CYMBIAN
ENVIRO-SOCIAL CONSULTING SERVICES

Biophysical Specialist Study Report for the Bravo 4 Power Line Route Alternatives

Draft Report

This is a report compiled for Zitholele Consulting

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Job No:

ESC 228-4

Report No:

228_4_Draft Spes Report-kk-v2-08Jan08

Date:

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PURPOSE OF THIS DOCUMENT

The growing demand for electricity is placing increasing pressure on Eskom's existing power generation and transmission capacity. Eskom are committed to implementing a Sustainable Energy Strategy that complements the policies and strategies of National Government. Eskom aims to improve the reliability of electricity supply to the country, and in particular to provide for the growth in electricity demand in the Gauteng and Mpumalanga provinces. For this reason, Eskom obtained environmental authorisation to construct the new 400 kV Bravo (Kusile) Power Station between Bronkhorstspruit and Witbank in 2007. Construction of this power station has already commenced.

The new Bravo power station needs to be integrated with the existing Eskom electricity infrastructure. This proposed project is to construct a two new 400 kV overhead power lines from the Kendal Power Station to the Zeus Substation. Each of these lines, running parallel to each other, will be approximately 90 km in length.

Eskom Transmission has appointed Zitholele Consulting (Pty) Ltd, an independent company, to conduct an EIA to evaluate the potential environmental and social impacts of the proposed project.

As part of the environmental authorisation specialist studies have to be undertaken in order to inform the Environmental Impact Assessment Report (EIR). This report details the findings for Geology, Climate, Surface Water, Topography, Soils, Land Capability, Land Use, Flora, Fauna (especailly avifauna), Wetlands and Visual Impacts.

Zitholele Consulting appointed Cymbian Enviro-Social Consulting Services to undertake the aformentioned specialist studies. The purpose of this document is therefore to present the findings of the aforementioned assessments and to provide management measures to protect sensitive features located on site.

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1.0 INTRODUCTION

1.1 Project background

The growing demand for electricity is placing increasing pressure on Eskom's existing power generation and transmission capacity. Eskom is committed to implementing a Sustainable Energy Strategy that complements the policies and strategies of National Government. Eskom aims to improve the reliability of electricity supply to the country, and in particular to provide for the growth in electricity demand in the Gauteng and Mpumalanga provinces. For this reason, Eskom obtained environmental authorisation to construct the new 400 kV Bravo (Now renamed Kusile) Power Station between Bronkhorstspruit and Witbank in 2007. Construction of this power station has commenced in 2008.

The construction and operation of the Bravo Power Station requires not only the construction of the Power Station itself, but also the construction of additional auxiliary structures such as power lines. The Bravo Integration Project aims to obtain authorisation and construct these auxiliary structures. In specific detail the project will look at high voltage power lines that span the provinces of Gauteng and Mpumalanga and will be handled as five individual Environmental Impact Assessments (EIA), namely (Figure 1):

Phase 1: Sol – Camden By-Pass Power Line

The intention of Bravo 1 is to build two 400 kV bypasses lines for Zeus substation, the two 400 kV lines from Sol Substation and the two 400 kV power lines from Camden power station will be disconnected from Zeus substation and joined to each other to form two Camden- Sol 400 kV power lines. The location of the two by-pass lines is planned to be within approximately 10 km radius of the Zeus substation. The project is located within the Govan Mbeki District Municipality.

Phase 2: Apollo and Kendal loop in and loop out lines

Eskom propose to construct four new 400 kV overhead power lines, located within the Emalahleni Local Municipality in Mpumalanga, to loop in and out of Bravo Power Station. The existing Kendal-Apollo line will be looped in and out of Bravo to form the Bravo-Apollo and Bravo-Kendal lines. In addition, the existing Duvha-Minerva 400 kV overhead power line will be looped in and out of Bravo Power Station, to form the Bravo-Duvha and Bravo-Minerva lines. The study area in which the alternatives were selected is within the 10 km radius surrounding the new Bravo Power Station and each of the alternative 400kV power lines will be not exceed 10 km in length.

Phase 3: Construction of a 400kV power line from Bravo Power Station to Lulamisa Substation

In order for the Bravo power station to be integrated within the existing Eskom infrastructure, Eskom propose to construct a new 400 kV power line from the new Bravo Power Station to the existing Lulamisa substation, near Diepsloot. This line will be approximately 150 km in length. The construction of this proposed 400 kV power line is aimed to ensure sufficient electricity supply to the Diepsloot and Johannesburg North areas, where currently frequent electricity shortages are experienced. The alternative Bravo power line corridors are located on the eastern Highveld of Southern Africa. The corridors cover an area from Witbank in the east, to Diepsloot in the west.

Phase 4: Two new 90 km Kendal –Zeus 400 kV Power Lines

Eskom propose to construct two new 400 kV power lines, one from Bravo to Zeus and the other one from the Kendal Power Station (near Ogies) to the Zeus substation (near Secunda), Mpumalanga. These lines will run parallel to each other and will be approximately 90 km in length. The three alternative route corridors will be 5 km wide. These three alternative corridors merge into two corridors approximately 30 km from the Zeus substation. **This report details the biophysical findings for the Bravo 4 project.**

Phase 5: New 10km Bravo-Vulcan Power Line

Eskom propose to construct a 400 kV overhead power line, by-passing the existing Duvha substation, to form a new Bravo-Vulcan line near Middelburg, Mpumalanga. This by-pass line is planned to be approximately 10 km in length. The area to be investigated for this by-pass line is a 10 km radius surrounding the existing Duvha substation.

Eskom Transmission has appointed Zitholele Consulting (Pty) Ltd, an independent company, to conduct an EIA to evaluate the potential environmental and social impacts of the proposed project. Zitholele Consulting has in turn appointed Cymbian Enviro-Social Consulting Services to undertake the bio-physical specialist studies required, including:

- Vegetation Assessment;
- Soil and Land Capability Assessment; and
- Wetland Delineation.
- Geology
- Visual
- Fauna (especially avifauna)

1.2 Regional setting and project locality

The Bravo Integration Project will span the provinces of Gauteng and Mpumalanga, stretching from Secunda, Ogies and Middelburg in Mpumalanga, to Bronkhorstspruit, Midrand and Kayalami in Gauteng. Refer to Figure 1 for a locality map for the entire Bravo Integration Project.

This report details the biophysical assessments undertaken for the Bravo 4 study area. The Bravo 4 site is located between the Zeus substation south of Secunda and Kendal Power Station to the north. This study area will include 3 route alternatives connecting the Zeus Sub Station with the Kendal Power Station as shown in Figure 2.

1.3 Study scope

As part of the environmental authorisation process for the aforementioned project it is required for the Environmental Impact Assessment Process that certain biophysical specialist studies be undertaken. Zitholele Consulting appointed Cymbian Enviro-Social Consulting Services to undertake the following biophysical specialist studies:

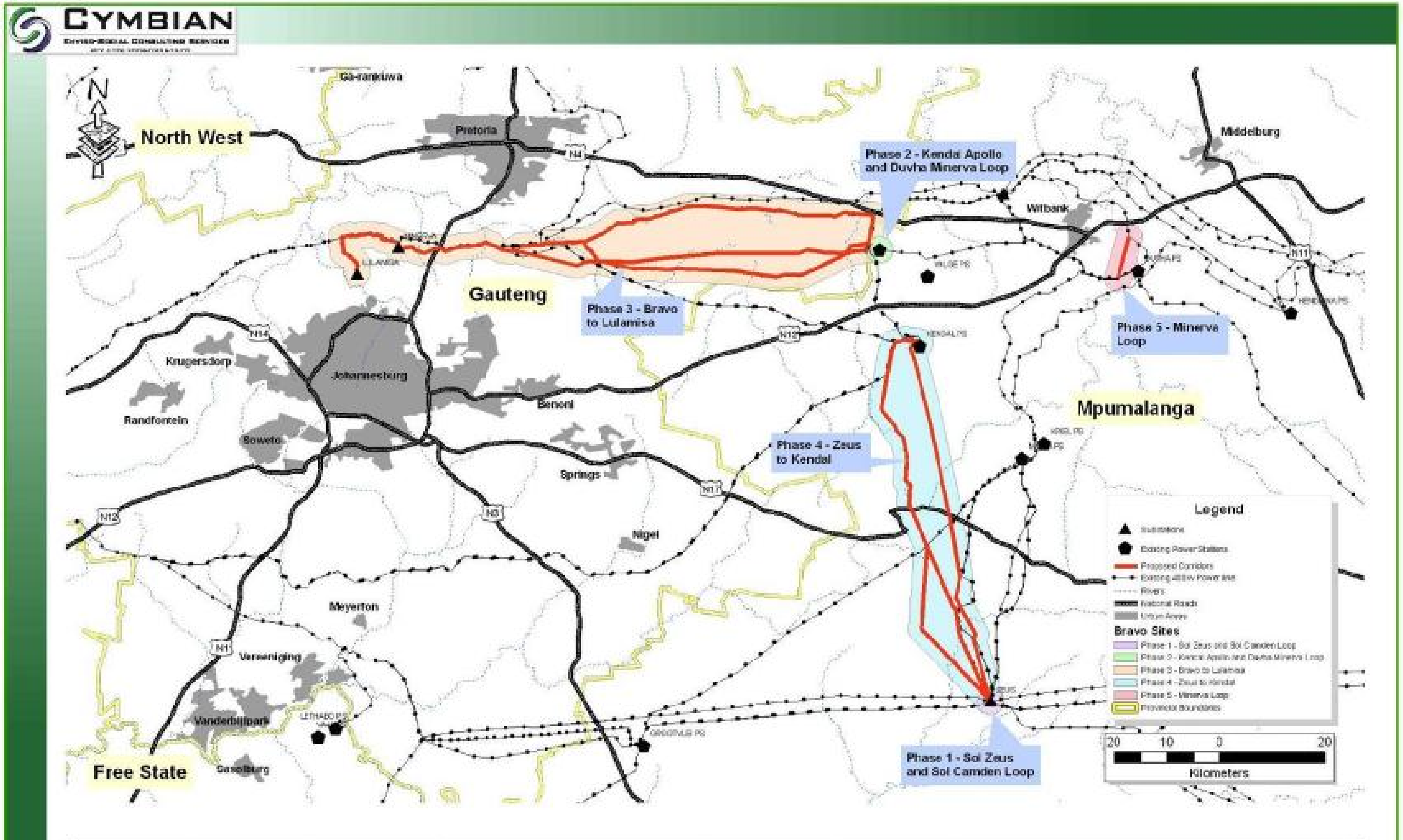
- A Geology, Soil and Land Capability Assessment;
- A Topographical Assessment;
- A Visual Assessment;
- An Ecological Assessment; and
- An Ornithological Assessment.

