DIGBY WELLS
ENVIRONMENTAL

Proposed Open Cast Coal Mine on Portions 1, 2, 4, 9, 13 and 19 of the Farm Palmietkuilen 241 IR, near Springs in the Gauteng Province

Soil, Land Use and Land Capability Assessment Report

Project Number:

CNC4065

Prepared for:

Canyon Coal (Pty) Ltd

March 2017

Digby Wells and Associates (South Africa) (Pty) Ltd
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Project Name:	**Proposed Open Cast Coal Mine on Portions 1, 2, 4, 9, 13 and 19 of the Farm Palmietkuilen 241 IR, near Springs in the Gauteng Province**
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I, Siphamandla Madikizela as duly authorised representative of Digby Wells and Associates (South Africa) (Pty) Ltd., hereby confirm my independence (as well as that of Digby Wells and Associates (South Africa) (Pty) Ltd.) and declare that neither I nor Digby Wells and Associates (South Africa) (Pty) Ltd. have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of Canyon Coal (Pty) Ltd, other than fair remuneration for work performed, specifically in connection with the proposed Palmietkuilen Open Coal Mine near Springs, Gauteng.

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EXECUTIVE SUMMARY

Digby Wells Environmental (hereafter Digby Wells) was requested by Canyon Coal (Pty) Ltd to conduct a soils land use and land capability assessment, pursuant to an application for a Mining Right to mine coal on Portions 1, 2, 9, 13, and 19 of the Farm Palmietkuilen 214 IR, near Springs in the Gauteng Province of South Africa. The proposed project area falls within the Sedibeng District Municipality within Gauteng and borders the province of Mpumalanga. The soils assessment forms part of the report and application.

In order to identify soils accurately, it is necessary to undertake a soil survey. The aim is to provide an accurate record of the soil resources of an area. Land capability, land use and agricultural potential are then determined from these results. The objective of determining the land capability is to find and identify the most sustainable use of the soil resource without degrading the system.

As part of the desktop assessment, baseline soil information was obtained from South African land type data published with maps at a scale of 1:250 000 by the Institute for Soil, Climate and Water (ISCW) of the Agricultural Research Council (ARC). A detailed study of the soils within the project area was conducted during field visits in August and September, 2016. The site was traversed by vehicle and on foot. Soils were investigated by augering to a maximum depth 1.2 m or to the depth of refusal. Soil survey positions were recorded as waypoints using a handheld GPS. At each observation point, the South African Taxonomic Soil Classification System was used to describe and classify the soils. Land capability was determined by a combination of soil, terrain and climate features. Land capability is defined by the most intensive long term sustainable use of land under rain-fed conditions. Land use was determined by aerial imagery, ground-truthed during the site visit.

The land type data indicated that the main land types were Ba1, Bb3 and Ea15, all dominated by moderately deep to deep well drained soils. The soils are dominated by Hutton (red) and Clovelly (yellow-brown) forms with subsidiary occurrence of Mispah, Glencoe, Kroonstad, Westleigh, Katspruit and Arcadia forms.

Hutton and Clovelly soil forms are well drained and have high agricultural potential. Glencoe and Mispah have a shallow rooting depth and have high erosion hazard. The land capability consists of predominately Class II (Hutton and Clovelly soils suitable for intensive cultivation), followed by Class III (Moderate cultivation) and Class v (Wet zones). Class III land has limitations that include moderately steep slopes, highly susceptibility to water or wind erosion, very slow permeability of the subsoil, low water-holding capacity, moderate salinity or sodicity, and/or low fertility that is not easily corrected. Class V land represents the Arcadia soils. Although these soils are deeper, they have high expansible clay content and are physically difficult to manage. The dominant land use within the project area is cultivated crops with subsidiary areas of grassland, shrubland and woodland.

The fertility status of the soils is generally moderate with some requirement for lime (to counteract acidity) and phosphate fertiliser to achieve full cropping potential. Exchangeable base cations (potassium, calcium, magnesium) are present at sufficient levels and there is neither sodium nor salinity hazard. Texture is variable, from loamy sand through sandy loam to sandy clay loam. Of the total area, approximately 2000 ha is assessed to be arable and very suitable for agriculture while about 1500 ha is either marginal or unsuitable.

The major impact on soil resources associated with open pit mining occurs through destruction of the soil profile. Soil layers are stripped and stockpiled for later use in rehabilitation. During this process there can be a loss of topsoil through erosion and dilution of topsoil through mixing with deeper soil horizons. Compaction and loss of soil structure commonly also occur as well as a loss of biological activity if topsoil is deeply stockpiled for long periods. Thus the rehabilitated land is typically less suitable for agriculture than it was before mining. In addition, depending on the geochemical nature of the mined environment, there is a risk of the land becoming polluted. Colliery spoils are frequently affected by acidity and/or salinity associated with the oxidation of sulphide minerals.

The following actions are recommended to minimise adverse effects of mining on soils and land capability:

- Soil should be stripped during dry months (May to October), adhering to clearly defined guidelines for stripping, with topsoil being saved separately to permit, after mining, reconstruction of the soil profile into one resembling that which was removed.
- The soil stockpile should have a maximum height of 10 m to minimise adverse effects on soil chemical and physical properties.
- Soil fertility should be assessed and restored by means of sampling and chemical analysis, before mining and after rehabilitation.

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Pandospan (Pty) Ltd (Pandospan) concluded a contract with Anglo Operations (Pty) Limited (AOL) in support of the acquisition of a Prospecting Right for coal (DMR Ref. No. GP 30/5/1/1/2 (201/10026) PR). Pandospan forms part of the Canyon Group of Companies for which Canyon Coal functions as the operational division. The enviro-legal applications for the project will be managed by Pandospan on behalf of AOL, the Project applicant.

AOL is planning the development of a new open pit coal mining operation located near Springs within the Gauteng Province to be known as the Palmietkuilen Coal Mining Project. A coal processing plant and associated infrastructure will also be constructed. The Project is a green-fields development planned on Portions 1, 2, 4, 9, 13 and 19 of the Farm Palmietkuilen 241 IR.

Coal mining will be undertaken by conventional truck - and - shovel operations. Run of mine (RoM) coal will be processed at the proposed plant on site and sold to local and export markets. Key infrastructure will include:

- Open pit mining;
- Processing plant and fuel storage;
- Haul roads from pit to plant and from plant to mine access point, and various conveyor belts;
- Various overburden dumps and ROM stockpile area;
- Pollution control dam (PCD), storm-water trenches and sewage management systems; and
- Site offices and security offices.

1.1 Listed and Specified Activities

The project activities are divided into the three Project phases, namely, the Construction Phase, the Operational Phase and the Decommissioning (Table 1-1).

Table 1-1: Project Activities

Project Phase	Project Activity
Construction Phase	▪ Site establishment; ▪ Site clearing, including the removal of topsoil and vegetation; ▪ Construction of mine related infrastructure, including haul roads, pipes, dams; ▪ Construction of washing plant; ▪ Relocation of Infrastructure (gravel road diversion) ▪ Blasting and development of initial box-cut

Project Phase	Project Activity
	for mining, including stockpiling of material from initial box-cuts; and ▪ Temporary storage of hazardous products (fuel and explosives), waste and sewage.
Operational Phase	▪ Stripping topsoil and soft overburden; ▪ Removal of overburden, including drilling and blasting of hard overburden; ▪ Loading, hauling and stockpiling of overburden; ▪ Drilling and blasting of coal; ▪ Load, haul and stockpiling of RoM coal; ▪ Use and maintenance of haul roads for the transportation of coal to the washing plant; ▪ Water use, pit dewatering and storage on-site; ▪ Slurry management; and ▪ Storage, handling and treatment of hazardous products (including fuel, explosives and oil) and waste.
Decommissioning Phase	▪ Demolition and removal of all infrastructure, including transporting materials off site; ▪ Rehabilitation, including spreading of soil, re-vegetation and profiling or contouring; ▪ Environmental monitoring of decommissioning activities; and ▪ Storage, handling and treatment of hazardous products (including fuel, explosives and oil) and waste. ▪ Post-closure monitoring and rehabilitation.

1.2 Terms of Reference

The following tasks were undertaken in the compilation of the soil, land use and land capability assessment:

- A baseline soil assessment of the proposed project site;
- Field survey - Soils occupying the area were surveyed and the project site was traversed by vehicle and on foot. A hand soil auger was used to survey the soil types present as well to obtain soil samples for laboratory analysis;
- Description and categorisation of soils using the South African Soil Classification Taxonomic System;
- Soil fertility analysis;

- Identification and assessment of potential soil, land use and land capability impacts resulting from the proposed open pit, topsoil stockpile and other associated infrastructure project including impacts associated with the construction, operation, decommissioning and post closure phases of the project;
- Recommendations with regards to mitigation measures to minimise impacts and/or optimise benefits associated with the proposed project; and
- The findings of the study were included in Environmental Impact Assessment (EIA) report and provided a baseline analysis of existing soil conditions.

2 Details of the Authors

The following is a list of the Digby Wells' staff who were involved in compilation of the soils assessment report and peer review for Palmietkulien Project:

Siphamandla Madikizela is a Soil Scientist and completed his MSc in Soil Science at University of KwaZulu-Natal. Prior to his employment at Digby Wells Environmental, Siphamandla worked as an Assistant Plantation Manager at EcoPlanet Bamboo SA. He is the part of the Closure, Rehab and Soils Department at Digby Wells Environmental. His role involves conducting soil surveys, identification of soil forms, interpreting results of soil samples and writing detailed scientific reports.

Brett Coutts: Rehabilitation Unit Manager received a Bachelor of Science and Honours degree in Zoology and Environmental Science from the University of Witwatersrand. Brett assists with the management and co-ordination of all relevant studies related to rehabilitation. This includes the compilation of rehabilitation plans and undertaking of rehabilitation assessments. In addition to this, Brett assists within the Biophysical Department with the management of specialist studies that are undertaken by the department and is also responsible for the compilation of the Geographic Information System (GIS) component of Biodiversity Land Management Plans (BLMP) and undertaking ecological assessments. He previously worked for Hydromulch, a company that specialises in vegetation rehabilitation.

Renée van Aardt; Renée is the Divisional Manager: Mine Closure and Rehabilitation. Renée's specialisation is compilation of practical mine closure plans and development closure liability assessments throughout the mine life cycle. Renée has extensive expertise in rehabilitation and several years' experience in the implementation of closure plans as well as negotiating closure criteria and financial provisions in both South Africa and Tanzania.

Prof Martin Venn Fey is a private consultant and an Associate of Digby Wells. Martin obtained the BSc Agric (soil science, chemistry, 1971) and PhD (soil science, 1976) degrees from the University of Natal. His career began with mapping soils in the Eastern Cape for the Soil and Irrigation Research Institute and evaluation of bauxite deposits in the Natal midlands for a private exploration company. Most of his subsequent career was spent in academic positions at the Universities of Natal (Pietermaritzburg), Texas A & M (USA), Georgia (USA), Cape Town, Stellenbosch (as Professor and Head of the Dept. of Soil

Science) and Western Australia (as Professorial Fellow). His research has dealt with the genesis, chemistry, mineralogy and fertility of soils. He recently spent five years in Australia doing research on the rehabilitation of mineral and mining wastes. He is Extraordinary Professor at the University of Pretoria and is currently engaged as a consultant with the IFC (World Bank Group) in Kenya. He has authored or co-authored 70 papers in refereed journals and another 50 articles published either as book chapters or in conference proceedings. His book on Soils of South Africa was published in 2010 by Cambridge University Press.

3 Aims and Objectives

This report aimed to provide an accurate record of the soil resources of the study area through provision of the following data:

- The land type data describing the soil types to be found;
- Soil types and their mapped distribution;
- Description of the pre-development baseline land capability;
- Description of the baseline and pre-development land use;
- Soil chemical and physical properties;
- Soil management plan;
  - Stripping depth and volumes;
  - Soil stripping guidelines; and
  - Soil utilisation guideline.
- Impact assessment of the proposed open pit mining and infrastructure development activities on the soil, land capability and land use; and
- Mitigation measurements to manage the existing and expected impacts on soil, land capability and land use.

4 Environmental Law Applicable to Study

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

- Soils and land capability area protected under the National Environmental Management Act 107 of 1998, the Minerals Act 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 treated;

- The Conservation of Agricultural Resources Act of 1983 states that the degradation of the agricultural potential of soil is illegal; and
- The Conservation of Agricultural Resources Act 43 of 1983 requires that protection of land against soil erosion and the prevention of water logging and salinization of soils means of suitable soil conservation works to be constructed and maintained. The utilisation of marshes, water sponges and water courses are also addressed.

5 Methodology

This section provides methodology used in the compilation of the soils report as indicated in Figure 5-1.

