

## **8. GEOLOGY, SOILS AND AGRICULTURAL POTENTIAL**

### **8.1. Geology**

#### **8.1.1. Candidate Site Geology**

Due to the layered nature of the geology and various structures the candidate sites are underlain by differing geological units (refer to Figure 6.1).

- *Appelvlakte 448 LQ*  
Clarens Formation sandstone underlies the farm. The sandstone is covered with a well sorted, 1 m to 3 m, sand veneer. Minor faulting and three distinct aerial magnetic lineations have been identified on this farm. The magnetic lineations, possibly faults, influence the pollution plume migration on the farm. Figure 6.6 (refer to Chapter 6), plume migration modelling, indicates plume migration along the southern most magnetic lineation. The plume is migrating along the lineation away from the Grootegeluk slimes dams.
- *Nelsonskop 464 LQ*  
Clarens Formation sandstone underlies the majority of the site. The repetitive outcrop in the southwest portion of the farm occurs due to thrust faulting (Daarby fault, refer to Figure 6.3). Younger Letaba basalt outcrops to the north of the Daarby fault, which strikes SSW-NNE across the farm. The basalt is located within a graben structure, due to minor faulting. Swartrant Formation sandstone outcrops to the south of the Daarby fault. Minor faulting and magnetic lineations have been identified across the farm.
- *Naauwontkomen 509 LQ*  
The geology on Naauwontkomen is similar to that of the neighbouring farm, Eenzaamheid 512 LQ. Sandstone of the Mogalakwena Formation underlies the majority of this farm. Limited sandy soil cover occurs along the western boundary of the farm. The Eenzaamheid Fault strikes east - west across the site, some 250 m south of the northwest border to 1.25 km south of the northeast border (refer to Figure 6.1). Grootegeluk Formation (minor outcrop) and Swartrant Formation outcrops to the north of the fault. A north-south striking fault, joining the Daarby and Eenzaamheid faults, extends onto the farm. Fluorspar, associated with the Eenzaamheid fault and Waterberg Group, and stone aggregate occurs on the farm.
- *Eenzaamheid 512 LQ*  
Waterberg Group sediments underlie the majority of this site. The Mogalakwena Formation sandstone is covered with a  $\pm 2$  m thick sand veneer. The sand is derived from weathering of the Waterberg Group. The sand has angular grains and is poorly sorted. The Eenzaamheid fault strikes east - west across the farm,  $\pm 250$  m south of the farm's northern boundary. Grootegeluk Formation (shallow coal) and Swartrant Formation (sandstone) outcrops to the north of the fault. The Waterberg Group contains moderate

percentages of apatite (fluoride bearing), which gives rise to the presence of fluorspar mineralisation along the Eenzaamheid fault.

- *Droogeheuvel 447 LQ*  
Clarens Formation sandstone underlies the farm. The sandstone is covered with a well sorted, 1 m to 3 m, sand veneer. Minor faulting has been identified on this farm.
- *Zongezien 467 LQ*  
Clarens Formation sandstone underlies the northern portion of the farm. The Daarby fault strikes across the centre of the farm. Swartrant Formation sandstone outcrops to the south of the Daarby Fault.
- *Kuipersbult 511 LQ*  
Sandstone of the Mogalakwena Formation underlies the farm. A minor east-west striking fault is mapped within the centre of the farm. Fluorspar, associated with the Eenzaamheid fault and Waterberg Group, and stone aggregate occurs on the farm.
- *Kromdraai 690 LQ*  
Waterberg Group sediments underlie the entire site. The Mogalakwena Formation sandstone underlying the farm is almost totally covered with a  $\pm 2$  m thick sand veneer. A minor fault, recognised on Kuipersbult, extends into the eastern boundary of the farm. Fluorspar mineralisation occurs along this fault.

### **8.1.2. The Grootegeluk Coal Deposits**

The Grootegeluk coal mine produces coking coal and middlings from the Grootegeluk and Goedgedacht Formations (Upper and Middle Ecca Group).

The Grootegeluk Formation comprises intercalated shale and bright coal, with an average depth of 60 m. Coking and middlings grade coal are obtained from this formation.