The Geology, Soil and Land Capability Assessments were conducted using a Geographic Information System (GIS) as well as a site investigation to identify soils on site. The Topographical and Visual assessment were completed using a GIS. The Ecological and Ornithological assessment were conducted by first undertaking a literature review and then followed up with site investigations to confirm the findings of the literature review. During the Ecological and Ornithological site investigations, all fauna were noted and identified.

1.4 Study approach

Cymbian undertook the aforementioned specialist studies during a week site visit conducted from the 3rd - 7th of November 2008. The study area was 75km in length encompassing the area from the Kendal Power Station to the Zeus Substation, within a 10 km radius of the power line alternatives.

Transects were walked on either side of the power line alternatives in which vegetation, soil, fauna and wetland characteristics were sampled. Each sampling point was marked using a GPS for mapping purposes, photos of each sampling point were also taken.



CLIENT CODE:	PROJ CODE:	REF NO:	DATE DRAWN: 2008/03/27 AUTHOR: K. Kruger	PROJECTION:	SCALE:	DATA SOURCES:
ZIT001	228	01		WGS 84 Hartebeesthoek	1:650,000	Surveyor General's Office Eskom SANBI Vegmap CSIR Land Cover Database

Figure 1: Site Location

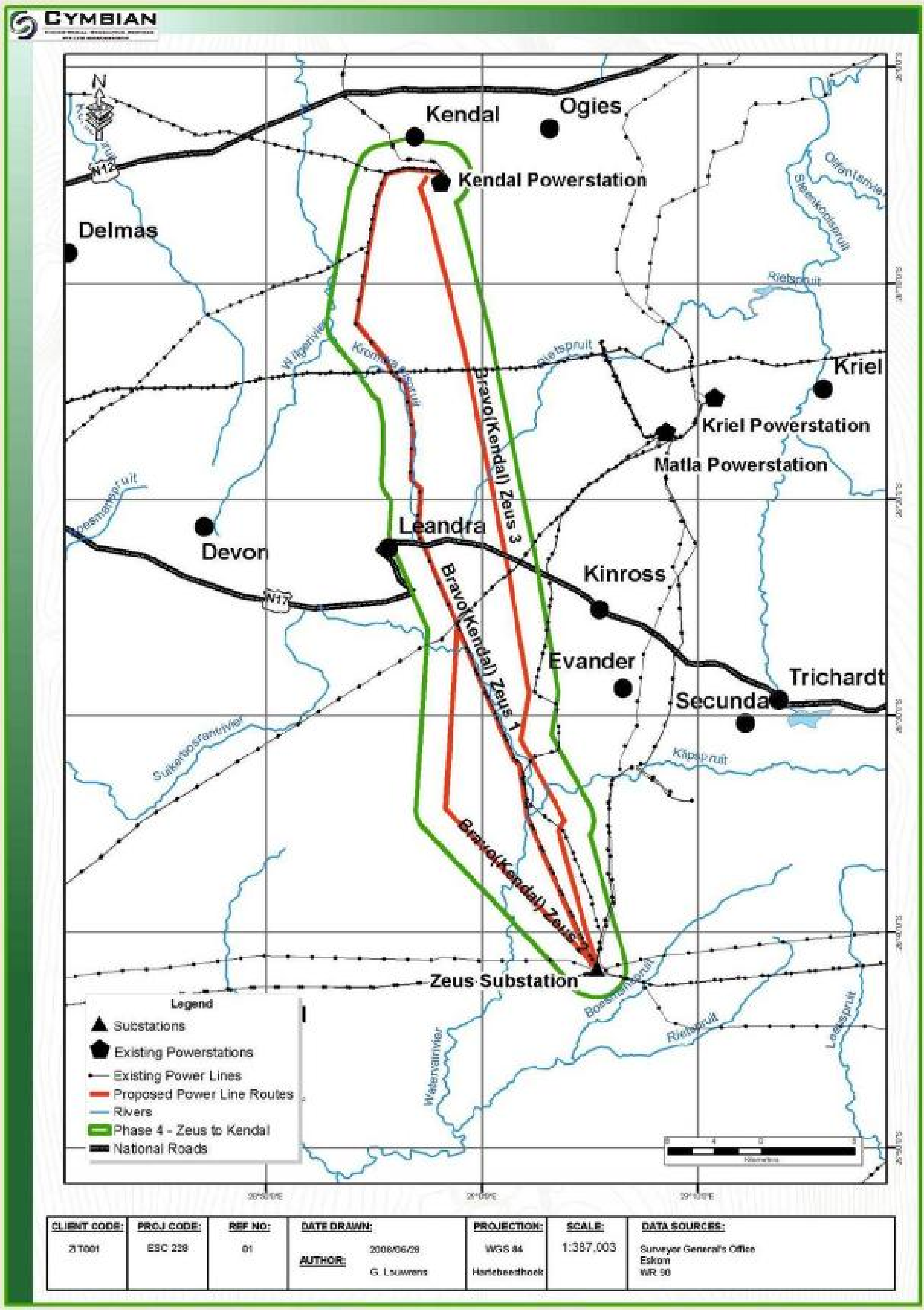


Figure 2: Site Map

1.5 Project team

The technical project team consists of:

- Ü **Konrad Kruger** – Landscape Ecologist and Environmental Consultant
- Ü **Glen Louwrens** – Conservation Ecologist and Junior Environmental Consultant
- Ü **Brett Coutts** – Conservation Ecologist and Junior Environmental Consultant

Konrad Kruger graduated from the University of Pretoria with a BSc Honours in Geography in 2003. Konrad has been involved in a variety of environmental projects in the last three years and has become specialised in undertaking specialist studies, mapping and environmental consulting. Konrad has undertaken GIS mapping for mining, residential as well as industrial developments. Konrad is also an experienced land ecologist and will provide expertise for this project in terms of soil surveys, land capability assessments and mapping. He is currently in the process of acquiring his MSc in Geography (Landscape Ecology) from the University of Pretoria.

Glen Louwrens graduated from the University of the Witwatersrand with a BSc Honours in Zoology and Ecology in 2007. Currently a Junior Environmental Consultant at Cymbian Enviro-Social Consulting Services, he is experienced in GIS mapping and can provide expertise in terms of faunal and floral surveys.

Brett Coutts graduated from the University of the Witwatersrand with a BSc Honours in Zoology and Ecology in 2007. His Honours year was based with the Endangered Wildlife Trust (EWT), working on the porcupine quill trade. He has worked for Hydromulch between 2007 and 2008 as a junior project manager on environmental rehabilitation projects. Currently a Junior Environmental Consultant at Cymbian Enviro-Social Consulting Services, he is experienced in rehabilitation projects, population dynamics of small mammals and can provide expertise in terms of faunal and floral surveys.

1.6 Assumptions and Limitations

The following assumptions were made during the assessment:

- Ü The information regarding the routes provided by Zitholele Consulting and ESKOM is accurate;
- Ü If the corridors could not be accessed, data from adjacent sites could be used;
- Ü A corridor width of 5 km was used;
- Ü Fauna, flora and wetland delineation studies can only be completed during the summer months;
- Ü Power line design will be similar to the existing high voltage power lines on site.

2.0 DETAILED PROJECT DESCRIPTION

2.1 Project Alternatives

Several strategic alternatives were considered at the conceptual phase of the Bravo Power Station EIA. This strategic information was again revisited during the planning phase of the Bravo Integration Project.

2.2 Design Alternatives

The primary motivating factors behind the consideration of underground power lines include the following:

1.) Areas prone to significant infrastructure damage due to extreme weather conditions, on an annual basis, usually consider underground power lines. The cost of power line replacement over the life of the infrastructure is usually more cost effective in such areas;

2.) The visual impact of underground power lines is much less than those of overhead power lines, and are usually considered in highly sensitive visual landscapes, such as wide open wilderness spaces and tourism facilities e.g. game farms and nature reserves.

The primary motivating factors behind the consideration of overhead power lines include the following:

1.) The cost of overhead lines is between 250% and 400% less. Eskom have a responsibility to provide cost effective and reliable energy resources;

2.) Overhead circuits can often be worked on while they are still energized. Nearly all work on underground circuits is performed while things are de-energized and grounded.

3.) Underground cables need a larger conductor to handle the same amperage as a smaller overhead conductor. This is due to the difficulty of dissipating heat to the earth. Larger conductors means higher cost.

4.) Overhead distribution circuits are much easier to modify to serve customers or make other changes. A simple set of fuses on an overhead circuit might cost ~R2 000.00, yet the underground equivalent costs over ~R10 000.00.

5.) An overhead line can generally span and not disturb sensitive features such as cultural resources sites, streams, most wetlands, isolated steep slopes, or a sensitive species location to mention a few. Underground lines however require the construction of a trench and results in a disturbed area of approximately 15 m in width for the entire length of the line.

As none of the areas affected by the proposed Bravo Integration Project are annually affected by extremely damaging environmental events, or fall within highly sensitive visual environments it was decided to implement the more cost effective overhead power line alternative.

2.3 Route Alternatives

The various route alternative corridors of approximately 5 km were analysed and will be assessed during this EIA. These three alternative corridors have been selected considering existing environmental information; engineering feasibilities as well as existing Eskom servitudes power lines. The following 3 alternatives were identified (Figure 2). The 3 alternative routes merge into 2 corridors 30 km from the Zeus substation, since there is and existing 400 kV Eskom servitude present.

Alternative 1:

Alternative 1 is to construct the two proposed 400 kV power lines, running parallel, approximately 76 km from Zeus Substation to Kendal Power Station. This proposed line will run furthest to the west as illustrated in Figure 2. This alternative is the longest alternative, and will be along an existing power line servitude. This alternative is currently the preferred alternative.

Alternative 2:

Alternative 2 is to construct the two proposed 400 kV power lines, running parallel, approximately 70 km from Zeus Substation to Kendal Power Station. The line will follow the same corridor as alternative 1 for the first 60 km's and later divert south before heading east towards the Zeus substation for 30 kms.

Alternative 3:

Alternative 3 is to construct the two proposed 400 kV power lines, running parallel, approximately 63 km from Zeus Substation to Kendal Power Station. This alternative will lead to a shorter power line length and is the alternative furthest to the east of the area as illustrated in Figure 2.

