

SOIL SURVEY REPORT ON THE HILL SITE DEVELOPMENT, SEDGEFIELD

By:

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1 TERMS OF REFERENCE

The soil survey of The Hill, Sedgefield (approximately 80ha), was instructed by Mr. P Badenhorst on behalf of his client during October 2008.

The terms of reference regarding the form of the survey and report were as follow:

- A detail soil survey of the farm to determine the inherent properties, mainly physical and morphological, of the soils.
- Compilation of a soil map at scale large enough (1 : 2 500) to describe the natural distribution of the soils.
- Description of the soils in the different map units in terms of their physical and morphological properties.
- Evaluation of the general suitability of the soils in terms of agricultural potential for annual and perennial crops.

2 ALLOCATION OF RESPONSIBILITIES

The following individuals and organizations were responsible for the different actions:

- VPM Planning (Knysna) for the arrangements concerning siting of the soil profiles in the field on a grid of approximately 100 m x 150 m and arrangements for the excavation of the soil pits.
- VPM Planning will arrange for the compilation of a base map with a photo background of the study area involved on a scale of 1 : 2 500 with profile pit positions.
- The surveyor for describing and classifying the soil profiles.

- The surveyor will be responsible for the compilation of the soil map and a report on the properties, limitations, and relative suitability of the soils for agricultural purposes, with specific reference to deep-rooted perennial crops.

3 DESCRIPTION AND CLASSIFICATION OF SOIL PROFILES

During the soil survey a total of 43 soil pits were made on The Hill study area. The final positioning of the profile pits were limited due to steep slopes and accessibility. The soils were investigated in the field and the important properties described following standard procedures.

Based on recognizable, as well as inferred properties, the soils were classified according to the South African soil classification system (**Soil Classification Working Group, 1991**) into soil forms and soil families. This system is based on the recognition of diagnostic soil horizons and materials.

Soil forms are defined in terms of the type and vertical sequence of diagnostic horizons or materials. For communication, soil forms are given locality names, e.g. Lamotte or Fernwood. These names are abbreviated to two-letter symbols, e.g. Lt or Fw for the Lamotte and Fernwood soil forms respectively. Soil forms are subdivided into soil families using properties that are not used in the definition of diagnostic horizons or materials. Reference to a soil family is by combining the soil form abbreviation and a four-digit symbol, e.g. Lt 1100 is family number 1100 of the Lamotte form. In **Annexure A: Table 1** all the soil forms and families recognized during the soil survey is listed alphanumerically according to the profile numbers.

Depending on the purpose of the soil survey, soil families can be subdivided on an *ad hoc* basis into soil phases using properties such as soil and horizon depths, stoniness etc. Phase subdivision is achieved by detail coding of individual soil profiles (refer to **Annexure B: Structure of Soil Code and Explanation of Symbols** for the symbols used during this survey). Codes of all the profiles described are listed alphanumerical according to the Map legend abbreviations in **Annexure A: Table 1**.

4 MAP LEGEND AND SOIL MAP

The aim of a soil map is to reflect the natural distribution of soil types and spatial variation in soil properties on any particular farm or area. Depending on the relationship between soil parent material, soil types and terrain, the spatial variation in soil properties and the influence of these variations on land use and soil suitability for specific agricultural activities, different approaches could be followed to develop a map legend according to which a soil map is compiled.

The approach that was followed for the Hill was to develop a map legend that will accommodate most of the variations in soil properties that might have an effect on soil suitability, soil amelioration measures and potential land use. In **Annexure A: Table 2** the map legend that was developed for the Hill is explained. The properties and features of the different map units are defined in terms of *inter alia*:

- soil form,
- diagnostic horizons,
- family criteria,
- additional features such as clay content of A horizon, horizon depths, nature and depth of deep subsoil, coarse fragments in A and/or E horizon; and
- effective depth.

Soil Classification Working Group, 1991. Soil Classification: A Taxonomic System for South Africa. Mem. Natural Agric. Resources for S.A. No. 15.

With reference to the accuracy of the soil map, the following aspects should be kept in mind:

- The most important factor that determines the accuracy of the soil map is the accuracy of the base map itself and in particular the positioning of the soil pit positions with reference to land features such as roads, fences, lands and streams.
- According to the terms of reference the profile pits were made on a grid of approximately 100 m x 150 m. This means that the minimum size of a map unit is approximately 1,5 ha. Map units smaller than 1,5 ha could therefore be included in larger soil units on the map.
- In situations where the boundaries between map units coincide with fairly prominent changes in slope, the soil boundaries are usually relatively accurate within the 100 m x 150 m spacing between soil pits. In cases where slope changes are gradual, the soil boundaries are only approximate divisions.

The final soil map units are shown on the base map. Map units are identified by means of a symbol that consists of the abbreviation for the soil form followed by an Arabic number (e.g. Lt 1). The number suffix has no intrinsic meaning. It only serves as an identifier for different map units that consist of soils belonging to the same soil form, but differ in one or more important soil properties.

