**REPORT**

**for Lidwala Environmental and Planning Services**
**by**


**INSTITUTE FOR SOIL CLIMATE AND WATER**
AGRICULTURAL RESEARCH COUNCIL


# SOIL INFORMATION FOR PROPOSED ASH DISPOSAL FACILITY, TUTUKA POWER STATION, MPUMALANGA PROVINCE


By

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June 2014


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## DECLARATION

I hereby declare that I am qualified to compile this report as a registered Natural Scientist: Soil Science (Registration No. 400463/04) and that I am independent of any of the parties involved and that I have compiled an impartial report, based solely on all the information available.

***Dr. D.G. Paterson***

June 2014

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## 1. NTRODUCTION

### 1.1 Legal requirements

#### *1.1.2 Constitution of the Republic of South Africa (No. 108 of 1996)*

*Summary of Constitution*

The Constitution of the Republic of South Africa is the legal source for all law, including environmental law, in South Africa. The Bill of Rights is fundamental to the Constitution of the Republic of South Africa and in, Section 24 states that:

Everyone has the right (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that (i) prevent pollution and ecological degradation; (ii) promote conservation; and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

*Applicability to Study*

The residents of the immediate and surrounding area have the basic constitutional right to a protected environment that is not unnecessarily and/or irreparably damaged by any industrial or related development.

#### *1.1.3 National Environmental Management Act (Act 107 of 1998)*

*Summary of Act*

The National Environmental Management Act (NEMA) creates the legal framework that ensures the environmental rights guaranteed in Section 24 of the Constitution are abided by.

As such the fundamental principles that apply to environmental decision making are laid out, the core environmental principle being the promotion of ecological sustainable development. These principles serve as a guideline for any organ of state when exercising any function in the process of decision making under NEMA.

NEMA introduces the duty of care concept which is based on the policy of strict liability. This duty of care extends to the prevention, control and rehabilitation of significant pollution and environmental degradation. It also dictates a duty of care to address emergency incidents of pollution. A failure to perform this duty of care may lead to criminal prosecution, and may lead to the incarceration of managers or directors of companies for the conduct of the legal persons.

*Applicability to the Study*

Any mining-related or other industrial development has the potential to impact on the receiving physical (including soils), biophysical and social environments. As such potential impacts need to be thoroughly and competently assessed prior to execution of the proposed Project.

### *1.1.4 Subdivision of Agricultural Land Act (No. 70 of 1970)*

*Summary of Act*

The Subdivision of Agricultural Land Act (SALA) was enacted as a measure by which the Legislature, in the national interest, seeks to prevent the fragmentation of agricultural land into small uneconomic units, by (a) curtailing the common law right of landowners to subdivide their agricultural property; and (b) imposing the requirement to obtain the written consent of the National Department of Agriculture, Forestry and Fisheries (DAFF) Minister prior to any subdivision of agricultural land (which may be refused by the Minister if such subdivision will result in the uneconomic fragmentation of agricultural land). SALA also prohibits, amongst others, the change in land use of agricultural land (from use for agricultural purposes to use for any other purpose) without the prior written recommendation of the DAFF Minister.

*Applicability to Study*

If agricultural land, that is productive in terms of food and/or fibre production, becomes subdivided in some way as to make the reduced land parcel(s) uneconomic or unsustainable, then agricultural production is diminished. Such actions should be resisted wherever possible, especially where the prevailing agricultural potential is high.

### *1.1.5 The Conservation of Agricultural Resource Act (No. 43 of 1983)*

*Summary of Act*

The Conservation of Agricultural Resources Act (CARA) aims at controlling the utilization of natural agricultural resources in order to ensure that soil, water sources and vegetation are conserved, and that alien and invasive plants are combatted. The Act aims to prevent agricultural practices that contribute to the degradation of the environment.

*Applicability to Study*

CARA aims to protect the prevailing natural agricultural resources of South Africa from change of land use away from agriculture. This is especially important where

high potential soils are present. It is an unfortunate fact that the majority of the coal resources of South Africa, and the related infrastructure necessary to develop that coal into energy, occur beneath moderate to high potential arable soils, and every time some of these soils are removed from agricultural production, the local, and by implication, regional and national food security situation is affected.

### 1.2 Terms of Reference

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was requested by Lidwala Environmental and Planning Services to obtain carry out a soil and agricultural survey for an area within a 12 km radius of the Tutuka Power Station, near Standerton, in Mpumalanga Province.

### 1.3 Scope

The aim of the survey was to assess the soils occurring in the area for a proposed continuous ash disposal facility (ADF), and to assess the agricultural potential. In this way, an informed assessment can be made of the potential impacts involved in the construction of a continuous ADF, in terms of the soils that might be affected and their associated agricultural potential.

Google Earth images and 1:50 000 scale topo-cadastral maps were used to create a base map for the study area.

## 2 STUDY AREA

### 2.1 Location

Tutuka Power Station is located approximately 30 km north-east of Standerton. Originally, the study area comprised a radius around the site, while for the original scoping study, a number of different alternatives were identified, namely three for Tutuka (Alternatives A to C).

These are shown **in green** in Figure 1 below.

