Official Handbook of the International Soil Judging Contest

July 27-31, 2022

Stirling, Scotland

This handbook was compiled by Matt Aitkenhead and Richard Hewison, adapted from the original handbook produced for the Soil Judging Contest in Hungary in 2015

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GENERAL INFORMATION

The scope of the Soil Judging Contest is for participants to use their knowledge and practical skills to describe, understand and interpret soil characteristics in the field. Participants (in the form of teams and individuals) will describe a series of contest profiles using basic field methods, selected standards and guidelines. The winners will be selected on their ability to correctly describe each soil, evaluate potential soil functions and interpret their capacity to perform under different land use and management practices. To prepare for the event, a four day technical training course is offered.

This event follows the successful 1st International Soil Judging Contest that was held during the 20th World Congress of Soil Sciences in Jeju, Korea in June 2014 and the Soil Judging Contests held in Hungary in 2015 and Brazil in 2018.

Training (4 days)

An international team of soil experts will give an overview of the methods used to characterize site, profile descriptions and soil classification standards. Local experts will introduce the landscape, soil conditions and soil forming processes of Scotland with a focus on the areas of the contest. There will also be an emphasis on soil functionality and management. Short classroom sessions will be followed by practical training of field procedures and techniques. Standard samples will be provided for training of texture class, clay % and sand % determination. The soils in question will cover a diverse geographical area with a range of topographic, parent material, moisture regime and management conditions. The training profiles will include Histosols, Leptosols, Gleysols, Podzols, Stagnosols, Umbrisols, Cambisols, Arenosols, Fluvisols, Technosols and Regosols (according to the World Reference Base of Soil Resources (WRB)) and Histosols, Mollisols, Spodosols, Inceptisols and Entisols (according to Soil Taxonomy (ST)).

The Contest (1 day)

Participants (teams or individuals) will describe the contest profiles, based on the available field tools and selected standards and guidelines. Evaluation of potential soil functions and interpretation of the capacity of the soil to perform under different use and management will be also scored. The four contest soil profiles will be selected from the soil types observed or discussed during training.

Equipment and reference materials

The following equipment will be supplied to each team for the duration of the contest

- Soil knife/digging tool
- Water bottle
- Container for soil samples
- Clipboard and pencil
- Plastic bags (for collection of standard soil samples for texture determination)

The teams are recommended to bring their own Munsell Soil Colour Chart books, as only limited number can be supplied by the organizers (1 copy per team).

The following reference materials will be permitted during the contest:

- This printed handbook – provided by the organizers
- World Reference Base for Soil Resources (IUSS Working Group WRB, 2015) – provided by the organizers (only 1 copy/team)
- Keys to Soil Taxonomy Twelfth Edition (Soil Survey Staff, 2014) – provided by the organizers (1 copy/team)
- The official USDA published Illustrated Keys to Soil Taxonomy can be used – not provided by the organizers
- Guidelines for Soil Description (FAO, 2006) – not provided by the organizers
- Field Book for Describing and Sampling Soils (Schoeneberger et al., 2012) – provided by the organizers (1 copy/team)

Training and Contest Outline

On the 27th of July (Wednesday) after the opening there will be presentations on the soils of Scotland as well as an introduction to their governance and management, followed by a lecture on the concepts and workings of a soil judging contest. After lunch there will be field training on site and profile description around the Stirling University campus. This training will focus on soil texture, structure and colour assessment and the identification of horizon boundaries and general profile structure.

On the 28th of July (Thursday) training on soil classification will take place focusing on the diagnostic elements of the World Reference Base for Soil Resources (WRB) and Soil Taxonomy. After lunch, field training on soil classification will take place at two sites, on the banks of the River Forth near Stirling and at a farm near Flanders Moss, a famous peatland site to the west of Stirling. On the 29th of September (Friday) there will be further morning lectures on soil assessment and scoring followed by afternoon field training at Dumyat in the hills above Stirling. By the end of this day, participants will have received training in all elements of the contest scoresheet.

On the 30th of July (Saturday) there will be a full day of contest practice and teaching in and around Devilla Forest, 30 minutes east of Stirling. Four soil pits will be assessed in a live feedback and discussion format under semi-formal contest conditions. Teams will be able to assess each pit for one hour, rotating between pits and with opportunity to learn from coaches and event organisers. Field volunteers will be present to provide assistance, oversee contest guidelines and deal with practicalities.

On the 31st of July (Sunday) the formal Contest will take place. Following the rules of earlier International Soil Judging Contests, a typical section will be selected in each pit and clearly designated as the control section by the contest officials. A measuring tape will be placed within the control section and will be used for measurement of horizon depths and boundaries; it will constitute the officially scored profile and must remain undisturbed and unblocked. This will be maintained by official pit monitors. All measurements should be made within this designated area. A nail will be placed at the bottom of the third horizon. Up to seven (7) horizons will be described within a given depth. A card at each site will give the profile depth to be considered, the number of horizons to be described, the nail depth, and any chemical, physical or other data that may be required for classification or judging within each system.

During the training days, the organisers will provide one scoresheet per person for all field events, for practice and familiarisation. There will be one scoresheet printed on rain-proof paper per team for each pit in the team contest and one scoresheet per person for each pit in the individual contest. The scoresheets are to be filled out using information from the training given, laboratory information provided and instructions within this handbook.

During the Contest, a group of assessors including Contest organisers, team coaches and other specialists will receive the full laboratory dataset and the filled scoresheets, which will be photographed and sent to them at the World Congress venue in Glasgow for printing. These scoresheets will be assessed against a scoresheet completed by a group of expert soil scientists, and team/individual performance scored. The team and individual contests will be run in parallel, with half of the participants taking part in the team contest in the morning and the individual contest in the afternoon. The other half of the participants will reverse this order.

Conduct of the individual contest

Two sites will be used for the individual contest. Following the rules of previous International Soil Judging Contests, 60 minutes will be allowed for evaluating each site and soil for individual judging. Competitors will be assigned randomly to one of two groups at each site.

One group will follow this schedule: 10 minutes in the pit, 10 minutes out, 10 minutes in, 10 minutes out, and 20 minutes free-for-all. The other group will follow the opposite in-and-out schedule. At alternating sites, the competitors will switch the in-and-out schedule. Competitors may obtain a sample from the surface horizon while out of the pit, provided they do not enter the pit or disturb those already in the pit. Individual competitors will be assigned a number that will be used to identify their scoresheet and the rotation schedule. The procedures for student rotation and time in and out of the pit may be altered prior to the contest to meet unanticipated difficulties at the site (Official Handbook of the Inaugural International Soil Judging Contest, 2014).

General rules of the individual contest:

- Competitors must use the official abbreviations provided to them during the contest
- Competitors are not allowed to speak to each other
- Competitors are not allowed to use mobile phones or other electronic communication devices
- Competitors can bring their copy of this handbook with any notes that they have written on it within reason
- Competitors are allowed to use the equipment provided on site, a simple calculator, and the allowed standards

Conduct of the team contest

Two sites will be used for the individual contest. Following the rules of previous International Soil Judging Contests, 60 minutes will be allowed for teams to evaluate each of the two sites. The time will be divided into 10-minute segments similar to the individual contest. Teams will be randomly assigned a team number at registration. All competitors in a team may participate in the team contest.

General rules of the team contest:

- Teams must use the official abbreviations provided to them during the contest
- Team members are allowed to speak to other team members, as long as their conversation is not loud enough to be heard by other teams
- Competitors are not allowed to use mobile phones or other electronic communication devices
- Competitors are allowed to use the equipment provided on site, a simple calculator, and the allowed standards

SITE CHARACTERISTICS

Land use

Task on the scoresheet: Determine the land use class according to Table 1. (FAO Table 8.)

Table 1. Land use classification

Class	Classification
F	Forest
A	Arable or horticulture
I	Improved grassland
S	Seminatural grassland
W	Water
B	Bare ground/rock
U	Urban/built-up
H	Heath
B	Bog/swamp
O	Other

Slope (°)

Task on the scoresheet: Use the instructions given in training to determine the slope gradient as a percentage according to the Table 2. (FAO Table 17.). If the slope gradient is between 0 and 2 % choose 01, 02, 03 or 04.

