76 Valley View Road, Morningside, Durban, 4001
PO Box 37069, Overport, Durban. 4067

Tel: +27 (0)31 3032835
Fax: +27 (0)86 692 2547

SOIL AND AGRICULTURAL ASSESSMENT

VRYHEID STRENGTHENING PROJECT, SWELLENDAM LOCAL MUNICIPALITY, WESTERN CAPE PROVINCE

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Prepared by:
Afzelia Environmental Consultants
P.O. Box 37069,
Overport, 4067
Tel: 031 303 2835
Fax: 086 692 2547
Email: info@afzelia.co.za

Prepared for:
Nsovo Environmental Consulting
748 Richards Drive, Elite Park
Halfway House
1685
Tel: 011 312 5153
Fax: 086 6028821
Email ppp@nsovo.co.za

Declaration

I, **Rowena Harrison,** declare that -

- I act as the independent specialist in this application;
- I do not have and will not have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Date:

Specialist:	Rowena Harrison for Afzelia Environmental Consultants		
Contact person:	Rowena Harrison		
Qualification:	MSc Soil Science (UKZN)		
Postal address:	76 Valley View Road, Morningside		
Postal code:	4001	**Cell:**	078 023 0532
Telephone:	031 303 2835	**Fax:**	086 692 2547
E-mail:	rowena@afzelia.co.za		
Professional affiliation(s) (if any)	SACNASP *Cand.Sci.Nat*: 100169/13 IAIAsa		

Executive summary

Afzelia Environmental Consultants (Pty) Ltd was appointed by Nsovo Environmental Consulting to undertake a soil and agricultural assessment within the Swellendam area for the proposed development of the Eskom Agulhas 400/132KV 2X500 MVA Transmission Substation and Loop-in Loop-out Lines within the Swellendam Local Municipality, Western Cape Province.

This soil and agricultural study involved the assessment of seven proposed sites for the substation. These sites are located on the Farms 253, 257, Portion 3 of the Farm Leeuw Rivier 251 and Portions 2, 5 & RE of the Farm Kluitjeskraal 256.

The purpose of this Agricultural Impact Assessment has been fourfold:

- Establish and describe the soil and agricultural status quo of the seven target sites;
- Describe the land use and capability of the site based on the soil forms identified, slope of the site, climatic data, rockiness, surface crusting and wetness;
- To make recommendations as to which sites are preferable for the construction of the substation and associated loop-in loop-out lines based on the agricultural assessments;
- Determine the impact of the civil works required for construction of the proposed substation on the status quo of soils and agricultural activity within each target site and the immediately adjoining landscape;
- To make mitigation recommendations for any agricultural and agribusiness impacts that might be associated with the construction of the proposed development.

The soil sampling was taken at strategic locations across six of the seven sites and soils assessed in terms of the texture, soil depth, subsoil permeability, slope, rockiness, surface crusting, and wetness. Site G was not sampled as this Site was added to the project description after field work had been undertaken. Aerial imagery was examined for this site. Information collected in the field indicated that all sites have shallow soils, a high percentage of rock and a low clay percentage. The agricultural and land capability for all sites have been classified as Class IV. This Class has severe limitations to the choice of crop cultivated at the site as well as the need for careful management of these crops.

The dominant crop grown around the Swellendam area is Canola (*Brassica napus* L.). Site 'B' and Site 'E' were found to be actively used for the cultivation of Canola. Site 'D' has also been cultivated most likely for cereal/grain crops. Sites 'A' and 'C' were found to be used for livestock grazing and were found to have the lowest agricultural potential as a result of the shallow soils and high percentage of rocks within the profile.

The construction of the substation will not have a significant impact on the agricultural activities at any of the target sites however the impact will be slighter higher at Sites 'B', 'D', 'E', and 'F' as crops are actively cultivated in these areas. It is therefore recommended that either Site 'A' or Site 'C' is used in favour of the other sites for the construction of the substation.

Any development activity in a natural system will have an impact on the surrounding environment, usually in a negative way. The overall impacts of the proposed substation on the soil and agricultural capability of any of the target sites and their immediate surrounds will however be low due to the shallow soils present, the relatively small size of the substation (600mx600m) and the continued use of the land adjacent to the substation for agricultural activities.

There are potential impacts associated with the construction of the substation and these are predominantly associated with soil disturbance and compaction. The use of heavy machinery or vehicles will lead to the compaction of the disturbed soil, making rehabilitation of these areas unlikely to be successful. Sedimentation of drainage lines could occur if construction activities lead to the dumping of soil into these sensitive areas or soil is deposited downslope from surface runoff. Potential mismanagement of waste and pollution including hydrocarbons, construction waste and hazardous chemicals will result in the pollution of the soil through surface runoff during rainfall events, or subsurface water movement.

The impacts of the construction phase of the substation on the surrounding environment therefore must be controlled through the use of an Environmental Management Programme that will address these impacts as well as provide mitigation to lower their significance. Mitigation measures include but are not limited to the strict use of internal roads for heavy machinery; the control of vegetation clearing and exposure of soil; and the management of construction waste.

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1. INTRODUCTION

1.1 Background and Locality of the assessment

Afzelia Environmental Consultants (Pty) Ltd was appointed by Nsovo Environmental Consulting to undertake a soil and agricultural assessment within the Swellendam area for the proposed development of the Eskom Agulhas 400/132KV 2X500 MVA Transmission Substation and Loop-in Loop-out Lines, Swellendam Local Municipality, Western Cape Province within quarter degree square 3420AB (**Figure 1)**.

Seven potential sites were assessed for the proposed substation, situated on the Farms 253, 257, Portion 3 of the Farm Leeuw Rivier 251 and Portions 2, 5 & RE of the Farm Kluitjeskraal 256 (**Figure 2**).

1.2 Scope of work

The scope of work entailed the following:

- Establish and describe the soil and agricultural status quo of the seven target sites;
- Describe the land use and capability of the site based on the soil forms identified, slope of the site, climatic data, rockiness, surface crusting and wetness;
- To make recommendations on which sites are preferable for the construction of the substation and associated loop-in loop-out lines based on the agricultural assessments;
- Determine the impact of the civil works required for construction of the proposed substation on the status quo of soils and agricultural activity within each target site and the immediately adjoining landscape;
- To make mitigation recommendations for any agricultural and agribusiness impacts that might be associated with the construction of the proposed development.

2. METHODOLOGY

Soil sampling was conducted throughout the project area using a standard hand-held auger with a depth of 1200mm (**Figure 3**). At each sampling point the soil was described to form and family level according to "Soil Classification – A Taxonomic System for South Africa". The Soil Form and Family of a site are always good initial indicators of the agricultural and land capability of the area.

The initial classification assessment was then further refined in order to determine the Land Capability Classes (LCCs) of the Soil Forms found within the target sites. LCC determination includes establishing the following properties:

- Soil texture including clay percentage
- Surface rockiness
- Surface crusting
- Vegetation cover
- Permeability of the B horizon
- Effective rooting depth.
- Soil colour – as per the Munsell System

The infield methods of determining soil texture, clay percentage and soil colour are described in more detail in Appendix 1.

Topography is also taken into account during the agricultural assessment, as together with soil form, it plays a large part in determining the land potential of the target sites as well as any rehabilitation measures that may need to be taken as a result of the construction of the substation.

Lastly climate is used as an important determinant in the agricultural potential of the site. Climate determines the volume of rainfall precipitation, the type of precipitation, the seasonal occurrence, soil moisture evaporation rate, the effect of sunshine hours, heat and chill units on crop yield and ground cover.

