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 sandston dolerite, or rounded concretions	c e and
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 WinterRainfall 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 bounda of free water surface (cm)	ry 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.