Table 2. Slope gradient class codes

Code	Description	Slope gradient (°)
03	Nearly level	<1
04	Very gently sloping	1 - <2
05	Gently sloping	2 - <5
06	Sloping	5 - <10
07	Strongly Sloping	10 - <15
08	Moderately steep	15 - <30
09	Steep	30 - <60
10	Very steep	≥60

Aspect

Task on the scoresheet: Use the instructions given in training to determine the slope aspect as a direction according to Table 3. Select the aspect category closest to the direction of the downhill slope.

Table 3. Aspect class codes

Code	Description	Aspect (°)
01	North	315-45
02	East	45-135
03	South	135-225
04	West	225-315

Slope position

Task on the scoresheet: Determine the slope position according to Figure 1. (FAO Figure 2.) and Figure 2. Use the class codes indicated in Table 4. Slope stakes are placed on the same landscape position as the pit. The flat positions are used on slopes of <1° where there is no associated undulating hillslope.

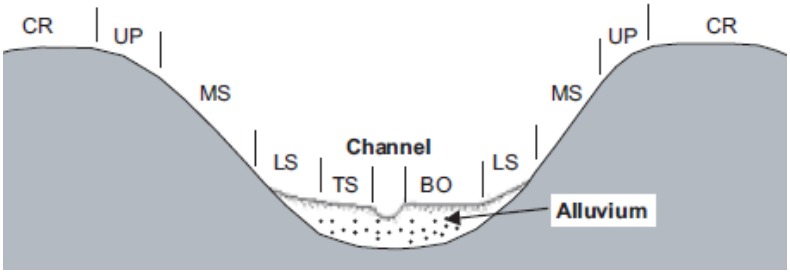


Figure 1. Slope positions in undulating and mountainous terrain

Figure 2. Scottish landscape features

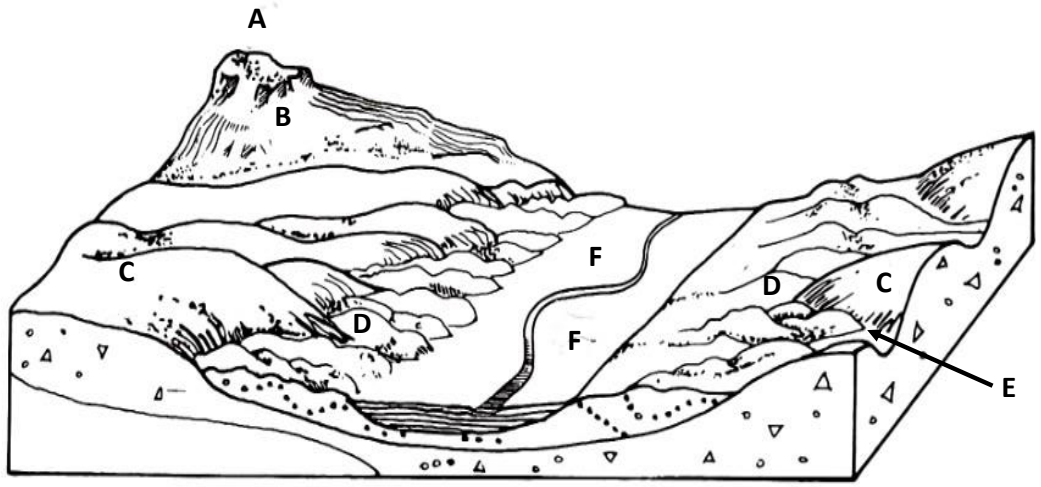


Table 4. Slope positions and codes in undulating/mountainous terrain and Scottish landscape features

Position in undulating/mountainous terrain		**Scottish landscape features**	
Code	Landform	Code	Landform
CR	Crest (summit)	**A**	Volcanic plug/weathered bedrock on highest slopes
UP	Upper slope (shoulder)	**B**	Steep mid slopes with crags, scree and colluvium
MS	Middle slope (backslope)	**C**	Gentle mid-lower slopes with or without glacial till
LS	Lower slope (foot slope)	**D**	Fluvioglacial terraces/mounds on lower slopes
TS	Toe slope	**E**	Basins in mid slope positions
BO	Bottom (flat)	**F**	Alluvial flat/low raised beach deposits

Parent material

Task on the scoresheet: Determine the parent material according to Table 5. (FAO Table 12.). If the parent material is igneous, metamorphic or consolidated sedimentary indicate only the *major class code*. If the parent material is unconsolidated sedimentary indicate the *group code*.

Table 5. Types of possible parent materials to be indicated

Major class code	Group code	Lithology
I		Igneous bedrock
M		Metamorphic bedrock
S		Sedimentary bedrock
U	UTL	Unconsolidated Till
	UFG	Unconsolidated Fluvioglacial
	UMO	Unconsolidated Morainic
	URB	Unconsolidated Raised Beach
	UFL	Unconsolidated Fluvial
	ULA	Unconsolidated Lacustrine
	UCL	Unconsolidated Colluvial
	USC	Unconsolidated Scree
	UAE	Unconsolidated Aeolian
O		Organic

Erosion Potential

Soil erosion potential refers to the likelihood of soil erosion by water. The potential for future erosion losses is influenced mainly by the texture of the surface soil and the amount of surface runoff at a site. Soil erosion potential is estimated using Table 6.

Table 6. Soil erosion potential classes in relation to surface runoff and surface horizon texture.

	Surface Horizon Texture			
Surface Runoff	**S, LS**	**SCL, SC**	**SL, CL, C, SIC**	**Org, L, SI, SIL, SICL**
Ponded	Very Low	Very Low	Very Low	Very Low
Very low	Very Low	Very Low	Low	Medium
Low	Very Low	Low	Medium	Medium
Medium	Very Low	Low	Medium	High
High	Low	Medium	High	Very High
Very high	Medium	High	Very High	Very High

Runoff

Surface runoff refers to the relative rate at which water is removed by overland flow. Soil characteristics, management practices, climatic factors (e.g., rainfall intensity), vegetative cover, and topography determine the rate and amount of runoff. In this contest, six runoff classes as described in the *Soil Survey Manual* (1993) will be used (Table 8). Contestants should consider vegetative cover quantity and quality to determine the runoff class. **Where good vegetative cover (bare soil generally not visible below cover) OR an O horizon is present, contestants should mark the next slower surface runoff class (up to very low).** Contestants should mark Ponded for sites in a depression with no surface runoff.

Table 8. Surface runoff classes in relation to slope and surface hydraulic conductivity (see Soil Profile Characteristics section).

Limiting hydraulic conductivity within 50 cm of soil surface* **(move one class lower for good vegetative cover, unless class is already very low or ponded)*			
	High	**Moderate**	**Low**
Depression	Ponded	Ponded	Ponded
0-<2% slope	Very low	Low	Medium
≥2-5% slope	Low	Medium	High
≥5-10% slope	Medium	High	Very high
≥10% slope	High	Very high	Very high

SOIL DESCRIPTION

Horizon designations

Task on the scoresheet: Indicate the horizon designation including a numeric prefix (Prefix), a capitalized alphabetic master designation (Master), a lower case alphabetic subordinate designation (Sub) and if applicable, a numerical subdivision (Number)

Horizon – Master – Letter (Master horizons and layers)

Table 9. The master horizons to be used

Code	Determination
Mineral horizons	
A	Surface or near-surface mineral horizon with some organic accumulation, usually a darker colour than underlying horizons and/or smaller clay content than underlying horizons.
E	A near-surface mineral horizon characterized by a loss of clay, iron, aluminium, or some combination of these; usually lighter in colour (higher value and/or lower chroma) than the overlying A and underlying B.
B	A mineral horizon characterized by one or more of the following: a concentration of clay, iron, aluminium, organic material or several of these; a structure and/or consistence unlike the horizons above and below; stronger colours (higher chroma and/or redder hue) than the horizons above and below.
C	Consolidated or unconsolidated material, usually partly weathered, little affected by pedogenic processes (secondary carbonate accumulation possible).
R	Hard bedrock that cannot be cut with a spade.
Organic horizons	
O	Horizons dominated by organic material consisting of partially decomposed organic materials that have accumulated on the surface of either mineral or organic soils. O horizons are not saturated with water for prolonged periods.
H	These horizons dominated by organic material formed from accumulations of undecomposed or partially decomposed organic material. All H horizons are saturated with water for prolonged periods or were once saturated but are now drained artificially.

