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Baseline and Environmental Impact Assessment for Proposed Eskom Kilbarchan Water Treatment Plant, Newcastle, KwaZulu-Natal Province

Soil, Land Use and Land Capability Assessment Report

Prepared for:
Eskom Holdings SOC Limited (Eskom)

Project Number:
ESK5108

April 2020

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This document has been prepared by Digby Wells Environmental.

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Project Name:	Baseline and Environmental Impact Assessment for Proposed Eskom Kilbarchan Water Treatment Plant, Newcastle, KwaZulu-Natal Province
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Aamirah Dramat	Report Writer		March 2020
Arjan van 't Zelfde	Report Reviewer		March 2020

DETAILS AND DECLARATION OF THE SPECIALIST

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Qualification(s):	MSc Soil Sciences
Experience (years):	5
Registration(s):	SACNASP (*Prof. Nat. Sci, 400154/17*)

I, Siphamandla Madikizela, declare that: –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
  - I declare that there are no circumstances that may compromise my objectivity in performing such work;
  - I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and

- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

September 2018

Signature of the Specialist *Date*

Findings, recommendations and conclusions provided in this report are based on the best available scientific methods and the author's professional knowledge and information at the time of compilation. Digby Wells employees involved in the compilation of this report, however, accepts no liability for any actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, and by the use of the information contained in this document.

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Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

EXECUTIVE SUMMARY

Digby Wells Environmental (hereafter Digby Wells) was appointed by Eskom Holdings SOC Limited (Eskom) to undertake an Integrated Water Use License Application (IWULA) for the proposed water uses in terms of Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) (NWA). As part of a basic assessment process completed by Digby Wells (2006), a Phytoremediation plantation passive treatment system was developed. The Environmental Authorization was granted to Eskom Holdings SOC Limited on 17/11/2017, however no Water Use License was granted.

The aim of the soil survey was to provide an accurate record of the soil resources of the area in order to apply for an IWULA for the proposed biological/passive mine water treatment plant (WTP) at the Kilbarchan Colliery. This report presents the findings of a specialist soils and land capability assessment that forms part of the IWULA Process.

The soils underlying the Kilbarchan project site are mainly derived from sandstone, shale and dolerite which dominate the underlying geology. Due to undulating topographical landscape features causing variation in soil forming factors, soils of the study area are expected to be varying in nature and will be mostly of mixed agricultural potential. The land type gathered suggested that the project area was dominated by land types Ac5, Bb54, Ea34 and Dc40.

The dominant land capability in the project areas was Class IV (Moderate grazing). Land in Class IV has very severe limitations that restrict the choice of plants that can be grown and may require special conservation practices. Land may be used for cultivated crops but has more restrictions than Class III and careful management is required. Limitations restrict the amount of cultivation, time of planting, tillage, harvesting and choice of crops. Conservation practices are more difficult to apply and maintain. Soils in class IV may be used for pasture, grazing, wildlife and food. Grazing land capability has severe limitations that restrict the choice of plants, require very careful management or both. The present land use was identified using satellite images and visual observations during the site visit. The dominant land uses in the area is veld for grazing.

The soil pH ranged from 4.0 to 6.0 and are acidic to slightly acidic. The soil pH below 7 may be due to the acidic nature of the parent material from which the soils were derived and leaching of the nutrients. Lime is required to counteract acidity and to increase plant growth performance, should agricultural activities have taken place. Sodium levels of the soils are very low and tolerable to plant growth and development. Soil dispersion is unlikely to occur and cause dense structure and drainage problems (de Villiers *et al*., 2003). No serious chemical issues such as soil salinity or sodicity occur on site. The P levels encountered in the samples from the site were all very low according to guidelines, with most values being 1 mg/kg. Phosphorus will be limiting on ecosystem function if the soil was going to be used for agricultural purposes and at least 15 mg/kg would be required. Phosphorus fertilisation would have been required to establish good crop stand and growth, should agricultural activities have taken place over the area.

A monitoring programme is essential as a management tool to detect negative impacts as they arise and to ensure that the necessary mitigation measures are implemented together with ensuring effectiveness of the management measures in place. A very important aspect is the supervision and monitoring during construction and operational phase.

The following should be observed when clearing and removing topsoil:

- Close supervision to ensure that soils are not being removed incorrectly;
- Environmental officer is responsible to determine effectiveness of the erosion control structures; and
- Contractor is responsible to undertake the clearing and removing of topsoil.

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

- Runoff must be controlled and managed by use of proper storm water management facilities;
- Fuel and oil spills are common; remediate using commercially available emergency clean up kits;
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place;
- Restriction of vehicle movement over sensitive areas to reduce compaction;
- Minimise unnecessary removal of the natural vegetation cover;
- Re-fuelling must take place on a sealed, hardstanding and bunded surface areas away from freshwater features to prevent ingress of hydrocarbons into topsoil;
- Use of accredited contractors for removal or demolition of infrastructures must be ensured, this will reduce the risk of waste generation and accidental spillages;
- All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan; and
- Surface inspection on the fully rehabilitated areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams.

Soil management measures should be followed as outlined in this report and land needs to be rehabilitated to prevent possible soil erosion, contamination and compaction. It is the opinion of the specialist that this project is feasible and could be considered if the management and mitigation measures tabled are rigorously adhered to for the project in order to minimise potential impacts on the soils and to maintain their land capability for future land use. Soil management measures and monitoring requirements as set out in this report should form part of the conditions of environmental authorisation.

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ACRONYMS, ABBREVIATIONS AND DEFINITION

ADM	Amajuba District Municipality
ARC	Agricultural Research Council
CARA	Conservation of Agricultural Resources Act
Digby Wells	Digby Wells Environmental
DWS	Department of Water and Sanitation
EC	Electrical Conductivity
Eskom	Eskom Holdings SOC Limited
GPS	Global Positioning Services
ISCW	Institute for Soil, Climate and Water
IWQO	Interim Water Quality Objectives 2008
IWULA	Integrated Water Use Licence Application
IWWMP	Integrated Water and Waste Management Plan
I&APs	Interested and Affected Parties
mbgl	Metres Below Ground Level
MD	Mine Drainage
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
MRA	Mining Rights Area
MTIS	Mineable tonnes in-situ
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NEMWA	National Environmental Management Waste Act, 59 (Act No. 59 of 2008)
NLM	Newcastle Local Municipality
NWA	National Water Act, 1998 (Act No. 36 of 1998)
PCD	Pollution Control Dam
PP	Public Participation
TDS	Total Dissolved Solids
WTP	Water Treatment Plant

Legal Requirement		Section in Report
(1)	A specialist report prepared in terms of these Regulations must contain-	
(a)	details of- (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Please refer to Section 6
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Please refer to Page iii
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Please refer to Section 5
c-A	And indication of the quality and age of the base data used for the specialist report;	Please refer to Section 2
c-B	A description of existing impacts on site, cumulative impacts of the proposed development and levels of acceptable change;	
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Please refer to Section 2
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of the equipment and modelling used;	Please refer to Section 8
(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure inclusive of a site plan identifying site alternative;	Please refer to Section 9
(g)	an identification of any areas to be avoided, including buffers;	Please refer to Section 9
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Please refer to Section 9
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Please refer to Section 7
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Please refer to Section 10
(k)	any mitigation measures for inclusion in the EMPr;	Please refer to Section 12
(l)	any conditions/aspects for inclusion in the environmental authorisation;	
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Please refer to Section 11
(n)	a reasoned opinion (Environmental Impact Statement) -	Please refer to Section 13

Legal Requirement		Section in Report
	whether the proposed activity, activities or portions thereof should be authorised; and	Please refer to Section 12
	if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Please refer to Section 4
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	
(q)	any other information requested by the competent authority.	No additional information was requested.

1 Introduction

Digby Wells Environmental (hereafter Digby Wells) was appointed by Eskom Holdings SOC Limited (Eskom) to undertake an Integrated Water Use License Application (IWULA) for the proposed water uses in terms of Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) (NWA).

Kilbarchan Colliery was commissioned in 1954 and consisted of underground mining sections, as well as open pit areas where the coal seam was less than 20 metres below ground level (mbgl). Kilbarchan Colliery, operated by Trans Natal (later Ingwe Coal), supplied coal to the Natal inland market and to the adjacent Eskom Holdings SOC Limited (Eskom) and Ingagane Power Station until it's decommissioning in 1992. The Kilbarchan Colliery and Ingagane Power Station is located 14km south of Newcastle, KwaZulu-Natal and falls within the Newcastle Local Municipality (NLM) and Amajuba District Municipality (ADM).

