SOIL SURVEY REPORT ON ERF 360

McGREGOR

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Report compiled by:

B Schloms

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Eco Impact Legal Consulting (PTY) Ltd

EXECUTAVE SUMMARY

This report deals with an evaluation of the agricultural potential of Erf 360 McGregor in the Breede Valley, with the emphasis on its agricultural production potential. The evaluation was based on two well established guidelines, namely:

- Lambrechts *et al* 1978. Soil code and map symbol for detail mapping in the Winter Rainfall Region. Technical Communication No. 165, Dept. Agric. Tech. Services, Pretoria.

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

Fifteen soil profiles were dug by a mechanical digger and they were decribed and classified according to **Soil Classification: A Taxonomic System for South Africa** into **soil forms** and **soil families.** This system is based on the recognition of diagnostic soil horizons and materials. Seven different soil forms were identified, which gives an indication of the heterogeneity in terms of soils occurring on Erf 360.

The suitability ranged from very low- medium to medium – high for agricultural production.

DECLARATION OF INDEPENDENCE

I, Bernardt HA Schloms, declare that I am an independent consultant, and that I am financially independent of the client and their consultants, and that all opinons expressed in this report are substantially my own.

Bernardt HA Schloms

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Table 2 Map units with a complete list of profiles and soil codes

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1 INTRODUCTION

The soil survey on the terrain of Erf 360 in McGregor was instructed by Eco Impact Legal Consulting (PTY) LTD during September 2013. Soil profile pits were dug by machine on 18 October 2013 and the soil survey was done the next day. Fifteen soil pits were dug on selected sites and decribed in the field. The soil survey report is an essential document of information for the proposed rezoning of this portion of the property.

Erf 360 is situated on the eastern side of McGregor and borders the town.

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

- A detail soil survey of a portion of Erf 360 (approximately 10 hectars) to determine the inherent properties, mainly physical and morphological, of the soils.
- Compilation of a soil map at scale large enough (1 : 5000) 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.

ALLOWCATION OF RESPONSIBILITIES

The following individuals were responsible for the various actions during the soil survey:

- Eco Impact Legal Consulting (PTY) LTD for providing the base map with contours and ASLA for the digging of soil pits. Initially a fixed grid spacing of 75 m x 75 m was recommended but the digger could not go in the vineyards (rows too narrow) and the profiles were dug next to the end of rows. In total fifteen profile pits were dug which was representative of the study area.
- The soil surveyor (soil specialist and compiler of this report) for describing and classifying the soil profiles in the field.
- The surveyor was responsible for compilation of the soils map and a report on the properties, limitations and relative suitability of the soils for wine grapes.

A total of fifteen profile pits were described during the field study that took place. The soil

profiles were investigated in the field and the important properties were described following standard procedures.

Based on recognizable, as well as inferred properties, the soils were classified according to **Soil Classification: A Taxonomic system for South Africa** (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. Glenrosa and Klapmuts. These names are abbreviated to two-letter symbols, e.g. Gs for Glenrosa form.

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. Gs 2111 is family number 2111 of the Glenrosa form. In **Tables 1 & 2** all the soil forms and families identified during the soil survey are briefly described according to the soil code.

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 (see **Annexure A: Structure of Soil Code and Explanation of Symbols**).

TABLE 1 SOIL CODES AND POTENTIAL OF PROFILES ON ERF 360, McGREGOR

Profile No	SOIL CODE	POTENTIAL	MAP SYMBOL
1	35Gs2112 lo/so so // 4f1g fi2/3	5,5	Gs
2	24Gs2112 lo/so so // 3f fi2/3	5,5	Gs
3	25Gs21/212 lo so // 2f2g fi3	5,5	Gs
4	37Gs2111 lo/so // 3f fi3	6,5	Gs
5	2472Km2110 vp lw/sw 2f // 2f fi2/3 3/4	5	Km
6	26Gs2111 lo so 3f2g // 3f2g fi3	5,5	Gs
7	3Gs2111 so // 2f1g fi3	5	Gs
8	353Gs1111 lo so 3f2g // 2f fi3	5,5	Gs
9	363Gs1111 lo so 3f3g // 3f fi3 >Oa	6	Gs
10	26Tr2210 nc db 3f1g // 3f fi2/3	5,5	Tr
11	272Gs1111 lo so 3f4g // 3f fi3	5,5 - 6	Gs