Transitional horizons

There are two kinds of transitional horizons: those with properties of two horizons *superimposed*; and those with the two properties *separate.*

For horizons dominated by properties of one master horizon but having subordinate properties of another, two capital letter symbols are used, such as AB, EB, BE and BC. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon.

Horizons in which distinct parts have recognizable properties of two kinds of master horizons are indicated as above, but the two capital letters are separated by a virgule (/), such as A/C, B/E, B/C and C/R. Commonly, most of the individual parts of one of the components are surrounded by the other.

Horizon – Master – Prefix (Discontinuities)

In mineral soils, Arabic numerals are used as prefixes to indicate discontinuities. Wherever needed, they are used preceding the Master Letters. These prefixes are distinct from Arabic numerals used as suffixes to denote vertical subdivisions.

Where a soil has formed entirely in one kind of material, a prefix is omitted from the symbol; the whole profile is material 1. Similarly, the uppermost material in a profile having two or more contrasting materials is understood to be material 1, but the number is omitted. Numbering starts with the second layer of contrasting material, which is designated 2. Underlying contrasting layers are numbered consecutively. Even where a layer below material 2 is similar to material 1, it is designated 3 in the sequence. The numbers indicate a change in the material, not the type of material.

Horizon – Suffix (Subordinate characteristics within master horizons and layers)

Designations of subordinate distinctions and features within the master horizons and layers are based on profile characteristics observable in the field and are applied during the description of the soil at the site. Lower case letters are used as suffixes to designate specific kinds of master horizons and layers, and other features.

Table 10. The suffixes to be used.

Suffix	Short description	Used for
a	Highly decomposed organic matter	Organic horizons
e	Moderately decomposed organic matter	Organic horizons
i	Slightly decomposed organic matter	Organic horizons
d	Dense	Mineral horizons
b	Buried genetic horizon	Mineral horizons
g*	Stagnic conditions / *ST strong gley	No restriction
h	Illuvial accumulation of organic matter	Mineral horizons
s	Illuvial accumulation of sesquioxides (WRB) / illuvial accumulation of sesquioxides and organic matter (ST)	Mineral horizons
i/*ss	Slickensides / *ST	Mineral horizons
l*	Capillary fringe mottling (gleying) *only in FAO	No restriction
p	Ploughing or other human disturbance	No restriction, E, B or C as Ap
r*	Strong reduction *only in FAO	No restriction
w	Development of colour or structure	B horizons

Horizon – Number (Vertical subdivisions)

Horizons or layers designated by a single combination of letter symbols can be subdivided using Arabic numerals, which follow all the letters.

These conventions apply whatever the purpose of subdivision. A horizon identified by a single letter symbol may be subdivided on the basis of evident morphological features, such as structure, colour or texture. These subdivisions are numbered consecutively.

Horizon boundary

Task on the scoresheet: Determine the *depth (in cm)* from the mineral soil surface to lower boundary of each horizon except the last horizon. Determine the *distinctness* of the horizon boundaries according to Table 11 (FAO Table 24), and the *topography* of the horizon boundary according to Table 11 (FAO Table 24) and Figure 3.

Table 11. Classification of horizon boundaries by distinctness and topography

Distinctness			Topography		
Code	Class	Cm	Code	Class	Determination
A	Abrupt	0-2	S	Smooth	Nearly plane surface
C	Clear	2-5	W	Wavy	Pockets less deep than wide
G	Gradual	5-15	I	Irregular	Pockets more deep than wide
D	Diffuse	>15	B	Broken	Discontinuous

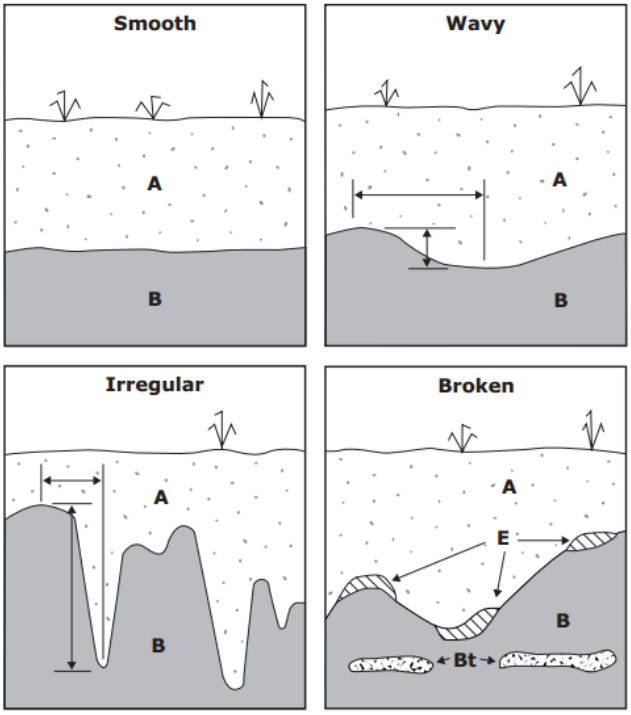


Figure 3. The categories of horizon topography (Schoeneberger et al., 2011).

Colour

Task on the scoresheet: Use the Munsell colour chart to determine the moist colour of each horizon described. Colours must be designated by Hue, Value and Chroma.

For routine descriptions, soil colours should be determined out of direct sunlight and by matching crushed but not rubbed sample (surface O, H and A horizons) or a broken ped (subsurface horizons) with the colour chip of the Munsell Soil Colour Charts. For special purposes, such as for soil classification, additional colours from crushed or rubbed material may be required.

Texture

Task on the scoresheet: Estimate the clay and sand content for each horizon. Determine the textural class using the USDA Textural Classification chart (Figure 4, FAO Figure 3) and use the coding indicated in Table 12 (FAO Figure 4).

Table 12. The coding of texture classes.

Code	Textural class	
S	Sand	Sand
LS	Loamy sand	
SL	Sandy loam	Loam
SCL	Sandy clay loam	
SiL	Silt loam	
SiCL	Silty clay loam	
CL	Clay loam	
L	Loam	
Si	Silt	Silt
SC	Sandy clay	Clay
SiC	Silty clay	
C	Clay	

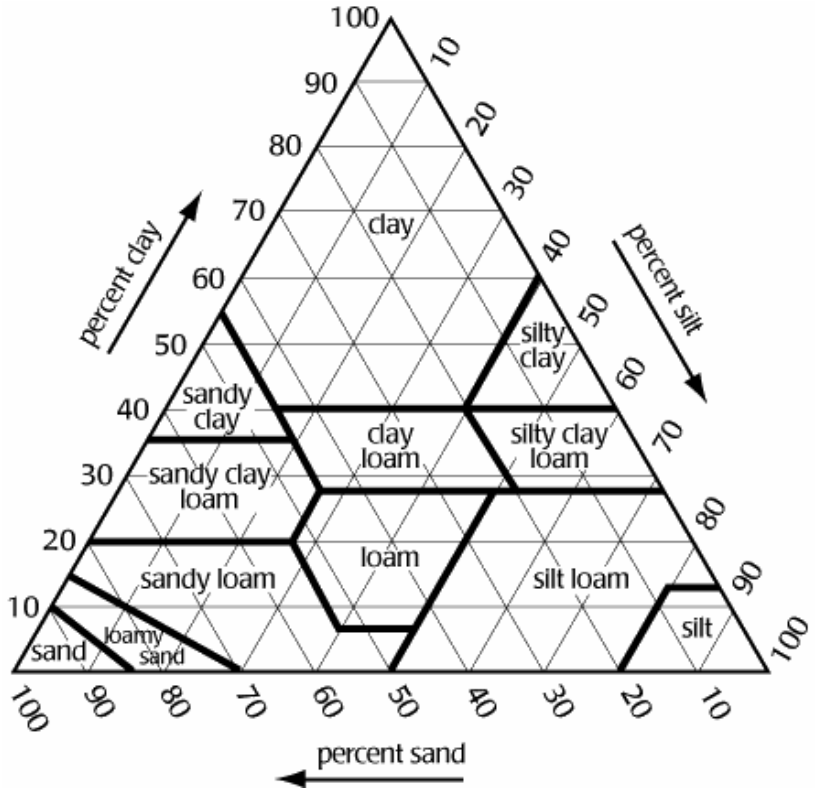


Figure 4. Relation of constituents of fine earth by size, defining textural classes

