PROFILE DESCRIPTION AND SOIL SAMPLING PROTOCOLS FOR THE NATIONAL SOIL INVENTORY OF SCOTLAND (2007-2009)

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INTRODUCTION

During 1978 to 1988 an inventory of the soils of Scotland was undertaken by the staff of the Soil Survey of Scotland. The surveyors visited a number of locations throughout Scotland that were on a regular 5km grid aligned to the British Ordnance Survey grid. Where possible, a soil profile at each site was described. At each 10km on this same grid, the soil profile was also sampled and a range of soil properties were subsequently determined in the laboratory. In total, 721 profiles were sampled with a further 66 locations having no accessible soil as they were in lochs or rivers, in built up areas or on solid rock. The protocols used in this first Inventory are described in Lilly et al (2010). Between 2007 and 2009 a partial resampling of this first National Soil Inventory of Scotland (NSIS_1) was undertaken where a proportion of the previously samples sites were revisited (at 20km intervals) and fresh soil samples taken.

The aims of the resampling programme were to:

- determine evidence of change in soil properties
- compare sampling methods
- measure new soil attributes to test their suitability as indicators of soil quality
- develop and test new methods for assessing soil quality

A 20km grid sampling framework meant that 25% of the original sites on the 10km grid were revisited, that is, 195 sites. At each of these sites the original aerial photograph and the previously recorded site characteristics (aspect, slope degree and form, rockiness, boulders and degree of flushing) were used to relocate the site as accurately as possible. A few small trial soil pits or auger borings were then made to find a soil that closely matched the soil described during the initial visit. Where a close match could not be found, a soil pit was dug at the location indicated by the mark on the aerial photograph and the soil and site described. Samples were taken according to set protocols and the national grid reference, as indicated by a GPS, was recorded. A total of 183 soil profiles were relocated on the 20km grid (NSIS_2) and the remaining 12 sites were classed as ‘non-soils.

The protocols used to describe and sample the revisited soils are set out in this document and consist of a series of instructions and definitions for the recording of the environmental and morphological characteristics at each site. Much of the field data were recorded as a series of codes rather than text using a set proforma (Appendix 1) and were subsequently entered into the Scottish Soil Database now held at the James Hutton Institute, Aberdeen. This method was designed to minimise errors and standardise the information recorded. A profile description sheet was used in the field in preference to electronic data entry in the field to facilitate the recording of additional notes and to have a hard copy record of the site and profile description. Table 1 shows a list of the attributes recorded in the field with an abbreviated description.

The data were recorded by ticking the appropriate box (for example, soil texture); by entering proscribed codes (for example, frequency of roots in organic horizons) or by entering percentages, depths as numerals.

This document consists of two main parts: the protocols for recording site and morphological characteristics and the sampling protocols. Within the former, the document describes and defines the attributes used to describe the site; the soil morphological attributes of organic horizons and the soil morphological attributes of mineral horizons. Appendices show an example of the profile description profoma, the rock type codes and the horizon nomenclature.

Table 1: ATTRIBUTES RECORDED IN THE FIELD.

Environmental properties:

Attribute name*	Description
Title	The site name, often the location, hill or farm name
Title No	Used where two or more profiles had the same title or site name*
Surveyor	The surveyor who described and sampled the profile
Site ID	The letter symbols of the 100 km square followed by the six figure reference
GPS NGR	The OS National Grid reference as derived from a GPS reading
Date	The date when the profile was described
Slope	The slope angle (°) as measured in the field using an Abney Level or clinometer
Slope form	The curvature of the slope
Slope type	Whether simple or complex slopes
Aspect	The direction of slope as a bearing (°)
GPS Alt	The altitude in metres above sea level, taken from a GPS reading, cross-checked against the OS map
Veg	The vegetation community classified according to Robertson (1984)
Rock outcrop	The presence and spacing of rock outcrops
Boulders	The presence and spacing of surface boulders
Erosion type/area	The type of erosion present within a 50m radius of the site, if any, and the extent as a percentage of the site)
Deposition/area	The type of deposition from erosion events (wind or water) and the percentage area of the site affected within a 50m radius of the profile pit
Site drainage	The flow of water across the landscape around the pit
Flush	The presence of near continuous lateral flow of water through the soil
Soil drainage	The natural drainage characteristics of the soil profile
Assoc	The two-letter symbol for the soil association
Series	The two-letter symbol for the soil series
Rock type/(%)	The lithology of rocks/stones within the soil profile and their relative proportions as a percentage
Type of PM	The soil parent material
Soil classification	According to the Scottish soil classification system including gley subgroups (SWG – surface water gley; GWG - ground water gley; ? – unknown) and Peatland type (BPT – basin peat; HPT – blanket peat)
Phase	Subdivision of some major soil subgroups and further information on forestry plantation or management operations
Misc map units	Non-soil map units
Base of pit	The presence of any restrictions on the profile depth
Bulk samples	The horizon type and depth at which samples were taken
Max Rooting depth	The maximum depth that roots were observed in the profile

* It is likely that, with subsequent revisions of the Scottish soils database, some of these field names will be changed in the database, therefore it will be necessary to consult the database metadata to determine the most recent field attribute names.

Profile morphological characteristics: Organic soil horizons

Horizon symb	The master and sub-horizon horizon symbol(s)
Depth (cm)	The depth (cm) of the base of the horizon measured from the soil surface (including litter layers)
Colour	The Munsell colour of the horizon
Nature of OM	The degree of decomposition of the organic material
Moisture status	The moisture status of the organic horizon at the time of sampling
Mineral content	The presence and degree of mineral grains
Von Post	An assessment of the degree of humification of the organic material using the von Post scale
Structure (degree)	The degree of aggregation
Structure (size)	The size class of aggregates
Structure (type)	The shape of the aggregates
Roots (frequency)	The frequency class of roots
Roots (size)	The size class of roots present
Roots (kind)	The type of roots present
Stones (frequency)	The frequency class of stone content
Stones (size)	The size class of stones present
Stones (shape)	The shape of stones present
Total %	The total volume of stones in horizon expressed as a percentage
Boundary (thickness)	The thickness of the transition zone between soil horizons
Boundary (form)	The degree of irregularity of the horizon boundary

Profile morphological characteristics: Mineral soil horizons

Horizon symbol	The master and sub-horizon horizon symbol(s)
Depth (cm)	The depth (cm) of the base of the horizon measured from the soil surface (including litter layers)
Colour	The colours of soil in the horizon according to the Munsell notation with separate lines for Matric colour, Ped face colour, and the colour of up to 2 sets of mottles
Mottle frequency	The frequency class of mottles
Mottle size	The size of mottles present
Mottle contrast	The relative colour difference between mottle and soil matrix
Mottle sharpness	A description of the transition zone between mottle and matrix
Texture	Field estimate of the soil texture with subdivisions if necessary
Structure degree	The degree of aggregation
Structure size	The size class of aggregates
Structure type	The shape of the aggregates
VSSQA	Visual assessment of the soil structural status; applied to topsoils only
Consistence–moisture status	The moisture content class of the horizon at the time of sampling
Consistence	The cohesiveness of the soil when wet, moist or dry
Induration	The degree of natural compaction within the horizon
Cement	The degree of cementation within the horizon
Root frequency	The frequency class of roots in the horizon
Root size	The size class of roots present
Root kind	The type of roots present
Stone frequency	The frequency class of stone content
Stone size	The size class of stones present
Stone shape	The shape of stones present
Stone lithology	The lithology of stones present
Total % stones	The total volume of stones in the horizon expressed as a percentage
Boundary thickness	The thickness of the transition zone between soil horizons
Boundary form	The degree of irregularity of the horizon boundary

NSIS 2007- 2009 PROFILE DESCRIPTION PROTOCOLS

SITE DESCRIPTION

The site attributes recorded are important as they contain the contextual information relevant to interpretation of the soil morphological and analytical data as well the location, the surveyor, the soil classification and a note of the soil samples taken from the profile.

Title – Use the same name as was given to the original profile, including any numbers used within name.

Title No. – Use the same number as given to the original profile.

Surveyor – Record the initials of the surveyor who describes and samples the profile using a standard set of initials. Enter the initials in the boxes left justified. Record all surveyors present at the time on the description sheet.

Site ID – Enter the 6 figure NGR as used previously to record the site location e.g. ‘NJ200200’

GPS NGR – Enter the 10-figure alpha-numeric national grid reference of the new NSIS_2 profile as determined by a GPS e.g. ‘NJ1000010000’.

Date – Enter the six-figure date on which description and sampling was undertaken in the boxes e.g. ‘060607’.

Slope (°) – Enter (right justified) the slope at the profile site (°) as measured by clinometer or abney level.

Slope form – Tick the box which best describes the form of the slope along the direction of true slope, relevant to the profile pit where CX=Convex, ST=Straight and CC=Concave.

Slope type – Tick the box which best describes the type of slope as Simple (SI) or Complex (COM) (see Hodgson, 1997,p6 for diagrams).

Aspect (°) – Enter (right justified) the aspect (°) of the slope on which the profile pit is located.

GPS Alt (m) – Enter (right justified) the altitude in metres at the profile pit location. Altitudes should be obtained from a GPS and cross-checked against a topographic map where the GPS signal is weak, for example, under dense tree cover.

Veg – Enter the four-figure vegetation code of the vegetation community at the profile pit location as described in '*A Key to the Common Plant Communities of Scotland*' (Robertson, 1984). The third box (outlined) should contain the numeric component of the code. Entries in the first two boxes should be right justified where appropriate.

Rock outcrop – Tick the box which best describes the rockiness of the site using the classes detailed below by measuring or assessing the typical distance between rock outcrops.

Rockiness refers to the relative spacing of visible rock exposed at the surface within 100 m radius of the profile pit.