The No-Go Alternative

The No-Go alternative will also be assessed further in the EIA. In the case that none of the three alternatives is suitable for the proposed power lines, the recommendation would be that the proposed power line not be constructed and further alternative alignments, or project solutions be generated.

2.4 Major Activities of the Project

The project involves 21 major activities:

1. Environmental Impact Study.
2. Negotiations for the servitude.
3. Land survey to determine the exact routing of the line and tower placement.
4. Profiling work to produce the profiles for construction.
5. Pegging of bend tower by a Transmission surveyor.
6. Erection of camp sites for the Contractors' workforce.
7. Negotiations with landowners for access roads to the servitude.
8. Servitude gate installation to facilitate access to the servitude.
9. Vegetation clearing to facilitate access, construction and the safe operation of the line.
10. Establishing of access roads on the servitude where required as per design parameters.
11. Pegging of tower positions for construction by the contractor.
12. Transportation of equipment, materials and personnel to site and stores.
13. Installation of foundations for the towers.
14. Tower assembly and erection.
15. Conductor stringing and regulation.
16. Taking over the line from the contractor for commissioning.
17. Final inspection of the line, commissioning and hand over for operation.
18. Rehabilitation of disturbed areas.
19. Signing off of all Landowners upon completion of the construction and rehabilitation.
20. Handing over and taking over of the servitude by the Grid Environmental Manager.
21. Operation and maintenance of the line by the Grid.

2.5 Project Timeframes

The primary project milestones are represented in Table 1 below.

Table 1: Primary Project Milestones for Bravo 4

Milestones	Date
Final Scoping Report	20 October 2008
Undertake Specialist Studies	15 January 2008
Draft EIR and EMP	10 February 2009
Stakeholder Engagement on EIR / EMP	11 March 2009
Finalise EIR and EMP	6 April 2009
Submission to Relevant Authorities	7 April 2009
Environmental Authorisation	19 May 2009
Appeal Period	21 July 2009
Commence with Construction	To be advised
Construction (including EMP Auditing)	To be advised
Completion of Construction (including Rehabilitation)	To be advised
Close out Audit	To be advised

3.0 RECEIVING ENVIRONMENT

This section details the receiving environment at the project location. Although the aim of this report is to detail the vegetation, wetlands and, soil and land capability component of the receiving environment; certain additional factors have been included, as they provide perspective to the soil and vegetation study. These include geology, topography, climate, surface water and land use.

It should be noted that during the site visit, the Bravo Power Station site clearance and construction has already begun and large sections of the site was inaccessible and already disturbed.

3.1 Geology

3.1.1 Data Collection

The geological analysis was undertaken through the desktop evaluation using a Geographic Information System (GIS) and the relevant data sources. The geological data was taken from the Environmental Potential Atlas Data from the Department of Environmental Affairs and Tourism. Data was supplemented with on site observation during site visits conducted on the 8th – 12th September 2008 and the 3rd – 7th November 2008.

3.1.2 Regional Description

The lithology of the area comprises several geological sequences as illustrated in Figure 4. From the Figure it is clear that the study area is dominated by Dolerite flows along with Arenite. These main two geologies are prevalent for more than 80% of the study area. Several small sections of Granite, Shale and Tillite also occur within the study area.

The Arenite (sandstone) overlies the majority of the Mpumalanga coal fields and has been extensively disturbed by opencast mining operations all over the study area. This geology weathers to form the main agricultural red and brown soils of the province.

The Dolerite originates from lave intrusions throughout the area and can be distinguished by the “dinosaur egg” weathering of the rock. The Dolerite in the region weathers to a dark clayey soil that is not ideal for cultivation and is mostly used for grazing.

Figure 3: Dolerite (left) and sandstone (right) are the two main geologies found on site

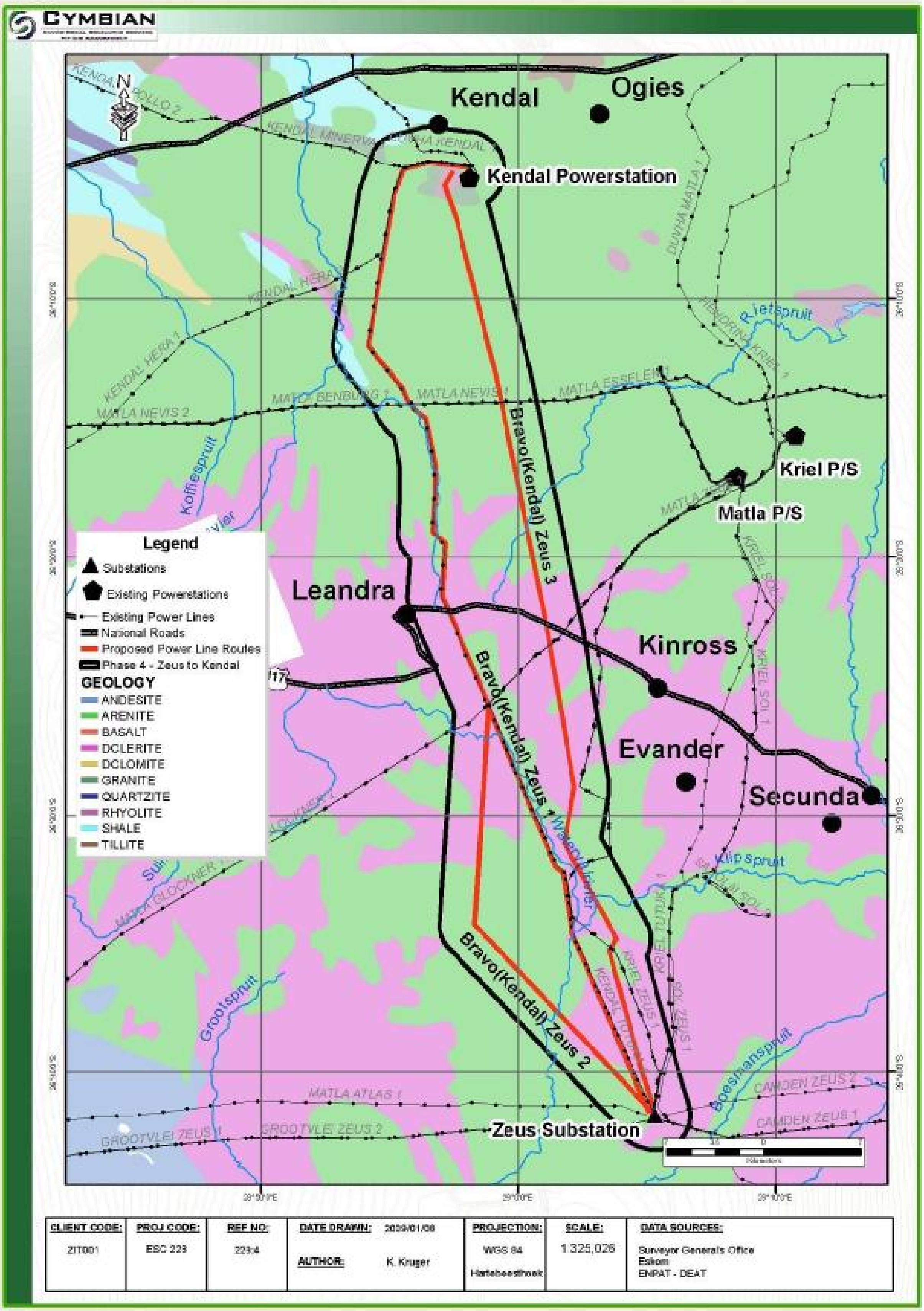


Figure 4: Regional Geology

3.2 Climate

3.2.1 Data Collection

Climate information was attained using the climate of South Africa database, as well as from Air Quality Impact Assessment for the Proposed New Coal-Fired Power Station (Kendal North) in the Witbank Area undertaken by Airshed Planning Professionals[1].

3.2.2 Regional Description

The study area displays warm summers and cold winters typical of the Highveld climate. The region falls within the summer rainfall region of South Africa, rainfall occurs mainly as thunderstorms (Mean Annual Precipitation 662 mm) and drought conditions occur in approximately 12% of all years. Mean annual potential evaporation of 2 060 mm indicates a loss of water out of the system.

The region experiences frequent frosts, with mean frost days of 41 days, winds are usually light to moderate, with the prevailing wind direction north-westerly during the summer and easterly during winter. In addition to frost the area is prone to hail storms during the summer time. Such a storm was experienced during the site visits and the hail stones are illustrated in Figure 5 below.

Figure 5: Hail stones from a storm event in November 2008 (Secunda)

[1] Air Quality Impact Assessment for the Proposed New Coal-fired Power Station (Kendal North) in the Witbank Area. Report No.: APP/06/NMS-01 Rev 0.2, 2006.

Ambient Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers. Long-term average (2003) maximum, mean and minimum temperatures for Kendal 2 is given in Table 2.

Table 2: Long Term Temperature Data for Kendal (Airshed, 2006)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Maximum	31	32	32	29	24	20	22	24	29	30	30	32
Mean	21	22	20	18	13	10	10	12	18	20	21	22
Minimum	15	15	12	11	6	4	3	4	10	13	14	15

Annual maximum, minimum and mean temperatures for Kendal 2 are given as 32°C, 3°C and 17°C, respectively, based on the 2003 record. Average daily maximum temperatures range from 32°C in December to 20°C in July, with daily minima ranging from 15°C in January to 3°C in July.

3.3 Surface Water

3.3.1 Data Collection

The surface water data was obtained from the WR90 database from the Water Research Council. The data used included catchments, river alignments and river names. In addition water body data was obtained from the CSIR land cover database (1990) to show water bodies and wetlands.

3.3.2 Site Description

The study area falls within the Olifants River (Catchment B) and Vaal River (Catchment C) Primary Catchments as shown in Figure 6 (Northern section) and Figure 7 (Southern section).

The main river in the northern section of the site is the Wilge River along with the Kromdraai Spruit and the Riet Spruit. All these watercourses drain primarily northwards towards the Olifants River. Several non-perennial streams and drainage lines also occur throughout the area, draining towards the main rivers.

The southern section of the site drains towards the Vaal River and the main tributaries are the Waterval River, The Klip Spruit and the Boesman Spruit. The main drainage direction is southeast towards the Vaal River.

The streams and their associated dams support a number of faunal and floral species uniquely adapted to these aquatic ecosystems and therefore all surface water bodies are earmarked as sensitive features and should be avoided as far as possible.