In addition to the textural class, a field estimate of the percentage of clay and sand are given. This estimate is useful for indicating increases or decreases in clay and/or sand content within textural classes, and for comparing field estimates with analytical results. The relationship between the basic textural classes and the percentages of clay, silt and sand is indicated in a triangular form in Figure 4. A colour version and flowchart for soil hand texturing is given at the end of this handbook

Organic Horizons

Nature of Organic Matter

- Fibric (F): more than two-thirds of recognizable plant tissue after rubbing
- Hemic (H): intermediate between fibric and sapric
- Sapric (S): less than one-sixth of recognizable plant tissue after rubbing

Moisture Status

- Dry (D): colour darkens when water is added
- Moist (M): does not change colour when water is added
- Wet (W): glistening water films on peds without added water

Mineral Content

- None (N):
- Bleached sand grains present (B)
- Sandy peat (S): Org C >35% but <50%, mineral fraction is >50% sand
- Loamy peat (L): Org C >35% but <50%, mineral fraction is <50% sand

Degree of Decomposition

The Von Post scale given below contains information about the level of decomposition of the organic material. This is carried out by taking a small ball (2 cm) of material mixed with a small amount of water and squeezing it in your fist.

Table 13. Von Post scale for decomposition of organic material.

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

Rock fragments (RF)

Task on the scoresheet: Estimate the abundance of rock fragments (> 2 mm) by volume according to the Table 14 (FAO Table 26).

Table 14. Abundance of rock fragments by volume

Code	Abundance	%
N	None	0
V	Very few	0-2
F	Few	2-5
C	Common	5-15
M	Many	15-40
A	Abundant	40-80
D	Dominant	> 80

Structure

Task on the scoresheet: Record the dominant ped type for each mineral horizon using Table 15 and Figure 5. Record the dominant structure grade for each horizon using the codes indicated in Table 16 (FAO Table 47). If the structure type is SGR (Single Grain) or MA (Massive) the structure grade must be ∅.

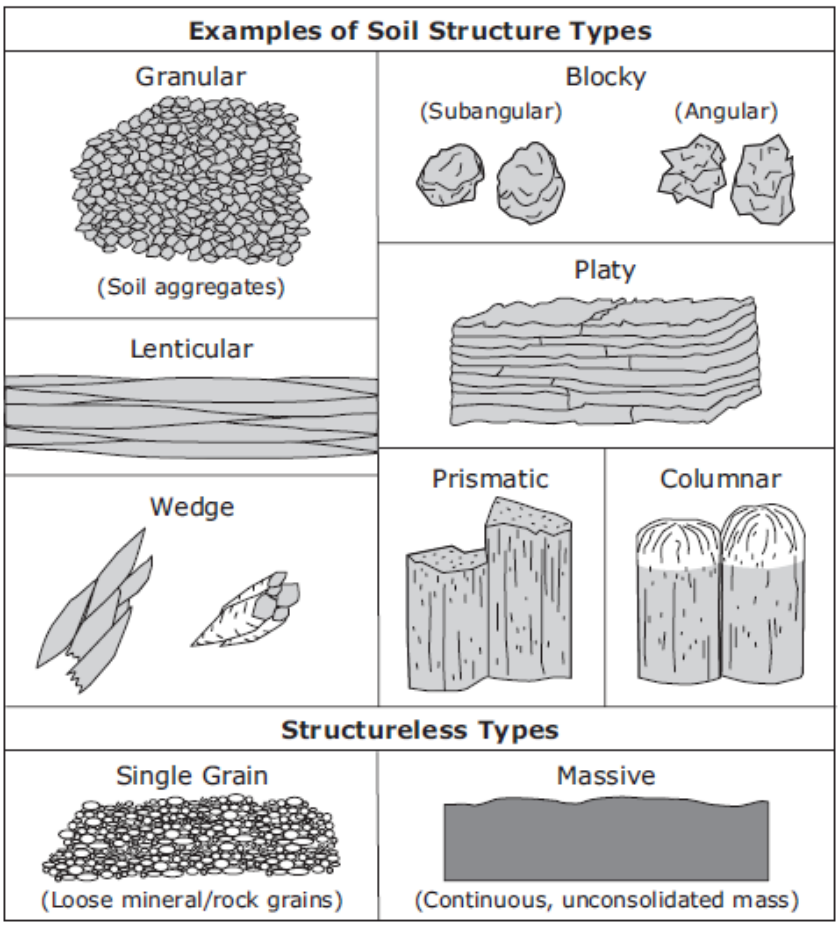


Figure 5. Examples of soil structure types (Schoeneberger et al., 2011)

Table 15. Classification of soil structure (Schoeneberger et al., 2011).

Code	Type	Determination
NATURAL SOIL STRUCTURAL UNITS (pedogenic structure)		
GR	Granular	Small polyhedrals with curved or very irregular faces.
ABK	Angular blocky	Polyhedrals with faces that intersect at sharp angles (planes).
SBK	Subangular blocky	Polyhedrals with subrounded and planar faces lacking sharp angles.
PL	Platy	Flat and platelike units.
WEG	Wedge	Elliptical, interlocking lenses that terminate in acute angles, bounded by slickensides; not limited to vertic materials.
PR	Prismatic	Vertically elongated units; flat tops.
COL	Columnar	Vertically elongated units with rounded tops that commonly are "bleached."
STRUCTURELESS		
SGR	Single grain	No structural units; entirely noncoherent; e.g., loose sand.
MA	Massive	No structural units; material is a coherent mass (not necessarily cemented).
ARTIFICIAL EARTHY FRAGMENTS OR CLODS1 (nonpedogenic structure)		
CDV	Cloddy	Irregular blocks created by artificial disturbance; e.g., tillage or compaction.

Table 16. Classification of structure of pedal soil materials.

Code	Class	Determination
WE	Weak	Aggregates are barely observable in place and there is only a weak arrangement of natural surfaces of weakness. When gently disturbed, the soil material breaks into a mixture of few entire aggregates, many broken aggregates, and much material without aggregate faces. Aggregate surfaces differ in some way from the aggregate interior.
MO	Moderate	Aggregates are observable in place and there is a distinct arrangement of natural surfaces of weakness. When disturbed, the soil material breaks into a mixture of many entire aggregates, some broken aggregates, and little material without aggregates faces. Aggregates surfaces generally show distinct differences with the aggregates interiors.
ST	Strong	Aggregates are clearly observable in place and there is a prominent arrangement of natural surfaces of weakness. When disturbed, the soil material separates mainly into entire aggregates. Aggregates surfaces generally differ markedly from aggregate interiors.

Redoximorphic features

Task on the scoresheet: Indicate the type of redox concentrations or depletion (Table 17).