The map units are listed alphanumerical in **Annexure A: Table 1**. All the profiles and codes in the different map units are listed according to the soil form symbol alphanumerical in **Annexure A: Table 2** (see **Figure 1: Soil map**).

Certain properties (e.g. horizon/soil depth, wetness, etc.) of the soils in map unit individuals are specified in **Annexure A: Table 2**. Additional properties can be abstracted from the:

- definition of the soil form in terms of diagnostic horizons and materials,
- properties of diagnostic horizons and materials,
- differentiating family criteria, and
- additional information specified in the soil code.

5 PHYSICAL SOIL LIMITATIONS

Due to their genetic composition the lateral and vertical root growth pattern may vary significantly between different types of plants. The minimum useable soil depth required for good root development and water and nutrient uptake to ensure healthy and productive plants can therefore differ greatly between different plant types. In addition, the tolerance of different plants to soil wetness and soil borne diseases may also vary greatly.

In the following paragraphs the most important soil properties that might affect infiltration, root development, and nutrient and water uptake will be discussed.

5.1 Low clay content in topsoils and E horizons

The potential of soils, especially those with a low organic carbon content (<1,0% organic carbon), to store water and plant nutrients for use by plants, is primarily determined by the clay content. At a clay content of approximately 8 - 10 %, the water retention is already so low that it can be considered as a limitation for most plants; the lower the clay content the greater the limitation. With less than 5 % clay as is the case at The Hill, water retention is likely to be a severe limitation.

5.2 Soil erosion

Due to the severe sandy ness of the soils in the study area, wind erosion may be a severe problem after clearing of vegetation during dry summer months and associated high wind velocities (south easterly winds). Protection for especially annual crops (eg. vegetables) with wind breaks and a permanently installed irrigation system to keep the top soil moist at all times will be necessary to prevent wind damage.

5.3 Water erosion

Water erosion on these older coastal dunes can be a serious problem due to the hydrophobic properties (due to organic material and resinous coating of sand grains by fungi) of these deposits. Examples of serious water erosion was encountered on similar dunes in the Brenton area near Knysna.

The evaluation of the suitability of soils for crop production can be approached in different ways.

The National Department of Agriculture is a report in which the criteria for high potential agricultural land in South Africa were defined (Schoeman, 2004). Terminology that were used include the following:

- **Effective soil depth** means the depth of soil material that plant roots can penetrate readily to obtain water and plant nutrients; the depth to a layer that differs sufficiently from the overlying material in physical or chemical properties to prevent or seriously retard the growth of roots.
- **High potential** means prime or unique.
- **Permanent irrigation** means the availability for, and regular artificial application of, water to the soil for the benefit of growing crops. Application may be seasonal.
- **Prime** means the best land available, primarily from the national perspective, but with allowance of provincial perspectives; land best suited to, and capable of, consistently producing acceptable yields of a wide range of crops (food, feed, forage, fibre and oilseed), with acceptable expenditure of energy and economic resources and minimal damage to the environment (and is available for these uses);
- **Topsoil clay content** means the average percentage clay-sized material (<0.002 mm) in the uppermost part of the soil; that is, the part ordinarily moved in tillage, or its equivalent in uncultivated soils, ranging in depth from about 100 to 300 mm; frequently designated as the plough layer or the Ap horizon;
- **Unique agricultural land** means land that is or can be used for producing specific high-value crops. It is usually not prime, but important to agriculture due to a specific combination of location, climate or soil properties that make it highly suited for a specific crop when managed with specific farming or conservation methods. Included is agricultural land of high local importance where it is useful and environmentally sound to encourage continued agricultural production, even if some or most of the land is of mediocre quality for agriculture and is not used for particularly high-value crops.

Schoeman (2004) defined a range of soil forms for the Western Cape that qualify for high potential agricultural land. A minimum effective depth of 300 mm and a topsoil clay content of >5 - <35 % were used as additional criteria for the identification of high potential agricultural land. In **Table 4** the map units are rated according to these guidelines.

Except for those map units that consists of soils forms that are not considered as high potential soils, all the other map units are considered as unique agricultural land, because of the specific combination of soil form - climate – terrain that renders the area moderate to highly suitable for the production of wine grapes.

In addition to the Schoeman (2004) evaluation of the agricultural potential, the suitability of the individual soil pits for the commercial production of deep-rooted perennial crops that are moderately sensitive to wetness was evaluated in the field by the soil surveyors. The suitability rating ranges from 1 to 10, with 1 the lowest and 10 equal to the highest or best suitability in terms of growth and general production. Due to the significant influence of soil and plant management practices as well as plant type and rootstock selection on product characteristics, the suitability rating has no implication in terms of for instance potential fruit quality.