As illustrated in the Figures below, it is evident that the Alternative 1 route is aligned along several streams, while Alternative 2 crosses very close to Leeupan. Alternative 3 does not traverse along any streams, but it does cross several. It should be noted that a large number of the existing power lines in the area are aligned along streams and drainage lines. The reasoning behind this was not to interfere with the farming activities that take place in all the surrounding areas. The recent emphasis on environmental impact limitation has however changed this perception, and it is now preferred that power lines avoid water courses. The streams support sensitive fauna and flora species which are described in more detail in the sections below. On the basis of the above it would be best to utilise Alternative 3, as this alternative avoids the most of the streams.

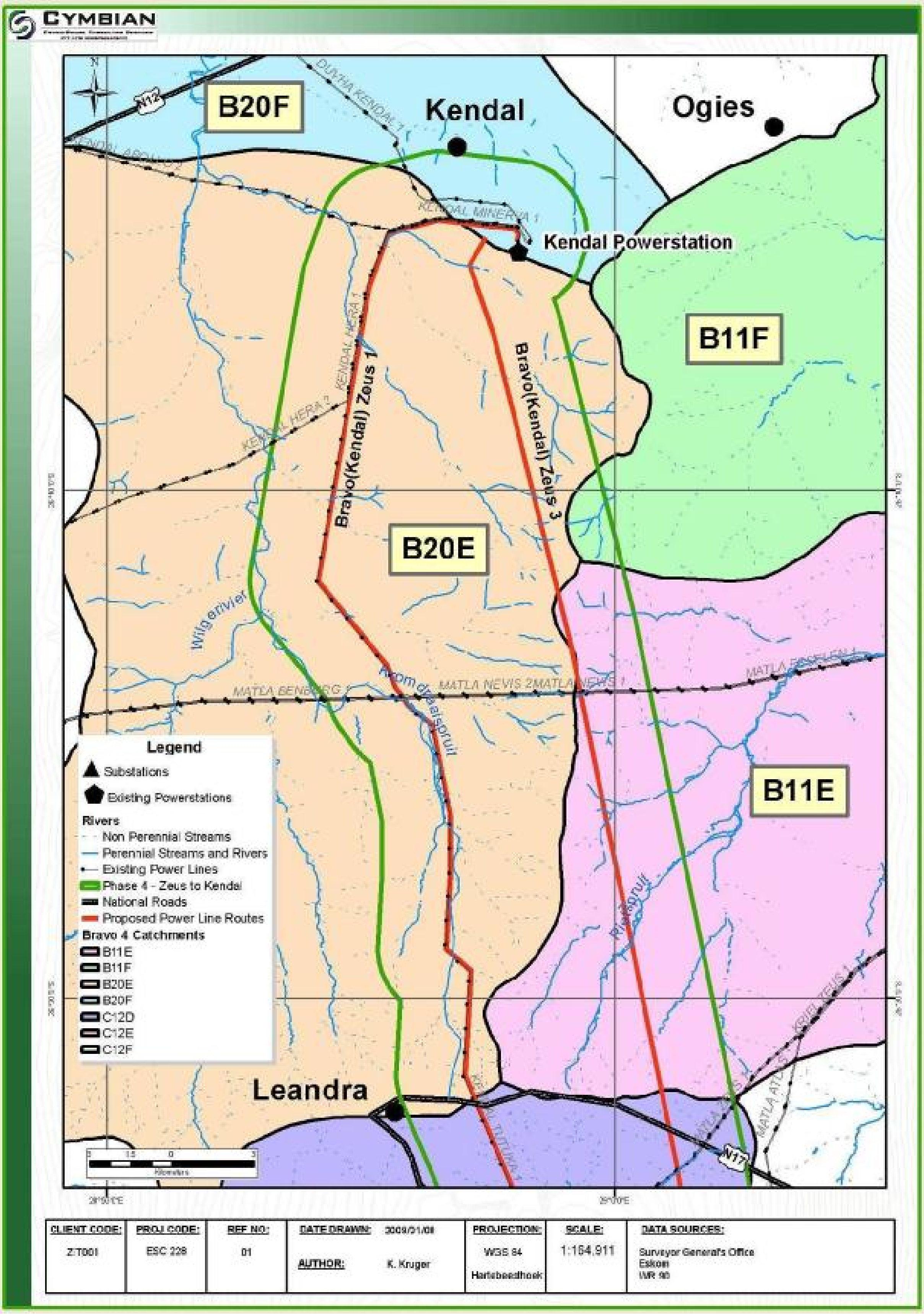


Figure 6: Surface water and drainage features of the northern section of the site

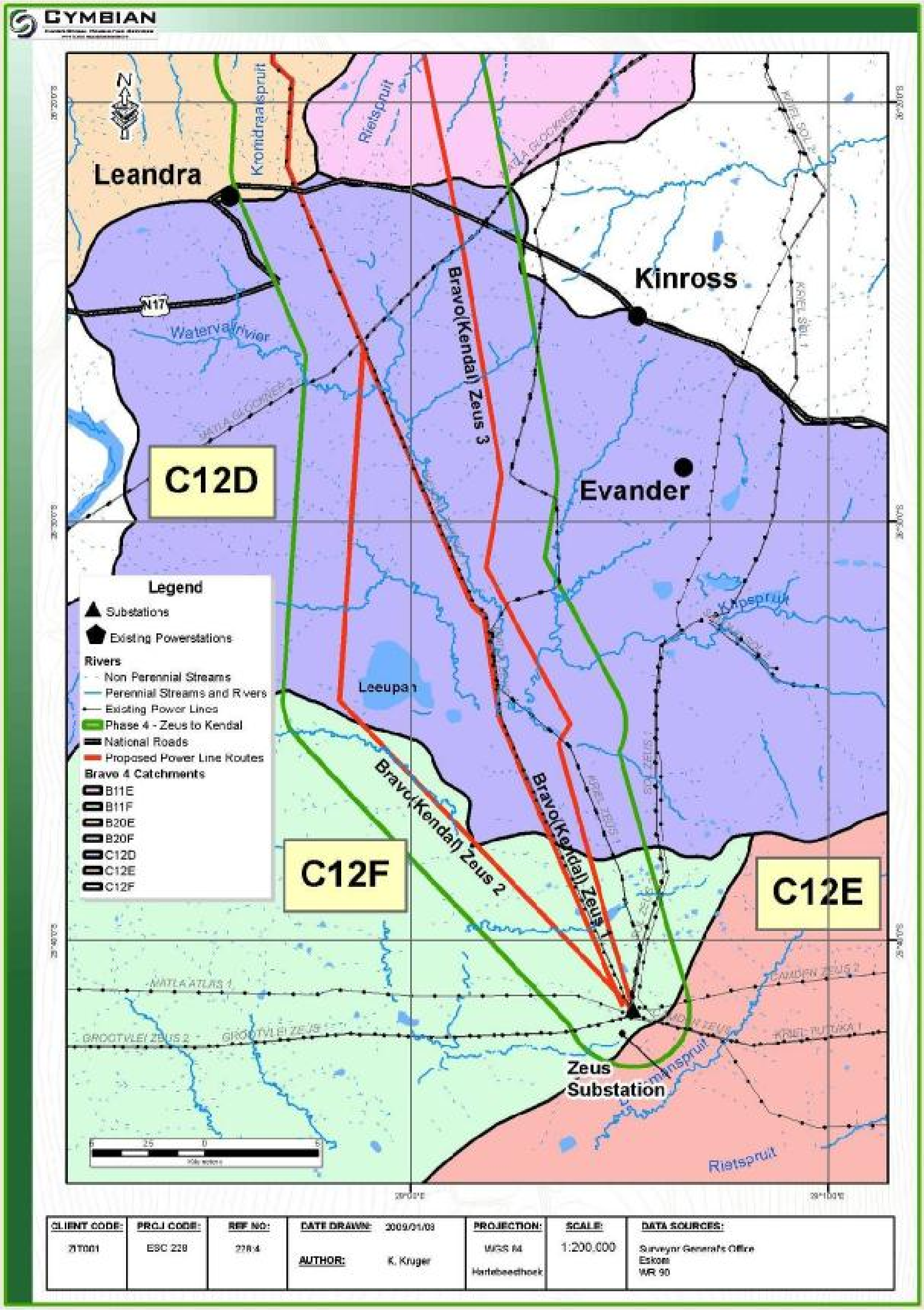


Figure 7: Surface water and drainage features of the southern section of the site

The Waterval River along which a significant section of Alternative 1 is aligned.

Leeupan, a significant water body found along the Alternative 2 alignment. Note Secunda in the background (left) and the angling club (right).

Waterval River showing existing power line crossings

Kromdraai Spruit, another stream that is traversed by the Alternative 1 alignment for a considerable distance.

Figure 8: Photographs of the surface water resources encountered on site

3.4 Topography

3.4.1 Data Collection

The topography data was obtained from the Surveyor General's 1:50 000 toposheet data for the region, namely 2628 BB, BD, DB and 2629 AA, AC and CA. Contours were combined from the topo mapsheets to form a combined contour layer. Using the Arcview GIS software the contour information was used to develop a digital elevation model of the region as shown in Figure 9 below.

3.4.2 Regional Description

The topography of the region is gently undulating to moderately undulating landscape of the Highveld plateau. Some small scattered wetlands and pans occur in the area, rocky outcrops and ridges also form part of significant landscape features in the area. Altitude ranges between 1420-1800 metres above mean sea level (mamsl).

3.4.3 Site Description

The study area's topography is representative of the region, that being gently undulating grassland of the Highveld plateau. This undulating topography gives rise to the number of streams and rivers in the area, which form at the bottom of the gently rolling hills. Elevations range from 1480 metres above mean sea level (mamsl) in the north to 1760 mamsl in the central parts of the site.

Figure 9 below illustrates the digital elevation model created from the contours of the region. The low lying areas are clearly visible in light blue while the higher areas are shown in brown. The watershed along the N17 highway is clearly visible in the centre of the site, from which the water drains either northwards or southwards.

Although the height difference is clear on the map, the higher lying areas in this region are not classified as ridges.