As part of a basic assessment process completed by Digby Wells (2006), a Phytoremediation plantation passive treatment system was developed. The Environmental Authorization was granted to Eskom Holdings SOC Limited on 17/11/2017, however no Water Use License was granted. The treatment plantation was developed to manage the impacts of decanting mine affected water on the soils and surface water resources as well as lowering the volume of water required for active treatment. The Phytoremediation Plantation is located upstream of the decant locations and are within 52 ha of wetland habitat (Figure 3-1). The purpose of the Phytoremediation Plantation was to offer a long-term permanent solution to the environmental impacts caused by historical mining activities.

The aim of the soil survey was to provide an accurate record of the soil resources of the area in order to apply for an IWULA for the proposed biological/passive mine water treatment plant (WTP) at the Kilbarchan Colliery. This report presents the findings of a specialist soils and land capability assessment that forms part of the IWULA Process.

2 Project Description

Kilbarchan Colliery consisted of two underground mining sections: Roy Point in the north and Kilbarchan in the south. Underground mining commenced at the Kilbarchan Colliery in 1954 and utilized the bord and pillar mining method with an average coal seam height of 3.5 m.

Construction of Eskom's Ingagane Power Station began in 1959 and was completed and began operations in April 1963 (Leech, 2003). Kilbarchan Colliery supplied coal to the Natal inland market as well as to the Ingagane Power Station, however, the Colliery served to supply coal solely to the Power Station from 1981 to 1987. The Ingagane Power Station began decommissioning in 1990 and Kilbarchan Colliery ceased all mining activities in 1992, with rehabilitation undertaken up until 2012.

Following the decommissioning of Kilbarchan Colliery in 1992, the underground workings, as well as open pit areas, began filling up with water at a rate of approximately 4 000 m^3 per day (Vermeulen and Van Zyl, 2011). This mine affected decant directly affected water of the adjacent freshwater systems and was first recorded in April 2004. The mine affected decant is predominantly taking place to the south, southeast and east of the discard dump, underground workings and open pit sections (Proxa, 2014). The mine affected water was characterised as having:

- High sodium and sulphate levels resulting in high Electrical Conductivity (EC);
- High Total Dissolved Solids (TDS); and
- Elevated levels of chloride, iron and manganese (Proxa, 2014).

The mine affected water has a negative impact on the surrounding freshwater systems it encounters, as it does not meet the Interim Water Quality Objectives 2008 (IWQO) of the Ingagane Catchment.

Eskom claimed responsibility for the area and applied best practice by commissioning a Rehabilitation Plan, in accordance with the requirements of National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and its Regulations. The purpose of the Rehabilitation Plan was to ensure that:

- The Kilbarchan Colliery is socially and environmentally safe; and
- The previously rehabilitated areas are maintained and managed effectively.

Phase 1 of the Rehabilitation Plan commenced in 2016 and involved developing a phytoremediation plantation and rehabilitation plan of the Kilbarchan Colliery. The plantation aimed to passively treat mine affected water from the historical mine workings. In this regard a Basic Assessment Process was undertaken to obtain environmental authorisation for the proposed phytoremediation plantation and rehabilitation of the Kilbarchan Colliery. This authorisation was subsequently granted in 2017 **(KZN30/5/1/1/2/00078BP)**.

Phase 2 of the project involves the construction and operation of a biological/passive mine water treatment plant (WTP). The WTP will be located within mining licence boundary as depicted in Figure 2-1. The mine treatment plant will serve to treat a flow of 0.50 mega litres per day (ML/day) of mine affected water. The water will be treated to an acceptable standard and discharged into the surrounding environment which will then eventually make its way to the Ingagane River. An Integrated Water Use License Application (IWULA) will be submitted to the Department of Water and Sanitation (DWS) for proposed water uses in terms of Section 21 of the National Water Act, 1998 (Act No. 36 of 1998) (NWA). A technical report in the form of an Integrated Water and Waste Management Plan (IWWMP) will be compiled in support of the IWULA together with the recommended specialist studies.

It is important to highlight that mining commenced in the early 1950's and ceased in 1992, therefore there is no mining right or permit, in terms of the Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) or the Minerals Act (Act No. 50 of 1991). There is thus no legal requirement for Eskom to apply for mine closure as the mine was operational, pre-legislation in 1952.

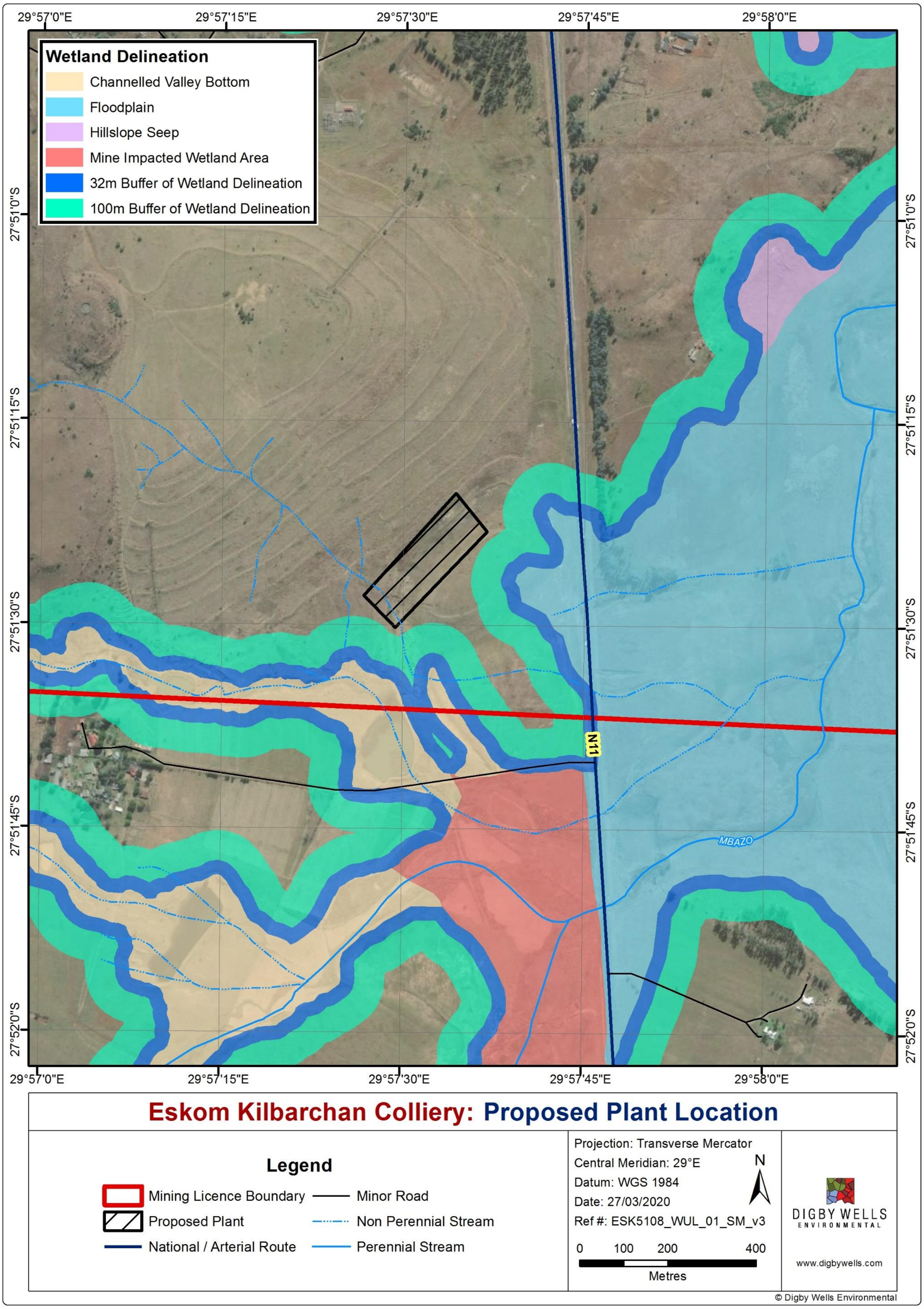

Figure 2-1: Infrastructure for the WTP Project

2.1 Water Treatment Plant Process Description

A new treatment for Mine Drainage (MD) has subsequently been developed, namely the WTP technology to effectively treat the major contaminants found in mining wastewater. The process is to treat the mine affected water with the use of a passive system, in which the heavy metals and sulphates will be removed to meet the targeted water quality objectives before discharge into adjacent freshwater systems.

The **Abstraction Phase** includes the mine affected water (MAW) from the underground section be extracted by two boreholes. The boreholes will pump the mine affected water from the underground workings to the WTP system. Each borehole will deliver a flow of 0.50 ML/day. The pumps will not work simultaneously, the one will work and the other one will be on standby.

Thereafter, the water will be sent to the **Pre-treatment** plant which is an oxidation vessel where iron will be removed as the incoming mine water is aerated with a fan which will result in the precipitation of iron oxides. The precipitated iron oxides solids will be sent to a filter press for solid liquid separation. The extracted water will be returned to the oxidation vessels and the dry filter cake stored in the bunded solids storage area for offsite disposal to an accredited waste disposal facility. Iron free water from the oxidation vessels will be sent to a reservoir which will serve as a storage area prior to entering the downstream process for further treatment.

