NACTA Soil Judging Contest Handbook
4 Year Division

Fort Hays State University
April 3, 2020

Modified from previous versions prepared by the Soil Judging Coaches and Official Judges of NACTA and Region 5
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USDA United States Department of Agriculture

PREFACE

This handbook provides information about the 2020 NACTA Soil Judging Contest for the 4 Year Division. This manual provides the rules, scorecard instructions, and additional information about the contest. Much of the material comes from previous handbooks, with some modification. The handbook has been adapted to the soils and landscapes of northwestern Kansas. Other references used to develop this handbook include: Chapter 3 of the *Soil Survey Manual* (Soil Survey Division Staff, 1993), *Field Book for Describing and Sampling Soils*, version 3.0 (Schoeneberger et al., 2012), *Soil Taxonomy* (Soil Survey Staff, 1999), *Keys to Soil Taxonomy* 12th Edition (Soil Survey Staff, 2014), *Illustrated Guide to Soil Taxonomy* (Soil Survey Staff, 2014), and *National Soil Survey Handbook* (Soil Survey Staff, 2011). In keeping with recent contests, emphasis is placed on fundamentals such as soil morphology, taxonomy, and soil-landscape relationships.

We welcome the teams to Hays, KS and hope the contest provides both an educational and rewarding experience. Many thanks to those who helped with preparations and funding for this event. The contest is hosted by Fort Hays State University and the USDA-NRCS. We thank the volunteers and landowners that made this event possible.