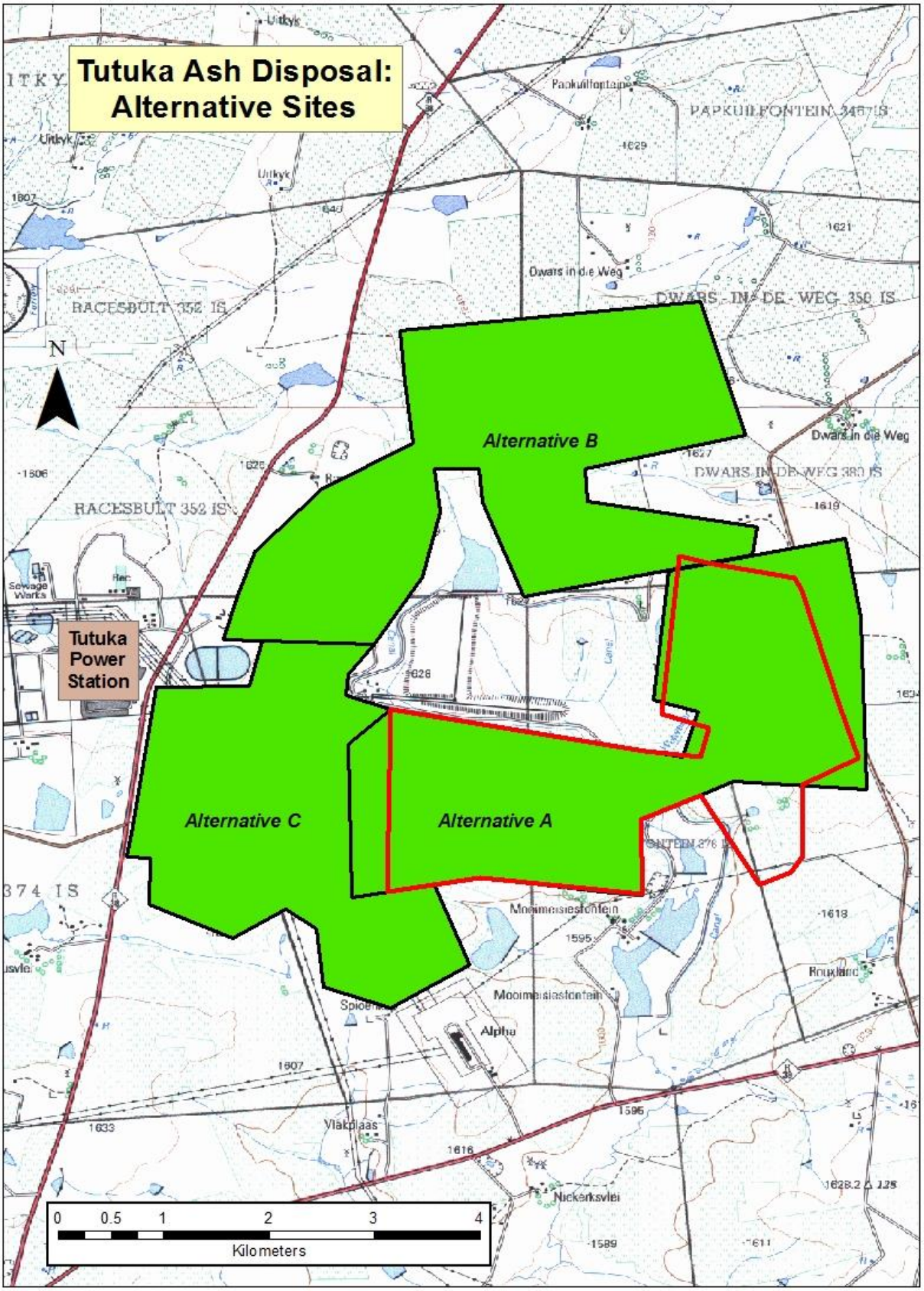



**Figure 1:** Location Map, showing original alternatives and amended Alternative A

The size of the various alternatives originally identified is as follows:

| Alternative | Area (ha) |
|---|---|
| A | 756 |
| B | 764 |
| C | 534 |

Alternative A was subsequently slightly altered, and this area is indicated by the **red outline** in Figure 1. The amended area of Alternative A covers approximately 695 ha.

### 2.2 Site Details

The area around Tutuka Power Station is located on the Highveld plateau, with generally undulating slopes of between 2 and 6%. Altitude is between 1 600 and 1 630 metres above sea level. No major rivers occur in the area, although several wetland areas, both seasonal and perennial, are present. The Wolwespruit flows southward to the immediate east of the existing Ash Disposal Facility (ADF).

The area comprises a mixture of natural grassland and cultivated areas (either cash crops or cultivated pastures). However, at the time of the survey, the fields under cash crops were limited to the east of the gravel road that occurs in the east of the area. The greater part of the area is under natural grazing, but was not utilized by livestock.

### 2.3 Climate

Long-term average climate data was obtained from the national Land Type Survey (Kotzé, 1985).

The climate has warm, moist summers with cool, dry winters. On average, 85% of the annual average rainfall of 720.3 mm falls in the growing season (October to March).

Frost, often severe, occurs in winter. The extreme maximum temperature is 35.6$^{o}$C and the extreme minimum ï 11.1$^{o}$C

The climatic data is given in Table 1 below.