The **Principle treatment** phase involves the biofiltering of the MAW. The MAW will be pumped into 20 anaerobic biofilters (arranged in parallel) to ensure high residence time and create a modular environment for the microorganisms present to thrive. An electron donor wil be dosed in the biofilter as it will allow sulphate reduction. Each biofilter will be filled with a floating fibre matrix containing microorganisms which will degrade the contaminants present in the mine water (the composition of the fibre matrix has not yet been finalised). Thereafter, filtered water exiting the biofilter will be sent to a banking tank for buffer storage before continuing in the process.

The **Polishing phase** consists of pumping the filtered water from the balancing tank to a granular filter. The three filters will be filled with rock, limestone and a zero-valance iron. This will serve to remove sodium, remaining heavy metals and sulphur from the water. The granular filters will require periodic backwashing in order to remove any contaminants that have present on the filter media. The backwashing sludge stream will be sent to a sludge drying bed before disposed of every two to three months to an accredited waste disposal facility.

Once the water has passed through the filters it will be sent to constructed wetlands for final salt rejection prior to effluent release.

The treatment process is illustrated below in Figure 2-2:

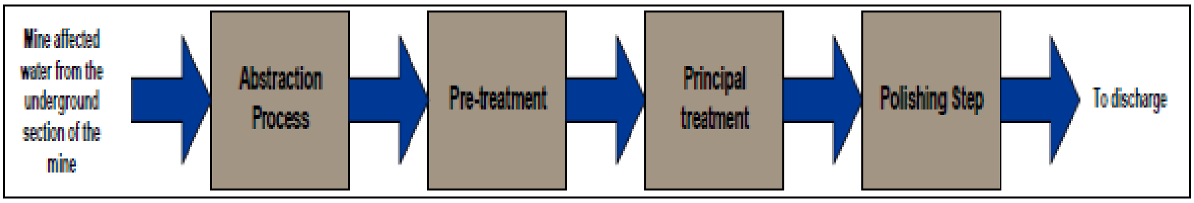

Figure 2-2 Process Flow Diagram

2.2 Applicant Details

The objective of this section of the report is to provide the relevant client information. Eskom's particulars are detailed in Table 2-1.

Table 2-1: Particulars of the Applicant

Name of Applicant:	Eskom Holdings SOC Limited
Tel no:	011 800 4834
Fax no	
Cell phone no	0813823436
Postal Address:	PO Box 1091, Johannesburg
Physical Address:	Megawatt Park, 1 Maxwell Drive, Sunninghill, Johannesburg; 2157
Email	PhalanM@eskom.co.za
Contact person	Mula Phalanndwa

3 Project Location

The Kilbarchan Colliery and Ingagane Power Station is located 14 km south of Newcastle, KwaZulu-Natal and falls within the Newcastle Local Municipality (NLM) and Amajuba District Municipality (ADM) (Figure 3-1). The Colliery is situated in the northwest corner of KwaZulu-Natal, bordering the Free State and Mpumalanga provinces.

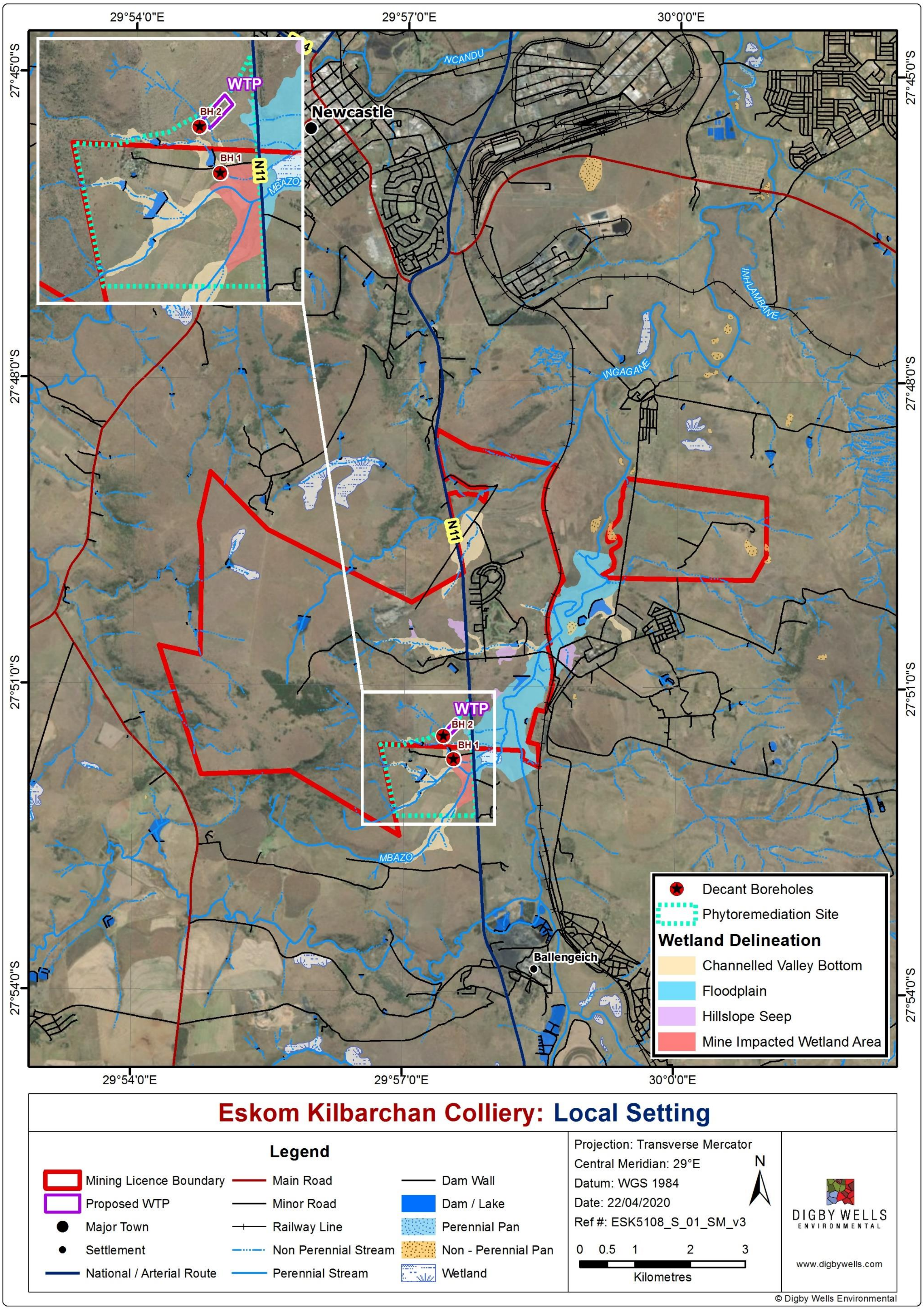

Figure 3-1: Local setting of Eskom Kilbarchan Colliery

4 Relevant Legislation, Standards and Guidelines

The South African Environmental Legislation needs to be considered with the reference to the management of the soil. Soils and land capability are protected under the following and listed in Table 4-1 below.

- The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA); and
- The Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) (CARA).

Table 4-1: Applicable Legislation, Regulations, Guidelines and By-Laws

Legislation, Regulation, Guideline or By-Law	Applicability
The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) To provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote cooperative governance and procedures for co-ordinating environmental functions exercised by organs of state; to provide for certain aspects of the administration and enforcement of other environmental management laws; and to provide for matters connected therewith. • (4) (a) (i). That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and **remedied; and** • (4) (a) (ii). That pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and **remedied.**	This report will be compiled in order to comply with the NEMA regulations and to provide co-operative soil environmental governance for decision making whether the proposed Phase 2 will have impacts on the soil and its environment.
National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA) The NEM:BA regulates the management and conservation of the biodiversity of South Africa within the framework provided under NEMA. This Act also regulates the protection of species	This study provides reasonable management and mitigation measures to avoid the disturbance of ecosystems or loss of biodiversity, as well as the pollution and degradation of the environment.