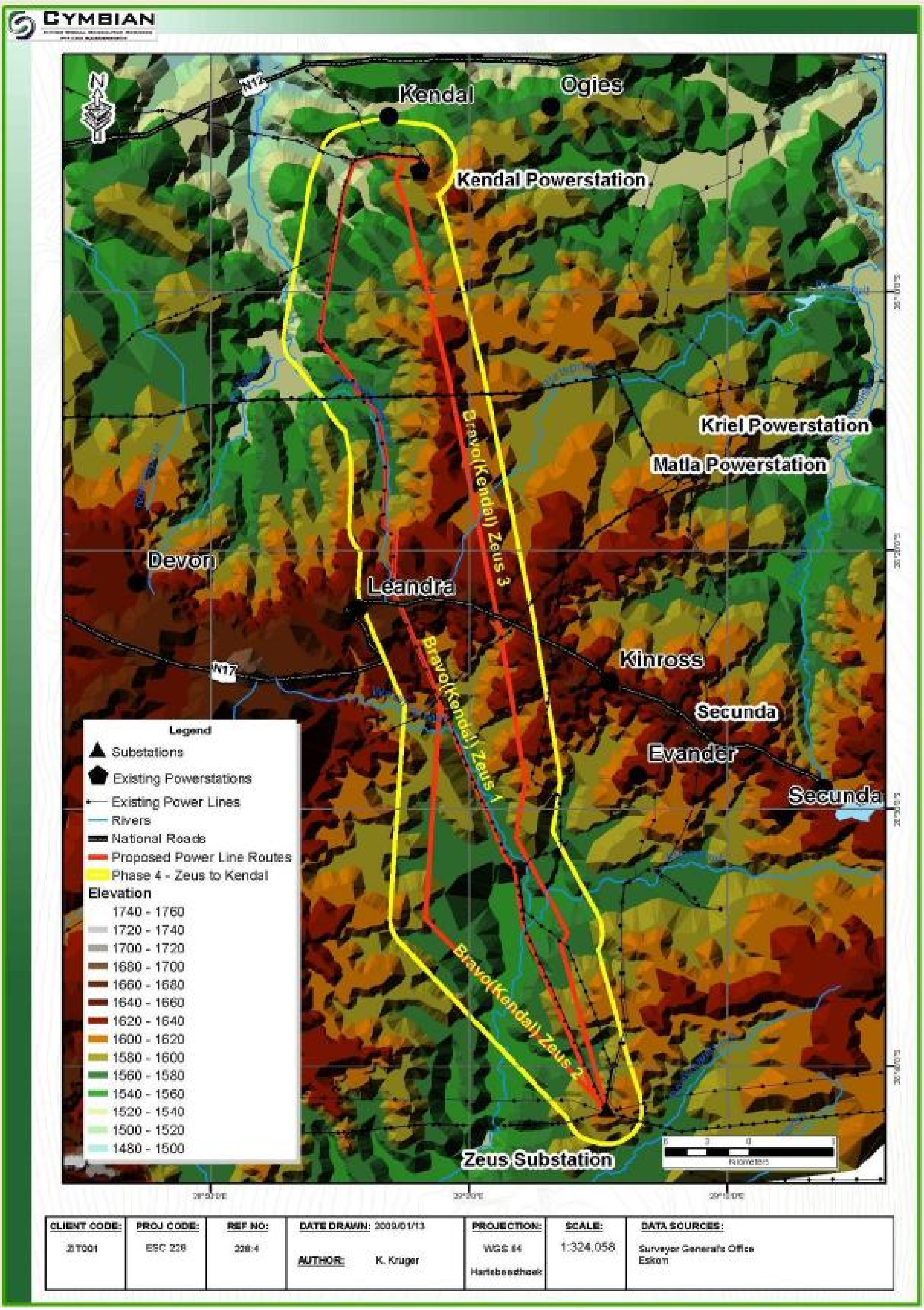


Figure 9: Topography of Site

3.5 Soils

3.5.1 Data Collection

The site visits were conducted on the 8th – 12th September 2008 and the 3rd – 7th November 2008. Soils were augered at 300 m intervals along the proposed power line routes using a 150 mm bucket auger, up to refusal or 1.2 m. Soils were identified according to Soil Classification; a taxonomic system for South Africa (Memoirs on the Natural Resources of South Africa, no. 15, 1991). The following soil characteristics were documented:

- Soil horizons;
- Soil colour;
- Soil depth;
- Soil texture (Field determination)
- Wetness;
- Occurrence of concretions or rocks; and
- Underlying material (if possible).

3.5.2 Regional Description

The soils in the region are mostly derived from the geology of the region namely, predominantly shale, sandstone or mudstone of the Madzaringwe Formation (Karoo Supergroup), or the intrusive Karoo Suite dolerites which feature prominently in the area. The soils on the sandstones are generally deep with a brown colour, while the dolerites generally form dark clay soils.

3.5.3 Site Description

During the site visit several soil forms were identified including Mispah, Avalon, Clovelly, Katspruit, Longlands, Wasbank, Rensburg, Arcadia, Willowbrook, Steendal, Milkwood, Inhoek, Kroonstad, Westleigh, Dresden, Glencoe, Bainsvlei, Shortlands, Sterkspruit and Witbank. In order to simplify the assessment, the soil forms have been grouped into management units that have similar characteristics, and therefore would require similar management. These units are agricultural soils, disturbed soils, rocky soils, wetlands soils and transitional soils. Each of the soil management units are described in detail in the sections below and Figure 10 and Figure 11 illustrates the location of the soil units. The land capability (agricultural potential) of the abovementioned soils are described in more detail in Section 3.6.