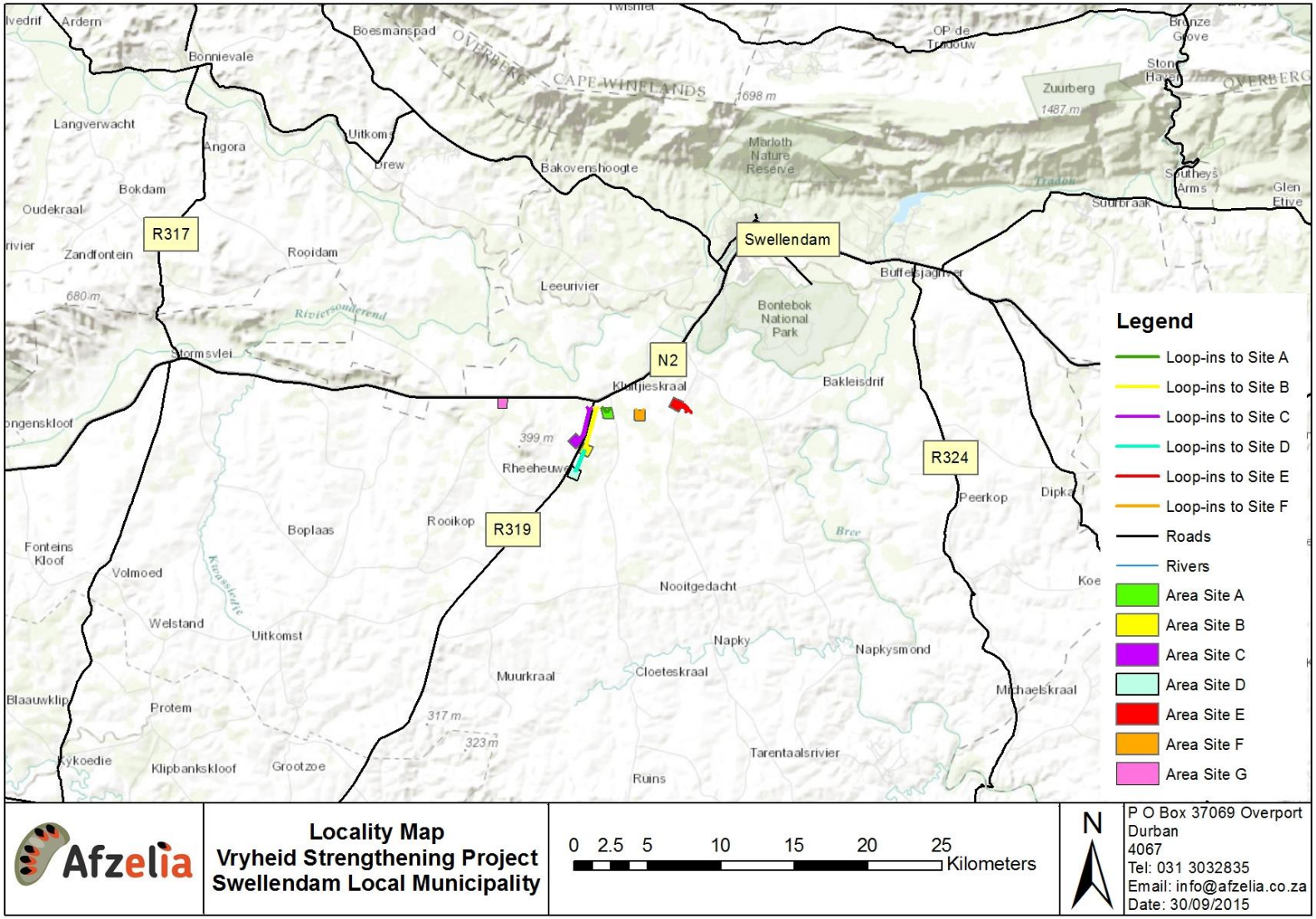


Figure 1: Locality of the study areas

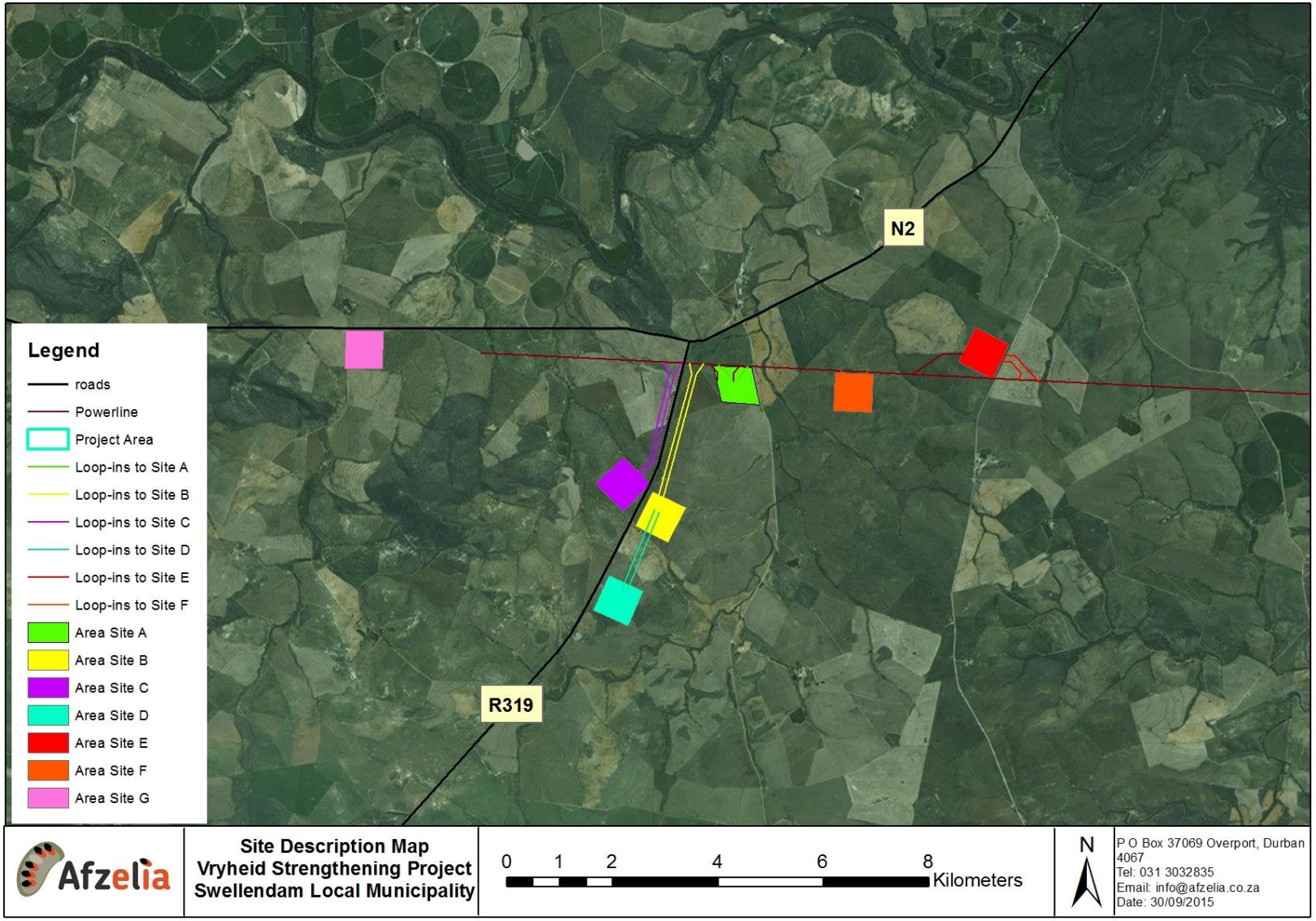


Figure 2: Project description map

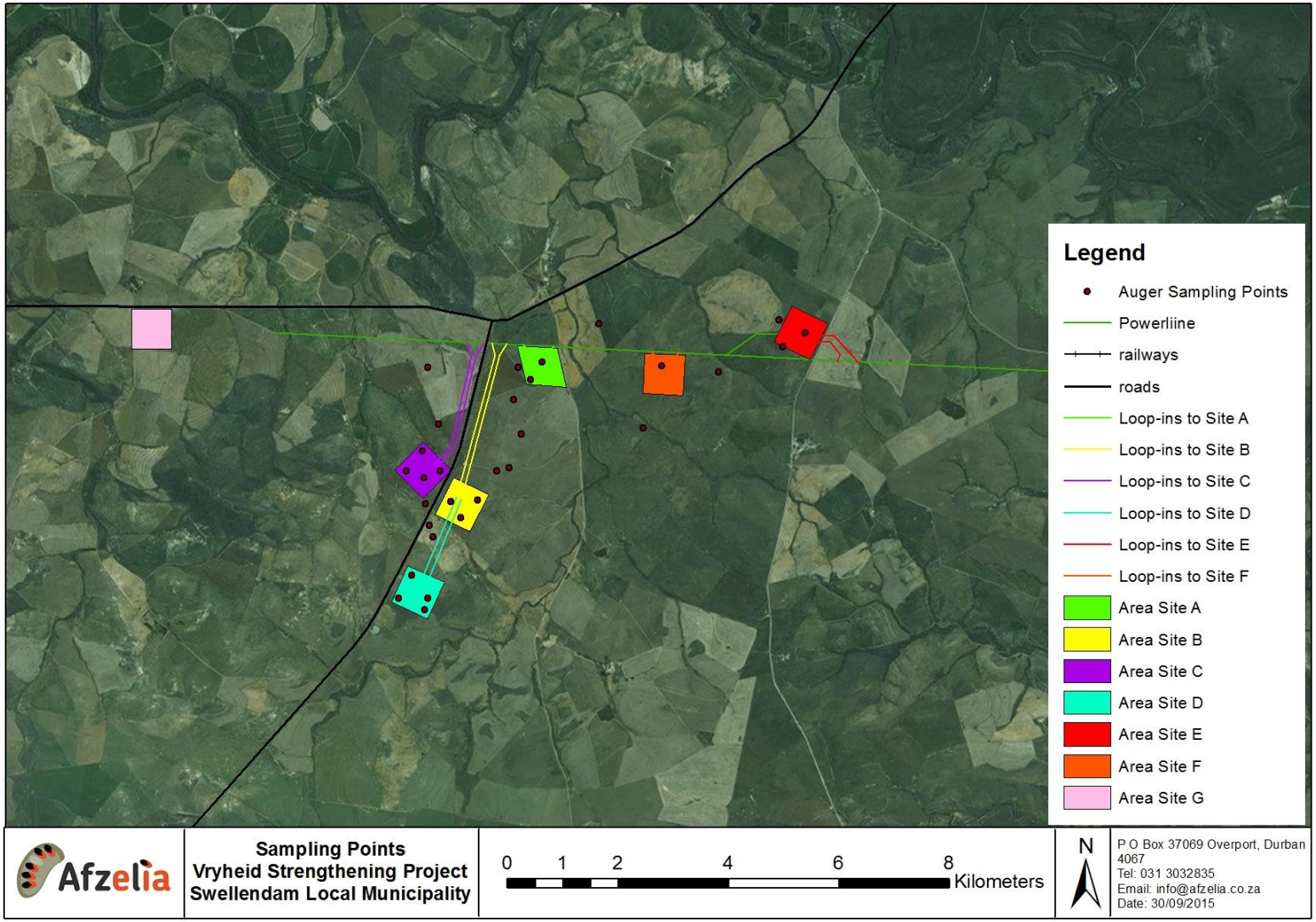


Figure 3: Auger sampling points at the seven target sites

3. BACKGROUND INFORMATION

3.1 Climate

The Swellendam area is characterised by a winter rainfall pattern with some rain occurring in summer. Initial climatic data was obtained from the Agricultural Geo-Referenced Information System (Agis agric). The annual rainfall is given as 400 to 600 mm per annum. Mean maximum annual temperatures are given as 27 to 29.2 Deg. C and mean minimum temperatures as 7.5^{O}C to 10^{O}C. First frosts are normally experienced after June and continue through to the beginning of September.

