REPORT

On contract research for

Savannah Environmental (Pty) Ltd

VOLUME 2

Tshwane Strengthening Project Phase 1

SOILS AND AGRICULTURAL POTENTIAL FOR PROPOSED PHOEBUS-KWAGGA TRANSMISSION LINE, KWAGGA SUBSTATION EXPANSION AND PHOEBUS SUBSTATION ESTABLISHEMENT NEAR PRETORIA

By

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1. TERMS OF REFERENCE

The ARC-Institute for Soil, Climate and Water (ARC-ISCW) was contracted by Savannah Environmental (Pty) Ltd to undertake an investigation of the soils and associated agricultural potential for a transmission line from the proposed Phoebus substation near Soshanguve southward to the existing Kwagga substation, near Atteridgeville in Gauteng Province. The objectives of the study are;

- To classify the soils and to produce a soil map of the specified area as well as
- To assess the broad agricultural potential.

Two different routes were proposed, namely Alternative 1 (denoted by the **orange** dotted line), with two smaller sub-alternatives, namely Alternative 2 (denoted by the **blue** dotted line) and Alternative 3, near the Magaliesberg ridge (denoted by the **purple** dotted line) (see Appendix).

Secondly, the area where the proposed Phoebus substation is to be located (to the north of the existing Hangklip substation, near Soshanguve) was investigated to look at the soils occurring, as well as their agricultural potential.

2. SITE CHARACTERISTICS

2.1 Location

The proposed Phoebus substation lies to the west of the R80 Highway, south of Soshanguve, with the Kwagga substation lying to the south of the R104 road, east of Atteridgeville. The terrain is undulating, with slopes of around 2-4%, and altitude is around 1 300 m above sea level. The exception is the steep Magaliesberg ridge, with summits of over 1 500 m and slopes of more than 50%.

2.2 Climate

The climate of the area can be regarded as typical of the Highveld, with cool to cold, dry winters and warm, moist summers (Koch, 1984). The main climatic indicators are given in Table 1.

Table 1 Climate Data

Month	Average Rainfall (mm)	Average Min. Temp (°C)	Average Max. Temp (°C)	Average frost dates
Jan	109.9	16.6	29.8	Start date: 24/5
Feb	89.7	16.3	29.2	End date: 23/8
Mar	76.6	14.5	28.2	Days with frost: ± 32
Apr	40.2	10.7	25.7	
May	18.0	5.6	23.0	
Jun	6.5	2.0	20.4	
Jul	6.2	1.8	20.8	**Heat units (hrs > 10°C)**
Aug	6.5	4.0	23.6	Summer
Sep	14.2	8.6	27.0	(Oct-Mar): 2 213
Oct	51.9	12.7	28.8	
Nov	97.1	14.6	28.7	Winter
Dec	102.2	15.8	29.4	(Apr-Sept): 796
Year	**619.0 mm**	**18.2 °C (Average)**		

The long-term average annual rainfall is 619.0 mm, of which 527.4 mm, or 85.2%, falls from October to March. Temperatures vary from an average monthly maximum and minimum of 29.8°C and 16.6°C for January to 20.8°C and 1.8°C for July respectively. The extreme high temperature that has been recorded is 40.6°C and the extreme low –9.0°C. Frost occurs every year on approximately 32 of the 100 days on average between May and August.

2.3 Parent Material

The parent material of the area comprises different geology to the north and to the south of the Magaliesberg, which consists of quartzite of the Magaliesberg Formation. To the north is gabbro and norite of the Rustenburg Layered Suite, Bushveld Complex, while to the south, the ares is underlain by shale of the Silverton Formation, Pretoria Group (Geological Survey, 1978).

3. METHODOLOGY

The area was covered by existing soil maps, at 1:50 000 scale, of the PWV peri-urban soil survey (Yager, 1990). The soils were classified (MacVicar *et al*, 1977) and similar soils were grouped into map units. This information was digitised in ArcGIS and each soil map unit was allocated a class of broad agricultural potential (Section 5).

The soil boundaries are shown on the map in the Appendix.

4. SOILS

Over most of the proposed alternatives, most of the soils are shallow (<400 mm), often on rock, with much surface rock outcropping. However, in parts, the route crosses areas of deeper, usually reddish-yellow soils, especially close to Soshanguve in the north and in parts of the Moot, immediately to the south of the Magaliesberg. Much of Alternative 2 passes through a wetland, where hydromorphic (wet) soils occur.