Redoximorphic (RMF) features are soil morphological features caused by alternating reduction/oxidation processes. The reduction/oxidation of iron (Fe) and, to a lesser extent, manganese (Mn), minerals result in most RMF features. Iron is a major pigment that influences soil colour. The loss, accrual, and valence/mineral state of Fe are major determinants of colour patterns within or across soil horizons. Iron or Mn reduction occurs when free oxygen is limited or excluded from a soil volume or horizon by water saturation for extended time. Reduced iron (Fe^{2+}) is comparatively much more soluble and mobile than oxidized iron (Fe^{3+}) and moves with water flow and by diffusion gradients. When soil is reduced, Fe and Mn in local zones can be removed, leaving *uncoated mineral grains (depletions)* of lighter colour. Reduced Fe is oxidized and precipitates when water drains from soil (re-entry of free oxygen), or where oxygen is present in, or along, soil pores, including root channels, or along roots. The re-oxidized Fe or Mn may form crystals, soft masses, or *hard concretions or nodules (concentrations)*. Oxidized Fe will generally have a redder or yellower colour than adjacent soil particles, while Mn often will have a darker colour than adjacent soil particles.

Redox concentrations are defined as zones of Fe-Mn accumulation from:

Nodules and concentrations – concentrations have internal rings and nodules do not.

Masses – are non-cemented concentrations.

Pore linings – may be either coatings on pore surfaces or impregnations from the matrix adjacent to pores.

Redox depletions are defined as zones with chromas less than 2. They may be identified as:

Iron depletions – zones that contain lesser amounts of Fe and Mn oxides but have clay content similar to that of the adjacent matrix.

Concentrations and depletions are present compared to the described, dominant soil matrix colour in the hue, value, and chroma columns. If the dominant soil colour is described as a depleted matrix (with a value of 2 or less) ***and*** concentrations are present, depletions should not be indicated in the (Conc/Dep) column and a 'g' should be used as the Master horizon suffix (e.g. Btg).

The Concentrations or depletions should be scored according to the Table 15.

Table 17. Types of redoximorphic features to be indicated on the scoresheet.

Class	Types
∅	Redoximorphic features with Munsell Value >= 4 and Chroma <=2 are absent
CONC	Nodules, concentrations, masses, or pore linings
DEP	Iron depletions with Value >= 4 and Chroma <= 2
CONC/DEP	Concentrations and depletions with Value >= 4 and Chroma <= 2

SOIL PROFILE CHARACTERISTICS

For each of the four characteristics to be assessed, competitors are to place an 'X' in one box only.

Hydraulic conductivity

Task on the scoresheet: Determine the hydraulic conductivity of the *surface* and the most *limiting* (lowest hydraulic conductivity) horizon.

Critical for agronomic soil functions and partitioning of rainfall, we will estimate the saturated hydraulic conductivity of the surface horizon (*Surface*) and the most limiting horizon (*Restrictive layer*) within the depth specified on the scoresheet. If a lithic or paralithic contact occurs at or above the specified depth, it should be considered in evaluating conductivity.

Three general hydraulic conductivity classes are used:

High (H) – includes *sand* and *loamy sand* texture classes. *Sandy loam*, *sandy clay loam*, *silt loam* and *loam* texture grades that are especially 'loose' because of very high organic matter content (>5% organic carbon) also fall into this category. Horizons containing >60% of coarse fragments with insufficient fines to fill voids between fragments are also considered to have high hydraulic conductivity.

Moderate (M) – this includes those materials excluded from 'low' and 'high' classes.

Low (L) – low hydraulic conductivity is indicated with any of the following:

- *Clays*, *silty clays* or *sandy clays* having structure grade of MO or WE; or structureless and massive.
- *Silty clay loam*s and *clay loams* that have a structure grade of WE; or structureless and massive.
- Organic horizons (counterintuitive, but they are likely saturated already).
- Bedrock layers (Cr or R horizons) where the horizon directly above contains redoximorphic depletions or a depleted matrix due to prolonged wetness (value ≥4 with Chroma ≤2).

Effective soil depth and root restrictive layers

Task on the scoresheet: Determine the effective soil depth category

Soil depth classes are defined as the depth from the soil surface to the upper boundary of a root restricting layer. Restrictive layers include:

- Bedrock (lithic or paralithic materials).
- SiC, C or SC texture grades that are structureless and massive.
- Continuous Iron Pan (Plaggic horizon).

If the lower depth of judging is less than 150 cm, and there is no restricting layer within or at the judging depth, the horizon encountered at the bottom of the judged profile may be assumed to continue to at least 150 cm and 'very deep' should be selected.

Available Water-Holding Capacity (AWC)

Task on the scoresheet: Determine the available water-holding capacity of the soil

Critical to agronomic interpretations for crop growth, the available water-holding capacity is approximately the water held between field capacity and permanent wilting point. The approximate amount of moisture stored in the soil is calculated for the top 150 cm of the soil profile. This soil thickness may or may not be the same as that designated for the purposes of profile descriptions. The total water is calculated by summing the amount of water held in each horizon or portion of horizon, if the horizon extends beyond 150 cm. If a horizon or layer is unfavourable for roots (as defined under effective soil depth), this and all horizons below should be excluded in calculating the available moisture. For available water calculations, the properties of the lowest horizon designated for description can be assumed to extend to 150 cm, if no restrictive layer is present. If a restrictive layer is present between the lowest described horizon and the 150 cm depth, the depth to the restrictive layer should be considered for available water estimations. Four retention classes listed will be used:

Very low (VL)	<7.5 cm
Low (L)	7.5 to <15.0 cm
Moderate (MO)	15.0 to <22.5 cm
High (H)	≥22.5 cm

The relationship between available water retained per centimetre of soil and the textures is given in the table below. Coarse fragments are considered to have negligible (assume zero) moisture retention, and estimates must be adjusted to reflect the coarse fragment content. If a soil contains coarse fragments, the volume occupied by the rock fragments must be estimated and the available water holding capacity corrected accordingly.

For example, if a silt loam A horizon is 25 cm thick and contains rock fragments which occupy 10% of its volume, the available water-holding capacity of the horizon would be **25 cm × 0.20 cm/cm × [(100-10)/100] = 4.50 cm** of water. Calculate the available water for each horizon to the nearest hundredth, sum all horizons, then round the grand total to the nearest tenth. For example, 14.92 would round to 14.9 in the low class; 15.15 would round to 15.2 in the moderate class.

Texture is an important factor influencing available water capacity, and the following estimated relationships are used:

Available Water Capacity (cm water per cm soil)	Texture classes
0.05	sand, loamy sand
0.10	sandy loam
0.15	sandy clay loam, sandy clay, clay, silty clay, loam, clay loam
0.20	silt loam, silt, silty clay loam

Soil Wetness class

Task on the scoresheet: Determine the soil wetness class

Critical for understanding the effects of critical soil function of flooding, partitioning of water, drainage, habitat, water purification, and construction, Soil wetness is a reflection of the rate at which water is removed from the soil by both runoff and percolation. Landscape position, slope gradient, infiltration rate, surface runoff, and permeability, are significant factors influencing the soil wetness class. Redoximorphic features, including concentrations, depletions and depleted matrix, are the common indicators of prolonged soil saturation and reduction (wet state), and are used to assess soil wetness class. The following determines the depth of the 'wet state':

(1) The top of an A horizon with:

a. Matrix chroma ≤2, and

b. Redoximorphic depletions with value >= 4 and chroma <= 2; or redoximorphic concentrations as soft masses or pore linings, and

c. Redoximorphic depletions with value >= 4 and chroma <= 2; or a depleted matrix with value >= 4 and chroma <= 2 due to prolonged saturation and reduction in the horizon directly below the A horizon, **or**

(2) The shallowest observed depth of value ≥4 with chroma ≤2 redoximorphic depletions or depleted matrix due to prolonged saturation and reduction.

The wetness classes utilized in this contest are those which define a 'depth to the wet state'.

Class	Description
Class 1	Not wet above 150 cm depth
Class 2	Wet in some part between 101 and 150 cm
Class 3	Wet in some part between 51 and 100 cm
Class 4	Wet in some part between 26 and 50 cm
Class 5	Wet at 25 cm or shallower

Notes:

If no evidence of wetness exists within the specified depth for judging and that depth is less than 150 cm, then assume Class 1: not wet above 150 cm.