Other important climatic data is that the evaporation rate is relatively low, typically 1800 to 2000 mm per annum. A description of Climate Capability Class Criteria is shown in Table 1.

Table 1: Description of Climate Capability Classes

Description of Climate Capability Class Criteria (Scotney *et al*. UKZN 1987)		
Climate Capability Class	**Limitation Rating**	**Description**
C1	None to slight	Local climate is favourable for good yields for a wide range of adapted crops throughout the year.
C2	Slight	Local climate is favourable for a wide range of adapted crops and a year round growing season. Moisture stress and lower temperatures increase risk and decrease yields relative to C1
C3	Slight to Moderate	Slightly restricted growing season due to the occurrence of low temperatures and frost. Good yield potential for a moderate range of adapted crops.
C4	Moderate	Moderately restricted growing season due to low temperatures and severe frost.
C5	Moderate to Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Suitable crops at risk of some yield loss.
C6	Severe	Moderately restricted growing season due to low temperatures, frost and/or moisture stress. Limited suitable crops which frequently experience yield loss.
C7	Severe to Very Severe	Severely restricted choice of crops due to heat, cold and/or moisture stress.
C8	Very Severe	Very severely restricted choice of crops due to heat, cold and/or moisture stress. Suitable crops at high risk of yield losses.

A Climate Capability Class of 2 to 3 was determined during the course of the site visit.

3.2 Vegetation

The study site is located within the Eastern Ruens Shale Renosterveld vegetation type (**Figure 4**). This vegetation type is characterised by low to moderately tall grassy shrubland dominated by Renosterbos. It is considered critically endangered with at least 80% transformed mostly by cultivation and croplands (Mucina and Rutherford, 2006). Small fractions are conserved within the Bontobok National Park and the De Hoop Nature Reserve. The vegetation cover at all target sites assessed has been completely transformed as a result of agricultural activities including crop production and livestock grazing. A number of well-vegetated drainage channels surround the proposed construction sites.

3.3 Geology

After climate, geology is probably the second most important factor in the genesis of the soil-terrain landscapes of South Africa. The geological formations constituting the soil parent materials are highly variable with respect to the clay forming potential and silica content of soils as well as differences in natural fertility and erodibility. Differential weathering of resistant and weatherable rock types serves to amplify the effects of scarp retreat or results in enhanced local relief.

The geology of the study area is situated on the Bokkeveld Group Shales dominated by clay and loamy soils. Soils are both shallow and well drained including the Mispah and Glenrosa soil forms (Mucina and Rutherford, 2006; Agis Agric).

3.4 Land type [i]

Land type data for the site was obtained from the Agricultural Research Council (ARC). The land type data is presented at a scale of 1:250000 and entails the division of land types, typical terrain cross sections for the land type and the presentation of dominant soil types for each of the identified terrain units (in the cross section). The soil data is classified according to the Binomial System. The soil data was interpreted and re-classified according to the Taxonomic System (Land Type Survey Staff. (1972-2006).

The majority of the sites fall within Fb41 land type while Site G falls within landtype Fb48 (**Figure 5; Appendix 3**). These land types are predominantly associated with shallow soils of the Mispah and Glenrosa Soil Forms. Textures range from fine sand to clay with most texture classes within the sandy loam category with 2-6% clay.

