (ARC, 2006). The maps and their accompanying reports provide a statistical estimate of the different soils expected in the area.

7.2 Baseline Environmental Assessment

Rainfall, evaporation and runoff data obtained from the WR2012 study (WRC, 2015) was evaluated to determine the Mean Annual Precipitation (MAP), Mean Annual Runoff (MAR) and Mean Annual Evaporation (MAE) for the site. Understanding of the variables was useful in broadly determining soil characteristics which are influenced by incident rainfall, evaporation and by water movement through the soil matrix.

7.3 Soil Survey and Classification

A site visit was undertaken on the 22nd of August 2019, during which soil surveys, soil sampling and land use assessments were conducted.

A zig-zagged transect soil survey was undertaken, using a hand-held bucket auger for freely drained soils and Dutch auger for clays in order to classify the present soil forms. The soils were classified and mapped according to the South African Soil Classification Taxonomic System (Soil Classification Working Group, 1991). Soil distribution maps were generated using the ArcGIS 10.1 programme for Geographic Information Systems (GIS) (ESRI, 1995). Eight soil samples were collected from the study site and these were sent to the UIS Sediba Laboratory in Pretoria, a SANAS accredited laboratory, for chemical testing. Sample collection points were based on the major or dominant soil types within the Project Area, which represent a grouping of similar conditions.

7.4 Soil Physical and Chemical Analysis

In accordance with the methodology given in the Handbook of Standard Soil Testing Methods for Advisory Purposes (Soil Science Society of South Africa, 1990), the soil samples were tested for the following parameters:

- pH (KCl);
- Exchangeable cations: Calcium, Magnesium, Potassium and Sodium;
- Phosphorus (Bray 1);
- Aluminium and Iron;
- Organic carbon; and
- Soil texture (Sand, Silt and Clay).

Fertility analysis was used to provide recommendations for fertilisation and liming that is mostly used for soil management.

Soil texture is defined as the relative proportions of sand, silt and clay particles found in the soil. The relative proportions of these 3 fractions (clay, sand and silt) as illustrated by the red arrows in Figure 7-1 determine 1 of 12 soil texture classes for example sandy loam, loam, sand, sandy and clay loam. The different texture class zones are demarcated by the thick black line in the diagram.

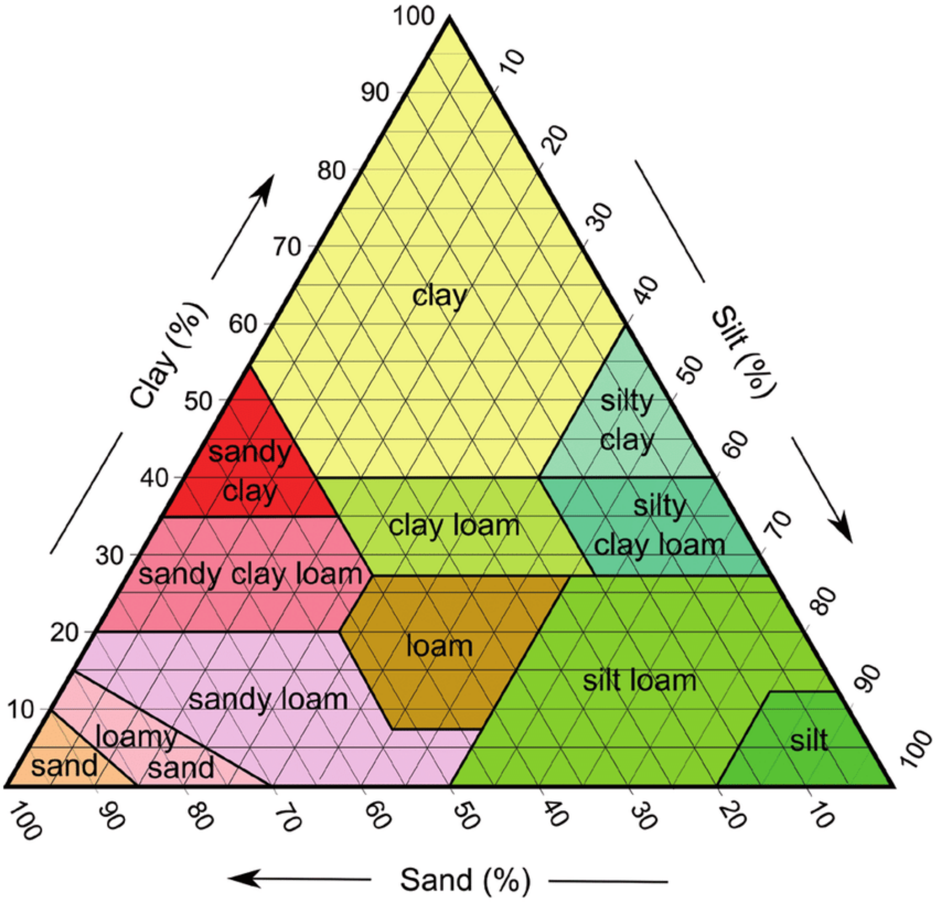

Figure 7-1: The Soil Textural Triangle

(Source: South African Sugar Association, 1999)

7.5 Land Capability and Suitability (Agricultural Potential)

Land capability and suitability (agricultural potential) mapping which highlight the capability (what could be practised) of the various soils identified at a site, and the suitability (what should be practised considering various restrictions), respectively, were undertaken for the Project Area.

7.5.1 Land capability

Land capability mapping was based on identified soil forms at the site. The land capability mapping involved dividing land into one of eight (8) potential classes of soil capability, whereby Classes I-IV represent arable land and Classes V-VIII represent non-arable land according to the guidelines (refer toTable 7-1) (Schoeman *et al.*, 2002).

Table 7-1: Land Capability Classes

Class	Increased Intensity of Use									Land Capability Groups	
I	W	F	LG	MG	IG	LC	MC	IC	VIC	Arable land	W - Wildlife F - Forestry LG - Light grazing MG - Moderate grazing IG - Intensive grazing LC - Light cultivation MC - Moderate cultivation IC - Intensive cultivation VIC - Very intensive cultivation
II	W	F	LG	MG	IG	LC	MC	IC	-		
III	W	F	LG	MG	IG	LC	MC	-	-		
IV	W	F	LG	MG	IG	LC	-	-	-		
V	W	-	LG	MG	-	-	-	-	-	Grazing land	
VI	W	F	LG	MG	-	-	-	-	-		
VII	W	F	LG	-	-	-	-	-	-	Wildlife	
VIII	W	-	-	-	-	-	-	-	-		

7.5.2 Land Suitability

Soil agricultural potential or suitability mapping was determined by considering the soil forms, land capability classes, soil chemistry results, the hydrology of the site and the current land use. The process involved allocating terrain factors (such as slope) and soil factors (such as depth, texture, internal drainage and mechanical limitations (which affect soil-water processes)) which define soil forms, to an area of land. The soil chemistry, which includes pH, cation and anion concentrations as well as nitrogen compositions, which are affected by the site hydrology, were considered in determining the final suitability of the soil. The suitability guidelines used in this study are presented in Table 7-2 (Schoeman *et al.*, 2002)

Table 7-2: Land Classes - Descriptions and Suitability

Class	Definition	Conservation Need	Use-Suitability
I	▪ No or few limitations. ▪ Very high arable potential. ▪ Very low erosion hazard.	Good agronomic practice.	Annual cropping.
II	▪ Slight limitations. ▪ High arable potential. ▪ Low erosion hazard.	Adequate run-off control	Annual cropping with special tillage or ley (25 %).
III	▪ Moderate limitations. ▪ Some erosion hazards.	Special conservation practice and tillage methods.	Rotation of crops and ley (50 %).
IV	▪ Severe limitations. ▪ Low arable potential. ▪ High erosion hazard.	Intensive conservation practice.	Long term leys (75 %).

Class	Definition	Conservation Need	Use-Suitability
V	▪ Watercourse and land with wetness limitations.	Protection and control of water table	Improved pastures or Wildlife
VI	▪ Limitations preclude cultivation. ▪ Suitable for perennial vegetation.	Protection measures for establishment e.g. Sod-seeding	Veld and/or afforestation
VII	▪ Very severe limitations. ▪ Suitable only for natural vegetation.	Adequate management for natural vegetation.	Natural veld grazing and afforestation.
VIII	▪ Extremely severe limitations. ▪ Not suitable for grazing or afforestation.	Total protection from agriculture.	Wildlife.

7.6 Soil Impact Assessment

The impacts were assessed based on the impact’s magnitude as well as the receiving environment’s sensitivity, resulting in an impact significance rating which identifies the most important impacts that require management. Based on the international guidelines and legislation, the following criteria were considered when examining potentially significant impacts relating to soils and land use:

- Nature of impacts (direct/indirect and positive/negative);
- Duration (short/medium/long-term, permanent (irreversible)/temporary (reversible) and frequent/seldom);
- Extent (geographical area and size of affected population/species);
- Intensity (minimal, severe and replaceable/irreplaceable);
- Probability (high/medium/low); and
- Measures to mitigate avoid or offset significant adverse impacts.

7.6.1 Significance Rating

Impacts and risks were identified based on a description of the activities to be undertaken. Once impacts were identified, a numerical environmental significance rating process was undertaken that utilises the probability of an event occurring and the severity of the impact as factors to determine the significance of an environmental impact.

The severity of an impact was then determined by taking the spatial extent, the duration and the severity of the impacts into consideration. The probability of an impact was then determined by the frequency at which the activity takes place or is likely to take place and by how often the type of impact in question has taken place in similar circumstances.