Legislation, Regulation, Guideline or By-Law	Applicability
and ecosystems that require national protection and also takes into account the management of alien and invasive species. The following regulations which have been promulgated in terms of the NEM:BA are also of relevance: • Alien and Invasive Species Lists, 2014 published (GN R.599 in GG 37886 of 1 August 2014); • National Environmental Management: Biodiversity Act, 2004: Threatened and Protected Species Regulations; and • National list of Ecosystems Threatened and in need of Protection under Section 52(1) (a) of the Biodiversity Act (GG 34809, GN R.1002, 9 December 2011).	
The Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) (CARA). The Act is to provide control over utilization of the natural agricultural resources of the Republic in order to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants; and for matters connected therewith. The objective of the act is to provide for the conservation of the natural agricultural resources of the Republic by the maintenance of the production potential of land. • 12.(1) (a) – A soil conservation work shall, except where otherwise provided in this Act or a scheme, be maintained by every land user of the land concerned and his successor in title at his own expense in a manner which, in the opinion of the executive officer, will ensure the continued efficiency thereof; • The CARA requires that protection of land against soil erosion, the prevention of water logging and salinization of soils by means of suitable soil conservation works to be constructed and maintained.	This study provides detail of conservation/rehabilitaiton methods of the soils in order to mitigate the soils back to a state to use for agriculture.

5 Scope and Purpose of this Report

The soil, land use land capability assessment was done in order to comply with the IWUL application. The Scope of work comprised of the following activities:

- Review of the existing soils information;
- Soil survey: The soils occupying the Project site were surveyed during site visits. A hand soil auger was used to survey the soil types present and survey positions were recorded as waypoints;
- Description and categorisation of soils was identified using the South African Soil Classification Taxonomic System (Soil Classification Working Group, 1991);
- Land capability: was assessed from the soil classification for the proposed area and climate capability;
- Land use: present land use was mapped in conjunction with the soil survey which included current land uses/covers associated with the respective project components;
- Description of soils in terms of soil fertility: six soil samples were collected; and
- Identification and assessment of potential impacts on soils resulting from the proposed project using the prescribed impact rating methodology. Mitigation measures were recommended to minimise impacts associated with the proposed project.

6 Details of the Specialists

The following is a list of Digby Wells' staff who was involved in the compilation and review of the soil and land capability report for Kilbarchan:

- **Siphamandla Madikizela** is a Soil Scientist, completed his MSc in Soil Science at University of KwaZulu-Natal and is a Professional Natural Scientist (Registration no. 400154/17) in the Republic of South Africa. 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; soil, land capability and land use environmental impact assessments; soil and agricultural potential studies; soil contamination assessments; interpreting results of soil samples; soil management plans and writing detailed scientific reports in accordance to local legislation and IFC standards and World Bank Guidelines. Siphamandla has worked on projects in South Africa, Democratic Republic of the Congo, Malawi and Mali.

- **Willnerie Janse van Rensburg** is a Soil Scientist in the Closure, Rehabilitation, and Soils Department at Digby Wells. She received her Bachelor of Science degree in Environmental Geography as well as her Honours degree in Soil Science from the University of the Free State. She joined Digby Wells in 2019. She has four years of experience in Soil Science and Environmental Sciences. She currently focuses on soils in the Closure, Rehabilitation and Soils Department where she is involved in conducting soil surveys, environmental impact assessments, land use and land capability assessments, soil amelioration studies, agricultural potential, soil sampling and results interpretation and writing detailed scientific reports. Willnerie also has experience in wetlands and are thus involved in the Wetland Department at Digby Wells. She is involved in conducting wetland impact assessments, wetlands delineations, wetland monitoring programs and compiling specialist wetland reports. She previously worked as a Soil Scientist and Wetland Consultant. She then worked for two year in the Agricultural sector, specializing in irrigation scheduling.

- **Aamirah Dramat** is a Rehabilitation Intern in the Rehabilitation, Closure and Soils Department at Digby Wells. She received her Bachelor of Science in Biology and Environmental and Geographical Science as well as her Honours degree in Biological Sciences from the University of Cape Town. She joined Digby Wells in 2020.
- **Arjan van 't Zelfde** is a Senior Hydrogeologist at Digby Wells with 15 years' experience in Europe and Africa. He specialises in numerical groundwater flow modelling including multi-species solute and heat transport modelling using the MT3D and SEAWAT modules for Modflow. He has worked for mine sites for various His experience includes hydrogeological investigations for Feasibility Studies, EIA's, mine dewatering, construction dewatering, groundwater management plans, and groundwater monitoring programmes – design and implementation, aquifer thermal energy storage (ATES) impact studies, groundwater contamination studies and risk assessments, environmental management program reports and project management.

7 Assumptions, Limitations and Exclusions

The following assumptions and limitations have been made:

- The information provided in this report is based on information gathered from the site visit undertaken in May of 2018;
- Proposed pipeline routes were surveyed using aerial imagery and verified on site;
- A total of six soil samples were collected on the proposed infrastructure areas;
- The information contained in this report is based on auger points taken and observations on site; and
- The area surveyed was based on the preliminary layout presented by Eskom.

8 Methodology

This section provides the methodology used in the compilation of the soils report. To complete the proposed scope of work, there were several tasks which needed to be completed and these tasks are explained separately below.

8.1 Desktop Assessment and Literature Review

Existing Land Type data was used to obtain generalised soil patterns and terrain types for the Project site. Land Type data exists in the form of published 1:250 000 maps. These maps indicate delineated areas of relatively uniform terrain, soil pattern and climate (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.

Digby Wells conducted a desktop review of the baseline data and findings related to the soil surveys. The following sources of information were reviewed and utilised for the compilation of this report:

- ESK51088: Baseline and Environmental Impact Assessment for Proposed Eskom Kilbarchan B-DAS Treatment, Newcastle, KwaZulu-Natal Province, September 2018;
- ESK3520. Closure Plan and Basic Assessment Process for Closure Activities at the Eskom Kilbarchan Colliery, Newcastle, KwaZulu-Natal Province. Soil Assessment Report. February 2016; and
- ESK3520. Closure Plan and Basic Assessment Process for Closure Activities at the Eskom Kilbarchan Colliery, Newcastle, KwaZulu-Natal Province. Rehabilitation Action Plan. June 2016.

8.2 Soil Classification

The site was traversed on foot and 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 1.2m or to the depth of refusal. Survey positions were recorded as waypoints using a handheld Global Positioning System (GPS). Other features such as existing open trenches were helpful to determine soil types and depth. The soil forms (types of soil) found was identified using the South African Soil Classification System (Soil Classification Working Group, 1991).

8.3 Soil Sampling and Analysis

Six soil samples (0 to 0.6 m) were collected from the proposed areas (Figure 8-1). The soil 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;
- Exchangeable cations (Ca, Mg, K and Na) (Ammonium acetate extraction);
- Phosphorus (Bray No.1 extractant);
- Soil Organic carbon; and
- Soil Texture (Clay, Sand and Silt).