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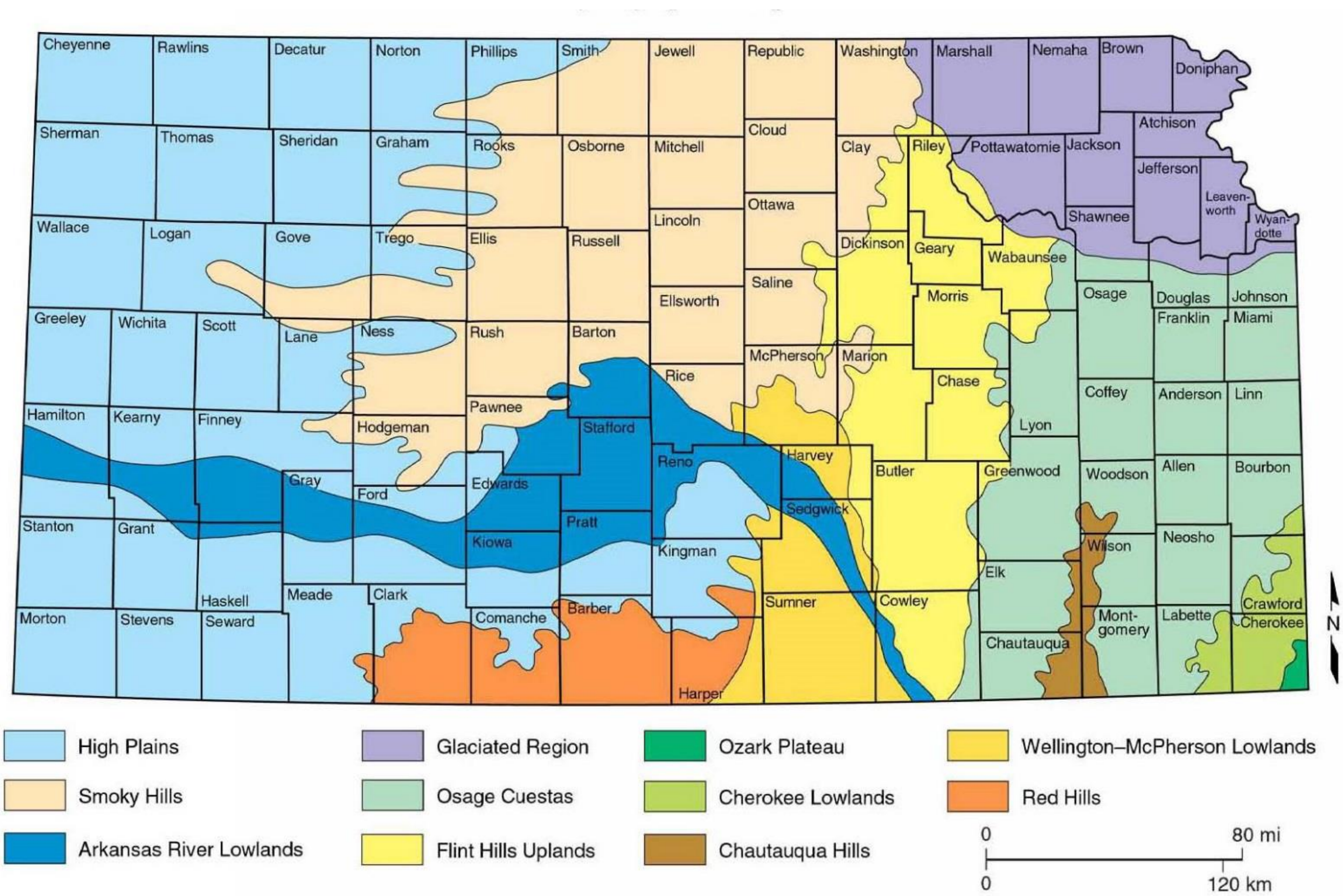
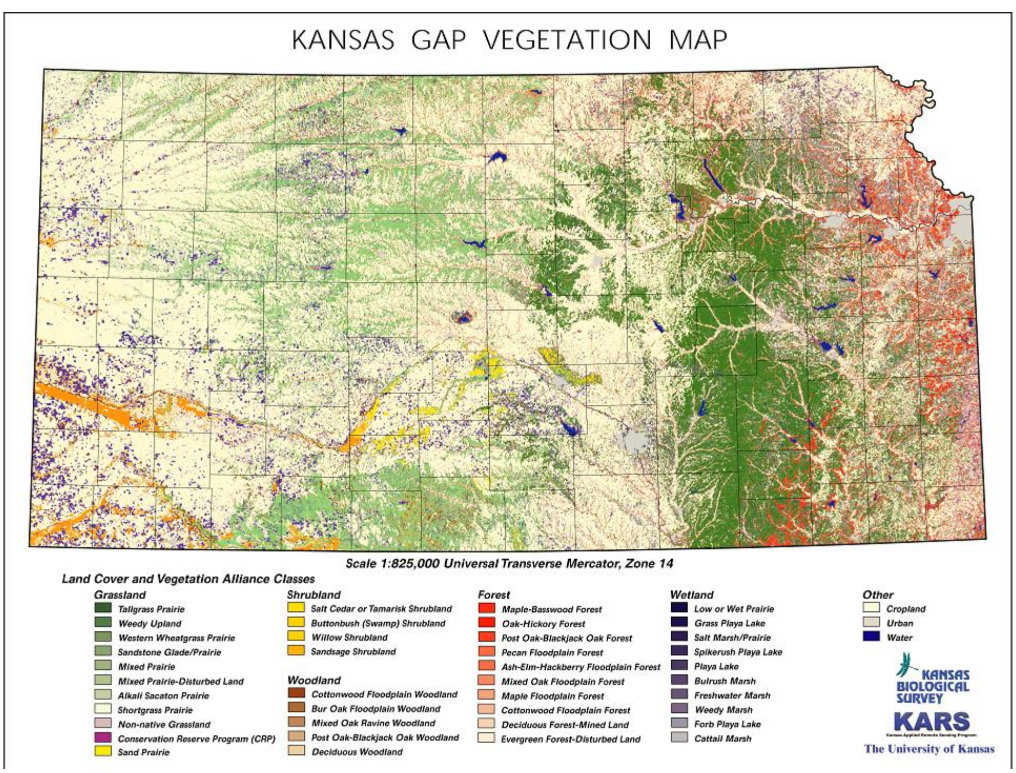
Figure 1. Physiographic regions and vegetation map of Kansas.





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INTRODUCTION

Soil judging provides an opportunity for students to study soils through direct experience in the field. Students learn to describe soil properties, identify different kinds of soils and associated landscape features, and interpret soil information for agriculture and other land uses. These skills are developed by studying a variety of soils formed from a wide range of parent materials and vegetation in different topographic settings. Students gain an appreciation for soil as a natural resource by learning about soils and their formation. We all depend on soil for growing plants, crops, and range for livestock; building materials; replenishing water supplies; and waste disposal. If we do not care for our soils, loss of productivity and environmental degradation will follow. By understanding more about soils and their management through activities like soil judging, we stand a better chance of conserving soil and other natural resources for future generations.