The Goedgedacht Formation consists of 5 predominantly dull coal seams interbedded with carbonaceous shale, siltstone, and sandstone ( $\pm 60$  m thickness). This coal is suitable for power generation, direct reduction, and formcoke.

Coal deposits occur on: -

- Eenzaamheid (north of the Eenzaamheid fault)
- Naauwontkomen (north of the Eenzaamheid fault)
- Appelvlakke (at depth )
- Nelsonskop (at depth)
- Droogeheuvel (at depth)
- Zongezien (at depth)

The construction of a power station and infrastructure on these coal deposits may have economic implications, as these coal deposits will become sterilised.

## **8.2. Geotechnical studies**

Investigations with regards to geotechnical conditions were undertaken on the four alternative sites proposed for the establishment of a proposed new power station in order to determine geotechnical constraints and founding conditions. The geotechnical conditions on the farms Appelvlakte, Nelsonskop, Eenzaamheid and Naauwontkomen are described below:

- *Farm Appelvlakte 448 LQ*  
This farm is underlain by sandstone of the Clarens Formation, which, on the basis of borehole data, is overlain by 5 – 10 m of sand and calcrete. The upper 2 m of the sandstone is usually weathered. The depth to competent founding material may thus exceed 10 m. In addition, a fault and several lineaments (probably smaller faults) are indicated by the geophysics and airphoto interpretation. Weathering along these is likely to be even deeper. Geotechnical conditions on this farm are therefore likely to be considerably poorer than those present at the existing Matimba Power Station, where suitable founding for heavy structures was generally encountered at less than 5 m depth.
- *Farm Nelsonskop 464 LQ*  
The northern part of this farm is underlain by sandstone of the Clarens Formation. Two faults with downthrows to the north cross the site; to the south of the more southerly of these (the Daarby Fault) softer mudstones and siltstones of the Red Beds are thought to be present. The entire area, with the exception of the isolated outcrop of Clarens sandstone at Nelsonskop, is covered with sand. A few borehole records indicate similar thicknesses of sand and underlying calcrete to those on Appelvlakte. A smaller thickness of cover appears to be present along the eastern boundary of the farm, but the underlying sandstone is only 10 m thick in this locality. A considerable number of airphoto lineaments suggests that the area is structurally complex. Geotechnical conditions beneath this farm are likely to be even less favourable than those on Appelvlakte.
- *Farm Naauwontkomen 509 LQ*  
On this farm the Eenzaamheid Fault is also present close to the northern boundary, but it swings further south towards the eastern limit of the farm. Ecca sediments (mostly soft mudstones and shales) are present to the north of the fault, whereas hard Waterberg sandstones and conglomerates occur to

the south of it. Fairly widely spaced lineaments (probably dykes) are again present. Sand, overlying gravel, is widely present over the bedrock, but within an area near the centre of the farm 0 m – 2 m of gravel directly overlies soft to hard rock conglomerate and rock outcrops are exposed in places. This area has been identified as being particularly favourable from a geotechnical viewpoint. Elsewhere the soil/gravel cover is generally less than 3 m thick on the evidence of several road quarries and a railway cutting near the eastern end of the farm. However, boreholes drilled close to two of the lineaments showed that the cover thickness can increase locally to 7 m – 10 m in proximity to these features. The central area on this farm, in which shallow bedrock with a discontinuous thin gravel cover is present, seems to offer the most favourable founding conditions of any on the four farms that were inspected.