No	Non-rocky	Occurrences are greater than 100 m apart
SL	Slightly rocky	Rock outcrops are 35-100 m apart.
M	Moderately rocky	Rock outcrops are 10-35 m apart.
R	Rocky	Rock outcrops are 3-10 m apart.
VR	Very rocky	Rock outcrops are less than 3 m apart.
ExR	Extremely rocky	Rock pavements and cliffs.

Boulders – Tick the box which best describes the boulderiness of the site using the classes detailed below by measuring or assessing the typical distance between boulders.

Boulders are defined as stones greater than 60 cm diameter but where they cannot be distinguished from rock outcrops, they should be classified with the latter and where rock outcrop and discrete boulders are both present, they should be collectively described under **'Rock outcrop'**. However, where only boulders e.g. boulder-strewn slopes and moraines, are the major impedance to tillage, they should be described separately from rock outcrop.

No	Non-bouldery	Occurrences are greater than 100 m apart
SL	Slightly bouldery	Boulders are 35-100 m apart.
M	Moderately bouldery	Boulders are 10-35 m apart.
B	Bouldery	Boulders are 3-10 m apart.
VB	Very Bouldery	Boulders are less than 3 m apart.
ExB	Extremely bouldery	Boulder fields.

Erosion type - Tick the box which best describes the presence and type of any erosion present within a 50 m radius centred on the profile pit. Descriptions are taken from Soil Survey Field Handbook (Hodgson, 1997)

No	No erosion	Present
R	Rill	a rill is a small channel which, in cultivated soils could be smoothed out by normal cultivation, i.e. <30 cm deep.
GU	Gully	a gully is a channel, which, in cultivated soils, would be too deep to be smoothed out by normal cultivation.

LS	Landslip	Soil and substrate which has slipped en masse downslope, e.g, arcuate slip features, irregular microrelief.
ST	Sheet	the erosion of a thin layer of surface soil and can include small rills.
W	Wind	movement of surface material by wind action, e.g. exposing crop roots or where areas of seedlings have been blown away.
T	Terracette	movement of soil downslope forming small terraces

Erosion area – Record the proportion (1-5% and multiples of 5% thereafter) of the total area affected by erosion within a 50 m radius centred on pit.

Deposition (type) - Tick the box which best describes the presence and type of any deposition within a 50 m radius of the pit.

Wat Water	deposition of material transported by water action, e.g. accumulation of sand or laminated silt upslope of hedge banks, at the foot of slopes.
Win Wind	deposition of material transported by wind action, e.g. accumulation of sand and silt against hedge banks; small dune-like features.

Deposition area – Record the proportion (1-5% and multiples of 5% thereafter) of the total area of deposits from wind or water erosion events within a 50 m radius centred on pit.

Site drainage – Tick the box which best describes the overall drainage of the site.

SH Shedding site, refers to slopes with run-off exceeding the amount of water reaching the site from slopes above e.g. many convex slopes and upper slopes of hills.

NOR Normal site, refers to slopes on which run-off might be expected to equal approximately the amount of water running down from higher land onto the site e.g. straight slopes in mid slope situations.

REC Receiving site, refers to situations where a site receives more water from slopes above than is lost by run-off e.g. lower concave slopes, basins and channels.

Flush – Tick the appropriate box to indicate whether the soil is flushed (Yes) or unflushed (No). Flushing being defined as: *a near continual lateral flow of water through the surface horizons and across the soil surface.*

Soil drainage – Tick the box which best describes the natural drainage of the soil after considering and assessing the morphological properties and degree

of gleying in the soil. The general characteristics of each class are given below (from: *The Soils of the country round Stranraer and Wigtown*, Bown and Heslop 1979).

EX	Excessive	Soil horizons are shallower than is normal and B horizons are bright and uniform in colour.
F	Free	The B horizons are bright and uniformly coloured.
M	Moderate	The B horizons are slightly duller than freely draining soils and there may be a small number of mottles in the subsoil.
I	Imperfect	The B horizons are less bright than freely and moderately draining soils and have appreciable mottling.
P	Poor	The Bg horizons are dull and mottling is evident.
VP	Very Poor	The Bg horizons are dull and mottling is very evident.

Assoc – Enter the two-letter code for the soil association (use the current 'serieslist' Oracle table).

Series - Enter the two-letter code for the Series (use the current 'serieslist' Oracle table).

Rock type/(%) – Enter (right justified) the dominant rock type code of the stones found in the profile in the first three boxes. The codes of all rock types are given in Appendix 2. Enter an estimate of the % occurrence of the rock type within the profile in the box with the heavy outline. If subsidiary rock types are present, enter and right justify the appropriate code and % occurrence in the remaining eight boxes.

Type of PM – Tick the box which best describes the parent material of the soil.

Till	Unaltered till
Wm Till	Water-modified or layered till
Flg	Fluvioglacial
RBch	Raised beach
All	Alluvium including marine alluvium.
Aeol	Aeolian
Col	Colluvium
Scree	Scree
Res	Residual or extremely stony
Mor	Moraine
Org	Organic deposit
Cry	Cryogenic deposit
Lac	Lacustrine
Other	Other (this designation should be further explained in the notes)

Soil Classification – Tick the box which best describes the soil type. The soil classification has been slightly modified from that shown in Handbook 8 (Soil Survey of Scotland Staff, 1984) with the addition of brown podzolic soils, peaty gleyed podzols and the renaming of brown forest soils and brown forest soils with gleying to brown earths and brown earths with gleying, respectively. The latter two to avoid any confusion with land use. When the soil is a gley, the subgroup box should also be ticked to indicate whether the soil is a surface-water (SWG) or a ground-water (GWG) gley soil. If this decision cannot be made, or the soil exhibits both characteristics, tick the '?' box.

Major Soil Group	Proforma code	Major Soil SubGroup
Brown Soils	Mag	Brown magnesian soil
	Calc	Brown calcareous soil
	Earth	Brown earth
	Pod	Brown podzolic soil
	Rend	Brown rendzina
Gley Soils	Mag	Magnesian gley soil
	Calc	Calcareous gley soil
	N/Cal	Noncalcareous gley soil
	Hum	Humic gley soil
	Pty	Peaty gley soil
	SubA	Subalpine gley soil
	Alp	Alpine gley soil
Podzols	Iron	Iron podzol
	Hum	Humus podzol
	H/Iron	Humus-iron podzol
	Pty	Peaty podzol
	Pty Gl	Peaty gleyed podzol
	SubA	Subalpine podzol
	Alp	Alpine podzol
Rankers	Brown	Brown ranker
	Gley	Gley ranker
	Hum	Humic ranker
	Pty	Peaty ranker
	Podz	Podzolic ranker
	Calc	Calcareous ranker
Lithosols	Brow	Brown lithosol
	Pty	Peaty lithosol
Regosols	Cal	Calcareous regosol
	N/Cal	Noncalcareous regosol
Alluvial Soils	Min	Mineral alluvial soil
	Pty	Peaty alluvial soil
	Sal	Saline alluvial soil
Organic soils	Eut	Eutric
	Mes	Mesic
	Dyst	Dystric

Peatland type – Tick the box which best describes the peatland type.

HPT	Hill and blanket peat
BPT	Basin peat

Phase – Tick the box which best describes any phases which are relevant. Phases describe additional characteristics of the soil and site that would otherwise not be recorded and are not part of the soil classification system. Some of the most likely to be encountered during the resampling are listed on the proforma. Others should be detailed in the notes section of the proforma.

Cult	Cultivated
Plag	Plaggen (Soils which have had material added to increase the thickness of the topsoil beyond that due to simple cultivation)
C/O	Cut-over (usually organic soils)
D Loch	Dubh-lochans (discrete, closely packed pools in areas of deep blanket peat)
Hag	Hagged or severely eroded peat
Other	Other (should be expanded in notes)
For Pl	Forestry ploughing
For2Pl	2nd Rotation with ploughing
For2	2nd Rotation without ploughing
Regen	Natural regeneration (native & non-native)
Felled	Felled woodland

Misc map units Tick this box if the site is non-soil (miscellaneous map units) and enter the code into the database

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BU	Built-up area including roads
R	Rock outcrop
W	Lochs, rivers, streams
Q	Quarry and associated disturbed ground
C	Coal mine, tip
O	Other, expand in notes

Base of pit – Tick the appropriate box to indicate whether the soil within profile depth is restricted by rock, boulder, induration or flooding or if the soil depth is greater than that observed in the profile pit.

RK	Solid rock
W RK	Weathered rock
BL	Boulder
IND	Induration
FL	Pit flooded
↓	Bottom horizon continues down

Bulk samples – Enter horizon symbol of the uppermost horizon that is sampled in the first box and enter (right justified) the top and bottom depths of each sample in the remaining boxes marked ‘depth’. Repeat using the remaining boxes for the subsequent sampled horizons. Where more than nine samples are collected, enter additional sample depths in notes section.

Max rooting depth Enter the maximum depth at which live roots are observed in the profile.

ORGANIC HORIZON DESCRIPTION

This section outlines the protocols for describing organic horizons (L, F, H and O) present in the profile.

Horizon Symb – Enter the appropriate master horizon symbol(s) (see Appendix 3).

Depth (cm) – Enter (right justified) the depth (in centimetres) of the base of the horizon measured downwards from the soil surface and include any litter layer. Record any variability in horizon thickness in the notes.

Colour – Record the Munsell colour of the horizon. Enter the hue number, right justified in boxes one and two, ignoring the decimal point (that is 7.5 is recorded as 75); the hue letters, right justified in boxes three and four and the value and chroma in boxes five and six respectively. Record colour ‘value’ of 2.5 as 2, as done previously. For example 7.5YR2.5/1 is recorded as

7	5	Y	R	2	1

Nature of OM – Tick the box which best describes the nature of the organic horizon.

FIB	Fibrous	Plant remains are easily recognised; the original structure and some of the mechanical strength of the plant materials are maintained.
SF	Semi-fibrous	Consists mainly of partially decomposed plant remains which are recognisable but fibrous in appearance only; when moist, peat is soft and plastic in character.
AM	Amorphous	Absence of recognisable plant remains and highly decomposed.