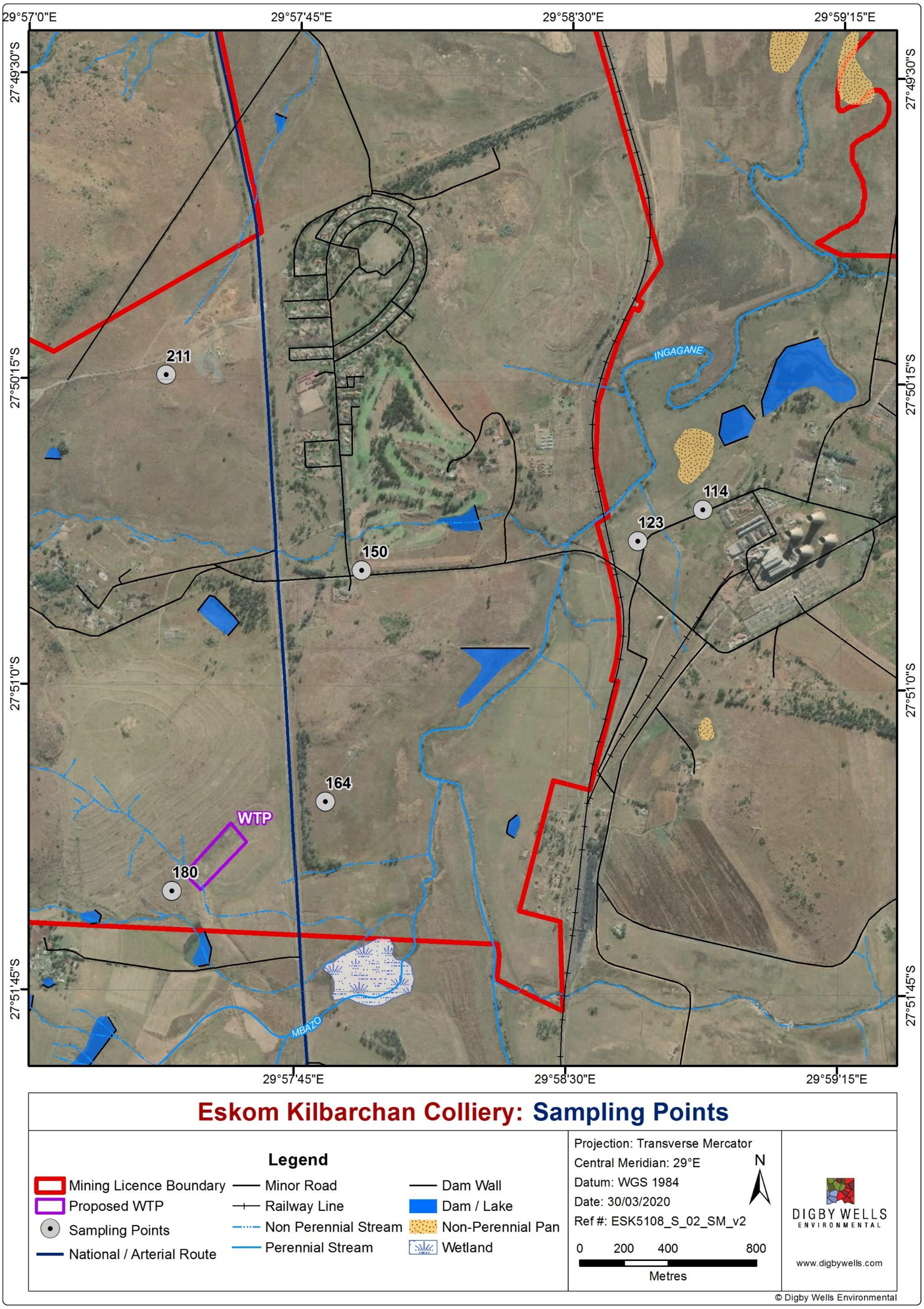

Figure 8-1: Soil Sampling Locations for Kilbarchan Colliery

Soil texture is defined as the relative proportion of sand, silt and clay particles found in the soil. The relative proportions of these three fractions (clay, sand and silt) as illustrated by the red arrows in Figure 8-2, determines one of 12 soil texture classes, for example sandy loam, loam, sand, sandy clay loam, etc. The different texture class zones are demarcated by the thick black line in the diagram. The green zone can be used as a guideline for moderate to high agricultural potential but need to be evaluated together with other soil properties.

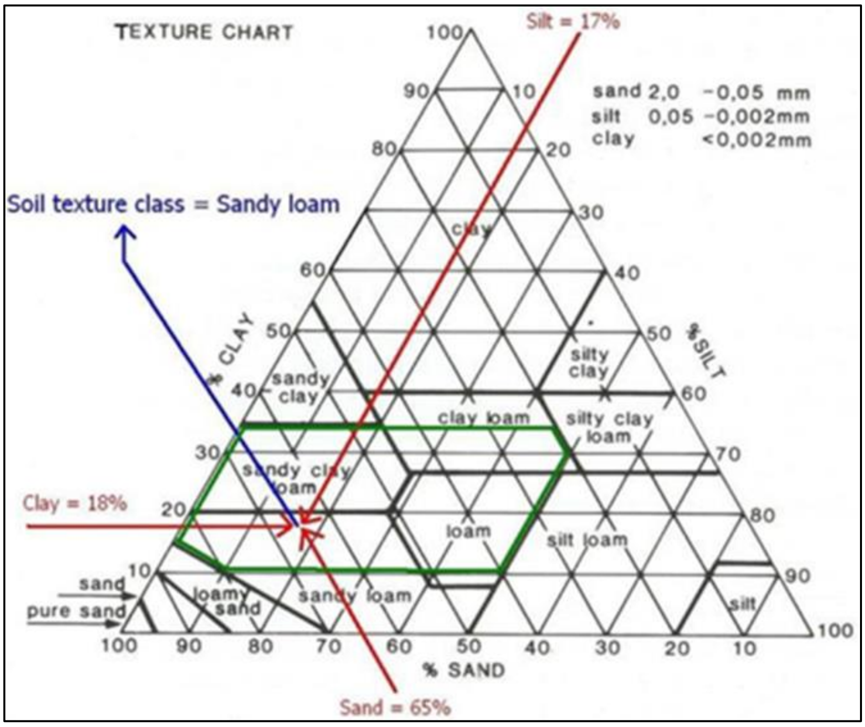

Figure 8-2: Soil Textural Triangle (SASA, 1999)

8.4 Land Capability

Land capability was determined by assessing a combination of soil, terrain and climate features. Land capability is defined by the most sustainable land use under rain-fed conditions. The approach used 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 2.0m;
- **Grazing**: The soil depth is more than 0.25m but less than 0.6m;
- **Wilderness**: The soil depth is more than 0.15m but less than 0.25m; and
- **Wetland**: The soil depths are as for grazing, but soil must be used for the construction of wetlands.

8.5 Land Use

The current land use was identified using aerial imagery during the desktop assessment and on-site visual inspection. The land use is classified as follows:

- Mines;
- Waterbodies;
- Urban built-up and
- Cultivated areas.

9 Findings and Discussion

Information related to the soils associated with the project area is discussed in this Section. The laboratory analyses and results are also presented. The land type gathered suggested that the project area was dominated by land types Ac5, Bb54, Ea34 and Dc40 (Figure 9-6). Further information related to the soil within the project area is discussed in Section 9.1 and photos taken during the field survey presented in Figure 9-5.

9.1 Land Types and Soil Forms

The soils occupying the Kilbarchan project site are mainly derived from sandstone, shale and dolerite which dominate the underlying geology. Due to the undulating topographical landscape features causing variation in soil forming factors, soils of the study area are expected to be varying in nature and will be mostly of mixed agricultural potential.

9.1.1 Land Type Ac5

The Ac land type consists of a catena where red soils are widespread within the dominant terrain forms. The dominant terrain forms consist of 60% crest and mid-slope terrain units as depicted in Figure 9-1. Unit Ac indicates land with red and yellow soils each of which covers more than 10% of the area while dystrophic and/or mesotrophic soils occupy a larger area than high base status red-yellow apedal soils.

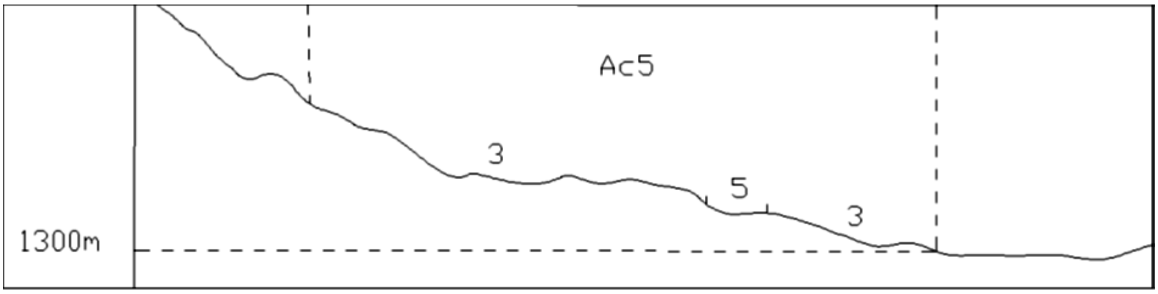

Figure 9-1: Dominant Terrain Units Present Within the Ac5 Land Type

9.1.2 Land Type Bb54

The Bb land type consists of a plinthic catena where red soils are not widespread. Plinthic properties occur in subsoil horizons, especially in the crest and mid-slope terrain units occupying 85% of the Bb landscape as depicted in Figure 9-2. Unit Bb (dystrophic and/or mesotrophic, red soils not widespread) accommodate land where valley bottom is occupied by Rensburg and Arcadia soil forms.

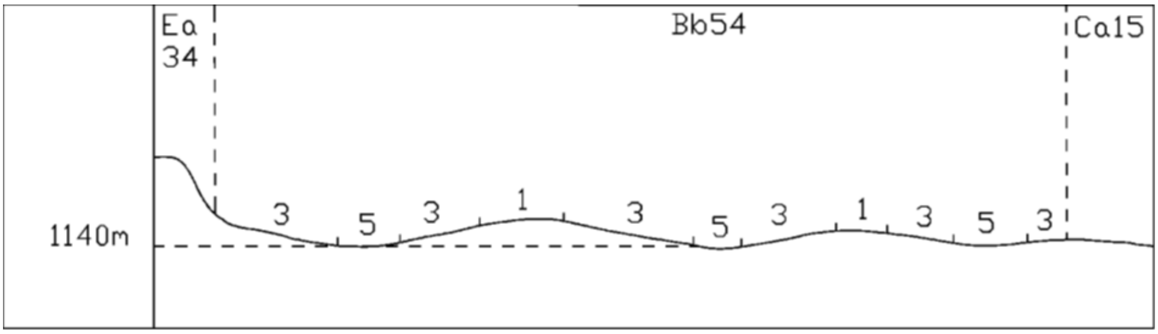

Figure 9-2: Dominant Terrain Units Present Within the Bb54 Land Type

9.1.3 Land Type Dc40

The Dc land type consists of 95% mid-slope and valley bottom terrain units as depicted in Figure 9-3. These terrain units are occupied and dominated by clay soils. Unit Dc accommodate land where duplex soils are dominant. Also, the land type is made up of soils that have one or more of the following diagnostic horizons: vertic, melanic & red structured.