Following the identification and significance ratings of potential impacts, mitigation and management measures were incorporated into the Environmental Management Programme (EMPr). Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below. The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts

The matrix calculates the rating out of 147, whereby intensity, extent, duration and probability are each rated out of seven as indicated in Table 7-3. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation proposed in this report. The significance of an impact is then determined and categorised into one of seven categories, as indicated in Table 7-3, which is extracted from Table 7-4. The description of the significance ratings is discussed in Table 7-5.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 7-3: Impact Assessment Parameter Ratings

Rating	**Intensity/ Replicability**		**Extent**	**Duration/Reversibility**	**Probability**
	Negative Impacts **(Nature = -1)**	**Positive Impacts** **(Nature = +1)**			
7	Irreplaceable loss or damage to biological or physical resources or **highly** sensitive environments. Irreplaceable damage to **highly sensitive** cultural/social resources.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will occur. >80% probability.
6	Irreplaceable loss or damage to biological or physical resources or **moderate to highly** sensitive environments. Irreplaceable damage to cultural/social resources of **moderate to highly** sensitivity.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur.>65 but <80% probability.

Rating	Intensity/ Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
5	Serious loss and/or damage to physical or biological resources or **highly** sensitive environments, limiting ecosystem function. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	Serious loss and/or damage to physical or biological resources or **moderately** sensitive environments, limiting ecosystem function. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.

Rating	Intensity/ Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
3	Moderate loss and/or damage to biological or physical resources of **low to moderately** sensitive environments and, limiting ecosystem function. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local including the site and its immediate surrounding area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	**Minor loss and/or effects** to biological or physical resources or low sensitive environments, not affecting ecosystem functioning. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited extending only as far as the development site area.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low because of design, historic experience or implementation of adequate mitigation measures. <10% probability.

Rating	Intensity/ Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
1	**Minimal to no loss** and/or effect to biological or physical resources, not affecting ecosystem functioning. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited/Isolated Limited to specific isolated parts of the site	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

Table 7-4: Probability/Consequence Matrix

Probability	Significance																																				
7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Consequence

Table 7-5: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive) (+)
36 to 72	A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative) (-)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative) (-)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes.	Moderate (negative) (-)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)

8 Assumptions and Limitations

The assumptions and limitations of the study are described below:

- The increase and decrease of a soil's fertility status within the topsoil over time was assumed to be non-restrictive for land capability assessments. This is because the fertility property can be rectified through use of additives;
- Land suited to crop production was assumed also suitable for other less intensive uses such as pasture, natural grazing, forestry and wildlife;
- Soils are contiguous hence differentiation is not abrupt and the transition zone cannot be fully captured during any given soil survey. The number and spatial extent of surveyed points in this study were, however, considered adequate to capture the differentiation in soil form distribution;
- The soils within a capability class are similar only with respect to the degree of limitations in soil use for agricultural purposes or with respect to the impact on the soils when they are so used;
- The land capability classification is not a productivity rating for specific crops but an indication of the potential use to which the soil can be put;
- The land capability classification is not, however, a grouping of soils according to the most profitable use to be made of the land; and
- The land capability groupings are subject to change as new information about the behaviour and responses of the soils becomes available.

9 Baseline Environmental

Information related to the climate, topography, geology, vegetation, soils, land use and land capability associated with the Project Area is discussed in this Section.

9.1 Climate

The Project Area falls within the summer rainfall area of South Africa, and as such rainfall is highly seasonal with rainfall predominantly occurring in the summer months. According to the Köppen-Geiger system classification, within the class Cwb that stretches over much of the South African Highveld and escarpment, which is a warm temperate area with a dry winter and warm summer. The area typically experiences warm summer temperatures, whilst winters are generally cold with a high incidence of frost (Mucina & Rutherford, 2012). Frost is common during the cold winter months of June to August, with early morning mist being a common occurrence. The climate of the Project Area is similar to that of the close by town of Ermelo. Sheepmoor receives an average of 750 mm/annum, with most rainfall occurring during summertime. The Project Area is situated within the Cold Interior Climatic Zone of the country. Due to its position near the escarpment, the area is somewhat windier than is typical for the

South - Eastern Mpumalanga Highveld, although the majority of winds are still light and their direction is controlled by topography (Msukaliswa Local Municipality, 2010).

9.2 Topography

The topography is that of slight to moderately undulating plains, with some low hills and pan depressions scattered throughout the landscape. Altitude typically varies from 1500 m to 1800 m (refer to Figure 9-1). Drainage occurs in the North-easterly direction. Non-perennial drainage lines are located to the East and West. Most of the Project Area has steep slopes with the higher-lying areas have steeper slopes of between 10° and 45°, whereas low lying areas have gentle slopes that range from 0° and 10° (refer to Figure 9-2).

