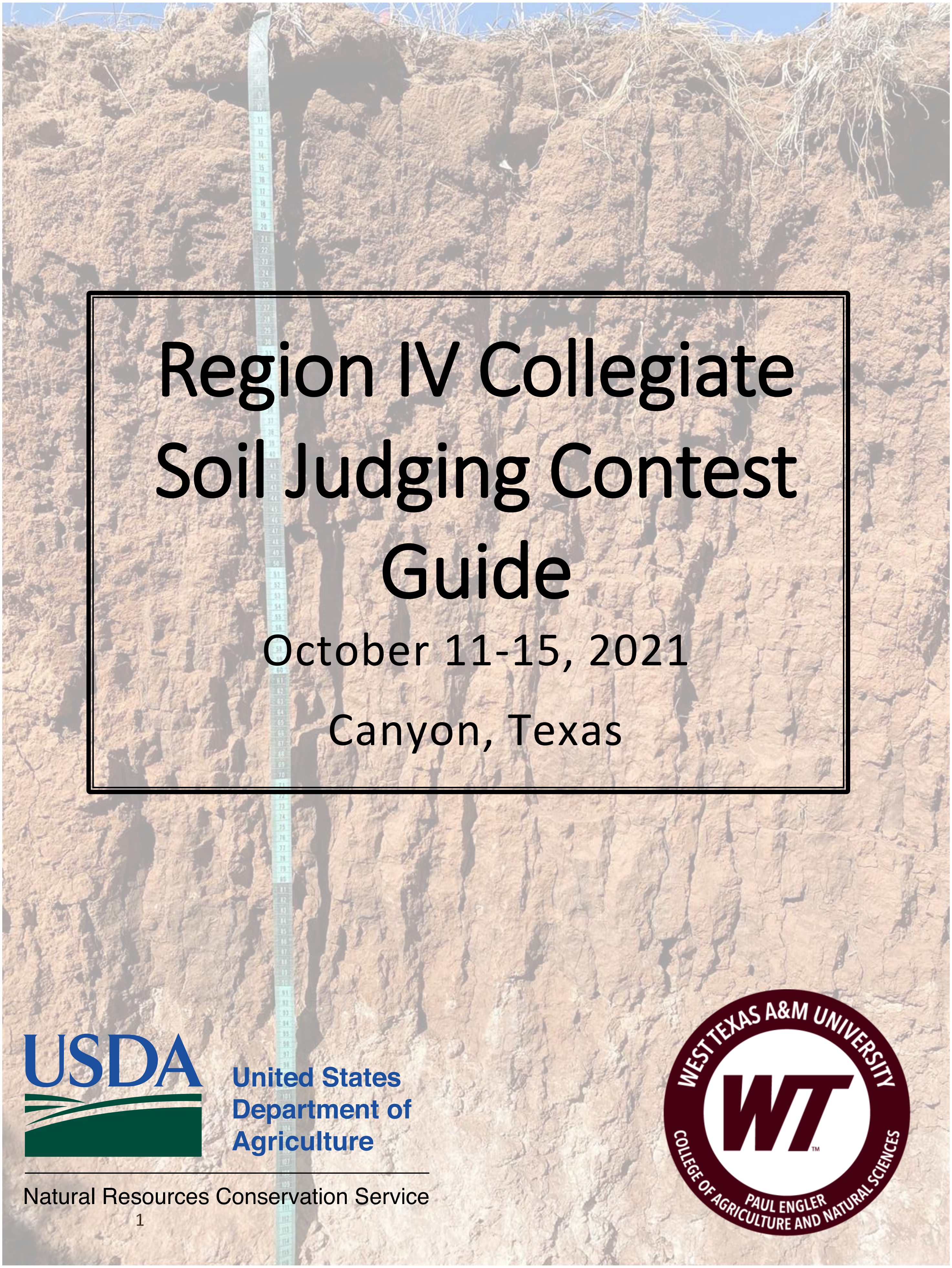

Region IV Collegiate Soil Judging Contest Guide

October 11-15, 2021

Canyon, Texas

USDA United States Department of Agriculture

Natural Resources Conservation Service

West Texas A&M University
Paul Engler College of Agriculture and Natural Sciences

Soil Judging Contest Guide

Disclaimer: Keep in mind that this competition has simplified many factors and the compiled definitions have been edited to fit its narrower scope compared with proper applications of Soil Taxonomy.

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IN-PERSON CONTEST OVERVIEW

Team Composition

A team is composed of three or four undergraduate students who are enrolled in a full-time, four-year curriculum in the institution they are representing. Each institution may enter only one team in the contest. Additionally, alternate competitors from each team are allowed to compete in the contest activities, but their individual-pit-judged scores will not count towards the sweepstakes (i.e., overall) total. However, alternate competitors are eligible for individual awards. All students must be eligible to represent their institution according to the rules and regulations governing eligibility at their institution. Team and alternate students should be designated by 9:00 pm Wednesday night, October 13, 2021.

Contest Format

This contest will be a mostly “closed book" contest, with the exception that, on the day of the contest, all contestants will be provided a copy of the textural triangle (included at the end of this packet), the abbreviations page (included at the end of this packet), and the Soil Use Interpretations Tables (listed on page 18 of this packet). Cell phones are prohibited. Each contest pit to judge will have its own scorecard indicated by a unique color and alphanumeric code. Each individual contestant will be given colored scorecards corresponding to each contest pit. Students must enter their contestant ID code on each of their scorecards. Scorecard entries must be made according to the instructions for each specific feature to be judged (see following sections of this guidelines packet). Only one response should be entered in each blank, unless told otherwise.

The contest will consist of three parts: a) four, individually judged pits (Thursday morning October 14), b) one, team-judged pit (Thursday afternoon October 14), and c) the sweepstakes (overall) score, a combination of both team and individual results. The sweepstakes placings will be used to select which teams advance to the National Collegiate Soil Judging Contest in Spring 2022. The team scores from the individually judged pits will be the sum of the top three individual scores for each pit. Therefore, the sum of 13 scorecards (3 individuals x 4 individual pits + 1 team-judged pit) will determine the overall sweepstakes score per team. All alternate students from an institution may participate in the one team-judged pit. Students from institutions having less than three team members may compete, but they are only eligible for individual awards.

The clay content of the third horizon will be used to break ties in both the individual and team competitions. In order to break a tie, the actual clay content for the third horizon of individually judged Pit 1 will be used. If this does not break the tie, the next pit in order (i.e., Pit 2) will be used in the same manner, and so on, if necessary, will be compared to that estimated by the individual in order to break a tie between individuals. For the team-judged pit, the team estimate of the clay content of the third horizon will be compared to the actual value. The team with the estimate closest to the actual value will receive the higher placing. If this does not break the tie, the next deepest horizon will be used. 4 Results will be announced Friday morning October 15 and will be final. Awards will be given to the top three overall sweepstakes teams, the top three teams in the team-judged-pit portion of the contest, and the top five individuals in the individual-pit-judged portion of the contest.

At each practice and contest site, a pit will be excavated and a restricted area will be designated on one of the pit walls for the measurement of horizon depth and determination of boundary distinctness and coarse fragment concentration. The restricted area will be clearly outlined and a nail will be placed somewhere in the third horizon. A tape measure will also be attached to the restricted area. THE RESTRICTED AREA IS TO BE UNDISTURBED! Picking, taking samples, or other disturbances within the restricted area will not be permitted for practice or contest pits.

The pit ID #, number of horizons to describe, depth to be considered, percent base saturation (% BS), and percent organic carbon (% OC) for each horizon and other relevant information will be displayed on a sign at each pit such as the example provided in Figure i. Contestants should expect to evaluate between four and six horizons per pit. Slope stakes will be placed along the grade for determination of slope and to facilitate the determination of the landform and hill slope profile.

Practice Pit 1

Describe 5 mineral horizons to a depth of 121 cm.
The nail is in the third horizon at 52 cm.

Horizon	BS (%)	OC (%)
1	90	0.8
2	88	0.6
3	88	0.4
4	78	0.2
5	76	0.2

Figure i. Example of information provided at each contest and practice pit.

Fifty (50) minutes will be allowed for judging of each contest pit. The morning of the individually judged pit portion of the contest, each contestant will be provided an assigned number-letter combination corresponding to team-group designations. This will uniquely identify each contestant and will be used to facilitate rotations at the pit according to the schedule provided in Table i.

Table i. Contestant rotations for individuals judged pits.

	Individual Pits 1 and 3		Individual Pits 2 and 4	
	Odd team no.	Even team no.	Odd team no.	Even team no.
First 5 min.	In*	Out	Out	In
Next 5 min.	Out	In	In	Out
Next 10 min.	In	Out	In	Out
Next 10 min.	Out	In	In	Out
Next 20 min.	Free**	Free	Free	Free

*In and Out refer to contestants being allowed in the pit or out of the pit, respectively, to start.

**During free time, all constestants may be in or out of the pit.

Team-pit Judging

Two teams will be at the team-judged pit at the same time, but start times for each team will be staggered so that only one team has access in the pit at a time. Each team will have two 10- minute intervals in the pit and two 10-minute intervals out of the pit (i.e., 10 minutes in, 10 minutes out, 10 minutes in, 10 minutes out) with the last 10 minutes of the 50-minute total time as free time to be in or out of the pit if desired.

Restricted Pit Area, Allowable Items, and Other Rules

A restricted area on the pit wall will be outlined with flagging and a tape measure mounted for every practice and contest pit that is NOT to be disturbed, and a nail will be inserted somewhere in the third horizon of each pedon, similar to that pictured in Figure ii. Contestants should provide the following for their personal use: tape measure, clinometers (or Abney level), water bottle or sprayer, acid bottle, knife, pencils, Munsell color charts (10R to 5Y), hand towel, hand lens, and containers for soil samples. Calculators, 2-mm diameter sieves, and clipboards may also be used. No other materials other than those supplied by the host will be permitted during the contest. Cell phones, pagers, or other communication devices are prohibited during the contest. Talking is NOT permitted between contestants during the 50 minutes of pit judging. Pit monitors will be instructed to collect scorecards from contestants and they will receive a zero for that pit if any of the above rules are broken, particularly talking to other contestants during the judging period. Contestants should show respect for each other and avoid creating distractions during the competition.

Figure ii. Example of restricted area of pit wall.

Scoring and Abbreviations

Coaches and assistant coaches/graduate students from participating schools will be requested to help grade at the contest site. Additional graders competent in soil morphology and classification will also be recruited to assist in grading. Each grader will grade only one pit and each scorecard will be re-graded and scores tallied by a second individual for confirmation of accuracy. Point allocations vary among cells and are listed on the scorecard in parentheses. Where an answer is not needed or is inappropriate, a dash (-) may be used or the cell can be left blank.

Contestants may use the official abbreviations (preferred, see Attachment 1) or write out answers. Use of abbreviations other than official abbreviations is strongly discouraged, but graders shall give credit if, in their opinion, the meaning of an unofficial abbreviation is obvious.

For the individually judged portion of the contest, a team is composed of three or four undergraduate students. The team score will be the sum of the top three individual scores at each pit (see example in Table ii). This method maximizes the opportunity for all four team members to contribute to the final team score.

Table ii. Score tabulation example for the individual contest. Shaded scores represent those that are the low score for a pit among the team's contestants and are not included in the team's overall score for that pit or overall.

Contestant	**Pit 1**	**Pit 2**	**Pit 3**	**Pit 4**	**Total**
A	132	130	110	144	516
B	146	116	141	138	541
C	130	112	160	158	560
D	125	114	129	145	513
Total score:	**408**	**360**	**430**	**447**	**1645**

The score from the team-judged pit will be added to the individual scores for the overall sweepstakes team totals and final rankings.

ONLINE CONTEST ALTERNATIVE FORMAT

Contest Format

In the event that an in-person contest is prevented, an alternative virtual contest will be conducted. In this format, coaches will be provided the contest materials early on October 11, 2021 and will have until October 15th at 8 PM to complete the contest with their students at the time of their choosing. Practice pits will be provided virtually several weeks before the contest.