12	**37Mu2110 nc gl // fi3 3**	**6**	**Mu**
13	**3Br1000 U5+3k4g 2f // fi3 3**	**4**	**Br**
14	**2Br U5+3k4g // 3f fi3**	**3,5 - 4**	**Br**
15	**38Mu2110 nc gl // fi3 3**	**6**	**Mu**

In **Table 2** codes of all the profiles described are listed alphanumerical according to the soil map legend.

TABLE 2 SOIL CODES AND POTENTIAL OF PROFILES ON TOPSHELL AGRIPARK ARRANGED ACCORDING TO MAP SYMBOLS

Profile No	SOIL CODE	POTENTIAL	MAP SYMBOL
13	**3Br1000 U5+3k4g 2f // fi3 3**	**4**	**Br1**
14	**2Br U5+3k4g // 3f fi3**	**3,5 - 4**	**Br1**
6	**26Gs2111 lo so 3f2g // 3f2g fi3**	**5,5**	**Gs1**
7	**3Gs2111 so // 2f1g fi3**	**5**	**Gs1**
1	**35Gs2112 lo/so so // 4f1g fi2/3**	**5,5**	**Gs2**
2	**24Gs2112 lo/so so // 3f fi2/3**	**5,5**	**Gs2**
4	**37Gs2111 lo/so // 3f fi3**	**6,5**	**Gs3**
8	**353Gs1111 lo so 3f2g // 2f fi3**	**5,5**	**Gs3**
9	**363Gs1111 lo so 3f3g // 3f fi3 >Oa**	**6**	**Gs3**
11	**272Gs1111 lo so 3f4g // 3f fi3**	**5,5 - 6**	**Gs3**
3	**25Gs21/212 lo so // 2f2g fi3**	**5,5**	**Gs4**
5	**2472Km2110 vp lw/sw 2f // 2f fi2/3 3/4**	**5**	**Km1**
12	**37Mu2110 nc gl // fi3 3**	**6**	**Mu1**
15	**38Mu2110 nc gl // fi3 3**	**6**	**Mu1**
10	**26Tr2210 nc db 3f1g // 3f fi2/3**	**5,5**	**Tr1**

4 MAP LEGEND AND SOIL MAP

A basic mapping legend was compiled to accommodate the variation in soil properties.

- soil form, and
- diagnostic horizons

Additional soil properties such as:

- family criteria;
- clay content of A horizon (topsoil);
- depth to B horizon;
- depth to and nature of lower subsoil horizons/materials;
- coarse fragments in top-soils and/or upper sub-soil horizons, and
- effective depth

are listed for each map unit. Additional properties may be deduced from the detail soil code. With reference to the accuracy of the soil map, the following aspects should be kept in mind:

- According to the original recommendation the grid spacing of the profile pits should be 75 m x 75 m. This means that the minimum size of a map unit that can be identified is approximately 0,56 ha. Soil units smaller than these limits could therefore be included in larger soil units on the map.
- In situations where the boundaries between map units coincide with relatively prominent changes in slope or other soil surface features, the soil boundaries are should be fairly accurate. On Erf 360, however, the slope changes are usually gradual and the soil boundaries are therefore only approximate divisions.

The soil map units are shown on the Soil Map (**Annexure B**) and are identified by means of a symbol that consists of the abbreviation for the soil form combined with an Arabic number (e.g. Gs 1). The number suffix has no intrinsic meaning. It is 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.

