**REPORT**

**for Lidwala Environmental and Planning Servives**
**by the**

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


# SOIL SURVEY FOR PROPOSED WET ASH DISPOSAL FACILITY, HENDRINA POWER STATION, MPUMALANGA PROVINCE

By

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# 1 INTRODUCTION

## 1.1 Terms of Reference

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was requested by Lidwala Environmental and Planning Services to carry out a soil survey in the vicinity of Hendrina Power Station in Mpumalanga Province. The aim of the survey was to describe, classify and map the soils occurring in the area of the proposed ash disposal facility, and to assess the agricultural potential. Soil samples were collected for verification purposes.

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

# 2 STUDY AREA

## 2.1 Location

The study area (Figure 1, yellow boundary) is located immediately to the south of the Hendrina Power Station at Pullen's Hope.


**Figure 1:** Location Map

The area lies between latitudes 26° 02' 10" and 26° 03' 15" S and between longitudes 29° 34' 50" and 29° 36' 15" E.

## 2.2 Site Details

The site is just over 208 ha in extent, and lies between 1 630 and 1 650 metres above sea level, with the highest point in the south-east. The terrain falls gently to the north, with slopes of between 2% and 5%.

Most parts of the site show that it was previously or is presently being cultivated. However, in the south-eastern corner there is a portion (±48 ha) that comprises disturbed soils due to excavation.

There is an abandoned dwelling in the northern part (south of the power station).

## 2.3 Climate

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°C and the extreme minimum –11.1°C

The climatic data is given in Table 1 below.

**Table 1** Climate Data for Hendrina area

| Month | Rainfall (mm) | Min. Temp (°C) | Max. Temp (°C) | Average frost dates |
|---|---|---|---|---|
| Jan | 154.2 | 14.2 | 27.6 | Start date: 06/01 |
| Feb | 92.8 | 13.1 | 28.0 | End date: 11/11 |
| Mar | 73.7 | 11.6 | 27.2 | Days with frost: ±46 |
| 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 sandstone and shale of the Vryheid Formation, of the Karoo Sequence (Geological Survey, 1986).

## 3 METHODOLOGY

The soils were investigated using a hand-held soil auger to a maximum depth of 1 200 mm, on a grid of 150 x 150 metres, which was established using a GPS. All the relevant soil properties (horizons, colour, structure, texture, calcareousness, drainage, etc) at each observation point were noted and the soils were classified according to the South African Soil Classification System (Soil Classification Working Group, 1991). Similar soils were grouped together into mapping units.

Representative topsoil and subsoil samples were collected from three sites within the areas for laboratory analysis (marked S1 to S3 on the soil map in the Appendix).

The samples were analysed for particle size (sand, silt and clay), $pH_{(H2O)}$, cation exchange capacity (CEC) and exchangeable cations, organic carbon and P (Bray 1) according to the standard prescribed methods (Non-Affiliated Soil Analysis Work Committee, 1990).

## 4 RESULTS

### 4.1 Soils

Several soil map units were identified. A description of the most important soil characteristics of each unit, such as the dominant soil form and family, soil depth, topsoil texture and underlying material, is given in the soil legend shown in Table 2. The colours used correspond to those shown on the soil map (Appendix).

In general, the soils are moderately deep, yellow-brown to red, light- to medium-textured soils (**Av**, **Bv** and **Gc** map units), with no significant degree of structure. Shallower soils, with ferricrete outcrops in places, also occur (**Wa** map unit), as well as some areas of disturbance (**Ex** map unit). The soils in the lower-lying positions (**Tu** and **Ka** map units) are darker brown to black, with a slightly heavier texture and signs of wetness lower in the profile.

The map units are shown on the soil map in the Appendix as for the following example:

**Av**
**61.72 ha**

Where **Av** represents the map unit (in this case Avalon soils) and **61.72 ha** is the area.

### 4.2 Soil Analysis Results

Samples of topsoil and subsoil were collected at three localities (S1 to S3). These points are marked on the soil map (Appendix). The analysis results are shown in Table 3.