All elements of the contest guide will still apply to the virtual contest, however the following items will be provided to the participant on the scorecard for each pit:

- presence or absence of clay films
- % sand and % silt
- hue, value and chroma
- structure grade and shape
- effervescence
- slope
- % OC, BS%, pH, CCE, and other necessary data as needed

- depth to describe to
- Number of subsurface horizons and features to indicate
- depth of an imaginary nail in the third horizon

Additionally, the student will be provided with the following information for each pit:

- a brief description of the site history
- a high-quality image of the profile
- images of the surrounding area
- indication of site position by line drawing and an “x” indicating the pit

Additionally, students are allowed to use the following during the contest:

- Munsell Color Book
- Pen/pencil
- Flashlight
- Calculator
- Textural triangle
- Abbreviations handout
- Interpretations tables

Role of the Coach

A coach is necessary to prepare the students using the provided practice materials and additional resources as necessary to prepare students in the fundamentals of soil morphological description, taxonomic classification, and application of the information for land use interpretations.

The coach for this contest will ensure all rules are followed which includes facilitation of all testing for the individual and group competitions of their students. It is the responsibility of the coach to print all necessary contest materials, to plan a time and facilitate the contest with his/her own students, and to send results to the contest organizer for grading.

No assistance is to be given by the coach during the contest administration. Questions cannot be answered about specific aspects of the contest, but questions about the general format, amount of time remaining, etc. may be addressed as needed.

Following contest administration, coaches should submit each individual and team score card to the shared OneDrive folder using the following labeling system: pit#_student_school (e.g, IndPit1_GuySmith_School). The following steps will then take place:

1. Pit keys will be distributed to the graders on 10/16/21.
2. Pit graders should review the keys and bring any discrepancies to the zoom meeting for discussion. If you cannot attend the zoom meeting communicate directly with Lauren on this.
3. A zoom meeting will be held to go over details for contest pit grading on 10/15/21.
4. Pit grading will be performed 10/16/21 to 10/21/21.
5. Pits will be assigned to pit grading pairs.

- Assigned pits will be labelled: pit#_student_school (e.g, IndPit1_GuySmith_School).
- Assigned pits will be in a folder labelled by the grading pair last names (e.g., Dokuchaev_Marbut). The folder is located in PIT_CONTEST -> PIT_FOR_GRADING

6. The pit grading pairs will be grading all or some of the pits for a specific contest pit. Graders will not be grading multiple pits.
7. Each grader will grade the pits independently. Mark incorrect answers and tally up the points in each section and the totals for the pit.
8. Each pit grading pair will review the pits together for score agreement for each section and for the total pit. Any discrepancies should be discussed and rectified by the pit grading pair. Consult with the contest organizer if needed.
9. Once complete submit a pdf of each graded pit back to the organizer.
    - The pit name must be changed to indicate that it was graded (e.g., Graded_IndPit1_GuySmith_School).
    - The graded pits should be placed in the graded folder within your grading pairs folder (e.g., GRADED_Hole_Bennett).
10. Pit grading pairs should create an excel file that lists Student Name (First Last), School, and the total score for the pit. The excel file should be sent to Lauren or placed in the graded folder.
11. Scores and graded pits should be submitted to the organizer by 10/21/21 at 12 PM.

Scoring and Abbreviations

At the conclusion of the contest, scorecards will be distributed to coaches for grading. Two or more coaches will be assigned to grade all scorecards for one pit. It is the responsibility of the assigned coaches to reach a consensus on each participant's score and report the scores to the contest organizer. One copy of each graded scorecard should also be sent to the contest organizer. Ideally, each coach will only grade scorecards from one pit and the scores will be confirmed by at least one additional coach. Additional graders will be sought from pools of assistant coaches and grad students as needed. More information regarding grading will be provided as necessary.

A virtual award ceremony will be held on October 22, 2021 via Zoom.

PART 1: SOIL MORPHOLOGY

Horizon Designation and Description

Soil Morphology Overview: For entering answers in the morphology section of the scorecard, the provided standard abbreviations (see attachment) may be used or the word(s) may be written out. Abbreviations or words that are ambiguous or may be interpreted as an incorrect answer will not receive credit. The Munsell color notation (e.g., 10YR 4/2) should be used and not the color names. If spaces on the scorecard for the soil morphology section do not require an answer (e.g., if no prefix is necessary), a dash or blank in those spaces will be considered correct. The Field Book for Describing and Sampling Soils (version 3.0, 2012), Chapter 3 of the Soil Survey Manual (1993) entitled, "Examination and Description of Soils", and Chapter 18 of Keys to Soil Taxonomy 12th Edition (2012) entitled "Designations for Horizons and Layers" should be used as a guide for horizon symbols and descriptions.

Horizon Designation: The number of horizons to be described and the total depth of soil to judge will be provided for each pit site. With the exception of the A and E horizons, **no sub-soil horizon less than 8 cm thick will be described**. If a horizon less than 8 cm thick occurs in the B horizon or lower, it should be combined with the adjacent horizon that is most similar for the depth measurement purposes. When two horizons combine to a total thickness of 8 cm or more, the properties of the thicker horizon should be described. If lamellae are encountered that are thinner than 8 cm, then the convention is to describe the eluvial and illuvial horizons as a unit (i.e., E & Bt) and the thickest horizon's morphology would be described.

Three kinds of symbols are used in various combinations to designate horizons and layers in Section I of the contest scorecard (Table 1): capital letters, lower case letters, and Arabic numerals. Capital letters are used to designate master horizons (or in some cases, transition horizons). Lower case letters are used as suffixes to indicate specific characteristics of the master horizon and layers. Arabic numerals are used both as suffixes to indicate vertical subdivisions within a horizon or layer and as prefixes to indicate lithological discontinuities.

Table 1. Horizon designators for scorecard section I and their descriptions.

Horizon Designation	Description
Prefix	Lithological discontinuities will be shown by the appropriate Arabic numeral(s). If no discontinuities exist in the profile, enter a dash. A dash will receive credit where there is no prefix on the master horizon and should be used in lieu of the Arabic number one.

Master	The appropriate master horizon (A, E, B, C, and R), as well as any transitional horizons (e.g., EB) or horizons having dual properties of two master horizons (e.g., B/E, B and E) should be entered as needed.
Subordinate designator	Enter the appropriate lower case letter or letters, according to the definitions given in Chapter 18 of *Keys to Soil Taxonomy* (2014). For this contest, the following horizon subordinate distinctions will be used: b, c, g, k, kk, m, n, p, r, ss, t, u, w, y, and z. Some subordinate designators such as "ss" (slickensides) should also be indicated as a horizon feature in section IV of the scorecard as a "Subsurface Horizons and Features". If used in combination, the standard conventions for ordering multiple subordinate distinctions will be waived for the contest, e.g., Btk = Bkt. If a subordinate distinction (subscript) is not applicable, enter a dash in the box.
Number	Arabic numerals are used as suffixes to indicate vertical subdivisions within a horizon or layer. Sequential subhorizons having the same master horizon and subordinate distinction designations should be numbered to indicate the vertical sequence. Where no suffixes are required, a dash should be entered on the scorecard. Note that the numbering of vertical subdivisions within a horizon is not interrupted at a lithological discontinuity if the same master horizon and subordinate distinction is used in both materials (e.g., Bt1-Bt2-2Bt3-2Bt4).
Primes	Primes are used when the same designation is given to two or more horizons in a pedon, but where the horizons are separated by a different kind of horizon. The prime is used on the lower of the two horizons having identical letter designations (both master and subordinate distinction) and should be entered with the capital letter for the master horizon. For example, the sequence A-E-Bt-E´-Btx-C identifies a soil that has two E horizons separated by a Bt horizon.

Naming Horizons

Recording Horizon Names: Master, transitional or combination horizon symbol should be recorded in the "Master" column, and when needed, a lower-case symbol in the suffix/subordinate distinction column labeled "Sub". When needed, an Arabic numeral should be recorded in the "No." column. Arabic numerals should also be used in the "Prefix" column preceding the "Master" column to indicate lithologic discontinuities. Prime symbols used to distinguish otherwise identical designations should be placed in the "Master" column following the master horizon name. All B horizons must have a suffix/subordinate distinction. If no designation is necessary for a cell, contestants may leave the cell blank or record a dash (-) to indicate no designation. Only mineral horizons will be described for the contest, and students should be familiar with A, E, B, C and R horizon designations, plus transitional and combination horizons.

Use of the Prime Symbol (')

If two or more horizons with identical number prefixes and letter combinations are separated by one or more horizons with a different horizon designation in a pedon, identical letter and number symbols can be used for those horizons that have the same characteristics. For example, the sequence A-E-Bt-E- Btx-C identifies a soil that has two E horizons. To emphasize this characteristic, the prime symbol (´) is added after the master-horizon symbol of the lower of the two horizons that have identical designations, e.g., A-E-Bt-E´-Btx-C. The prime symbol, where appropriate, is placed after the capital-letter horizon designation and before the lowercase suffix letter symbols that follow it, e.g., B´t.

The prime symbol is not used unless all letters and number prefixes are completely identical. The sequence A-Bt1-Bt2- 2E-2Bt1-2Bt2 is an example. It has two Bt master horizons of different lithologies; thus, the Bt horizons are not identical and the prime symbol is not needed. The prime symbol issued for soils with lithologic discontinuities when horizons have identical designations, e.g., A-C-2Bw-2Bc-2B´w-3Bc. In this example, the soil has two identical 2Bw horizons but two different Bc horizons (a 2Bc and a 3Bc), so the prime symbol is used only with the lower 2Bw horizon (2B´w).
Vertical subdivisions of horizons or layers (number suffixes) are not taken into account when the prime symbol is assigned. The sequence A-E-Bt-E´-B´t1-B´t2-B´t3-C is an example.

These same principles apply in designating layers of organic soils. The prime symbol is used only to distinguish two or more horizons that have identical symbols, e.g., Oi-C-O´i-C´ (when the soil has two identical Oi and C layers) and Oi-C-Oe-C´ (when the soil has two identical C layers). The prime symbol is added to the lower layers to differentiate them from the upper.

Vertical Subdivision

Commonly, a horizon or layer identified by a single letter or a combination of letters has to be subdivided. For this purpose, numbers are added to the letters of the horizon designation. These numbers follow all the letters. Within a sequence of C horizons, for example, successive horizons may be designated C1, C2, C3, etc. If the lower horizons are strongly gleyed and the upper horizons are not strongly gleyed, they may be designated C1-C2-Cg1-Cg2 or C-Cg1-Cg2-R.

These conventions apply whatever the purpose of the subdivision. In many soils a horizon that could be identified by a single set of letters is subdivided because of the need to recognize differences in morphological features, such as structure, color, or texture. These divisions are numbered consecutively, but the numbering starts again with 1 wherever in the profile any letter of the horizon symbol changes, e.g., Bt1-Bt2-Btk1-Btk2 (not Bt1-Bt2-Btk3-Btk4). The numbering of vertical subdivisions within consecutive horizons is not interrupted at a discontinuity (indicated by a numerical prefix) if the same letter combination is used in both materials, e.g., Bs1-Bs2-2Bs3-2Bs4 (not Bs1-Bs2-2Bs1-2Bs2).

Lithologic Discontinuities

Numbers are used as prefixes to horizon designations (preceding the capital letters A, E, B, C, and R) to indicate discontinuities in mineral soils. These prefixes are distinct from the numbers that are used as suffixes denoting vertical subdivisions.

A discontinuity that can be identified by a number prefix is a significant change in particle-size distribution or mineralogy that indicates a difference in the parent material from which the horizons have formed and/or a significant difference in age, unless that difference in age is indicated by the suffix b. Symbols that identify discontinuities are used only when they can contribute substantially to an understanding of the relationships among horizons. The stratification common to soils that formed in alluvium is not designated as a discontinuity, unless particle-size distribution differs markedly from layer to layer (i.e., particle-size classes are strongly contrasting), even though genetic horizons may have formed in the contrasting layers.

Where a soil has formed entirely in one kind of material, the whole profile is understood to be material 1 and the number prefix is omitted from the symbol. Similarly, the uppermost material in a profile consisting of 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 when the material of a layer below material 2 is similar to material 1, it is designated 3 in the sequence; the numbers indicate a change in materials, not types of material. Where two or more consecutive horizons have formed in the same kind of material, the same prefix number indicating the discontinuity is applied to all the designations of horizons in that material, e.g., Ap-E-Bt1-2Bt2-2Bt3-2BC.