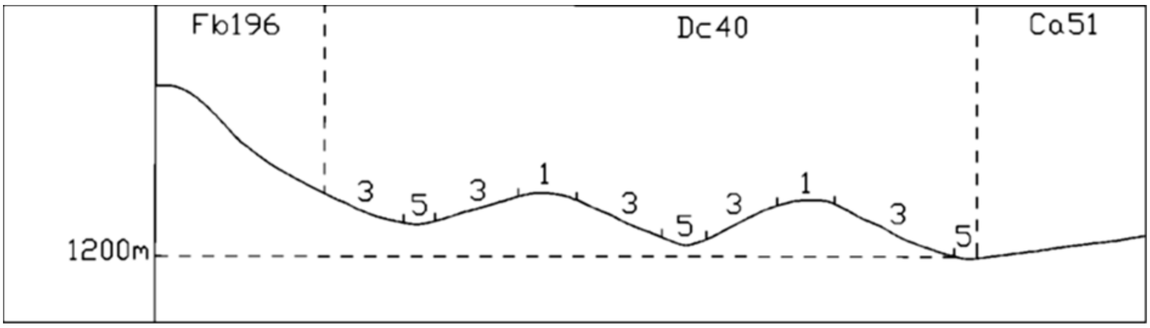

Figure 9-3: Dominant Terrain Units Present Within the Dc40 Land Type

9.1.4 Land Type Ea34

The Ea land type consists of 93% crest and mid-slope terrain units as depicted in Figure 9-4. The dominating soils occupying these terrain units are structured clayey soils. Unit Ea indicates land with high base status, dark coloured and/or red soils, usually clayey, associated with basic parent materials.

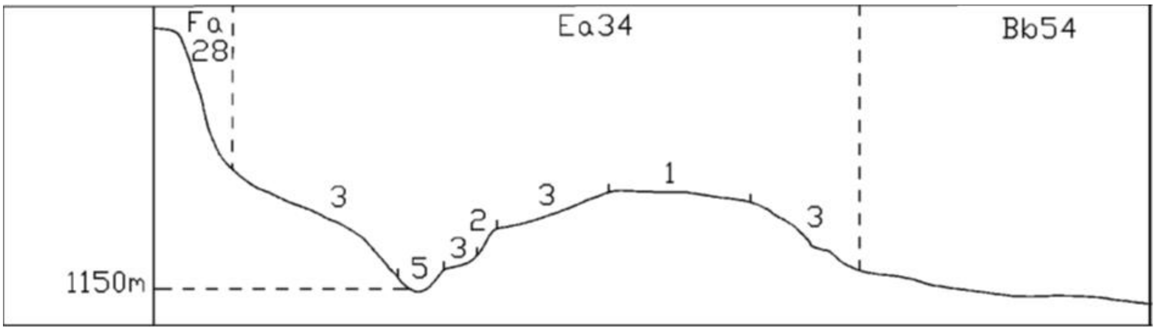

Figure 9-4: Dominant Terrain Units Present Within the Ea34 Land Type

Figure 9-5: Examples of Soils Found on the Site (Red apedal, yellow brown and dark brown soils)

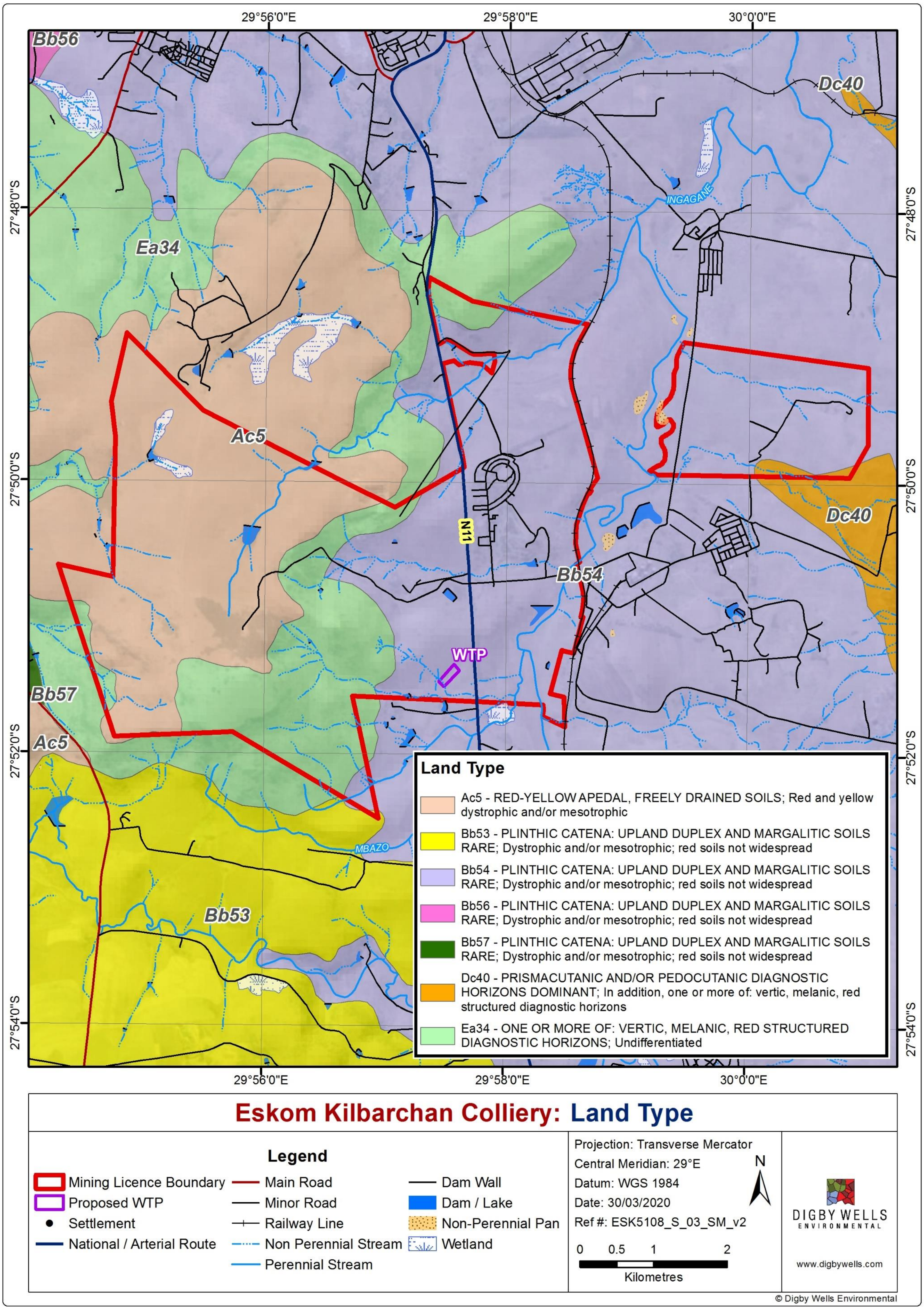

Figure 9-6: Land Type at Eskom Kilbarchan Colliery

9.2 Land Capability

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.

The dominant land capability in the project areas was Class IV (Moderate grazing) as depicted in Figure 9-7. Land in Class IV has very severe limitations that restrict the choice of plants that can be grown and may require special conservation practices. Land may be used for cultivated crops but has more restrictions than Class III and careful management is required.

Limitations restrict, individually or in combination, the amount of clean cultivation, time of planting, tillage, harvesting and choice of crops. Conservation practices are more difficult to apply and maintain. Soils in class IV may be used for pasture, grazing, wildlife and food. Grazing land capability has severe limitations that restrict the choice of plants, require very careful management or both.