Eight different map units were identified on Erf 360:

Br1 Orthic A horizon on a soft carbonate horizon

Gs1 Orthic A horizon on a lithocutanic horizon, not red and not calcareous

Gs2 Orthic A horizon on a lithocutanic horizon, not red and calcareous

Gs3 Orthic A horizon on a lithocutanic horizon, red and not calcareous

Gs4 Orthic A horizon on a lithocutanic horizon, red and calcareous

Km1 Orthic A horizon on an E horizon (yellow) on a sub/fine blocky pedocutanic B horizon

Mu1 Orthic A horizon on a non red neocarbonate B horizon on unspecified wet material

Tr1 Orthic A horizon on a non red neocarbonate B horizon on dorbank

In **Table 2** the map units are listed alphanumerical according to the soil form symbol.

5 PHYSICAL SOIL LIMITATIONS

The minimum useable soil depth required for good root development and water and nutrient uptake to ensure healthy and productive plants differ greatly between different plant types and rootstocks. In addition, the tolerance of different plants to soil wetness and soil borne diseases may also vary. In the following paragraphs the most important soil properties on Erf 360 that might affect infiltration, root development, and nutrient and water uptake will be discussed.

5.1 Dense subsoil clay layers

Some soils on the farm have dense subsoil clay layers occur as moderately to strong structured pedocutanic horizons (e.g. Klapmuts form).

With a clear to abrupt (sharp) increase in clay from the overlying horizon to the clay layer, free water generally accumulates in the overlying, lighter textured horizon during the rainy season or as a result of over-irrigation. Under conditions of water saturation, reduction and loss of iron leads to the development of a bleached E horizon in the overlying sandy material (e.g. Klapmuts form). Such horizons can set hard on drying and have a high soil density.

The effective depth of soils with dense subsoil clay layers is therefore limited by the clay layer itself and indirectly by the periodic wetness in the overlying layer with less clay.

The dispersive nature of the clay due to high exchangeable magnesium + sodium to calcium ratios may also have a negative effect on the long-term loosening effect of mechanical amelioration measures such as deep soil tillage with a tine implement.

5.2 Wetness

This refers to the presence of free water at varying depths in a soil profile.

On Erf 360 wetness occur mostly as ***perched water tables.*** This refers to the accumulation of free water in E horizons that may develop above a B horizon (Klapmuts form) and in the lower subsoil (Montagu form). Seasonal ground water tables may develop during the wet winter months. Soil families with a "yellow" E horizon are generally less hydromorphic and have a more friable consistency than families with a "grey" E horizon

During the field survey the soil water condition in individual soil profiles was evaluated according to the wetness classification that was developed for soils in the winter rainfall region (refer to **Annexure A**). This wetness classification is based on the number of days during the year 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 were 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. The wetness rating for individual profiles is listed in **Table 1**.

Wetness during active root respiration results in a low oxygen concentration with an increased carbon dioxide concentration. This causes reduction of iron oxides/hydroxides and leaching of the reduced iron. As the iron content decreases soil density increases and very large soil strengths can develop when the soil dries out.

Other adverse effects of wetness are:

- Toxic concentrations iron (Fe^{2+}), manganese (Mn^{2+}), sulfides, nitrites, ethylene and volatile organic acids can develop. In certain plants a moderate degree of wetness will only have a negative influence on growth without dieback of the plants. Sensitive plants, however, can die back.
- Various diseases can become epidemic under wet conditions. *Phytophthora* in particular can wipe out sensitive crops/plants.
- As a result of limited volume of non-wet soil that is available for root development, plants have a restricted root system during the wet season. Crops with a high water requirement may show drought stress during warm

and/or dry spells if water content becomes very low.

6 SUITABILITY OF SOIL TYPES FOR CROP PRODUCTION

The most common limitations for crop production of the soils in the study area are the following:

- dense subsoil clay layers;
- wetness

During the field soil survey the individual soil pits were evaluated by the surveyors in terms of its suitability for the commercial production of irrigated perennial crops, e.g. vines.

The suitability rating ranges from 1 to 10, with 1 the lowest and 10 equal to the highest or best suitability. The suitability rating refers to vigour and potential production potential without considering product quality. Although fairly subjective, suitability ratings by experienced soil scientists with many years of field experience are a handy tool to group soil types into production potential classes and for land use recommendations. The ratings can be interpreted according to the guidelines in **Table 3**.