INTERPRETATIONS

For most rapid analysis of limitations:

1. Start in the right column of the tables.
2. Read down the column, checking the criteria.
3. If one factor is met in the right-hand column, place a mark in the Class 3 box on the scoresheet. Record the number of that factor on the scoresheet. Only the first factor met should be recorded.
4. If none are met, check the middle column. If one factor is met in the middle column, place a mark in the Class 2 box on the scoresheet. Record the number of that factor on the scoresheet. Only the first factor met should be recorded.
5. If none are met in either the right-hand or middle column, place a mark in the Class 1 box on the scoresheet. If the soil is Class 1, enter a dash for the reason.

Spring Barley Production

Task on the scoresheet: Assess the suitability for land for Spring Barley production, Scotland's #1 crop used for the production of Scotch whisky, by assessing a range of soil and land features with the most limiting factor of any of the five soil attributes used to allocate a soil to a suitability class. Erosion degree is not included on this table because barley can be an effective cover crop to improve soil quality in eroded soils.

	Suitability		
Factor	**Class 1** Optimal	**Class 2** Suitable	**Class 3** Unsuitable
pH in thickest horizon in upper 20 cm of soil	>6.2 – 7.0	5.0 – 6.2 or >7.0 – 8.0	<5.0 or 8.0 or greater
Slope (%)	<5	5 – <15	15 or more
Available Water-Holding capacity (AWC) class	High or Moderate	Low	Very low
Wetness Class	Class 1 or 2	Class 3	Class 4 or 5
Rock Fragments (% in thickest horizon in upper 20 cm of soil)	<15	15-35	>35

Golf Course Maintenance

Task on the scoresheet: Assess the suitability for maintenance for golf courses by assessing a range of soil and land features with the most limiting factor of any of the six soil attributes used to allocate a soil to a suitability class.

Golf in Scotland was first recorded in the Scottish late Middle Ages, and the modern game of golf was first developed and established in the country. Scotland has 587 courses. The highest concentrations are around Glasgow (94 courses) and Edinburgh (67 courses), since these two cities and their environs account for the bulk of the population. The Old Course at St Andrews, has an ancient links course dating to before 1574. Major Golf courses in Scotland have always managed the courses with what could be described as a low input programme with minimal watering, fertilising and the limited use of pesticides, working with nature and the indigenous grass types, climate and soils. Working with the natural landscape, designers strive to create sustainable systems that have the look and feel of a native landscape but maximize the experience of playing the game with firm surfaces and healthy turf. The extent to which the tee surface is firm and level and well turfed not only determines a player's first impression, it also sets expectations for their play experience.

Limitations			
Factor	**Class 1** Slight	**Class 2** Moderate	**Class 3** Severe
Flooding	None	Not a choice	Flooding occurs
Slope (%)	<5	5–<20	20 or more
Shrink swell potential in summer (anywhere in the upper 100 cm)	No open cracks (Θ) and no slickensides	Surface crack Width (F, M) and no slickensides	Slickensides present; or surface crack width (W, V, E)
Wetness Class	Class 1, 2, or 3	Class 4	Class 5
Organic horizons	None	Organic horizons < 5 cm total	Organic horizons ≥ 5 cm total
Susceptibility to frost action in winter (anywhere in the upper 100cm)	S, LS, SL	All other textures	Si, SiL, SiCL

Carbon storage potential

Task on the scoresheet: Assess the suitability for carbon storage by assessing a range of soil and land features with the most limiting factor of any of the eight soil attributes used to allocate a soil to a suitability class.

Soils in Scotland store an estimated 3600 million tonnes of carbon, a mean value of nearly 500 tonnes per hectare. This is over three times the global average. In many places, soils have the capacity for more carbon than they currently hold, either through accumulation of carbon in the mineral horizon or the increased thickness of organic horizons. The Scottish Government has a stated goal of mitigating greenhouse gas emissions by increasing the amount of carbon stored in soil and is developing a payment/incentivization scheme for land managers that would reward them financially for increasing soil carbon stocks. Farmers are exploring regenerative land management practices that aim to improve soil carbon storage, but need to know what potential their soils have for doing so.

Limitations			
Factor	**Class 1** Slight	**Class 2** Moderate	**Class 3** Severe
Slope	<5	5-15	>15
Erosion potential	Very Low, Low	Medium	High, Very High
pH in thickest horizon in upper 20 cm of soil	<5	5-7	>7
Texture in thickest horizon in upper 20 cm of soil	Org, C, SiC, SiCL	SC, CL, L, SiL, Si	S, LS, SL, SCL
Wetness Class	Class 4, 5	Class 3	Class 1, 2
Land cover	Heath, Bog/swamp	Forest, Improved grass, seminatural grass	Arable, water, bare, urban, other
AWHC	High	Moderate	Low or Very Low
Rock Fragments (% in thickest horizon in upper 20 cm of soil)	<15	15-40	>40

Biodiversity support

Task on the scoresheet: Assess the suitability for biodiversity support by assessing a range of soil and land features with the most limiting factor of any of the nine soil attributes used to allocate a soil to a suitability class.

Biodiversity is a key factor in ecosystem resilience. Areas with high biodiversity provide additional important functions such as crop pollination and are often areas of outstanding natural beauty. There are many different ways to measure biodiversity and different geographical areas can be diverse in relation to different ecosystem types, so high biodiversity support does not mean that the same species will always be present.

Limitations			
Factor	**Class 1** Slight	**Class 2** Moderate	**Class 3** Severe
Land use	Forest, Seminatural grassland, Bog/swamp	Improved grassland, Heath	Arable, Urban, Bare, Water, Other
Slope	All other classes	Steep or Very Steep	-
Aspect	North, East, West	South	-
Erosion potential	Very low, Low	Medium	High, Very high
Organic horizons	>5 cm total	<=5 cm total	None
Ploughing or other disturbance (p horizon suffix)	-	-	Present
Structure (thickest horizon in upper 20 cm of soil)	-	-	Massive
Effective soil depth	-	<25 cm	-
AWHC	All other classes	Low	Very Low

DIAGNOSTICS AND SOIL CLASSIFICATION

The competitors can choose between the Soil Taxonomy (Twelfth Edition, 2014) and the World Reference Base for Soil Resources (2015). For each contest profile, the maximum possible points obtainable from the Soil Classification part will be the same for both the Soil Taxonomy and WRB parts. Chemical data necessary for the classification will be provided at each pit on a pit card.

World Reference Base for Soil Resources (2015)

Diagnostic horizons/properties/materials

Task on the scoresheet: Use a cross (X) to select as many diagnostic horizons/properties/materials that apply to the profile within the specified judging depth. For detailed information on the horizons/properties/materials see pages 22-84 in the WRB 2015.

Reference soil group

Task on the scoresheet: Use a cross (X) to select one Reference Soil Group (RSG) only. Use the key to the RSG of the WRB on pages 85-116.

Principal qualifiers

Task on the scoresheet: Use a cross (X) to select only the first two principal qualifiers that applies to the profile within the specified judging depth. For detailed information on the principal qualifiers see pages 117-139 in the WRB 2015.

Soil Taxonomy (2014)

Use Key to Soil Taxonomy, 12th Edition (2014).

Epipedon

Task on the scoresheet: Use a cross (X) to select one epipedon that applies to the profile. For detailed information on the epipedon definitions see pages 7-11 of the Keys to Soil Taxonomy, 12th Edition.

Subsurface horizons

Task on the scoresheet: Use a cross (X) to select as many of the subsurface horizons to the profile within the specified judging depth. For detailed information on the subsurface horizon definitions see pages 11-17 of the Keys to Soil Taxonomy, 12th Edition. There will be a penalty for excess answers.

Diagnostic characteristics

Task on the scoresheet: Use a cross (X) to select as many of the diagnostic characteristics to the profile within the specified judging depth. For detailed information on the diagnostic characteristic definitions see pages 17-36 of the Keys to Soil Taxonomy, 12th Edition. There will be a penalty for excess answers.

Order

Task on the scoresheet: Use a cross (X) to select only one soil order. See pages 37-41 for the Key to Soil Orders in the keys to Soil Taxonomy, 12th Edition.