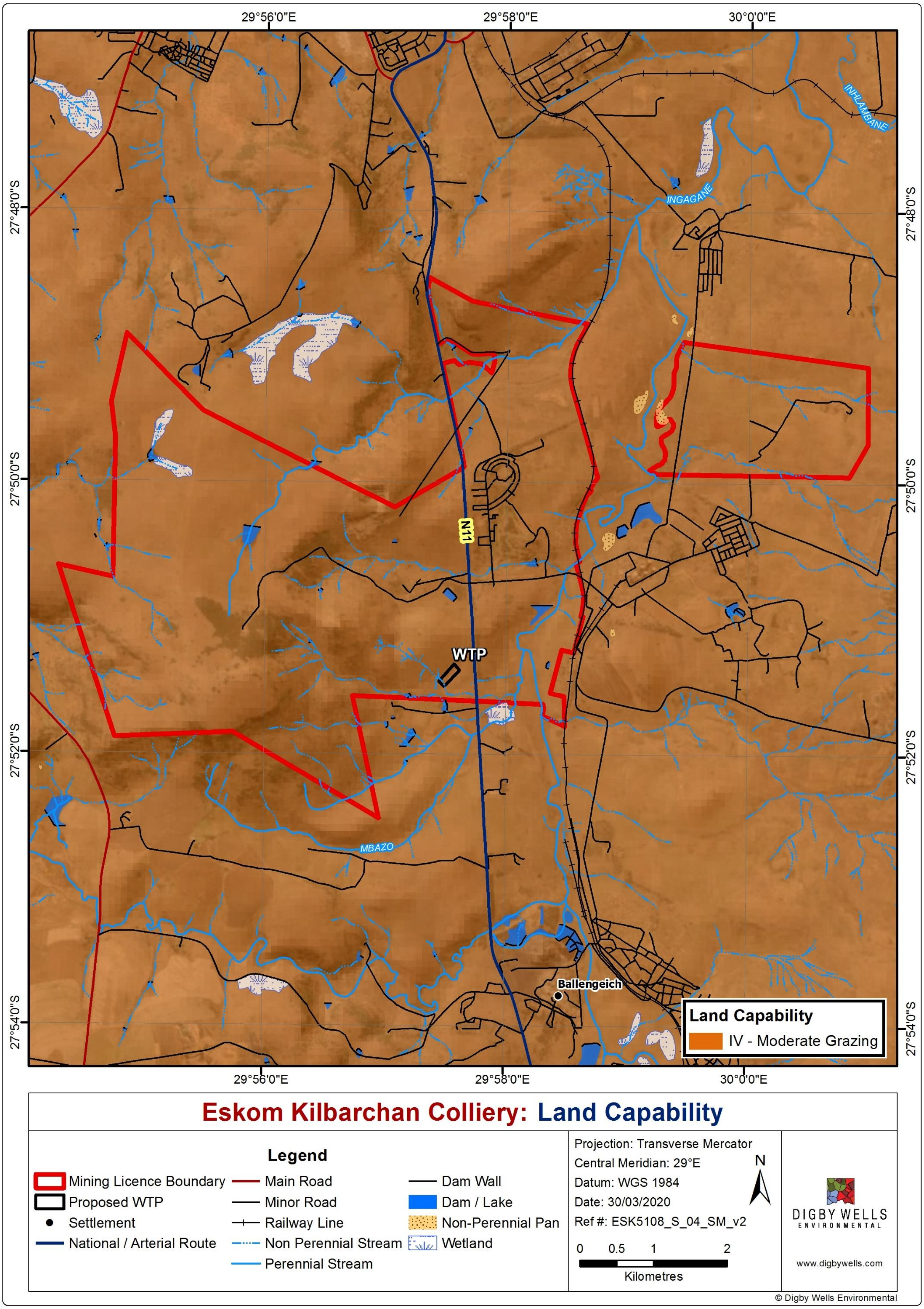

Figure 9-7: Land Capability at Eskom Kilbarchan Colliery

9.3 Land Use

The present land use was identified using satellite images and visual observations during the site visit. The dominant land uses in the area is veld for grazing as depicted in Figure 9-8. The sampling points were covered by grass and no current agriculture was taking place at the locations, however agricultural activities are taking place at other locations outside the Eskom Kilbarchan Colliery area.

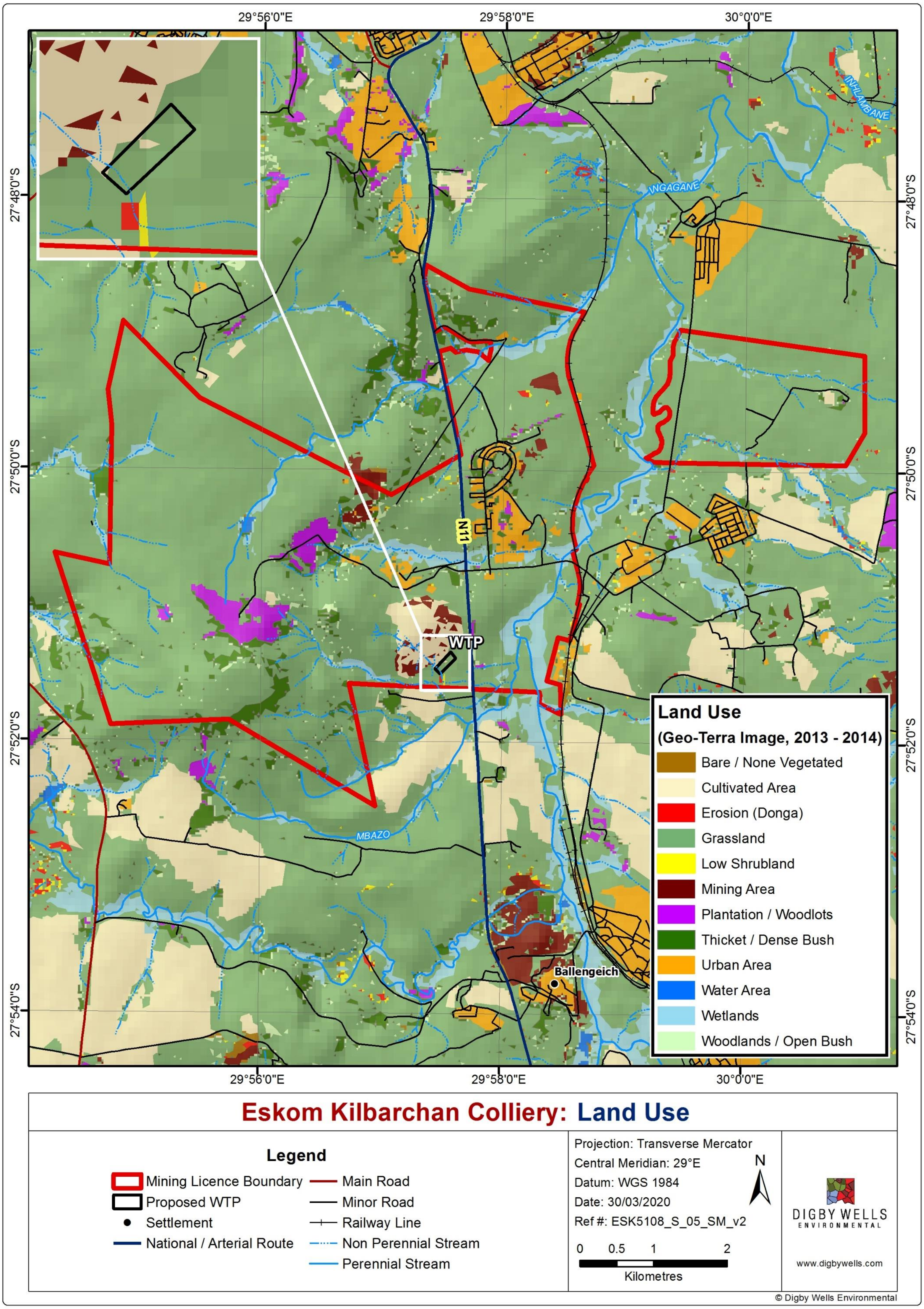

Figure 9-8: Land Use at Eskom Kilbarchan Colliery

9.4 Soil Chemical and Physical Characteristics

A total of six (6) soil samples were analysed for the chemical and physical properties. The objective of this section of the study is to characterise the soil physical-chemical properties which included:

- Chemical properties (pH, cations & phosphorus); and
- Soil texture (Clay, Silt & Sand).

Table 9-1 presents a summary of physical-chemical properties and local soil fertility guidelines as a basis for interpreting these results.

9.4.1 Soil pH

The soil pH is determined in the supernatant liquid of an aqueous suspension of soil after having allowed the sand fraction to settle out of suspension. Soil pH influences plant growth in the following manner:

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

The pH was measured to determine the oxidation potential of the soils. The soil pH ranged from 4.0 to 6.0 as depicted in Table 9-1 and these soils are considered to be acidic to slightly acidic. The soil pH below 7 may be due to the acidic nature of the parent material from which the soils were derived and leaching of the nutrients. Lime is required to counteract acidity and to increase plant growth performance, should agricultural activities have taken place.

9.4.2 Cations

The levels of the basic cations Ca, Mg, K and Na are determined in soil samples for agronomic purposes through extraction with an ammonium acetate solution. In general, the amounts of exchangeable cations normally follow the same trend as outlined for soil pH and texture. For most soils, cations follow the typical trend Ca>Mg>K>Na.

Calcium and magnesium levels in the soils were generally adequate for crop production (Table 9-1), not below the required levels and these nutrients are not limiting any production or considered as toxic. Thus, there is no need to add calcium, potassium and magnesium in a fertiliser form as they might suppress levels of potassium during nutrient uptake by plants, should agricultural activities take place.