Table 3 Interpretation of suitability ratings

Rating	General suitability	
≤2	Very low	Not recommended
>2 - ≤3	Low	
>3 - ≤4	Low-medium	Marginally recommended
>4 - ≤5	Medium	Conditionally recommended
>5 - ≤6	Medium-high	Recommended
>6	High	Highly recommended

The suitability ratings for irrigated perennial crops largely depend on limiting soil properties/features such as dense subsoil clay pans, seasonal wetness, cemented hardpans, low clay content in top- and upper subsoil and coarse fragments. The average rating for each map unit in **Table 2** was calculated from the individual profile ratings.

Table 4 Average suitability rating (Lambrechts) of soil types for the production of supplementary irrigated wine grapes

Map symbol	% Of total profiles	Average suitability	Recommendation for supplementary irrigated wine grapes
Br1	**13,3**	**3,9**	**Marginally recommended**
Gs1	**13,3**	**5,3**	**Recommended**
Gs2	**13,3**	**5,5**	**Recommended**
Gs3	**26,7**	**5,9**	**Recommended**
Gs4	**6,7**	**5,5**	**Recommended**
Km1	**6,7**	**5**	**Conditionally recommended**
Mu1	**13,3**	**6**	**Recommended**
Tr1	**6,7**	**5,5**	**Recommended**

According to **Table 4** most map units are recommended for wine grape production, Km1 is conditionally recommended and Br1 marginally recommended.

7 AGRICULTURAL LAND POTENTIAL

The National Department of Agriculture published a report in which the criteria for high potential agricultural land in South Africa were defined (Schoeman, 2004). In the report a number of concepts and terminology applicable to the evaluation of agricultural land potential were defined. These definitions include *inter alia* the following:

- **Agricultural** means land zoned for agricultural use.
- **Land** means the total natural environment of the exposed part of the earth's surface, including atmosphere, climate, soils, vegetation and the cultural environment.
- **Arable** means land that can produce crops requiring tillage; land so located and constituted that production of cultivated crops is economical and practical.
- **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 30 cm and a topsoil clay content of >5 - <35 % were used as additional criteria for the identification of high potential agricultural land.

In the agricultural land potential evaluation system of Schoeman (2004), only one minimum effective depth (viz. >30 cm) is specified irrespective of the growing season of the crop. The effective depth of most soils with an E horizon on a clayey B horizon will be restricted to the topsoil (A horizon) during the rainy winter months when the E horizon is water saturated. The anaerobic conditions in saturated horizons are unsuitable for root development. During summer the effective depth of these soils will depend on the depth of the subsoil clay layer. For this reason the agricultural land potential of map units was evaluated for winter and summer growing crops.

In **Table 5** the map units on Erf 360 were evaluated according to these guidelines and compared with the field suitability rating for irrigated perennial crops.

According to Schoeman (2004; refer to Table 9 in the Schoeman report) to qualify as high potential agricultural land a minimum effective soil depth of 30 cm is required and the topsoil clay must be more than 5 %.

Table 5 Land potential rating of map units according to Schoeman (2004) in comparison to the field suitability rating for irrigated wine grapes

Map symbol	Potential	Suitability
Br1	**Arable**	**Low - medium**
Gs1	**Arable**	**Medium - high**
Gs2	**Arable**	**Medium - high**
Gs3	**Arable**	**Medium - high**
Gs4	**Arable**	**Medium - high**
Km1	**Arable**	**Medium**
Mu1	**Arable**	**Medium - high**
Tr1	**Arable**	**Medium – high**

Combining soil form - effective soil depth, unit Br1 has a low to medium potential, and the Km1 soil unit a medium potential. The rest of the soil units (the majority) on Erf 360 have a medium to high potential.