**Table 2** Soil map legend

| Map Unit | Depth (mm) | Dominant Soil Form(s) | Sub-dominant Soil Form(s) | General description of soils occurring | Agricultural Potential |
|---|---|---|---|---|---|
| **Structureless soils** | | | | | |
| **Av** | 500-1200 | Avalon | Glencoe | Grey-brown, structureless, loamy sand to sandy loam topsoils on yellow-brown, structureless, loamy sand to sandy loam subsoils on grey, mottled, soft plinthite (**Avalon** form) or occasionally on cemented ferricrete (**Glencoe** form). | Moderate to high **(63.98 ha)** |
| **Bv** | 750-1200+ | Bainsvlei | Hutton | Reddish, structureless, sandy loam topsoils on red, structureless, sandy loam to sandy clay loam subsoils on grey mottled, soft plinthite (**Bainsvlei** form). Where no plinthite is present, the soils belong to the **Hutton** form. | Moderate to high **(56.37 ha)** |
| **Gc** | 400-700 | Glencoe | Glenrosa, Avalon | Grey-brown, structureless, loamy sand to sandy loam topsoils on yellow-brown, structureless, loamy sand to sandy loam subsoils on cemented ferricrete (**Glencoe** form). | Low to moderate **(8.40 ha)** |
| **Wa** | 500-900 | Wasbank | Dresden | Grey-brown, structureless to weakly structured, sandy loam topsoils on greyish, structureless, sandy loam subsoils, on hard plinthic (**Wasbank** form). Where grey subsoil horizon is absent, the soils belong to the **Dresden** form. | Low to moderate **(6.17 ha)** |
| **Soils with signs of wetness** | | | | | |
| **Tu** | 500-900 | Tukulu | Avalon | Dark brown, structureless to weakly structured, sandy loam to sandy clay loam topsoils on yellow-brown to dark grey, weakly structured, mottled, sandy clay loam subsoils, on grey, mottled clay (**Tukulu** form), occasionally on grey, mottled, soft plinthite (**Avalon** form). | Low **(17.91 ha)** |
| **Ka** | 200-350 | Katspruit | - | Brown to dark brown, weakly structured, sandy clay loam topsoils on dark brown to dark grey-black, weakly structured, sandy clay loam subsoils, often wet (**Katspruit** form). | Very low **(7.08 ha)** |
| **Miscellaneous** | | | | | |
| **Ex** | - | - | - | Much topsoil removed through excavation, signs of red deep soils, but much mixing and disturbance | Very low **(48.13 ha)** |
| | | | | **TOTAL AREA** | **208.04 ha** |

**Table 3** Soil analysis results

| **Sample site** | | **S1** | | **S2** | | **S3** | |
|---|---|---|---|---|---|---|---|
| **Co-ordinates (Lat/Long)** | | 26° 02' 19.0" 29° 35' 08.0" | | 26° 02' 50.3" 29° 35' 16.5" | | 26° 02' 41.1" 29° 35' 32.9" | |
| **Soil Form** | | Avalon | | Avalon | | Bainsvlei | |
| **Horizon** | | A1 | B1 | A1 | B1 | A1 | B1 |
| **Depth (mm)** | | 0-300 | 300-700 | 0-300 | 300-700 | 0-300 | 300-700 |
| **Sa** | % | 88 | 80 | 86 | 82 | 70 | 66 |
| **Si** | | 2 | 2 | 2 | 4 | 6 | 8 |
| **Cl** | | 10 | 18 | 12 | 14 | 24 | 26 |
| | | | | | | | |
| **Na** | **cmol $kg^{-1}$** | 0.141 | 0.147 | 0.129 | 0.120 | 0.125 | 0.130 |
| **K** | | 0.159 | 0.104 | 0.310 | 0.207 | 0.760 | 0.291 |
| **Ca** | | 3.237 | 2.232 | 2.786 | 1.528 | 5.347 | 4.731 |
| **Mg** | | 1.238 | 1.211 | 1.082 | 0.652 | 2.041 | 1.410 |
| **CEC** | | 13.313 | 13.171 | 12.928 | 10.230 | 13.825 | 19.630 |
| | | | | | | | |
| **P (ppm)** | | 9.69 | 1.23 | 36.73 | 5.98 | 6.82 | 0.79 |
| **pH ($H_2O$)** | | 7.54 | 7.12 | 6.54 | 6.00 | 6.57 | 6.62 |
| **Org C (%)** | | 0.79 | 0.49 | 0.75 | 0.60 | 1.63 | 1.32 |

The soil analysis results show the light texture of the yellow-brown (**Av**) soils, with the red (**Bv**) soils being slightly higher in clay. The soils are not highly leached (eutrophic), with pH levels being neutral to slightly acidic. S1 and S2 were cultivated sites, where the lower organic carbon levels and higher residual P fertilization contrast with the uncultivated site S3.

However, in general, these are fertile, productive soils, and no abnormal or unexpected values were observed.

### 4.3 Agricultural Potential

The general agricultural potential class of each map unit, and the main limiting factors, are given in Table 4 below.

**Table 4** Agricultural Potential

| Agricultural Potential | Map unit | Limitations | Area (ha) |
|---|---|---|---|
| **Moderate to high** | **Av, Bv** | Few limitations. Moderately deep to deep, friable soils. Underlying plinthite may occur at shallow depth in places | **120.35** |
| **Low to moderate** | **Wa, Gc** | Restricted depth to underlying plinthite in many areas. Reduced natural fertility | **14.57** |
| **Low** | **Tu** | Occasional subsoil wetness and flood hazard **(Wetland)** | **17.91** |
| **Very Low** | **Ka** | Almost continuous subsoil wetness and flood hazard (**Ka**) **(Wetland)** | **7.08** |
| **Very Low** | **Ex** | Soil has been disturbed with topsoil removal (**Ex**) | **48.13** |
| | | | **208.049** |

From Table 4, it can be seen that most of the survey area comprises soils with moderate to high agricultural potential (**Bv** and **Av** map units); the soils are deep and freely drained, with few limitations, and climatic conditions for rain-fed cultivation are generally good, with sufficient rainfall (Section 2.3).