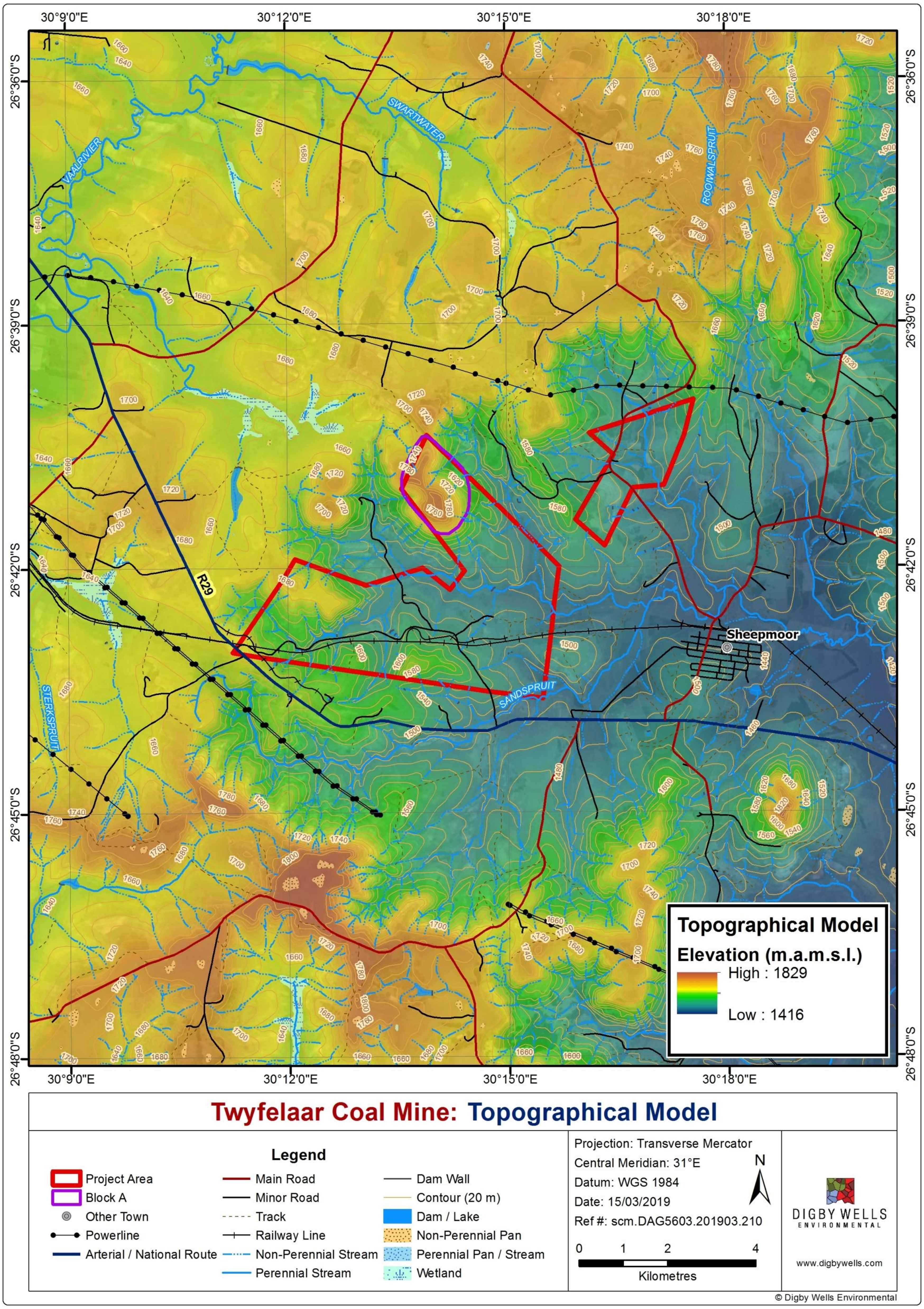

Figure 9-1: Topography for the Project Area

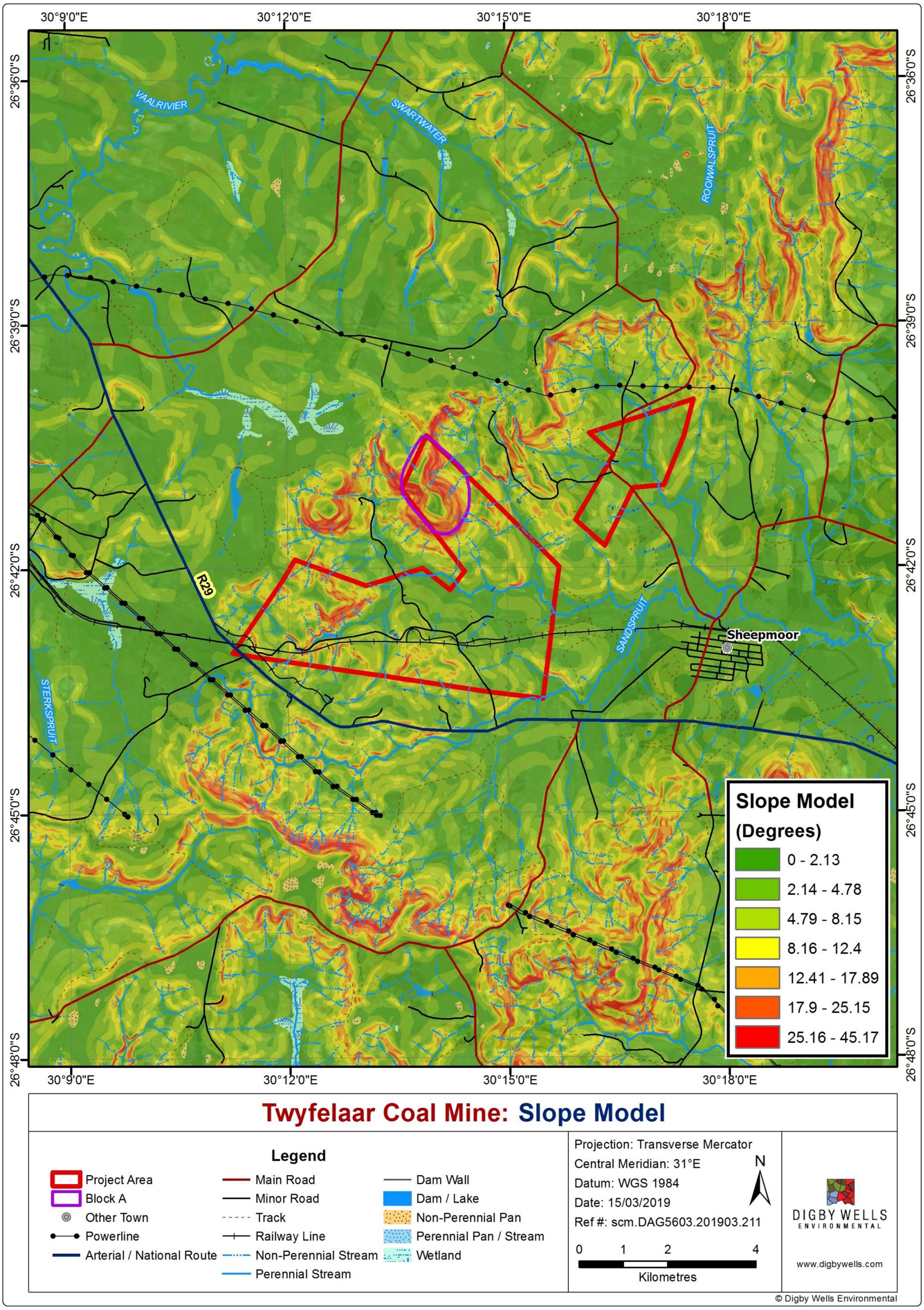

Figure 9-2: Slope aspect for the Project Area

9.3 Geology

The regional area surrounding the Project Area is predominantly underlain by Formations of the Karoo Supergroup. The dominant lithologies present in the area are coal-bearing sandstone, mudstone, siltstone, shale and coal seams of the Vryheid Formation with dolerite dyke and sill type intrusions of the Karoo dolerite Suite present throughout the area (Figure 9-3).

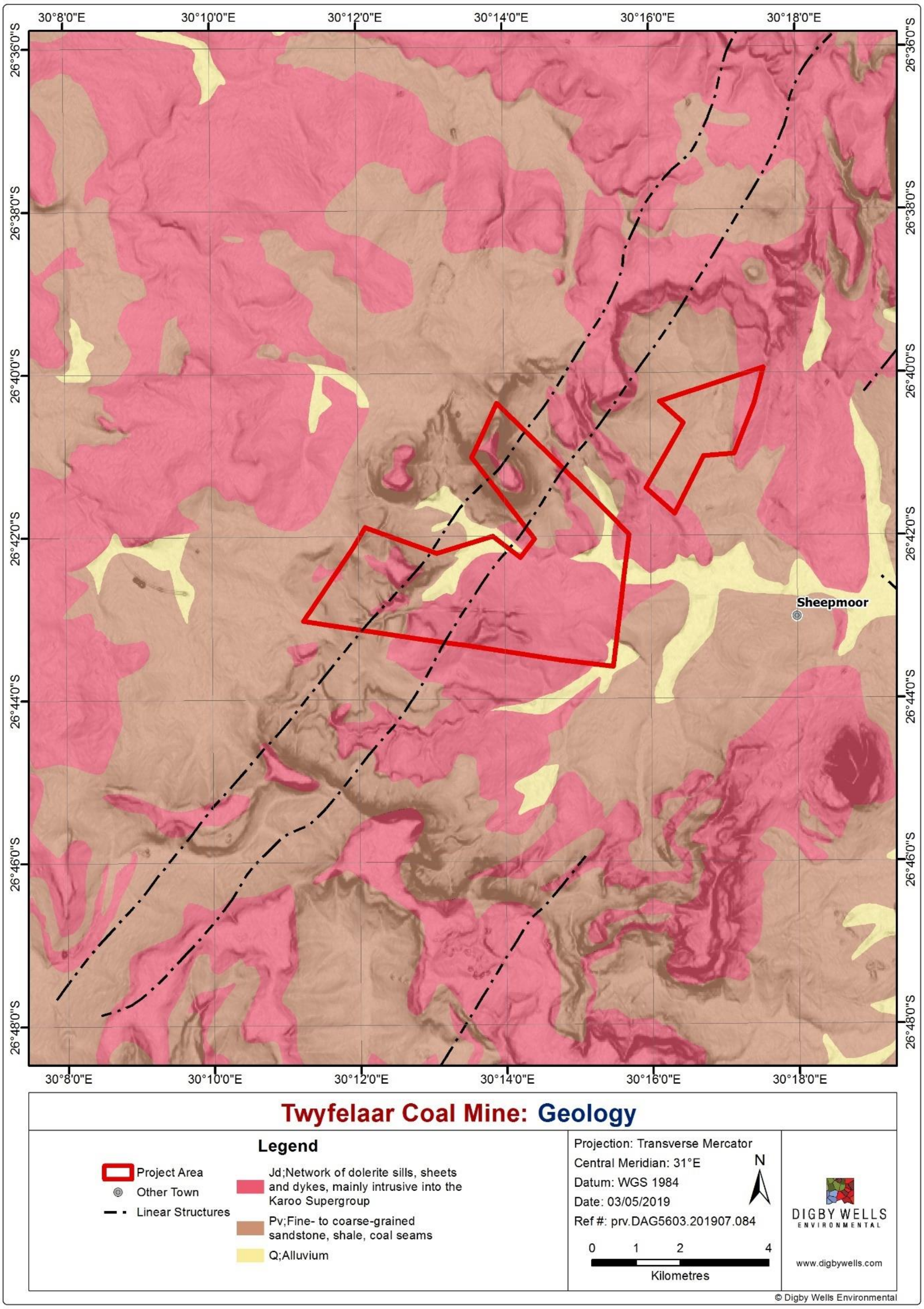

Figure 9-3: Regional geology for the Project Area

9.4 Vegetation

According to Mucina and Rutherford (2012), the proposed Project Area is located in areas classified as Eastern Highveld Grassland (Gm 12) and Wakkerstroom Montane Grassland (Gm 14) as depicted in Figure 9-4.

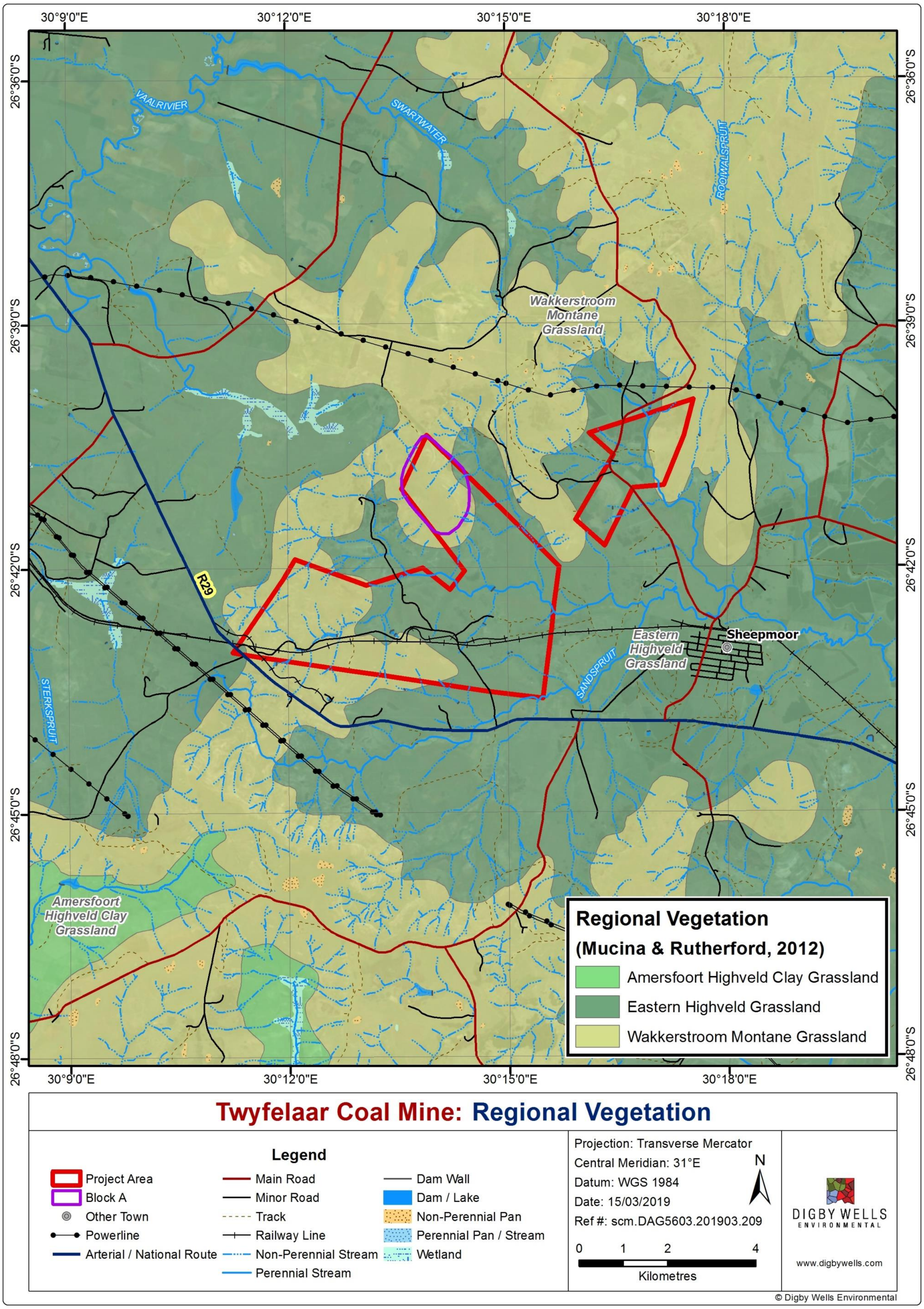

Figure 9-4: Regional vegetation for the Project Area

9.5 Land Types

A total of three (3) Land Type units occur within the Project Area, namely: Fa162 (Shallow soils, no lime); Bb35 (Yellow, highly weathered structureless soils with plinthic subsoils) and Ba51 (red, highly weathered structureless soils with plinthic subsoils). Table 9-1 gives a brief description of the dominant Land Types within the Project Area.