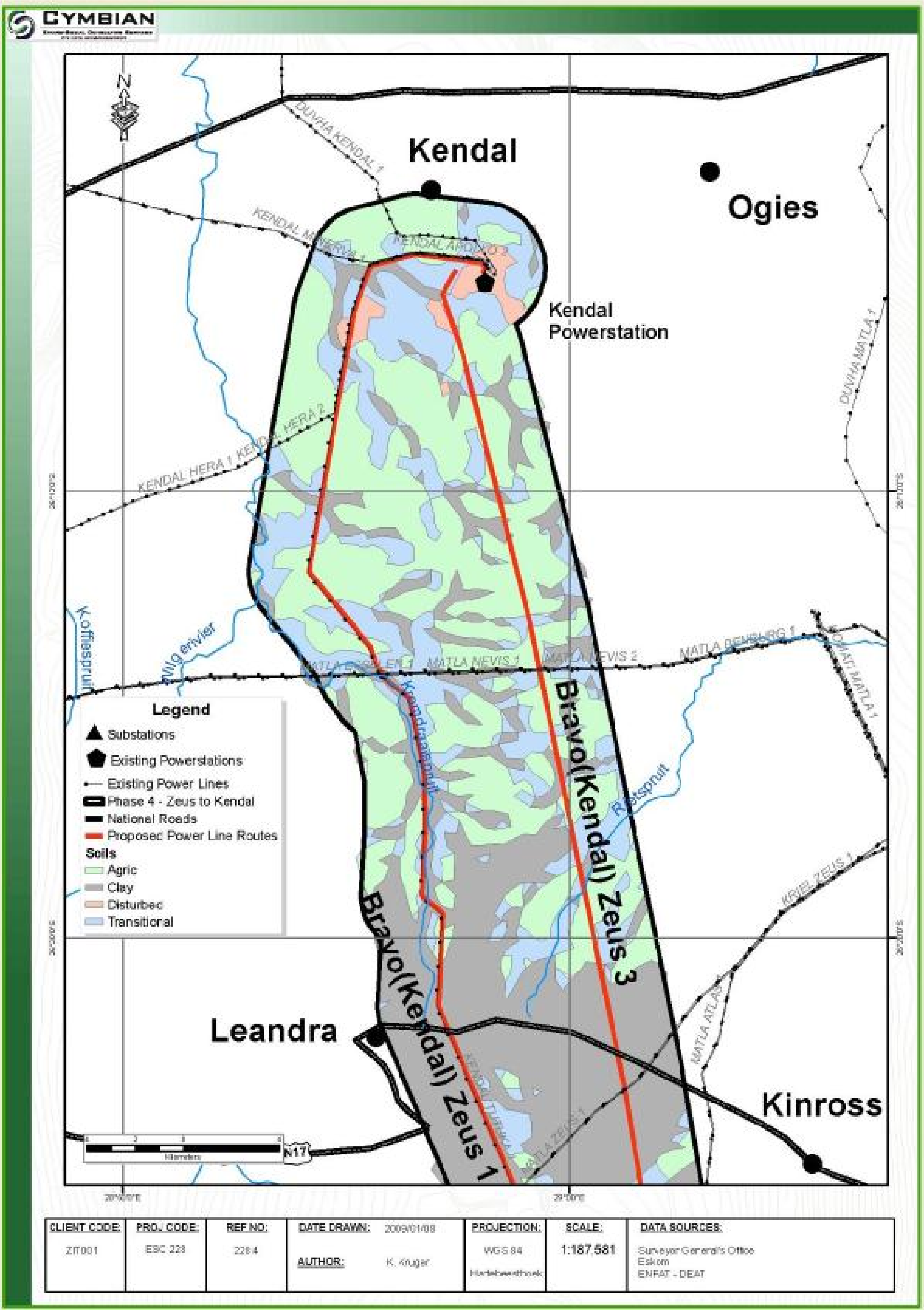


Figure 10: Soil Type Map of the northern section of the site

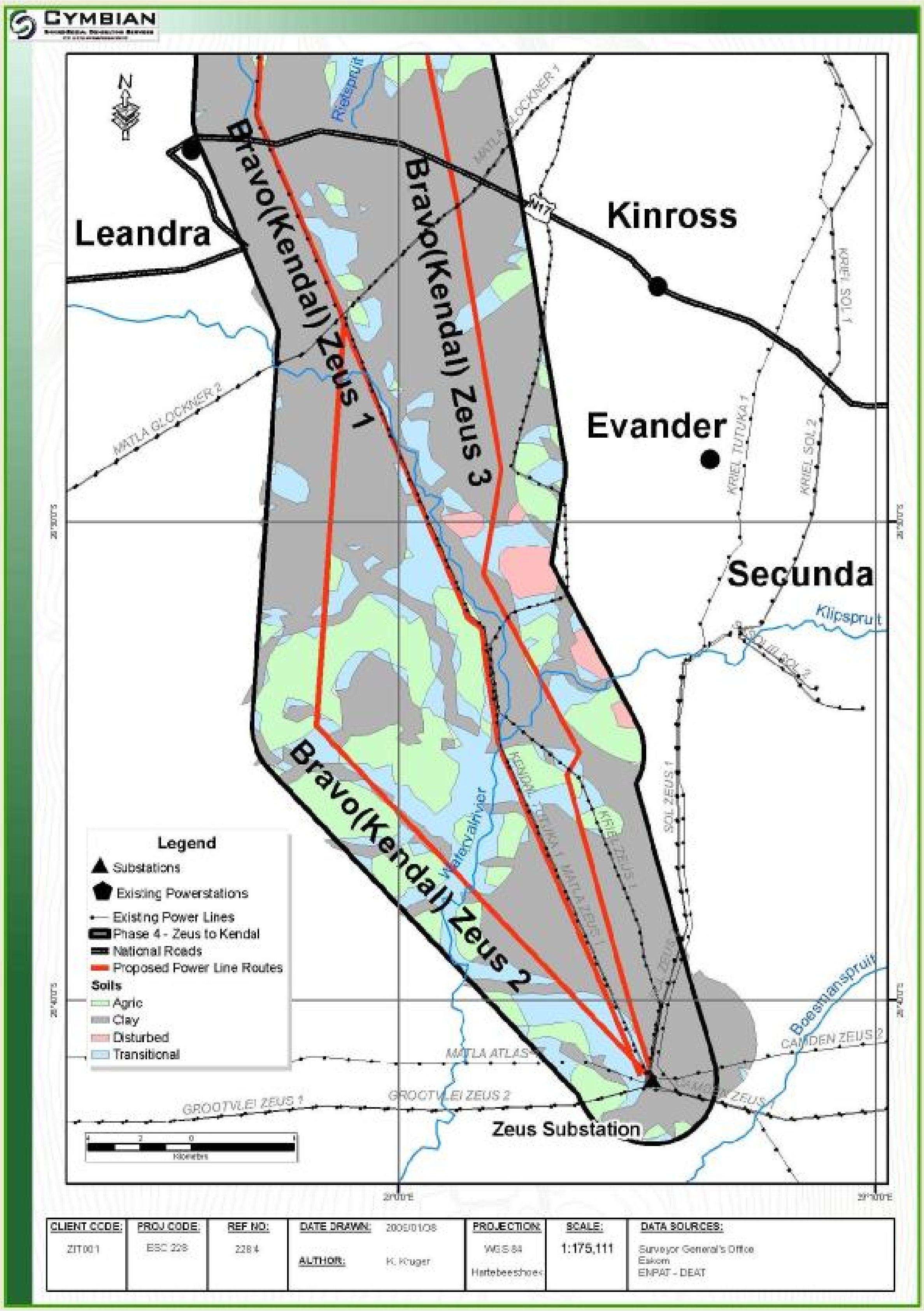


Figure 11: Soil Type Map of the southern section of the site

Agricultural Soils

The agricultural soils found on site support an industry of commercial maize production. These soils include Hutton, Clovelly, Avalon, Bainsvlei, Glencoe and Shortlands. These soils have deep red or yellow-brown B-horizons with minimal structure, but in the case of Shortlands soils the B-horizon has some degree of structure. These soils drain well and provide excellent to moderate cultivation opportunities. Each of the soils is described in detail below.

Hutton and Clovelly Soil Forms

Hutton's are identified based on the presence of an apedal (structureless) "red" B-horizon and Clovelly's with an apedal "yellow" B-horizon as indicated in Figure 12 below. These soils are the main agricultural soil in the country due to the deep, well-drained nature of these soils.

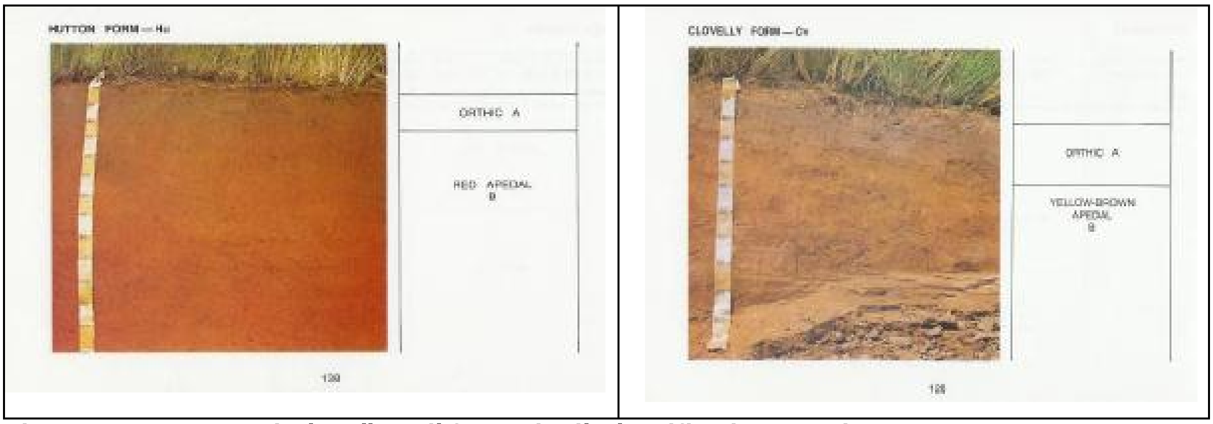


Figure 12: Hutton and Clovelly soil forms (Soil Classification, 1991)

Avalon and Bainsvlei Soil Forms

The Avalon and Bainsvlei soil forms are characterised by the occurrence of a soft plinthic B – horizon (See Figure 14). The Avalon has a yellow-brown B-horizon while the Bainsvlei has a red apedal B-horizon. These horizons are the same as described for the Hutton and Clovelly soils above. The plinthic horizon has the following characteristics:

- Has undergone localised accumulation of iron and manganese oxides under conditions of a fluctuating water table with clear red-brown, yellow-brown or black strains in more than 10% of the horizon;
- Has grey colours of gleying in or directly underneath the horizon; and
- Does not qualify as a diagnostic soft carbonate horizon.

These soils are found lower down the slopes than the Clovelly and Hutton soils and indicate the start of the soils with clay accumulation.

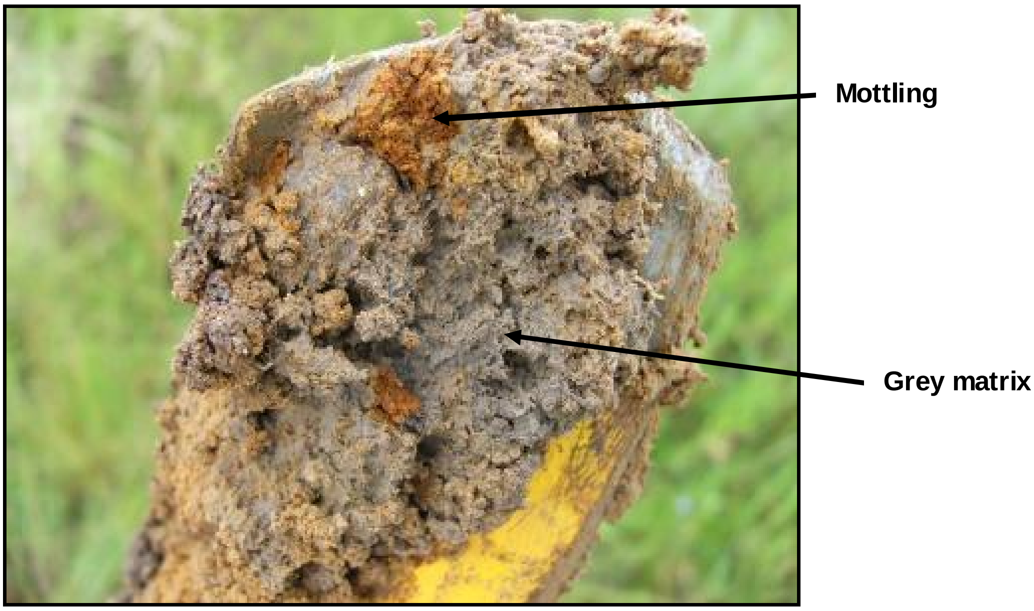


Figure 13: Soft plinthic B-horizon.

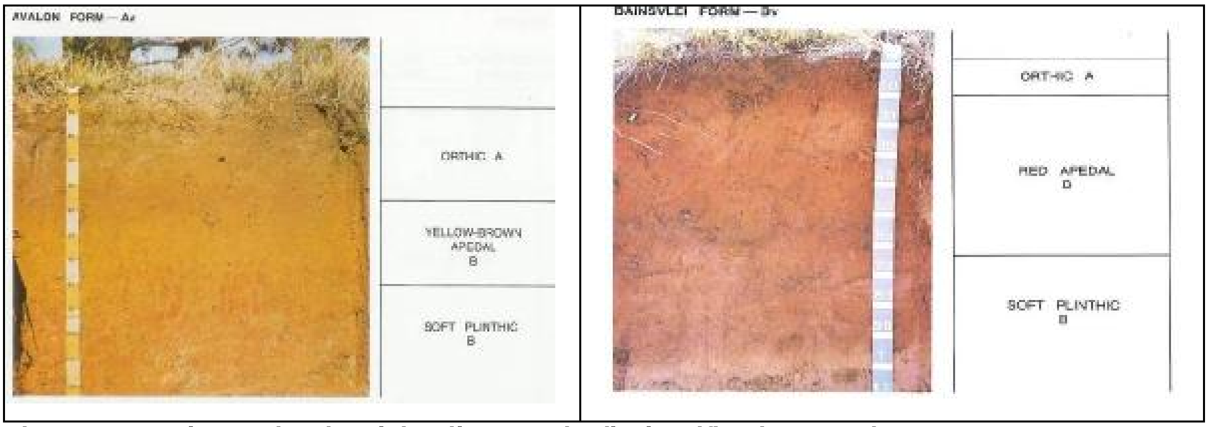


Figure 14: Avalon and Bainsvlei Soil Forms (Soil Classification, 1991)

Glencoe:

The Glencoe soil form is found in areas where the soft plinthic B-horizon of an Avalon has hardened irreversibly into Hard Plinthite (Ferricrete). Refer to Figure 15 for an illustration of this soil form.