Students in soil judging participate in contests held annually in different locations. These contests are an enjoyable and valuable learning experience, giving students an opportunity to obtain a first-hand view of soils and land use outside their home areas.

This handbook is organized into several sections that describe the format and content of the contest. The contest involves soil description and interpretation at sites by students, who record their observations on a scorecard (see Appendix). The sections below follow the organization of soil and related information given on the scorecard. Those sections include morphology, soil hydrology and profile characteristics, site characteristics, soil classification, and site interpretations.

CONTEST RULES, SCORING, AND PROCEDURES

The contest will be held on Friday, April 3, 2020 and will consist of four sites. At each site, a pit will be excavated, and two control areas will be designated for the measurement of horizon depths and boundaries. The control area will constitute the officially scored profile and must remain <u>undisturbed</u> and <u>unblocked</u> by contestants. A tape measure will be fixed within the control area.

The site number, number of horizons to be described, the profile depth to be described, and any additional information or laboratory data deemed necessary for correct classification will be provided to each contestant for that pit. A maximum of six horizons will be described at each pit. A marker (e.g., nail) will be placed at the <u>bottom of the third horizon</u>. A pit/site monitor at each site will enforce the rules, answer any questions, keep time limits, clean soil from the base of the pit as needed and/or requested, and assure all contestants have an equal opportunity to judge the soil.

A team is typically comprised of four contestants from each participating university but can consist of as few as three members. Each team coach must designate the four official contestants prior to the contest (by 7 pm Thursday, April 2, 2020). Each university can have an additional four alternates participating in judging. All four are eligible to compete for individual awards. Any team with more than four alternates should obtain permission for the additional alternates from the contest organizers.

All scorecards will be graded by hand. In order to avoid ambiguity, all contestants are urged to write clearly and use only those abbreviations provided. Ambiguous and unrecognizable answers will receive no credit.
Designated abbreviations or the corresponding, clearly written terminology will be graded as correct responses.

Contestants are allowed the following materials for their use:

- clipboard
- pencils (number 2 pencil is required)*
- knife (<u>durable and sturdy</u>)
- acid bottle (10% HCI)
- calculator
- containers for soil samples
- 2 mm sieve
- clinometer or Abney level
- hand lens
- tape measure
- water bottle
- Munsell Color Charts (10R to 5Y)
- hand towel
- rock hammer
- additional items contestants want (e.g., notes and practice sheets)

*A number 2 pencil is required because of the waterproof paper used for the scorecards. <u>An ink pen will not work when the scorecards are wet.</u>

The reference materials allowed are the list of abbreviations site interpretations (Tables 21 & 23) and texture triangle. <u>Any</u> relevant written materials (including this handbook and practice sheets) will be allowed in the contest. At set of equipment including a clinometer or Abney level, sturdy knife, and color book will be provided at each pit for emergency situations, as well as extra water, acid (10% HCl), and blank scorecards. **Contestants are not allowed to have mobile phones during the contest under any circumstances. If a contest official sees one, that contestant will be disqualified for both the individual and team events.**

Contestants will be allowed fifty (50) minutes to judge each site. The time in and out of the pit will be as follows: 10 minutes in/out, 10 minutes out/in, 10 minutes in/out, 10 minutes out/in, and 10 minutes free time for all to finish. The contestants who are first "in" and "out" will switch for the next pit to allow equal opportunity for all contestants to be first in or first out. *NOTE: This timing schedule may be modified depending on the number of teams and contestants participating. However, each individual will have at minimum 50 minutes at each site.*

Each site will have its own scorecard designated by a unique border color. Each contestant will be given a packet during the contest that contains color scorecards corresponding to each site. Since this is an open book contest, an extra set of abbreviations will not be provided, and contestants should use the set of abbreviations in their guidebook. Students must correctly enter the pit number on their scorecard. Scorecard entries must be recorded according to the instructions for each specific feature to be judged (see following sections of the handbook). Only one response should be entered in each blank, unless otherwise specified. The official judges may decide to recognize more than one correct answer or to allow partial credit for alternative answers. Entries for soil morphology may be recorded using the provided abbreviations or as a complete word. Contestants should enter the depth of the last horizon (if a boundary) or a dash to specify a completed response.