In the rating process it is assumed that all the amelioration measures (e.g. deep soil tillage, drainage and/or ridging) required to improve or eliminate the limitations of a specific soil for perennial crop production are correctly applied before planting. It is further assumed that irrigation scheduling and fertilization management are of high a high standard, and a system of mulching is followed to prevent surface crusting and hard setting.

These ratings (Lambrechts *et al*) are listed in **Table 3**. ratings can be interpreted according to the guidelines in Table 3.

Table 3 Interpretation of suitability ratings and recommendation for annual and perennial crops

Rating	Suitability class	Recommendation
≤2	Very low	Not recommended
>2 - ≤3	Low	
>3 - ≤4	Medium low	Marginally recommended
>4 - ≤5	Medium	Conditionally recommended
>5 - ≤6	Medium high	Recommended
>6 - ≤7	High	Highly recommended

In **Table 4** the area of the different map units is listed as well as the recommendation for

perennial crops and general suitability for annual crops.

These ratings (Lambrechts *et al*) are also listed in **Annexure A: Table 1** for each profile. The average suitability rating for map units was calculated from the individual profile ratings.

Four qualitative suitability five classes were used, viz. **Not recommended, Marginally recommended, Conditionally recommended, Recommended and Highly recommended**, to rate the soil suitability of perennial crops

In **Table 4** the surface area (ha) per map unit. In addition the soil potential based the criteria for high potential soils in the Western Cape by Schoeman (2004) and average suitability for perennial crops (Lambrechts *et al*) are also listed for each map unit.

Table 4 Surface area, soil potential according to Schoeman (2004) and Lambrechts *et al* for perennial and annual crops per map unit

Map symbol	Area (ha)	Soil potential according to Schoeman (2004)	Suitability for perennial crops Lambrechts <i>et al</i>	Suitability for annual crops Lambrechts <i>et al</i>
Fw 1	14,1	Low	Medium	Medium
Fw2	7,6	Low	Medium	Medium
Gm1	0,7	Low	Medium	Medium High
Lt 1	2,5	Low	Medium	Medium
Oa1	59,9	Low	Medium High	Medium High
Vf1	8,2	Low	Medium	Med – Med High

From **Table 4** it is evident that the soil potential (Lambrechts) is predominantly medium for perennial crops and medium to medium high for annual crops. This rating is mainly due to the low topsoil clay content ($\leq 5\%$), which leads to low water holding capacity, low cation exchange capacity and wind erosion hazard during the summer months. The Schoeman rating of low potential is due to the low top soil clay content ($< 5\%$).

8	References
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Schoeman, JL, 2004. Criteria for high potential agricultural land. National Department of Agriculture, Pretoria. Report Number GW/A/2002/21

Soil Classification Working Group, 1991. Soil Classification: A Taxonomic System for South Africa. Mem. Natural Agric. Resources for S.A. No. 15.

**TABLE 1 SOIL CODES, MAP SYMBOLS AND POTENTIAL OF
PROFILES ON THE HILL SITE DEVELOPMENT,
SEDFIELD**

Profile No	Soil Code	Potential perennial crops	Potential annual crops	Map Symbol
1	36Oa2110 ne sa // me1 >Fw	4,5	5	Oa
2	2Fw1110 sa // me1	4 – 4,5	5	Fw
3	4Fw1110 gs // me1	4,5	5	Fw
4	37Oa2110 ne sa // me1	5,5 - 6	6	Oa
5	269Vf1120 ne sa/sk // me1	5	5,5	Vf
6	389Oa2110 ne ne/vp sa // me1 >Vf	5,5 - 6	6	Oa
7	36Oa2110 ne sa // me1	5	5,5	Oa
8	4Fw1110 sa // me1 >Vf	4 – 4,5	5	Fw
9	39Vf2120 ne sa // me1 >Fw	4,5	5	Vf
10	369Oa2110 ne sa ne/vp // me1	5	5,5	Oa
11	26Oa2110 ne/sa // me1	5	5,5	Oa
12	36Oa2110 ne sa // me1	4,5	5	Oa
13	37Oa2110 ne sa // me1	5	5,5	Oa
14	36Oa2110 ne sa // me1	4,5 - 5	5	Oa
15	25Oa2110 ne sa // me1 >Fw	4,5	5	Oa
16	4Fw1210 sa // me1	4 – 4,5	5	Fw
17	356Lt1100 pd sa // me1 >Fw	4,5	5	Lt
18	37Oa2110 ne sa/ca // me1	6,5	6	Oa
19	36Oa2110 ne sa // me1 >Fw	5 – 5,5	6	Oa
20	3678Oa2110 ne ne/vp sa // me1 >Vf	5	5,5	Oa
21	4Fw1110 sa // me1	4 – 4,5	5	Fw
22	368Vf2120 ne sa // me1	4,5 - 5	5	Vf
23	4Fw1110 sa // me1	4 – 4,5	5	Fw
24	36Oa2110 ne sa // me1 >Fw	5	5,5	Oa
25	360Oa2110 ne sa ne/vp+hk // me1	4,5 - 5	5	Oa
27	36Oa2110 ne sa // me1	5	5,5	Oa
28	368Vf2120 ne sa // me1	5	5,5	Vf
29	36Oa2110 ne sa // me1 >Fw	5	5,5	Oa
30	3Fw1110 sa // me1	4,5	5	Fw
31	36Oa2110 ne sa // me1	5	5,5	Oa
32	36Oa2110 ne sa // me1	5	5,5	Oa
33	36Oa2110 ne sa // me1	5	5,5	Oa
34	26Gm2110 ne nc/hk // me1	5	5,5	Gm
35	36Oa2110 ne sa // me1 >Fw	5	5,5	Oa
36	4Fw1110 sa // me1	4,5	5	Fw
37	36Oa2110 ne gs // me1 >Vf	5	5,5	Oa
38	3Fw1110 sa // me1	4,5	5	Fw
40	3Fw1120 sa // me1	4,5	5	Fw
41	68Vf2120 ne // me1 >Lt	5,5	6	Vf
42	36Oa2110 ne sa // me/fi1 >Fw	4,5 - 5	5,5	Oa
43	36Oa2110 ne sa // me/fi1 >Fw	4,5 - 5	5,5	Oa