**Table 1 Long-term c**limate data for study area

| Month | Rainfall (mm) | Min. Temp (°C) | Max. Temp (°C) | Average frost dates |
|---|---|---|---|---|
| Jan | 154.2 | 14.2 | 27.6 | Start date: 06/01<br>End date: 11/11<br>Days with frost: ±46 |
| Feb | 92.8 | 13.1 | 28.0 | |
| Mar | 73.7 | 11.6 | 27.2 | |
| Apr | 46.1 | 8.0 | 24.5 | |
| May | 15.0 | 2.9 | 22.3 | |
| Jun | 10.6 | -0.4 | 20.0 | |
| Jul | 2.9 | -1.8 | 19.5 | **Heat units (hrs > 10°C)** |
| Aug | 10.1 | 1.9 | 22.6 | Summer (Oct-Mar): 1308.34 |
| Sep | 9.3 | 6.0 | 26.3 | |
| Oct | 79.8 | 10.4 | 27.1 | Winter (Apr-Sept): 603.27 |
| Nov | 104.6 | 12.5 | 26.5 | |
| Dec | 136.5 | 13.7 | 27.1 | |
| **Year** | **735.6** | **(Average) 14.9°C** | | |

## 2.4 Geology

The geology of the study area consists of extensive dolerite intrusions into the sandstone and shale of the Vryheid Formation, of the Karoo Sequence (Geological Survey, 1984). The dolerite occurs mainly in the east, with the sandstone and shale occurring in the west and north. The distribution of the geological formations is shown by the purple lines in Figure 2.

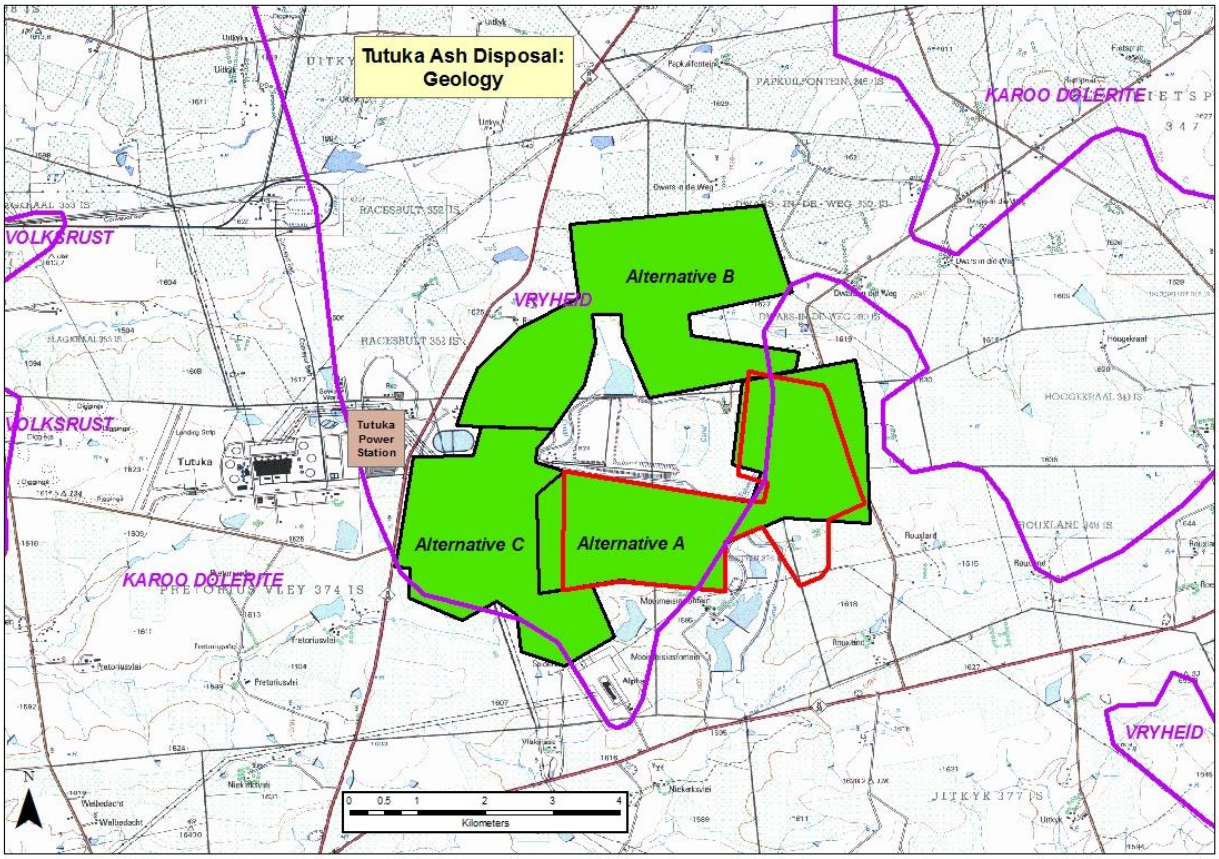



**Figure 2** Geological map

## 3 METHODOLOGY

As reported in the original scoping report, the area around Tutuka, comprising all of the various alternatives, falls within a single land type mapping unit, namely Ea17. This unit has an extremely high degree of uniformity, with approximately 75% of the unit comprising moderately deep to deep (450-1200 mm), dark, swelling clay soils of the Arcadia and Rensburg soil forms. This is supported by a reconnaissance investigation (unfortunately unpublished) carried out by ARC-ISCW in the early 1990's around Tutuka Power Station, where the same broad soil pattern was encountered.