- *Farm Eenzaamheid 687 LQ*

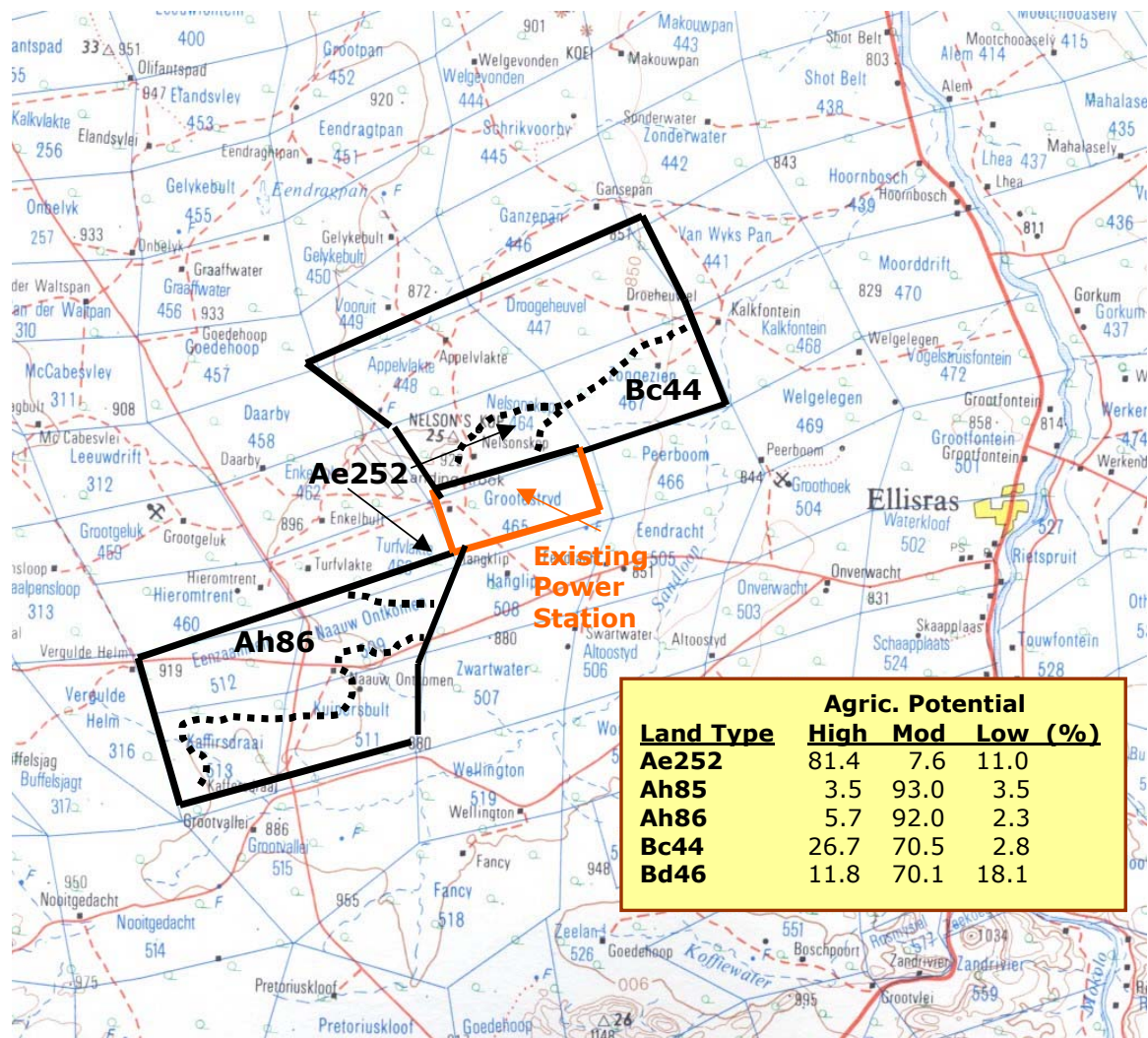
The Eenzaamheid Fault lies a short distance to the south of the northern boundary of this farm. The remaining area to the south is underlain by sandstone and conglomerate of the Waterberg Group. Fairly widely spaced lineaments (probably dykes) cross the farm. All of these rocks are, however, overlain by sand and gravel. A number of quarries used previously for road construction show that the sand cover is mostly less than 3 m thick; beneath it gravels, sometimes in a ferruginous or calcareous matrix and usually up to 1 m thick, overlie bedrock, which is usually of soft to hard rock consistency. Greater depths of cover are likely to be present in proximity to the lineaments. Founding depths over much of the farm are thus likely to be moderate. The Waterberg bedrock is likely to be able to support high foundation pressures.