44	36Oa2110 ne sa // me1	5	5,5	Oa
45	4Fw1120 sa // me1	4	4,5	Fw

**TABLE 2 SOIL CODES, MAP SYMBOLS AND POTENTIAL OF
PROFILES ON THE HILL SITE DEVELOPMENT
ARRANGED ACCORDING TO MAP SYMBOLS**

Profile No	Soil Code	Potential perennial crops	Potential annual crops	Map Symbol
2	2Fw1110 sa // me1	4 – 4,5	5	Fw1
3	4Fw1110 gs // me1	4,5	5	Fw1
8	4Fw1110 sa // me1 >Vf	4 – 4,5	5	Fw1
21	4Fw1110 sa // me1	4 – 4,5	5	Fw1
23	4Fw1110 sa // me1	4 – 4,5	5	Fw1
30	3Fw1110 sa // me1	4,5	5	Fw1
36	4Fw1110 sa // me1	4,5	5	Fw1
38	3Fw1110 sa // me1	4,5	5	Fw1
16	4Fw1210 sa // me1	4 – 4,5	5	Fw2
40	3Fw1120 sa // me1	4,5	5	Fw2
45	4Fw1120 sa // me1	4	4,5	Fw2
34	26Gm2110 ne nc/hk // me1	5	5,5	Gm1
17	356Lt1100 pd sa // me1 >Fw	4,5	5	Lt1
1	36Oa2110 ne sa // me1 >Fw	4,5	5	Oa1
4	37Oa2110 ne sa // me1	5,5 - 6	6	Oa1
6	389Oa2110 ne ne/vp sa // me1 >Vf	5,5 - 6	6	Oa1
7	36Oa2110 ne sa // me1	5	5,5	Oa1
10	369Oa2110 ne sa ne/vp // me1	5	5,5	Oa1
11	26Oa2110 ne/sa // me1	5	5,5	Oa1
12	36Oa2110 ne sa // me1	4,5	5	Oa1
13	37Oa2110 ne sa // me1	5	5,5	Oa1
14	36Oa2110 ne sa // me1	4,5 - 5	5	Oa1
15	25Oa2110 ne sa // me1 >Fw	4,5	5	Oa1
18	37Oa2110 ne sa/ca // me1	6,5	6	Oa1
19	36Oa2110 ne sa // me1 >Fw	5 – 5,5	6	Oa1
20	3678Oa2110 ne ne/vp sa // me1 >Vf	5	5,5	Oa1
24	36Oa2110 ne sa // me1 >Fw	5	5,5	Oa1
25	360Oa2110 ne sa ne/vp+hk // me1	4,5 - 5	5	Oa1
27	36Oa2110 ne sa // me1	5	5,5	Oa1
29	36Oa2110 ne sa // me1 >Fw	5	5,5	Oa1
31	36Oa2110 ne sa // me1	5	5,5	Oa1
32	36Oa2110 ne sa // me1	5	5,5	Oa1
33	36Oa2110 ne sa // me1	5	5,5	Oa1
35	36Oa2110 ne sa // me1 >Fw	5	5,5	Oa1
37	36Oa2110 ne gs // me1 >Vf	5	5,5	Oa1
42	36Oa2110 ne sa // me/fi1 >Fw	4,5 - 5	5,5	Oa1

43	36Oa2110 ne sa // me/fi1	>Fw	4,5 - 5	5,5	Oa1
44	36Oa2110 ne sa // me1		5	5,5	Oa1
5	269Vf1120 ne sa/sk // me1		5	5,5	Vf1
9	39Vf2120 ne sa // me1	>Fw	4,5	5	Vf1
22	368Vf2120 ne sa // me1		4,5 - 5	5	Vf1
28	368Vf2120 ne sa // me1		5	5,5	Vf1
41	68Vf2120 ne // me1	>Lt	5,5	6	Vf1