Each of the mapping units from the PWV survey was allocated to a class of broad agricultural potential, mainly using a combination of depth, texture, soil form and rockiness. The results of this exercise are shown in Table 2 below and the colours used correspond to the colours used in the map in the Appendix.

Table 2 Agricultural Potential

Agricultural Potential Class	Soil Mapping Units	Effective Depth (mm)
HIGH	Deep to moderately deep Hutton & Avalon soils; no or few physical limitations	600-1200
MODERATE	Moderately deep or variable depth soils; limited depth and occasionally heavy texture	300-1200
LOW	Shallow, gravelly soils, often with some rock; severe depth limitation	<600
ROCKY	Significant rock outcropping (>40%), usually shallow soils with severe depth limitation	<300
WET AREAS	Low-lying areas, soils prone to seasonal waterlogging or flooding	<300
WASTE	Industrial waste areas, such as mine dumps or slimes dams etc	-
URBAN	Housing, industrial, mining, commercial areas etc; not surveyed	-

5. AGRICULTURAL POTENTIAL

From the map, it can be seen that there is significant variation in agricultural potential along the route, and that parts of the route cross soils of high agricultural potential.

Alternative 2 is **not recommended**, since most of the soils along this portion of the route are either of high potential, or are wetland soils, with a significant seasonal flooding hazard, which should be conserved, and not developed.

Alternative 3 crosses similar soils to the adjoining portion of Alternative 1, so there is no real difference between the two.

6. PHOEBUS SUBSTATIUON

The proposed Phoebus substation is to be located immediately to the north of the existing Hangklip substation, near Soshanguve. The co-ordinates are approximately 25^{o} 33' 40" S 28^{o} 05' 58" E, and the site is gently sloping, with a slope angle towards the south of approximately 3%.

The area was investigated in some detail, with a 100 x 100 m grid of investigation. A hand-held soil auger was used to auger to a maximum depth of 1.2 metres (or shallower, if a restricting layer such as rock was encountered), and topsoil and

subsoil samples were collected at two locations for analysis. These results are given in Table 3 below.

Table 3 Soil analyses

Sample site		**S 1**		**S 2**	
Co-ordinates (Lat/Long)		25° 33' 38.9" S 28° 05' 59.4" E		25° 33' 45.4" S 28° 05' 55.8" E	
Soil Form		Hu		Hu	
Horizon		A1	B1	A1	B1
Depth (mm)		0-300	300-900	0-250	250-550
Sa	%	75.9	60.0	71.5	63.6
Si		10.1	22.0	14.5	18.4
Cl		14	18	14	18
Na	cmol kg^{-1}	0.001	0.018	0.013	0.009
K		0.243	0.251	0.247	0.253
Ca		0.858	0.349	1.052	0.733
Mg		0.603	0.565	0.673	0.883
CEC		7.052	5.328	8.669	5.533
P (ppm)		20.71	2.36	4.09	0.85
pH (H_2O)		6.30	5.44	5.93	5.70
Org. C	%	0.66	0.46	0.74	0.52

The soils occurring on the site (see map in Appendix 2) are red (occasionally yellow-brown), weakly structured, sandy loam soils on rock or cemented ferricrete. When the soil depth is sufficient to allow for the development of a topsoil and subsoil, the soil belongs to the Hutton (Hu) form (and occasionally Clovelly (Cv) form, where the colour is yellow-brown), while where the soil is shallow, so that only a topsoil has formed (total soil depth to rock generally <350 mm), then the soil belongs to either the Hutton (Hu) form (on rock) or Dresden form (on ferricrete).

On the map in Appendix 2, the soils occurring are shown, with the soil form abbreviations of Hutton (**Hu**), Clovelly (**Cv**) and Dresden (**Dr**). The prefixes used indicated depth to underlying rock/ferricrete as follows: **s** = shallow (<350 mm); **m** = moderately deep (500-750 mm); **d** = deep (>900 mm).

However, one of the clear characteristics of the area is not only the restricted soil depth of many of the soil observations that were made, but also the occurrence of many large rocks (and ferricrete boulders) outcropping at the surface. These were observed more or less throughout the area, so that even where the soil happened to be deep enough for theoretical cultivation (>750 mm or so), the presence of the

boulders close by (< 10 meters in some cases) would render the area unsuitable for cultivation.

Thus, the whole area will be classed as having **low potential** for arable agriculture, suited for grazing at best.