Both the **Tu** and the **Ka** unit comprise wetlands (the **Tu** unit is a temporary wetland, while the **Ka** unit is a permanent wetland), and these should, as far as possible be left undisturbed

The **Ex** map unit comprises areas where excavations have occurred. In some instances, there has been replacement of topsoil, but there are also significant areas where the excavation has been left with very little topsoil, and in some cases with the ferricrete outcropping at the surface. Due to the uneven distribution of these areas, the increased compaction of the soils in places and the subsequent significant reduction in available soil depth, this map unit is difficult to describe or classify and has a very low potential for agriculture.

## REFERENCES

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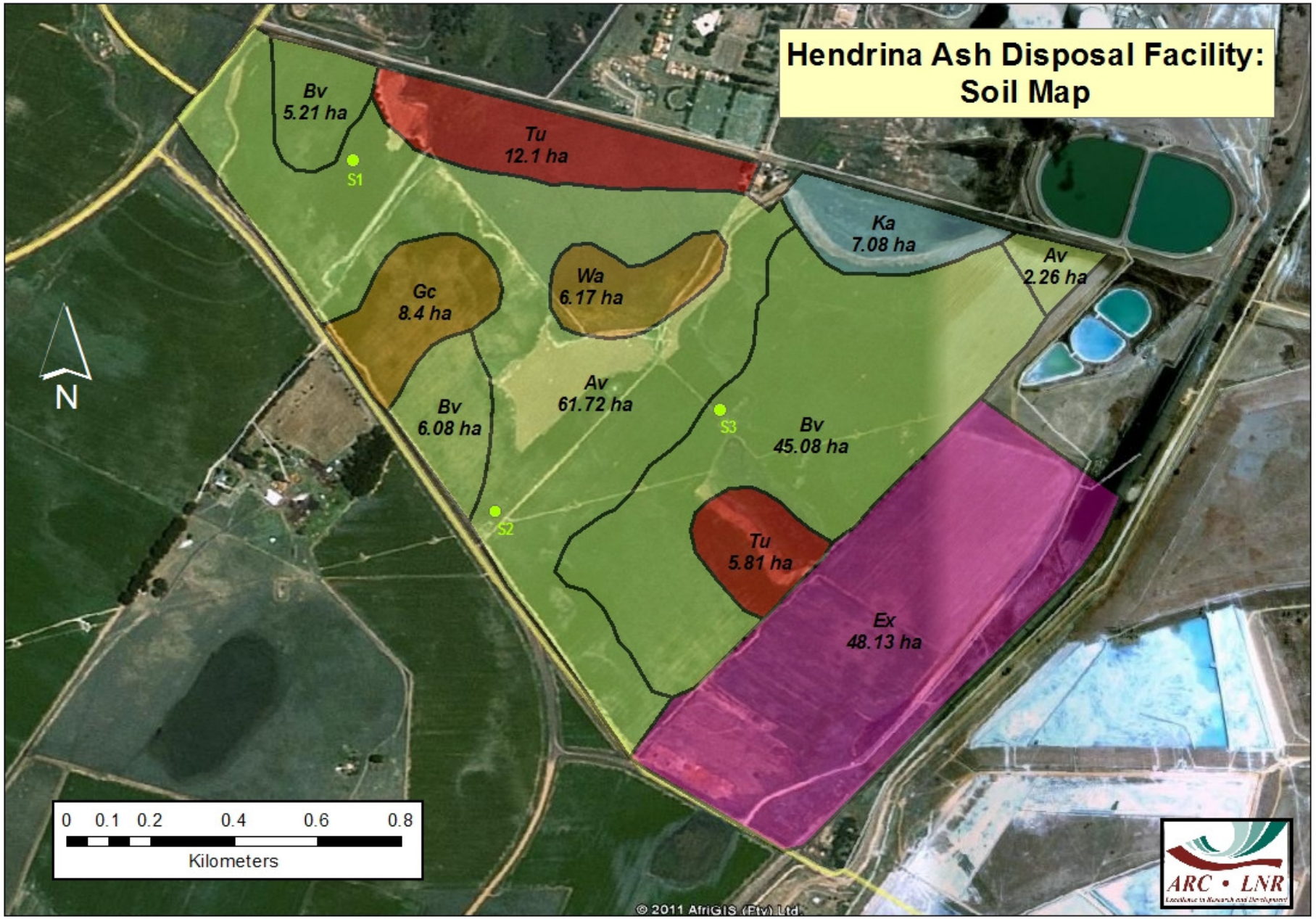
**Non – Affiliated Soil Analysis Work Committee,** 1990. Handbook of standard soil testing methods for advisory purposes. Soil Science Society of South Africa, Pretoria.

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

## Appendix:

## Soil Map


Hendrina Ash Disposal Facility:
Soil Map
Bv
5.21 ha
Tu
12.1 ha
S1
Ka
7.08 ha
Av
2.26 ha
Gc
8.4 ha
Wa
6.17 ha
Av
61.72 ha
Bv
6.08 ha
S3
Bv
45.08 ha
S2
Tu
5.81 ha
Ex
48.13 ha
N
0 0.1 0.2 0.4 0.6 0.8
Kilometers
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