APPENDIX 1

STRUCTURE OF SOIL CODE AND EXPLANATION OF SYMBOLS

1 STRUCTURE OF SOIL CODE

The code consists of two series of letter-number symbols, separated by a horizontal line, arranged in the following order:

ABOVE THE LINE	
Depth of horizons and/or materials	
Soil form	
Soil family	
Subsoil limitations or properties	
BELOW THE LINE	
Coarse fragments in the topsoil horizon and outcrops	
Texture of the topsoil horizon	
Soil water conditions	
Changes in soil properties and conditions	

In uncultivated soils the term topsoil horizon refers to the natural A horizon, while for cultivated soils it refers to the upper 200 - 300 mm of the soil profile affected by tillage.

2 CLASSES AND SYMBOLS FOR PROPERTIES ABOVE THE LINE

2.1 Horizon and/or effective depths

The depths of all diagnostic as well as non-diagnostic horizons and/or materials are coded with a number symbol in front of the soil form symbol. Depth classes and symbols used are:

DEPTH CLASS (cm)			SYMBOL
0	-	15	1
15	-	25	2
25	-	35	3
35	-	45	4
45	-	55	5
55	-	75	6
75	-	95	7
95	-	115	8
115	-	135	9
135	-	155	0
>155			no symbol

Depth symbols for diagnostic horizons or materials specified in a particular soil form are arranged from shallow (topsoil transition) to deep (subsoil transition) before the form symbol (e.g. 3 5 Es 1100, where 3 refers to the A/E transition and 5 to the E/B transition). Depth symbols for subsoil limitations or properties (arranged from shallow to deep) appear between the depth symbols for diagnostic horizon transitions and the form symbol (e.g. 3 5 3 Es 1100; the second 3 indicates the depth of a subsoil limitation or property.)

2.2 Soil Form

The soil forms that were identified, as well as the abbreviations used in the code are explained in Chapter 3.2.2 of the Report.

2.3 Soil family

The soil family is coded by means of a four-digit symbol directly after the form symbol.

2.4 Subsoil limitations and properties

The depth of soil utilised by plant roots is determined by several soil materials and factors. For example, in the Estcourt soil form the maximum effective root depth is determined by the prismatic B. In the Avalon form the depth is restricted seasonally by a fluctuating free water table which leads to the development of the soft plinthic B horizon. In other forms, e.g. Mispah, weathering rock determines the effective depth. In those forms where the limiting horizon is part of the defined sequence of horizons which are diagnostic of the soil form, the symbol for the limiting material or horizon is not coded. If the limiting horizon or material is not included in the sequence of diagnostic horizons, the symbol for the horizon or material must be specified after the family number in the code symbol. The depth symbol for such horizons is written between the depth symbol for diagnostic horizons and the soil form symbol (see 2 above).

The more important materials that may affect root penetration and water infiltration to a greater or lesser extent are one or more of the following:

- **Non-diagnostic hardpans; irreversibly cemented**

This is soil material cemented by one or more compounds to such an extent that it does not soften in water.

- ba - Bauxite pan: cemented by aluminium hydroxides, e.g. gibbsite.
- db - Dorbank: cemented by silica. Calcium carbonate and iron oxide are permissible as secondary cementing agents.
- hk - Calcrete: cemented by calcium and/or magnesium carbonate. It meets the requirements of a hardpan carbonate horizon.
- hp - Ferricrete: cemented by iron and/or manganese oxides/hydroxides. It meets the requirements of hard plinthite.
- or - Ortstein: cemented by organic matter, with or without iron and/or aluminium hydroxides. It meets the requirements of an ortstein indurated podzol B horizon.
- pp - Ironpan: a material which largely meets the requirements of a diagnostic placic pan.
- si - Silcrete: cemented by silica; no other cementing agent(s) is present.
- ms - Hardpans: cemented by compounds other than those mentioned above.

- **Non-diagnostic hardpans; reversibly cemented**

These are pans which appears cemented when dry, but which softens if left in water overnight.

- xp - Fragipan (Afr. brosbank): a subsurface material, usually mottled, low in organic material with a high bulk density. It appears cemented when dry. It is usually polygonal with bleached fracture planes. It is slowly permeable to water. When moist it shows a moderate to weak brittleness.

The degree of cementation is distinguished in terms of the intensity and continuity of cementation:

- 1 - Numerous vertical fracture planes, or vesicular; moderate degree of cementation; more

than 25% of the layer is accessible and penetrable to roots; sufficient fracture planes for free drainage through the pan under normal conditions.

- 2 - Platy and/or massive with occasional vertical fracture planes; moderate to high degree of cementation; predominantly impenetrable to roots; locally (<25% over a horizontal section) soft enough for root penetration; sporadic accumulation of free water on the pan.
- 3 - Massive and/or continuously platy with no fracture planes in which root development can occur; under normal conditions impermeable to water; regular accumulation of free water on the pan.