The overall team score will be the aggregate of the top three individual scores for each of the four sites. In the case where a team is comprised of only three members, all individual scores will count towards the team's overall score. Individual scores will be determined by summing the three site scores for each contestant (Table 1).

Table 1. Example team score calculation.

STUDENT	SITE 1	SITE 2	SITE 3	SITE 4	TOTAL Individual
Jones	232	241	254	183	910
Smith	261	262	313	186	1022
Brown	**208***	277	**251**	171	907
Green	275	**234**	289	**167**	965
TEAM	768	780	856	540	

Team Score = 2944

** Lowest score shown in* ***bold*** *is not used to determine team score.*

The clay content of the third horizon at a specified individually-judged site (C-1) will be used to break ties in both team and individual scores. In order to break a tie in team scores, the mean clay content will be calculated from the estimates provided by all members of a given team. The team with the mean estimate closest to the actual value will receive the higher placing. If this method does not break the tie, the next lowest horizon of the same site will be used in the same manner until the tie is broken. In the event of a tie in individual scores, the clay content of the tie breaker horizon will be compared to that estimated by each individual. The individual with the estimate closest to the actual value will receive the higher placing. If this does not break the tie, the next lowest horizon at the same will be used in the same manner until the tie is broken.

Final contest results will be announced at an awards ceremony on Saturday, April 4. Every effort will be made to avoid errors in determining the contest results. However, the results presented at the awards ceremony are final. Trophies will be awarded to the top five teams overall and the top ten individuals.

SCORECARD INSTRUCTIONS

The scorecard (attached at the end of this guidebook) consists of five parts: A. Soil Morphology; B. Soil Hydrology and Profile Properties; C. Site Characteristics; D. Soil Classification; and E. Site Interpretations. Numbers in parentheses after each item in a section indicate the points scored for one correct judgment. If a pedon has more than one parent material or diagnostic subsurface horizon, five points will be awarded for each correct answer. In these sections of the scorecard, negative credit (minus 5 points for each incorrect answer, with a minimum score of zero for any section) will be used to reduce guessing. More than one entry in other items of the scorecard will be considered incorrect and will result in no credit for that item. Official judges have the prerogative of giving full or partial credit for alternative answers to fit a given site or condition (e.g., hydraulic conductivity where 3 points could be given if the answer is close to the correct answer).

A. SOIL MORPHOLOGY

For entering answers in the morphology section of the scorecard, the provided standard abbreviations (see appendix) 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 matrix concentrations are present in a horizon), 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.

Designations of Horizons

The number of horizons to be described and the total depth of soil to judge will be provided on an information card or sheet for each site. Narrow transition horizons (< 8 cm thick) should be regarded as a gradual boundary, and the center used as the measuring point for the boundary depth. Horizons that can be thinner than 8 cm and should be described are O, A or E. These horizons must be at least 2.5 cm thick to be described.

Three kinds of symbols are used in various combinations to designate horizons and layers in Section A of the contest scorecard (Table 2): 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 2. Accepted horizon designators for scorecard Section A 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 (O, 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 distinction (Subscript)	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 may include, but are not limited to: b – buried genetic horizon. Exhibits past soil-forming development g – Strong gleying produced by wetness and reduction. Chroma is 2 or less. k – accumulation of carbonates m – root-restrictive, pedogenically cemented horizon n - accumulation of exchangeable sodium

	p – tillage or other disturbance r – weathered or soft bedrock ss – presence of slickensides t – illuvial accumulations of clay w - weakly expressed color or structural development or minimal accumulation of pedogenic constituents. Used with master horizon B, but not with transitional horizons. y – accumulation of gypsum z – accumulation of salts more soluble than gypsum 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.

Lower Boundary

Depth of Lower Boundary

Boundary depths are determined (in centimeters) from the soil mineral surface to the middle of the lower boundary of each horizon (if an O horizon is present, measurements begin at the base of the O horizon). For a reference as to the position of the soil surface, the depth from the soil surface to the nail in the base of the third horizon is posted on the pit card. Total soil profile depth to be described will also be given on the pit information card or sheet.