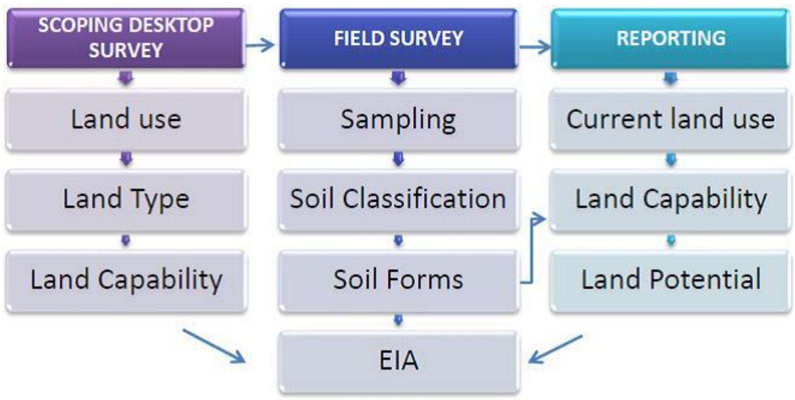

Figure 5-1: Soil, Land Use and Land Capability Survey and Report Process

5.1 Literature Review and Desktop Assessment

The desktop study was completed during the Scoping Phase in July 2016. The following data was obtained and studied to prepare for the site survey and the baseline reporting:

- Existing Land Type data was used to obtain generalised soil patterns and terrain types for the proposed Palmietkuilen 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 (Land Type Survey Staff, 1972 - 2006). These maps and their accompanying reports provide a statistical estimate of the different soils that can be expected in the area;
- The land types for the site are Ba1, Bb3 and Ea15;
- The project area is not yet disturbed by mining activities and the area is dominated by Class II (Intensive cultivation) capability followed by Class III (Moderate cultivation) and Class V (Wet zones) land capabilities; and
- Class II and III falls under Arable land group, while Class V falls under Grazing land group.

5.2 Soil Classification

A detailed soil assessment of the soils present on the proposed site was conducted during a field visit in August and September 2016. The site was traversed by vehicle and on foot. A hand soil auger was used to determine the soil type and depth. Soils were investigated using a bucket auger to a maximum depth of 1.2 m or to the depth of refusal. Survey positions were recorded as waypoints using a handheld GPS. Other features such as existing open trenches were helpful to determine soil types and depth. The soil forms (types of soil) found were identified using the South African Soil Classification System (Soil Classification Working Group, 1991).

5.3 Soil Sampling and Analysis

Nineteen soil samples (Figure 5-2) (topsoil: 0 – 0.3 m and subsoil: 0.3 – 0.6 m) of the dominant soil forms were collected at the project area. The samples were stored in plastic bags and sent to Intertek Agricultural Laboratory in Bapsfontein for analysis. Samples were analysed for indicators of acidity, fertility and texture as follows:

- Soil pH (KCl);
- Exchangeable cations (Ca, Mg, K, Na) and S (ammonium acetate extraction);
- Cation exchange capacity (CEC using ammonium acetate);
- Phosphorus (Bray No. 1 extractant); and
- Soil texture (Sand, Clay and Silt).

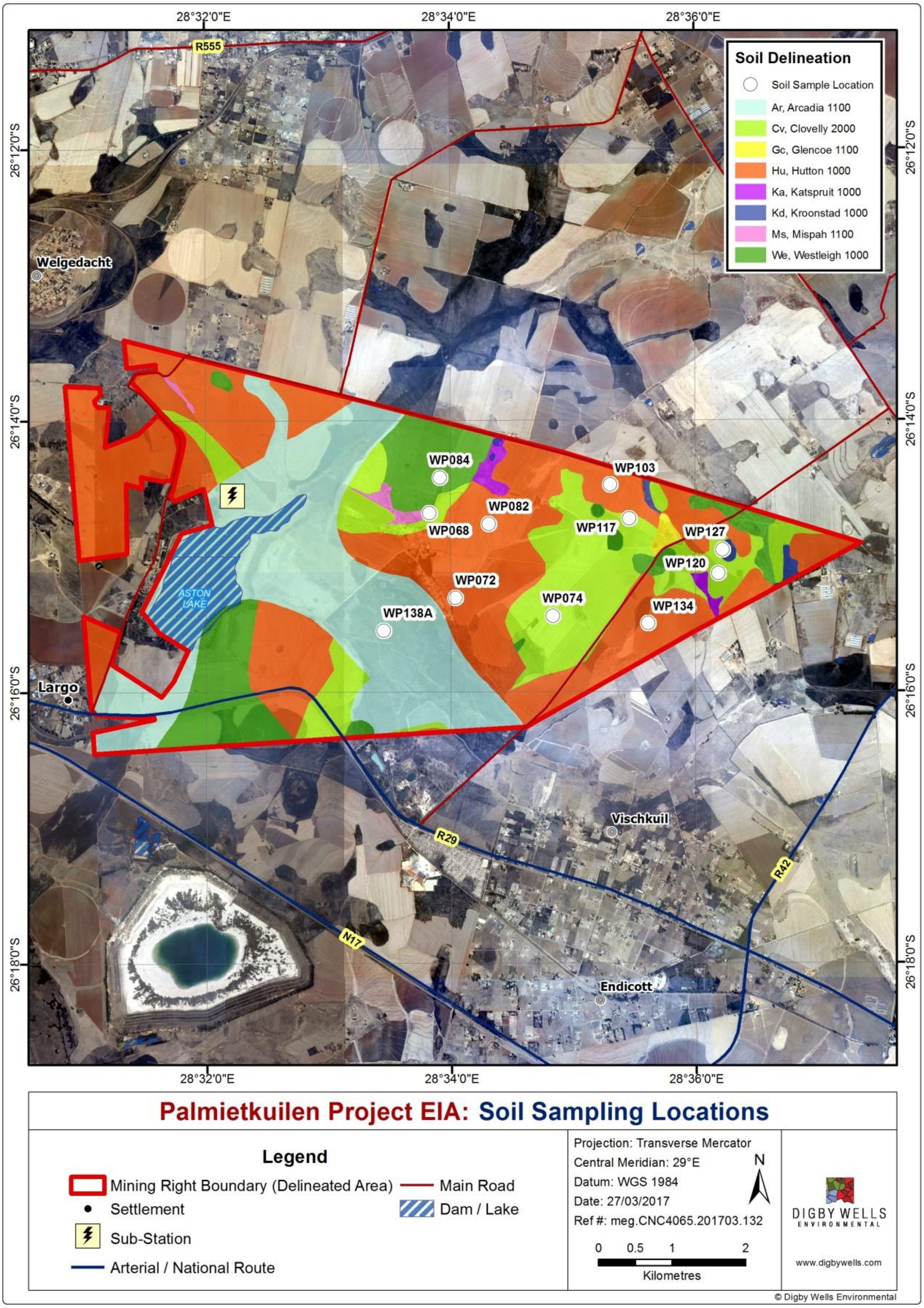

Figure 5-2: Soil Sampling Locations

5.4 Land Capability

Land capability was determined by a combination of soil, terrain and climate features. Land capability is defined by the most sustainable land use under rain-fed conditions. Land capability was categorised into the classes listed in Table 5-1.

Table 5-1: Land Capability Classes

Land Capability Class	**Increased Intensity of Use**									**Land Capability Groups**
I	W	F	LG	MG	IG	LC	MC	IC	VIC	**Arable Land**
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							
VIII	W									**Wildlife**

W – Wildlife

MG - Moderate Grazing

MC - Moderate Cultivation

F- Forestry

VIC - Very Intensive Cultivation

IG - Intensive Grazing

IC - Intensive Cultivation

LG - Light Grazing

LC - Light Cultivation

Land capability as defined in South Africa can be classified using two approaches. The **first approach** is used in agriculture and is recommended by Schoeman *et al* (2000) who defined land capability in terms of the combined effects of soil, terrain and climatic features. The defined land capability shows the most intensive long-term use of land for rain-fed agriculture and at the same time indicates the permanent limitations associated with different land use classes. The classification system is made up of land capability classes and land capability groups (Table 5-1).

The **second approach** is contained in the Coaltech Research Association and the Chamber of Mines of South Africa Guidelines for the Rehabilitation of Mined Land, 2007. These 2007 Guidelines recommend the following classes of post mining rehabilitated land: arable, grazing, wilderness and wetland.

The following criteria are used to define these classes:

- **Arable:** The soil depth exceeds 0.6 m, the soil material is not sodic or acidic and slope percentage is such that when multiplied by the soil erodibility factor K, the product does not exceed a value of 2.0;
- **Grazing:** The soil depth is less than 0.6 m but more than 0.25 m;
- **Wilderness:** The soil depth is less than 0.25 m but more than 0.15 m; and
- **Wetland:** The soil depths are as for grazing but soil must be used for the construction of wetlands. These wetland soils must be separately stockpiled.

5.5 Land Use

The current land use was identified by aerial imagery during the scoping phase and by on-site inspection during the environmental impact assessment (EIA) phase. The land use is classified as follows:

- Plantations;
- Natural;
- Waterbodies;
- Mines;
- Urban built-up; and
- Cultivated.

6 Assumptions and Limitations

The following assumptions and limitations have been made:

- The information provided in this report is based on information gathered from site visit undertaken on the 31st August to 2nd September 2016;
- The information contained in this report is based on auger points taken and observations on site; and
- The area surveyed was based on the infrastructure layout presented by the Applicant.

7 Baseline Environment

The land type data gathered during the scoping phase suggested that the dominant land types on site were Ba1, Bb3 and Ea15 (Figure 7-1). The field survey confirmed these findings with the dominant soil forms in the area of the open pit and infrastructure. Further information related to the soil within the project area is discussed in Section 7.1 below. The project area is dominated by the Hutton, Clovelly and Arcadia soil forms with small portions of Mispah, Glencoe, Katspruit, Kroonstad and Westleigh forms as shown in Figure 7-2.

These soils are described in more detail in the sections below. The project site is dominated by the presence of soils highly suited to agriculture such as Hutton and Clovelly which represent 56% of the project site. The remainder of the project area consists of soils with low agricultural potential and wetland soils.

7.1 Land Type Data and Soil Forms

Table 7-1: Dominant Land Types and Soil Forms

Land Type	Soil Forms	Geology	Characteristics
Ba1	Hutton; Mispah and Clovelly.	Shale, sandstone, slate, quartzite and lava of the Witwatersrand Supergroup	Dominated by moderately deep to deep well drained soils. Mispah has a high erosion hazard and a shallow rooting depth.
Bb3	Hutton; Mispah; Westleigh; Kroonstad, Katspruit, Glencoe and Clovelly	Shale, sandstone, clay, conglomerate and limestone of the Ecca Group, shale and tillite of the Dwyka Formation, dolerite and dolomite	This land type is dominated by moderately deep to deep well drained soils with plinthic character at depth on the higher lying areas.
Ea15	Arcadia and (probably) Rensburg forms	Alluvium, dolerite, sandstone and shale of the Ecca Group	Consists of soil with significant accumulation of smectitic (swelling) clay (vertic horizon).

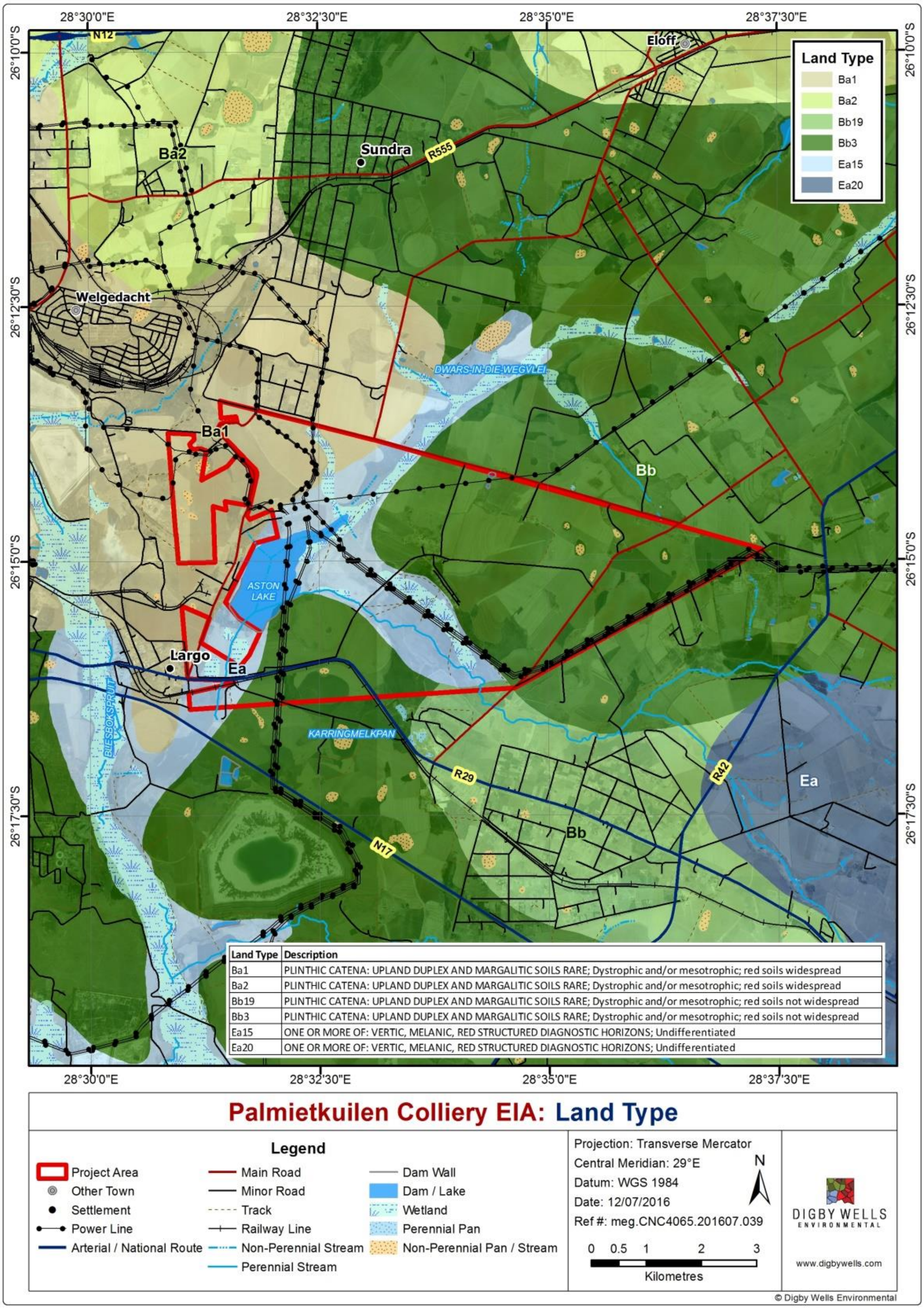

Figure 7-1: The Land Type Map for the Palmietkuilen Colliery EIA (Land Type Survey Staff, 1976-2006)