It was decided that a more detailed survey would be carried out in Alternative A, which would include soil sampling and analysis to quantify the soil characteristics, which would hopefully confirm the expected soil distribution. The area was visited in September 2013 and the soil map is shown in Appendix A.

In order to carry out the soil assessment of Alternative A, a grid was established, at an interval of 300 x 300 m. The points were loaded into a GPS for location in the field. The soils were investigated using a hand-held soil auger, to a maximum depth of 1 200 mm (or shallower, if a restricting layer, such as rock or gleyed clay) was encountered.

In addition to the soil augering exercise, in the eastern part of Alternative A, a number of wide trenches have been excavated to a depth of approximately 1 500 mm, where the soil profile can easily be observed *in situ*, thus aiding soil characterization process.

Soil samples were collected from five sites (S1 to S5) throughout the Alternative A study area, and the soil analysis results are given in Table 3. The position of each sampling site is shown on the soil map in Appendix A.

# 4 RESULTS

## 4.1 Soils (Alternative A)

As expected from the scoping study and other available sources, the soils are dark clays, with shrink-swell properties. The soils are alkaline, with a high pH and have moderate to strong structure, caused mainly by the high clay content inherited from the parent material. The clay content means that water movement through the soil is slow and the soils remain moist for a long time following rain. However, in wet periods, there is a significant waterlogging hazard, which can often lead to crop roots becoming saturated, and causing problems for cultivation

The characteristics of the various mapping units in the Alternative A study area are given in Table 2.

**Table 2** Soil legend, Tutuka Alternative A study area

| Map Unit | Depth (mm) | Soils occurring | Characteristics | Agric. Potential | Area (ha) |
|---|---|---|---|---|---|
| **Ar** | 750-1200+ | *Dominant:* Arcadia 30/40,<br><br>*Sub-dominant:* Rensburg 10/20 Valsrivier 31/32/41/42, Bonheim 31/41 | Dark brownish-grey to black, swelling, calcareous clay soils on weathering rock. The soils have a strong blocky structure, with cracks in the soil profile, as well as on the soil surface. In certain areas, there is grey, structured clay gleyed material lower in the soil profile. | Low to moderate | **592.9** |
| **Rg** | 600-1000 | *Dominant:* Rensburg 10/20<br><br>*Sub-dominant:* Arcadia 30/40, Willowbrook | Dark brownish-grey to black, swelling, calcareous clay soils with a strong blocky structure, overlying grey, structured clay gleyed material lower in the soil profile. This unit occurs in the lower parts of the landscape, with surface and/or subsurface wetness being common. | Low | **61.7** |
| **Rg/D** | 600-1000 | *Dominant:* Rensburg 10/20<br><br>*Sub-dominant:* Arcadia 30/40, Willowbrook | Similar soils to the **Rg** map unit, but with a high degree of disturbance in parts of the unit, due to excavation and other soil mixing. | Very low | **39.9** |
| | | | | **Total** | **694.5** |

**Table 3** Soil analysis results, Tutuka Alternative A

| **Sample site** | | **S1** | | **S2** | | **S3** | | **S4** | | **S5** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Co-ordinates (Lat/Long)** | | 26º 46ô00.7ôS 29º 25ô16.9ôE | | 26º 47ô07.9ôS 29º 25ô31.4ôE | | 26º 47ô09.8ôS 29º 24ô25.3ôE | | 26º 47ô27.3ôS 29º 23ô45.6ôE | | 26º 46ô48.5ôS 29º 23ô33.1ôE | |
| **Soil Form** | | ***Arcadia*** | | ***Arcadia*** | | ***Rensburg*** | | ***Arcadia*** | | ***Bonheim*** | |
| **Horizon** | | A1 | A2 | A1 | A2 | A1 | G | A1 | A2 | A1 | B1 |
| **Depth (mm)** | | 0-350 | 350-900 | 0-300 | 300-800 | 0-250 | 250-600 | 0-350 | 350-650 | 0-300 | 300-750 |
| **Sa** | **%** | 36 | 32 | 19 | 20 | 14 | 11 | 26 | 20 | 20 | 28 |
| **Si** | | 25 | 26 | 27 | 24 | 47 | 45 | 23 | 26 | 28 | 35 |
| **Cl** | | 39 | 42 | 54 | 56 | 39 | 46 | 51 | 54 | 52 | 37 |
| | | | | | | | | | | | |
| **Na** | **cmol $kg^{-1}$** | 0.36 | 0.99 | 2.99 | 3.83 | 1.34 | 3.83 | 0.38 | 0.86 | 0.54 | 0.16 |
| **K** | | 0.27 | 0.22 | 0.45 | 0.54 | 0.55 | 0.24 | 0.31 | 0.62 | 0.42 | 0.46 |
| **Ca** | | 8.43 | 11.53 | 13.05 | 22.05 | 13.44 | 18.88 | 20.80 | 22.39 | 13.00 | 8.43 |
| **Mg** | | 6.03 | 8.07 | 28.71 | 35.16 | 9.45 | 13.43 | 33.42 | 31.25 | 12.40 | 5.96 |
| **CEC** | | 18.02 | 22.81 | 42.98 | 61.58 | 26.60 | 36.38 | 52.14 | 50.66 | 28.87 | 18.47 |
| | | | | | | | | | | | |
| **P (ppm)** | | 1.88 | 0.77 | 2.06 | 0.78 | 1.66 | 0.92 | 2.36 | 0.99 | 1.16 | 0.54 |
| **pH ($H_2O$)** | | 5.81 | 7.48 | 8.81 | 8.84 | 6.40 | 7.84 | 8.26 | 8.41 | 7.46 | 6.58 |
| **Org C (%)** | | 1.44 | 0.53 | 2.21 | 1.17 | 1.33 | 0.84 | 1.67 | 0.73 | 1.36 | 0.66 |

The analysis results reflect the clay-rich nature of the soils, with high base status (shown by the high CEC values), high pH values, moderate organic carbon levels and low P values due to the lack of any recent cultivation.