Potassium status is relatively low to moderate compared to the soil fertility guidelines (Table 9-1). High rainfall intensity, leaching and underlying parent material may have been responsible for these low values. The potassium uptake by plants is further decreased by the dominance of cation complex by high calcium and magnesium levels. Potassium fertiliser application will be required on significant portions to increase the levels for good crop production, should agricultural activities take place. Sodium levels of the soils are very low and tolerable to plant growth and development. Soil dispersion is unlikely to occur and cause dense structure and drainage problems (de Villiers *et al*., 2003). No serious chemical issues such as soil salinity or sodicity occur on site.

9.4.3 Phosphorus

The Bray 1 extraction and analysis procedure for phosphorus is preferred for soils with pH levels below 7. The P levels encountered in the samples from the site were all very low according to guidelines in Table 9-1, with most values being 1mg/kg. Phosphorus will be limiting on ecosystem function if the soil was going to be used for agricultural purposes and at least 15mg/kg would be required. Phosphorus fertilisation would have been required to establish good crop stand and growth, should agricultural activities have taken place over the area.

9.4.4 Soil Texture

The particle size distribution of the soil sampled in the area was classed into the percentages of sand, silt and clay present. The textural classes were obtained from plotting the three fractions on a textural triangle (Figure 8-2). The soils can be described as sandy clay loam, sandy loam and clay (Table 9-1).

Table 9-1: Soil Physical-chemical Properties

Sample Number	Sample ID	pH (KCl)	P(Bray1)	Na	K	Ca	Mg	Clay	Sand	Silt	Texture Class
			mg/kg					%			
1	**114**	5.7	1	112	51	432	205	23	61	16	Sandy clay loam
2	**123**	4.7	1	40	56	516	235	19	62	19	Sandy loam
3	**150**	4.2	1	33	62	179	103	41	40	19	Clay
4	**164**	4.1	1	13	80	325	122	3	62	35	Sandy loam
5	**180**	5.3	1	239	103	1837	805	25	51	24	Sandy clay loam
6	**211**	5.0	1	23	18	388	217	49	27	24	Clay

Soil Fertility Guidelines (mg per kg)

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

pH (KCl)

Very Acid	Acid	Slightly Acid	Neutral	Slightly Alkaline	Alkaline
<4	4.1-5.9	6-6.7	6.8-7.2	7.3-8	>8

9.5 Agricultural Potential

Among the dominant soils listed in Table 9-1, the Hutton and Clovelly have high agricultural potential; the remainder of the soils have low agricultural potential Arcadia and Longlands have low potential in its wetland setting.

Table 9-1: Agricultural Potential for Soils

Soil Form	Depth (m)	Agricultural Potential
Hutton	0 – 1.0	High
Clovelly	0 – 1.0	Moderate to high
Longlands	0 – 0.6	Moderate
Arcadia	0 – 0.5	Low*

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

10 Unplanned Events and Low Risks

There is a risk of accidental spillages of hazardous substances, for example brine, hydrocarbons or oils from vehicles or other construction machineries and from waste storage facilities during operations. Contamination is the result of leakage of oils and hydrocarbons from equipment used. It must be ensured that the requirements of South African legislation are met to prevent pollution.

10.1.1 Emergency Procedures

Hydrocarbon spills or leaks can occur; therefore, emergency procedures need to be put in place for remediation (Table 10-1). These procedures can include the following:

- Contractors must ensure that all employees are aware of the procedure for dealing with spills and leaks and undergo training on site;
- Ensure that emergency spill equipment is available to site personnel;
- All machines should be serviced and refuelled in demarcated bunded areas, workshops or at an off-site location specifically designed for servicing of machinery;
- If a spill occurs, it should be cleaned up immediately, reported to the appropriate authorities and recorded;
- The brine will be collected and disposed in a registered and licensed Waste Land Facility; and
- Contaminated soils must be disposed in a registered and licensed Waste Land Facility.

Table 10-1: Unplanned Events and their Management Measures

Unplanned Event	Potential Impact	Mitigation/Management/Monitoring
Hydrocarbon leaks from vehicles and machinery or hazardous materials	Soil Contamination	• Place drip trays where the leak is occurring if vehicles are leaking; • All vehicles should be serviced in a concrete bunded area or at an off-site location specifically designed for servicing of machinery. • Machinery must be parked within hard park areas and drip trays must be used. Further the machinery must be inspected daily for fluid leaks.
Hazardous substance spillage from pipelines or waste storage	Soil Contamination	• Prevent any spills from occurring; • If a spill occurs it should be cleaned up (Drizit spill kit/ Zupazorb type spill kit, Oil or Chemical spill kit) immediately and reported to the appropriate authorities; • Pipelines must be inspected regularly for leaks; • Integrity of pipelines must be maintained; and • Emergency response plans should be in place.

11 Monitoring Requirements

A monitoring programme is essential as a management tool to detect negative impacts as they arise and to ensure that the necessary mitigation measures are implemented together with ensuring effectiveness of the management measures in place.

11.1 Monitoring

The following items should be monitored continuously:

- Soils:
  - Erosion status;
  - Compaction;
  - Runoff; and
  - Contamination.
- Vegetation:
  - Vegetation cover;
  - AIPs proliferation; and
  - Species diversity.

The following maintenance is required:

- Repair any damage caused by erosion;
- Traffic should be limited where possible while the vegetation is establishing;
- The area must be fenced, and animals should be kept off the area until the vegetation is self-sustaining;
- Fertilize grassed areas with nitrogen containing fertiliser after germination of seeds;
- If soil is polluted, treat the soil by means of in-situ bioremediation; 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.

11.2 Responsibilities

A very important aspect is the supervision and monitoring during construction and operational phase. The following should be observed when clearing and removing topsoil:

- Close supervision will ensure that soils are not being removed incorrectly;
- Environmental officer is responsible to determine effectiveness of the erosion control structures; and
- Contractor is responsible to undertake the clearing and removing of topsoil.

Table 11-1 provides roles and responsibilities of the people that will be responsible for implementing all the procedures. The responsibilities of the contractor need to be documented in contract documents.

Table 11-1: Responsibilities

Environmental Aspect	Measures and Actions	Responsibility	Timeframes
Waste management	Bins must be provided for disposal of waste during construction	Contractors, Environmental Control Officer and Project Manager	During construction phase to end
Equipment and storage areas	Equipment maintenance must be done offsite. Storage areas must be within the fenced area and located away from all sensitive areas	Contractors, Environmental Control Officer and Project Manager	During construction phase
Hazardous materials	Spillage plan must be developed. Refuelling must be done offsite to prevent potential soil pollution from spillage	Contractors and Environmental Control Officer	During construction phase to end

12 Recommendations

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

- Runoff must be controlled and managed by use of proper storm water management facilities;
- Fuel and oil spills are common; remediate using commercially available emergency clean up kits;
- If any erosion occurs, corrective actions must be taken to minimise any further erosion from taking place;
- Restriction of vehicle movement over sensitive areas to reduce compaction;
- Minimise unnecessary removal of the natural vegetation cover;
- Re-fuelling must take place on a sealed surface area away from freshwater features to prevent ingress of hydrocarbons into topsoil;
- Use of accredited contractors for removal or demolition of infrastructures must be ensured, this will reduce the risk of waste generation and accidental spillages;
- All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan; and
- Surface inspection on the fully rehabilitated areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams.

13 Reasoned Opinion of the Specialist

Soil management measures should be followed as outlined in this report and land needs to be rehabilitated to prevent possible soil erosion, contamination and compaction. It is the opinion of the specialist that this project is feasible and could be considered if the management and mitigation measures tabled are rigorously adhered to for the project in order to minimise potential impacts on the soils and to maintain their land capability for future land use. Soil management measures and monitoring requirements as set out in this report should form part of the conditions of environmental authorisation.

14 Conclusion

The finding of the soil assessment suggested that the land type associated with the project area was dominated by land types Ac, Bb, Dc and Ea. The soils are dominated by Clovelly and Longlands forms (yellow-brown), Hutton forms (red apedal) and (black and greyish) Arcadia forms. The dominant land capabilities based on the soils, texture and fertility status found on the project area was grazing. Yellow brown soils are known to be highly susceptible to water or wind erosion, very slow permeability of the subsoil, low water-holding capacity and moderate salinity or sodicity. Wetland areas are characterised by Arcadia soils. Although these soils are deeper, they have high expansible clay content and are physically difficult to manage.

The fertility status of the soils is generally low to moderate with some requirement for lime to counteract acidity. Exchangeable base cations (calcium and magnesium) are present at sufficient levels while potassium and phosphorus levels were very low. Potassium and phosphate fertiliser are required to achieve full cropping potential, should the soils have been used for agricultural purposes. There is neither sodicity nor salinity hazard in the soils. Texture is variable from sandy clay loam, sandy loam and clay.

15 References

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