Example: A hardpan cemented primarily by iron with vertical cracks approximately 10 mm to 15 mm apart is coded by the symbol hp2.

- **Moderate to strongly structured, non-diagnostic unconsolidated materials without signs of wetness**

- pr - Prismatic clay: a non-gleyed material with a strong prismatic or columnar structure. It largely meets the requirements of a prismatic B horizon.
- ve - Coarse blocky clay with vertic properties; numerous slickensides and cracks when dry. It largely meets the requirements of a vertic A horizon.
- vp - Blocky clay: a non-gleyed soil material with a non-uniform colour and a moderate or stronger structure when moist. It largely meets the requirements of a pedocutanic B horizon

- **Weaker than moderately structured, non-diagnostic unconsolidated materials without signs of wetness**

- al - Alluvial material.
- nc - Calcareous unconsolidated material with signs of soil development, e.g. aggregation, clay illuviation and/or disappearance of original stratification. It largely meets the requirements of a neocarbonate B horizon. Red as well as non-red variants occur.
- ne - Non-calcareous unconsolidated material with signs of soil formation, e.g. aggregation, clay illuviation and/or disappearance of original stratification. It largely meets the requirements of a neocutanic B horizon. Its colour must not qualify for diagnostic red or yellow-brown.
- pd - Material which largely meets the requirements of a podzol B horizon.
- re - Red, non-calcareous soil material with a structure weaker than moderate blocky or prismatic. It largely meets the requirements of a red apedal B horizon.
- rs - Sandy material which largely meets the requirements of diagnostic regic sand.
- sk - Calcareous material which largely meets the requirements of a soft carbonate horizon.
- ye - Brown or yellow-brown, non-calcareous soil material with a structure weaker than moderate blocky or prismatic. It largely meets the requirements of a yellow-brown apedal B horizon.

- **Non-diagnostic unconsolidated materials with signs of wetness; predominantly gleyed**

- gc - Gleyed clay, usually with a firm or firmer consistency; it is firmer than the overlying horizon. If the structure is prismatic or columnar, it is usually weakly developed;

moderate to strong blocks are permitted.

gl - Gleyed loam, usually with a consistency not firmer than firm; it is usually not firmer than the overlying horizon. If the structure is prismatic or columnar, it is usually weakly developed; moderate to strong blocks are not permitted.

gs - Gleyed, coarsely textured materials, usually friable, non-sticky and non-plastic.

- **Non-diagnostic unconsolidated materials with signs of wetness; predominantly plinthic**

sp - A material in which accumulation of sesquioxides in the form of mottles (usually yellow, brown; sometimes red, black) and/or concretions occur. The matrix usually has light grey colours because of gleying. It largely meets the requirements of a soft plinthic B horizon.

- **Textural stratification in diagnostic and non-diagnostic unconsolidated materials**

Depending on the mode of transport and deposition, certain unconsolidated materials can be texturally stratified. With time soil development results in the disappearance of the stratification. However, in certain young soils stratification can still be detected. Since textural stratification is an important characteristic in soil use, it has to be indicated in the code in the following way:

SYMBOL	DESCRIPTION
Textural stratification prominent	
U1	Alternating layers of sand and silt
U2	Alternating layers of sand and clay
U3	Alternating layers of silt and clay
U4	Alternating layers of sand, silt and clay
Textural stratification non-prominent or absent	
U5	Predominantly sandy
U6	Predominantly loamy or porous silt
U7	Predominantly clayey or dense silt

Non-red stratified alluvium is qualified in terms of accumulation of organic matter and/or degree of bleaching by one of the following symbols:

bl - Highly bleached, pale coloured material; usually sandy.

hu - Dark, organic rich without signs of periodic wetness in or below it.

pt - Dark, peaty, organic rich layer with signs of periodic wetness in or below it.

- **Predominantly gravelly, stony, or bouldery diagnostic and non-diagnostic horizons or materials**

Coarse fragments (>2 mm) can occur in varying quantities either in a part of or throughout a horizon or layer. Such coarse material can seriously affect root development, water infiltration and water holding capacity and must be indicated in the soil code in terms of size, quantity (volume percentage) and shape.

The predominant size classes and symbols for coarse fragments used in the code are as follows:

CLASS NAME	SIZE	SYMBOL
Fine gravel	2 - 25 mm	f
Coarse gravel	25 - 75 mm	g
Stones	75 - 250 mm	k
Boulders	>250 mm	r

The volume percent of coarse fragment size classes is qualified by the following numerals:

Volume %	Symbol	Volume %	Symbol
0-10	1	10-20	2
20-30	3	30-40	4
40-50	5	50-60	6
60-70	7	70-80	8
80-90	9	90-100	10

The general form of the coarse fragments can be coded in the following way:

TYPE and DESCRIPTION	SYMBOL
Angular stones Angular; fragments of hard rock e.g. granite and dolerite, or quartz gravel	a
Cobblestones Rounded to subrounded; fragments of hard rock such as sandstone and dolerite, or rounded concretions	c
Flaggy Relatively thin and flat; fragments of hard rock such as sandstone	p
Shaly Relatively thin and flat; fragments of soft rock such as shale	s

Example: 45 volume-% relatively thin, flat, reasonably soft shale fragments with sizes varying from 150 mm to 200 mm are indicated with the symbol 5ks.