Some of the characteristics of these soils can be seen in Figure 3.

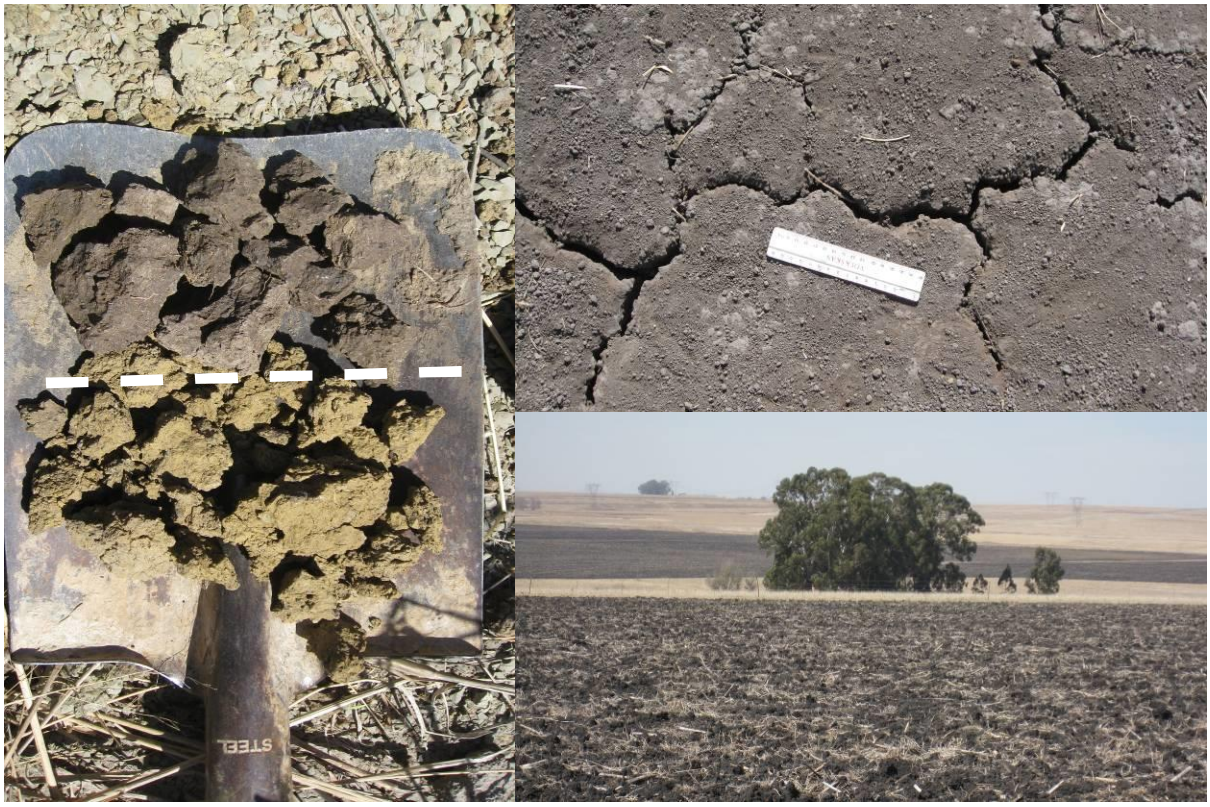


**Figure 3** Soil characteristics in the Tutuka area

The photo on the left shows the contrast between the dark, swelling clay topsoils (above the dashed line) and the mottled,olive-greyish, wetter subsoils (below the dashed line). This sequence of soil horizons (layers) is typical of the Rensburg soils found in the **Rg** and **Rg/D** map units.

The photo on the top right shows the cracks occurring on the soil surface (scale of ruler 15 cm) due to the shrink-swell nature of these soils, whereby the soils shrink and crack in the dry season.The photo on the bottom right shows a ploughed field just to the south of the study area, where the uniformly dark colour of the topsoils can clearly be seen.

## 4.2 Agricultural Potential (Alternative A)

The general agricultural potential class of each map unit, and the main limiting factors, are given in Table 4 below. The distribution of the units is shown in ***Appendix B***.

**Table 4** Agricultural Potential, Alternative A

| Agricultural Potential | Map Unit(s) | Limitations | Area (ha) + % |
|---|---|---|---|
| **Low to moderate** | **Ar** | Strong structure and high clay content with shrink-swell properties makes cultivation difficult despite natural fertility | **592.9** ***(85.4%)*** |
| **Low** | **Rg** | As for **Ar** unit, but with surface and subsurface wetness being more common due to landscape position | **61.7** ***(8.9%)*** |
| **Very low** | **Rg/D** | As for **Rg** unit, but with disturbance and/or excavation | **39.9** ***(5.7%)*** |
| | | **Total** | **694.5** |

The area surrounding Tutuka is dominated by low to moderate potential soils, due to the high clay content and associated strong, blocky soil structure. The soils are fertile, but there are significant management requirements required to sustainably cultivate these heavy, swelling clays. These soils are not suited to maize, but sunflowers, wheat and possibly soya beans or some vegetables could be grown.