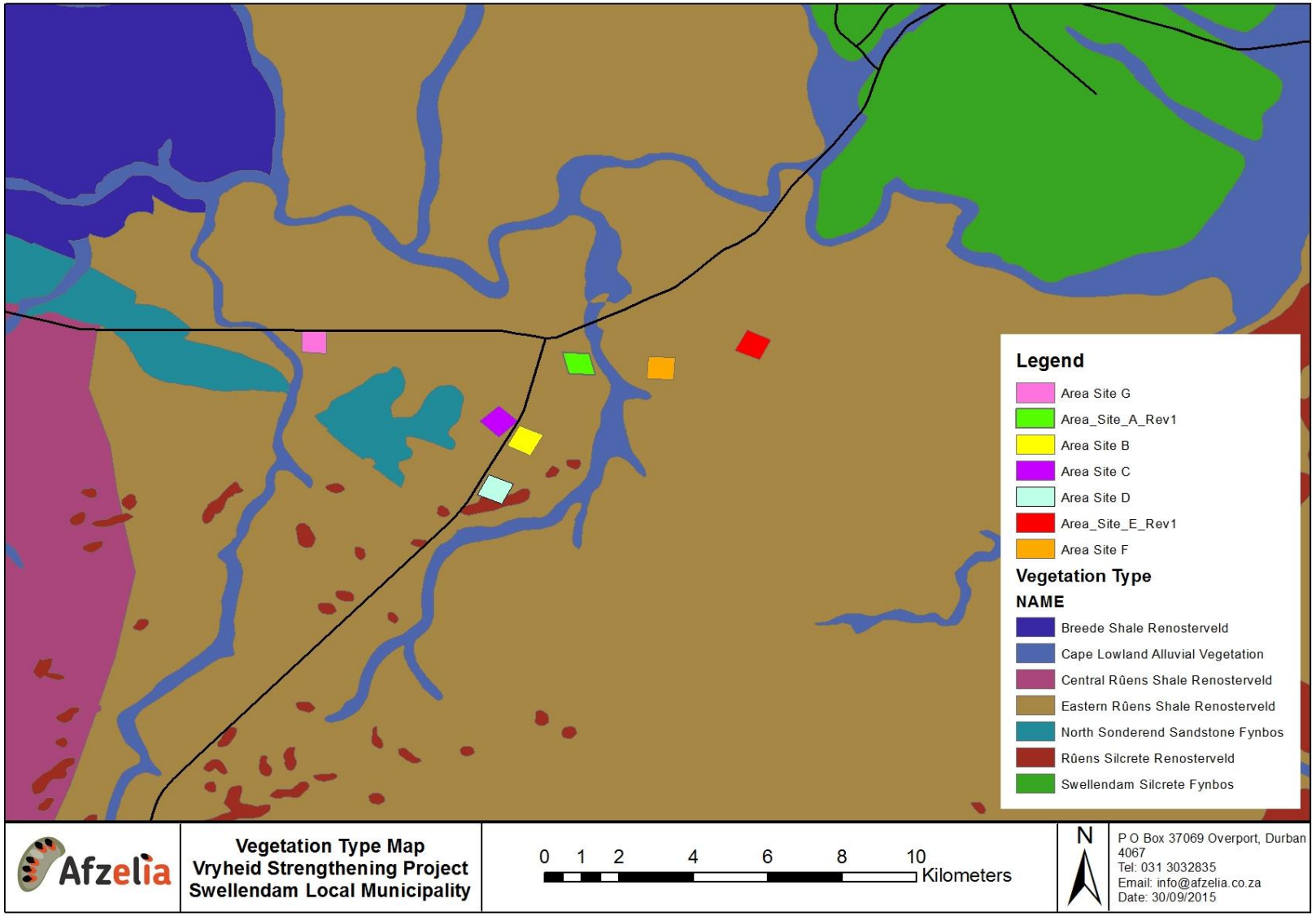


Figure 4: Vegetation type of the site

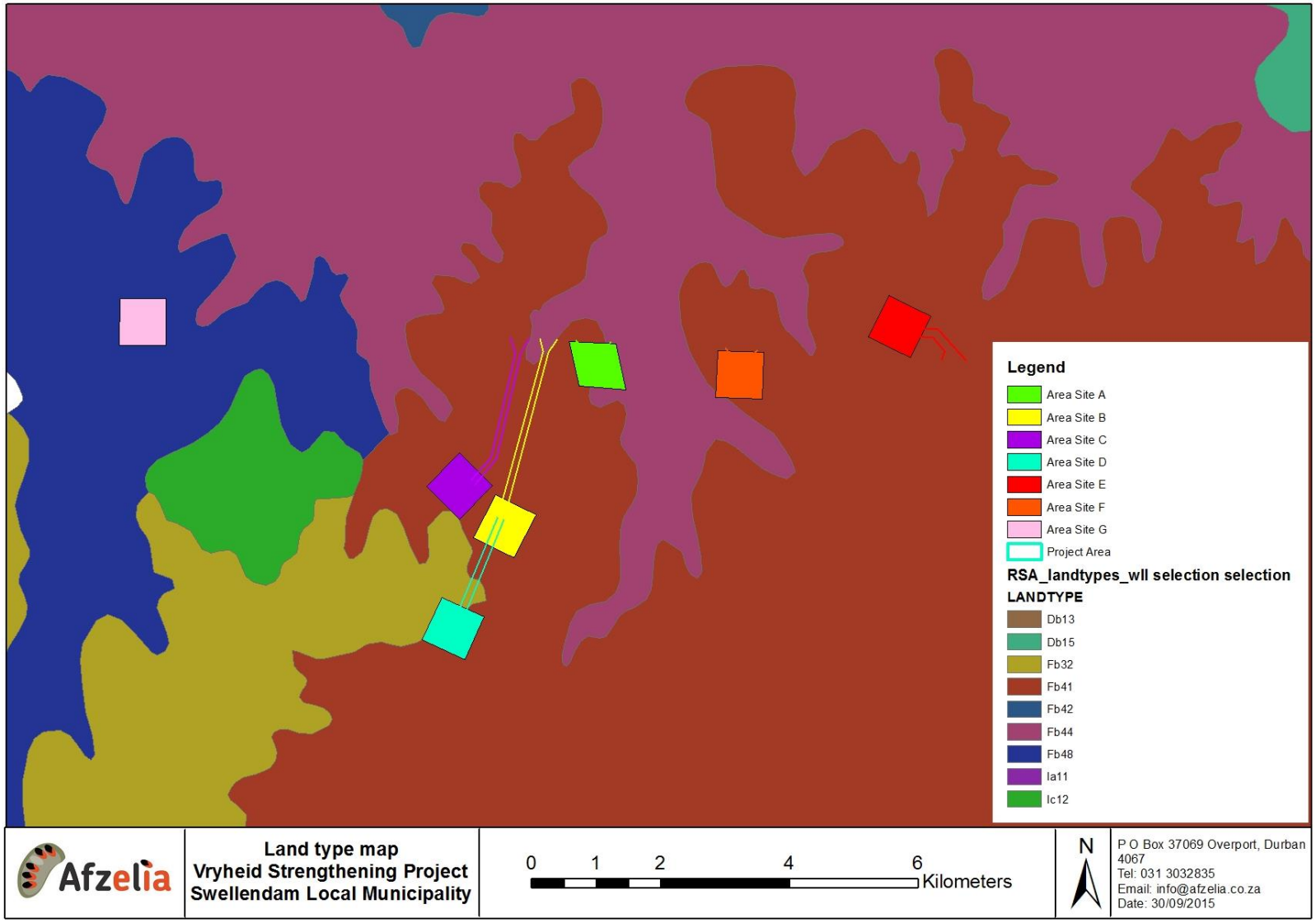


Figure 5: Land type of the site

4. SOIL DESCRIPTIONS

Augur points were dug throughout the project site in order to determine the extent of soil types (**Figure 2**) located within the target sites. The Mispah and/or Clovelly Soil Forms were identified at all sample points throughout the sites (**Photograph 1**).

Photograph 1: Soil forms identified: (A) Mispah (B) Clovelly

The soils are generally shallow with underlying shale bedrock, usually no deeper than 300mm, but in many areas even shallower. Field inspection revealed that the soil surface has little or no organic mulch layer over the surface as a result of tillage and the mixing of horizons. Soil properties are described in more detail below:

Mispah Soil Form

The Mispah soils are very shallow (0,2m) The Mispah Form is characterised by an Orthic A topsoil over hard rock/saprolite horizon. Textures ranged from loamy sand to sandy loam texture (2 - 15% clay in the A).

Clovelly Soil Form

Clovelly soil samples were also very shallow (200-350mm). The Clovelly Form is an Orthic A horizon over a yellow brown apedal sub horizon. Textures ranged from sandy loam to loam (15-20% clay in both horizons).

No significant variation in soil characteristics were observed throughout all target sites. The main characteristics noted were a lack of depth at all sites as well as a high percentage of rocks within the soil profile. A Yellow-Brown apedal B horizon was identified at a number of sampling points. This B horizon was however noted to be shallow. No hydric characteristics were identified at any of the samples taken and all soils have been classified as terrestrial in nature.

5. AGRICULTURAL POTENTIAL AND LAND CAPABILITY

Land evaluation is the process of estimating the production potential for alternative land uses. The purpose of land evaluation is to predict the possible effects, both detrimental and beneficial for a change in land use.
The physical data acquired from soil profiles is applied to a flow sheet adapted to South African conditions from the US Department of Agriculture standards and utilized by land usage authorities as the basic template for benchmarking soil quality throughout South Africa.

Land capability evaluation is an attempt to grade the potential of the land in terms of its best and worst uses in an arable situation. The land is classified according to its limitations, either in a permanent or temporary basis. The system is biased towards soil conservation and is based on the negative features of the land. The classification system is categorised on a scale of I to VIII so yield potential matrices can be easily formulated. Land Capability Classes (LCC) I soils to LCC III soils are suitable for arable crops. LCC IV soils can sometimes be cultivated for annual crops, but under carefully controlled conditions. LCC V soils are usually wetlands while LCC VII and VIII soils are suited to domestic livestock and wild game only. Table 2 reflects the LCC of each Class. The flowsheets used to determine Land Capability Class are shown in Appendix 2.

Table 2: Land capability classification descriptions

Class	Description
I	Land in Class I has few limitations that restrict its use; it may be used safely and profitably for cultivated crops; the soils are nearly level and deep; and generally well drained; they are easily worked and are fairly well supplied with plant nutrients or are highly responsive to inputs of fertilizer; when used for crops, the soils need ordinary management practices to maintain productivity; the climate is favourable for growing many of the common field crops.
II	Land in Class II has some limitations that reduce the choice of plants or require moderate conservation practices; it may be used for cultivated crops, but with less latitude in the choice of crops or management practices than Class I; the limitations are few and the practices are easy to apply.
III	Land in Class III has severe limitations that reduce the choice of plants or require special conservation practices, or both; it may be used for cultivated crops, but has more restrictions than Class II; when used for cultivated crops, the conservation practices are usually more difficult to apply and to maintain; the number of practical alternatives for average farmers is less than that for soils in Class II.
IV	Land in Class IV has very severe limitations that restrict the choice of plants, require very careful management, or both; it may be used for cultivated crops, but more careful management is required than for Class III and conservation practices are usually more difficult to apply and maintain; restrictions to land use are greater than those in Class III and the choice of plants is more limited.
V	Land in Class V has little or no erosion hazard as it is nearly level but has other limitations

	which are impractical to remove. These limitations limit its use largely to pasture, range, woodland or wildlife food and cover and restrict the kind of plants that can be grown; prevent normal tillage of cultivated crops;; some occurrences are wet or frequently flooded; others are stony, have climatic limitations, or have some combination of these limitations.
VI	Land in Class VI has severe limitations that make it unsuited to cultivation and restrict its use largely to grazing, woodland or wildlife food and cover; continuing limitations that cannot be corrected include steep slope, severe erosion hazard, effects of past erosion, stoniness, shallow rooting zone, excessive wetness or flooding, low water-holding capacity, salinity or sodicity and severe climate.
VII	Land in Class VII has very severe limitations that make it unsuited to cultivation and that restrict its use largely to grazing, woodland or wildlife; restrictions are more severe than those for Class VI because of one or more continuing limitations that cannot be corrected, such as very steep slopes, erosion, shallow soils, stones, wet soil, salts or sodicity and unfavourable climate.
VIII	Land in Class VIII has limitations that preclude its use for commercial plant production and restrict its use to recreation, wildlife, water supply or aesthetic purposes; limitations that cannot be corrected may result from the effects of one or more of the following: erosion hazard, severe climate, wet soil, stones, low water-holding capacity, salinity or sodicity.

The most important soil and landscape characteristics when applying this system are topsoil texture (Clay %), soil depth, slope, wetness, permeability and rockiness. At the samples taken these were found to occur according to Table 3. The reference in Table 3 refers to the sampling point and is shown in Figure 6.