Moisture Status

Tick the box which best describes the moisture status of the organic horizon.

W	Wet	Glistening water films visible on peds and particles
M	Moist	Soil does not change colour when moistened
D	Dry	Colour darkens when wetted

Mineral Content

Tick the box which best describes the amount and the particle size distribution of the <2mm mineral fraction, if present. Record NO if there is no discernable mineral fraction.

NO	None	No recognisable mineral grains present
BL	Bleached	Bleached sand grains present
SP	Sandy Peat	Organic Carbon >35% but <50%, mineral fraction >50% sand
LP	Loamy Peat	Organic Carbon >35% but <50%, mineral fraction <50% sand

Von Post

O (Peaty), H (Humus), L (Litter) and F (Fermentation) horizons can be described in terms of their degree of decomposition by reference to a modified version of a 10-point scale (Table 2) devised by von Post (1924). The classification is based on the characteristics of both the fluid expressed when peat is squeezed in the hand, and the peat remaining. Note that the definition of O and H horizons in Scotland are opposite from that used by FAO (2006).

Table 2: Modified version of the von Post scale for assessing the degree of decomposition of peat

A sample of **wet peat** is squeezed in the closed hand and the colour of the liquid that is expressed between the fingers, the proportion of the original sample that is extruded and the nature of the plant residues are observed.

Degree of decom-position	Nature of liquid expressed on squeezing	Proportion of peat extruded between fingers	Nature of plant residues	Description
H1	Clear, colourless	None	Plant structure unaltered; fibrous, elastic	Undecomposed
H2	Almost clear, yellow-brown	None	Plant structure distinct; almost unaltered	Almost undecomposed
H3	Slightly turbid, brown	None	Plant structure distinct; most remains easily identifiable	Very weakly decomposed
H4	Strongly turbid, brown	None	Plant structure distinct; most remains identifiable	Weakly decomposed
H5	Strongly turbid, contains a little peat in suspension	Very little	Plant structure clear; but becoming indistinct, most remains difficult to identify	Moderately decomposed
H6	Muddy, much peat in suspension	One-third	Plant structure indistinct but clearer in the squeezed residue than in undisturbed peat; most remains unidentifiable	Well decomposed
H7	Strongly muddy	One-half	Plant structure indistinct but recognisable; few remains identifiable	Strongly decomposed
H8	Thick mud, little free water	Two-thirds	Plant structure very indistinct; only resistant remains such as root fibres and wood identifiable	Very strongly decomposed
H9	No free water	Nearly all	Plant structure almost unrecognisable; practically no identifiable remains	Almost completely decomposed
H10	No free water	All	Plant structure unrecognisable; completely amorphous	Completely decomposed

If the peat is dry, then use '**Nature of plant residues**' and '**Description**' to classify the peat.

Structure

If the organic horizon (L, F, H or O) has a developed structure, enter the symbols for degree, size and type of structure in boxes one, two and three respectively. Repeat in boxes four, five and six for any secondary structure. If no structure is present, leave boxes blank.

Degree (Taken from Soil Survey Field Handbook, Hodgson, 1997)

"The degree of ped (aggregate) development is distinguished in the field by the proportion of the soil appearing as peds and by the frequency and distinctness of natural surfaces that persist through cycles of wetting and drying. It reflects both cohesion within peds and adhesion between neighbouring peds. It is assessed by the ease with which the soil separates into peds and their durability when separated. Grade varies with soil-water state, and is normally described at the soil-water state in which the soil is found." The terms describing the degree of ped development are as follows:

Apedal – no observable aggregation; without a definite orderly arrangement of natural lines of weakness. Apedal are divided into:

Single grain – soil which separates when disturbed into individual primary particles with such coatings as adhere to them. The primary particles may however be held together by surface tension when very moist or wet.

Massive – when disturbed soil breaks into masses which may be easily crushed (or broken) into smaller pieces or may be strongly coherent. The ease with which they can be crushed is described under 'Consistence'. Massive soil materials can have a wide range of consistence properties".

Weakly Developed – poorly formed, indistinct, weakly coherent peds that are barely observable in place. When disturbed, the soil breaks into a few entire peds, many broken peds and much unaggregated material. Although the peds are weakly coherent they part from each other easily. The individual peds are weak in consistence when very moist. A **very *weakly developed*** grade is recognised where it can be distinguished consistently from better developed structure within the weakly developed class.

Moderately Developed – well formed moderately durable peds which are evident but not distinct in undisturbed soil. When disturbed, the soil breaks down into a mixture of many distinct entire peds, some broken peds and a little unaggregated material.

Strongly Developed – durable peds that are quite evident *in situ*, adhere weakly to one another and withstand displacement, separating cleanly when the soil is disturbed. Disturbed soil material consists very largely of entire peds and includes a few broken peds and little or no unaggregated material. If the soil separates with little manipulation into entire, durable peds, the grade of the soil may be described as *very strongly developed*.

Size and Shape

The size and shape of peds (aggregates) are described in terms defined in Table 3 (Taken from Soil Survey Field Handbook, Hodgson, 1997), using figures in Munsell book insert as a guide. The term 'type' is used on the description sheet proforma instead of 'shape'. The above description of

aggregation is generally more relevant to mineral soils but the size and shape of any aggregation in organic layers can be readily determined.

Table 3: Size and Shape of Peds and Fragments

	Shape and arrangement of peds and fragments				
	Plate-like with one dimension (the vertical) limited and much less than the other two; arranged around a horizontal plane; faces mostly horizontal	Prism-like with two dimensions (the horizontal) limited and considerably less than the vertical; arranged around a vertical line; vertical faces well defined; vertices angular	Block-like, polyhedron-like, or spheroidal, with three dimensions of the same order of magnitude, arranged around a point		
			Block-like; blocks or polyhedrons having plane or curved surfaces that are casts of the moulds formed by the faces of the surrounding peds		Spheroids or polyhedrons having plane or curved surfaces with slight or no accommodation to the faces of surrounding peds
Size			Faces flattened; most vertices sharply angular	Mixed rounded and flattened faces with many rounded vertices	
	Platy [1]	*Prismatic* [2]	*Angular blocky* [3]	*Subangular blocky*	*Granular*
Very Fine	Very fine platy; < 1mm	Very fine prismatic; <10 mm	Very fine angular blocky; <5 mm	Very fine subangular blocky; <5 mm	Very fine granular; <1 mm
Fine	Fine platy; 1 to 2 mm	Fine prismatic; 10 to 20 mm	Fine angular blocky; 5 to 10 mm	Fine subangular blocky; 5 to 10 mm	Fine granular; 1 to 2 mm
Medium	Medium platy; 2 to 5 mm	Medium prismatic; 20 to 50 mm	Medium angular blocky; 10 to 20 mm	Medium subangular blocky; 10 to 20 mm	Medium granular; 2 to 5 mm
Coarse	Coarse platy; 5 to 10 mm	Coarse prismatic; 50 to 100 mm	Coarse angular blocky; 20 to 50 mm	Coarse subangular blocky; 20 to 50 mm	Coarse granular; 5 to 10 mm
Very Coarse	Very coarse platy; >10mm	Very coarse prismatic; >100 mm	Very coarse angular blocky; >50 mm	Very coarse subangular blocky; >50 mm	Very coarse granular; >10 mm

1 Platy structure is described as lenticular when plates are thick in the middle and thin towards their edges.

2 Aggregates similar to prisms but with rounded tops are described as columnar. Columnar aggregates are rare in the British Isles.

3 Aggregates with approximately tetrahedral form found in some soils can be described, for example, as '*tetrahedral angular blocky*'.

Codes

Degree

VW	Very weak
W	Weak
M	Moderate
S	Strong
VS	Very strong

Size

VF	Very fine
F	Fine
M	Medium
C	Coarse
VC	Very coarse

Shape

SG	Single grain
MA	Massive
PL	Platy
PR	Prismatic
AB	Angular blocky
SAB	Subangular blocky
GR	Granular

Box one should only be used for the '*Degree*', box two for '*Size*', and box three for '*Shape*'

W	M	SAB

Weak Medium Subangular Blocky

		MA

Massive

Roots

Enter the frequency, size and kind of the dominant root type codes in boxes one, two and three respectively. Using the same sequence, the second and third most dominant root type should be entered in boxes four to six and seven to nine respectively.

Frequency

Root frequency is determined by estimating the number of roots in 100 cm^2 of soil surface or by comparisons with dot diagrams. See Table 4 (*Taken from Soil Survey Field Handbook, Hodgson, 1997*). The frequency category code should be entered in boxes one, four and seven (where applicable).

Table 4: Abundance of Live Roots

Frequency Class	***Number of roots per 100 cm^2***	
	Very fine and fine roots	*Medium and coarse roots*
None	0	0
Few	1-10	1 or 2
Common	10-25	2-5
Many	25-200	>5
Abundant	>200	-

Frequency Symbols

N None
F Few
C Common
M Many
A Abundant

Size

The size of roots (diameter) can be measured or assessed visually and the category code entered in boxes two, five and eight (where applicable). Roots larger than 10 mm diameter are usually very few in number, even in woodland soils, and their size, number and distribution should be described separately in general terms, stating their diameter and average distance apart.

VF	Very fine	<1 mm diameter
F	Fine	1-2 mm diameter
M	Medium	2-5 mm diameter
C	Coarse	5-10 mm diameter
VC	Very coarse	>10 mm diameter

Kind

The nature of the roots should be assessed and the category code entered in boxes three, six and nine (where applicable).

FL	Fleshy	e.g. tap roots or bracken rootstock
FI	Fibrous	e.g. grass roots
W	Woody	e.g. larger tree roots
RHI	Rhizomatous	e.g. rhizomes

A	F	FI	C	M	W	F	VF	FL
Abundant		Fine Fibrous	Common	Medium	Woody	Few	Very Fine	Fleshy

Max rooting depth Enter the maximum depth at which live roots are present within the profile here or within the contextual environmental information above.