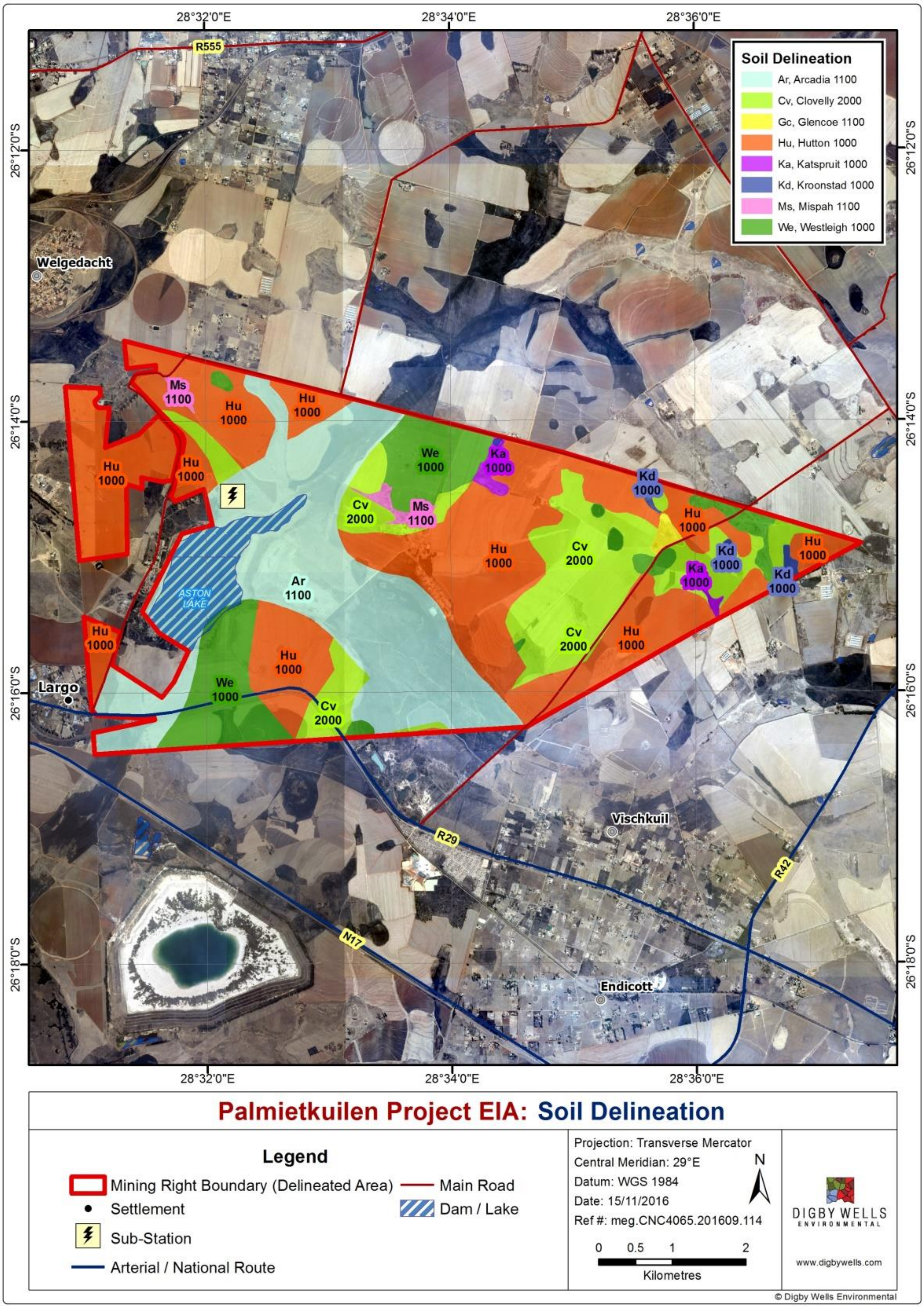

Figure 7-2: Soil Map for the Palmietkuilen Project EIA

7.1.1 Hutton Form

The Hutton soil form consists of an orthic A and red apedal B over unspecified material. These soils are well drained, usually slightly acidic, and have a low cation exchange capacity (CEC) due mainly to clay mineral composition (kaolinite, iron oxides) and sometimes low clay content. This soil form was identified in relatively flat landscape positions and has high arable potential and high value for use as topsoil, having favourable structure (weak blocky to apedal) and consistence (slightly firm to friable).

7.1.2 Clovelly Form

The Clovelly soil form consists of an orthic A and yellow-brown apedal B over unspecified material. Like those of the Hutton form these soils are well drained, slightly acidic and have low CEC. They have similarly favourable physical properties for use in rehabilitation. The yellow-brown colour (due to goethite) is commonly indicative of a moister soil climate than that of adjacent Hutton soils (red colour due to hematite) in the same landscape.

7.1.3 Arcadia Form

The Arcadia soil form consists of a deep vertic A over unspecified material. (If the material at depth is gleyed clay, then the soil form is Rensburg). These soils are black in colour and extremely physically active. They have shrink-swell properties (Fey *et al*., 2010). With the start of the rainy season, Arcadia soils are dry and cracked and water infiltration is high bypassing the soil body and potentially recharging the groundwater or downslope soils. When it rains, the soil swells and the cracks close and infiltration rate slows (Fey *et al*., 2010). These soils hold large amounts of water which often are not available to crops. Arcadia soils can accommodate a selected composition of vegetation such as grazing vegetation for cattle or strong rooted crops such as cotton or sunflower.

7.1.4 Mispah Form

The Mispah soil form consists of an orthic A over hard rock material. These soils are shallow, have a low agricultural potential, usually a high erosion hazard and have limited rooting depth.

7.1.5 Glencoe Form

The Glencoe soil form consists of an orthic A, and yellow-brown apedal B over a hard plinthic B horizon (iron oxide cemented pan, known colloquially as *mgubane* or *ouklip*). Glencoe soils are low to moderately suitable for crop production depending on the depth of the hard plinthic horizon. For shallow Glencoe soils, the impermeable plinthic material can impede rooting depth and cause periodic waterlogging (Fey *et al*., 2010).

7.1.6 Katspruit Form

The Katspruit soil form consists of an orthic A over a diagnostic G horizon. The G horizon it is saturated with water for long periods unless artificially drained is dominated by grey colour and lacks saprolitic and plinthic character. This soil form usually indicates the presence of seasonal or permanent wetlands and thus signifies a wetland land capability class.

7.1.7 Kroonstad Form

The Kroonstad soil form consists of an orthic A over an E horizon overlying a G horizon. Saturation of the G horizon results in protracted anaerobic conditions resulting in reduction of ferric oxides which results in the grey colour (Fey *et al*., 2010). Intermittent wetness in the E horizon and even more protracted wetness in the G horizon can prove problematic and drainage of some kind is usually required.

7.1.8 Westleigh Form

The Westleigh soil form consists of an orthic A over soft plinthic B horizon. The soft plinthic layer forms as a result of intermittent wetness due to a fluctuating water table typically associated with distinct dry and wet seasons. Iron and manganese migrate and precipitate as mottles and concretions or nodules. Westleigh soils are normally not considered suitable for cultivation.

7.2 Land Capability

Land capability is determined by a combination of soil, terrain and climate features. The dominant land capability classes in the project area were Class II (Intensive cultivation, 57%), followed by Class III (Moderate cultivation, 15%) and Class V (Wet zones, 28%), as depicted in Figure 7-3. The ensuing paragraphs list in detail the limitations used to define the three classes. Arable land capability covers 72% of the area while non-arable covers 28%. The land capability where the proposed open mining and infrastructure is to be constructed will be reduced from highly arable to non-arable.

7.2.1 Class II: Arable

Class II land capability coincides with the Hutton and Clovelly soils. These soils are well drained, easily managed and have high agricultural potential. Land in Class II has some limitations that reduce the choice of plants or require moderate conservation practices. It may be used for cultivated crops, but with less latitude in the choice of crops or management practices than Class I. The limitations are few and the practices are easy to apply. Limitations may include, singly or in combination, the effects of:

- Gentle slopes;
- Moderate susceptibility to wind and water erosion;
- Less than ideal soil depth;
- Somewhat unfavourable soil structure and workability;

- Slight to moderate salinity or sodicity easily corrected but likely to recur;
- Occasional damaging flooding;
- Wetness correctable by drainage but existing permanently as a moderate limitation; and
- Slight climatic limitations on soil use and management.

Limitations may cause special soil-conserving cropping systems, soil conservation practices, water-control devices or tillage methods to be required when used for cultivated crops.

7.2.2 Class III: Arable

Land in Class III has more severe limitations that reduce the choice of plants or require special conservation practices or both. Land may be used for cultivated crops, but has more restrictions than Class II. When used for cultivated crops, the conservation practices are usually more difficult to apply and to maintain. The number of practical alternatives for average farmers is less than that for soils in Class II. Limitations restrict, singly or in combination, the amount of clean cultivation, time of planting, tillage, harvesting and choice of crops. Limitations may result from the effects of one or more of the following:

- Moderately steep slopes;
- High susceptibility to water or wind erosion or severe adverse effects of past erosion;
- Frequent flooding accompanied by some crop damage;
- Very slow permeability of the subsoil;
- Wetness or some continuing waterlogging after drainage;
- Shallow soil depth to bedrock, hardpan, fragipan or clay-pan that limits the rooting zone and water storage;
- Low water-holding capacity;
- Low fertility not easily corrected;
- Moderate salinity or sodicity; and
- Moderate climatic limitations.

7.2.3 Class V: Grazing

Class V land capability coincides with the Arcadia soils. Although these soils are deeper, they have high clay content and shrink/swell properties, making them very difficult to manage from an agricultural perspective. Land in Class V has little or no erosion hazard but has other limitations impractical to ameliorate which limit its use largely to grazing or wildlife. Limitations restrict the kind of plants that can be grown and prevent normal tillage of cultivated crops.

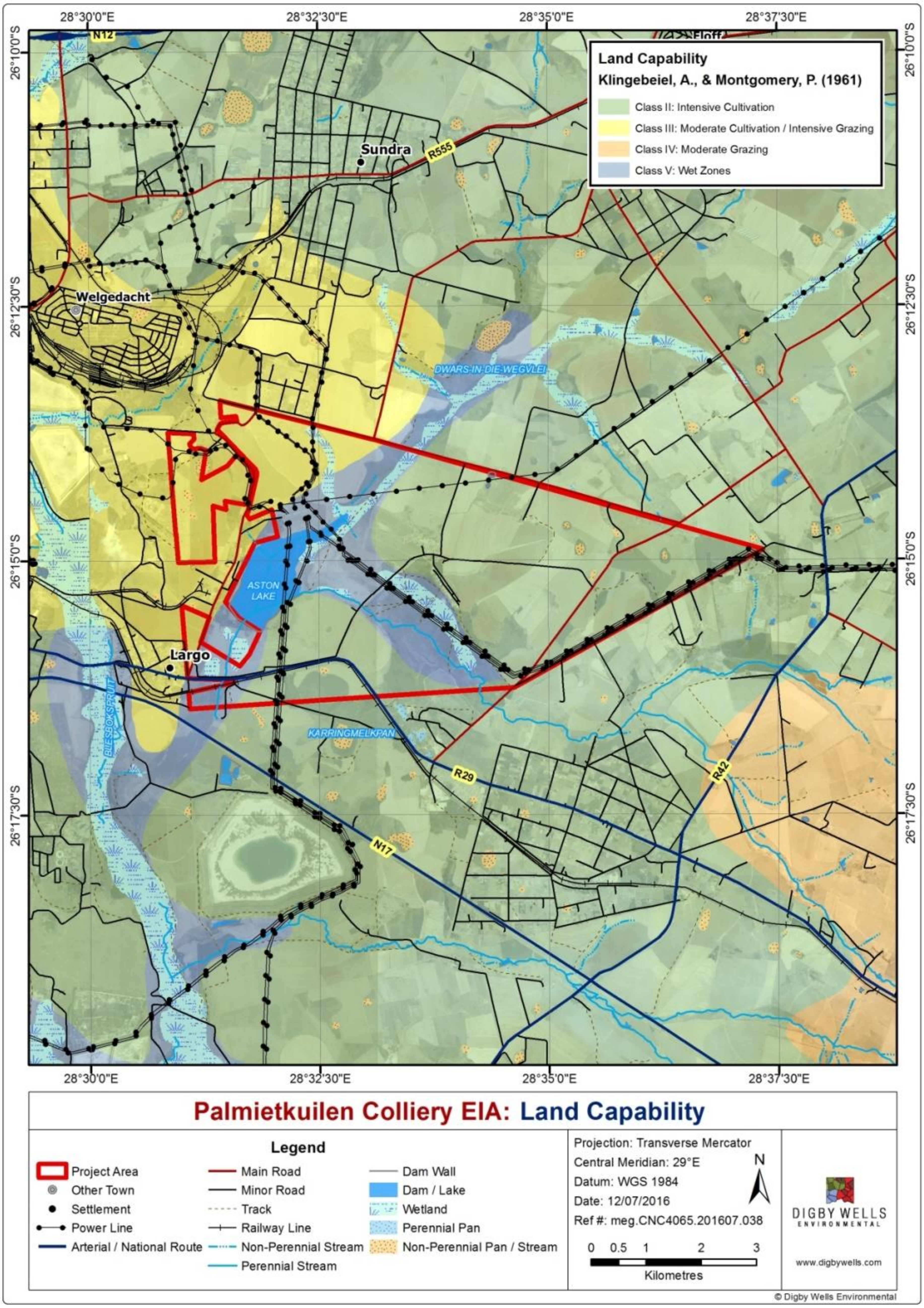

Figure 7-3: The Land Capability Map for the Palmietkulien Colliery EIA (Land Type Survey Staff, 1976 – 2006)