Table 3: Descriptions of soils identified on site

Reference	Soil Form	Soil Family and code	Soil Colour	Texture	Depth (mm)	Slope	Wetness	Permeability	Rockiness	LCC
1	Mispah	Myhill (1100)	7.5YR 3/4	Sandy loam	300	3%	W0	1-3	R3	IV
2	Mispah	Myhill (1100)	7.5YR 3/4	Sandy loam	350	3%	W0	1-3	R3	IV
3	Mispah	Myhill (1100)	7.5YR 3/4	Sandy loam	300	3%	W0	1-3	R3	IV
4	Mispah	Myhill (1100)	7.5YR 5/6	Loamy sand	<200	4%	W0	1-3	R4	IV
5	Mispah	Myhill (1100)	7.5YR 5/6	Loamy sand	<200	4%	W0	1-3	R4	IV
6	Mispah	Myhill (1100)	7.5YR 5/6	Loamy sand	<200	4%	W0	1-3	R4	IV
7	Clovelly	Leiden (2200)	A7.5YR 3/4 B7.5YR 4/4	Loamy sand	200	5%	W0	1-3	R3	IV
8	Clovelly	Leiden (2200)	A:7.5YR 3/4 B:7.5YR 4/4	Loamy sand	250	5%	W0	1-3	R3	IV
9	Clovelly	Leiden (2200)	A:7.5YR 3/4 B:7.5YR 4/4	Loamy sand	250	5%	W0	1-3	R3	IV
10	Mispah	Myhill	7.5YR 4/4	Sandy	<200	6%	W0	1-3	R4	IV

Reference	Soil Form	Soil Family and code	Soil Colour	Texture	Depth (mm)	Slope	Wetness	Permeability	Rockiness	LCC
		(1100)		loam						
11	Mispah	Myhill (1100)	7.5YR 4/4	Sandy loam	300	6%	W0	1-3	R4	IV
12	Mispah	Myhill (1100)	7.5YR 4/4	Sandy loam	<200	6%	W0	1-3	R4	IV
13	Mispah	Myhill (1100)	7.5YR 4/4	Sandy loam	<200	6%	W0	1-3	R4	IV
14	Mispah	Myhill (1100)	7.5YR 4/4	Loamy sand	250	6%	W0	1-3	R3	IV
15	Clovelly	Leiden (2200)	A: 7.5YR 3/4 B: 7.5YR 4/4	Loamy sand	300	5%	W0	1-3	R3	IV
16	Clovelly	Leiden (2200)	A: 7.5YR 3/4 B: 7.5YR 4/4	Loamy sand	300	5%	W0	1-3	R3	IV
17	Mispah	Myhill (1100)	7.5YR 3/3	Loam	350	2%	W0	4-8	R3	IV
18	Mispah	Myhill (1100)	7.5YR 3/3	Loam	300	2%	W0	4-8	R3	IV
19	Mispah	Myhill (1100)	7.5YR 3/3	Loam	350	2%	W0	4-8	R3	IV
20	Mispah	Myhill (1100)	7.5YR 3/3	Loam	<200	2%	W0	4-8	R3	IV
21	Clovelly	Leiden (2200)	A: 7.5YR 3/4 B: 7.5YR 4/4	Loamy sand	350	3%	W0	1-3	R3	IV
22	Clovelly	Leiden (2200)	A:7.5YR 3/4 B:7.5YR 4/4	Loamy sand	300	3%	W0	1-3	R3	IV
23	Clovelly	Leiden (2200)	A:7.5YR 3/4 B:7.5YR 4/4	Loamy sand	300	4%	W0	1-3	R4	IV
24	Clovelly	Leiden (2200)	A:7.5YR 3/4 B:7.5YR 4/4	Loamy sand	350	4%	W0	1-3	R4	IV
25	Clovelly	Leiden (2200)	A:7.5YR 3/4 B:7.5YR 4/4	Sandy loam	300	6%	W0	1-3	R3	IV
26	Clovelly	Leiden (2200)	A:7.5YR 3/4 B:7.5YR 4/4	Sandy loam	300	6%	W0	1-3	R3	IV

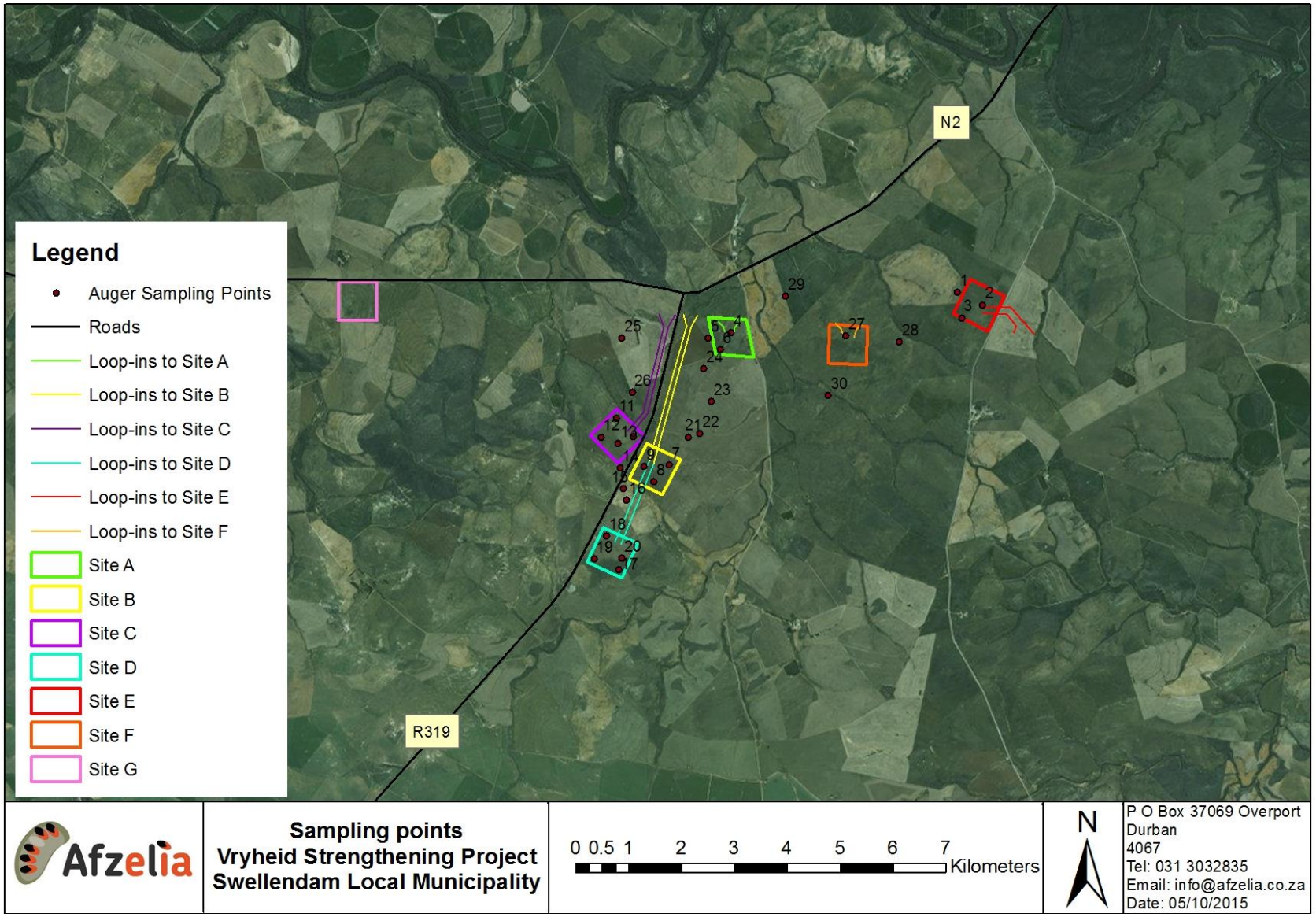


Figure 6: Sampling points within the target areas

- **Surface texture:** All sites have a low clay percentage (less than 10%) and can be classified as loamy sand, sandy loam or loam. These textures are not a limitation to crop production.
- **Soil depth:** A large percentage of rocks were noted on all target sites. These caused a limitation in the auger sampling depth. Soil depth were therefore recorded as between <200mm-350mm. Because rocks in the profile are not a solid layer, but are rather mixed with soil, root growth will permeate between these rock layers, making the effective rooting depth for certain plants deeper.
- **Subsoil permeability:** Soils classified as Clovelly have a 'Rapid' to 'Good' subsoil permeability which is not a limitation to crop growth. Subsoils are not associated with the Mispah Soil Form.
- **Slope:** There is a wide range in slopes, which for the land capability classification, have been grouped as follows:
    - 0-8% - land, which depending on soil profile characteristics is potentially in Class II
    - 8-12% - land, which depending on soil profile characteristics is potentially in Class III
    - 12-20% - land, which depending on soil profile characteristics is potentially in Class IV
    - >20% - land, which is in Class VI or even VII, on slopes greater than 40%.

  All sites consisted of terrain within the 0-8% category
- **Rockiness:** Rockiness is a major limitation to crop growth and limits the type of plant that can be cultivated at all sites
- **Crusting:** In the field this was found to not be a limitation to cultivation. There is no need to consider this factor further.
- **Wetness:** In the field this was found to not be a limitation to cultivation. There is no need to consider this factor further.

Taking into account the above information as well as the limitations to cultivation as a result of soil depth, and rockiness, all target sites have been classified as Class IV. This Class has severe limitations to the choice of crop cultivated at the site as well as the need for careful management of these crops.