The suffix numbers designating vertical subdivisions of the Bt horizon continue in consecutive order across the discontinuity. However, vertical subdivisions do not continue across lithologic discontinuities if the horizons are not consecutive or contiguous to each other. If other horizons intervene, another vertical numbering sequence begins for the lower horizons, e.g., A-C1- C2-2Bw1-2Bw2-2C1-2C2.

If an R layer is present below a soil that has formed in residuum and if the material of the R layer is judged to be like the material from which the soil has developed, the number prefix is not used. The prefix is used, however, if it is thought that the R layer would produce material unlike that in the solum, e.g., A-Bt-C-2R or A-Bt-2R. If part of the solum has formed in residuum, the symbol R is given the appropriate prefix, e.g., Ap-Bt1-2Bt2-2Bt3-2C1-2C2-2R.

A buried genetic horizon (designated by the letter b) presents special problems. It is obviously not in the same deposit as the overlying horizons. Some buried horizons, however, have formed in material that is lithologically like the overlying deposit. A prefix is not used to distinguish material of such a buried horizon. If the material in which a horizon of a buried soil has formed is lithologically unlike the overlying material, the discontinuity is indicated by a number prefix and the symbol for the buried horizon also is used, e.g., Ap-Bt1-Bt2-BC-C-2ABb-2Btb1-2Btb2-2C.

Lower Boundary Depth and Distinctness

Boundary depths are determined (in centimeters) from the soil mineral surface to the lower boundary of each horizon. For example, a Bt1 horizon occurring from 30-45 cm may be recorded as “45 cm”. The depth from the soil surface to a nail in the third horizon is posted on the pit card. Note that the nail may be anywhere in the third horizon (top, middle, bottom depth). Total soil profile depth to be described will also be given on the pit information card or sheet.

The last horizon boundary should be the specified judging depth with a “+” added. Thus, if the pit sign states “Describe 5 horizons to a depth of 140 cm”, the fifth lower depth designation should be “140+”. However, when the specified depth is at a lithic or paralithic contact, the “+” is dropped from the depth. Measurements of boundary depth should be made in the undisturbed area of the pit reserved for this purpose. Therefore, for horizons with wavy boundaries, the boundary depth at the tape should be recorded rather than an estimate of the middle of the wavy boundary across the control section. Boundary measurements should be made at the center of the boundary separating the two horizons, particularly when the boundary distinctness is not abrupt. Answers for lower boundary depths will be considered correct if within the following limits above or below the depth determined by the official judges: for **abrupt** (including *very abrupt*) boundaries +/- 1 cm; for **clear** boundaries +/- 3 cm; for **gradual** boundaries +/- 8 cm; and for **diffuse** boundaries +/- 15 cm. Partial credit for depth measurements may be given at the discretion of the official judges where the boundary is not smooth.

If a lithic or paralithic contact occurs at or above the specific judging depth, the contact should be marked as a subsurface feature in Part IV of the scorecard and should be considered in evaluating the hydraulic conductivity, effective soil depth, water retention, and soil wetness class to 150 cm. Otherwise, the lowest horizon should be mentally extended to a depth of 150 cm for all relevant evaluations. When a lithic or paralithic contact occurs within the specified judging depth, the contact should be considered as one of the requested horizons, and the appropriate horizon nomenclature should be applied (e.g., Cr or R). However, morphological features of Cr or R horizons need not be provided in Part I of the scorecard. If the contestant gives morphological information for a designated Cr or R horizon, the information will be ignored and **will not** count against the contestant’s score. If contestants are unsure if a layer is a Cr horizon, they are encouraged to complete the morphological information for that layer.

The distinctness of boundaries separating various soil horizons must be described if they fall within the designated profile depth indicated by the official judges for each site. Categories of distinctness of soil boundaries are shown in Table 2.

Table 2. Soil horizon boundary distinctness categories.

Category	Symbol	Boundary Distinctness
Abrupt	A	< 2 cm (within 1 cm)
Clear	C	2-5 cm (within 3 cm)
Gradual	G	5-15 cm (within 8 cm)
Diffuse	D	> 15 cm (within 15 cm)

No boundary distinctness designator should be given for the last horizon, unless a lithic or paralithic contact exists at the lower boundary. If (+) appears on the lower boundary depth provided for the contest, a dash is acceptable for distinctness of the last horizon to be described.

Texture

Chpt. 3, pp. 136 - 143, Soil Survey Manual

Texture refers to the proportion of sand, silt, and clay-sized particles in soil. These proportions are expressed on a percentage basis, with sand, silt, and clay always adding up to 100%. Textural classes, shown in the USDA texture triangle (see Appendix), group soil textures that behave and manage similarly.

Textural Classes

Soil texture classes are those defined in the *Soil Survey Manual* (1993). The twelve classes are shown on the textural triangle (Figure 1). Any deviation from the standard nomenclature will be considered incorrect (e.g., silty loam or sandy silt). Sandy loam, loamy sand, and sand should be further specified if the soil is dominated by a particular sand size other than medium sand (see Table 3). Credit for sand, loamy sand, and sandy loam textures will NOT be given if sand modifiers are required (i.e. very fine, fine, coarse, or very coarse). The textural class should be recorded in the "Class" column. Very coarse sand should be included with coarse sand for this contest.

Table 3. Soil textural classes and symbols.

Texture	Symbol	Texture	Symbol
Coarse sand	COS	**Sandy loam**	SL
Sand	S	**Loam**	L
Fine sand	FS	**Sandy clay loam**	SCL
Very fine sand	VFS	**Silt loam**	SIL
Loamy coarse sand	LCOS	**Silt**	SI
Loamy sand	LS	**Silty clay loam**	SICL

Loamy fine sand	LFS	**Clay loam**	CL
Loamy very fine sand	LVFS	**Sandy clay**	SC
Coarse sandy loam	COSL	**Silty clay**	SIC
Fine sandy loam	FSL	**Clay**	C
Very fine sandy loam	VFSL		

Contestants will determine soil texture classes by hand. The official judges will use field estimates along with laboratory data on selected samples to determine the soil texture class. Estimates of the clay content as a weight percentage of the soil fines should be recorded in the "Clay %" column. A scaled range for correct answers compared to values estimated by the judges will be used according to parameters in Table 4:

Table 4. Scaled range of correct clay percentages.

Actual %	Allowed Deviation
< 20%	+/- 2
20-40%	+/- 3
> 40%	+/- 4

If clay skins are observed a check mark (√) or the initials "CF" should be placed in the 'clay films' column of the score card.

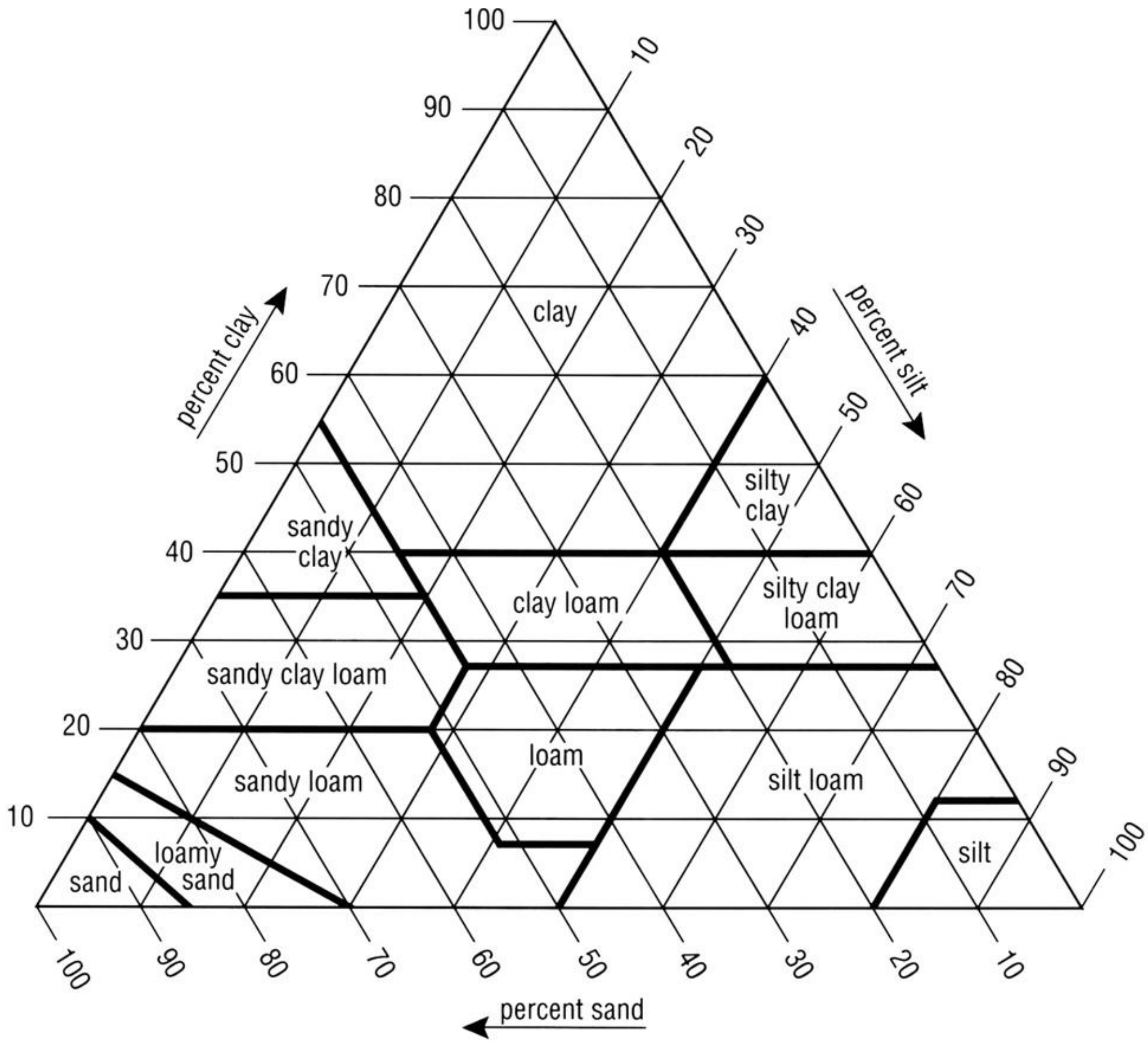

Figure 1. Soil textural triangle.

Coarse Fragments (CF Mod)

Modifications of texture classes are required whenever rock fragments > 2 mm occupy more than 15% of the soil volume. For this contest, the terms "gravelly and cobbly" will be used (Table 5). For a mixture of sizes (e.g. both gravels and cobbles present), the largest size class is named. A smaller size class is named only if its quantity (%) exceeds 2 times the quantity (%) of a larger size class. The total rock fragment volume is used (i.e. sum of all the separate size classes) to determine which modifier goes with the fragment term (none, very, or extremely). For example, a horizon with 30% gravel and 14% stones (44% total fragments) would be named very gravelly (**GR**), but only 20% gravel and 14% cobbles (34% total fragments) would be named cobbly (**CB**).

Coarse fragment modifiers (Table 6) should be recorded in the column labeled "CF Mod." and should not be recorded in the "Class" column for the soil textural class.

Table 5. Coarse fraction modifiers by size and shape with their requirements and symbols.

Size (diameter)	Adjective	Symbol
0.2 to 7.5 cm	Gravel	GR
7.6 to 25.0 cm	Cobble	CB
25.1 to 60 cm	Stone	ST
>60 cm	Boulder	BD

Table 6. Coarse fraction modifiers by percentage of fragment present.

Percent Rock (By Volume)	Modifier Name
< 15%	No special term used with the soil textural class. Enter a dash or leave blank.
15-34%	Use **“gravelly or cobbly”** as a modifier of the texture term (e.g. gravelly loam or **GR-L**).
35-60%	Use “**very (V) + size adjective”** as a modifier of the texture term (e.g., very cobbly fine sandy loam or **CBV-FSL**).
60-100%	Use “**extremely (X) + size adjective”** as a modifier of the texture term (e.g., extremely stony clay loam or **STX-CL**).