Stones

Enter the frequency, size and shape codes for the dominant stones in boxes one, two and three respectively. Using the same sequence, the second and third most dominant group of stones should be entered in boxes four to six and seven to nine respectively. The presence of stones is not considered to constitute mineral content in these horizons.

Frequency

The percentage by volume of stones should be estimated by eye using the proportion diagrams on the Munsell book insert and the code entered in boxes one, four and seven (where applicable).

N	None	0% volume
F	Few	1 to 5% volume
C	Common	6 to 15% volume
M	Many	16 to 35% volume
A	Abundant	36 to 70% volume
VA	Very abundant	>70% volume

Size

The size of the stones should be estimated using the scale below and the code entered in boxes two, five and eight respectively.

VS	Very small	<6 mm diameter
S	Small	6 mm to 2 cm diameter
M	Medium	2 to 6 cm diameter
L	Large	6 to 20 cm diameter
VL	Very large	20-60 cm diameter
B	Boulder	>60 cm diameter

Shape

Fragments/stones with more or less, equal sized axes are described as varying degrees of roundness or angularity. The ‘roundness/angularity’ should be described using the following terms: *rounded, subrounded, subangular, angular*

Stones with unequal axes should be described further as ‘*platy*’.

The codes below should be entered in boxes three, six and nine (where appropriate).

R	Rounded
SR	Subrounded
SA	Subangular
A	Angular
PL	Platy

Total %

Enter an estimate of the total percentage of stones in the horizon

Boundary

Horizon boundaries are three-dimensional though they are normally described as two-dimensional as seen on the pit face.

Enter the ‘Thickness’ symbol (Box 1) and ‘Form’ symbol (Box 2), relevant to the horizon being described and the immediate, underlying horizon.

Thickness

The distinctness of a horizon boundary depends partly on the contrast between adjacent horizons and partly on the thickness of any transitional zone. The thickness of the transitional zone should be recorded in the classes given below:

Distinction		Change to next horizon occurs over:
S	Sharp	<2 cm
C	Clear	2 to 5 cm
G	Gradual	5 to 12 cm
D	Diffuse	>12 cm

Form

The degree of irregularity of the horizon boundary is described using the following terms:

SM	Smooth	Nearly plane
W	Wavy	Pockets wider than deep
I	Irregular	Pockets deeper than wide
B	Broken	Not continuous

MINERAL HORIZON DESCRIPTION

This section outlines the protocols for describing the mineral horizons present in the profile.

Horizon Symbol – Enter the appropriate master horizon symbol(s) (see Appendix 3).

Depth (cm) – Enter (right justified) the depth (in centimetres) of the base of the horizon measured downwards from the surface. If the horizon thickness varies the bottom depth range can be entered in rows one and two with the uppermost depth in row one.

Colour – Record the Munsell colour of the matrix of each horizon (and where appropriate the ped face colour and the colour of the dominant and sub-dominant mottles). Enter the hue number, right justified in boxes one and two, ignoring the decimal point (that is 7.5 is recorded as 75); the hue letters, right justified in boxes three and four and the value and chroma in boxes five and six respectively. Record colour 'value' of 2.5 as 2, as done previously. For example 7.5YR2.5/1 is recorded as

7	5	Y	R	2	1

Mottles - Tick the box which best describes the mottle frequency, size, contrast and sharpness of the dominant mottle in the horizon, avoiding complex descriptions when many colours are present. If other mottles exist, these can be described using the four boxes in the bottom right hand corner, entering the codes for frequency in top left, size in top right, contrast in bottom left and sharpness in bottom right.

Frequency – The percentage cover of mottles present should be estimated using the proportion diagrams contained in the Munsell book inserts.

N	None	0%
F	Few	<2%
C	Common	2 to 20%
M	Many	21 to 40%
A	Abundant	>40%

Size – The diameter of mottles should be measured and different size classes described if appropriate.

VF	Very Fine	<2 mm diameter
F	Fine	2 to 5 mm diameter
M	Medium	5 to 15 mm diameter
C	Coarse	>15 mm diameter

Contrast – The difference between mottle and matrix colour should be estimated

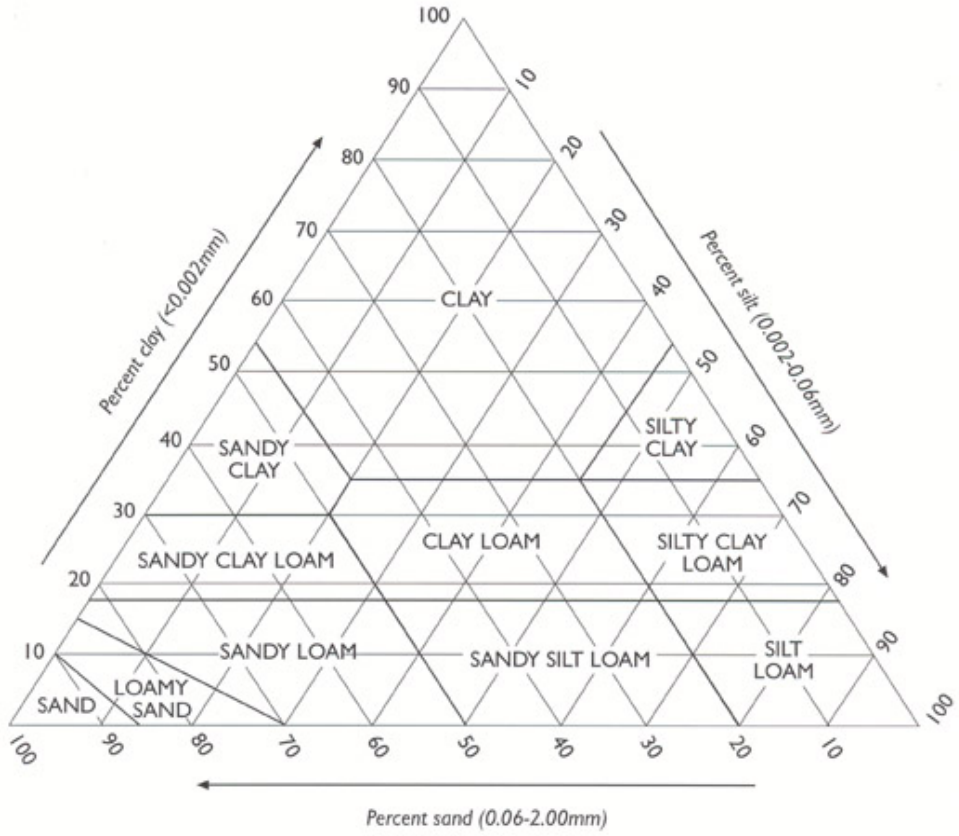
F	Faint	Similar colour to matrix
D	Distinct	Readily seen
P	Prominent	Colour very different to matrix

Sharpness – The sharpness of the mottle edge should be estimated.

S	Sharp	Knife edge
C	Clear	<2 mm
D	Diffuse	>2 mm

Texture – Tick the box which best describes the texture. Eleven classes according to the British Standards Institution (1981) are shown in Figure 1. Fine, medium and coarse may be used as qualifiers for the sandy textures: sand, loamy sand and sandy loam and humose can be used as a qualifier with all textures. Although only one texture box can be ticked, it is permissible to have two qualifiers, e.g. HFSL=Humose fine sandy loam.

Figure 1 British Standard Soil Textural Classification



Codes

Texture

S	Sand	SCL	Sandy clay loam	CL	Clay loam
LS	Loamy sand	ZL	Silt loam	SC	Sandy clay
SL	Sandy loam	ZCL	Silty clay loam	C	Clay
SZL	Sandy silt loam	ZC	Silty clay		

Qualifiers

F Fine – more than two-thirds of the sand fraction (0.063-2 mm) is between 0.063 and 0.212 mm.

M Medium – less than two-thirds of the sand fraction is between 0.063 and 0.212 mm and less than one-third of the sand fraction is larger than 0.6 mm.

C Coarse – more than one-third of the sand fraction is larger than 0.6 mm.

H Humose – has insufficient organic matter to be classed as organic but has (from Soil Survey Field Handbook, Hodgson, 1997):
a) more than 6% organic carbon (10% organic matter) if the mineral fraction (<2 mm) has 50% or more clay, or
b) more than 3.5% organic carbon (6% organic matter) if the mineral fraction has no clay, or
c) proportional organic carbon contents if the clay content is intermediate.

Structure – Tick the box which best describes the degree (top row of boxes), the size (row 2) and type (rows three and four) of structure. Where two structures are present, e.g. moderate, medium angular blocky breaking to weak fine granular, the symbol for the secondary structure is entered in the appropriate order in the blank three boxes with heavy outline on row four.

Degree (Taken from Soil Survey Field Handbook, Hodgson, 1997)

“The degree of ped (aggregate) development is distinguished in the field by the proportion of the soil appearing as peds and by the frequency and distinctness of natural surfaces that persist through cycles of wetting and drying. It reflects both cohesion within peds and adhesion between neighbouring peds. It is assessed by the ease with which the soil separates into peds and their durability when separated. Grade varies with soil-water state, and is normally described at the soil-water state in which the soil is found’’. The terms describing the degree of ped development are as follows:

Apedal – no observable aggregation; without a definite orderly arrangement of natural lines of weakness. Apedal are divided into:

Single grain – soil which separates when disturbed into individual primary particles with such coatings as adhere to them. The primary particles may however be held together by surface tension when very moist or wet.

Massive – when disturbed soil breaks into masses which may be easily crushed (or broken) into smaller pieces or may be strongly coherent. The ease with which they can be crushed is described under 'Consistence'. Massive soil materials can have a wide range of consistence properties.