Table 9-1: Dominant Land Types in the Project Area

Land Type	Description
Fa162	Shallow soils such as the Mispah and Glenrosa forms predominate with little to no lime in the landscape.
Bb35	Red and yellow structureless soils with low to medium base status due to leaching. This land type has plinthic subsoils which are characterized by iron oxides in the form of mottles and concretions. Plinthic soils are usually indicative of a fluctuating water table. Red soils comprise less than 33% of the land type. Soil forms that are found within this land type include Glenrosa, Mispah, Clovelly, Avalon, Cartref, Longlands, Wasbank, Huuton, Griffin and Katspruit.
Ba51	Red and yellow structureless soils with low to medium base status due to leaching. This land type has plinthic subsoils which are characterized by iron oxides in the form of mottles and concretions. Plinthic soils are usually indicative of a fluctuating water table. Red soils comprise more than 33% of the land type. Soil forms that are found within this land type include Hutton, Mispah, Glenrosa, Avalon, longlands, Swartland, Griffin, Shortlands, Glencoe, Kroonstad, Bonheim, Katspruit, Willowbrook and Dundee.

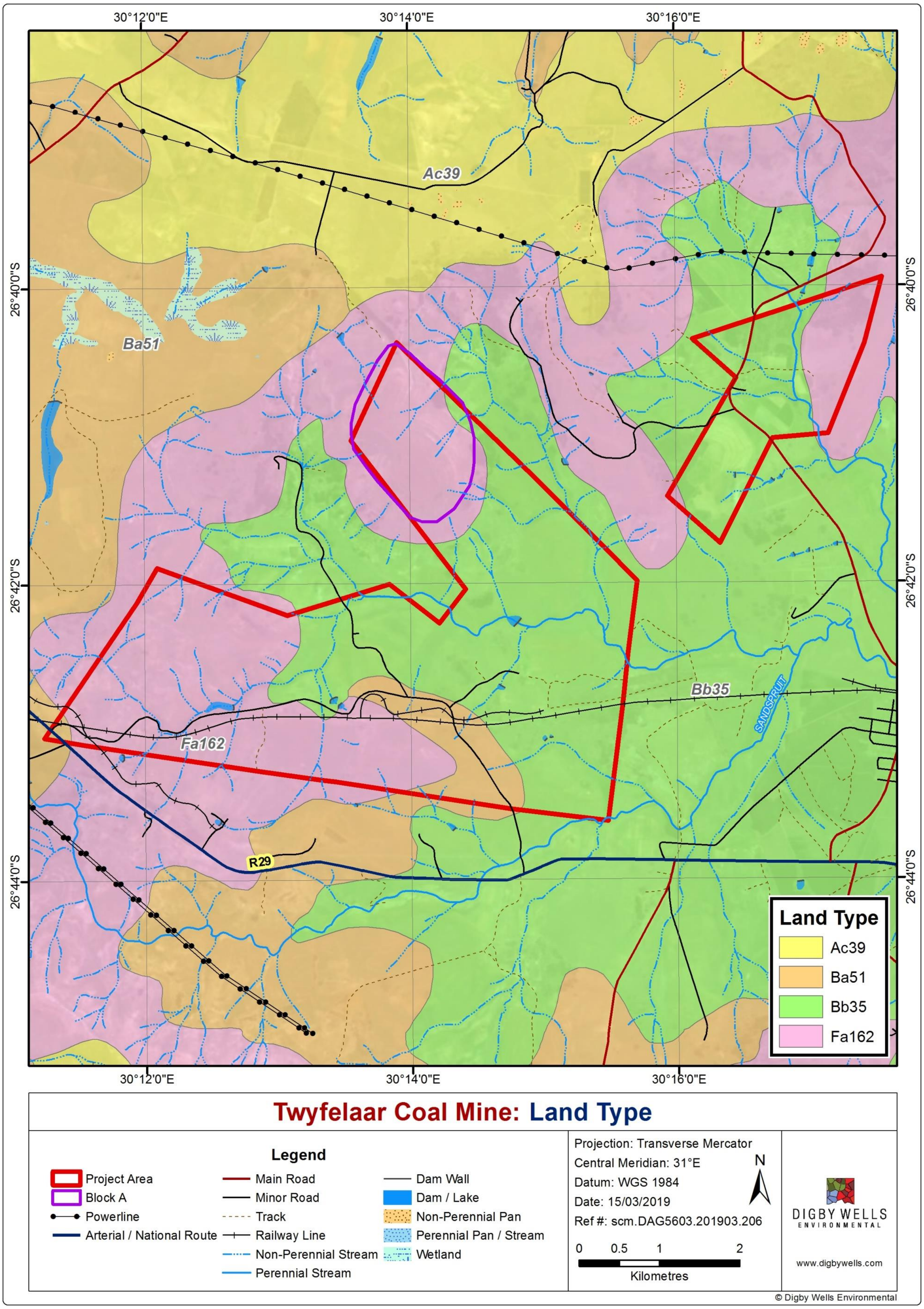

Figure 9-5: Land Type Map of the Project Area

9.6 Land Use

The Project Area is dominantly Greenfield. Other land uses identified in the area include cultivated land, forestry plantations animal grazing and settlement or built-up area. These are visually depicted in Figure 9-6.

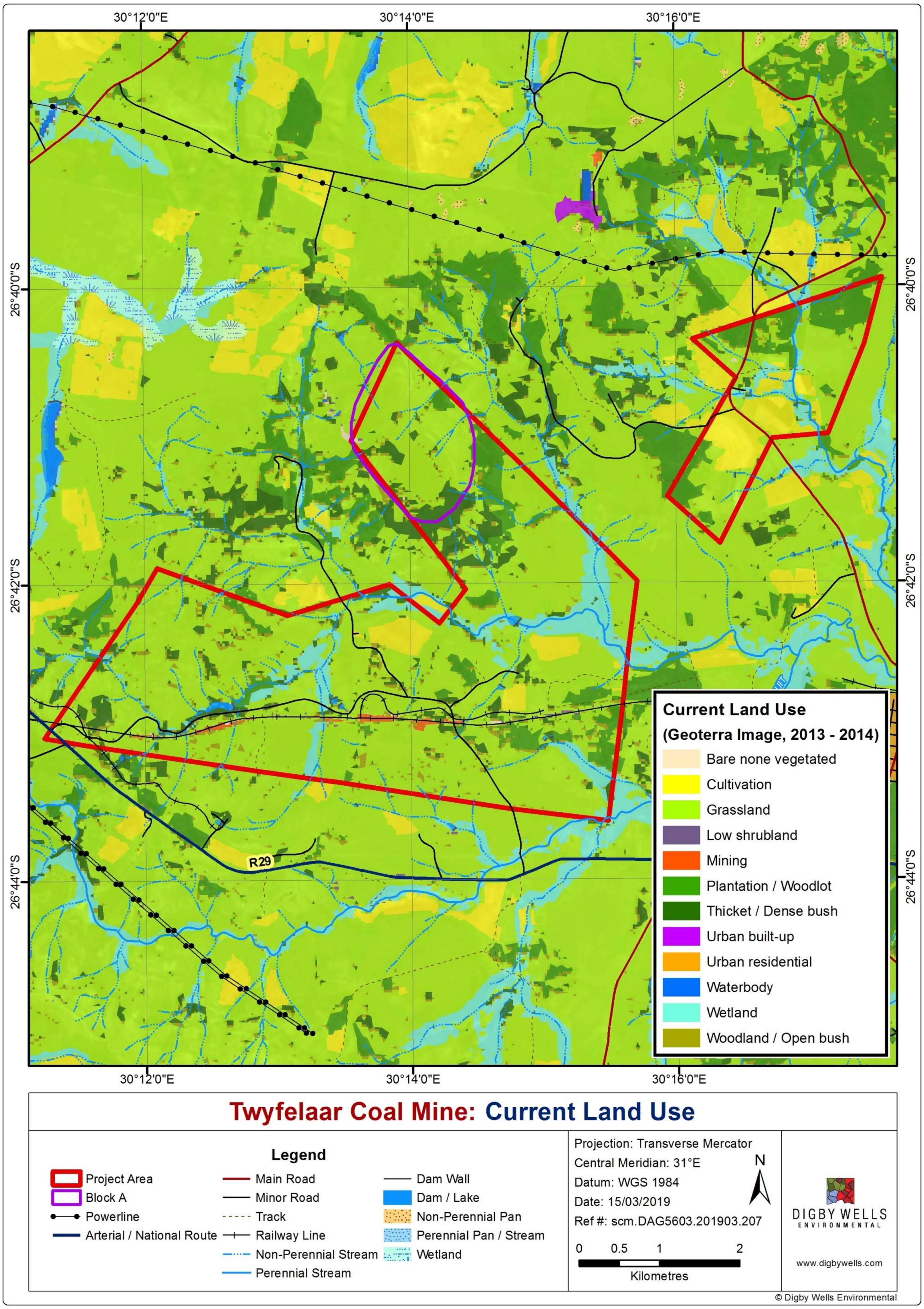

Figure 9-6: Land Use Map for the Project Area (Geoterraimage, 2014)

9.7 Soil Chemical Characteristics

9.7.1 Soil pH

The soil pH is determined in the supernatant liquid of an aqueous suspension of soil after having allowed the sand fraction to settle out of suspension. Soil pH has a direct influence on the plant growth:

- Through the direct effect of the hydrogen ion concentration on nutrient uptake;
- The mobilisation of toxic ions such as aluminium which restrict plant growth; and
- Indirect impacts include the effect on trace nutrient availability.