Structure

Soil structure refers to the aggregation of primary soil particles into secondary compound groups or clusters of particles. These units are separated by natural planes, zones, or surfaces of weakness. Dominant type (formerly called shape) and grade of structure for each horizon are to be judged. If the horizon lacks definite structural arrangements or if there is no observable aggregation, **“structureless”** should be recorded in the grade column and either **“massive”** or **“single grain”** (whichever is appropriate) should be recorded in the type column.

If various types of structure exist within the horizon, contestants should record the type and grade of structure that is most common. Compound structure (e.g., prismatic parting to angular or subangular blocky structure) is common in the horizons of many soils. In this case, structure having the stronger grade should be described. If the structures are of equal grade, the structure type with the largest peds should be described. The term "blocky" always requires a modifier, either angular or subangular blocky. Blocky will not receive full credit if used alone.

The grade of structure is determined by the distinctness of the aggregates and their durability (Table 7). Expression of structure grade is often moisture dependent and may change with drying of the soil.

Table 7. Soil structure grades, symbols, and descriptions.

Grade	Symbol	Description
Structureless	0	That condition in which there is no observable aggregation or no definite, orderly arrangement of natural lines of weakness.
Weak	1	Soil breaks into a very few poorly formed, indistinct peds, most of which are destroyed in the process of removal. Type of structure is barely observable in place. Clay coatings, if present, are thin and ped interiors look nearly identical to outer surfaces.
Moderate	2	Soil contains well-formed, distinct peds in the disturbed soil when removed by hand. They are moderately durable with little unaggregated material. The type of structure observed in the undisturbed pit face may be indistinct.
Strong	3	Durable peds are very evident in undisturbed soil of the pit face with very little or no unaggregated material when peds are removed from the soil. The peds adhere weakly to one another, are rigid upon displacement, and become separated when the soil is disturbed.

Color

Munsell soil color charts are used to determine the **moist** soil matrix color for each horizon described. Color must be designated by hue, value, and chroma. Space is provided to enter the hue, value, and chroma for each horizon separately on the scorecard. At the discretion of the official judges, more than one color may be given full credit. If peds are dry, they should be moistened before the matrix color is determined. Moist color is that color when there is no further change in soil color when additional water is added.

Color is to be judged for each horizon by selecting soil material to represent that horizon. The color of the surface horizon will be determined on a moist, rubbed (mixed) sample. For lower horizons (in some soils this will also include the lower portion of the epipedon), selected peds should be collected from near the central part of the horizon and broken to expose the matrix. For Bt horizons with continuous clay films, care should be taken to ensure that the color of a ped interior rather than a clay film is described for the matrix color.

Moist Consistence

Soil consistence refers to the resistance of the soil to deformation or rupture at a specified moisture level and is a measure of internal soil strength. Consistence is largely a function of soil moisture, texture, structure, organic matter content, and type of clay, as well as adsorbed cations. As field moisture will affect consistence, contestants should use their personal judgment to correct for either wet or dry conditions on the day of the contest. These corrections also will be made by the official judges. Contestants should judge the consistence of moist soil (midway between air-dry and field- capacity) for a ped or soil fragment from each horizon as outlined in the *Field Book for Sampling and Describing Soils, 2012* and Table 8.

Table 8. Soil moist consistencies, symbols, and descriptions.

Consistence	Symbol	Description
Loose	L	Soil is non-coherent (e.g., loose sand).
Very friable	VFR	Soil crushes very easily under very slight force (gentle pressure) between thumb and finger but is coherent when pressed.
Friable	FR	Soil crushes easily under slight force (gentle to moderate pressure) between thumb and forefinger and is coherent when pressed.
Firm	FI	Soil crushes under moderate force (moderate pressure) between thumb and forefinger, but resistance to crushing is distinctly noticeable.
Very firm	VFI	Soil crushes or breaks only when strong force is applied between thumb and all fingers on one hand.
Extremely firm	EF	Soil cannot be crushed or broken by strong force between thumb and all fingers but can be by applying moderate force between hands.
Slightly rigid	SR	Soil cannot be crushed by applying moderate force between hands but can be by standing (entire body weight on one foot) on the structural unit.
Rigid	R	Soil cannot be crushed by standing on it with one body weight but can be if moderately hit with hammer.
Very rigid	VR	Soil requires heavy, strong blow(s) with hammer to crush.

Matrix Concentrations

Identify the type of visible pedogenic concentrations, if present, that occur in the soil matrix (including soft, non-cemented masses or other bodies; excluding soft rock fragments) for each horizon. Concentrations that occur as pore linings, ped surface coatings, films, or finely disseminated forms are not to be described in this section, but should be considered when naming horizons. Concentrations are identifiable bodies found in the soil matrix. They contrast sharply with surrounding soil material in terms of color and composition. Water movement and the extent of soil formation can be related to concentration location and abundance within the soil profile as well as orientation within a horizon. To avoid problems with variability within the pit, only the type of concentrations will be determined. For this contest, four types of concentrations (based on composition) will be described (Table 9):

Carbonates (K), gypsum (Y), other salts (Z), and iron-manganese (FE-MN). If more than one type of concentration occurs in a horizon, describe all types present. At each contest site, the pH, sodium adsorption ratio (SAR), electrical conductivity (EC), and/or % gypsum may be provided when needed for each horizon. The concentration types recognized include:

Table 9. Matrix concentrations, symbols, and descriptions.

Concentration	Symbol	Description
None	Blank or (-)	No visible concentrations are present in the horizon studied.
Carbonate	K	In many soils in the contest area, calcium and magnesium carbonates accumulate in the lower parts of the profile. Carbonates can also accumulate at or near the soil surface as a result of capillary water movement from a close water table. Carbonates are recognized by their white appearance and strong to violent reaction with 10% HCl. The symbol used to identify the presence of carbonates is a "K." (NOTE: This is the same symbol that may be used as a subordinate designation.)
Gypsum	Y	In some soils in the contest area, gypsum accumulates in the lower parts of the profile. Gypsum concentrations can often be recognized by the clusters of crystals (gypsum rose) often seen by the naked eye but easily seen with a hand lens. Gypsum may also occur as coats on peds, or be finely disseminated, and not as crystals. The concentrations may be clear to white and do not effervesce when 10% HCl is added. The symbol used to identify the presence of gypsum is a "Y." (NOTE: This is the same symbol that may be used as a subordinate designation.)
Iron-manganese	FE-MN	Fe-Mn concentrations are sometimes found in horizons where seasonal changes in the reduction-oxidation state occur. Fe-Mn concentrations vary from red to dark, rounded to irregular bodies, or soft non-cemented masses, that usually can be crushed between fingers or cut with a knife. They are often referred to as "shot concentrations.' The symbol used to identify Fe-Mn concentrations is "FE-MN."
Other salts	Z	In addition to carbonates and gypsum, the soils of the area may contain other more soluble salts. These salts can be recognized by their white appearance, lack of effervescence when 10% HCl is added, lack of defined crystal structure (when compared to gypsum), and the lab data. The symbol used to identify the presence of other salts is a "Z." (NOTE: This is the same symbol that may be used as a subordinate designation.)

Effervescence

Material from each horizon should have 1 to 2 drops 10% HCl applied to it so as to observe the effervescence of carbonates. Effervescence categories and descriptions are in Table 10.

Table 10. Effervescence categories, symbols, and descriptions.

Effervescence	Symbol	Description
None	Blank or (-)	No bubbles detected.
Very slight	VSL	Few bubbles seen.
Slight	SL	Bubbles readily seen.
Strong	ST	Bubbles form low foam.
Violent	V	Thick foam forms quickly.

PART II: SOIL PROFILE CHARACTERISTICS

Hydraulic Conductivity

The saturated hydraulic conductivity of the surface horizon (Surface) and the most-limiting horizon (Limiting Layer) within the depth specified for judging will be estimated. "Limiting layer" refers to the horizon or layer with the slowest hydraulic conductivity. If a lithic or paralithic contact occurs at or above the specified judging depth, the hydraulic conductivity for the limiting layer is very low. The presence of a natric horizon at or above the specified judging depth will move the hydraulic conductivity class to the next lower class. In some soils, the surface horizon is the limiting horizon with respect to saturated hydraulic conductivity. In this case, the surface hydraulic conductivity would be reported in two places on the scorecard. For a discussion of factors affecting hydraulic conductivity, refer to the *Soil Survey Manual* (1993). (*NOTE: Attention should be paid to how the official judges handle restricting layers at the practice sites*.) Coarse fragments will usually increase hydraulic conductivity. The hydraulic conductivity classes, flow estimates, and descriptions of included soil textural classes and profile features for each hydraulic conductivity class are found in Table 11.

Table 11. Hydraulic conductivity classes, flow rates and descriptions.

Class	Flow Rate	Description
Very high	>100 µm/s (>36.0 cm/hr)	Usually includes textures of coarse sand, sand, and loamy coarse sand. It also includes textures of loamy sand and sandy loam if they are especially "loose" because of high organic matter content. Horizons containing large quantities of rock fragments with insufficient fines to fill many voids between the fragments are also in this class.
High	10 to 100 µm/s (3.7 to 36.0 cm/hr)	Usually includes textures of fine sand, very fine sand, loamy sand, loamy fine sand, loamy very fine sand, coarse sandy loam, sandy loam, and fine sandy loam.
Moderately High	1 to 10 µm/s (0.36 to 3.6 cm/hr)	Includes textures of very fine sandy loam, sandy clay loam, loam, silt loam, and silt.
Moderately low	0.1 to 1 µm/s (0.036 to 0.36 cm/hr)	Includes textures of sandy clay, clay loam, silty clay loam, It also includes a texture of silt loam if it has a low organic matter content and a high clay content.
Low	0.01 to 0.1 µm/s (0.0036 to 0.036 cm/hr)	Usually includes textures of clay and silty clay that have moderate structure and a moderate organic matter content as well as low to moderate shrink-swell potential (mixed or kaolinitic mineralogy).

Very low	< 0.01 µm/s (<0.0036 cm/hr)	Usually includes textures of clay and silty clay with a low organic matter content and weak or massive structure or clay or silty clay textures with moderate to high shrink-swell potential (smectitic mineralogy). Mark very low on the scorecard if a lithic or paralithic contact occurs at or above the specified judging depth.

Due to the difficulty in measuring and estimating hydraulic conductivity, this contest combines the six classes into three grouped classes: **High (Very High and High), Moderate (Moderately High and Moderately Low), and Low (Low and Very Low).**

Effective Soil Depth

The depth of soil to a root restricting layer, or effective soil depth, is the depth of soil that can be easily penetrated by plant roots. Soil materials must be loose enough so that roots do not experience severe physical resistance and yet fine enough to hold and transmit moisture. Horizons that provide physical impediments to rooting limit the effective depth of the soil. For this contest, materials considered restrictive to plant roots include: lithic and paralithic contacts. Soils that are clayey throughout, abrupt textural changes, and seasonal high-water tables do not restrict the depth of rooting. For most contests, a natric horizon will not be considered as a root restrictive layer. The depth to a restricting layer is measured from the soil surface (excluding O horizons). Besides its direct importance for plant growth, this property also relates to key factors such as water relationships and nutrient supplying capacity.

The presence or absence of roots may be helpful in determining the effective soil depth, but it is not always the sole indicator. In many cases, the plants growing at the site may be shallow rooted or, conversely, a few roots may penetrate into or through the restrictive layer, particularly along fractures or planes of weakness. At all sites, actual profile conditions should be considered and observed. A soil is considered very deep if no root restricting layers appear in the upper 150 cm (Table 12). If the profile is not visible to a depth of 150 cm, or if you are requested to describe a soil only to a shallower depth, then you may assume that the conditions present in the last horizon described extend to 150 cm.

Table 12. Effective soil depth classes and descriptions.

Class	Depth to restrictive feature
Very shallow	<25 cm
Shallow	25 to 49.99 cm
Moderately deep	50 to 99.99 cm
Deep	100 to 149.99 cm
Very deep	≥150 cm

Water Retention Difference

Water retention difference (WRD) refers to the soil water held between -33 kPa (field capacity) and - 1500 kPa (permanent wilting point), which approximates the range of available water for plants. WRD depends on the effective depth of rooting, the texture of the fine earth fraction (< 2 mm) (Table 13), and the content of rock fragments in the soil.