If more than one size class and/or type of coarse material occur in a horizon, it must be indicated in the code (eg. 3fa + 2ga). If the coarse fragments are poorly sorted and range in size from fine gravel to stones, a slash is used to separate the size class limit symbols (eg. 4f/g).

- **Non-diagnostic materials with signs of weathering residual rock**

- lo - Material in different stages of weathering which varies from hard rock to fully homogenized soil with cutanic properties in the form of tongues of prominent variegation because of residual soil formation and illuviation. There are no signs of wetness. It largely meets the requirements of a non-hard lithocutanic B horizon or saprolite.
- lw - Material as defined by lo, except that signs of wetness do occur.
- so - Weathering rock which, although unconsolidated, still has distinct geogenic properties. No signs of wetness occur. It largely meets the requirements of a hard lithocutanic B horizon or saprolite.
- sw - Material as defined in so, except that it shows signs of wetness.
- Ro - Hard rock without signs of wetness.
- Rw - Hard rock with signs of wetness.

- **Additional properties in diagnostic and non-diagnostic horizons or materials**

In some diagnostic as well as non-diagnostic horizons or materials, properties occur which are important for soil use, but which cannot be inferred from the definition of such horizons or materials. The following additional properties are recognised in the Winter-Rainfall Region.

- df - Dystrophic. This symbol is used for diagnostic neocutanic horizons which have a low base status (e.g. S to clay value < 5).

- le - Lamellae are wavy, horizontally orientated layers, in vertical section often branched, which, relative to the surrounding soil, are enriched in one or more of aluminosilicate clays, sesquioxides and organic matter. They are not the boundaries between depositional layers.
- lu - If a weaker than moderately structured horizon or material has an increase in clay relative to the directly overlying horizon or material such that it meets the requirements of luvic, and this property is not accommodated in the family, it is indicated with the lu symbol. If the increase in clay occurs in a diagnostic horizon (e.g. from a B1 to a B2 in a red apedal B horizon), only the lu symbol is used with an indication of depth. If the increase occurs in a non-diagnostic neocutanic horizon below a diagnostic red apedal B, it is coded as follows: ne/lu.
- mf - Mesotrophic. This symbol is used for diagnostic neocutanic horizons which have a medium base status (e.g. S to clay value 5 - 15).
- rp - A material in which accumulation of sesquioxides in the form of mottles (usually red, dark brown, black; occasionally yellow) and/or concretions occur. There are no signs of gleying in the material or the horizon; the matrix is usually red or yellow. In exceptional cases the concretions form a continuous, vesicular indurated layer which can be confused with hardpan ferricrete. Locally such materials are described as relic plinthite and are associated with high-lying incised landscapes.
- sl - A discordant material (usually thin, <100 mm), e.g. a stoneline. This symbol is used only if the texture of the material above and below the stoneline is more or less the same, e.g. if it occurs in a red apedal B horizon. If the texture differs, the symbols defined in 4.2 and 4.3 are used.
- yp - Subsurface hardsetting; a material, whether diagnostic or non-diagnostic, low in organic material with a high bulk density, which is hard to very hard in the dry state with a definite restriction on root penetration and to a lesser extent on water infiltration. It is friable to slightly firm when moist.

3 CLASSES AND SYMBOLS FOR PROPERTIES BELOW THE LINE

3.1 Coarse fragments in topsoil horizon and outcrops

The presence of coarse fragments (>2 mm) in the topsoil horizon or rock outcrops has an important effect on several physical (e.g. water holding capacity) and chemical (e.g. exchangeable cation content) properties, as well as on tillage and landuse. The size, quantity, and form of coarse fragments in the topsoil horizon (or plough layer) are indicated with the same symbols as those used to describe such materials as Subsoil limitations or properties.

The presence of outcrops is coded as follows:

QUANTITY (percentage of land surface occupied by exposed rock)	SYMBOL
5 - 25	R1
25 - 50	R2
>50	R3

3.2 Texture of topsoil horizon

The texture of the upper part (usually to a depth of 200 to 300 mm) of the profile is coded in terms of:

- i) the sand grade for soils with less than 20% clay and
- ii) the clay content (percentage).