## 4.3 Land Cover

Using data from the National Land Cover database, a shape file was created, showing classes of land use as assessed by remote sensing for all of the original alternatives (***Appendix C***). It can be seen that for most of the area, the land cover class is natural grassland (orange), with some areas indicated as cultivated (in green). However, at the time of the site visit, none of the areas indicated in Alternative A were cultivated, and approximately half of the areas indicted in Alternative C as being cultivated were in fact not being so used. Some areas of cultivation were observed in Alternative B.

Figure 4 shows a typical view in the south of the Alternative A area, close to the electrical substation, where the landscape is dominated by natural grassveld.

**Figure 4** Tutuka landscape

## 5 RECOMMENDATIONS

### 5.1 Comparison of Alternatives

Three alternatives are under consideration, namely Alternative A to the south and east of the existing ADF, alternative B to the north and Alternative C to the south.

There is little to choose between the alternatives regarding soils or the associated agricultural potential, due to the homogeneous nature of the soil pattern in the area. The only variant in terms of agriculture is the slight difference in the amount of cultivation in the different alternatives.

The recommendation is therefore as follows

| | |
|---|---|
| **Recommended:** | **Alternative A** |
| Possible: | Alternative B or C |

## 5.2 Impacts on wetlands

As discussed above, the main impact of the establishment of an extension to the ADF would be the loss of several hundred hectares of potentially arable land. The low to moderate (at best) potential of the majority of the soils under consideration means that this impact would not be of the highest significance. However, a definite area of concern is the fact that there are wetlands in the central part of the area, where the Wolwespruit flows southward, eventually joining the Vaal River in the Grootdraai Dam some 15 km to the south.

Wetland soils are among the most fragile and most important of soils due to their position in the landscape and their function in stabilizing and regulating the wetland ecosystem. The presence of permanent wetlands in the area is thus somewhat of a cause for concern. Here, great care must be taken to avoid contamination of the watercourse by waste material, which should be planned in conjunction with hydraulic engineers and/or groundwater specialists.

Along the edge of the existing ADF, chemical precipitation can be seen, as well as around the shores of the dams in the large wetland. This situation, and the potential exacerbation thereof, needs to be investigated further. The clayey nature of the soils means that any runoff from an extension to the ADF will percolate very slowly through the soil profile, giving ample time for precipitation from solution and deposition on the surface or in the soil.

The quantification of this situation, as well as possible solutions, needs to be done in conjunction with hydrologists and/or groundwater specialists.

## REFERENCES

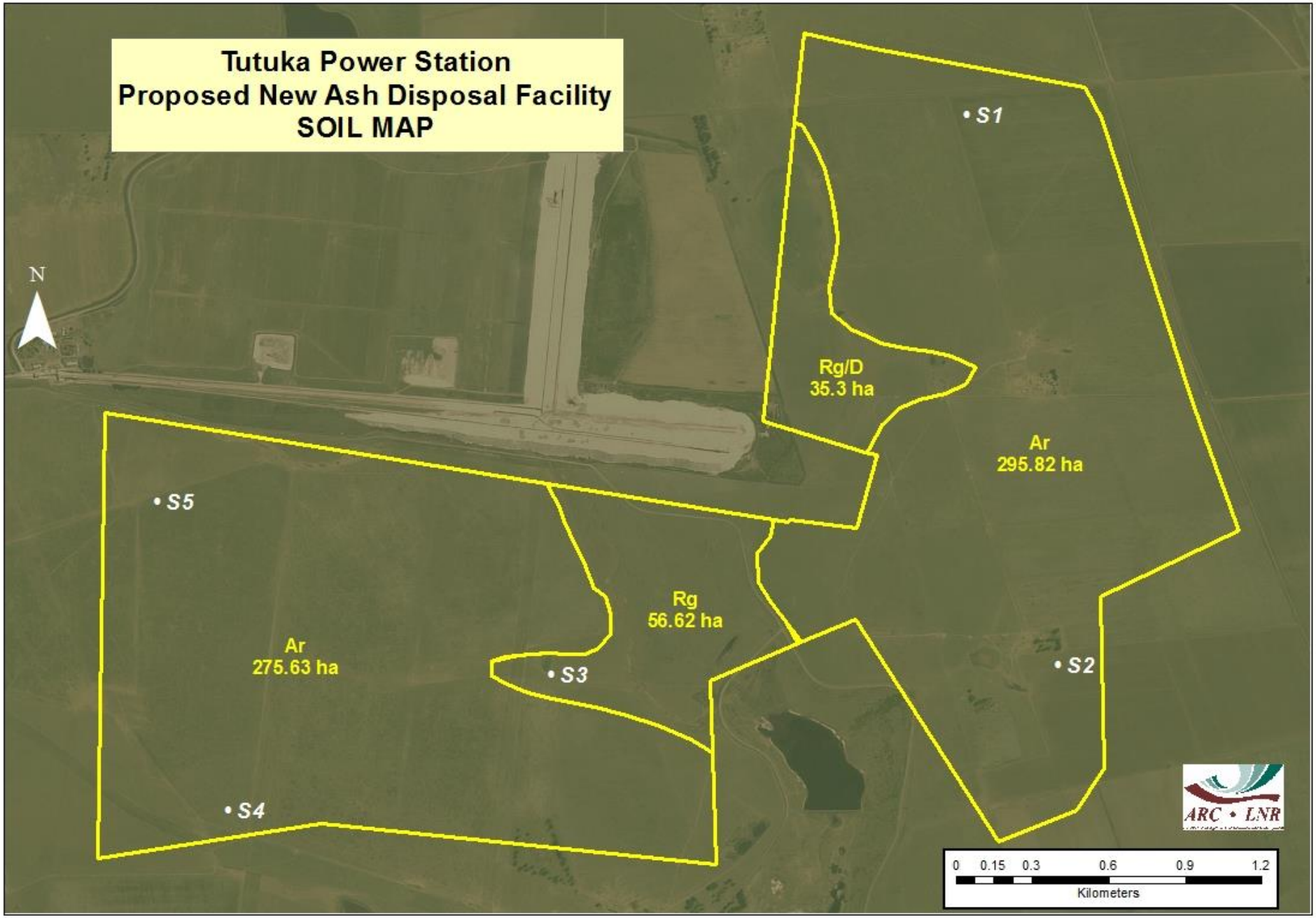
**Kotze, A.V.**, 1986. Climate data. In: *Land types of the maps 2628 East Rand and 2630 Mbabane. Mem. Agric. Nat. Res. S. Afr.* No 5. Dept. Agric & Water Supply, Pretoria.