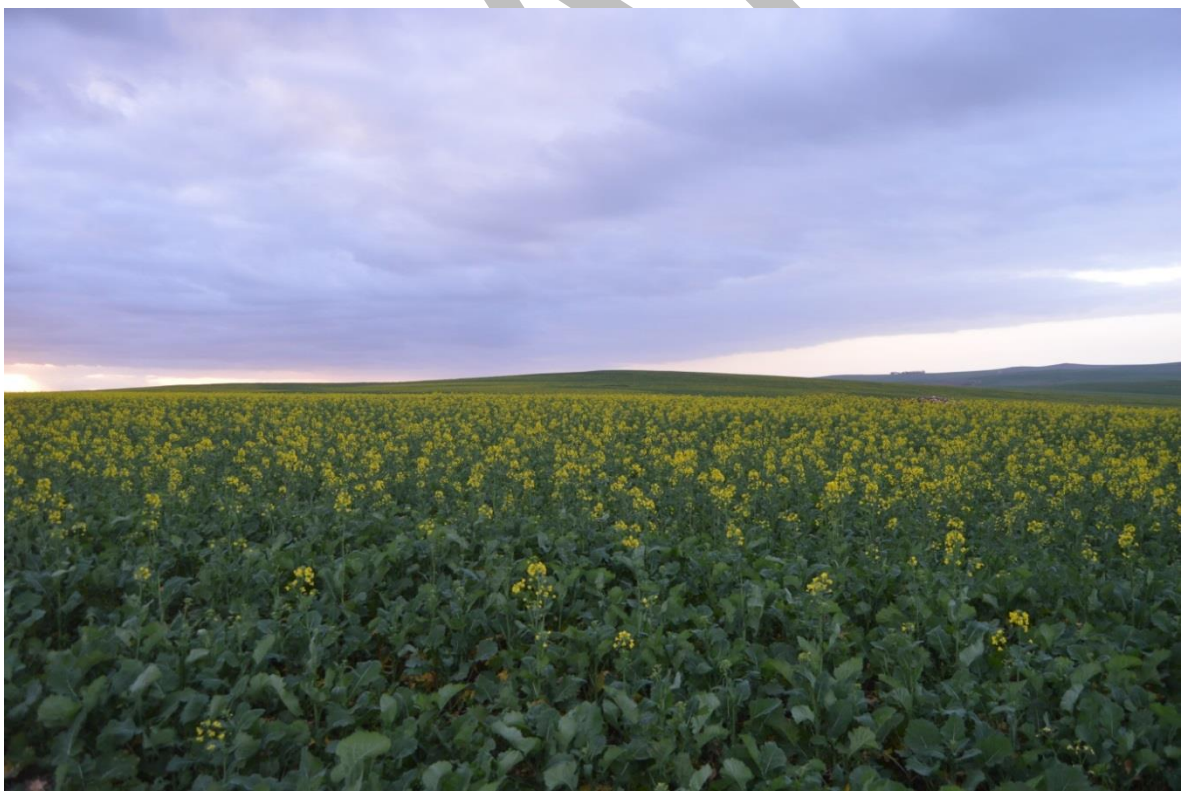
The dominant crop grown around the Swellendam area is Canola (*Brassica napus* L.) and is used in the production of Canola Oil in the SOILL factory based in Swellendam itself. Site 'B', Site 'E' and Site 'F' were found to be actively used for the cultivation of Canola. This plant has a taproot system with lateral secondary roots (**Photograph 2**). This root system is well suited to the type of soil found at these sites (i.e. rocky and shallow) as the growth of the tap root will not be significantly affected by loose rocks in the profile. In addition, the shallow lateral roots do not require a substantial soil depth. 85% of the root dry matter is within the top 250mm of the soil (DAFF, 2010).

Photograph 2: Canola plant showing the shallow root mass

Site 'D' has been cultivated most likely for cereal/grain crops. At sites 'A', 'C' the soil quality is poor (very shallow and rocky soils; i.e. majority of soils were classified as Mispah). This is probably the reason why these areas are used extensively for livestock grazing. The Agis Agric figure of 8 to 10 ha per one Large Stock Unit (LSU) for the veld carrying capacity for these sites is a moderate to good carrying capacity although supplementary feeding would be required during drier months. Photographs of the target sites are shown below.

Soil samples were not taken at site G, as this site was added to the scope of the assessment after the site investigation has been completed. Aerial imagery of the site shows that it used for the cultivation of either Canola or a cereal/grain. Given the land type, slope and proximity to the other sites it is likely that Site G will have similar shallow soil content within a low clay percentage.

Photograph 3: Site 'A', note the grazing lands, and high percentage of rocks on the surface



Photograph 4: Site 'B', used extensively for Canola cultivation

Photograph 5: Site 'C', used for grazing. Note the high percentage of rocks on the soil surface

Photograph 6: Site 'D' used for cultivation of a cereal/grain crop

Photograph 7: Site 'E' used for Canola cultivation

6. RECOMMENDATIONS AND CONCLUSIONS

Site A and C were found to have the lowest agricultural potential as a result of the shallow soils and high percentage of rocks within the profile. This is probably why these sites are used for livestock grazing and not the cultivation of crops. Sites 'B', 'E' and 'F' are actively used for the cultivation of Canola crops and Site D is used for the cultivation of a cereal/grain crop. A field assessment of Site G was not undertaken as this site has been added to the project as a result of a public participation process by landowners after the initial field investigation. Aerial imagery of the site indicates that it is used for cultivation; this is most likely cultivation of the Canola crop or of a cereal/grain. Given the land type of the site, the gentle slope and the proximity to the other sites the soil is most likely shallow in nature with a high percentage of rocks and a low percentage of clay. The construction of the substation will not have a significant impact on the agricultural activities at any of the target sites however the impact will be slighter higher at Sites 'B', 'D', 'E', 'F' and 'G' as crops are actively cultivated at these sites. It is therefore recommended that either Site 'A' or Site 'C' is used in favour of the other sites for the construction of the substation.

Any development activity in a natural system will have an impact on the surrounding environment, usually in a negative way. The overall impacts of the proposed substation on the soil and agricultural capability of any of the target sites and their immediate surrounds will be low due to the shallow soils present, the relatively small size of the substation (600mx600m) and the continued use of the land adjacent to the substation for agricultural activities.

There are potential impacts associated with the construction of the substation and these are predominantly associated with soil disturbance and compaction. The use of heavy machinery or vehicles will lead to the

compaction of the disturbed soil, making rehabilitation of these areas unlikely to be successful. Sedimentation of surrounding drainage lines could occur if construction activities lead to the dumping of soil into these sensitive areas or soil is deposited downslope in surface runoff. Potential mismanagement of waste and pollution including hydrocarbons, construction waste and hazardous chemicals will result in the pollution of the soil through surface runoff during rainfall events, or subsurface water movement.

The impacts of the construction phase of the substation on the surrounding environment therefore must be controlled through the use of an Environmental Management Programme that will address these impacts as well as provide mitigation to lower their significance. Mitigation measures include but are not limited to the strict use of internal roads for heavy machinery; the control/limitation of vegetation clearing and exposure of soil; and the management of construction waste.