Table 13. Soil texture classes and standard water retention difference values.

Texture Class of Soil Horizon	**cm H2O/cm soil**
silt, silt loam, silty clay loam, loam, clay loam, and very fine sandy loam	0.20
sandy loam, fine sandy loam, sandy clay loam, sandy clay, clay, and silty clay	0.15
coarse sandy loam, loamy fine sand, loamy very fine sand, and loamy sand	0.10
loamy coarse sand and all sands	0.05

The amount of available water stored in the soil is calculated for the top 150 cm of soil or to a root-limiting layer, whichever is shallower. Total WRD is calculated by summing the amount of water held in each horizon (or portion of a horizon if it extends below 150 cm). If the depth designated for describing soil morphology is less than 150 cm, contestants should assume that the water retention properties of the last horizon extend to 150 cm or to the top of a lithic or paralithic contact, if either feature is observed at a depth shallower than 150 cm. If a horizon or layer is restrictive (all except natric horizons) to roots, this horizon and all horizons below should be excluded when calculating WRD. For natric horizons, and all horizons below the natric horizons, the available water content is reduced by 50%.

Rock fragments are assumed to hold no water that is available for plant use. If a soil contains rock fragments, the volume occupied by the rock fragments must be estimated and the WRD corrected accordingly. For example, if a silt loam A horizon is 25 cm thick and contains coarse fragments occupying 10% of this volume, the available water-holding capacity of that horizon would be 4.5 cm of water rather than 5.0 cm (e.g. 25 cm * 0.20 cm water/cm soil * 90% fine fraction = 4.5 cm).

Once the water retention difference is calculated for the appropriate soil profile depth, the water retention class can be determined using Table 14. An example water retention difference calculation and classification for a theoretical soil profile can be found in Table 15.

Table 14. Water retention classes based upon amount of plant available water to 150 cm.

Water Retention Class	**Plant available water (cm water/150 cm soil)**
Very low	<7.50 cm
Low	7.50 to 14.99 cm
Medium	15 to 22.49 cm
High	22.5 to 29.99 cm
Very High	≥ 30 cm

Table 15. Example of water retention difference calculation for a theoretical profile.

Horizon	Horizon Depth	Textural Class	Coarse Fragments (%)	Water Retention
Ap	0-12	ls	0	(12cm)(0.10) = 1.2
Bt1	12-28	sc	0	(16cm)(0.15) = 2.4
Bt2	28-54	scl	0	(26cm)(0.15) = 3.9
2Bt3	54-105	l	5	(51cm)(0.20)(0.95) = 9.69
2Bt4	105-132	grl	20	(27cm)(0.20)(0.80) = 4.32
2R	132+	-	-	0
Total water retention difference = 21.51 cm water/150 cm soil = MEDIUM				

Soil Wetness Class

Soil wetness classes as defined in the *Soil Survey Manual* (1993) will be used (Table 16). Soil wetness is a reflection of the rate at which water is removed from the soil by both runoff and percolation. Position, slope, infiltration rate, surface runoff, hydraulic conductivity, and redoximorphic features are significant factors influencing the soil wetness class. The depth to chroma ≤ 2 and value ≥ 4 redox features due to wetness will be used as a criterion to determine the depth of the wet state for most contests (i.e., gray depletions of at least common abundance as defined by the NRCS).

Table 16. Soil wetness classes based upon depth to gleying color requirements.

Class	Depth to wetness features (from soil surface)
Very shallow	<25 cm
Shallow	25 to 49.99 cm
Moderately deep	50 to 99.99 cm
Deep	100 to 149.99 cm
Very deep	≥150 cm

If no evidence of wetness exists within the specified depth for characterization and that depth is less than 150 cm, assume the wetness class is “Very deep”. These classes indicate free water and reduction occurs, but do not indicate the duration of occurrence of free water.

Part 3: Site Characteristics

Parent Material

Parent material refers to unconsolidated organic and mineral material in which soils form. As parent material cannot be observed in its original state, inference from the properties of the soil and from other evidence must be used. Mode of deposition and/or weathering may be implied or implicit. Parent material may be difficult to infer from the nature of the soil materials themselves. Table 17 shows common parent materials.

Sometimes two parent materials may be evident in a pedon, for example alluvium over residuum. If evident, indicate the transition with an Arabic numeral in the "Prefix" column beginning with the number 2 for the first transition. It is implied that the overlying parent material is number 1. For example, the following sequence may be found in a profile with two parent materials: A – E – Bt1 – 2Bt2 – 2Bt3, etc.

Table 17. Common parent materials and their descriptions.

Parent Material	Description
Alluvium	Alluvium consists of sediment transported and deposited by running water and is associated with landforms such as floodplains and stream terraces. As running water sorts sediment by particle size, these materials are often stratified. Rock fragments are often rounded in shape. Alluvium may occur on terraces above present streams (old alluvium) or in the normally flooded bottomland of existing streams (recent alluvium). The sediments may be of either a general or local origin.
Colluvium	Colluvium/pedisediment consists of sediment that has accumulated on hillslopes, usually but not always near the base of slopes (i.e., footslopes), in depressions, or along small upland intermittent streams. This material is unconsolidated material transported or moved by gravity and by local, unconcentrated runoff that accumulates on or near the base of the slopes. The sediment is typically a poorly sorted mixture of particle sizes. These materials can occur on summits, shoulder slopes, and backslopes as well as footslope positions. The material is of local origin.
Eolian sand/loam	Eolian sand/eolian loam consists of sandy and loamy sediments transported and deposited by wind. Eolian sand is associated with sand dunes of varying size and shape. Eolian loam is associated with transition areas where eolian sand and loess parent materials are in close proximity.
Loess	Loess consists of silty-textured, wind-deposited sediment that is dominantly of silt-size. Loess may contain significant amounts of clay and very fine sand, depending on the distance from the loess source. Some loess near the source may contain more sand than would be expected due to local fluvial action and/or reworking by the wind. Thin loess deposits over residuum or colluvium can have up to 15% rock fragments.
Residuum	Residuum is bedrock that has weathered in place into an unconsolidated state. Rock fragments tend to be oriented in relation to the fabric of the bedrock.
Lacustrine	Lacustrine consists of deposits by still water (lakes, playas). Soils forming in lacustrine deposits are characteristically well sorted, devoid of coarse sands or gravels, and possessing thin layers reflecting annual sediment deposition.

Slope Gradient

Slope refers to the inclination of the ground surface and has length, shape, and gradient. Gradient is usually expressed in percent slope and is the difference in elevation, in length units, for each one hundred units of horizontal distance. Slope may be measured by an Abney level or by a clinometer (Figure 2). Slope classes are indicated on the scorecard. Stakes or markers will be provided at each site for determining slope and the slope should be measured between these two markers. The tops of the markers will be placed at the same height, but it is the responsibility of the contestant to make sure that they have not been disturbed. If the slope measurement falls on the boundary between two slope classes, contestants should mark the steeper class on the scorecard. Contestants may want to write the actual slope value in the margin of the scorecard to aid in the completion of the interpretations section.

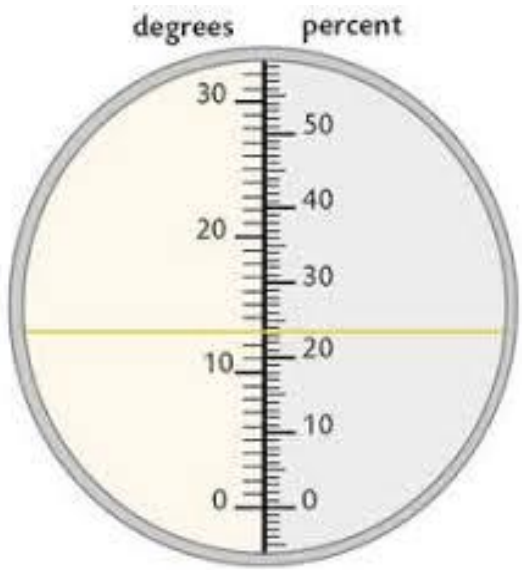

Figure 2. Depiction of a standard clinometer view. The slope of the area in this example is 13 degrees or 23%.

Site Position

A landform is a physical, recognizable form or feature of the Earth's surface that usually has a characteristic shape and is produced by natural causes. Parent materials are often associated with particular landforms. In the contest area, the separation of landform and hillslope position is complicated by the relatively flat landscape. Therefore, landform and hillslope categories appear together in this contest. Contestants should select the site position that best describes the situation. If the pit is in an ambiguous position or the position is obscured by the spoil pile, the slope stakes will be placed in such a position and/or orientation to reinforce the identity of the landform upon which the pit resides. Common landforms are found in Table 18. Some landforms are depicted in Figure 3. Figure 4 shows common hillslope positions.

Table 18. Common landforms and their descriptions

Landform	Description
Depression	A closed basin within an upland that is not directly connected to an integrated surface drainage system. Surface accumulations of organic- enriched soil and redoximorphic features are commonly found in these areas, but are not necessary for identification.
Stream terrace	A step-like surface or platform along a stream valley that represents a remnant of an abandoned floodplain. Where occurring in valley floors, this landform is commonly smooth, having low relief, and may or may not be dissected by an under-fitted stream. It consists of a relatively level surface, cut or built by a stream and a steeper descending slope (scarp or riser). A stream may have more one or more terraces.
Floodplain	A nearly level alluvial plain that borders a stream and is subject to flooding *first* when the stream goes into flood stage unless artificially protected. The floodplain refers to the lowest level(s) associated with a stream valley and is sometimes referred to as bottom soil, stream bottom, or first bottom. Sediments may or may not be stratified. Soils found in a floodplain position normally have little profile development beneath the A horizon. If coarse fragments are present, they are normally rounded or subrounded. Each stream has only one floodplain.
Dune/interdune	Stabilized rolling hills, dunes, and intermittent valleys between the hills and dunes. The hills are mostly round-topped or conical and smooth. The dunes can be in distinct ridges, or they can be very choppy. Some portions of the landscape may have an irregular appearance. If present, this landform will take precedence over “depression” and “footslope”. Interdune areas may also be referred to as “depressions”
Plain	Site position that is level to nearly level (0 to 5 % slope) that does not meet any other geomorphic position.
Playa	Shallow temporary lakes that occur primarily in semi-arid and arid environments. The correct parent material is lacustrine. Most playas on the Southern High Plains have formed as a result of dissolution and deflation. Older playas are characterized by wind-blown material deposited on the eastern to southeastern side of the playa. This geomorphic surface represents the major surface. For this landscape, the site position will be determined by its position on the landscape, such as Summit, Shoulder, Backslope, Footslope or Toeslope. Eolian should be marked as the parent material.

Playa step	A bench surrounding a playa. The correct site position would be either Footslope or Toeslope depending upon its relationship to the surrounding landscape. Colluvium should be marked as the parent material.
Summit	Highest level of an upland landform with a relatively gentle, planar slope. The summit is often the most stable part of a landscape. If the site is on a summit and has a slope < 2%, the summit position on the scorecard should be selected. Not every hillslope has a summit, as some hillslopes have shoulders at the crest of the hill.
Shoulder	Rounded (convex-up) hillslope component below the summit. The shoulder is the transitional zone from the summit to the backslope and is erosional in origin.
Backslope	Steepest slope position that forms the principal segment of many hillslopes. The backslope is commonly linear along the slope, is erosional in origin, and is located between the shoulder and the footslope positions.
Footslope	Slope position at the base of a hillslope that is commonly rounded, concave up along the slope. The footslope is transitional between the erosional backslope and depositional toeslope. Accumulation of sediments often occurs within this position.
Toeslope	Lowest landform component that extends away from the base of the hillslope. If the site is a toeslope and has a slope of < 2%, toeslope should be selected on the scorecard.