7.3 Land Use

The most dominant land use as shown in Figure 7-4 is cultivated areas which occupy 63% of the project site followed by grazing which occupies 37 % including wetlands and water body. This reflects the fact that that the area has been developed for agriculture over years. The main impact on land use will be the change from crop production to that of mining. The cumulative impact on land use will be converting into open cast mining and infrastructure areas resulting in loss of agricultural land in that area for the mining life (<50 years) and after mining land can be restored. Surrounding land use can be broadly defined as arable land under cultivation on commercial farms.

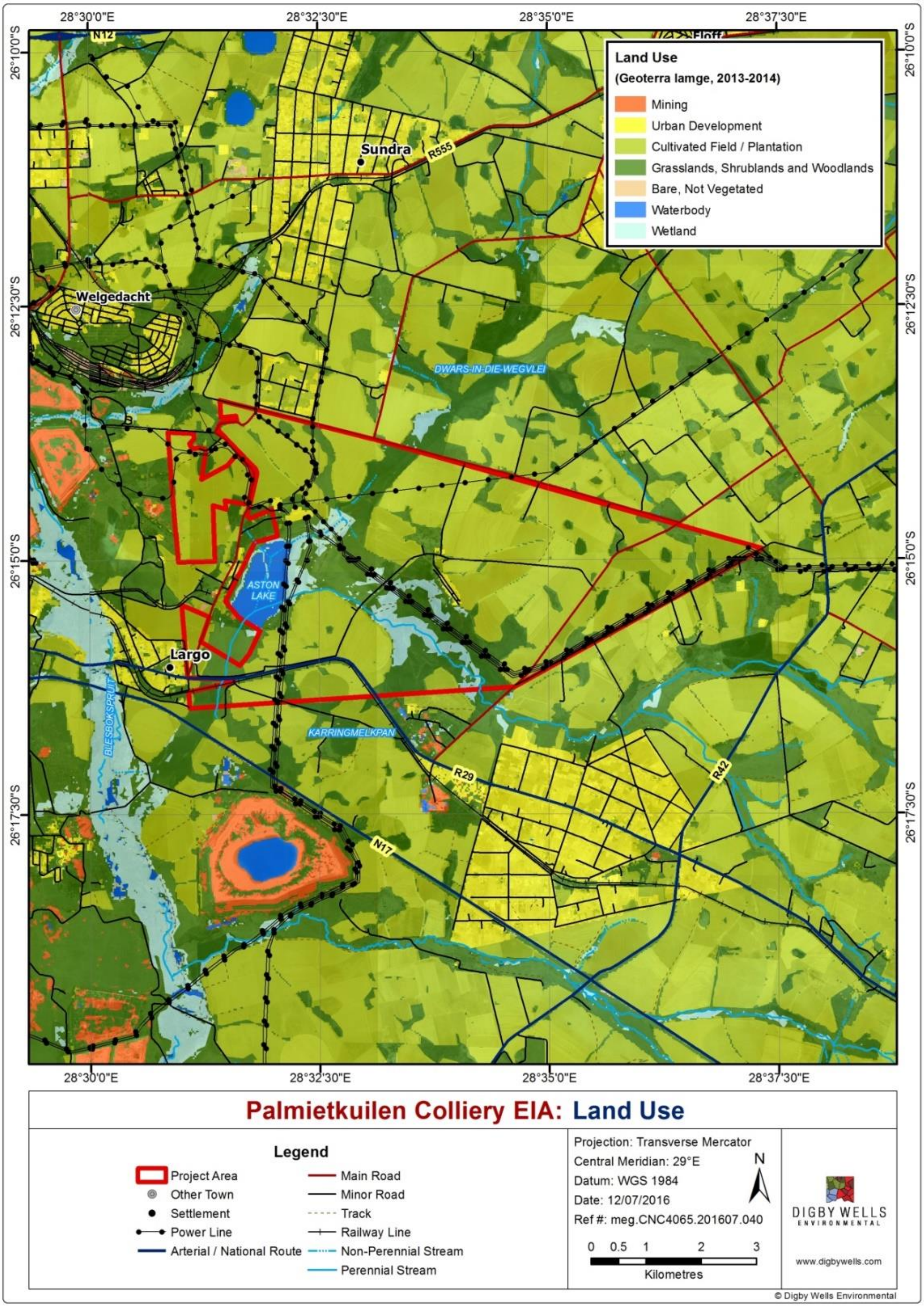

Figure 7-4: The Land Use Map for the Palmietkulien Colliery EIA

7.4 Soil Chemical and Physical Characteristics

The results of soil analysis are presented in Table 7-2 and as a basis for interpreting these data some local soil fertility guidelines are presented in Table 7.3.

Table 7-2: Soil Physico-Chemical Results

Land Ref	Soil Form	pH (KCl)	P(Bray1)	K	Na	Ca	Mg	S	CEC	C	Clay	Sand	Silt	Texture
			mg/kg						cmol/kg	%				
WP068	Ms1100	4.4	17	166	9	473	104	10	37	0.6	13	71	16	Loamy Sand
WP072A	Hu1000	4.4	58	95	7	344	80	23	27	0.6	13	81	6	Loamy Sand
WP072B	Hu1000	5.2	3	38	9	432	103	20	25	0.7	19	72	9	Loamy Sand
WP074A	Cv2000	5.7	9	85	9	689	158	12	32	0.5	27	70	3	Sandy Clay Loam
WP074B	Cv2000	6.1	4	52	10	853	184	18	33	0.4	23	61	16	Sandy Clay Loam
WP082A	Hu1000	4.3	84	94	6	260	74	9	20	0.7	11	81	8	Loamy Sand
WP082B	Hu1000	4.2	16	64	7	190	57	15	18	0.6	13	77	10	Loamy Sand
WP084A	We1000	4.5	10	89	12	543	136	10	32	0.6	13	69	18	Sandy Loam
WP084B	We1000	5.2	1	61	45	719	321	34	39	0.5	27	56	17	Sandy Clay Loam
WP103A	Hu1000	4.9	39	197	10	595	144	16	32	0.4	23	62	15	Sandy Clay Loam
WP103B	Hu1000	5.4	6	66	8	634	145	18	26	0.5	31	54	15	Sandy Clay Loam
WP117A	Cv2000	5.5	12	106	7	572	100	10	28	0.7	13	74	13	Sandy Loam
WP117B	Cv2000	5.4	3	49	8	770	119	14	33	0.6	27	61	12	Sandy Clay Loam
WP120A	Cv2000	4.8	20	242	22	758	264	17	39	0.7	23	59	18	Sandy Clay Loam
WP120B	Cv2000	4.6	3	189	95	1147	451	44	40	0.6	37	43	20	Clay Loam
WP127A	Kd1000	5.5	16	236	10	684	135	14	33	0.6	15	68	17	Sandy Loam
WP127B	Kd1000	6.0	8	241	9	708	179	15	38	0.6	19	65	16	Sandy Loam
WP134A	Hu1000	4.9	14	212	16	706	149	12	37	0.4	17	69	14	Sandy Loam
WP138A	Ar1100	5.2	2	309	149	5135	1811	63	44	2.5	55	20	25	Clay

Table 7-3: Soil Fertility Guidelines (Fertiliser Association of South Africa, 2003)

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

In general the acidity level of the soils is slight to moderate, with only a few samples having a pH near the threshold of about 4.5 (measured in KCl) indicative of a likely response to lime application. On most of the soils a positive crop response to lime application would not be expected. This is confirmed by the Ca and Mg status which in all but one or two soils (WP082A and B with pH of 4.2-4.3) is satisfactory in relation to the norms in Table 7-3.

Phosphorus availability is variable but shows evidence of past fertilizer application on many of the soils and potassium status is relatively high in the great majority of the soils. The light texture and low organic carbon status of all the soils besides the Arcadia (WP138A, last row of Table 7-2) have adverse implications for rehabilitation because compaction problems are potentially severe, as has been widely found in open cast coal mining areas of the Highveld. By contrast, the Arcadia soil is considerably better endowed with base cations, organic carbon, clay, and cation exchange capacity. The low available P status of the Arcadia sample reflects a probable history of no cropping on this wetland soil. Because of the high nutrient status and well buffered pH, soils such as Arcadia with a vertic horizon are potentially very suitable for rehabilitation work. Although the black clay is potentially difficult to work because of unfavourable consistence, it has the advantage of a self-mulching habit meaning that clods will "weather" to a fine crumb structure due to shrinking and swelling with changes in water content. Also, the shrink-swell behaviour could potentially have a favourable effect in counteracting mechanical compaction caused by heavy machinery employed for rehabilitation. Vertic soils can be used successfully for crop and pasture production if managed judiciously (Fey *et al*, 2010).

8 Agricultural Potential

Among the dominant soils in Table 8-1, the Hutton and Clovelly forms have high agricultural potential, Westleigh has low potential and Arcadia has a low potential in its wetland setting but as discussed above this can be moderate to high under suitable management.

Table 8-1: Agricultural potential for soils

Soil Form	Depth	Hectares	Agricultural Potential
Hutton	0 – 1.2	1382	High
Clovelly	0 – 1.2	575	High
Glencoe	0 – 0.5	12	Low to moderate
Kroonstad	0 – 0.5	18	Low to moderate
Mispah	0 – 0.3	20	Very Low
Arcadia	0 – 0.4	1025	Low*
Katspruit	0 – 0.4	28	Very low*
Westleigh	0 – 0.4	413	Low

* Potential rated low in a wetland context but can be high with suitable management.

8.1 Dryland Crop Production

The largest part of the project area is currently used for crop production. Soils of Hutton and Clovelly are highly suitable for crop production and according to the Department of Agriculture in co-operation with ARC-Grain Crops Institute; 350 to 450 mm of rain per annum is required for successful maize production. The project area is therefore suitable for rain-fed maize production with its average annual rainfall of 677 mm (Digby Wells Environmental, 2016). The Glencoe and Mispah soil are considered more suitable for grazing. Soils of Katspruit and Arcadia have wetland land capability and are not suitable for crop production except possibly if landscaping during rehabilitation allows suitable drainage and water management in which case these soils can be very productive. .

8.2 Irrigated Crop Production

The project area has irrigation infrastructure that was being used for irrigation purposes including a large dam. Currently the Hutton, Clovelly and Glencoe soils are suitable for irrigated crop production.

9 Sensitivity Analysis and No-Go Areas

Burial grounds, graves and heritage buildings are sensitive areas in the project area (Figure 9-1). Soils in these areas should not be stripped as they are protected as the graves and heritage buildings are protected by the law (National Heritage Resources Act, No. 25 of 1999).