7. REFERENCES

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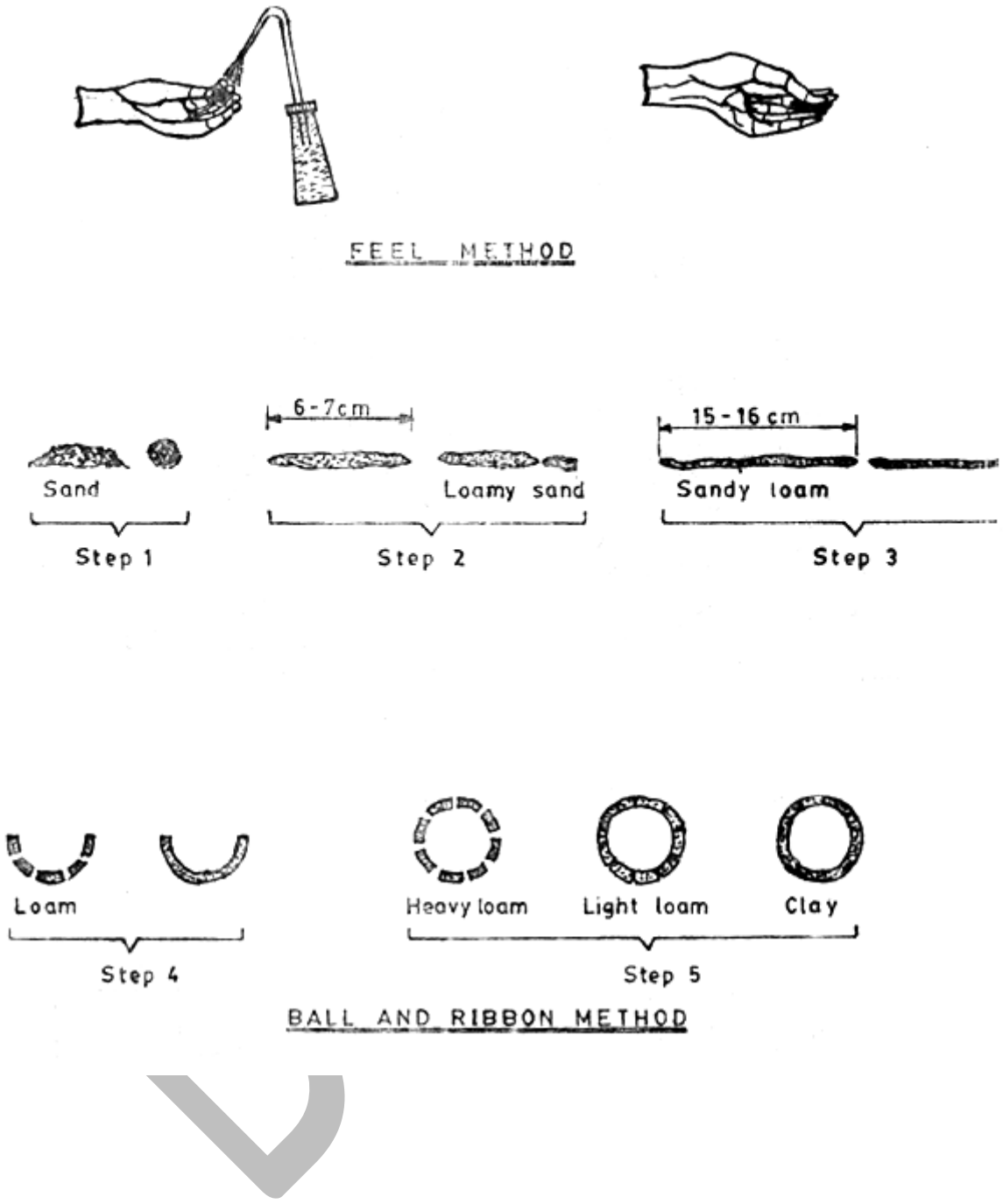
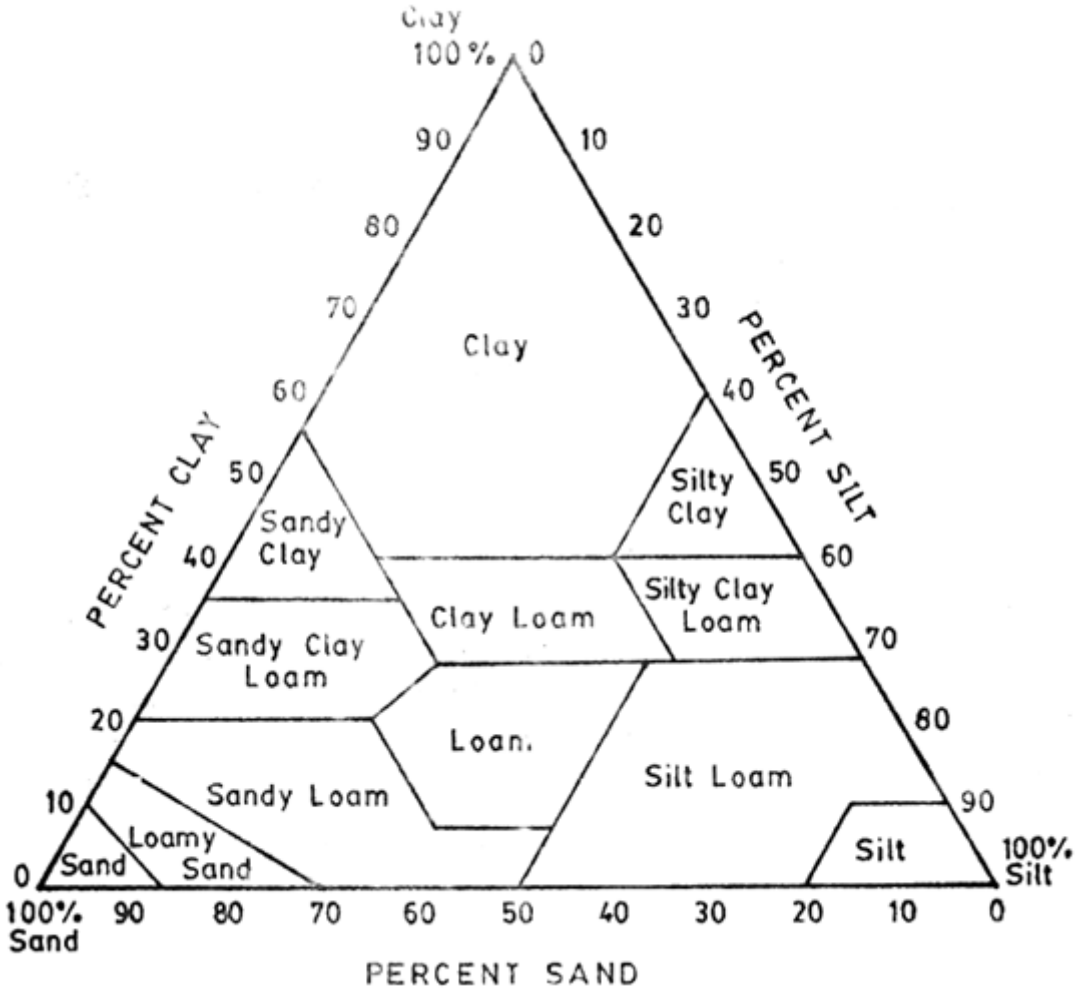
Appendix 1: In field test to determine texture



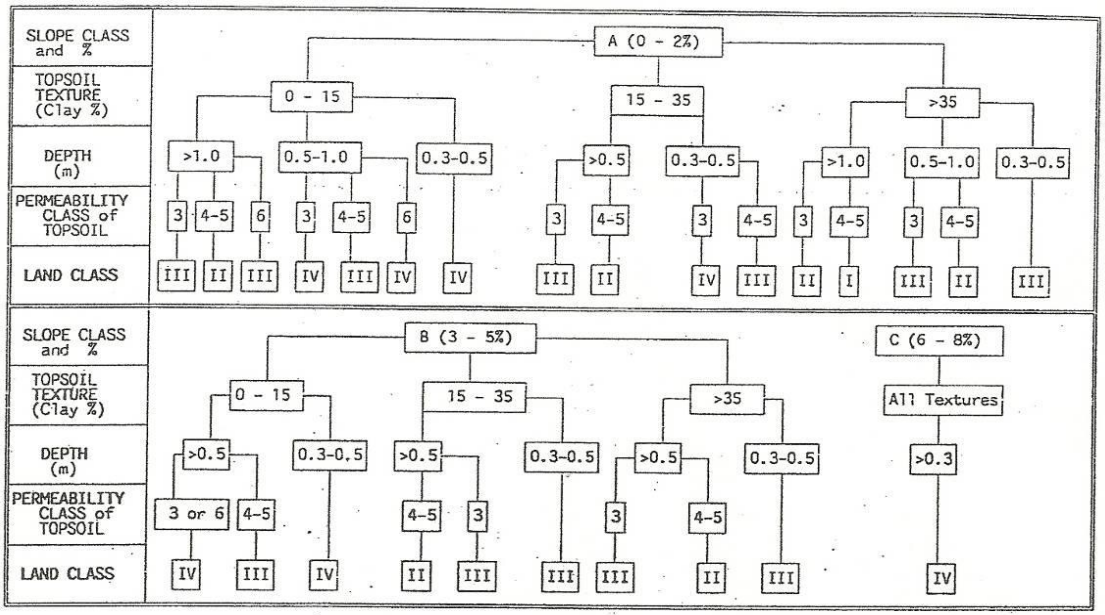
Texture triangle used to calculate clay percentage



Appendix 2 – LCC flow sheet

CAPABILITY CLASS DETERMINATION GUIDELINE for BRGs:
Dry Zululand Thornveld (20), Valley Bushveld (21), Lowveld (22), Sandy Bushveld (23) (Average annual rainfall 587-830 mm)

Use the following flow chart to determine the land capability classes for land to be cropped in the above Bioresource Groups.



PERMEABILITY CLASS DESCRIPTION*			
Class	Rate (seconds)	Description	Texture
7	<1	Extremely rapid	Gravel and Coarse Sand. 0 to 10 % clay.
6	1-3	Rapid	5% to 10% clay.
5	4-8	Good	> 10% clay.
4	9-20	Slightly restricted	
3	21-40	Restricted	Strong structure, grey colours, mottles. > 35% clay.
2	41-60	Severely restricted	Strong structure, weathered rock. > 35% clay.
1	>60	Impermeable	Rock and very strong structure. > 35% clay.

* If roots can penetrate the subsoil, test permeability of upper subsoil.
If roots cannot penetrate the subsoil, test the permeability of the mid-topsoil.
Dark structured clay topsoil (vertic & melanic) with a Class 2 permeability should be assessed in the chart as if it has a Class 3 permeability. If permeability is Class 7, downgrade to Land Class IV.

Now refer to the opposite page to make adjustments for wetness, rockiness, crusting or permeability.

USE THE FOLLOWING LAND CHARACTERISTICS TO MODIFY THE LAND CLASS OBTAINED OPPOSITE, IF NECESSARY: The land capability class determined using the "flow chart" cannot be upgraded through consideration of wetness, rockiness, surface crusting or permeability classes given below, but it may be downgraded as indicated.