7. REFERENCES

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MacVicar, C.N., De Villiers, J.M., Loxton, R.F., Verster, E., Lambrechts, J.J.N., Merryweather, F.R., Le Roux, J., Van Rooyen, T.H. & Harmse, H.J. von M., 1977. Soil classification. A binomial system for South Africa. Dept Agricultural Technical Services, Pretoria.

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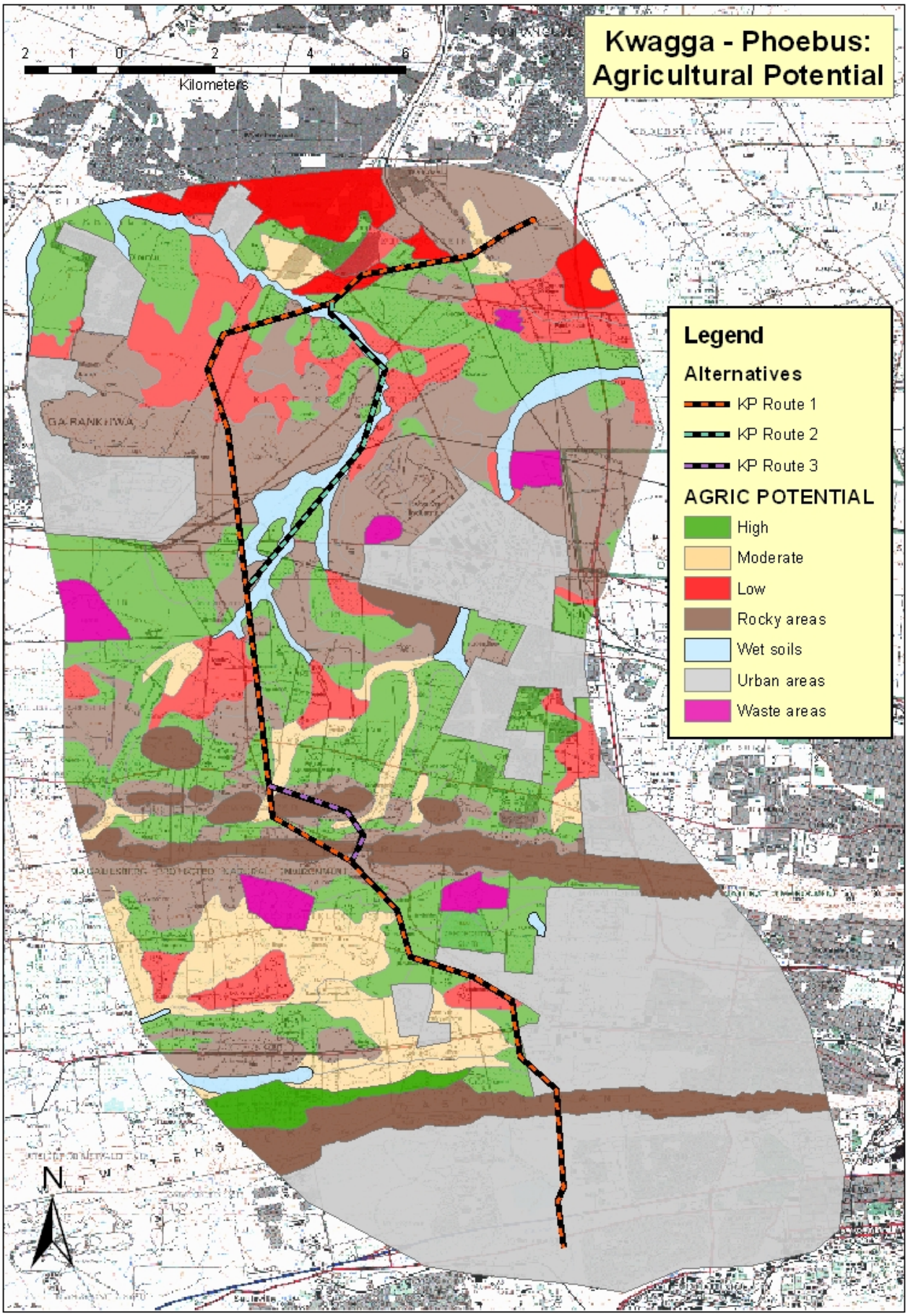