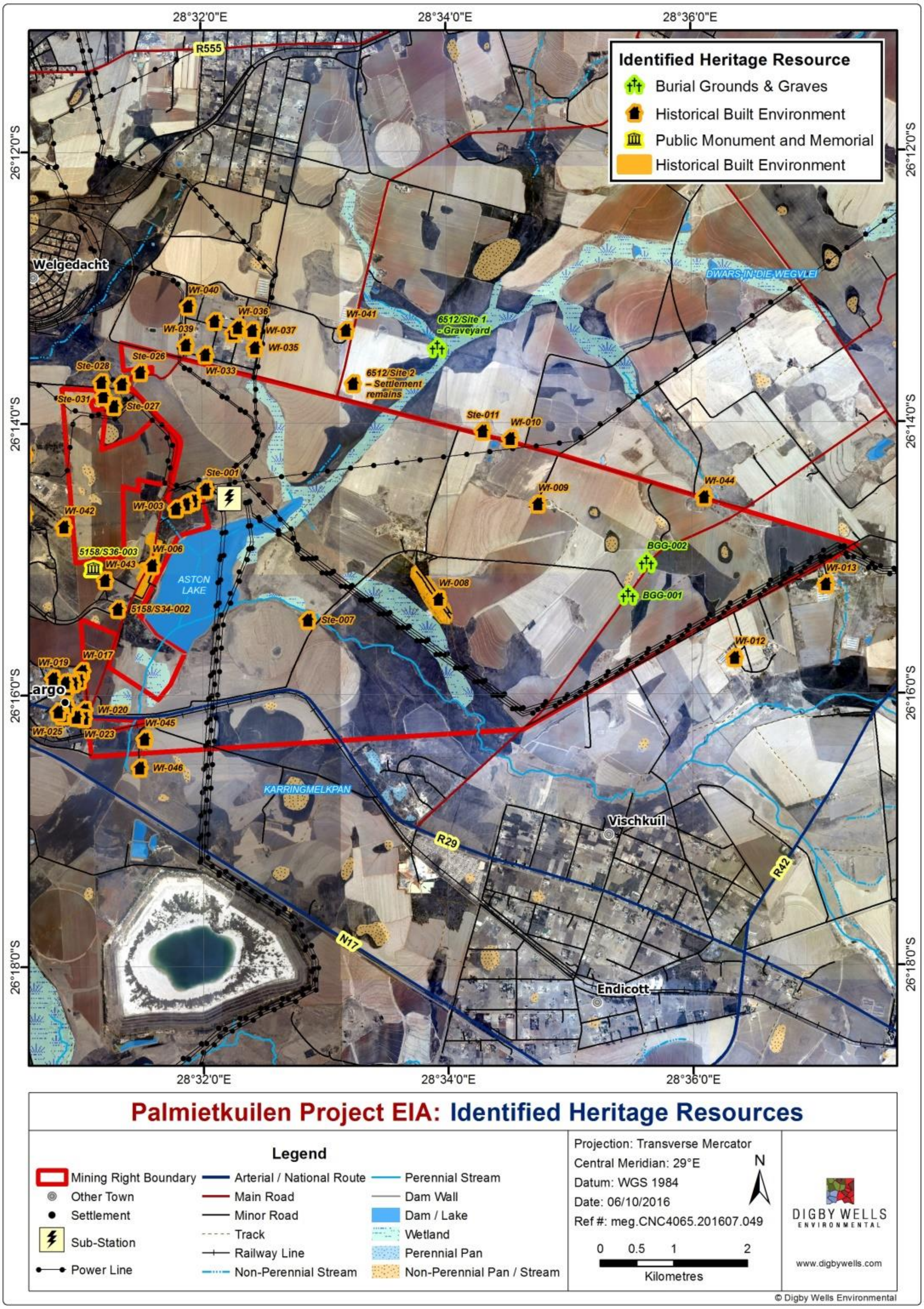

Figure 9-1: Identified Heritage Resources for Palmietkuilen Project

10 Potential Impacts

The major impact associated with open pit mining and infrastructure development is the disturbance of the naturally occurring soil profiles consisting of soil horizons. The impact on the soil is high because natural soil horizons are stripped and stockpiled for later use in rehabilitation. Soil fertility is adversely affected because soil horizon thickness does not coincide with that of the defined topsoil layer. The topsoil is where most plant roots are found and is generally about 0.3 m thick. Topsoil contains organic matter which is linked to nutrient cycling, improving soil fertility. Mixing topsoil with subsoil dilutes soil fertility and impacts on microbial activity leading to soil quality degradation in stockpiles over time. The impacts on soils associated with open pit mining can be split up into the following:

- Dilution of topsoil through mixing with subsoil and deeper lying materials;
- Decline in organic matter content and biological activity during stockpiling;
- Compaction and loss of soil structure;
- Disconnection of soil type with original landscape position, hence destruction of the toposequence; and
- Impossibility of reconstructing soil profile hydrology, especially the proportions of runoff, infiltration, interflow and through flow of rain water, especially in cases where less permeable subsurface horizons consisting of clay, plinthite or rock were present initially.

11 Impact Assessment

11.1 Methodology used in Determining and Ranking the Nature, Significance, Consequence, Extent, Duration and Probability of Potential Environmental Impacts and Risks

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 11-3. 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 measure proposed in this EIA/EMP Report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 11-2, which is extracted from Table 11-1. The description of the significance ratings is discussed in Table 11-3.

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 11-1: 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.	<u>International</u> 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 definitely 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.	<u>National</u> 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. <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 extending only as far as the development site 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 to the site and its immediate surroundings.	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 as a result 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 11-2: Probability/Consequence Matrix

		Significance																																					
Probability	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 11-3: 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) (-)

11.2 Impact Assessment

The impact assessment is aimed at identifying impacts related to the various activities listed in from a soils perspective. The activities associated with soil impacts are highlighted in grey below and discussed within the impact and risk sections below.

Table 11-4: Proposed Project Activities for Coal Mine

	Construction
1	Site establishment;
2	Site clearing, including the removal of topsoil and vegetation;
3	Construction of mine related infrastructure, including haul roads, pipes and dams;
4	Construction of washing plant and Waste Rock Dump;
5	Relocation of Infrastructure;
6	Blasting and development of initial box-cut for mining, including stockpiling of material from initial box-cuts; and
7	Temporary storage of hazardous products, including fuel and explosives as well as waste and sewage.
	Operational
8	Stripping topsoil and soft overburden;
9	Removal of overburden, including drilling and blasting of hard overburden;
10	Loading, hauling and stockpiling of overburden;
11	Drilling and blasting of coal;
12	Load, haul and stockpiling of RoM coal;
13	Use and maintenance of haul roads for the transportation of coal to the washing plant;
14	Water use, pit dewatering and storage on-site;
15	Slurry management ; and
16	Storage, handling and treatment of hazardous products including fuel, explosives, soil and waste.
	Decommissioning
17	Demolition and removal of all infrastructure, including transporting materials off site;
18	Rehabilitation, including spreading of soil, re-vegetation and profiling or contouring;
19	Environmental monitoring of decommissioning activities;
20	Storage, handling and treatment of hazardous products including fuel, explosives, oil and waste; and
21	Post-closure monitoring and rehabilitation.

11.2.1 Construction Phase

11.2.1.1 Project Activities Assessed

The impacts to consider are those relating to the disturbance of the natural soil site. When soil is stripped, the physical properties are changed and this impacts on the soil health. During soil stockpiling, the soils' chemical properties will deteriorate unless properly managed. These will lead to loss of the topsoil layer. 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. Vegetation cover will be reduced and runoff potential will be increased. In which increased runoff potential will lead to increased erosion hazards. Soils should be handled with care from the construction phase through to the decommissioning phase. Topsoil and subsoil should not be stockpiled together as the topsoil's seed bank and natural soil fertility is diluted.

Table 11-5: Interactions and Impacts during Construction

Interaction	Impact
Site clearance and topsoil removal. Surface infrastructure development	Loss of land capability
	Loss of topsoil as a resource
	Soil compaction from heavy machinery and vehicles
The construction of stockpiles	Soil erosion due to wind and surface water runoff
	Loss of land capability
	Loss of land use
	Loss of topsoil as a resource

11.2.1.1.1 Impact Description: Loss of Topsoil as a Resource

Topsoil will be removed from a soil profile; the profile loses effective rooting depth, water holding capacity and soil fertility. Large volumes of topsoil will be removed in preparation for open pit mining and site infrastructure. The removed soil will be stockpiled and can be lost if not managed correctly. Soil is susceptible to erosion because vegetation will be cleared before construction takes place in infrastructure area. Topsoil stockpiles and roads will be susceptible to erosion. Soil is susceptible to compaction from heavy construction equipment and vehicles when soil is stripped and stockpiled. Soil compaction reduces ability of plants to absorb water due to soil pores being decreased, reduces water infiltration rate and bulk density increases.

11.2.1.1.2 Impact Description: Loss of Land Capability and Land Use

When topsoil is removed from the infrastructure areas, the land capability is reduced to nothing and land use will change from intensive cultivation (72%) to mining. There is loss of agricultural potential and topsoil degradation. The land capability during this phase will be reduced from classifiable (72%) to non-classifiable.

11.2.1.1.3 Management Objectives

The management objectives are to limit the impacts that could occur on the site. The following management objectives are recommended:

- Soils are only to be stripped by truck and shovel method to reduce compaction levels, however a bowlscrapers can be used even though they are ideal for creating roads or building dams ;
- Stripped soils are to be placed in the correct stockpile allocations to reduce cross contamination of soils. These soils must be monitored and maintained in a reasonably fertile state; and
- Vegetation cover on all stockpiled soils is essential to eliminate erosion.

11.2.1.1.4 Management Actions and Targets

Management actions and targets include the following:

- Ensure proper storm water management designs are in place;
- The topsoil should be stripped by means of an excavator bucket and loaded onto dump trucks;
- If possible topsoil should be stripped when the soil is dry, as to reduce compaction;
- Topsoil stockpiles are to be kept to a maximum height of 10 m;
- Topsoil of 0.3 m of the soil profile should be stripped first and stockpiled separately;
- The subsoil of 0.4 – 1.2 m will then be stripped and stockpiled separately for deep soils like Hutton and Clovelly. Hutton and Clovelly can be stripped and stockpiled together since their soil properties are similar. Wetlands soils (Katspruit and Arcadia) should not be stripped and stockpiled together and should not be mixed with Hutton and Clovelly;
- Soils to be stripped according to the soil stripping ratios and stockpiled accordingly;
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place;
- If erosion has occurred, topsoil should be sourced and replaced, shaped to reduce the recurrence of erosion;
- Only the designated access routes are to be used to reduce any unnecessary compaction;
- The handling of the stripped topsoil should be minimised to ensure the soil's structure does not deteriorate significantly;
- The stockpiles should be vegetated to reduce the risk of erosion, and to reinstitute the ecological processes within the soil; and

- Compaction of the removed topsoil must be avoided by prohibiting traffic on stockpiles.

11.2.1.1.5 Impact Ratings

The construction phase impacts are rated in Table 11-6 and Table 11-7.

Table 11-6: Potential Impacts for the Loss of Topsoil as a Resource

Dimension	Rating	Motivation	Significance
Activity and Interaction: 1, 2, 3, 4, 5 and 6			
Impact Description: During any excavation activity, the soil chemical and physical properties are impacted on. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result erosion could occur. Large areas of land will be cleared increasing the runoff potential of the area.			
Prior to Mitigation/Management			
Duration	5	Largest volumes of topsoil will be removed in preparation of open pit mining but may last after this phase	Moderate (negative) - 91
Extent	3	Loss of topsoil will only occur within project area	
Intensity	5	Loss of usable topsoil may result in compaction and erosion which can be serious.	
Probability	7	By excavating the soil it will certainly impact on the soil	
Nature	Negative		
Mitigation/Management Actions			
▪ Follow adequate stripping guidelines as mentioned in Section 14; ▪ Topsoil should be stripped by means of an excavator bucket and loaded onto dump trucks; ▪ If possible topsoil should be stripped during dry months, as to reduce compaction ▪ Only clear vegetation when and where necessary; ▪ Only remove topsoil when and where necessary ; ▪ Ensure topsoil is stored in one dedicated stockpile, 10 m high and away from drainages lines and surface water; ▪ Only the designated access routes are to be used; ▪ If erosion occurs, corrective actions must be taken to minimise any further erosion from taking place; ▪ Soils to be stripped according to the soil stripping ratios and stockpiled accordingly; ▪ Stockpiles are to be maintained in a fertile and erosion free state by sampling and analysing annually for macro nutrients and soil pH, and vegetating the stockpiles to reduce erosion; ▪ Compaction of the removed topsoil should be avoided by prohibiting traffic on stockpiles; ▪ Prevent unauthorised borrowing of stockpiled soil; and			

Dimension	Rating	Motivation	Significance
▪ Ensure proper storm water management designs are in place.			
Post-Mitigation			
Duration	5	Loss of topsoil makes land less productive. Usable soil will be stripped and stockpiled if this is done without following the mitigation measures the impact might have a long term effect. Effects will occur long after the project life	Minor (negative) - 45
Extent	2	Loss of soil will only occur within project area	
Intensity	2	Loss of usable soil may result in loss of good productive soils	
Probability	5	If mitigation measures are followed it is likely that the impact will occur	
Nature	Negative		

Table 11-7: Potential Impacts for the Loss of Land Capability and Land Use

Dimension	Rating	Motivation	Significance
Activity and Interaction: 1, 2, 3, 4, 5 and 6			
Impact Description: Removal of soil layers will impact on land capability and potential land use. The land capability during this phase will be reduced from classifiable (72%) to non-classifiable. Land use will be changed from agriculture (63%) to mining, thus increasing the impact on soils.			
Prior to Mitigation/Management			
Duration	7	Largest volumes of topsoil will be removed in preparation of open pit mining. Removal of soil from profile reduces the land capability to non-existent, this impact is permanent	Major (negative) – 112
Extent	2	Loss of topsoil will only occur on the project area (open pit and infrastructure)	
Intensity	7	Loss of soils is very serious and will have negative impact. Loss of usable topsoil will result in loss of land capability and land use. Soil regeneration takes a very long time.	