Suborder

Task on the scoresheet**:** Use a cross (X) to select only one soil suborder.

Great group

Task on the scoresheet**:** Use a cross (X) to select only one soil great group.

REFERENCES

FAO (2006): Guidelines for Soil Description. Food and Agriculture Organization of the United Nations, Rome

IUSS Working Group (2015): World Reference Base for Soil Resources 2014, Update 2015. World Soil Resources Report 106. Food and Agriculture Organization of the United Nations, Rome

Official Handbook of the Inaugural International Soil Judging Contest, June 5 -7, 2014, Jeju, Korea

Schoeneberger, P. J., Wysocky D. A., Benham, E. C., Soil Survey Staff (2012): Field Book for describing and sampling soils, Version 3.0., National Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

Soil Survey Staff (2014): Keys to Soil Taxonomy. United States Department of Agriculture National Resources Conservation Service. Twelfth Edition

SCORING INFORMATION

<table>
<tr><td colspan="2">SITE CHARACTERISTICS /EROSION/SURFACE CHARACTERISTICS</td></tr>
<tr><td>Land use</td><td rowspan="7">Only one answer for each is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 point will be awarded.</td></tr>
<tr><td>Slope (°)</td></tr>
<tr><td>Aspect</td></tr>
<tr><td>Slope position</td></tr>
<tr><td>Parent material</td></tr>
<tr><td>Erosion potential</td></tr>
<tr><td>Runoff</td></tr>
<tr><td colspan="2">SOIL DESCRIPTION</td></tr>
<tr><td>Master horizon letter</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 point will be awarded.</td></tr>
<tr><td>Master prefix</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 point will be awarded.</td></tr>
<tr><td>Suffix</td><td>Multiple suffixes might be correct. The maximum number of indicated suffixes is three. If all of the required suffixes are indicated 3 points will be awarded. The following examples illustrate the case when incorrect answer is given or suffix/suffixes is/are missing.
<table>
<tr><th>Correct answer</th><th>Your answer</th><th>Calculation</th><th>Point(s)</th></tr>
<tr><td>Bk</td><td>Bk</td><td>3-0</td><td>3</td></tr>
<tr><td>Bk</td><td>Bl</td><td>3-3</td><td>0</td></tr>
<tr><td>Bhs</td><td>Bs</td><td>3-1</td><td>2</td></tr>
<tr><td>Btnh</td><td>Bt</td><td>3-2</td><td>1</td></tr>
<tr><td>Btnh</td><td>Btsg</td><td>3-2</td><td>1</td></tr>
</table></td></tr>
<tr><td>Number</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Boundary lower depth</td><td>The threshold of correct lower depth readings will depend on the distinctness of the boundary. Abrupt/Clear: ±5 cm, Gradual/Diffuse: ±10 cm. If the answer is correct 2 points will be awarded. If the answer is incorrect 0 point will be awarded.</td></tr>
<tr><td>Boundary distinctness</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Boundary topography</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Soil Colour Hue</td><td>If the correct answer is given 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Soil Colour Value</td><td>If the correct answer is given 2 points will be awarded. If the answer is lower or higher than the correct one by 1 value category 1 points will be awarded. If the answer is lower or higher than the correct one by 2 value category 0 point will be awarded.</td></tr>
<tr><td>Soil Colour Chroma</td><td>If the correct answer is given 2 points will be awarded. If the answer is lower or higher than the correct one by 1 chroma category 1 points will be awarded. If the answer is lower or higher than the correct one by 2 chroma category 0 point will be awarded.</td></tr>
</table>

<table>
<tr><td>Texture clay %</td><td>A scaled range for correct answers compared to values obtained from laboratory data, will be used according to:<table><tr><th>Actual clay content</th><th>Range for grading</th></tr><tr><td><20 %</td><td>± 3 %</td></tr><tr><td>20-40 %</td><td>± 4 %</td></tr><tr><td>>40 %</td><td>± 5 %</td></tr></table></td></tr>
<tr><td>Texture sand %</td><td>A scaled range for correct answers compared to values obtained from laboratory data, will be used according to:<table><tr><th>Actual sand content</th><th>Range for grading</th></tr><tr><td><20 %</td><td>± 3 %</td></tr><tr><td>20-40 %</td><td>± 4 %</td></tr><tr><td>>40 %</td><td>± 5 %</td></tr></table></td></tr>
<tr><td>Texture class</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Organic horizons (nature)</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Organic horizons (moisture status)</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Organic horizons (mineral content)</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Organic horizons (degree of composition)</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Rock fragments</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Structure type</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Structure grade</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td>Redox features</td><td>Only one answer is correct. If the correct answer is given, 2 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td colspan="2">SOIL PROFILE CHARACTERISTICS/INTERPRETATIONS</td></tr>
<tr><td>Hydraulic conductivity/ Effective soil depth/ Type of the restrictive layer/ AWHC/Soil Wetness class/ Barley production/ Golf course maintenance/ Carbon storage potential/ Biodiversity support</td><td>Only one answer is correct. If the correct answer is given, 3 points will be awarded. If incorrect answer is given 0 points will be awarded.</td></tr>
<tr><td colspan="2">DIAGNOSTICS AND SOIL CLASSIFICATION - WRB</td></tr>
<tr><td>Horizons</td><td>Multiple answers might be correct. If correct horizons are marked 10 points will be awarded for each one. If incorrect horizons are marked -10 points will be awarded. The overall score cannot be lower than 0. Where WRB and ST have different numbers of</td></tr>
</table>

	horizons for the same profile, scores will be adjusted so that the total number of points available are the same.
Properties	Multiple answers might be correct. If correct properties are marked 5 points will be awarded for each one. If incorrect properties are marked -5 points will be awarded. The overall score cannot be lower than 0.
Material	Multiple answers might be correct. If correct materials are marked 5 points will be awarded for each one. If incorrect materials are marked -5 points will be awarded. The overall score cannot be lower than 0.
RSG	Only one answer is correct. If the correct RSG is marked 15 points will be awarded. If incorrect RSG is marked 0 points will be awarded.
Principal qualifiers	Multiple answers might be correct. If correct prefix qualifiers are marked 5 points will be awarded for each one. If incorrect prefix qualifiers are marked -5 points will be awarded. The overall score cannot be lower than 0.
DIAGNOSTICS AND SOIL CLASSIFICATION - SOIL TAXONOMY	
Epipedon	Only one answer is correct. If the correct RSG is marked 10 points will be awarded. If incorrect RSG is marked 0 points will be awarded.
Subsurface horizon	Multiple answers might be correct. If correct materials are marked 5 points will be awarded for each one. If incorrect materials are marked -5 points will be awarded. The overall score cannot be lower than 0.
Diagnostic characteristics	Multiple answers might be correct. If correct materials are marked 5 points will be awarded for each one. If incorrect materials are marked -5 points will be awarded. The overall score cannot be lower than 0.
Order	Only one answer is correct. If the correct RSG is marked 10 points will be awarded. If incorrect RSG is marked 0 points will be awarded.
Suborder	Only one answer is correct. If the correct RSG is marked 5 points will be awarded. If incorrect RSG is marked 0 points will be awarded.
Great Group	Only one answer is correct. If the correct RSG is marked 5 points will be awarded. If incorrect RSG is marked 0 points will be awarded.