Weakly Developed – poorly formed, indistinct, weakly coherent peds that are barely observable in place. When disturbed, the soil breaks into a few entire peds, many broken peds and much unaggregated material. Although the peds are weakly coherent they part from each other easily. The individual peds are weak in consistence when very moist. A **very *weakly developed*** grade is recognised where it can be distinguished consistently from better developed structure within the weakly developed class.

Moderately Developed – well formed moderately durable peds which are evident but not distinct in undisturbed soil. When disturbed, the soil breaks down into a mixture of many distinct entire peds, some broken peds and a little unaggregated material.

Strongly Developed – durable peds that are quite evident *in situ*, adhere weakly to one another and withstand displacement, separating cleanly when the soil is disturbed. Disturbed soil material consists very largely of entire peds and includes a few broken peds and little or no unaggregated material. If the soil separates with little manipulation into entire, durable peds, the grade of the soil may be described as *very strongly developed*.

Size and Shape

The size and shape of peds are described in terms defined in Table 5 (Taken from Soil Survey Field Handbook, Hodgson, 1997), using figures in Munsell book insert as a guide. The term 'type' was used on the description sheet proforma instead of 'shape'.

Table 5: Size and Shape of Peds and Fragments

Size	***Shape and arrangement of peds and fragments***				
	Plate-like with one dimension (the vertical) limited and much less than the other two; arranged around a horizontal plane; faces mostly horizontal	Prism-like with two dimensions (the horizontal) limited and considerably less than the vertical; arranged around a vertical line; vertical faces well defined; vertices angular	Block-like, polyhedron-like, or spheroidal, with three dimensions of the same order of magnitude, arranged around a point		
			Block-like; blocks or polyhedrons having plane or curved surfaces that are casts of the moulds formed by the faces of the surrounding peds		Spheroids or polyhedrons having plane or curved surfaces with slight or no accommodation to the faces of surrounding peds
			Faces flattened; most vertices sharply angular	Mixed rounded and flattened faces with many rounded vertices	
	Platy [1]	*Prismatic* [2]	*Angular blocky* [3]	*Subangular blocky*	*Granular*
Very Fine	Very fine platy; < 1mm	Very fine prismatic; <10 mm	Very fine angular blocky; <5 mm	Very fine subangular blocky; <5 mm	Very fine granular; <1 mm
Fine	Fine platy; 1 to 2 mm	Fine prismatic; 10 to 20 mm	Fine angular blocky; 5 to 10 mm	Fine subangular blocky; 5 to 10 mm	Fine granular; 1 to 2 mm
Medium	Medium platy; 2 to 5 mm	Medium prismatic; 20 to 50 mm	Medium angular blocky; 10 to 20 mm	Medium subangular blocky; 10 to 20 mm	Medium granular; 2 to 5 mm
Coarse	Coarse platy; 5 to 10 mm	Coarse prismatic; 50 to 100 mm	Coarse angular blocky; 20 to 50 mm	Coarse subangular blocky; 20 to 50 mm	Coarse granular; 5 to 10 mm
Very Coarse	Very coarse platy; >10mm	Very coarse prismatic; >100 mm	Very coarse angular blocky; >50 mm	Very coarse subangular blocky; >50 mm	Very coarse granular; >10 mm

1 Platy structure is described as lenticular when plates are thick in the middle and thin towards their edges.

2 Aggregates similar to prisms but with rounded tops are described as columnar. Columnar aggregates are rare in the British Isles.

3 Aggregates with approximately tetrahedral form found in some soils can be described, for example, as '*tetrahedral angular blocky*'.

Codes

Degree

VW	Very weak
W	Weak
M	Moderate
S	Strong
VS	Very strong

Size

VF	Very fine
F	Fine
M	Medium
C	Coarse
VC	Very coarse

Shape

SG	Single grain
MA	Massive
PL	Platy
PR	Prismatic
AB	Angular blocky
SAB	Subangular blocky
GR	Granular

Box one should only be used for the '*Degree*', box two for '*Size*', and box three for '*Shape*'

W	M	SAB

Weak Medium Subangular Blocky

		MA

Massive

Visual Soil Structure Quality Assessment (VSSQA)

With reference to VSSQA (Ball et al., 2007), record the structure quality (St1-St5) for the topsoil horizon in the appropriate box (bottom of 'Structure' section).

Structure quality	Ease of break up (moist soil)	Size and appearance of aggregates	Visible porosity	Roots
St5 Very compact	Difficult	Mostly large > 10 cm, very few < 7 cm, angular and non-porous	Very low; macropores may be present; may contain anaerobic zones	Few, if any, restricted to cracks
St4 Compact	Quite difficult	Mostly large > 10 cm and sub-angular non-porous; horizontal/platy also possible; less than 30% are <7 cm	Few macropores and cracks	All roots are clustered in macropores and around aggregates
St3 Firm	Not difficult	A mixture of porous aggregates from 2mm -10 cm; less than 30% are <1 cm. Some angular, non-porous aggregates (clods) may be present	Macropores and cracks present. Some porosity within aggregates shown as pores or roots.	Most roots are around aggregates
St2 Intact (retained as a block on the spade)	Aggregates easy to break with one hand	A mixture of porous, rounded aggregates from 2-70 mm. No clods present	Most aggregates are porous	Roots throughout the soil
St1 Friable (tends to fall off the spade)	Aggregates readily crumble with fingers	Mostly < 6 mm after crumbling	Highly porous	Roots throughout the soil

Consistence – Tick the boxes which best describe the moisture status and consistence of the horizon. Consistence refers to soil characteristics determined by the kind of cohesion and adhesion. It is described under the headings strength, characteristics of failure, maximum stickiness, maximum plasticity and cementation and induration. Strength and characteristics of failure vary widely with soil-water state. The soil-water state of the soil, at the time it is described, should be assessed first. Unless otherwise indicated, strength and characteristics of failure are described at this naturally occurring soil-water state.

Moisture Status

W	Wet	Glistening water films visible on peds and particles
VM	Very moist	At or near field capacity. Fingers quickly moistened when soil is handled
M	Moist	Soil does not change colour when moistened
D	Dry	Colour darkens when wetted

A slightly moist category (SM) is also used with properties intermediate between dry and moist.

Consistence-Wet

Plasticity

NP	Non-plastic	Will not form a 4 cm x 6 mm wire
SP	Slightly plastic	Will form a 4 cm x 6 mm wire but easily fractured or deformed
P	Plastic	4 cm x 4 mm wire easily formed
VP	Very plastic	4 cm x 2 mm wire easily formed

Stickiness

NS	Non-sticky	Does not adhere to fingers
SS	Slightly sticky	Adheres to finger or thumb when pressed
S	Sticky	Adheres to finger and thumb when pressed
VS	Very sticky	Adheres strongly to finger and thumb

Consistence-Moist

L	Loose	Non-coherent
VFRI	Very friable	Crushes under very gentle pressure and coheres
FRI	Friable	Crushes easily under gentle or moderate pressure and coheres
FRM	Firm	Crushes under moderate pressure but with noticeable pressure
VFRM	Very firm	Crushes only under strong pressure, but can only just be crushed between finger and thumb
EFRM	Extremely firm	Crushes only under very strong pressure, cannot be crushed between finger and thumb

Consistence – Dry

L	Loose	Non-coherent
S	Soft	Only very weakly coherent, breaks very easily
SH	Slightly hard	Weak resistance to pressure but broken easily between finger and thumb
H	Hard	Moderate resistance to pressure, but can only just be broken between finger and thumb
VH	Very hard	Very resistant to pressure but can be broken in the hands
EH	Extremely hard	Cannot be broken by hand

Induration – Tick the box which best describes any induration present in the horizon. An indurated horizon has a high degree of compactness and density which means that considerable physical effort is required to dig through such a layer. Indurated horizons are much more resistant to vertical than horizontal disruption. Moderately and strongly indurated horizons are generally not penetrated by roots.

W	Weak	No great force is required to break the specimen, but a well defined brittle fracture is present
M	Moderate	Can be broken with some effort with the hands
S	Strong	Cannot be broken with the hands, can only be crushed under foot or with a hammer

Cement – Tick the box which best describes any *cementation* present in the horizon. Cementation of soil is caused by substances such as calcium carbonate, humus, silica or compounds of iron, manganese or aluminium. A cemented soil does not slake when an air-dried block is placed in water for one hour. However, if only weakly cemented, the hardness of the soil mass will be somewhat reduced by the same treatment, but the brittle fracture will be retained.

W	Weak	Brittle and hard but can be easily broken by the hand. When placed between extended forefinger and thumb, the applied pressure will force the soil mass to explode rather than crumble
M	Moderate	Brittle but can only be broken with extreme pressure in the hand. Easily broken with a hammer
S	Strong	Can only be broken by a hammer, which generally rings As a result of the blow

Roots

Tick the boxes which best describe the frequency, size and kind of the dominant root type in the horizon. Using the blank boxes, on rows four and five, the appropriate symbols for the second most dominant (if applicable) root type should be entered in row four, using box 1 for the ‘frequency’, box 2 for the ‘size’ and box 3 for the ‘kind’ and similarly, where appropriate, the third

most dominant root type should be entered in row five. The maximum rooting depth i.e. depth at which there are no longer any live roots, should be entered in the box with bold outline if not already recorded.

Frequency

Root frequency is determined by estimating the number of roots in 100 cm^2 of soil surface or by comparisons with dot diagrams. See Table 5 (*Taken from Soil Survey Field Handbook, Hodgson, 1997*)

Table 5: Abundance of Live Roots

Frequency Class	***Number of roots per 100 cm^2***	
	Very fine and fine roots	*Medium and coarse roots*
None	0	0
Few	1-10	1 or 2
Common	10-25	2-5
Many	25-200	>5
Abundant	>200	-

Frequency Symbols

N None
F Few
C Common
M Many
A Abundant

Size

The size of roots (diameter) can be measured or assessed visually. Roots larger than 10 mm diameter are usually very few in number, even in woodland soils, and their size, number and distribution should be described separately in general terms, stating their diameter and average distance apart.