Dimension	Rating	Motivation	Significance
Probability	7	By removing topsoil the impact on land capability and land use is certain	
Nature	Negative		
Mitigation/Management Actions			
▪ No land capability mitigation measures are possible during the construction and operational phases because the land use is changed from intensive cultivation (agriculture) to open pit mining.			
Post-Mitigation			
Duration	7	No mitigation measures are possible and the impacts will be permanent	Major (negative) – 112
Extent	2	Loss of soil will only occur within project area	
Intensity	7	Loss of usable soil will result in loss of good productive soils. Impact is serious on soils	
Probability	7	By excavating the soil it will certainly impact on soil	
Nature	Negative		

11.2.2 Operational Phase

11.2.2.1 Project Activities Assessed

During the operational phase, erosion and compaction of all exposed areas and land capability and land use are the major impacts to consider.

Table 11-8: interactions and Impacts during Operational Phase

Interaction	Impact
The construction of stockpiles	Soil erosion due to wind and surface water runoff
	Loss of Land Capability
	Loss of Land Use
	Loss of topsoil as a resource
Operation and maintenance of the topsoil	Loss of topsoil as a resource: compaction and erosion

11.2.2.1.1 Impact Description: Loss of Stockpiled Topsoil

When topsoil is compacted or eroded, the soil profile is compromised and its ability to function as a growth medium is restricted. The movement of heavy machinery on the soil surface causes compaction which reduces the vegetation's ability to grow and as a result the risk of erosion will increase. The loss of topsoil will have a high negative impact and the natural regeneration of few millimetres of topsoil takes hundreds of years.

11.2.2.1.2 Impact Description: Loss of Land Capability and Land Use

When topsoil is removed from the open pit, the land capability is reduced to nothing and land use will change from intensive cultivation to mining. There is loss of agricultural potential and topsoil degradation. The land capability during this phase will be reduced from classifiable to non-classifiable.

11.2.2.1.3 Management Objectives

The following management objectives are to limit the impacts that could occur on the site:

- If erosion occurs, corrective actions must be taken to limit and reduce the impact from spreading;
- Bare areas need to be assessed for compaction and ripped if required; and
- Stripped red and yellow soils should not be stockpiled and stored together. These soils must be monitored and maintained in a reasonably fertile state.

11.2.2.1.4 Management Actions and Targets

The following management actions and targets are provided:

- Ensure proper storm water management designs are in place;
- The topsoil should be stripped by means of an excavator bucket and loaded onto dump trucks;
- If possible topsoil should be stripped when the soil is dry, as to reduce compaction;
- Topsoil stockpiles are to be kept to a maximum height of 10 m;
- Topsoil of 0.3 m of the soil profile should be stripped first and stockpiled separately;
- The subsoil of 0.4 – 1.2 m will then be stripped and stockpiled separately for deep soils like Hutton and Clovelly; Hutton and Clovelly can be stripped and stockpiled together since their soil properties are similar. Wetlands soils (Katspruit and Arcadia) should not be stripped and stockpiled together and should not be mixed with Hutton and Clovelly;
- Soils to be stripped according to the soil stripping ratios in Section 14 and stockpiled accordingly;

- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place;
- If erosion has occurred, topsoil should be sourced and replaced, shaped to reduce the recurrence of erosion; and
- Only the designated access routes are to be used to reduce any unnecessary compaction.

11.2.2.1.5 Impact Ratings

The operational phase impacts described are rate in Table 11-9 and Table 11-10.

Table 11-9: Potential Impacts for the Loss of Stockpiled Topsoil

Dimension	Rating	Motivation	Significance
Activity and Interaction: 8, 9, 10,12 and 13			
Impact Description: Topsoil losses can occur during the operational phase as a result of rainwater runoff and wind erosion from roads and soil stockpiles. Compaction of soils during operational phase will occur.			
Prior to Mitigation/Management			
Duration	5	Largest volumes of topsoil will be removed in preparation of open pit mining but may last after this phase	Moderate (negative) - 91
Extent	3	Loss of topsoil will only occur within project area	
Intensity	5	Loss of usable topsoil may result in loss of land capability and land use. Soil regeneration takes a very long time.	
Probability	7	By excavating the soil it will certainly impact on the soil	
Nature	Negative		
Mitigation/Management Actions			
▪ Follow adequate stripping guidelines in Section 14; ▪ Topsoil should be stripped by means of an excavator bucket and loaded onto dump trucks; ▪ If possible topsoil should be stripped when soil is dry, as to reduce compaction ▪ Ensure topsoil is stored in one dedicated stockpile, 10 m high and away from drainages lines and surface water; ▪ Only the designated access routes are to be used; ▪ If erosion occurs, corrective actions must be taken to minimise any further erosion from taking place; ▪ Stockpiles are to be maintained in a fertile and erosion free state by sampling and analysing annually for macro nutrients and soil pH, and vegetating the stockpiles to reduce erosion; ▪ Compaction of the removed topsoil should be avoided by prohibiting traffic on stockpiles;			

Dimension	Rating	Motivation	Significance
▪ Prevent unauthorised borrowing of stockpiled soil; and ▪ Ensure proper storm water management designs are in place.			
Post-Mitigation			
Duration	5	Loss of topsoil makes land less productive. Usable soil will be stripped and stockpiled if this is done without following the mitigation measures the impact might have a long term effect. Effects will occur long after the project life	Minor (negative) - 40
Extent	2	Loss of soil will only occur within project area	
Intensity	3	Loss of usable soil may result in loss of good productive soils	
Probability	4	By excavating the soil it will certainly impact on soil	
Nature	Negative		

Table 11-10: Potential Loss of Land Use and Land Capability

Dimension	Rating	Motivation	Significance
Activity and Interaction: 8, 9, 10, 12, 13 and 15			
Impact Description: When topsoil is removed from the open pit, land capability is reduced to nothing. The land use will be change from intensive cultivation to mining. As the pit expands in size the level of this impact increases as larger areas of land are converted.			
Prior to Mitigation/Management			
Duration	7	The impact will be permanent, reducing capability	Major (negative) - 112
Extent	2	Loss of land capability and land use will occur on a limited scale	
Intensity	7	Loss of natural soils is very serious and impact is negative	
Probability	7	The impact on land capability and land use is certain as it changes from arable to non-arable and from intensive cultivation to mining	
Nature	Negative		

Dimension	Rating	Motivation	Significance
Mitigation/Management Actions			
▪ No land capability mitigation is possible during the operational phase because the land use is changed from agriculture to open pit mining.			
Post-Mitigation			
Duration	6	Impact on land capability and land use will remain after project and potentially irreversible	Moderate (negative) – 84
Extent	2	Loss of land capability and land use will occur on a limited scale	
Intensity	6	Loss of soil is very serious and impact is negative.	
Probability	6	The impact on land capability and land use is almost certain	
Nature	Negative		

11.2.3 Decommissioning Phase

11.2.3.1 Project Activities Assessed

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. When the decommissioning and removal of infrastructure takes, vehicles will drive on the surface compacting it and this reduces infiltration rates as well as the ability for plant roots to penetrate the compacted soil. Vegetation cover will be reduced and increases runoff potential, therefore increased runoff potential leads to increased erosion hazards. During the decommissioning and rehabilitation phase, the open pit will be rehabilitated as per the rehabilitation guideline (See Rehabilitation Report).

Table 11-11: Interactions and Impacts during Decommissioning and Rehabilitation

Interaction	Impact
Demolition of infrastructure will take place	Loss of topsoil as a resource- erosion and compaction
	Land capability
Rehabilitation activities will cover the extent of the infrastructure footprint areas and will include the ripping of the compacted soil surfaces, spreading of topsoil and establishment of vegetation	Loss of topsoil as a resource- erosion and compaction
	Loss of Land capability

11.2.3.1.1 Impact Description: Loss of Topsoil as a Resource- Erosion and Compaction

When topsoil is compacted or eroded, the soil profile loses effective rooting depth, water holding capacity and fertility. Movement of heavy machinery on the soil surface causes compaction, which reduces the vegetation's ability to grow and as a result erosion could be cause. The loss of topsoil as a resource is a serious impact as the natural regeneration of millimetres of topsoil takes hundreds of years

11.2.3.1.2 Impact Description: Land Capability

During rehabilitation and decommissioning phase, there will be a final void this significantly impacts on the final land capability and land use. The infrastructure areas can be rehabilitated and as a result the impact may be reduced if mitigation measures are implemented.

11.2.3.1.3 Management Objectives

The rehabilitation process needs to be monitored for erosion. If erosion occurs corrective actions must be taken to limit and reduce the impact from spreading. Bare areas need to be assessed for compaction or contamination and ripped if required. If contamination has occurred, these soils need to be removed and dumped in a licensed landfill site.

After the infrastructure removal and rehabilitated, the areas must be assessed for compaction and possible erosion risk and corrected immediately.

11.2.3.1.4 Management Actions and Targets

The following management actions and targets are provided:

- Only the designated access routes are to be used to reduce any unnecessary compaction;
- Compacted areas are to be ripped to loosen the soil structure and vegetation cover re-instated;
- Implement land rehabilitation measures as defined in rehabilitation report;
- Topsoil should be replaced for rehabilitation purposes and used for their designated final purposes;
- Ensure proper storm water management designs are in place;
- Correction actions (erosion berms) must be taken to minimise any further erosion from taking place;
- The foundations of infrastructure must be removed; and
- Ensure proper storm water management designs are in place.

11.2.3.1.5 Impact Ratings

The impacts are described in Table 11-12, Table 11-13.

Table 11-12: Impact Rating for Loss of Topsoil as a Resource: Compaction and Erosion

Dimension	Rating	Motivation	Significance
Activity and Interaction: 17, 18 and 21			
Impact Description: Decommissioning and rehabilitation of the infrastructure and open pit areas could cause erosion and compaction if rehabilitation is not done correctly. Heavy machinery driving continuously over rehabilitated areas may result in compaction which could impact on plant rooting depth which then would have an impact to vegetation establishment.			
Prior to Mitigation/Management			
Duration	5	When the soil has eroded the impact will likely be permanent and potentially irreversible even with management.	Moderate (negative) - 91
Extent	3	Compaction and erosion will occur on a local scale and if not mitigated the erosion will extend beyond	
Intensity	5	Loss of topsoil is serious and soil regeneration takes a very long time	
Probability	7	By excavating the soil it will certainly impact on the soil	
Nature	Negative		
Mitigation/Management Actions			
▪ Deep rip compacted areas to allow for natural vegetation regrowth; ▪ Ensure proper storm water management designs are in place; ▪ Replaced soils to be re-vegetated and designed according to Chamber of Mines Rehabilitation Guidelines; ▪ Soils must be replaced according to the soil types; ▪ Compaction of the topsoil should be avoided; and ▪ A bowl scrapper is to be avoided as this piece of machinery compacts soil			
Post-Mitigation			
Duration	5	Impact will be permanent if mitigations are not implemented	Minor (negative) - 45
Extent	2	Compaction and erosion will occur on a limited scale	
Intensity	2	Intensity of the impact will be reduced if mitigation measures are implemented	

Dimension	Rating	Motivation	Significance
Probability	5	Impact is likely to occur if mitigation are not followed	
Nature	Negative		

Table 11-13: Impacting Rating for Loss of Land Capability

Dimension	Rating	Motivation	Significance
Activity and Interaction: 17, 18 and 21			
Impact Description: Backfilling of soil material layers will impact on land capability and land use. Infrastructure area will be rehabilitated and the land capability may be restoring to pre-mining land capability.			
Prior to Mitigation/Management			
Duration	5	The loss of land capability for open it area will likely be permanent	Moderate (negative) - 91
Extent	3	Impact will occur on a local scale	
Intensity	5	Loss of natural soil is serious and impacts negatively.	
Probability	7	The impact will be certain as there will be not enough material	
Nature	Negative		
Mitigation/Management Actions			
▪ Mitigation is not possible on the pit areas due to size of the void that will be left after mining			
Post-Mitigation			
Duration	5	Loss of land capability and land use will be likely permanent	Minor (negative) - 45
Extent	2	Impact will occur on a limited scale	
Intensity	2	Intensity will be reduce if mitigation measures are implemented	
Probability	5	Impact will be likely to occur if mitigation measures are implemented	
Nature	Negative		

Table 11-14: Impact Rating for Rehabilitation of Open pit and Infrastructure areas

Dimension	Rating	Motivation	Significance
Activity and Interaction: 17, 18 and 21			
Impact Description: Restoration of land capability to its pre-mining state or agreed upon alternative.			
Prior to Mitigation/Management			
Duration	7	The impact on soils will be permanent	Minor (positive) + 70
Extent	2	Impact will occur on a limited scale	
Intensity	5	The intensity of the impact is serious and soil profile will be reconstructed	
Probability	5	Impact will be likely to occur if mitigation measures are implemented	
Nature	Positive		
Mitigation/Management Actions			
▪ Rehabilitate according to the rehabilitation plan; ▪ Return the land conditions capable of supporting prior land use or uses equal or better than prior land use to the extent feasible or practical; and ▪ Contour slopes to minimise erosion and run-off.			
Post-Mitigation			
Duration	7	If rehabilitation measures are implemented correctly impact will be permanent	Moderate (positive) + 78
Extent	2	Impact will occur on a limited scale	
Intensity	4	The intensity will be reduced if mitigation measures are implemented	
Probability	6	Impact will be almost certain to occur if mitigation measures are implemented	
Nature	Positive		

12 Cumulative Impacts

The major impact associated with mining is the disturbance of the natural occurring soil profiles consisting of soil horizons. Rehabilitation of disturbed areas aims to restore land capability. Soil quality deteriorates during stockpiling and replacement of the soil materials into soil profiles during rehabilitation cannot imitate pre-mining soil quality properties. A change in land capability then forces a change in land use. Arable land capability changes to grazing land capability. The impact on soil is high because soil horizons are stripped and stockpiled for later use in rehabilitation. Soil fertility will be impacted because stripped soil horizons are usually thicker than the defined topsoil horizons.