**Land Type Survey Staff**, 1972-2002. 1:250 000 scale Land Type Survey of South Africa. ARC-Institute for Soil, Climate and Water, Pretoria

**Soil Classification Working Group,** 1991. Soil classification. A taxonomic system for South Africa. Institute for Soil, Climate & Water, Pretoria.

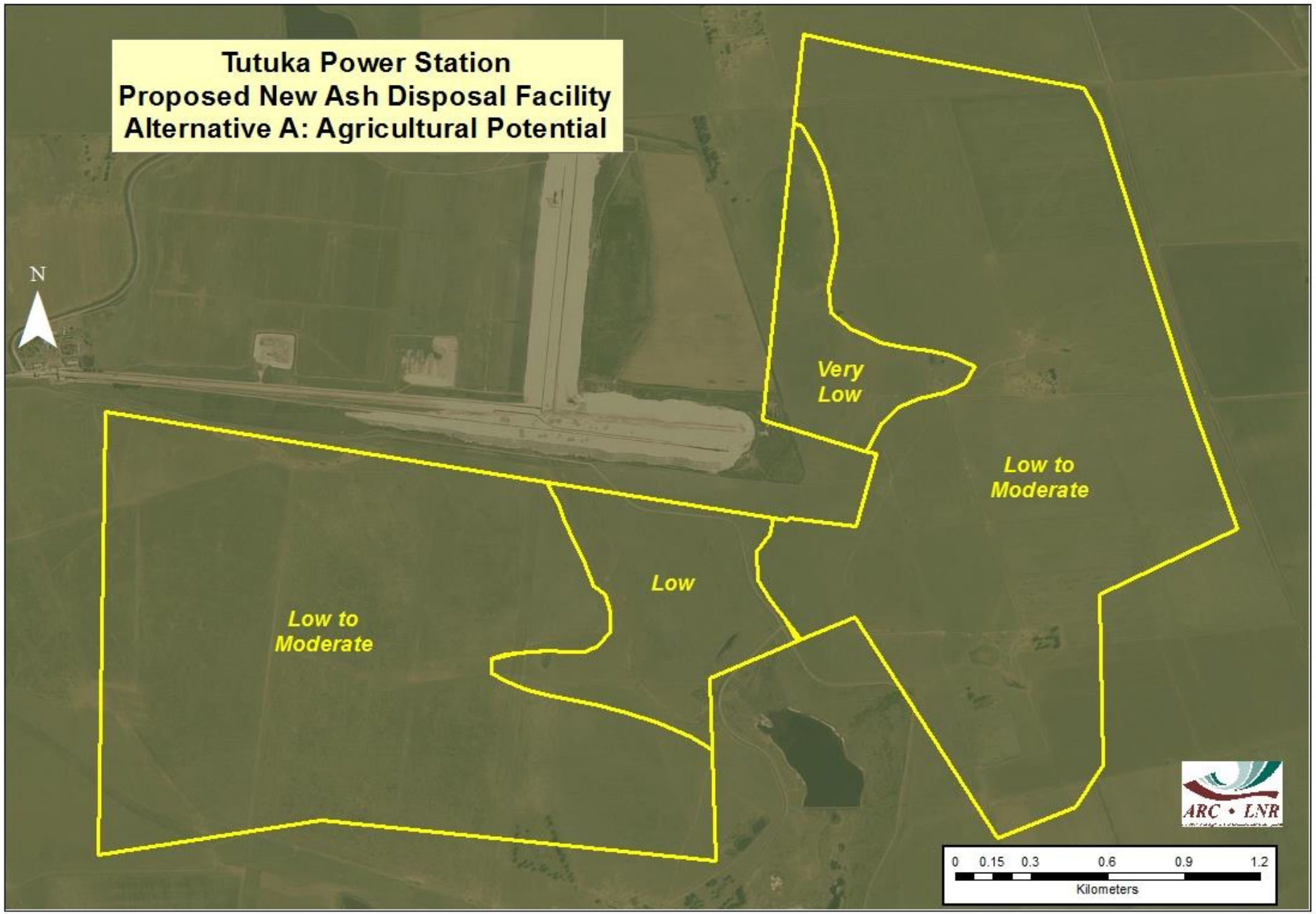
# APPENDIX A

# Soil Map


Tutuka Power Station
Proposed New Ash Disposal Facility
SOIL MAP
N
• S1
Rg/D
35.3 ha
Ar
295.82 ha
• S5
Rg
56.62 ha
Ar
275.63 ha
• S3
• S2
• S4
ARC • LNR
0 0.15 0.3 0.6 0.9 1.2
Kilometers