VF	Very fine	<1 mm diameter
F	Fine	1-2 mm diameter
M	Medium	2-5 mm diameter
C	Coarse	5-10 mm diameter
VC	Very coarse	>10 mm diameter

Kind

The nature of the roots should be assessed.

FL	Fleshy	e.g. tap roots or bracken rootstock
FI	Fibrous	e.g. grass roots
W	Woody	e.g. larger tree roots
RHI	Rhizomatous	e.g. rhizomes

Stones

Tick the boxes which best describe the frequency, size and shape of the dominant stones in the horizon. The lithology of the stones (see Appendix 2) should be entered and right justified in the blank boxes on row three. The ‘frequency’, ‘size’ and ‘shape’ symbols and the lithology codes of the second-most dominant stone type should be entered in sequence in the boxes on row four and similarly , if appropriate, for a third stone type in the boxes on row five.

Frequency

The percentage by volume of stones should be estimated by eye using the proportion diagrams on the Munsell book insert.

N	None	0% volume
F	Few	1 to 5% volume
C	Common	6 to 15% volume
M	Many	16 to 35% volume
A	Abundant	36 to 70% volume
VA	Very abundant	>70% volume

Size

The size of the stones should be estimated using the scale:

VS	Very small	<6 mm diameter
S	Small	6 mm to 2 cm diameter
M	Medium	2 to 6 cm diameter
L	Large	6 to 20 cm diameter
VL	Very large	20-60 cm diameter
B	Boulder	>60 cm diameter

Shape

Fragments/stones with more or less, equal sized axes are described as varying degrees of roundness or angularity. The ‘roundness/angularity’ should be described using the following terms: *rounded, subrounded, subangular, angular*

Stones with unequal axes should be described further as ’*tabular*’ or ‘*platy*’.

The symbols used are:

R	Rounded
SR	Subrounded
SA	Subangular
A	Angular
PL	Platy

Total (%) stones

An estimate of the total percentage of stones in the horizon should be right-justified and entered in the two blank boxes on row one.

Boundary

Horizon boundaries are three-dimensional though they are normally described as two-dimensional as seen on the pit face.

Tick the boxes which best describe the thickness and form of the boundary of the horizon described, with the underlying horizon.

Thickness

The distinctness of a horizon boundary depends partly on the contrast between adjacent horizons and partly on the thickness of any transitional zone. The thickness of the transitional zone should be recorded in the classes given below:

Distinction		Change to next horizon occurs over:
S	Sharp	<2 cm
C	Clear	2 to 5 cm
G	Gradual	5 to 12 cm
D	Diffuse	>12 cm

Form

The degree of irregularity of the horizon boundary is described using the following terms:

SM	Smooth	Plane
W	Wavy	Pockets wider than deep
I	Irregular	Pockets deeper than wide
B	Broken	Not continuous

Additional Information

Notes – Enter any relevant information regarding site or soil.

Veg: - List vegetation species present at site.

Sketch – Draw annotated sketch of site location if necessary.

Additional Samples: List the depths and horizon symbol of any additional samples, not entered in boxes on front of description sheet.

Use an additional profile description sheet proforma (NSIS2) if more than 5 organic or 5 mineral horizons are encountered. Label it with Title, Site ID and GPS NGR.

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NSIS 2007- 2009 SITE AND PROFILE SAMPLING PROTOCOLS

A soil profile pit should be excavated at each location to a depth in excess of 75cm wherever possible and certainly to within the soil parent material. Once excavated, the profile should be examined and the main horizons identified. Before describing, the plastic and metal sampling tubes for the central core sample and the 0-5cm soil/air Interface core sample should be inserted. The composite auger samples should ideally be taken prior to the excavation of the satellite variability pits as some sample locations will coincide.

Profile horizon Samples (PB)

The limits of the horizons to be sampled should first be marked with a knife on the pit face and where possible, with the exception of iron pans (Bf horizon), each horizon in the profile should be sampled. Every attempt should be made to sample surface organic horizons (L, F, H and O horizons), but it remains up to the surveyor to assess the practicality and relative importance of taking such samples. In circumstances where surface organic horizons are not thick enough, or the delineation so indistinct, to allow sampling horizons individually, composite samples may have to be taken to allow a satisfactory volume of sample to be obtained. Suggested composite samples are LF and FH. Approximately 1.5 to 2 kg of relatively stone free soil should be collected from each horizon. As many stones should be removed from the sample as possible.

Samples should be taken from a 10 cm depth band, approximately in the middle of the horizon or at depths thought to be appropriate, either for comparative purposes with archive samples or where the thickness of the horizon is judged to warrant more than one sample. In some situations where the horizon thickness is less than 10 cm, the top and bottom sample depths will be set to allow a representative and pure sample to be collected from the horizon. Thin transition zones up to 6 cm thick can be excluded where boundaries are gradual or diffuse.

The soil material is loosened and extracted by a clean trowel or knife, collected in a sampling tray held level with the lower boundary of the sample depth, and placed in a bag. Two labels are prepared with profile name, NSIS1 NGR, horizon symbol, depth of sample, type of sample (MARK AS PB), date of sampling and surveyor initials written legibly. Excess air should be removed from the sample bag and sealed as soon as possible to avoid contamination. It should be made air tight by folding over the top few centimetres twice. If not to be double bagged, a sample label should be slotted under the fold and another attached to the outside before stapling shut. This bag can be placed inside another if required, in which case, a label can be placed between both bags. This second bag is then stapled with the second label attached to it.

Bulk Density Samples from the main Profile (PDBD)

Food-grade stainless steel rings of 7.6 cm diameter (7.2 cm internal diameter) x 5 cm height are inserted either vertically or horizontally into the appropriate horizon by applying an even pressure. A knife, scraping tool or other sharp instrument can be used to cut the soil and large roots below the core depth and to push small stones to one side to improve insertion, however, it is best to attempt to avoid stones. Ensure there is no compression or compaction sustained in the sampling process. Bulk density samples will be taken in triplicate from each horizon whenever possible. The rings are carefully extracted using a trowel or knife and carefully trimmed to ensure that there is no extruding material or stones. Small gaps can be repacked with aggregates provided they are not compressed and extruding stones should be removed with the gap again filled with an appropriately sized aggregate. Where horizons are thinner than 5cm, it is legitimate to partially fill the ring, excavate, move to a fresh area and insert the partially filled ring until full. Take care not to compress the material. All the material is then extruded into individual mini-grip bags which are labelled using a marker pen with sample number 1-3. These bags can then be placed into a large soil sample bag for ease of sorting later. This bag is then labelled with profile name, NSIS1 NGR, horizon symbol, depth of sample, type of sample (MARK AS PDBD), date of sampling and surveyor initials and then stapled.

Central Core Sample (CS)

As one of the objectives of the NSIS resampling programme is to compare sampling methods currently in use in the UK, soil cores compatible with the CEH Countryside Survey sampling method will be taken from the centre of the soil pit using 15 cm long by 5cm internal diameter plastic sample rings. The rings will be inserted by applying an even pressure into the soil from the surface (after removal of vegetation and living plant material) so that the top edge is flush with the soil surface, incorporating any L horizon. A knife or other sharp instrument can be used to ease insertion. Ensure there is no compression or compaction sustained in the process. The sample ring is then extracted with the core intact using a trowel to dig the core out as necessary and the soil is trimmed flush with the base of the core. While still contained within the sample ring, the core is placed intact into a bag labelled with profile name, NSIS1 NGR, type of sample (MARK AS CS), date of sampling and surveyor initials.

Soil-air Interface Sample (ED)

Although originally considered as an ‘Endocrine Disruptor Sample’ this soil surface sample may be used to determine a range of near-surface soil properties particularly air-borne contaminants and it is important to keep the sample away from any plastic sampling material. A food-grade stainless steel ring of 7.6 cm diameter x 5 cm height (7.2 cm internal diameter) is inserted vertically into the soil surface by applying an even pressure and at a distance of at least 15cm from the CS sample ring along the face of the soil pit. A knife or other sharp instrument can be used to cut the soil and large roots below the

core depth and to push small stones to one side to improve insertion, however, it is best to attempt to avoid stones. Ensure there is no compression or compaction sustained in the process. The ring is carefully extracted using a trowel or knife and the base should be carefully trimmed to ensure that there is no extruding material or stones. Ensure at all times that any contact with plastic materials is kept to a minimum and preferably avoided. The sample is then extruded on to a double sheet of aluminium foil and sealed. Provided the sample **is sealed**, it can be placed in a plastic sample bag for transportation and sorting. The samples should be kept cool whenever possible and return to the Institute within 48 hours is desirable but not obligatory. The bags should be labelled with NSIS1 NGR, profile name, type of sample (MARK AS ED), date of sampling and surveyor initials.

Moisture Retention Core Samples (MRC)

Stainless steel rings of (5.6 cm diameter x 4 cm height) are inserted vertically into the main mineral topsoil horizon by applying an even pressure and at a depth similar to that of the bulk profile sample. A knife or other sharp instrument can be used to cut the soil and large roots below the core depth and to push small stones to one side to improve insertion, however, it is best to attempt to avoid stones. Ensure there is no compression or compaction sustained in the process. Moisture release samples will be taken in triplicate from the topsoil whenever possible. The rings are carefully extracted using a trowel or knife and carefully trimmed to ensure that there is no extruding material or stones. Small gaps can be repacked with aggregates provided they are not compressed and extruding stones can be removed with the gap again filled with a similar sized aggregate. The sample rings should be labelled with NSIS1 NGR, horizon symbol, depth of sample and sample number 1-3. Plastic lids should be carefully fitted to avoid compressing air which may force soil out of the ring. These cores can then be placed into a large soil sample bag for ease of sorting later, this bag is then stapled.