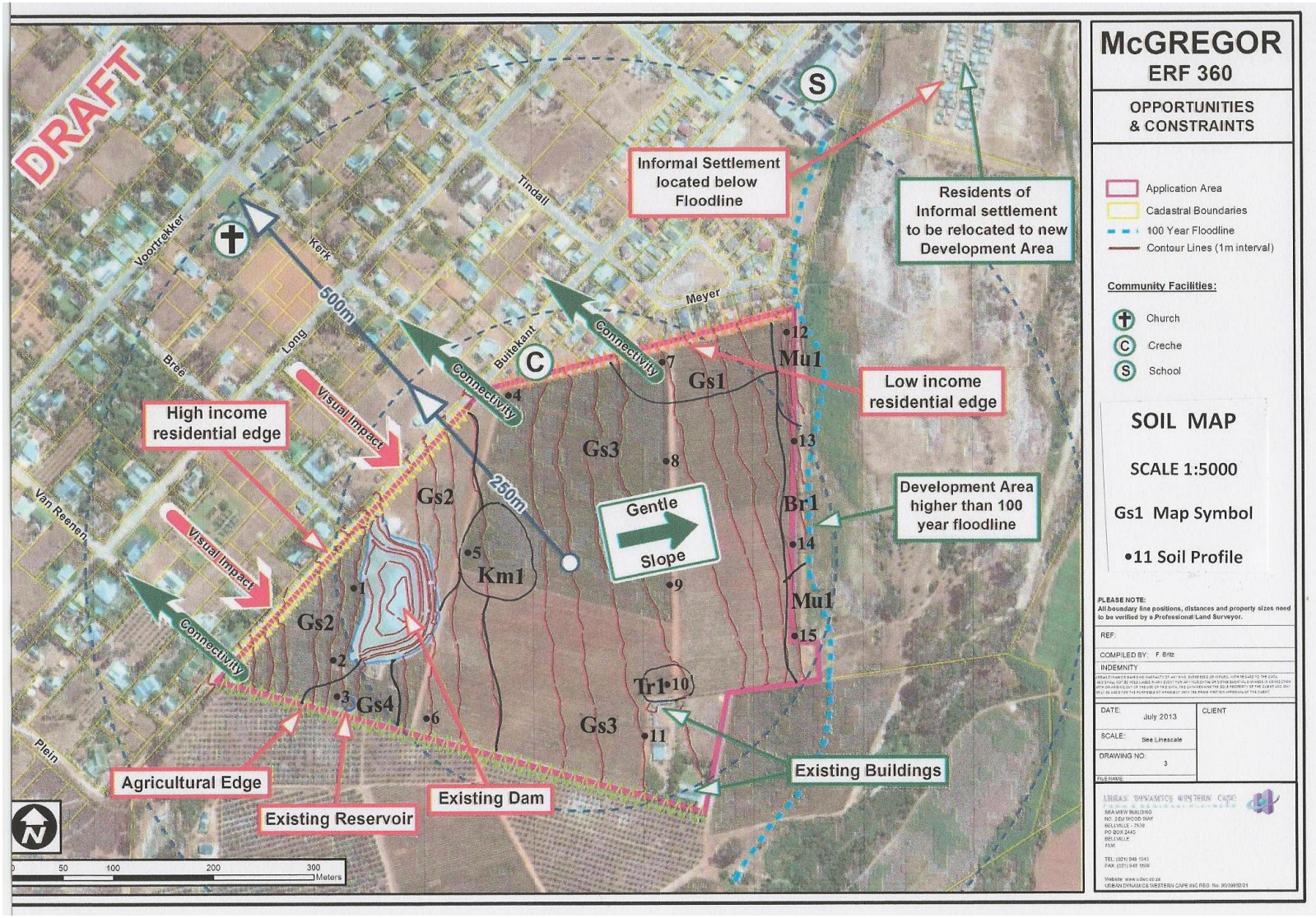
8 REFERENCES

Lambrechts, JJN; Van Zyl, J; Ellis, F and Schloms, BHA. 1978. Grondkode en kaartsimbool vir detail kartering in die Winterreënstreek. Technical Communication No. 165, Dept. Agric. Tech. Services, Pretoria.

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.

Annexture C: Soil Map



ANNEXURE B

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 prismacutanic 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, usualy 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 prismacutanic 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:

Code: 3 7 5 Hu 1200 hp2 sl / 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.