The soil pH ranged from 3.9 to 5.54 (refer to Table 9-4), thus the soils are very acidic to acidic when compared to the guidelines in Table 9-2. Soils with pH values below 5 might be due to the acidic nature of the parent material from which the soils were derived and high rate of leaching of the nutrients down the soil profile. Aluminium (Al), Manganese (Mn) and Iron (Fe) are especially soluble under conditions of low pH. Addition of agricultural lime would be required for soils with pH below 5 to remedy soil acidity and increase plant growth.

Table 9-2: Soil pH Range (Fertilizer Association of South Africa, 2016)

pH (KCl)					
Very Acid	**Acid**	**Slightly Acid**	**Neutral**	**Slightly Alkaline**	**Alkaline**
<4	4.1-5.9	6-6.7	6.8-7.2	7.3-8	>8

9.7.2 Exchangeable Cations

The levels of the basic cations Calcium, Magnesium, Potassium and Sodium are determined in soil samples for agronomic purposes through extraction with an ammonium acetate solution.

Calcium ranged from 207 to 3 998 mg/kg and Magnesium ranged from 371 to 6 574mg/kg, these levels in the soil were generally adequate for crop production and these nutrients are not limiting for any production on the site and are not considered as toxic.

Potassium ranged from 97 to 2 636 mg/kg and Sodium ranged from 39 to 844 mg/kg. These levels in the soil were generally adequate for crop production, with sodium being slightly low one of the sampled points.

The soil phosphorus levels are very low, ranging from 1 to 2.24 mg/kg. The low values of phosphorus may be due to phosphorus fixation due to the acidic nature of the soil. Phosphorus fertilisation will be required to establish good crop stand and growth at the area. An application of excess phosphorus will lead to long-term improvement in soil fertility.

Table 9-3: Soil Fertility Guidelines (Fertilizer Association of South Africa, 2016)

Guidelines (mg per kg)		
Macro Nutrient	**Low**	**High**
Phosphorus (P)	<5	>35
Potassium (K)	<40	>250
Sodium (Na)	<50	>200
Calcium (Ca)	<200	>3000
Magnesium (Mg)	<50	>300

9.7.3 Organic Carbon

Soil organic carbon provides an indication of organic matter content in a soil. Levels above 2 to 3 % are considered moderate to high (du Preez, Mnkeni, & van Huyssteen, 2010). The organic carbon content of the soil in the area ranged from 1.3 to 3.6% and these levels are between low to moderately high. An external nutrient input source, such as crop residues, will be required where deficiency of organic matter occurs, especially during the rehabilitation phase of the mining project so that revegetation can be successfully implemented.

9.7.4 Soil Texture

The particle size distribution of the soil sampled within the Project Area was classed into the percentages of sand, silt and clay present. The clay fraction ranged from 12 to 32%, sand from 20 to 75% and silt from 6 to 59 %. The textural class within each of the sample points was obtained from plotting the three soil fractions on a textural triangle (Figure 7-1).

Table 9-4: Soil Physico-Chemical Properties

Soil ID	**Soil form**	**pH**	**SAR**	**P (Bray1)**	**Na**	**K**	**Ca**	**Mg**	**B**	**Mo**	**Al**	**Fe**	**S**	**OC**	**Clay**	**Silt**	**Sand**	**Texture**
				mg/kg										**%**				
DAG01A	Glenrosa	4.82	1.04	1	296.5	406	2297	2314	176.4	<16	72208	115312	33.48	2.5	32	17.04	50.96	Sandy Clay Loam
DAG02A	Clovelly	3.90	0.71	1.46	106.1	2636	284.6	854.4	70.75	0	28270	20610	40.444	2.1	20	6.08	73.92	Sandy Loam
DAG03A	Glencoe	4.33	0.62	1.69	98.71	782.2	832.9	655.2	120.7	<16	32420	24960	38.59	1.3	20	8.24	71.76	Sandy Loam
DAG04A	Cartref	3.92	0.63	1	81.82	97.36	596.1	414.2	<80	<16	15190	46500	29.85	2.5	12	27.04	60.96	Sandy Loam
DAG06A	Bonheim	5.54	0.59	1.29	225.4	769.6	3998	4185	104.5	<16	77210	64384	25.70	3.6	20	59.84	20.16	Silty loam
DAG07A	Clovelly	3.92	0.38	2.24	39.93	449.6	207.3	371.5	<80	<16	42310	18240	40.38	1.6	20	6.64	73.36	Sandy Loam
DAG08A	Clovelly	5.26	1.91	1	844	327.6	3818	6574	<80	<16	35520	52592	20.65	1.6	12	12.64	75.36	Sandy Loam
DAG09A	Clovelly	4.02	65	1.26	93.48	905.2	446.3	667.7	<80	<16	49200	19360	40.70	1.6	24	10.6	65.4	Sandy Clay Loam

*Note: Highlighted cells indicate exceedance of guidelines for optimum agricultural potential

10 Soil Classification

Twelve different soil forms were identified within the surveyed area, and the distribution of the identified soil forms at the Project Area is presented in Table 10-1 and Figure 10-1.

Table 10-1: Identified Soil Forms within the Project Area

Soil Forms	Area Surveyed (km^2)	% Surveyed Area
Glenrosa	2.94	12
Clovelly	13.04	51
Mispah	7.99	31
Swartlands	0.26	1
Rock	0.25	1
Katspruit	1.04	4

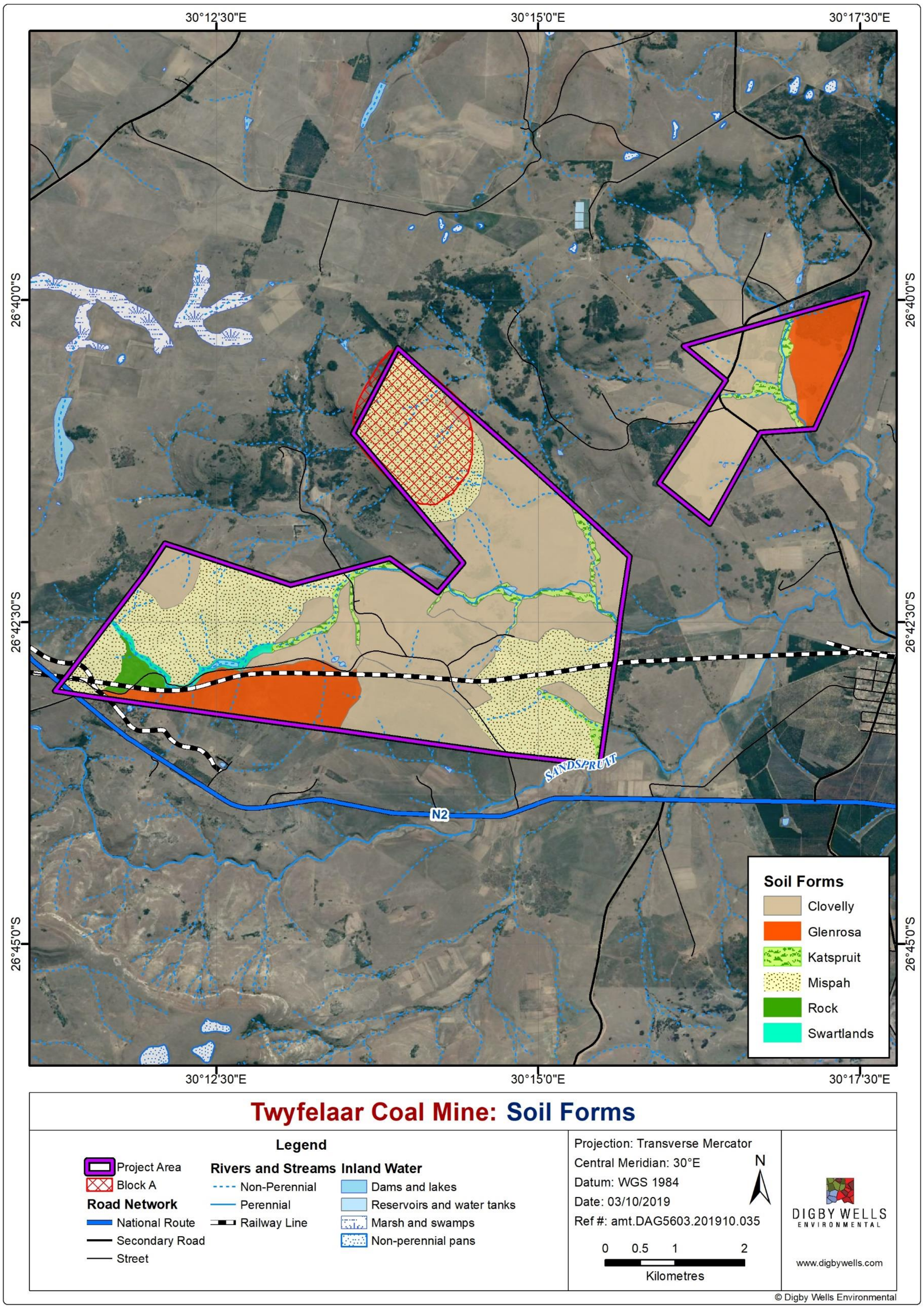

Figure 10-1: Soil Forms Distribution Map for the Project Area

11 Land Capability and Agricultural Potential

11.1 Land Capability

Land capability classes determined by Schoeman *et al*. (2002) were assigned to the Project Area, based on the soil form distribution on the project site. The site was classified into four (4) land capability classes. Class II and Class III represent arable capability, while Class VII and Class VIII represent soils capable for wildlife ranching. The land capability classes for the site are presented in Table 11-1 and in Figure 11-1.