Aggregate Stability Samples (AS)

Approximately 0.5kg of mineral topsoil and 0.5 kg of subsoil should be carefully extracted using a trowel, at the same depth as the bulk sample and retaining as many of the aggregates as intact as possible. The samples should be placed in a 0.6l plastic tub and labelled using permanent marker on the sample tub with profile name, NSIS1 NGR, horizon symbol, depth of sample, date of sampling and surveyor initials. It is important not to overfill the tub and to avoid compression of the aggregates.

Composite Auger Sample

As one of the objectives of the NSIS resampling programme is to compare sampling methods currently in use in the UK, composite auger samples which replicates the National Soil Inventory sampling in England and Wales (data now held by NSRI) will be taken. In mineral soils, twenty five 1” auger borings from 0-15cm (starting below a litter layer) will be taken from an area 20m by 20m centred on the profile pit and pattern The individual samples will be

bulked and placed in a bag. In organic soils, the grid should be increased in density to 3m intervals to provide sufficient soil for analyses. In rocky landscapes with shallow soils, additional auger borings will be taken within the 20m by 20m area to give approximately the same volume of soil as would be collected in non-rocky areas. Two labels are prepared with profile name, NSIS1 NGR of the main pit, type of sample (MARK AS NSRI), date of sampling and surveyor initials. Excess air should be removed from the sample bag and sealed as soon as possible to avoid contamination. It should be made air tight by folding over the top few centimetres twice. If not to be double bagged, a sample label should be slotted under the fold and another attached to the outside before stapling shut. This bag can be placed inside another if required, in which case, a label can be placed between both bags. This second bag is then stapled with the second label attached to it.

If any part of the sampling grid falls on a different land use or land holding, the grid will be off-set sufficiently to avoid such differences.

Topsoil Variability Samples (TV)

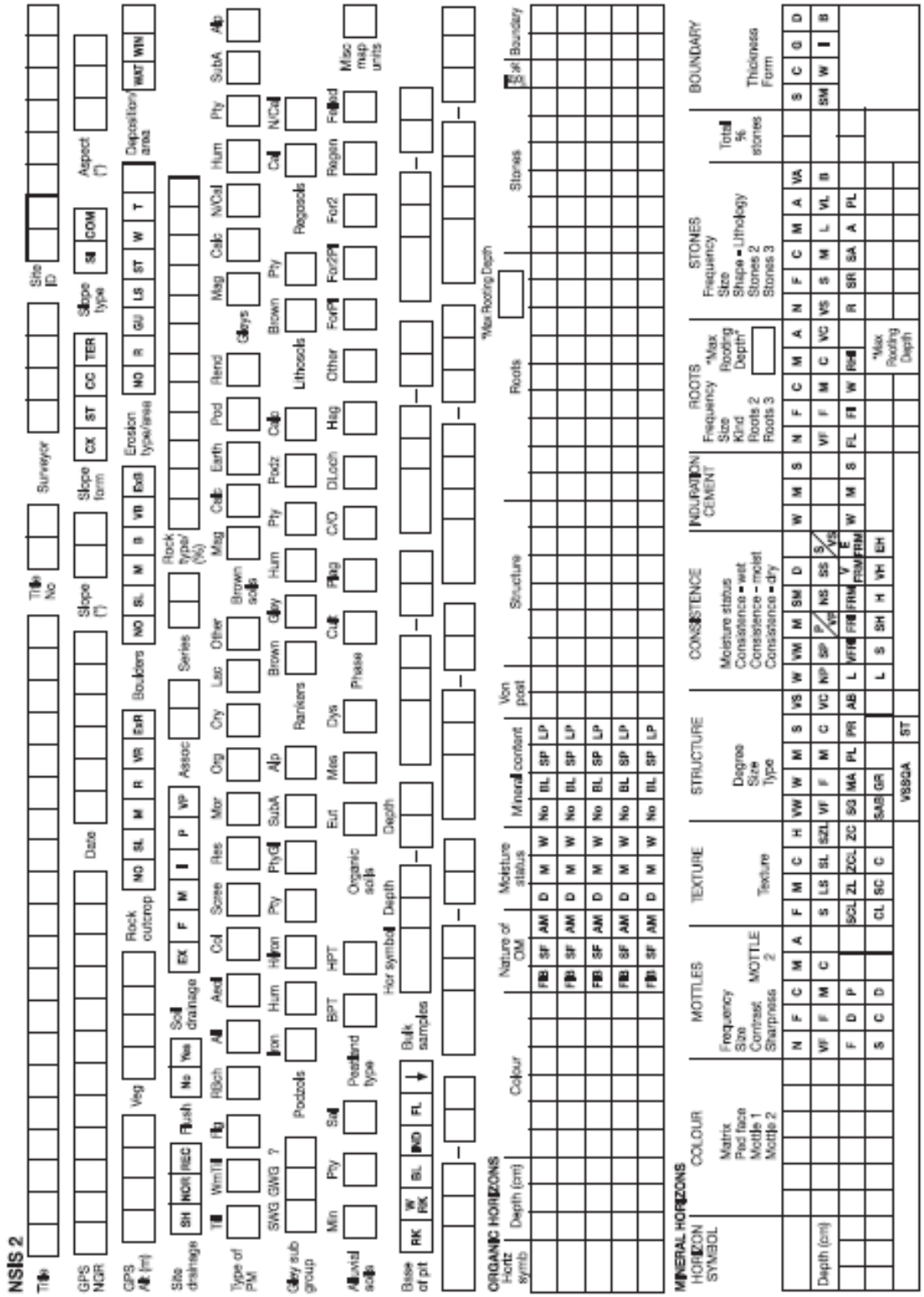
Four additional satellite pits, aligned to each of the 4 cardinal points and at a distance of 4, 8 or 16 m from the centre of the central soil pit, will be dug sufficiently deep to allow the determination of the thickness of all organic horizons wherever possible. The distances and directions will be randomized for each location and two samples at the 16m distance will be taken at different orientations (sheets with the list of directions and distances will be provided). A sample of approximately 1kg should be taken from the same near-surface, organic-rich, pedological horizon as the main profile pit and at the same depth if possible. If the soil type is different from that at the main pit or the horizon is not present, a sample should be taken at the same depth of the first major near-surface horizon sampled within the main pit and clearly marked as being different. If the sample point falls on bare rock, the point will be included as one of the four samples and recorded as rock. Two labels are prepared with profile name, NSIS1 NGR of the main pit, variability site number, horizon symbol, depth of sample, type of sample, date of sampling and surveyor initials. THE LABEL SHOULD BE CLEARLY MARKED WITH A ‘TV’ FOLLOWED BY SITE NUMBER USING A PERMANENT MARKER. Site number relates to the diagram on the field checklist.
Excess air should be removed from the sample bag and sealed as soon as possible to avoid contamination. It should be made air tight by folding over the top few centimetres twice. If not to be double bagged, a sample label should be slotted under the fold and another attached to the outside before stapling shut. This bag can be placed inside another if required, in which case, a label can be placed between both bags. This second bag is then stapled with the second label attached to it.

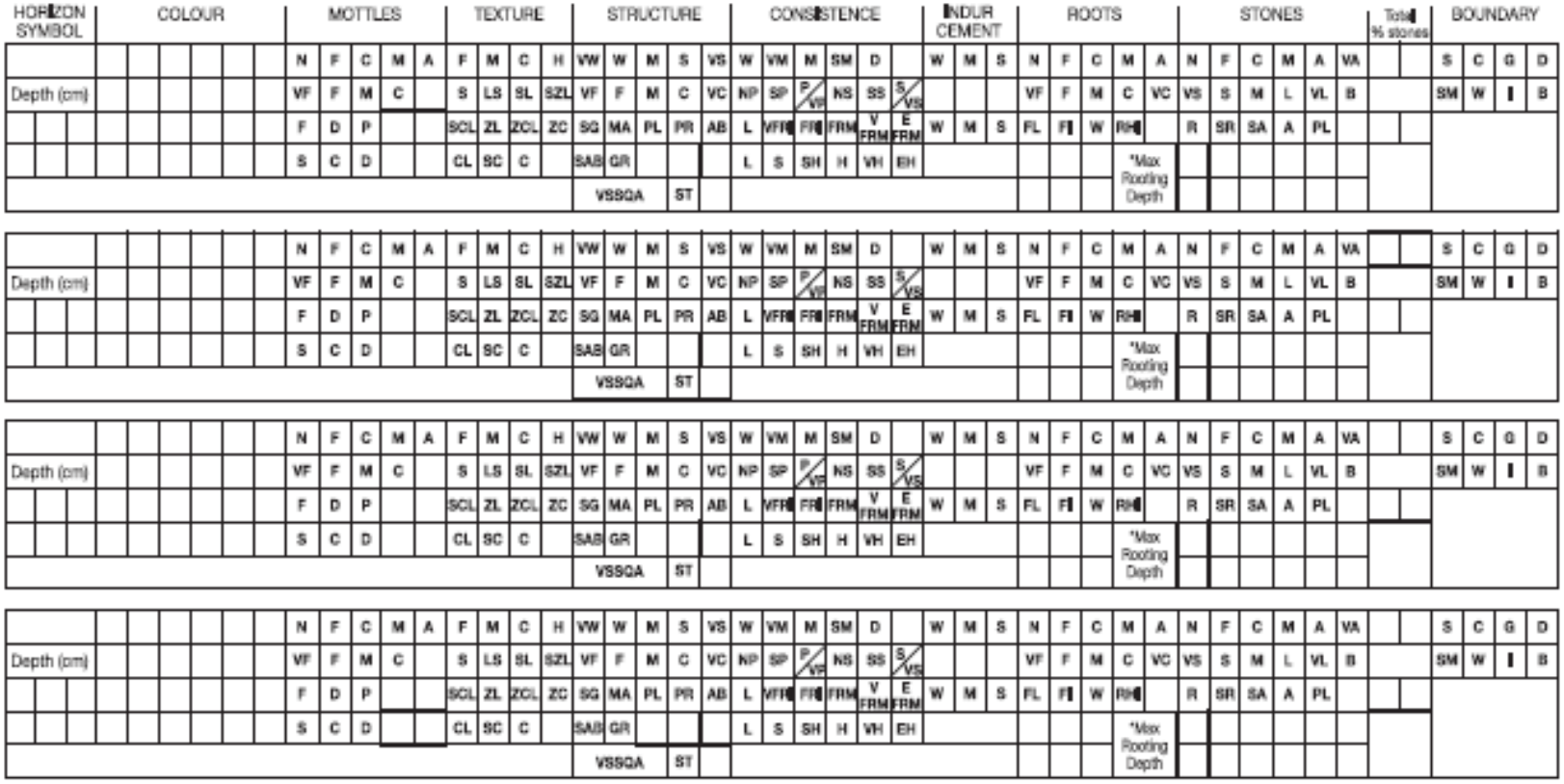
Topsoil Variability Bulk Density Samples (TVDBD)

One bulk density core (food-grade stainless steel rings of 7.6 cm diameter (7.2 cm internal diameter) x 5 cm height) will be taken from the sampled horizon, at each of the four satellite pits, following the protocols described

above (Section 2). The material will be extruded into mini-grip bags and each labelled with site number from field checklist, horizon symbol and depth of sample using a permanent marker. These bags can then be placed into a large soil sample bag for ease of sorting later. This bag is then labelled with profile name, NSIS1 NGR, variability site number, type of sample (MARK AS TVDBD), date of sampling and surveyor initials and stapled.