The cumulative impact on regional land capability and land use is high because there is commercial agriculture that is practiced within surrounding (Figure 12-1) and the contribution to regional agriculture will reduce to low as the project area has 72% of arable land under cultivation (maize and beans). Food security is impacted on because the available arable land will be lost to mining and rehabilitation cannot emulate pre-mining land capability in the short term. Maize and bean production has been continuing for decades and can continue for decades more on the same soils. However, mining will change the high agricultural potential soils resulting in yield losses.

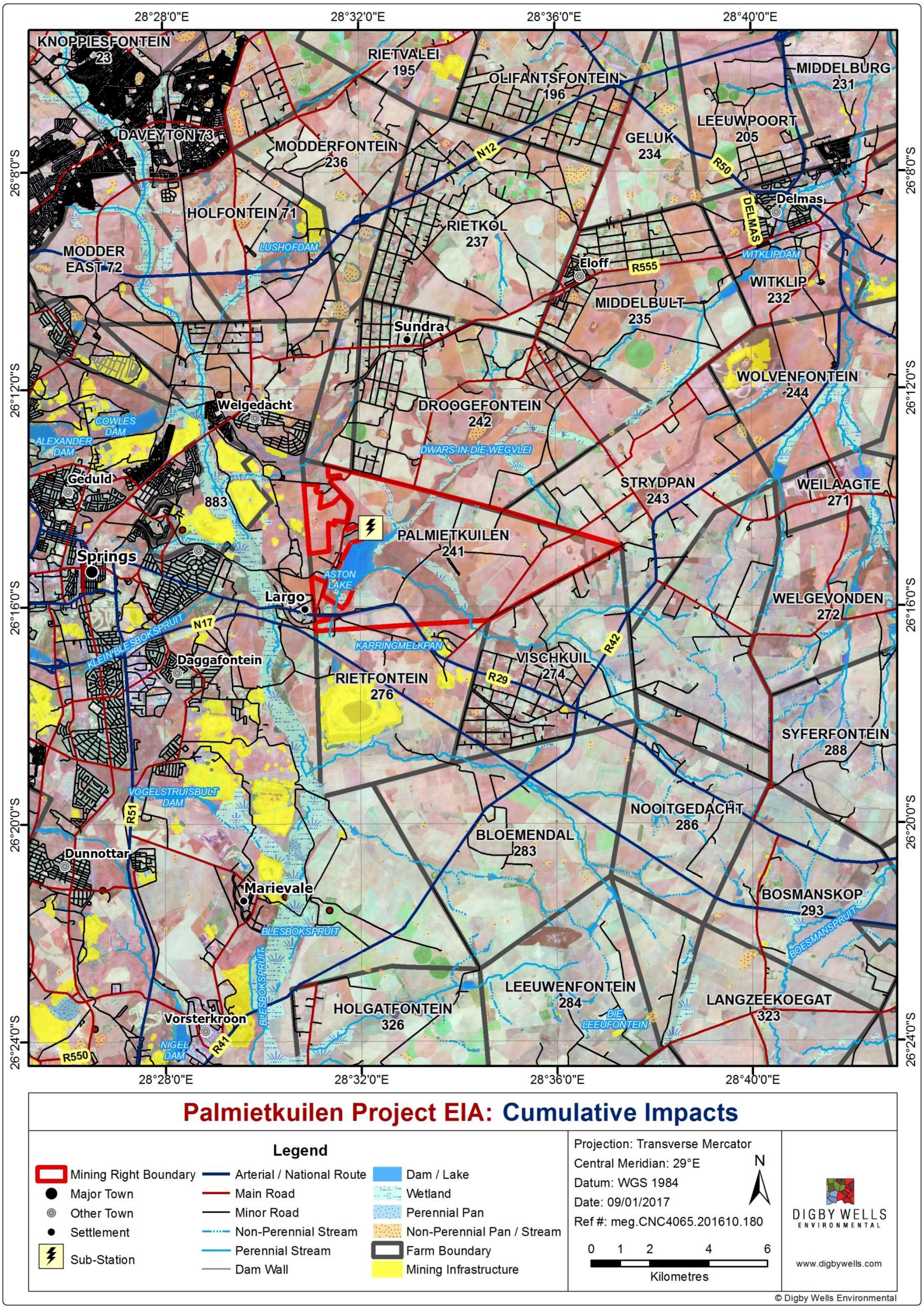

Figure 12-1: Cumulative Impacts on Soil Resources at Palmietkuilen Project EIA

13 Unplanned Events and Low Risks

Low risks can be monitored to gauge if the baseline changes and mitigation is required. Unplanned events may happen on any project, and as responsible consultants, we need to provide the client with information on the potential impacts of those events and how to manage them, if they occur. Table 13-1 is how we will achieve this and also provides an example of how to complete the table.

Table 13-1: Unplanned Events, Low Risks and their Management Measures

Unplanned event	Potential impact	Mitigation/ Management/ Monitoring
Hazardous substance spillage from pipelines or waste or water storage Hydrocarbon spill from vehicles and machinery or hazardous materials or waste storage facilities	Soil contamination	▪ Prevent any spills from occurring. Machines must be parked within hard park areas and must be checked daily for fluid leaks; ▪ If a spill occurs it is to be cleaned up immediately and reported to the appropriate authorities; ▪ All vehicles are to be serviced in a correctly concrete area or at an off-site location; ▪ Leaking vehicles will have drip trays place under them where the leak is occurring; ▪ Pipelines must be maintained; ▪ Pipeline must be checked regularly for leaks; and ▪ If there are leaks the pipelines must be repaired immediately.

14 Environmental Management Plan

The objective of an Environmental and Social Management Plan (ESMP) is to present mitigation is (a) to manage undue or reasonably avoidable adverse impacts associated with the development of a project and (b) to enhance potential positives.

The soil management plan demonstrates how soil should be preserved in a condition as near as possible to its pre-mining condition in order to allow successful rehabilitation. The plan should be implemented during clearance of the soil in preparation for mining activities and includes procedures for storage of soil. The management plan provides the following information:

- A topsoil stripping procedure that aims to maximise volumes of soil removed;
- Stripping soil volumes;
- Stockpile maintenance procedure; and

- A topsoil application procedure to be used during rehabilitation.

14.1 Soil Stripping

According to Guidelines for the Rehabilitation of Mined land (2007), soil stripping is a key rehabilitation activity because soil, once lost, takes many years to regenerate. Soils should be stripped and replaced in a similar location in the catena to their natural location. Wetland soils should not be stripped and stockpiled at all. This section provides details of the depths of topsoil to be stripped according to soil type and a stripping procedure.

14.1.1 Stripping Guideline

This section explains the correct measures that should be followed during the stripping of the soil. Correct stripping of soils will ensure that enough soils are available for rehabilitation and that the soils are of adequate quality to support vegetation growth. The steps that should be taken during soil stripping are as follows:

- If possible soil material should be stripped when it is in a lightly moist conditions to minimise compaction (i.e. when they are dry);
- Stripping should be supervised to ensure that the various soils are not mixed;
- Truck and shovel should preferably be used as a means of moving soil, instead of bowlscrapers;
- Strip red/brown and yellow soils separately;
- Topsoil should be stored separately from subsoil because it contains more nutrients and microbes;
- Soil stripping and stockpiling of the soils should be done in a single action to reduce compaction and to increase the viability of the seed bank contained in the stripped soil surface;
- Demarcate boundaries of different soil types;
- Stripping depths of different soil types. The Hutton and Clovelly soils are deeper and can be stripped between 0.4 to 1.2 m depending on depth; and
- Define cut-off horizons in simple terms that the stripping operator can understand.

14.1.2 Soil Stripping Volumes

A minimum layer of 0.4 of topsoil and 0.8 of subsoil for Hutton and Clovelly soil forms should be stripped and minimum of 0.25 to 0.4 m of topsoil for Glencoe, Mispah, Kroonstad and Westleigh should be stripped. Topsoil and subsoil should be stockpiled separately. Hutton and Clovelly can be stockpiled and stripped together as they have similar soil properties, while wetland soils Arcadia and Katspruit should not be stripped and together at all. Kroonstad and Westleigh topsails' can be stripped and stockpiled together but not the subsoil as they are different.

Table 14-1: Soil stripping volumes (m^3)

Soil Form	Depth of soil (m)	Area (ha)	Volume of soil to be stripped and stockpiled (m^3)
Hutton	1.2	1382.12	16 585 440
Clovelly	1.2	575.45	6 905 400
Arcadia	0.6	1024.65	6 147 900
Glencoe	0.5	12.25	61 250
Katspruit	0.6	27.70	166 200
Kroonstad	0.6	17.67	106 020
Mispah	0.3	20.31	60 930
Westleigh	0.4	413.25	1 653 000
Total		**3473.07**	**31 686 140**

14.1.3 Stripping Method

Soils should be stripped and replaced using the truck and shovel method. This method will limit the compaction of the soils.

14.1.4 Stockpiling

This section provides topsoil stockpile management measures which aim to conserve topsoil in a condition as close as possible to its original state.

- Separate stockpiles for topsoil and subsoil;
- Stockpiles should be at least not greater than 10 m high;
- Stockpiles should be revegetated to minimise loss of soil quality and maintained ;
- Stockpiles should be clearly signposted for easy identification;
- Locations should be accurately surveyed and data is recorded relating to the soil type and volume;
- Stockpile should be located outside proposed mine disturbance areas;
- Stockpiles should be located in areas away from drainage lines or windy areas to minimise the risk of soil erosion;
- Minimise compaction during stockpile creation and revegetate to avoid erosion losses;
- No waste material should be placed on the stockpiles;

- Equipment movement on top of the soil stockpiles should be limited to avoid topsoil compaction and subsequent damage to the soils and seedbank; and
- Soil erosion should be controlled on stockpiles by having control measures to reduce erosion risk such as erosion control blankets, soil binders, revegetation, contours, diversion banks and spillways.

14.1.5 Supervision

Close supervision and monitoring of the stripping process is required to ensure that soils are stripped correctly. Monitoring requires assessment of the depth stripped the degree of mixing soil materials and the volumes of material replaced directly or placed on stockpiles.

14.1.6 Soil Replacement

All soils should be replaced to a similar depth as was encountered prior to the mining operation. However, soils can be replaced to a depth (0.3 m) that will sustain grazing land capability. It is recommended that the soils should be replaced as follows:

- Soil horizons (topsoil and subsoil) should be replaced in the same sequence in which they were stripped;
- The usable subsoil material should be replaced on the reshaped spoil, flowed by the topsoil and ensure natural revegetation with the species that were originally in the area;
- Soils should be moved when dry to minimise compaction;
- Compaction should be minimised by use of appropriate equipment and replacing soils;
- Minimise compaction during smoothing of replaced soils by using dozers rather than graders; and
- Following replacement, all soils should be ripped to full rooting depth using dozer rippers.

14.1.7 Soil Amelioration

Replaced soils require both physical and chemical amelioration as the actions of soil removal, stockpiling and replacement result in high levels of soil compaction and a dilution of the fertility of the soil originally present and concentrated in the surface layers. The following steps should be taken during the amelioration of soils:

- The soils must be ripped to ensure reduced compaction;
- An acceptable seed bed should be produced by surface tillage;
- Restore soil fertility:
  - Soils should be analysed for plant nutrient content;

  - Fertiliser should be applied to raise soil nutrient content to the desired levels; and
  - Fertiliser should be applied annually until the soil fertility cycle is restored at determined rate.
- Incorporate the immobile fertilisers into the plant rooting zone before ripping; and
- Apply maintenance dressing of fertilisers on an annual basis until the soil fertility cycle has been restored.

14.2 Project Activities with Potentially Significant Impacts

The table below is a brief summary of the impacts that received a moderate or major rating and therefore are seen to be activities with significant activities.

Table 14-2: Potentially Significant Impacts of the Project on Soils, Land Capability and Land Use

Aspects	Potential Significant impacts
Site clearance and topsoil removal	Loss of topsoil as a resource, loss of land capability and land use
Construction of surface infrastructure and stockpiles	The land capability and land use will be changed permanently

14.3 Summary of Mitigation and Management

Table 14-3 provides a description of the mitigation and management options for the environmental impacts anticipated during the construction, operational and decommissioning and closure phases. Table 14-3 to Table 14-5 provide a summary of the proposed project activities, environmental aspects and impacts on the receiving environment. Information on the frequency of mitigation, relevant legal requirements, recommended management plans, timing of implementation, and roles / responsibilities of persons implementing the EMP.