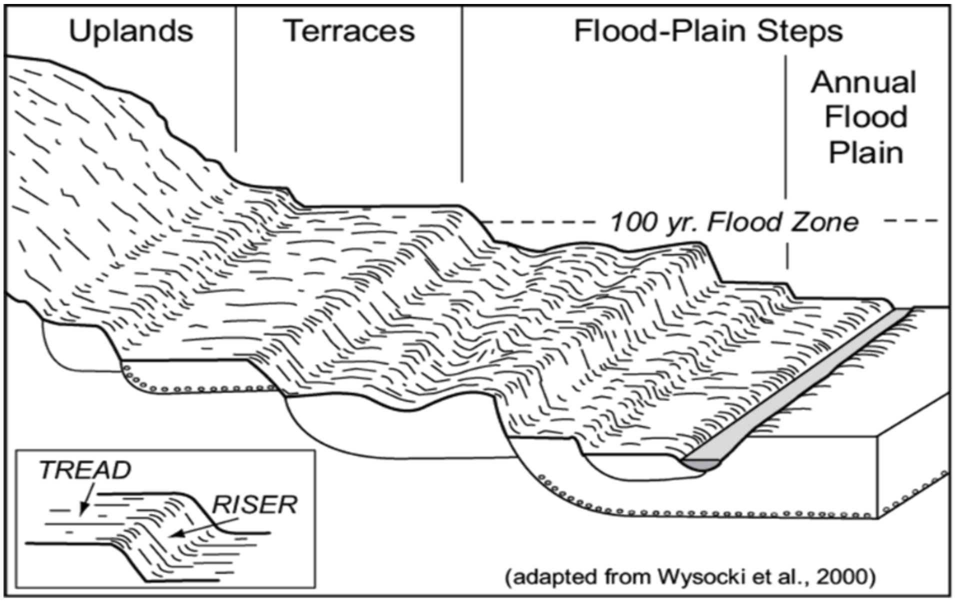

Figure 3. Examples of landforms including uplands, terraces, and floodplains.

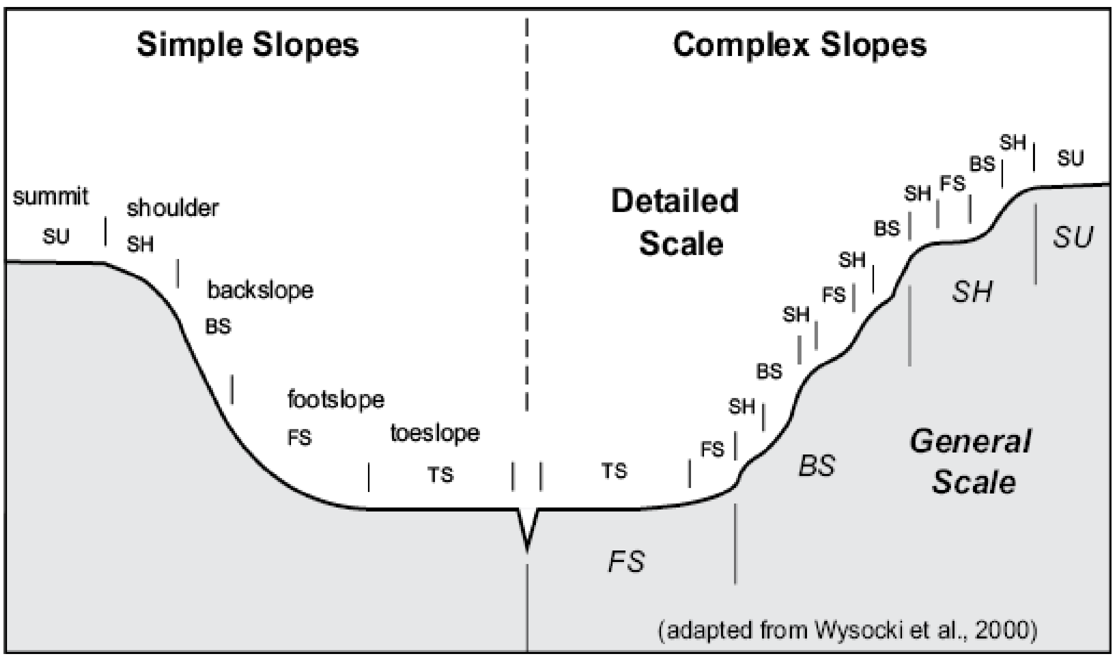

Figure 4. Comparison of a simple versus complex hillslope profile.

Surface 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. Some contests may determine runoff from the six hydraulic conductivity classes as described in the *Soil Survey Manual* (1993) (Table 19). Others may use a simplified format based on the high, medium, and low classifications (Table 20). Contestants should consider vegetative cover quantity and quality to determine the runoff class. Where good vegetative cover or an O horizon is present, contestants should mark the next slower surface runoff class. Contestants should mark Negligible/Ponded for sites in a depression with no surface runoff. Brief descriptions of the six runoff classes used in this contest can be found in Table 21.

Table 19. Surface runoff classes.

	SURFACE Hydraulic Conductivity					
Slope %	**Very High**	**High**	**Moderately High**	**Moderately Low**	**Low**	**Very Low**
<2%	Ponded	Ponded	Very Slow	Slow	Slow	Medium
2-6%	Ponded	Very Slow	Slow	Slow	Medium	Rapid
6-12%	Very Slow	Slow	Slow	Medium	Rapid	Very Rapid
12-18%	Slow	Slow	Medium	Rapid	Very Rapid	Very Rapid
18-30%	Slow	Medium	Rapid	Very Rapid	Very Rapid	Very Rapid
>30%	Medium	Rapid	Very Rapid	Very Rapid	Very Rapid	Very Rapid

Table 20. Simplified surface runoff classes.

	SURFACE Hydraulic Conductivity		
Slope %	**High**	**Moderate**	**Low**
< 1%	Very Slow	Very Slow	Very Slow
1-3%	Very Slow	Slow	Slow
3-5%	Slow	Medium	Medium
5-8%	Medium	Medium	Rapid
8-12%	Medium	Rapid	Very Rapid
12-20%	Rapid	Very Rapid	Very Rapid
>20%	Very Rapid	Very Rapid	Very Rapid

Table 21. Surface runoff classes and descriptions.

Runoff Class	Description
Negligible/Ponded	Added water flows away very slowly and free water lies on the soil surface for very long periods. Most of the water enters and passes through the soil or evaporates. Very open and porous soils (very high or high surface hydraulic conductivity) with little or no slope are considered to have negligible runoff.
Very Slow (Very Low)	Added water flows away so slowly that free water lies on the surface for long periods. Much of the water enters and passes through the soil or evaporates. Fairly open and porous soils in which the water enters immediately are also considered to have very low runoff. Soils with very low runoff are commonly nearly level to gently sloping depending on the surface hydraulic conductivity.
Slow (Low)	Added water flows away so slowly that free water covers the soil for brief, periods or a large part enters the soil in the case of sandy or porous soils. Soils with low runoff can be found in nearly level to strongly sloping depending on the surface hydraulic conductivity. There is usually little or no erosion problem.
Medium	Added water flows away at such a rate that moderate amounts enter the soil and free water lies on the surface for a very brief period. The erosion hazard is slight to moderate if cultivated. These soils are usually gently sloping or moderately sloping but can be found in all slope classes depending on the surface hydraulic conductivity.
Rapid (High)	A large portion of added water moves rapidly over the surface with only a small part entering the soil. These soils may be on gently sloping to steep slopes depending on the surface hydraulic conductivity. The erosion hazard is moderate to high.
Very Rapid (Very High)	A small part of the added water enters the soil and surface water runs off as fast as it is added. These soils are on moderately sloping to steep slopes depending on the surface hydraulic conductivity. The erosion hazard is high or very high.

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. For the purpose of this contest, only the erosion potential classes in Table 22 will be used. It is assumed that granular structure or structureless - single grained exists for the surface horizon and that the soil is bare, although in this contest there is no adjustment if that is not the case. A soil profile occurring not in a pit but in a natural cliff-like exposure will be classified with “very high” erosion potential.

Table 22. Erosion potential classes.

	SURFACE Textural Class			
Surface Runoff Class	**S, LS**	**SCL, SC**	**SL, CL, C, SiC**	**L, Si, SiL, SiCL**
Ponded	Very Low	Very Low	Very Low	Very Low
Very Slow (Very Low)	Very Low	Very Low	Low	Medium
Slow (Low)	Very Low	Low	Medium	Medium
Medium	Very Low	Low	Medium	High
Rapid (High)	Low	Medium	High	Very High
Very Rapid (Very High)	Medium	High	Very High	Very High

PART 4: SOIL CLASSIFICATION

The reference used in this section is *Keys to Soil Taxonomy,* 12th Edition (Soil Survey Staff, 2014). For pictures and illustrations for soil classification, see *Illustrated Guide to Soil Taxonomy, version 2* (Soil Survey Staff, 2015). Only the diagnostic horizons and features, orders, suborders, and great groups that exist or are plausible for mineral soils in the contest area are included on the scorecard. The total carbonate content (% by weight), SAR, % gypsum, EC, % organic C, and/or pH may be provided for each horizon at each site if the information is necessary for soil classification.

The following discussion of specific diagnostic horizons and taxa includes abbreviated and summarized definitions. Complete definitions and classification keys are available in *Keys to Soil Taxonomy*, 12th Edition (Soil Survey Staff, 2014). The simplified definitions and keys given in Section D will be used for classifying the soils in this contest.

Particle size control section will be delineated and the particle-size class for the soil family will be calculated as an average across the whole control section, weighted by share of the particle size control section taken by each horizon. The presence of rock fragments in the particle size control section will be ignored both for the purposes of calculating the weighted average of the texture and for the purposes of the use of the word "skeletal" in describing the family class (ignore use of the word skeletal). Strongly contrasting particle size classes in a control section will be ignored and only the weighted average of the whole control section will be determined (as above).

Epipedon

The epipedon (Gr. *epi*, over, upon, and *pedon*, soil) is a horizon that forms at or near the surface. Only one epipedon can be present in mineral soils. It is darkened by organic matter or shows evidence of eluviation, or both.

Any horizon may be at the surface of a truncated soil. The following section, however, is concerned with three diagnostic horizons that have formed at or near the soil surface (Figure 5). These horizons can be covered by a surface mantle of new soil material. If the surface mantle has rock structure, the top of the epipedon is considered the soil surface unless the mantle meets the definition of buried soils in chapter 1. If the soil includes a buried soil, the epipedon, if any, is at the soil surface and the epipedon of the buried soil is considered a buried epipedon and is not considered in selecting taxa unless the keys specifically indicate buried horizons, such as those in Thapto-Histic subgroups. A soil with a mantle thick enough to have a buried soil has no epipedon if the soil has rock structure to the surface or has an Ap horizon less than 25 cm thick that is underlain by soil material with rock structure.

A recent alluvial or eolian deposit that retains fine stratifications (5 mm or less thick) or an Ap horizon directly underlain by such stratified material is not included in the concept of the epipedon because time has not been sufficient for soil-forming processes to erase these transient marks of deposition and for diagnostic and accessory properties to develop.

An epipedon is not the same as an A horizon. It may include part or all of an illuvial B horizon if the darkening by organic matter extends from the soil surface into or through the B horizon.

Mollic

Required Characteristics:

1. 18 cm thick if a finer texture and 25 cm thick if loamy fine sand or coarser
2. %BS ≥ 50%
3. %OC ≥ 0.6%
4. Value ≤ 3 moist, chroma ≤ 3 moist

Umbric

Required Characteristics:

1. All requirements of mollic except possesses %BS ≤ 50%

Ochric

Required Characteristics:

1. Does not meet the requirements of mollic or umbric.

None

Required Characteristics:

1. Used for the situation where a diagnostic subsurface horizon occurs at the soil surface. This is rare in the contest area where part of the soil profile has been physically removed by erosion or human activity.