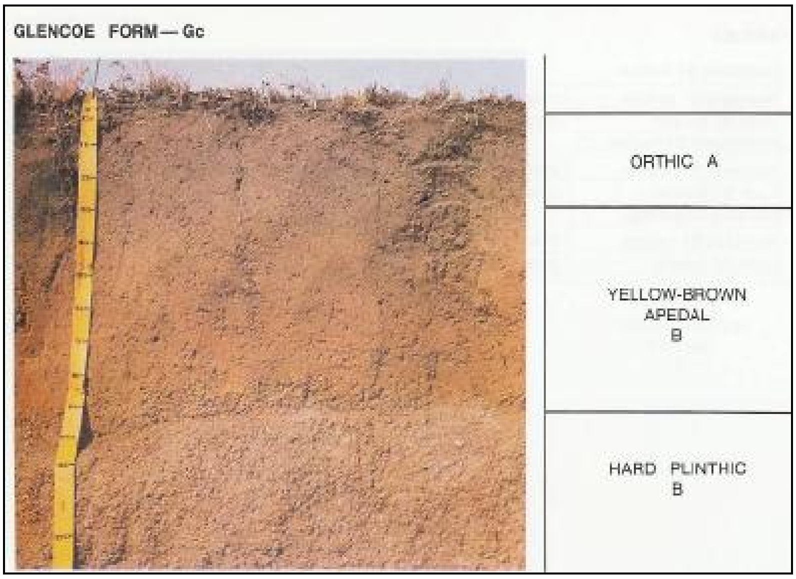


Figure 15: Glencoe Soil Form (Soil Classification, 1991)

Shortlands:

The Shortlands soil form has an Orthic A Horizon over a Red structured B Horizon as illustrated in Figure 16. These soils are very similar to the Hutton soils, the only difference being the formation of a structure in the B-horizon.

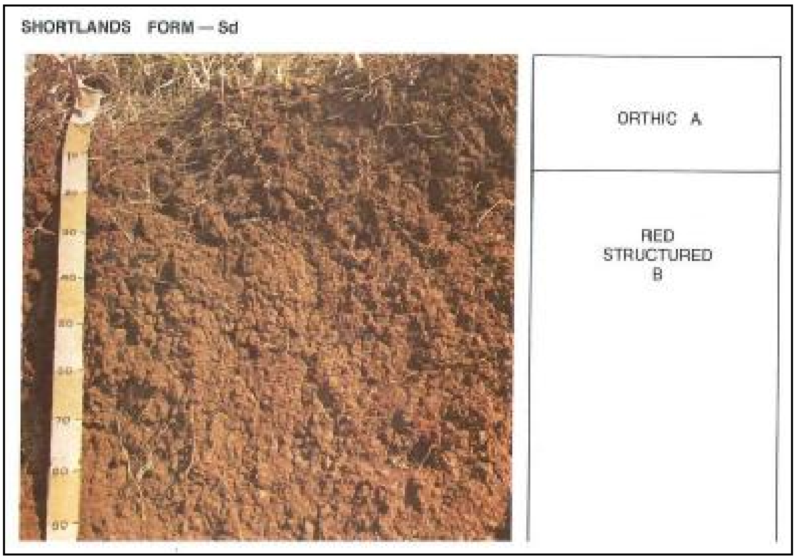


Figure 16: Shortlands Soil Form (Soil Classification, 1991)

Rocky Soils

The rocky soil management unit is made up of soils that are generally shallow and that overlie an impeding layer such as hard rock or plinthite. These soils are not suitable for cultivation and in most cases are only usable as light grazing. The unit comprises the following soil forms:

- Mispah (Orthic A horizon over hard rock);
- Milkwood (Melanic A horizon over hard rock);
- Dresden (Orthic over hard plinthic);

Mispah

The Mispah soil form is characterised by an Orthic A – horizon overlying hard rock. These soils are especially prevalent in the northern and central parts of the site and are commonly found on rocky ridges our outcrops. Please refer to Figure 17 for an illustration of a typical Mispah soil form.

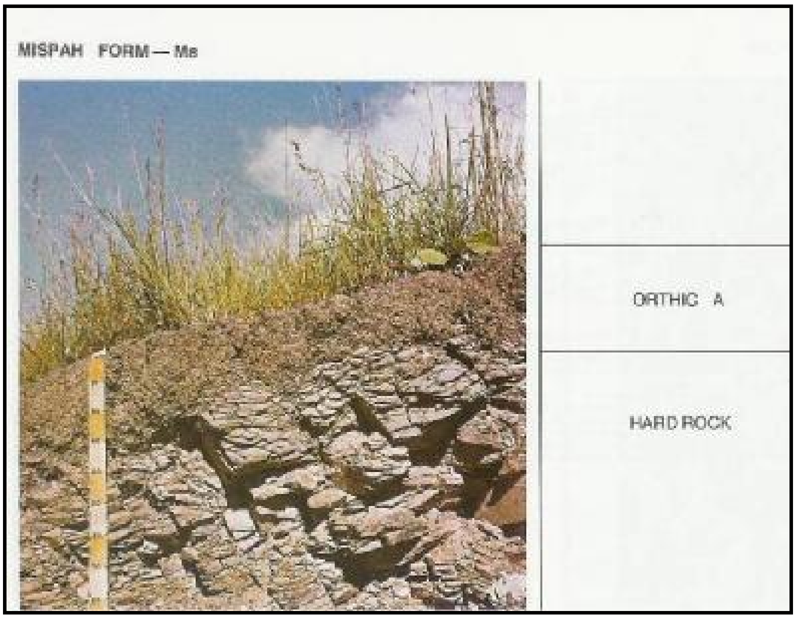


Figure 17: Mispah soil form (Memoirs on the Natural Resources of South Africa, no. 15, 1991).

Milkwood

The Milkwood soil form is characterised by a Melanic A horizon overlying hard rock. These soils dominate the southern parts of the site as they predominantly form from the Dolerite geology. Due to the underlying hard rock, these soils have limited cultivation potential and are most often used for grazing.

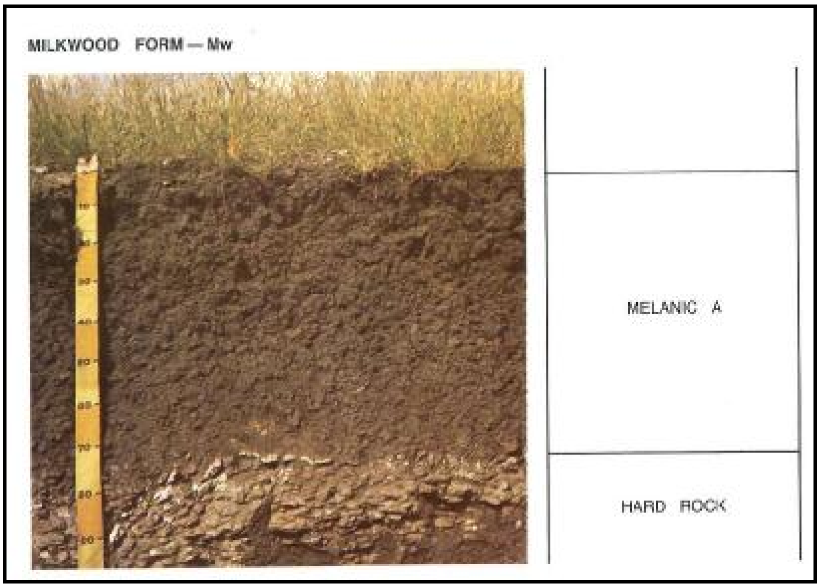


Figure 18: Milkwood soil form (Soil Classification, 1991)

Dresden

The Dresden soil form is characterised by a hard plinthic B-horizon (aka Ferricrete). This horizon develops when a soft plinthic horizon dries out and hardens irreversibly. These shallow soils have very limited potential and are mostly used for light grazing or wildlife.

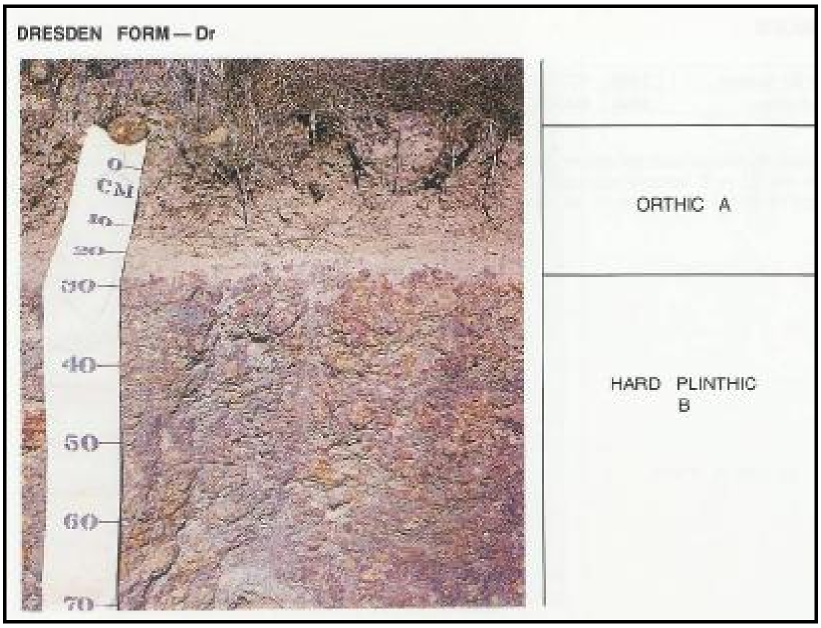


Figure 19: Dresden Soil Form

Transitional Soils

The transitional soil management unit comprises the soils found between clay soils and the agricultural soils. These soils often have signs of clay accumulation or water movement in the lower horizons. These soils are usually indicative of seasonal or temporary wetland conditions. Soil forms in this unit include:

Ü Longlands;
Ü Wasbank;
Ü Kroonstad; and
Ü Westleigh;

Wasbank, Kroonstad, Longlands and Westleigh Soil Forms

The Wasbank, Kroonstad and Longlands soil forms are all typified by an eluvial horizon, while the Westleigh soil form has a shallow soft plinthic horizon. These are also recognized as potential wetland soils. The E-horizon is a horizon that has been washed clean by excessive water movement through the horizon, while the soft plinthic horizon is formed by the accumulation of clays moving through the soil medium. These soils occur adjacent to the drainage channels found on site. Refer to Figure 7 for an illustration of these soil types.