Table 14-3: Soils, Land Use and Land Capability Mitigation and Management Plan

Activities	Phase	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
Site clearance and topsoil removal	Construction	Open pit & infrastructure footprint	▪ Ensure proper storm water management designs are in place; ▪ If any erosion occurs, corrective actions (erosion berms) must be taken to minimise any further erosion from taking place; ▪ Only the designate access routes are to be used to reduce any unnecessary compaction; ▪ Topsoil should be stripped by means of an excavator bucket and loaded onto dump trucks; ▪ Topsoil stockpiles are to be kept to a maximum height of 10 m; ▪ If possible topsoil should be stripped during dry months, as to reduce compaction; ▪ Compaction of the removed topsoil must be avoided by prohibiting traffic on stockpiles; ▪ The stockpiles must be vegetated in order to reduce the risk of erosion; and ▪ Handling of the stripped must be minimised to ensure the structure does not deteriorate.	Chamber of Mines Guidelines	Construction
Operation and maintenance of the topsoil and overburden stockpiles	Operational	Open pit & infrastructure	▪ Ensure proper storm water management designs are in place; ▪ If any erosion occurs, corrective actions (erosion berms) must be taken to minimise any further erosion from taking place; and ▪ Only the designate access routes are to be used to reduce any unnecessary compaction.	Chamber of Mines Guidelines	Operational
Demolition of infrastructure will take place and rehabilitation of the area will take place. Rehabilitation activities will include the ripping of the compacted soil surfaces, spreading of topsoil and establishment of vegetation	Decommissioning & Rehabilitation	Open pit & infrastructure footprint	▪ Compacted areas must be ripped to loosen the soil structure; ▪ Implement rehabilitation measures as defined in rehabilitation report; ▪ Topsoil should be replaced for rehabilitation purposes only; and ▪ Stockpiles should be used for their designated final purposes.	Chamber of Mines Guidelines	Decommissioning and Rehabilitation
Post-closure monitoring	Post-closure	Open pit & infrastructure footprint	▪ The rehabilitated areas must be assessed once a year for compaction, erosion and fertility; ▪ Compacted areas must be ripped to loosen the soil structure; ▪ Only designated access routes should be used to reduce any unnecessary compaction; and ▪ Corrective actions must be taken to minimise any further erosion from taking place	Chamber of Mines Guidelines	Post-Closure

Table 14-4: Objectives and Outcomes of the EMP

Activities	Potential impacts	Aspects affected	Phase	Mitigation	Standard to be achieved/objective
Site clearance and topsoil removal	Loss of topsoil – erosion, compaction, land capability and land use	Soils	Construction	▪ Site clearing procedures; ▪ Storm-water management plan	Soil Management in terms of the Chamber of Mines Guidelines for Rehabilitation
Construction of infrastructure	Loss of topsoil – erosion, compaction, land capability and land use	Soils	Construction	▪ Site clearing procedures; ▪ Storm-water management plan	Soil Management in terms of the Chamber of Mines Guidelines for Rehabilitation
Construction of stockpiles	Loss of topsoil – erosion and compaction	Soils	Construction	▪ Site clearing procedures; ▪ Storm-water management plan	Soil Management in terms of the Chamber of Mines Guidelines for Rehabilitation
Operation and maintenance of the stockpiles	Loss of topsoil – erosion and compaction	Soils	Operational	▪ Site clearing procedures; ▪ Storm-water management plan	Soil Management in terms of the Chamber of Mines Guidelines for Rehabilitation
Demolition of the infrastructure	Loss of topsoil – erosion, compaction, land capability and land use	Soils	Decommissioning	▪ Closure plan	Soil Management in terms of the Chamber of Mines Guidelines for Rehabilitation
Rehabilitation of the project area	Loss of topsoil – erosion, compaction and land capability	Soils	Rehabilitation	▪ Rehabilitation plan	Soil Management in terms of the Chamber of Mines Guidelines for Rehabilitation
Post-closure monitoring	Loss of topsoil – erosion, fertility and compaction	Soils	Post-closure	▪ Rehabilitation and Closure plan	Soil Management in terms of the Chamber of Mines Guidelines for Rehabilitation

Table 14-5: Mitigation for Soils, Land Use and Land Capability

Activities	Potential impacts	Aspects affected	Mitigation type	Time period for implementation	Compliance with standards
Site clearance and topsoil removal	Loss of topsoil – erosion, compaction, land capability and land use	Soils	▪ Site clearing procedures; ▪ Storm-water management plan	Construction	Soil management plan
Construction of infrastructure	Loss of topsoil – erosion, compaction, land capability and land use	Soils	▪ Site clearing procedures; ▪ Storm-water management plan	Construction	Soil management plan
Construction of stockpiles	Loss of topsoil – erosion and compaction	Soils	▪ Site clearing procedures; ▪ Storm-water management plan	Construction	Soil management plan
Operation and maintenance of the stockpiles	Loss of topsoil – erosion and compaction	Soils	▪ Site clearing procedures; ▪ Storm-water management plan	Operational	Soil management plan
Demolition of the infrastructure	Loss of topsoil – erosion, compaction, land capability and land use	Soils	▪ Closure plan	Decommissioning	Soil management plan
Rehabilitation of the project area	Loss of topsoil – erosion, compaction and land capability	Soils	▪ Rehabilitation plan	Rehabilitation	Soil management plan
Post-closure monitoring	Loss of topsoil – erosion, fertility and compaction	Soils	▪ Rehabilitation and Closure plan	Post-closure	Soil management plan

Table 14-6: Prescribed Environmental Management Standards, Practice, Guideline, Policy or Law

Specialist field	Applicable Standard, Practice, Guideline, Policy or Law
Soils	Chamber of Mines – Guidelines for the Rehabilitation of Mined Land

14.4 Monitoring Plan

Soil monitoring plan guidelines should be put in place to ensure that rehabilitation is a success from a soils perspective. The monitoring plan for soils must contain the following:

- The location of soil types that can be stripped and stockpiled together;
- Stripping depths of different soil types; and
- The location, dimensions and volumes of planned stockpiles for different soil types.

Monitoring should always be carried out at the same time of the year. Soils should be sampled and analysed for the following parameters:

- pH (KCl);
- Phosphorus (Bray 1);
- Cations: Calcium, Magnesium, Potassium, Sodium, Zin (mg/kg);
- Cation exchange capacity (CEC);
- Soil organic carbon (%); and
- Soil texture (Clay, Silt and Sand).

The following maintenance is required:

- Repair any damage caused by erosion;
- Traffic should be limited were possible while the vegetation is establishing;
- Replace dead plant material;
- The area must be fenced and animals should be kept off the area until the vegetation is self-sustaining;
- Fertilize grassed area with nitrogen containing fertiliser after germination of seeds;
- If soil is polluted, treat the pollution by means of in-situ bio-remediation; 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 at an appropriate, permitted or licensed disposal facility.

15 Consultation Undertaken

The farm manager was contacted on the 1st day of the site visit and the general supervisor accompanied the specialist to show the boundaries of the farm and where graves are allocated.

16 Comments and Responses

No comments have been received yet on the Soils Impact Assessment and if received, this section of the report will be updated to include the comments and responses provided.

17 Conclusion and Recommendation

The project area is dominated by Hutton and Clovelly soil forms with portions of Westleigh, Kroonstad, Mispah, Katspruit, Arcadia and Glencoe soils. The land capability is dominated by the Class II (Intensive cultivation), followed by Class III (Moderate cultivation) and Class v (Wet zones). The most dominant land use within the project area is cultivated areas followed by grasslands, shrubland and woodlands. The fertility status of the soils is generally considered moderate to high. Site had low soil pH and there is a need to add lime to remedy soil acidity. All of the soil samples collected on the site show the profile of Ca>Mg>K>>Na concentrations as expected. Calcium concentrations were high and adequate for crop production. Magnesium concentrations were adequate for crop production and there is no need for addition of magnesium source. Potassium concentrations were moderate to high, while sodium levels were low and are not of concern. Sulphur concentrations were low and require addition of sulphur fertilisation. Phosphorus concentrations were low to high and low levels require fertilisation. Soils had low organic carbon levels. CEC of the soils was moderate to high and soils are capable to retain mineral elements. The soil can be described as texturally variable, containing a mixture of sandy clay loam, loamy sand and sandy loam.

The impact on soil is high due to soil layers being stripped and stockpiled for later use in rehabilitation. The impacts associated with open pit mining on soils are:

- Loss of topsoil through:
  - Erosion;
  - Compaction; and
  - Chemical and physical alterations
- Loss of Land Capability and land use:
  - Low soil fertility;
  - Replacement of topsoil not to pre-land capability specifications.

The following recommendations are made to minimise the impact on the soils:

- All soils if possible should be stripped during dry months;
- It is recommended to stockpile to a maximum height of 10 m to reduce the impacts on soil chemical and physical properties;
- Soils should be reconstructed to pre-mining arable land capabilities on the planned opencast and infrastructure area following the closure of the project;
- Soil fertility should be established through representative soil sampling and analyses;
- Soils must be stripped according to the soil stripping guideline.

18 References

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Appendix A: CV

Mr. Siphamandla Madikizela

Soil Scientist

Closure, Rehabilitation and Soils

Digby Wells Environmental

Education

2012 – 2014: MSc in Soil Science – University of KwaZulu-Natal.

2011 – 2011: BSc Honours in Soil Science – University of KwaZulu-Natal.

2008 – 2010: BSc in Hydrology and Soil Science – University of KwaZulu-Natal.

Language Skills

English (2nd language).

Xhosa (1st language).

Zulu.

Employment

March 2016 – Present: Digby Wells Environmental - Soil Scientist.

August 2013 – March 2016: EcoPlanet Bamboo (Pty) Ltd - Assistant Plantation Manager.

2010 – 2013: University of KwaZulu-Natal - Student demonstrator (2nd and 3rd years majoring in Soil Science).

2012: Jeffares & Green Consulting Company - Field Assistant.

Experience

Siphamandla Madikizela is a Soil Scientist and completed his MSc in Soil Science at University of KwaZulu-Natal. Prior to his employment at Digby Wells, Siphamandla worked as an Assistant Plantation Manager for EcoPlanet Bamboo southern Africa. He joined Digby Wells in March 2016 and is part of the Closure, Rehabilitation and Soils Department. His role involved conducting soil surveys, identification of soil forms, interpreting results of soil samples and writing detailed scientific reports.

Project Experience

- Scoping and Environmental Impact Reporting for Proposed Palmietkuilen Colliery near Springs – Canyon Resources (Pty) Ltd – Soil Scientist.
- Scoping and Environmental Impact for an Environmental Authorisation Application in support of the Prospecting Right Applications – Anglo American Platinum Ltd – Soil Scientist.
- Scoping and Environmental Impact for Grootvlei TSF Reclamation Project - Ergo Mining (Pty) Ltd – Soil Scientist.
- Risk Assessment and Associated Water Use License Application for the Proposed KPSX Northern Bypass, in Mpumalanga – South32 SA Coal Holdings (Pty) Limited – Soil Scientist.
- Environmental and Social Impact Assessment Update for the Sadiola Sulphides Project (2016), Mali - Société d'Exploitation des Mines d'Or de Sadiola S.A – Soil Scientist.
- Environmental Impact Assessment for the proposed infrastructure expansion at Grootegeluk Coal Mine – Exxaro Reductants (Pty) Ltd – Soil Scientist.
- Gap analysis for the Environmental Authorisation for the Rietspruit Rehabilitation Project – South32 SA Coal Holdings (Pty) Ltd – Soil Scientist.
- Rehabilitation Guidelines for Sedibelo West – Sedibelo Platinum Mines Limited – Soil Scientist.
- Reviewing of the Soils, land capability and land use Environmental Impact Assessment for Hendrina Reserve – Glencore Operations South Africa (Pty) Ltd – Soil Scientist.
- Contamination Assessment for Konskilde Warehouse, Boksburg, Johannesburg, South Africa – EDF Fenice – Soil Scientist.

Research

- The Use of Hydrogel Application at Planting for *Bambusa Balcooa* Species at different rates – EcoPlanet Bamboo southern Africa – Assistant Plantation Manger.
- The Effect of Herbicide Application on *Bambusa Balcooa* – EcoPlanet Bamboo southern Africa – Assistant Plantation Manager.
- The Effect of Plastic Mulch on Growth and Yield *on Bambusa Balcooa* - EcoPlanet Bamboo southern Africa – Assistant Plantation Manager.
- Effect of Nitro-S fertilizer on growth and yield of *Bambusa Balcooa* and *Oxytenanthera Abyssinica*.

Responsibilities

- Plant management including adaptive fertilizer applications, pest management and irrigation schemes.
- Managing daily operations including the oversight of large staff teams of unskilled and semi-skilled workers, scheduling of operations and maintenance of farm equipment.
- Managing a schedule of community development activities
- Managing weekly activities in the nursery, including staff and overseeing the arrival and transplanting of new plants.
- Tracking and recording productivity data of the general workers and prepare the weekly KPI's for the corporate office.
- Adherence to international certification standards, in particular the Forest Stewardship Council (FSC), through plantation planning and administrative work.

Short Courses

- Certificate of Attendance: Wild Fire Suppression – Proto team (1-2 June 2015, Bathurst, Port Alfred).
- Certificate of Attendance: Basic Labour Relations (2 September 2015, Cape Town).Certificate of Attendance: Conflict Management Workshop (26 October 2015, Port Elizabeth).

Professional Affiliations

- Soil Science Society of South Africa (SSSA).

Professional Registration

- 2013: Registered as a Candidate Natural Scientist with The South African Council for Natural Scientific Professions. Registration number: 100033/13.

Publications

- Siphamandla Madikizela. The Effects of Burning or Mulching of Harvest Residues on Selected Soil Properties in a *Eucalyptus* Plantation in Northern KwaZulu-Natal – In Progress.