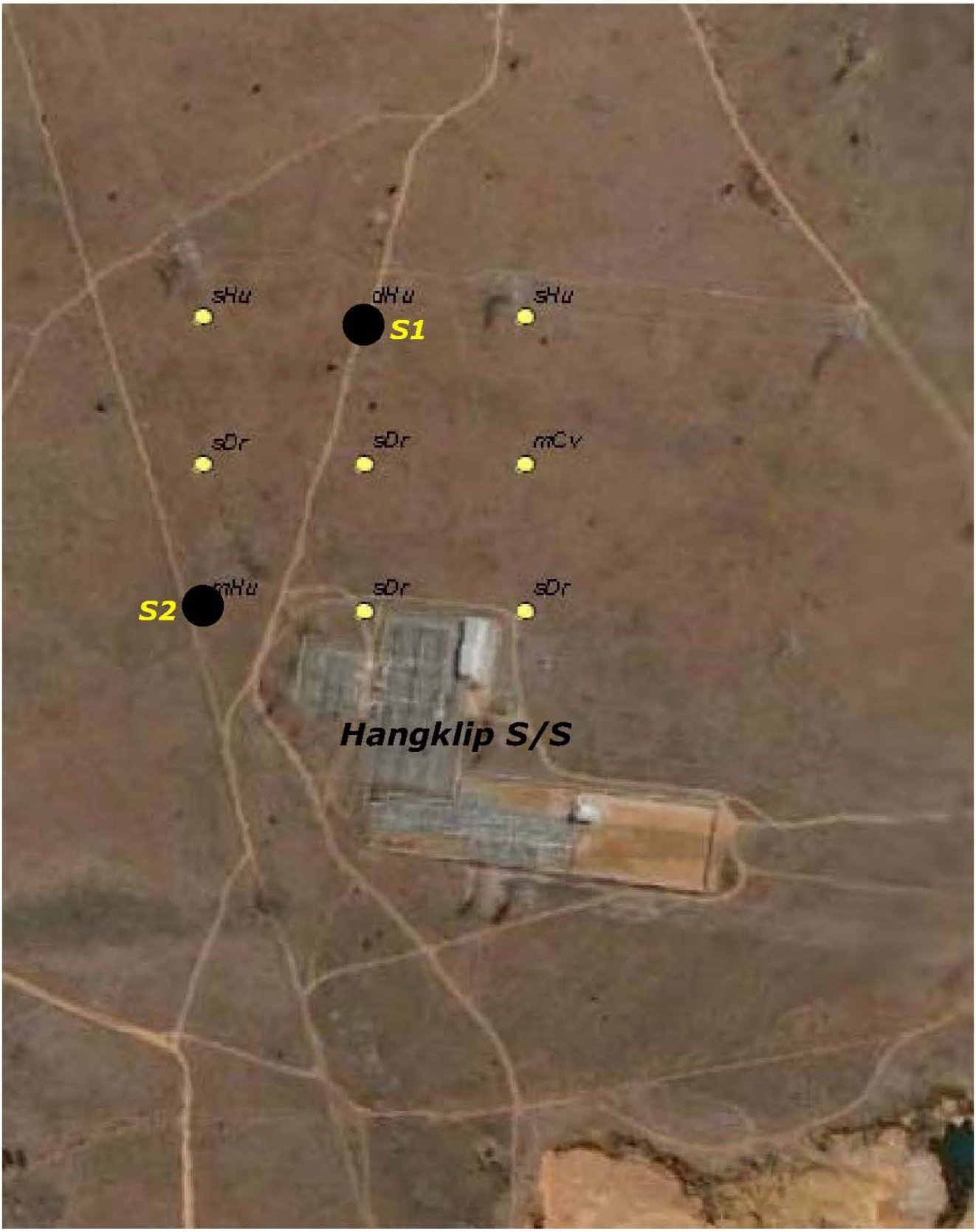
APPENDIX 1:

SOIL MAP OF TRANSMISSION LINE CORRIDOR


Kwagga - Phoebus:
Agricultural Potential
2 1 0 2 4 6
Kilometers
Legend
Alternatives
KP Route 1
KP Route 2
KP Route 3
AGRIC POTENTIAL
High
Moderate
Low
Rocky areas
Wet soils
Urban areas
Waste areas
N

APPENDIX 2:

SOIL MAP OF
PROPOSED PHOEBUS SUBSTATION


sHu
dHu
S1
sHu
sDr
sDr
mCv
S2
mHu
sDr
sDr
Hangklip S/S