Table 11-1: Land Capability within the Project Area

Class	**% Surveyed Area**	**Soil Form**	**Increased Intensity of Use**									**Land Capability Groups**	W - Wildlife F - Forestry LG- Light grazing MG - Moderate grazing IG - Intensive grazing LC - Light cultivation MC - Moderate cultivation IC - Intensive cultivation VIC - Very intensive cultivation
II	51	Clovelly	W	F	LG	MG	IG	LC	MC	IC	-	Arable land	
VII	48	Glenrosa, Mispah, Swartlands, Katspruit,	W	F	LG	-	-	-	-	-	-	Wildlife	
VIII	1	Rock	W	-	-	-	-	-	-	-	-		

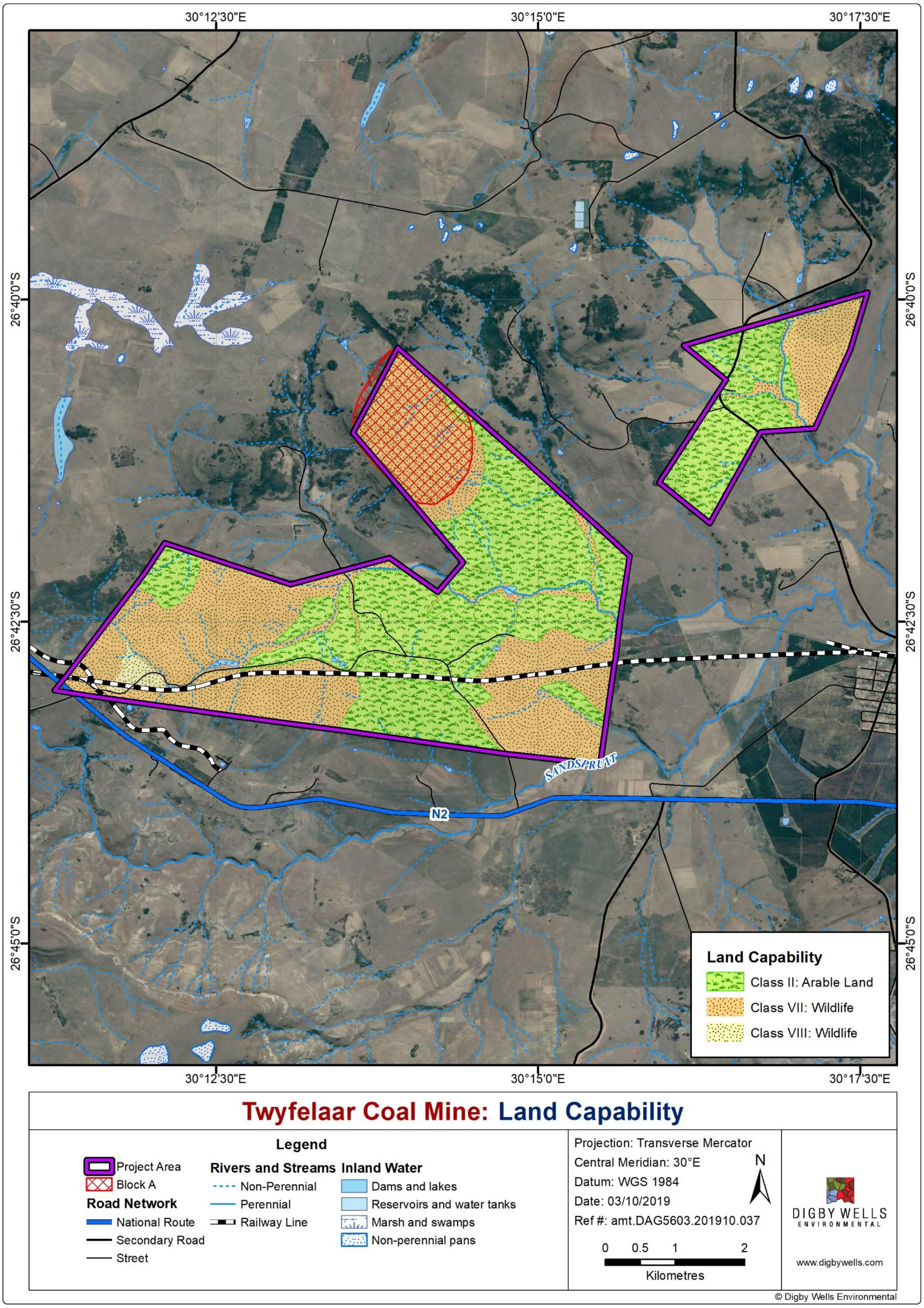

Figure 11-1: Land Capability Map for the Project Area

11.2 Land Suitability

Soil agricultural potential or suitability mapping was determined by considering the soil forms, land capability classes, soil chemistry results, the hydrology of the site and the current land use (Table 11-2). The process involved allocating terrain factors (such as slope) and soil factors (such as depth, texture, internal drainage and mechanical limitations (which affect soil-water processes)) which define soil forms, to an area of land. The soil chemistry, which includes pH, cation and anion concentrations as well as nitrogen compositions, which are affected by the site hydrology, were considered in determining the final suitability of the soil. The suitability guidelines used in this study are presented in Table 7-2 (Schoeman *et al.*, 2002)

Table 11-2: Land Suitability Classification within the Project Area

Class	% Surveyed Area	Soil Forms	Definition	Conservation Need	Agricultural Potential/ Use-Suitability
II	51	Clovelly	▪ Slight limitations. ▪ High arable potential ▪ Low erosion hazard	Adequate run-off control	Annual cropping with special tillage or ley
V	4	Katspruit	▪ Watercourse and land with wetness limitations	Protection and control of water table	Improved pastures or Wildlife
VII	45	Glenrosa, Mispah & Swartlands	▪ Very severe limitations ▪ Suitable only for natural vegetation	Adequate management for natural vegetation.	Natural veld grazing and afforestation
VIII	1	Rock	▪ Extremely severe limitations ▪ Not suitable for grazing or afforestation	Total protection from agriculture.	Wildlife

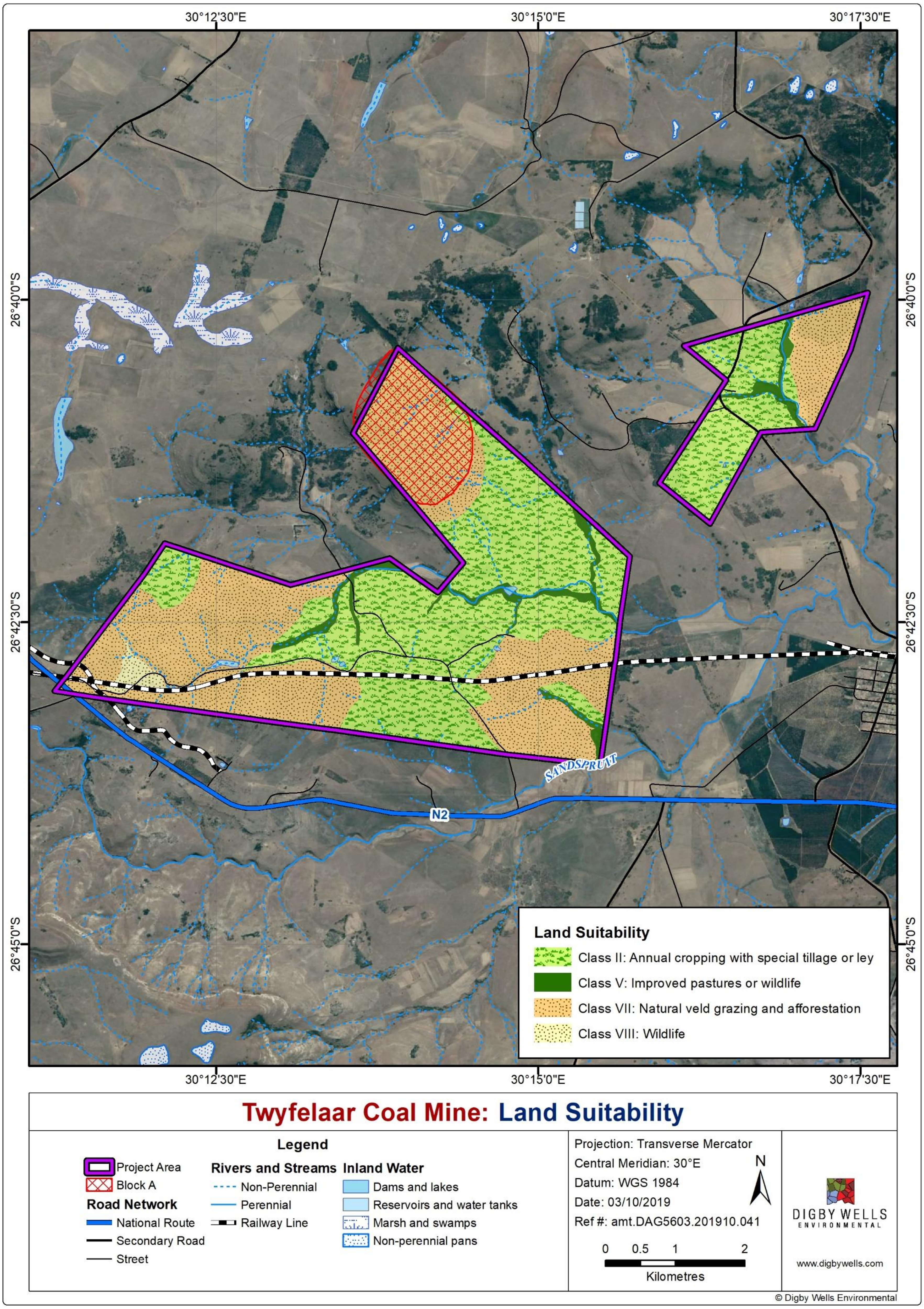

Figure 11-2: Land Suitability Map for the Project Area

12 Impacts Assessment

This section provides the significance rating of identified potential impacts pre-mitigation and post-mitigation. The potential impacts identified in this section are a result of both the environment in which the proposed project activities takes place, as well as the actual activities. The impacts that could affect the soils and land capability within the areas where activities will be undertaken are:

- Loss of the soil resource due to change in land use and removal of the soil. The construction of mine facilities will change land utilization potential (land capability) resulting in the complete loss of the soils resource for the life of the project activity;
- Loss of the soil resource due to wind and water erosion of unprotected soils;
- Change in soil characteristics (soil texture) due to compaction of areas during construction;
- Contamination of the soil resource due to hydrocarbon spillages and agrochemicals; and
- Loss of the soil resource due to the disturbance and clearing of vegetation.

12.1 Construction Phase Impacts

During the construction phase, site clearing is necessary for the preparation of surface infrastructure development, where vegetation will be removed along with topsoil. This includes the construction of pollution control dams, offices and workshops, adit, clearance for discard dumps and topsoil stockpiles. When soil is removed, the physical properties are changed, and the soils' chemical properties will deteriorate unless properly managed. When organic matter has been removed either by the clearing of an area for development or by erosion; the soils' fertility is reduced, or soil acidity could increase. Vehicles will drive on the soil surface during the construction phase, thereby causing compaction of the soils. This reduces infiltration rates and ability for plant roots to penetrate the compacted soil. Soil will be prone to erosion where vegetation has been removed during the construction phase. The loss of vegetation cover will exacerbate the impact as runoff potential will be increased leading to erosion. Once the soil is eroded it reduces the overall soil depth and as a result the land capability further deteriorates.

There are chances for contamination by hydrocarbons (oils, fuels, grease) from vehicles or other machinery during construction, operational and decommissioning phases which could contaminate soils.

12.1.1 Impact Rating

The construction phase impacts are rated in Table 12-1 to Table 12-3.

Table 12-1: Disturbance of Soils and Subsequent Soil Loss by Water Erosion

Dimension	Rating	Motivation	Significance
Activity and Interaction: Site clearance for construction work disturbs soils and exposes them to erosion by wind and water			
Impact Description: Soil loss by wind and water erosion from cleared land surfaces			
Prior to Mitigation/Management			
Duration	5	The impact of soil erosion will occur during the life of the project.	Moderate (negative) - 84
Extent	4	Loss of soil will only occur within Project Area and its surroundings.	
Intensity	5	Loss of soil resource due to erosion. Once the resource has been lost from the landscape it cannot be recovered.	
Probability	6	Site clearance will expose soil and erosion will occur.	
Nature	Negative		
Post-Mitigation			
Duration	4	The impact will occur on a long-term basis	Negligible (negative) - 32
Extent	2	Loss of soil is limited only to Project Area due to soil management measures being implemented.	
Intensity	2	Minor loss and/or effects to biological or physical resources or low sensitive environments, not affecting ecosystem functioning.	
Probability	4	There is a probability that the impact will occur.	
Nature	Negative		

Table 12-2: Soil Chemical Pollution as a Result of Spillages of Oils, Fuels and Grease from Vehicles and Machinery

Dimension	Rating	Motivation	Significance
Activity and Interaction: Movement of vehicles and machinery and general handling of hydrocarbons may result in spillages of hydrocarbons such as oils, fuels and grease			
Impact Description: Soil contamination by hydrocarbon spillages and leakages			
Prior to Mitigation/Management			
Duration	5	The impact on soils will occur during the life of the project.	Minor (negative) - 66
Extent	3	The impact may extend across the site and to nearby environments	
Intensity	3	Moderate loss and/or damage to biological or physical resources of low to moderately sensitive environments and, limiting ecosystem function.	
Probability	6	It is highly probable that oil, grease or fuel spillages will occur during the project life	
Nature	Negative		
Post-Mitigation			
Duration	4	Long term: 6-15 years and impact can be reversed with proper management	Negligible (negative) - 28
Extent	2	Impact on soils may occur through accidental spillages localised to the incident area.	
Intensity	1	Minimal to no loss and/or effect to biological or physical resources, not affecting ecosystem functioning	
Probability	4	The impact on soil resources will likely occur	
Nature	Negative		

Table 12-3: Soil compaction

Dimension	Rating	Motivation	Significance
Activity and Interaction: Movement of heavy machinery			
Impact Description: Soil compaction resulting from the movement of heavy machinery within the Project Area			
Prior to Mitigation/Management			
Duration	5	The impact of soil compaction will occur during the life of the project	Moderate (negative) - 60
Extent	3	Soil compaction will only occur within the Project Area	
Intensity	4	Soil compaction due to the movement of heavy machinery	
Probability	5	Site clearance and the movement of heavy mine vehicles will result in soil compaction	
Nature	Negative		
Post-Mitigation			
Duration	4	The impact will occur on a long-term basis	Negligible (negative) - 32
Extent	2	Soil compaction is limited only to Project Area provided that soil management measures are implemented	
Intensity	2	Minor loss and/or effects to biological or physical resources or low sensitive environments, not affecting ecosystem functioning.	
Probability	4	There is a probability that the impact will occur.	
Nature	Negative		

12.1.1.1 Management Actions

The following mitigation and management measures have been prescribed for the construction phase:

- Runoff must be controlled and managed by use of proper stormwater management measures;

- Re-fuelling must take place on bunded impervious surfaces to prevent seepage of hydrocarbons into the soil;
- Establishment of effective vegetation around constructed infrastructure for adequate soil protection from wind and water erosion;
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place at regular intervals or after high rainfall events;
- Restriction of vehicle movement over sensitive areas to reduce compaction;
- Minimise unnecessary removal of the natural vegetation cover outside the development footprint;
- All vehicles and machines must be parked within hard park areas and must be checked daily for fluid leaks;
- Place drip trays where there are vehicles or machinery leaks occurring;
- Fuel, grease and oil spills should be remediated using commercially available emergency clean up kits;
- For major spills (>5L), if soils are contaminated, they must be stripped and disposed of at a licensed waste disposal site; and
- Any contractors on site must ensure that all employees are aware of the procedure for dealing with spills and leaks and undergo training on site.

12.2 Operational Phase

Storage of fuel, lubricants and explosives can impact on soil quality while hydrocarbon spills can occur when heavy mining machinery is used because big machines contain large volumes of oils and diesel. There is a chance of the machines breaking down and/or leaking during mining.

Furthermore, when the soil is stockpiled, the soil chemical properties will deteriorate unless properly managed. This may lead to the loss of topsoil if stockpiling is not done properly.

Underground mines may result in subsidence of the surface topography which presents different challenges for farming. Subsidence of the soil surface may cause changes in drainage lines, waterlogging and a change in land capability influencing land use. This impact must be quantified through expert consultation with the relevant engineers/geotechnical specialists.

12.2.1 Impact Ratings

The operational phase impacts are rated in Table 12-4 and Table 12-5.

Table 12-4: Soil Chemical Pollution from Hydrocarbon waste (lubricants, explosives and fuels)

Dimension	Rating	Motivation	Significance
Activity and Interaction: Soil chemical pollution			
Impact Description: Soil Contamination from Hydrocarbon waste (lubricants, explosives and fuels)			
Prior to Mitigation/Management			
Duration	5	The impact on soils will occur during the life of the project.	Minor (negative) - 66
Extent	3	The impact may extend across the site and to nearby environments	
Intensity	3	Moderate loss and/or damage to biological or physical resources of low to moderately sensitive environments and, limiting ecosystem function.	
Probability	6	It is highly probable that oil, grease or fuel spillages will occur during the project life	
Nature	Negative		
Post-Mitigation			
Duration	4	Long term: 6-15 years and impact can be reversed with proper management	Negligible (negative) - 28
Extent	2	Impact on soils will may occur through accidental spillages localised to the incident area.	
Intensity	1	Minimal to no loss and/or effect to biological or physical resources, not affecting ecosystem functioning.	
Probability	4	The impact on soil resources can possibly occur	
Nature	Negative		

Table 12-5: Deterioration of Topsoil Quality in Topsoil Stockpiles

Dimension	Rating	Motivation	Significance
Activity and Interaction: During the stripping and stockpiling process there may be some unexpected changes in the depth and the nature of the soil.			
Impact Description: Deterioration of Topsoil Quality from in Topsoil Stockpiles			
Prior to Mitigation/Management			
Duration	4	The impact on soils will occur over a long-term period prior to mine rehabilitation	Minor (negative) - 60
Extent	2	The impact will be localised within topsoil stockpiles	
Intensity	4	Serious medium-term environmental effects. Environmental damage can be reversed in less than a year	
Probability	6	The impact is highly probable	
Nature	Negative		
Post-Mitigation			
Duration	4	The impact on soils will occur over a long-term period prior to mine rehabilitation	Negligible (negative) - 28
Extent	2	The impact will be localised within topsoil stockpiles	
Intensity	1	Amelioration of topsoil prior to rehabilitation will restore soil fertility hence impact intensity will be low after mitigation	
Probability	4	The impact on soil resources can possibly occur.	
Nature	Negative		

12.2.1.1 Management Actions

The following mitigation and management measures have been prescribed for the operational phase:

- Soil pollution monitoring should be conducted at selected locations on the project site to detect any extreme levels of pollutants;

- Any spillages of sewage effluent from treatment plant or ablution facilities should be quickly cleaned-up and the removed contaminated soils should be disposed of at accredited disposal sites;
- A Topsoil Management Plan (TMP) must be prepared to demonstrate how topsoil will be preserved in a condition as near as possible to its pre-mining condition in order to allow successful mine rehabilitation (Statham, 2014);
- Long term stockpiles should be revegetated to minimise loss of soil quality. This will minimise weed infestation, maintain soil organic matter levels, maintain soil structure and microbial activity and maximise the vegetative cover of the stockpile;
- Topsoil stripping should be scheduled for the dry season, where possible; and
- All long-term topsoil material stockpiles should be located outside the active mine path and away from drainage lines.