APPENDIX 1 NSIS 2007-2009 soil profile description proforma




HORIZON SYMBOL
COLOUR
MOTTLES
TEXTURE
STRUCTURE
CONSISTENCE
INDUR CEMENT
ROOTS
STONES
Total % stones
BOUNDARY
Depth (cm)
*Max Rooting Depth
NOTES:
VEG:
SKETCH:
ADDITIONAL SAMPLES:

APPENDIX 2 ROCK TYPE CODES

The frequency, size and shape of stones within the soil can be coded according to standard terms. However it is important that rock type is also recorded and these have been assigned the following codes.
The list is not exhaustive and rock types can be added when required.

IGNEOUS ROCKS (1-200)			
	GRAIN SIZE		
	COARSE	MEDIUM	FINE
ACID	GRANITE 1 GRANOPHYRE 2 PEGMATITE 3 TRONDHJEMITE 4 ADAMELLITE 5 GRANODIORITE 6 FOLIATED GRANITE 7 UNDIFF ACID 15	MICROGRANITE 16	RHYOLITE 31 ACID PITCHSTONE 32 QUARTZ PORPHRY 33 FELSITE 34
INTER-MEDIATE	SYENITE 46 DIORITE 47 MONZONITE 48 UNDIFF INTERMED 60	MICROSYENITE 61 MICRODIORITE 62	TRACHYTE 76 ANDESITE 77 INTERMED PITCHSTONE 78
BASIC	GABBRO 91 EUCRITE 92 ALLIVALITE 93 MUGEARITE 94 HARRISITE 95 TESCHENITE 96 KENTALLENITE 97 UNDIFF BASIC 105	DOLERITE 106 QUARTZ DOLERITE 107 OLIVINE DOLERITE 108	BASALT 121 CRINANITE 122 PNEUMATOLYSED BASALT 123
ULTRA-BASIC	PERIDOTITE 136 PYROXENITE 137 HORNBLENDITE 138 PICRITE 139 SERPENTINITE 140 INDIFF U/BASIC 180		

PYROCLASTIC ROCKS			
VERY COARSE	COARSE	FINE	NON-CRYSTALLINE
AGGLOMERATE 181	VOLCANIC BRECCIA 187	TUFF 191	GLASS 196 PUMICE 197

METAMORHIC ROCKS (201–500)		
	NORMAL FABRIC	**ROCK TYPE**
UNFOLIATED	HORNSFELIC	HORNFELS 201
	GRANULOSE	DOLOMITE 221 ECLOGITE 222 EPIDIORITE 223 LIMESTONE 224 MARBLE 225 QUARTZITE 226
FOLIATED (flaky minerals occurring in layers)	POORLY FOLIATED	AMPHIBOLITE 241 ARGILLITE 242 CHARNOCKITE 243 GRANULITE 244
	STRONGLY DEVELOPED CLEAVAGE PLANES	SLATE 261 BLACK SLATE 262
	CLEAVAGE PLANES BECOMING SCHISTOSE	PHYLLITE 281
	SCHISTOSE (finely foliated)	ANDALUSITE SCHIST 301 ANDALUSITE-CORDIERITE SCHIST 302 CALCAREOUS SCHIST 303 CHLORITE SCHIST 304 EPIDOTE-CHLORITE SCHIST 305 GARNET SCHIST 306 GLAUCOPHANE SCHIST 307 GRAPHITE SCHIST 308 HORNBLENDE SCHIST 309 MICA SCHIST 310 QUARTZ SCHIST 311 QUARTZ-MICA SCHIST 312 SCHISTOSE GRIT 313 SCHISTOSE FLAGS 314 SILLIMANITE SCHIST 315 STAUROLITE SCHIST 316 TALC SCHIST 317 BLACK SCHIST 318 ARGILLACEOUS SCHIST 319 UNDIFF SCHIST 380
	GNEISSIC	UNDIFF GNEISS 440
	INJECTED WITH GRANITE	MIGMATITE 441 BIOTITE GNEISS 442 GRANITIC GNEISS 443
BRECCIATED	MYLONITIC	MYLONITE 461
	AUGEN	AUGEN GNEISS 481

SEDIMENTARY ROCKS (500-700		
GRAIN SIZE	**ROCK TYPE**	
AMORPHOUS-MICROCRYSTALLINE	FLINT CHERT QUARTZITE	500 501 502
CLAYEY	MUDSTONE CALCAREOUS MUDSTONE CLAY SHALE DIATOMITE	521 522 523 524
SILTY	SILTSTONE SILTY SHALE FLAGSTONE UNDIFF SHALE	541 542 543 555
SANDY	FELSPATHIC SANDSTONE MICACEOUS SANDSTONE SILICEOUS SANDSTONE CALCAREOUS SANDSTONE ARKOSE SANDSTONE FERRUGINOUS SANDSTONE GRIT ARKOSE GRIT AEOLIAN SANDSTONE UNDIFF SANDSTONE	561 562 563 564 565 566 567 568 569 590
MIXED	GREYWACKE	591
COARSE	BRECCIA COMGLOMERATE	611 612
CARBONATIC	LIMESTONE SHELLY LIMESTONE OOLITIC LIMESTONE PISOLITIC LIMESTONE CHALK CORNSTONE DOLOMITIC LIMESTONE	631 632 633 634 635 636 637
CARBONACEOUS	COAL	681

APPENDIX 3 SOIL HORIZON NOMENCLATURE

Horizon nomenclature

In order to compare and classify soil profiles, it is convenient to designate soil horizons by a letter notation, the same letter being applied to similar horizons in profiles of similar type. The internationally approved symbols used are set out below however, it should be noted that, in Scotland, the definition of O and H horizons are the opposite of that used by FAO (2006).

Master horizons.

A master horizon is represented by one of nine capital letters: L, F, H, O, A, E, B, C or R. An Arabic figure following a letter indicates vertical subdivision (e.g. C1, C2). A transitional horizon with properties of two master horizons is shown by the combination of two capital letters (e.g. AE, BC). In layered parent materials, an Arabic numeral is used as a symbol prefix when it is necessary to distinguish lithological or textural contrasts (e.g. 2C when the C horizon differs from the material in which the solum, i.e. A and B horizons, is presumed to have formed.

L	Fresh annual litter, normally loose, original plant structures obvious.
F	Decomposed litter, only some of the original plant structures obvious.
H	Well-decomposed organic matter formed under aerobic conditions. Plant structures not visible. May be mixed with some mineral matter. (Mor humus).
O	Peaty material formed under wet, anaerobic conditions.
A	Mineral horizon formed at or near the surface that shows an accumulation and incorporation of organic matter, or which has morphology acquired by soil formation but lacks the properties of E or B horizons.
E	Eluvial horizon underlying an H, O or A horizon from which it can normally be differentiated by a lower content of organic matter and lighter colour, particularly when dry. Usually shows a concentration of sand and silt fractions with a large component of resistant minerals resulting from a loss of clay, iron or aluminium.
B	Mineral horizon in which there is little or no obvious rock structure and having one or both of the following: 1. alteration of the original material involving solution and removal of carbonates; formation, liberation or residual accumulation of silicate clays or oxides; formation of granular, crumby, blocky or prismatic peds; or (normally) some combination of these; 2. illuvial concentration of silicate clay or iron, aluminium or humus.
C	Mineral horizon of unconsolidated material from which the solum is presumed to have formed.
R	Underlying consolidated bedrock sufficiently coherent when moist to make hand digging with a spade impracticable.

Sub-horizons Mineral soils

A lower case letter may be added to the capital to qualify the master horizon designation. More than one letter may be used if necessary, e.g. Bhs1 indicates the first of two B horizons enriched in humus and sesquioxide material. Symbols may be bracketed if the feature development is weak.

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These symbols have more precise significance when applied to specific major soil subgroups.

b	Buried (e.g. bA).
f	Sharply defined thin iron pan.
g	Horizon with gley features.
h	Accumulation of organic matter in a mineral horizon (e.g. Ah or Bh).
m	A cemented horizon, other than a thin iron pan. Often used in conjunction with another symbol (e.g. Bmh for a horizon cemented with organic matter).
p	Disturbed by ploughing.
s	Accumulation of sesquioxide material.
t	Accumulation of illuvial clay.
w	Alteration in situ in accordance with section 1 of the description of the B horizon
x	Indurated layer, compacted but not cemented.

Sub-horizons Organic soils

A lower case letter (a,s,f) may be added to qualify the master O horizon designation. These equate to the degree of decomposition of the organic material.

a	Amorphous
s	Semi-fibrous
f	Fibrous