### **8.3. Soils and Agricultural Potential**

The soil information used to compile this study forms part of the Ellisras map sheet of the national 1:250 000 land type survey (Paterson & Haarhoff, 1989). Each land type is a unique combination of soil pattern, terrain and macroclimate. The entire study area, which comprises all eight properties being considered, comprises a total of five land types, namely:

<b>Ah85</b>	(red and yellow, sandy soils)
<b>Ah86</b>	(red and yellow, sandy soils)
<b>Ae252</b>	(red, structureless soils)
<b>Bc44</b>	(red, plinthic soils)
<b>Bd46</b>	(yellow, plinthic soils)

The distribution of the land types occurring is shown in the map in Figure 8.1.



**Figure 8.1:** The distribution of the land types occurring in the study area

The main characteristics of each of the land types are given in Table 8.1 below. The soils were classified according to MacVicar *et al* (1977).

The columns “Dominant Soils” and Sub-dominant Soils” show the soil series (MacVicar *et al*, 1977), soil depths and textures that are dominant and sub-dominant respectively, along with the occurrence (%) of each within the land type.

The column “Agricultural Potential” provides the percentage of each land type with high (H), moderate (M) or low (L) potential.

**Table 8.1.** Soil properties per land type

Property Land Type	Dominant soil(s)	Sub-dominant soils	Slope	Agric. Potential (%)
Ah85	Hu30/31/33/34 >1200 mm, LmSa-SaLm 43.5%	Cv30/31/33/34 + Hu32/35 >1200 mm >1200 mm LmSa-SaLm LmSa-SaLm 28.9% 9.8%	<4%	H: 3.5 M: 93.0 L: 3.5
Ah86	Hu25/35 >1200 mm, LmSa-SaLm 42.4%	Cv22/15 >1200 mm LmSa-SaLm 36.8%	<4%	H: 5.7 M: 92.0 L: 2.3
Ae252	Hu46 900-1200 mm, SaLm-SaCLm 75.1%	Ms10/20 + Hu35 50-250 mm >1200 mm LmSa-SaLm LmSa-SaLm 11.0% 7.6%	<4%	H: 81.4 M: 7.6 L: 11.0
Bc44	Hu35 >1200 mm, LmSa-SaLm 56.7%	Av34/35/36 + Cv35 800-1200 mm >1200 mm SaLm-SaCLm LmSa-SaLm 14.4% 13.8%	<4%	H: 26.7 M: 70.5 L: 2.8
Bd46	Cv25/Fw12/Ct12 1200 mm, LmSa-SaLm 24.9%	Av35/36 + We31/32 600-1200 mm 500-700 mm SaLm-SaCLm SaLm 24.64% 12.5%	<4%	H: 11.8 M: 70.1 L: 18.1

From Table 8.1 it can be seen that the soils in the area are generally deep and sandy. The sandy nature of most of the soils (topsoils with <6% clay and subsoils with 4-12% clay) make them less suited to cultivation, both due to increased susceptibility to wind erosion as well as excessively free drainage, leading to problems associated with drought conditions in an already dry area.

This sandy nature is the main reason for most of these deep, sandy soils having moderate potential, as indicated in the table above.

Land type Ae252, and to a lesser extent land types Bc44 and Bd46, contains soils with a somewhat higher clay content than the other land types, meaning that these soils have a higher agricultural potential, mainly due to their increased ability to retain moisture. However, it should be emphasised that the Lephalale area is dry and while the soils may have a high potential, the climatic conditions in the area are not suited to rain-fed arable cultivation.

#### 8.4. Nature and Extent of Impacts

The nature of the geology and soils of the site will determine the founding conditions that are available for the establishment of the proposed new coal-fired power station and associated infrastructure as well as the depth of foundations

required, and the method to be utilised for construction of the foundations. The founding conditions for the four proposed power station site alternatives are discussed in Section 8.1.

In terms of the findings of the preliminary geotechnical investigations undertaken on the four farms proposed as alternatives for the establishment of the power station, all four farms are considered acceptable for development in terms of founding conditions. The preliminary findings however, found a slight preference for the farms Naauwontkomen and Eenzaamheid.