12.3 Decommissioning and Closure Phase

The major impacts to consider in the decommissioning and rehabilitation of the site will be the loss of topsoil as a resource through erosion and compaction and contamination by hydrocarbon waste including oils, grease and fuels. When the decommissioning and removal of infrastructure takes place, vehicles will drive on the surface, compacting it and this will reduce infiltration rates as well as the ability for plant roots to penetrate the compacted soil. Vegetation cover will be reduced increasing runoff potential, which leads to increased erosion hazards.

The infrastructure areas need to be rehabilitated and as a result the impact may be reduced if mitigation measures are implemented. After the infrastructure removal and rehabilitation, the areas must be assessed for compaction and possible erosion risk and corrected immediately if necessary. Additionally, subsidence and cracking of soils must be monitored closely.

The waste or discard that may be expected from the Project Area is classified as a Type 3 waste which should be disposed of into a Class C landfill facility or a facility with a similar performing liner system. Some analysed coal samples from the project site show acid generating potential, hence, Acid Mine Drainage (AMD) is expected to occur post-closure (Diby Wells Environmental, 2019).

12.3.1 Impact Ratings

The rehabilitation impacts described are rated in Table 12-6 and Table 12-7.

Table 12-6: Impact Rating During Rehabilitation of Infrastructure Areas and Roads

Dimension	Rating	Motivation	Significance
Demolition of infrastructure and rehabilitation of affected areas			
Impact Description: Disturbance of soils and subsequent erosion by wind and water			
Prior to Mitigation/Management			
Duration	6	The impact will remain for some time after the life of a Project.	Minor (negative) - 65
Extent	3	Extending across the site and to nearby environments	
Intensity	4	Serious medium-term environmental effects	
Probability	5	The impact may likely occur	
Nature	Negative		
Post-Mitigation			
Duration	2	Impact will be less than a year if rehabilitation measures are implemented correctly	Negligible (negative) - 24
Extent	2	Impact will be limited to the site due to implementation of mitigation measures	
Intensity	2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants.	
Probability	4	The impact can possibly occur	
Nature	Negative		

Table 12-7: Impact Rating due to Acid Mine Drainage

Dimension	Rating	Motivation	Significance
Reaction of sulphide compounds in extracted coal residues with water and oxygen			
Impact Description: Contamination from Acid Mine Drainage			
Prior to Mitigation/Management			
Duration	6	The impact will remain beyond project life	Moderate (negative) - 98
Extent	5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate	
Intensity	3	Extending across the site and to nearby settlements.	
Probability	7	There are sound scientific reasons to expect that the impact will occur	
Nature	Negative		
Post-Mitigation			
Duration	2	Impact will be less than a year if rehabilitation measures are implemented correctly	Negligible (negative) - 30
Extent	2	Impact will be limited to the site due to implementation of mitigation measures	
Intensity	2	With effective prevention of the oxidation of iron sulphides the AMD impact will have low to moderate intensity	
Probability	5	The impact will likely occur	
Nature	Negative		

12.3.1.1 Management Actions

The following management actions are recommended:

- Implement land rehabilitation measures;
- Compacted areas are to be ripped to loosen the soil and vegetation cover re-instated;
- Inventory of hazardous waste materials stored on site should be compiled and arrange complete removal;

- Monitor decant of AMD and implement management measures which include in-situ passive treatment or neutralisation and electrolytic treatment using a Water Treatment Plant (WTP) to get purified water for discharge to the natural environment or for other beneficial uses.
- Seal the shaft by placing concrete plugs;
- Underground materials should be disconnected prior to removal;
- Ensure proper storm water management designs are in place to ensure no run-off or pooling occurs;
- Conduct soil contamination assessment to assess if any remediation is required prior to future land use development;
- Only designated access routes are to be used to reduce any unnecessary compaction; and
- The backfilled, reprofiled landscape should be top soiled and revegetated to allow free drainage close to the pre-mining conditions.

13 Cumulative Impact

Cumulative impacts on soil resources were viewed in the light of similar mining or related operations within the W53A quaternary catchment that contribute similar or related pollutants to soil resources within or downstream of the Project Area. No cumulative impacts are expected since there are no similar mining activities close to or immediately upslope of the Project Area.

14 Unplanned Events and Low Risks

There is a risk of accidental spillages of hazardous substances, such as hydrocarbons during the life of the project. The soil pollution impacts from these activities have already been detailed in Section 13.

15 Monitoring Plan

15.1 Supervision and Responsibilities

Supervision of activities and soil resources monitoring are essential aspects of any land use change project. The following should be observed:

- The Mine Manager and the Environmental Practitioner (EP) should be responsible to determine effectiveness of erosion control structures;
- The Mine Manager and the EP should ensure soil contamination monitoring on site, especially where hydrocarbons are stored and applied; and

- Training of sub-contractors and all workers on the operational procedures and mitigation measures should be undertaken.

15.2 Monitoring Requirements

The following items should be monitored continuously:

- Soils:
- Erosion status;
- Compaction;
- and
- Contamination; and
- Vegetation cover.

The following maintenance is required:

- Subsidence should be monitored annually;
- Repair any damage caused by erosion;
- If soil is polluted, treat the soil by means of *in-situ* remediation, if possible; and
- If *in-situ* treatment is not possible then the polluted soil must be classified according to the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Material and disposed of at an appropriate, permitted or licensed disposal facility.

16 Conclusions and Recommendations

The following actions are recommended to reduce adverse effects on the soil resources of the Project Area:

- Runoff must be controlled and managed by use of proper stormwater management measures;
- Re-fuelling must take place on a sealed surface area away from soils to prevent seepage of hydrocarbons into the soil;
- Establishment of effective soil cover such as lawn grass around constructed infrastructure for adequate protection from wind and water erosion;
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place at regular intervals or after high rainfall events;
- Restriction of vehicle movement over sensitive areas to reduce compaction;
- Minimise unnecessary removal of the natural vegetation cover outside the development footprint;

- All vehicles and machines must be parked within hard park areas and must be checked daily for fluid leaks;
- Place drip trays where there are vehicles or machinery leaks occurring;
- Fuel, grease and oil spills should be remediated using commercially available emergency clean up kits;
- For major spills (>5L), if soils are contaminated, they must be stripped and disposed of at a licensed waste disposal site;
- Any contractors on site must ensure that all employees are aware of the procedure for dealing with spills and leaks and undergo training on site; and
- Soil pollution monitoring should be conducted at selected locations on the project site to detect any extreme levels of pollutants.

17 Reasoned Opinion of the Specialist

Based on the baseline and impact assessment significance ratings, it is the opinion of the specialist that this project is feasible and should be considered if the recommended management and mitigation measures are correctly implemented to minimise potential impacts on soils and to maintain their land capability for future land use. Soil management measures and monitoring requirements as set out in this report should form part of the conditions for environmental authorisation.

18 References

ARC. (2006). *Land Types of South africa.* Pretoria: Agricultural Research Council of South Africa.

Camp. (1999). *A Bioresource Classification for KwaZulu-Natal, South Africa.* Pietermaritzburg: Unpublished MSc Thesis, University of KwaZulu-Natal.

Chamber of Mines of South Africa/Coaltech. (2007). *Guidelines for the Rehabilitation of Mined Land.*

de Villiers, E. (2014). *Twyfelaar Conceptual Mining Study Report.* Johannesburg: ECMA Consulting (Pty) Ltd.

Diby Wells Environmental. (2019). *Dagsoom Coal Mine Waste Classification.* Johannesburg.

du Preez, C., Mnkeni, P., & van Huyssteen, C. (2010). *Knowledge Review on Land Use and Soil Organic Matter in South Africa.* Brisbane, Australia: 19th World Congress of Soil Science, Solutions for a Changing World.

Fertilizer Association of South Africa. (2016). *Fertilizer Handbook.*

Geoterraimage. (2014). *South African National Land-Cover Dataset.* Retrieved from Data User Reportand Metadata: http://www.geoterraimage.com/downloads.php

Meng, L., Qi-yana, F., Laia, Z., Pinga, L., & Qing-juna, M. (2009). Environmental cumulative effects of coal underground mining. *Procedia Earth and Planetary Science 1*, 1280–1284.

Msukaliswa Local Municipality. (2010). *Msukaligwa Spatial Development Framework.*

Schoeman et al. (2002). *Development and application of a land capability classification system for South Africa.* Pretoria: Agricultural Research Council.

Soil Classification Working Group. (1991). *The Soil Classification System of South Africa.* Pretoria: Soil Science of South Africa.

South African Sugar Association. (1999). *Identification and management of the soils of the South African Sugar Industry.* Durban.

Statham, P. (2014). *NAC Topsoil Management Procedure.*

WRC. (2015). *Water Resources of South Africa Study.* Pretoria: Water Research Commission.