The Ultimate Soil Texture Flow Chart (USTF)

11 January 2022

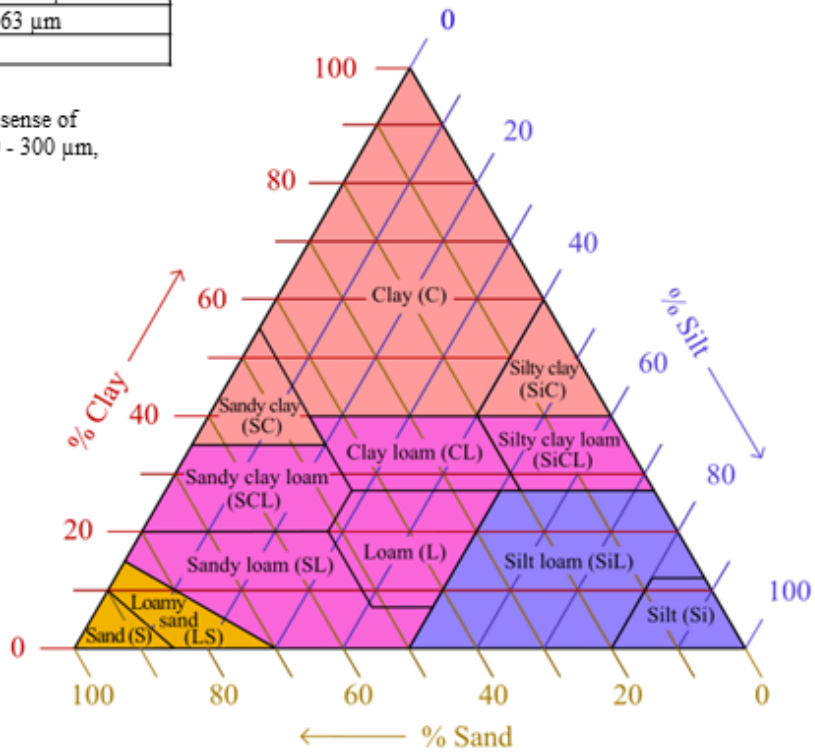
This flow chart only provides an estimation of the texture. Especially around the limits between the classes, the results might be not absolutely reliable. Beginners should ask experienced soil scientists for help.

Particle-size classes, according to ISO 11277:2009

Particle-size class	Diameter of particles
Fine earth	all particles ≤ 2 mm
Sand	> 63 µm - ≤ 2 mm
Very coarse sand	> 1250 µm - ≤ 2 mm
Coarse sand	> 630 µm - ≤ 1250 µm
Medium sand	> 200 µm - ≤ 630 µm
Fine sand	> 125 µm - ≤ 200 µm
Very fine sand	> 63 µm - < 125 µm
Silt	> 2 µm - ≤ 63 µm
Clay	≤ 2 µm

Note: The human eye and the tactile sense of the fingers can detect particles > 150 - 300 µm, depending on individual sensitivity.

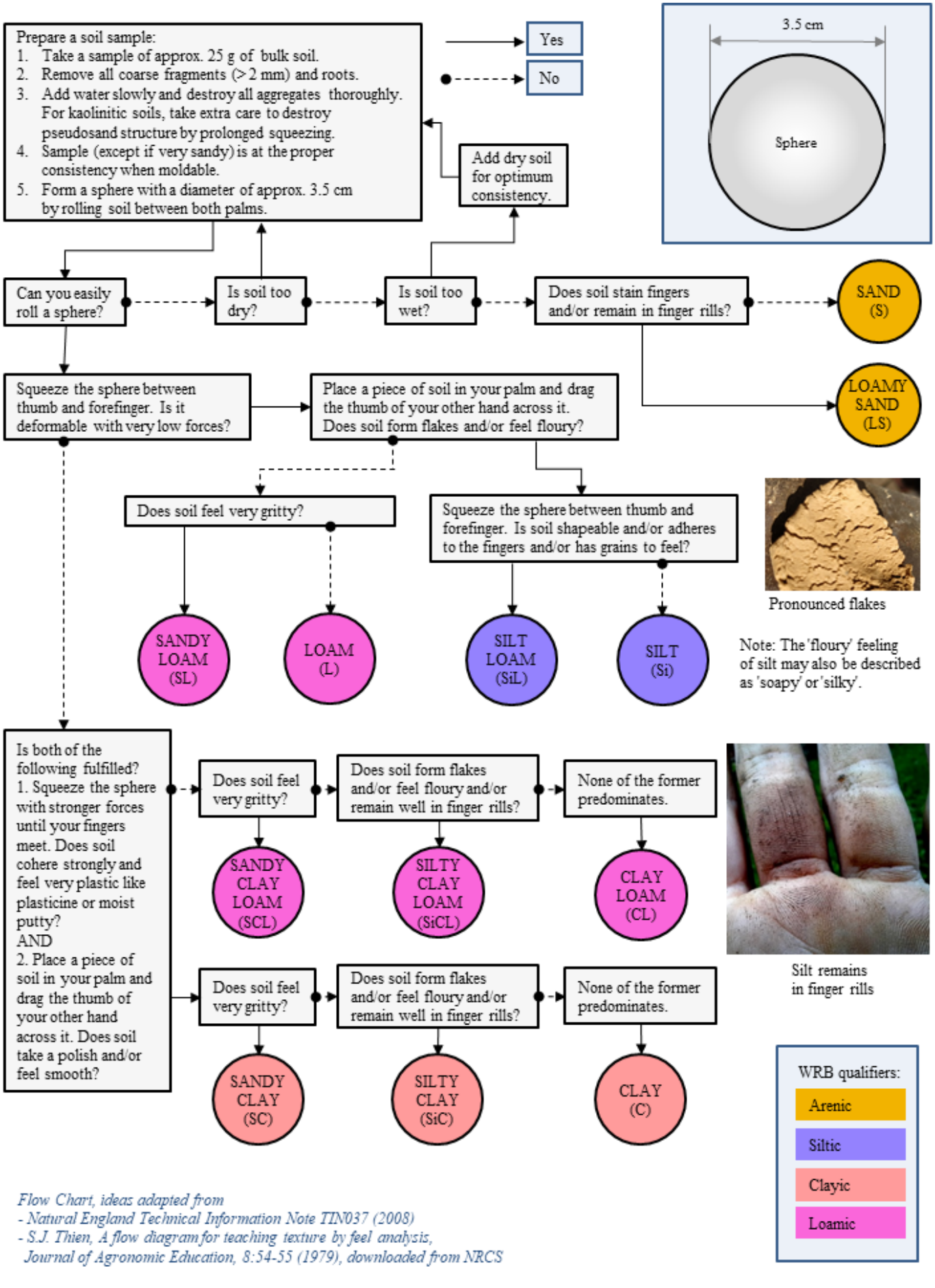
WRB qualifiers:
- Arenic
- Siltic
- Clayic
- Loamic



Texture classes triangle, from Blum et al. (2018), Figure 28, modified

Texture classes, according to NRCS Soil Survey Manual (2017)

Texture class	% sand	% silt	% clay	Additional criteria
Sand (S)	> 85	< 15	< 10	(%silt + 1.5×%clay) < 15
Loamy sand (LS)	> 70 to ≤ 90	< 30	< 15	(%silt + 1.5×%clay) ≥ 15 and (%silt + 2×%clay) < 30
Silt (Si)	≤ 20	≥ 80	< 12	
Silt loam (SiL)	≤ 50	≥ 50 to < 80	< 27	
	≤ 8	≥ 80 to ≤ 88	≥ 12 to ≤ 20	
Sandy loam (SL)	> 52 to ≤ 85	≤ 48	< 20	(%silt + 2×%clay) ≥ 30
	> 43 to ≤ 52	≥ 41 to < 50	< 7	
Loam (L)	> 23 to ≤ 52	≥ 28 to < 50	≥ 7 to < 27	
Sandy clay loam (SCL)	> 45 to ≤ 80	< 28	≥ 20 to < 35	
Silty clay loam (SiCL)	≤ 20	> 40 to ≤ 73	≥ 27 to < 40	
Clay loam (CL)	> 20 to ≤ 45	> 15 to < 53	≥ 27 to < 40	
Sandy clay (SC)	> 45 to ≤ 65	< 20	≥ 35 to < 55	
Silty clay (SiC)	≤ 20	≥ 40 to ≤ 60	≥ 40 to ≤ 60	
Clay (C)	≤ 45	< 40	≥ 40	



Flow Chart, ideas adapted from
- Natural England Technical Information Note TIN037 (2008)
- S.J. Thien, A flow diagram for teaching texture by feel analysis, Journal of Agronomic Education, 8:54-55 (1979), downloaded from NRCS