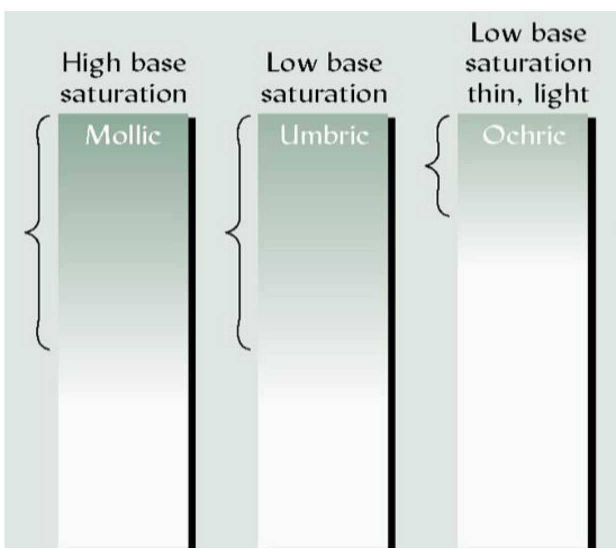

Figure 5. Epipedon diagrams illustrating key properties and depths of the mollic, umbric, and ochric epipedons.

Subsurface Horizon

The horizons described in this section form below the surface of the soil. They are composed of mineral soil material. They may be exposed at the surface by truncation of the soil. All of these horizons are typically designated as B horizons but may include parts of A or E horizons. Contestant should mark all diagnostic subsurface horizons and features present in a given profile. If no diagnostic subsurface horizon or feature is present, contestants should mark "none" for full credit. Five points are awarded for each correct answer and five points subtracted for each incorrect answer, with a minimum of score of zero available for this section. Figure 15 can be used to quickly identify the major diagnostic horizon(s).

Argillic

An argillic horizon is normally a subsurface horizon with a significantly higher percentage of phyllosilicate clay than the overlying soil material. It shows evidence of clay illuviation (clay films, bridges, etc.). The argillic horizon forms below the soil surface, but it may be exposed at surface later by erosion.

Required Characteristics:

All argillic horizons must meet the following requirements:

- Contain a significant clay increase.
    - If eluvial horizon has <15% clay, must have at least a 3% absolute increase (e.g., from 10 to 13%).
    - If eluvial horizon has 15 - 40% clay, must increase by a ratio of 1.2 or more. iii. If eluvial horizon has >40% clay, must contain at least 8% more clay (e.g., from 42 to 50%).

Calcic

The calcic horizon is an illuvial horizon in which secondary calcium carbonate or other carbonates have accumulated to a significant extent (Figure 18, 19, 20).

Required Characteristics:

Calcic horizon must meet the following requirements:

- Has a $CaCO_3$ equivalent ≥ 15% and contains ≥ 5% more $CaCO_3$ equivalent than the C horizon or
- Has a CaCO3 equivalent ≥ 15% and contains ≥ 5% identifiable pedogenic $CaCO_3$ forms such as concretions, soft powdery forms, threads, pendants on pebbles, etc.

Cambic

A cambic horizon is the result of physical alterations, chemical transformations, or removals or of a combination of two or more of these processes. *This horizon is the catch-all meant to signify considerable soil development that doesn't (yet) fit criteria for any of the other diagnostic horizons. It is most likely to coincide with an Inceptisol.

Required Characteristics:

A cambic horizon must meet the following requirements:

1. Has a texture class of very fine sand, loamy very fine sand, or finer; *and*
2. Shows evidence of alteration in one of the following forms:
    a. If aquic conditions occur < 50 cm (soil wetness class 4 or 5)
        i. Colors that do not change on exposure to air

        ii. Gray colors for one of the following situations
            1. Value of 3 or less and chroma of 0 or
            2. Value of 4 or more and chroma of 1 or less or
            3. Any value with chroma of 2 or less and redox concentrations
    b. If aquic conditions do not occur < 50 cm, one of the following situations
        i. Higher chroma, higher value, redder hue, or higher clay content than the underlying horizon or an overlying horizon.
        ii. Removal of carbonates or gypsum.
3. Is not part of an epipedon or another diagnostic subsurface horizon
4. Is not part of an Ap horizon

Lithic Contact

A lithic contact is the continuous boundary between soil and a coherent underlying material (Figure 21). Roots only penetrate in cracks with 10 cm+ spacing. The underlying material must be sufficiently coherent when moist to make hand-digging with a spade impractical, which includes chipping & scraping. The zone is strongly cemented and not petrolithic. Lithic contact is usually rock (R).

Natric Horizon

A natric horizon meets all of the requirements for an argillic horizon plus a high sodium content.

Required Characteristics:

The natric horizon:

- Usually has columnar or prismatic structure
- Thickness requirement of 7.5 to 15 cm depending on texture
- One of the following:
- Sodium absorption ratio (SAR) ≥ 13 or exchangeable sodium percentage (ESP) ≥ 15 within 40 cm of the upper boundary of the natric (i.e., where the clay films start).
- More exchangeable Mg + Na than Ca + exchangeable acidity within 40 cm of its upper boundary (i.e., where the clay films start) if ESP ≥ 15 or SAR ≥13 within 200 cm

Paralithic Contact

The contact between soil and paralithic materials that are weakly cemented (can dig with difficulty with a spade) with no cracks or the cracks are >10 cm apart. Usually, it is partially weathered or weakly cemented bedrock such as sandstone, siltstone, shale, or mudstone. Includes Cr, Crk, Crkt, etc. horizons.

Petrocalcic Horizon

The petrocalcic horizon is an illuvial horizon in which secondary calcium carbonate or other carbonates have accumulated to the extent that the horizon is cemented or indurated (Figure 19).

Required Characteristics

A petrocalcic horizon must meet the following requirements:

1. The horizon is cemented or indurated by carbonates, with or without silica or other cementing agents;
2. The horizon has a thickness of:

10 cm or more;

1 cm or more if it consists of a laminar cap directly underlain by bedrock.

Salic Horizon

A salic horizon is a horizon of accumulation of salts that are more soluble than gypsum in cold water.

Required Characteristics:

1. An electrical conductivity (EC) equal to or greater than 30 dS/m in the water extracted from a saturated paste
2. A product of the EC, in dS/m, and thickness, in cm, equal to 900 or more.

Slickensides

Polished and grooved surfaces on peds resulting from shear failure or sliding (Figure 22). Occurs in soils with shrink-swell clays and soils where they appear are most likely Vertisols. Includes Bss, Btss, Btkss, etc. If observed, the participant should also indicate the presence of vertic properties on the scorecard.

Vertic Properties

Vertic properties are a combination of heavy texture, smectitic mineralogy, slickensides, hard consistence when dry, sticky when wet, and shrinking and swelling. Vertic properties include the appearance of intersecting slickensides, wedge-shaped peds, and surface cracks of 1 cm or more when dry. Clay percentage must be 30% or more throughout the profile. Vertic properties are characteristic of soils in the Vertisols order.

Taxonomy

Hierarchal Tiers

Notes from pg. 210, table 7.1 in Soil Genesis & Classification Textbook

Order: Presence of absence of major diagnostic horizons, mineralogical properties, and extremes of soil temperature and moisture regimes.

Suborder: Soil moisture regimes and diagnostic horizons.

Great Group: Degree of diagnostic horizon expression within each suborder taxa.

Order

Orders are largely identified by their diagnostic horizons and other features. Chemical data provided at the site will be important for order determination. Table 23 provides basic identification information for all 12 soil orders.

Table 23. Simplified key to soil orders.

Soil Order	Key Characteristics
Gelisols	Permafrost within 200 cm of the ground surface
Histosols	Other soils with more than 30% organic matter to depth of 40 cm
Spodosols	Other soils with a Spodic horizon within 2 m
Andisols	Other soils with > 35 cm of Andic soil properties and no Albic horizon
Oxisols	Other soils with an Oxic horizon with 1.5 m and no Kandic horizon, or those that contain ≥ 40% clay in the surface 18 cm and have a Kandic horizon within 1.5 m
Vertisols	Other soils with more than 30% clay in all horizons; presence of vertic properties, some cracks when dry at 50 cm
Aridisols	Soils that are dry more than 50% of the year and have no Mollic epipedon
Ultisols	Other soils that have an Argillic or Kandic horizon but a B.S. at pH 8.2 less than 35% at a depth of 1.8 m
Mollisols	Other soils that have a Mollic epipedon with BS ≥ 50% throughout
Alfisols	Other soils that have an Argillic or Kandic horizon
Inceptisols	Other soils that have an Umbric, Mollic, or Plaggen epipedon, or a Cambic horizon
Entisols	Other soils

The following is a more specific key to select soil orders. To use it, start at Vertisols and narrow down the order according to the requirements listed. Select suborders with their requirements are also given for each of the following orders.

Vertisol

Have all of the following:

- ≥ 30% clay in top 50 cm of soil
- Cracks that open and close periodically (shrink/swell) (Figure 22)
- Slickensides or angled wedge-shaped peds in layer ≥ 25 cm

Aridisol

Have all of the following:

- Aridic soil moisture regime
- Ochric or anthropic epipedon
- One or more of the following within 100 cm of the surface: a cambic horizon with a lower depth of 25 cm or more; a cryic soil temperature regime and a calcic, gypsic, petrocalcic, petrogypsic, salic horizon, duripan, argillic, natric horizon, or salic horizon
- No sulfuric horizon within 150 cm of the surface

Mollisol

Have all of the following:

- Mollic epipedon
- %BS > 50% in ALL horizons

Alfisol

Have one or more of the following:

- Argillic or Natric Horizon

Inceptisol

Have one or more of the following:

- Umbric or Mollic Epipedon
- Cambic Subsurface Diagnostic Horizon

Entisol

All other soils

Suborder

Suborders further narrow down the soil order. The suborder is indicated by a formative unit appearing immediately before of the order formative unit in a taxonomic name. Table 24 (adapted from *Elements of the Nature and Properties of Soil,* 14th Edition) gives possible formative units for soil orders and their basic meanings. Most specific requirements can be found in *Keys to Soil Taxonomy*, 12th Edition (Soil Survey Staff, 2014).

Table 24. Soil suborder formative units and meanings.

Suborder Formative Unit	Meaning
aqu	Characteristics associated with wetness
arg	Presence of argillic horizons
calc	Presence of calcic horizon
camb	Presence of cambic horizon
fluv	Floodplains
gyps	Presence of a gypsic horizon
orth	The common ones
sal	Presence of a salic horizon
ust	Of dry climates, usually hot in summer (ustic moisture regime)

Great Groups

Great Groups further indicate soils information. They are added as formative units immediately before the suborder formative unit. Table 25 (adapted from *Elements of the Nature and Properties of Soil,* 14th Edition) gives possible formative units for soil orders and their basic meanings. More specific requirements can be found in *Keys to Soil Taxonomy*, 12th Edition (Soil Survey Staff, 2014). Possible contest suborders will be indicated on the scorecard.

Table 25. Soil Great Group formative units and meanings.

Great Group Formative Unit	Meaning
argi	Argillic horizon
calc, calci	Calcic horizon
camb	Cambic horizon
endo	Fully water saturated
epi	Perched water table
hapl	Minimum horizon
natr	Presence of a natric horizon
pale	Old development (reddened)
ust	Dry climate, usually hot summers

Family Particle-Size Control Section

The term particle-size class is used to characterize the grain-size composition of the whole soil, including both the fine earth and the rock and pararock fragments up to the size of a pedon, but it excludes organic matter and salts more soluble than gypsum.

Note that in this competition particle size control section will be delineated and the particle-size class for the soil family will be calculated as an average across the whole control section, weighted by share of the particle size control section taken by each horizon. The presence of rock fragments in the particle size control section will be ignored both for the purposes of calculating the weighted average of the texture and for the purposes of the use of the word "skeletal" in describing the family class (ignore use of the word skeletal). Strongly contrasting particle size classes in a control section will be ignored and only the weighted average of the whole control section will be determined.

Determining Particle Size Control Section Starting and Stopping Depths

The following flow chart, in addition to Figure 6, are used to determine the starting and ending depths of the particle size control section. The upper-boundary and lower-boundary are indicated by **bold** words. Note: Root-limiting includes duri-pan, petro-X-ic, densic, (para)lithic

1. Do you have a root-limiting layer <36cm from surface?
    a. If Yes…
        - Upper Boundary = Mineral soil surface
        - Lower Boundary = Root-limiting layer
    b. If No…Continue to #2
2. Is it an Alfisol or Mollisol with an argillic or natric horizon upper boundary within 100 cm of the mineral surface and lower boundary ≥25 cm?
    a. If Yes…Does it have strongly contrasting particle size classes?