The potential impact on the soil resource is anticipated to be of a high significance as both the establishment of a power station and the associated infrastructure will lead to a permanent loss of the soil resource. Therefore, there is no difference between the rating for the construction of the power station and the ancillary infrastructure.

Potential impacts associated with the establishment of the power station include the risk of erosion. The potential impact on the soil due to erosion is anticipated to be of a moderate to high significance as the soils are sandy in nature and are susceptible to wind erosion.

The potential impact on the agricultural potential will be of low significance at all eight alternative sites, as a result of the moderate to low agricultural potential of the soils due to their sandy nature, increased susceptibility to wind erosion and excessively free drainage. The potential impact on areas with a high agricultural potential is also anticipated to be of a low significance due to the fact that while the soils may have a high potential, the climatic conditions in the area are not suited to rain-fed arable cultivation.

## 8.5. Conclusions

The site preference rating for the sites in terms of geotechnical conditional is outlined in Table 8.2.

**Table 8.2:** The Site Preference Rating of the alternative Sites for the power station with regards to geotechnical conditions

<b>Farm name</b>	<b>Site Preference Rating</b>
Farm Appelvlakte 448 LQ	3 (Acceptable)
Farm Nelsonskop 464 LQ	3 (Acceptable)
Farm Naauwontkomen 509 LQ	3 (Acceptable)
Farm Eenzaamheid 687 LQ	3 (Acceptable)

The preliminary findings however, found a slight preference for the farms Naauwontkomen 509 LQ and Eenzaamheid 687 LQ.

The site preference rating for the sites in terms of geology, soils and agricultural potential is outlined in Table 8.3 and Table 8.4.

**Table 8.3:** The Site Preference Rating of the alternative Sites for the power station with regards to soil and agricultural potential

Farm name	Site Preference Rating
Farm Appelvlakte 448 LQ	4 (Preferred)
Farm Nelsonskop 464 LQ	3 (Acceptable)
Farm Naauwontkomen 509 LQ	3 (Acceptable)
Farm Eenzaamheid 687 LQ	4 (Preferred)

The farm Appelvlakte 448 LQ and farm Eenzaamheid 687 LQ are considered the preferred sites for the construction of the proposed power station.

**Table 8.4:** The Site Preference Rating of the alternative sites for the ancillary infrastructure with regards to geology, soil and agricultural potential

Farm name	Preference Rating
Farm Appelvlakte 448 LQ	4 (Preferred)
Farm Nelsonskop 464 LQ	3 (Acceptable)
Farm Naauwontkomen 509 LQ	3 (Acceptable)
Farm Eenzaamheid 687 LQ	4 (Preferred)
Farm Droogeheuvel 447 LQ	4 (Preferred)
Farm Zongezien 467 LQ	2 (not preferred)
Farm Kuipersbult 511 LQ	3 (Acceptable)
Farm Kromdraai 513 LQ	3 (Acceptable)

The farm Appelvlakte 448 LQ, farm Eenzaamheid 687 LQ and farm Droogeheuvel 447 LQ are considered the preferred sites for the establishment of ancillary infrastructure.

The soils pose no restriction to any infrastructure development, with little or no structure and generally sandy texture. The sandiness of the dominant soils, along with the prevailing climate, causes the entire study area to generally only be classed as moderate agricultural potential. The area is best suited for extensive cattle and/or game farming.

If water is available, the soils may be irrigated successfully, as long as good management practices are followed to prevent them drying out.



## **8.6. Recommendations**

In terms of the observations and interpretations recorded during the geotechnical investigations, the farms that provide the preferred founding conditions are Eenzaamheid and Naauwontkomen. Detailed geophysical surveys would be required to be undertaken on these two farms as a minimum in order to gain additional information regarding founding conditions and other geotechnical considerations.

A soil survey as well as soil sampling should be undertaken to quantify the soil properties. A report and soil map should be produced and included in the EIA report, detailing all the findings, including agricultural potential and potential impacts.