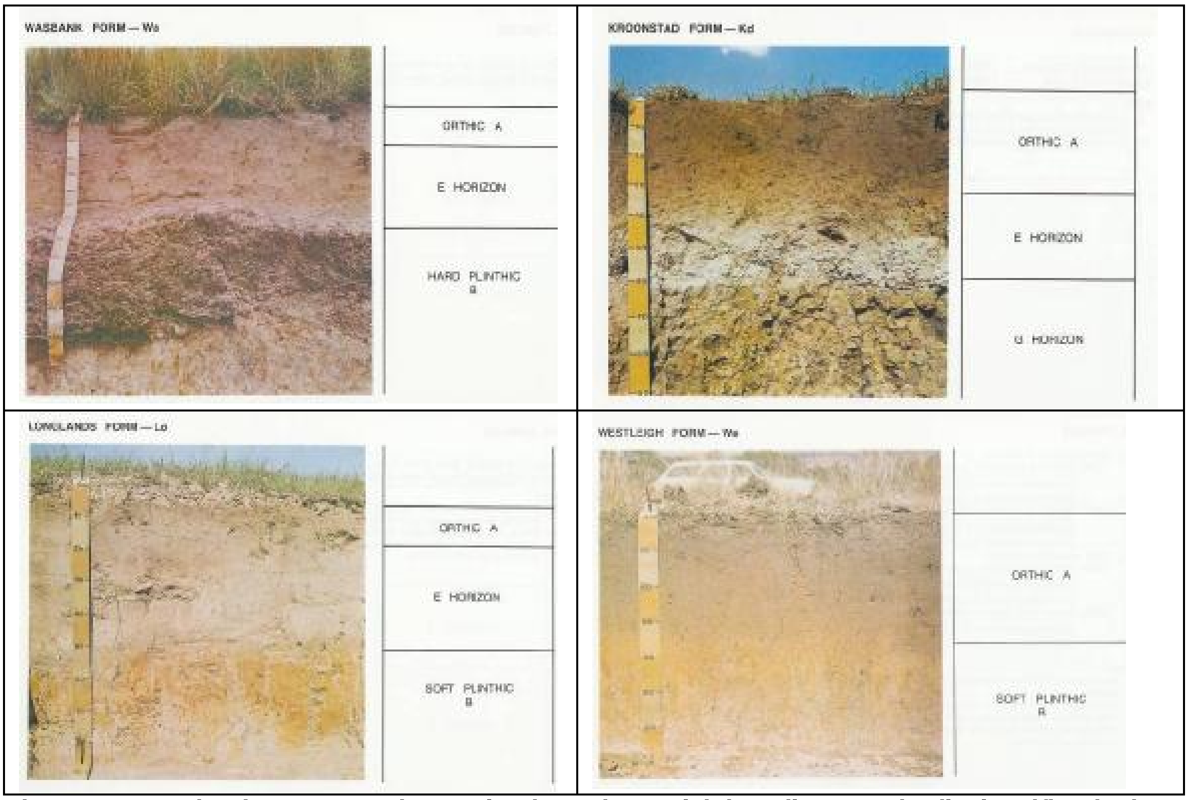


Figure 20: Wasbank, Kroonstad, Longlands and Westleigh Soil Forms (Soil Classification)

Clay Soils

The clay soil management unit is found in areas where clays have accumulated to such an extent that the majority of the soil matrix is clays. These soils are usually indicative of seasonal or permanent wetland conditions. Soil forms in this unit include:

Ü Rensburg;
Ü Arcadia;
Ü Inhoek;
Ü Katspruit;
Ü Willowbrook;
Ü Sterkspruit ; and
Ü Steendal;

Katspruit and Willowbrook Soil Forms

The Katspruit and Willowbrook soil forms are found in areas of semi-permanent wetness. These soils are typified by an Orthic A horizon (Katspruit) or a Melanic A horizon (Willowbrook) over a diagnostic G horizon, as indicated in Figure 21. The G horizon has several unique diagnostic criteria as a horizon, including:

Ü It is saturated with water for long periods unless drained;
Ü Is dominated by grey, low chroma matrix colours, often with blue or green tints, with or without mottling;
Ü Has not undergone marked removal of colloid matter, usually accumulation of colloid matter has taken place in the horizon;
Ü Has a consistency at least one grade firmer than that of the overlying horizon;
Ü Lacks saprolitic character; and
Ü Lacks plinthic character.

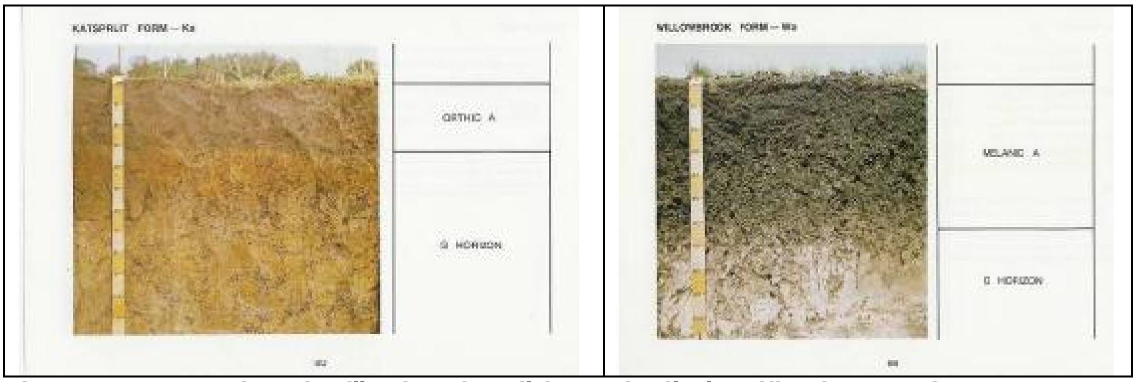


Figure 21: Katspruit and Willowbrook Soil forms (Soil Classification, 1991)

Rensburg and Arcadia soil forms

Arcadia and Rensburg soils are characterised by a vertic A-horizon. In the Rensburg the Vertic A is underlain by a G-horizon as described above, while the Arcadia is a pure vertic horizon. The Vertic horizon has several unique diagnostic criteria as a horizon, namely:

Ü Has strong developed structure

Ü Has at least one of the following:

  § Clearly visible, regularly occurring slicken sides in some part of the horizon or in the transition to an underlying layer

  § A plasticity index greater than 32 (using the SA Standard Casagrande cup to determine liquid limit), or greater than 36 (using the British Standard cone to determine liquid limit).

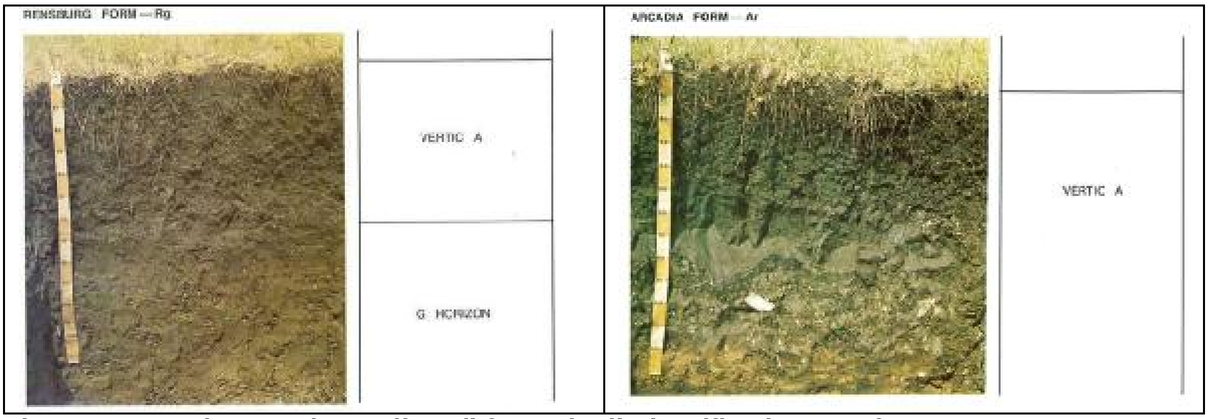


Figure 22: Rensburg and Arcadia soil forms (Soil Classification, 1991)

Inhoek and Steendal Soil Forms

The Inhoek and Steendal soil forms are typified by a Melanic A horizon. The Melanic horizon is characterised by the following:

Ü Dark colours in the dry sate with a value and chroma of 3 or less with the exception of 10YR 3/3 and colours redder than 5YR;

Ü No slickensides present as in the vertic clays;

In the case of the Steendal soil form the Melanic A horizon is underlain by a soft carbonate B horizon. This horizon is formed by the accumulation of carbonates in the horizon to such an extent that it dominates the morphology of the soil form. Please refer to Figure 23 for an illustration of the soil types.

Figure 23: Inhoek and Steendal soil forms (Soil Classification, 1991)

Sterkspruit:

The Sterkspruit soil form has an Orthic A Horizon over a Prismacutanic B Horizon over Saprolite with calcareous characteristics as illustrated in Figure 24 below. The effective depth is less then 40cm due to the strong clay accumulations. These soils are marginal and suitable only for grazing. These soils were predominantly found along a stream in the central part of the site.

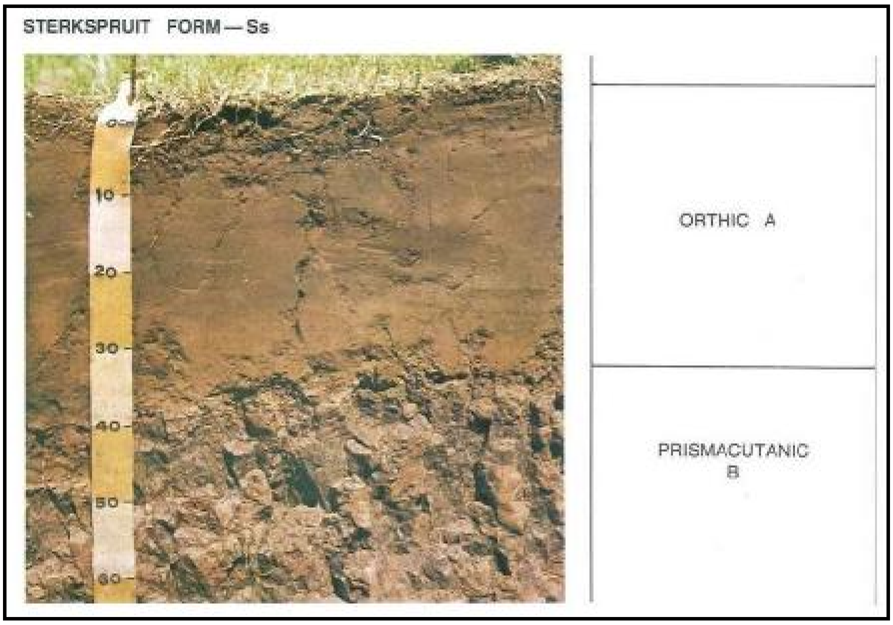


Figure 24: Sterkspruit Soil Form (Soil Classification, 1991)