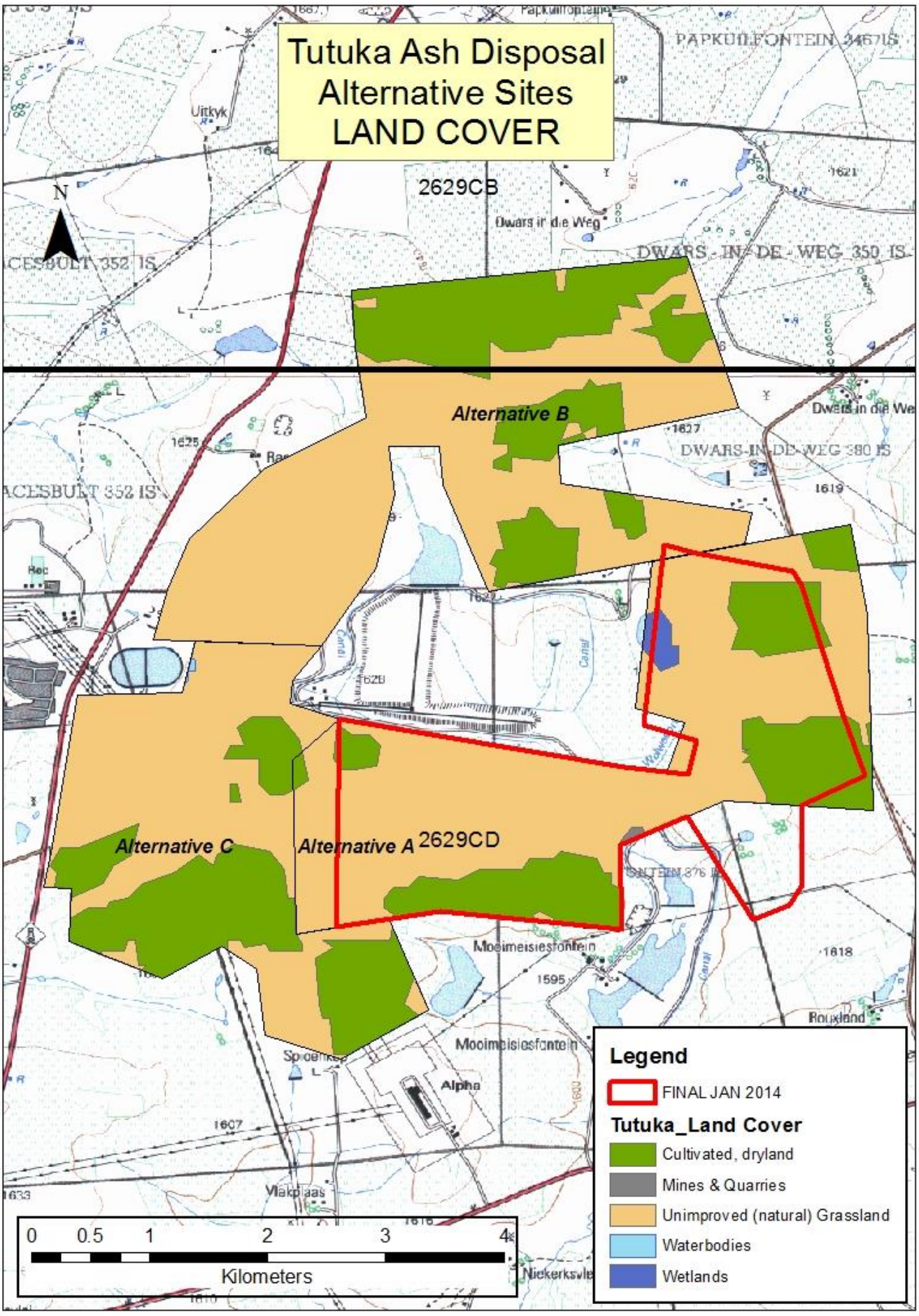
# APPENDIX B:

# Agricultural Potential


Tutuka Power Station
Proposed New Ash Disposal Facility
Alternative A: Agricultural Potential
N
Very Low
Low to Moderate
Low
Low to Moderate
ARC • LNR
0 0.15 0.3 0.6 0.9 1.2
Kilometers

# APPENDIX C:

# Land Cover


Tutuka Ash Disposal
Alternative Sites
LAND COVER
2629CB
2629CD
Alternative A
Alternative B
Alternative C
N
Legend
FINAL JAN 2014
Tutuka_Land Cover
Cultivated, dryland
Mines & Quarries
Unimproved (natural) Grassland
Waterbodies
Wetlands
0 0.5 1 2 3 4
Kilometers