1) If Yes…
    - **Upper Boundary = Top of argillic or natric horzon**
    - Lower Boundary = Upper 50 cm of the argillic or natric horizon or to a depth of 100 cm, whichever is deeper
2) If No…
    - **Boundaries = Top of argillic or natric horizon to bottom if ≤ 50 cm thick OR the upper 50 cm of the horizon if > 50 cm thick**

b. If No…Continue to #3

3. Do you have an argillic or natric horizon that has an upper boundary ≥ 100 cm from the surface?
    a. If Yes…
        - Upper Boundary = Lower boundary of an Ap horizon or a depth of 25 cm, whichever is deeper
        - Lower Boundary = 100 cm below the mineral soil surface or a root-limiting layer, whichever is shallower
    b. If No…Continue to #4
4. Is there is an argillic or natric horizon with a lower boundary within 25 cm of the surface?
    a. If Yes…
        - Upper Boundary = Upper boundary of argillic or natric horizon
        - Lower Boundary = 100 cm below the mineral soil surface or a root-limiting layer, whichever is shallower
    b. If No…
        - Upper Boundary = Lower boundary of an Ap horizon or a depth of 25 cm, whichever is deeper
        - Lower Boundary = A depth of 100 cm or a root-limiting layer, whichever is shallower

Determining Family Particle-Size Class

Particle-size class is a portion of the family-level taxonomic classification determined by the primary texture within the control section identified using the starting and ending depths. Most of the time, this area is within the diagnostic horizon. Note that Vertisols have clay boundary at 30%. Table 26 gives the particle-size classes and their descriptions. Strongly contrasting particle-size classes indicate sudden changes in pore-size distribution that seriously affect movement and retention of water and/or nutrients.

Table 26. Family level-particle size classes and descriptions.

Particle-Size Class	Texture Requirement	Additional Requirement(s)
Sandy	Have a texture class of coarse sand, sand, fine sand, loamy coarse sand, loamy sand, or loamy fine sand in the fine-earth fraction	None
Loamy	Have a texture class of loamy very fine sand, very fine sand, or finer, and less than 35% clay in the fine earth fraction	Shallow family or in Lithic, Arenic, or Grossarenic subgroup, or the layer is a part of a strongly contrasting particle-size class
Coarse-Loamy	Have 15% or more fine sand or coarser (including gravel) and < 18% clay	None
Fine-Loamy	Have 15% or more fine sand or coarser (including gravel) and 18-35% Clay	None
Coarse-Silty	Have less than 15% fine sand or coarser (including gravel) and < 18% clay	None
Fine-Silty	Have less than 15% fine sand or coarser (including gravel) and 18-35% clay	None
Clayey	Have over 35% Clay	Shallow family or in Lithic, Arenic, or Grossarenic subgroup, or the layer is a part of a strongly contrasting particle-size class
Fine	Have 35-60% Clay	None
Very Fine	Have >60% clay	None

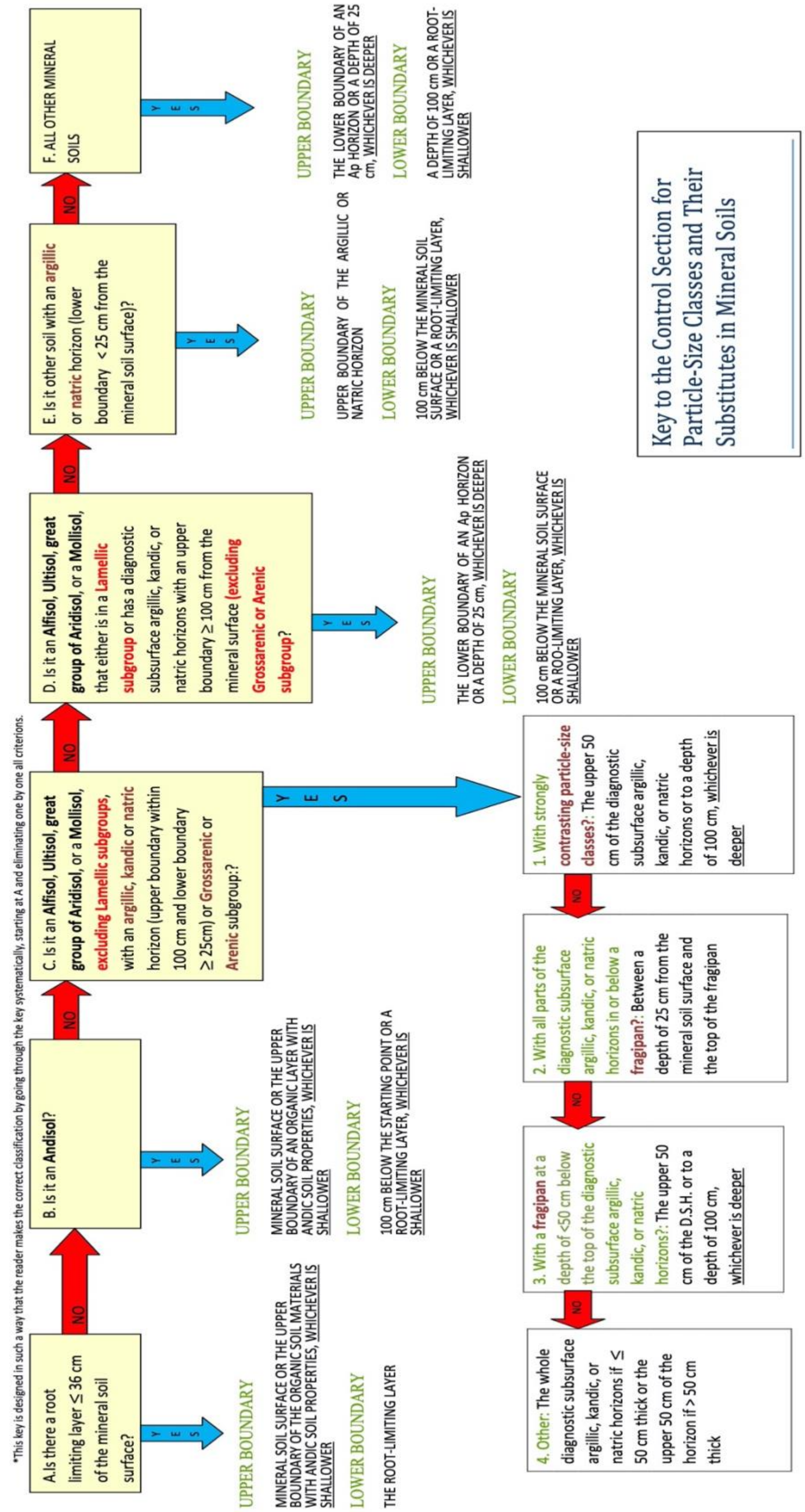

Figure 6. Flow chart for particle-size control class upper and lower boundaries.

PART 5: INTERPRETATIONS

Soil Use Interpretations

Soil interpretations involve the determination of the degree of limitation for each soil at a site for a specified use (Tables 27-30). The interpretations involve the determination of the degree of limitation within each soil for a specific use. The most restrictive property determines the limitation rating. In cases where the depth to be described does not extend to the required interpretive depth in the table (e.g., 150 cm for some criteria), contestants should assume that the lowest horizon in the pit extends to the depth of interest (unless a lithic or paralithic contact occurs at the observation depth).

The following soil use interpretation tables are partially extracted and modified from the National Soil Survey Handbook (NSSH). The most-limiting reason listed in the table should be marked on the scorecard. In addition to indicating the suitability rating for each soil use, contestants will record the number corresponding to the reason in the table used for the suitability rating selected on the scorecard. If all the evaluations are "slight", then record "none" as the reason on the scorecard. If more than one limitation is identified at the same level (e.g. 2 limitations are severe) then the student should indicate the reason which appears first on the table. For example, if a site is severely limited by both shrink-swell potential (reason 2) and slope (reason 6), the student should indicate "2" as the reason because it appears first on the list.

Table 27. Dwellings with Basements. Adapted from NSSH Table 620-3.

Factors Affecting Use	Degree of Limitation		
	Slight	**Moderate**	**Severe**
1. Flooding or ponding frequency	None		Rare to Frequent
2. Potential Shrink-swell (continuous thickness of C, SIC, or SC)	<8 cm	8-16 cm	>16 cm
3. Depth to seasonally high-water table (cm)	>200	100 - 200	<100
4. Depth to root-limiting layer other than hard rock (R) (cm)	>200	50 - 200	<50
5. Depth to hard rock (R) (cm)	> 200		≤200
6. Slope (%)	<6	6 - 20	>20

Table 28. Septic Tank Absorption Fields. Adapted from NSSH Table 620-17.

Factors Affecting Use	Degree of Limitation		
	Slight	Moderate	Severe
1. Flooding or ponding frequency	None		Rare to Frequent
3. Depth to seasonally high-water table (cm)	>150	100 - 150	<100
4. Occurrence of S or LS textures (cm)	> 100	< 50	50 - 100
5. Depth to root-limiting layer (cm)	>150	100 - 150	<100
6. Slope (%)	<6	6 - 20	>20

*Criteria for the septic tank absorption field interpretation excludes the upper 50 cm of the soil profile, thus only the soil between the depths of 50 and 150 cm should be considered.

Table 29. Local Roads & Streets. Adapted from NSSH Table 620-17.

Factors Affecting Use	Degree of Limitation		
	Slight	Moderate	Severe
1. Flooding or ponding frequency	None		Rare to Frequent
2. Potential Shrink-swell (continuous thickness of C, SIC, or SC)	<8	8-16	>16
3. Depth to seasonally high-water table (cm)	>50	25-50	<25
4. Potential Frost Action (upper 50 cm and only applicable for mesic and cooler STR)	S, LS, SL	all others	SI, SIL, SICL
5. Depth to bedrock or another continuous cemented layer (cm)	>150	100 - 150	<100
6. Slope (%)	<6	6 - 15	>15

Table 30. Suitability for corn production.

Factors Affecting Use	Degree of Limitation		
	Slight	Moderate	Severe
1. Flooding or ponding frequency	Protected or None	Rare	Common to Frequent
2. COS, S, FS, VFS, LCOS, LS, LFS, LVFS surface texture thickness (cm)	<50	50 - 100	>100
3. Depth to seasonally high-water table (cm)	>50	25 - 50	<25
4. Water retention difference (class)	Moderate, High	Low	Very Low
5. Depth to root-limiting layer (cm)	> 50	25 - 50	<25
6. Slope (%)	<6	6 - 10	>10

ATTACHMENT 1

Official Abbreviations

Boundary Distinctness

Abrupt - A	Clear - C	Gradual - G	Diffuse - D

Coarse Fragments

Gravelly	- GR	Cobbly	- CB
Very Gravelly	- VGR	Very Cobbly	- VCB
Extremely Gravelly	- XGR	Extremely Cobbly	- XCB

Texture

Coarse sand	- COS	Fine sandy loam	- FSL
Sand	- S	Very fine sandy loam	-VFSL
Fine sand	- FS	Loam	- L
Very fine sandy	- VFS	Clay loam	- CL
Loamy coarse sand	- LCOS	Silt	- SI
Loamy sand	- LS	Silt loam	- SIL
Loamy fine sand	- LFS	Silty clay loam	- SICL
Loamy very fine sand	- LVFS	Silty clay	- SIC
Coarse sandy loam	- COSL	Sandy clay loam	- SCL
Sandy loam	- SL	Sandy clay	- SC
Clay	- C		

Structure, Grade

Weak – 1	Moderate – 2	Strong – 3	Structureless – 0

Structure, Shape

Granular	- GR	Angular blocky	- ABK
Platy	- PL	Subangular blocky	- SBK
Prismatic	- PR	Single-grained	- SG
Columnar	- CO	Massive	- MA
Wedge	- W		

Effervescence

None	- N or '-'	Strong	- ST
Very slight	- VSL	Violent	- V
Slight	- SL		

Redox Features, Type and Abundance

RMF Type:	Concentration – CON		Depletion – DEP
Abundance:	Few - F	Common – C	Many – M

ATTACHMENT 2

Soil Textural Triangle