Classes and abbreviations for sand grade, texture class and clay and silt content are the following:

SAND GRADE	
SIZE	SYMBOL
coarse	co
medium	me
fine	fi
CLAY CONTENT	
PERCENT	SYMBOL
0 - 5	1
5 - 10	2
10 - 15	3
15 - 20	4
20 - 35	5
35 - 55	6
>55	7

3.3 Soil water conditions

A wetness classification was developed based on the number of days and depth of saturation with water. Profile morphology is used to determine the depth of water saturation and the maximum height of signs of hydromorphy is used as depth limit. Climate, locality, aspect, vegetation and water conditions during the survey as well as profile morphology are used to evaluate the duration of water saturation. The expected number of days of saturation during the rainy season in "wet" years is used to determine duration. It is essential for free water to occur in the profile continuously for at least seven (7) days. However, the total number of days with free water need not be continuous.

DIAGRAM FOR DETERMINATION OF WETNESS CLASSES

Depth range of upper boundary of free water surface (cm)	Wetness symbol			
0 - 30	6	7	8	9
30 - 70	3	6	7	8
70 - 120	2	3	4	5
>150	1			

0 30 90 180 365

Cumulative number of days with free water

Note: The numeral 1 is not used in the code.

3.4 Changes in soil properties and conditions

Soils as natural phenomena are subjected at their surface to recent geological processes, such as erosion by wind or water, as well as the deposition of material transported by water, wind or gravity. As a natural agricultural resource soil is also affected by man for shorter or longer periods. Activities such as grazing of natural veld, normal soil tillage, deep soil preparation and drainage, etc., can cause soils to change to a greater or lesser extent. The changes can vary in permanence and can benefit or adversely affect crop production. It is therefore essential that such phenomena be described and indicated in the soil code.

- **Recent deposits on the A horizon**

al - Recent alluvial material on the A horizon.

ko - Recent colluvium on the A horizon.

ob - A recent geological deposit on the A horizon which does not qualify for al, rs or ko.

rs - Recent aeolian material on the A horizon.

The thickness of the deposit can be indicated after the letter symbol with a depth numerical symbol, e.g. rs2 for a 200 mm thick recent aeolian deposit.

- **Water or wind erosion**

wa - The topsoil has been removed by water erosion.

wi - The topsoil has been removed by wind erosion.

- **Phenomena on or in the A horizon or plough layer**

ah - Dark, organic rich surface horizon, without signs of wetness in or directly below it, on stratified alluvium.

em - A thin (usually thinner than 50 mm), bleached layer which develops directly beneath a surface organic litter layer (lr) in the upper part of the A horizon. It largely meets the requirements of an E horizon.

lr - Layer of organic litter, e.g. pine needles, at the soil surface which is not subject to prolonged wetness. The thickness of such a layer is coded with the same symbols as those used for horizon depths, e.g. a 300mm thick organic litter is indicated by lr3.

oo - Dark, peaty, organic rich surface horizon, with signs of periodic wetness in or below it, on stratified alluvium.

pb - Ploughsole: a hard, compacted layer directly beneath the plough layer as a result of tillage.

cr - Surface crust: it refers to the tendency of some soils to puddle at the surface during rain or irrigation and to form a dense, compact crust when dry. Such crusts are unfavourable for water infiltration, air exchange and germination and emergence of seedlings. This phenomenon also occurs in untilled soils with a natural veld cover.

- **Deep soil cultivation**

It refers to soils which have been mechanically cultivated deeper than 350 mm by means of some implement. The following cultivation types are based on implement type and mixing action:

hd - Complete mixing of the soil by hand (Afr. handdol), or trenching (Afr. slootgrawerbewerking).

ld - Complete mixing of the soil with a bulldozer blade (Afr. lemdol).

md - Complete mixing of the soil with a delve plough (Afr. mengdol).

rd - Loosening of the soil with a ripper (Afr. skeurploegbewerking).

sd - Shifting (lateral displacement) without mixing the soil (Afr. skuifdol)

xd - Type of cultivation unknown or uncertain.

The cultivation depth must be coded with the numerical symbol after a letter symbol, e.g. rd7 for ripper cultivation to a depth of 900 mm.

- **Other changes**

These include changes not accommodated by the classes mentioned above.

- as - Scraped surface.
- dr - Artificial drainage.
- er - Ridged or bedded topsoil.
- ik - Clay introduced and partially mixed with classifiable soil.
- lm - The subsoil (or parts thereof) has been limed to such an extent that the base status has been drastically changed (e.g. dystrophic to eutrophic, etc.).
- is - Sand introduced and partially mixed with classifiable soil.
- op - Filling in with material other than the classifiable filled in soil.
- te - Terraced land.

4 **EXAMPLE**

In the following paragraph a soil code is given to illustrate the structure and composition:

	3 7 5 Hu 1200 hp2 sl
Code:	-----
	4kc co4lm

Description:

Dystrophic, luvic Hutton form with A/B transition at 300 mm and predominantly impenetrable hardpan ferricrete at 850mm. A stoneline is present at 500 mm. The topsoil contains 40 % rounded stones, 15 - 20 % clay, 15 - 50 % silt and has a coarse sand grade.