WETNESS		
Class	Definition	Land Class
W0	Well drained - no grey colour with mottling within 1.5 m of the surface. Grey colour without mottling is acceptable.	No change
W1	There is no evidence of wetness within the top 0.5 m. Occasionally wet - grey colours and mottling begin between 0.5 m and 1.5 m from the surface.	Downgrade Class I to Class II, otherwise no change
W2	Temporarily wet during the wet season. No mottling in the top 0.2 m but grey colours and mottling occur between 0.2 m and 0.5 m from the surface. Included are: soils with G horizons (highly gleyed and often clayey) at depths deeper than 0.5 m; soils with an E horizon overlying a B horizon with a strong structure; soils with an E horizon over G horizons where the depth to the G horizon is more than 0.5 m.	Downgrade to Class IV
W3	Periodically wet. Mottling occurs in the top 0.2 m, and includes soils with a heavily gleyed or G horizon at a depth of less than 0.5 m. Found in bottomlands.	Downgrade to Class Va
W4	Semi-permanently / permanently wet at or above soil surface throughout the wet season. Usually an organic topsoil or an undrained vlei. Found in bottomlands.	Downgrade to Class Vb

PERMEABILITY	
Permeability Class	Adjustment to be made
1 - 2	If in sub-soil, rooting is likely to be limited: Use the permeability of the topsoil in the flow chart. If this is the permeability of the topsoil, then the topsoil is probably a dark structured clay, in which case a permeability Class 3 can be used in the flow chart.
3 - 5	Classify as indicated in the flow chart.
6	Topsoil should have < 15% clay - use the flow chart.
7	Downgrade Land Classes I to III to Land Class IV.

ROCKINESS		
Class	Definition	Land Class
R0	No rockiness	No change
R1	2 - 10% rockiness	Downgrade Classes I to II, otherwise no change
R2	10 - 20% rockiness	Downgrade Classes I to II, otherwise no change
R3	20 - 30% rockiness	Downgrade to Class IV
R4	> 30% rockiness	Downgrade Classes I, II, III & IV to Class VI

SOIL SURFACE CRUSTING		
Class	Definition	Land Class
t0	No surface crusting when dry	No change
t1	Slight surface crusting when dry	Downgrade Class I to Class II, otherwise no change
t2	Unfavourable surface crusting when dry	Downgrade Classes I & II to Class III, otherwise no change

NB **Any land not meeting the minimum requirements shown is considered non-arable (Class V, VI, VII or VIII).**
Non-arable land in BRGs 2, 4, 6, 9, 12, 14, 15, 16, 17, 18 & 19 includes:

* all land with W3, W4 or R4,
* all land with slope exceeding 20%,
* land with slope 13-20%, if clay < 15% or depth < 0.4m,
* land with slope 8-12% and clay > 15%, if depth < 0.25m,
* land with slope 8-12% and clay < 15%, if depth < 0.5m, and
* land with slope 0-7%, if depth < 0.25m.

20 March 1996

Appendix 3 – Fb41 and FB48 Land Type Information Sheet

LAND TYPE / *LANDTIP* : **Fb41**
CLIMATE ZONE *KLIMAATSONE* : 824W
Area / *Oppervlakte* : 14309 ha
Estimated area unavailable for agriculture
Beraamde oppervlakte onbeskikbaar vir landbou : 200 ha

Occurrence (maps) and areas *Voorkoms (kaarte) en oppervlakte* :
3420 Riversdale (14309 ha)

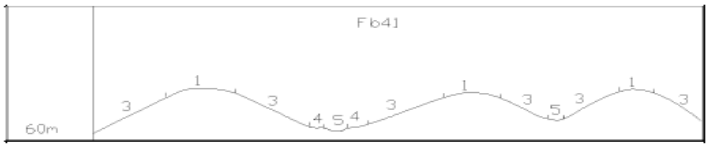
Inventory by *Inventaris deur* :
F Ellis, BHA Schloms & B Stehr

Modal Profiles *Modale profiele* :
None / Geen

Terrain uni *Terreineenheid*	1	3	4	5
% of land type *% van landtipe*	18	66	7	9
Area *Oppervlakte (ha)*	2576	9444	1002	1288
Slope / *Helling (%)*	0 - 3	6 - 15	2 - 6	0 - 3
Slope length *Hellingslengte (m)*	200 - 300	400 - 1000	200 - 300	50 - 100
Slope shape *Hellingsvorm*	Y	Y	X-Z	X
MB0, MB1 (ha)	1159	7555	952	1288
MB2 - MB4 (ha)	1417	1889	50	0

Soil series or land classes *Grondseries of landklasse*	**Depth** *Diepte* (mm)	MB	1 ha	1 %	3 ha	3 %	4 ha	4 %	5 ha	5 %	**Total** *Totaal* ha	Total %	**Clay content %** *Klei-inhoud %* A	E	B21	Hor	**Texture** *Tekstuur* Class / *Klas*	**Depth limiting material** *Diepte-beperkende materiaal*
Soil-rock complex																		
Grond-rotskompleks:																		
Rock/Rots		4	258	10	472	5	20	2			750	5.2						
Mispah Ms10	150-300	3	1159	45	1417	15	30	3			2606	18.2	2-6			A	fiSa	R
Kanonkop Gs13	200-400	0	902	35	5666	60	351	35			6918	48.4	6-15		10-25	A	fiSa-SaLm	so,R
Swartland Sw31, Hogsback Sw32	150-250	0	129	5	944	10	451	45	64	5	1588	11.1	10-20		40-55+	B	Cl	vp
Skilderkrans Sw11,																		
Breidbach Sw12	250-450	0	129	5	944	10	150	15			1223	8.6	10-20		35-55+	B	ClLm-Cl	vr
Dundee Du10	.000-1200+	0							580	45	580	4.1	2-6			A	fi/meSa	U,R,sa
Vaalrivier Oa33, Jozini Oa36	.000-1200+	0							451	35	451	3.2	10-15		10-25	B	fiSaLm-SaClLm	U,R,sa
Other/Ander	300-500	0							193	15	193	1.4	10-18		15-25	B	fiSaLm-SaClLm	

Terrain type *Terreintipe* : B3
Terrain form sketch *Terreinvormskets*



For an explanation of this table consult LAND TYPE INVENTORY (table of contents)
Ter verduideliking van hierdie tabel kyk LANDTIPE - INVENTARIS (inhoudsopgawe)

Geology: Shale and subordinate sandstone of the Bokkeveld Group.

Geologie Skalie en ondergeskikte sandsteen van die Bokkeveld Groep.

1

LAND TYPE / *LANDTIP* ..... : **Fb48**
CLIMATE ZONE *KLIMAATSONE* ..... : 823W
Area / *Oppervlakte* ..... : 10117 ha
Estimated area unavailable for agriculture
Beraamde oppervlakte onbeskikbaar vir landbou : 150 ha

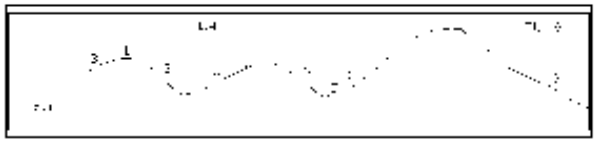
Occurrence (maps) and areas *Voorkoms (kaarte) en oppervlakte* :
3420 Riversdale (10117 ha)

Inventory by *Inventaris deur* :
BHA Schloms & B Stahr
Modal Profiles *Modale profiele* :
None / Geen

Terrain unit *Terreineenheid*	1	3	4	5
% of land type *% van landtipe*	15	70	5	10
Area *Oppervlakte (ha)*	1518	7082	506	1012
Slope / *Helling (%)*	0 - 3	8 - 15	2 - 4	0 - 3
Slope length *Hellingslengte (m)*	200 - 300	600 - 1500	100 - 200	200 - 300
Slope shape *Hellingsvorm*	Y	Y	Z-X	X
MB0, MB1 (ha)	182	2125	304	1012
MB2 - MB4 (ha)	1335	4957	202	0

Soil series or land classes *Grondseries of landklasse*	**Depth** *Diepte* (mm)	MB	1 ha	1 %	3 ha	3 %	4 ha	4 %	5 ha	5 %	**Total** *Totaal* ha	Total %	**Clay content %** *Klei-inhoud %* A	E	B21	Hor	**Texture** *Tekstuur* Class / *Klas*	**Depth limiting material** *Diepte-beperkende materiaal*
Soil-rock complex		:																
Grond-rotskompleks:		:																
Rock/Rots		4 :	243	16	708	10	10	2			961	9.5						
Mispah Ms10	100-250	3 :	713	47	1062	15	15	3			1791	17.7	2-6			A	fiSa	R
Kanonkop Gs13, Williamson Gs16	200-400	3 :	380	25	3187	45	177	35			3743	37.0	10-20		15-25	A	LmfiSa-SaLm	so,R
Skilderkrans Sw11,		:																
Broidbach Sw12	150-500	0 :	106	7	1062	15	152	30			1320	13.1	10-20		35-55+	B	ClLm-Cl	vr
Swartland Sw31, Hogsback Sw32	150-250	0 :	76	5	1062	15	126	25	51	5	1315	13.0	10-20		40-55+	B	Cl	vp
Vaalrivier Oa33, Jozini Oa36	000-1200+	0 :							506	50	506	5.0	6-10		10-20	B	LmfiSa-SaLm	U,R,sa
Dundee Du10	000-1200+	0 :							202	20	202	2.0	2-6			A	fi/moSa	U,R,sa
Other/Ander	200-800	0 :					25	5	253	25	278	2.8	5-15			A	fi/moSa-SaLm	

Terrain type *Terreintipe* : C3
Terrain form sketch *Terreinvormskets*



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