If the total soil profile depth corresponds to the lower boundary of the last horizon, the horizon boundary depth should be recorded. Otherwise, a dash or the total soil profile depth with a + sign (e.g., 100+) should be entered on the scorecard. Note that boundary depths should be judged from the tape measure anchored to the pit face and vertical to the nail within the control section. 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 D of the scorecard and should be considered in evaluating the hydraulic conductivity, effective rooting depth, and water retention 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 A 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.

Distinctness of Boundary

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 3.

Table 3. Soil horizon boundary distinctness categories.

Category	Symbol	Boundary Distinctness
Abrupt	**A**	< 2 cm
Clear	**C**	2.1 to 5 cm
Gradual	**G**	5.1 to 15 cm
Diffuse	**D**	> 15 cm

No boundary distinctness designator should be given for the last horizon, unless a lithic or paralithic contact exists at the lower boundary. A dash is acceptable for distinctness of the last horizon to be described when a lithic or paralithic contact is not present.

Texture

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.

Texture Classes

Soil texture classes are those defined in the *Soil Survey Manual* (1993). Any deviation from the standard nomenclature will be considered incorrect (e.g., silty loam). 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 4). Very coarse sand should be included with coarse sand for this contest.

Table 4. 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.

Percent Clay

Clay percentage estimates should be entered in the space provided. Answers within +/- 4% of the official value will be given credit.

Rock Fragment Modifier

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, cobbly, stony, bouldery, channery, and flaggy" will be used (Table 5). For a mixture of sizes (e.g. both gravels and stones 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 (**GRV**), but only 20% gravel and 14% stones (34% total fragments) would be named stony (**ST).**

Table 5. Rock fragment modifier size and shape requirements and symbols.

Size (diameter)	Adjective	Symbol
Spherical or equiaxial		
0.2 to 7.5 cm	Gravel	**GR**
7.6 to 25.0 cm	Cobbly	**CB**
25.1 to 60 cm	Stony	**ST**
>60 cm	Bouldery	**BD**
Flat		
0.2 to 15 cm	Channery	**CH**
15.1 to 38.0 cm	Flaggy	**FL**
38.1 to 60 cm	Stony	**ST**
>60 cm	Bouldery	**BD**

Additional requirements for rock fragment modifiers based upon percent of soil volume occupied can be found in Table 6.

Table 6. Rock fragment modifiers by percent rock fragment (> 2mm) present by volume.

Percent rock* (by volume)	**Rock fragment modifier**
< 15%	No special term used with the soil textural class. Enter a dash or leave blank.
15 to 35 %	Use **“gravelly, cobbly, stony, bouldery, channery,** or **flaggy”** as a modifier of the texture term (e.g. gravelly loam or **GR-L**).
35 to 60 %	Use “**very (V) + size adjective”** as a modifier of the texture term (e.g., very cobbly fine sandy loam or **CBV-FSL**).
60 to 90 %	Use “**extremely (X) + size adjective”** as a modifier of the texture term (e.g., extremely stony clay loam or **STX-CL**).
> 90%	Use **“coarse fragment noun”** as the coarse fragment term (e.g., boulders or **BD**) and dash or leave blank the soil texture class and the % clay boxes.

*Note: Assume all rock fragments do not slake in water and are at least partly cemented.

Texture Abbreviations

Texture abbreviations follow these rules:

1. Rock fragment modifier is listed before the texture class, separated by a dash (e.g. GR-SIC for a gravelly silty clay)
2. If a very or extremely modifier is needed, the X or V comes after the fragment name (e.g. GRV-SIL for a very gravelly silt loam or STX-SICL for an extremely stony silty clay loam).

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. 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. 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. 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.

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 Kansas. 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.

Grade
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 so 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.

Type
Types of soil structure are described below (Table 8) and on page 2-53 in *Field Book for Describing and Sampling Soils, version 3.0, 2012*.

Table 8. Soil structure types, symbols and descriptions.

Type	Symbol	Description
Granular	**GR**	Spheroids or polyhedrons bounded by curved planes or very irregular surfaces, which have slight or no accommodation to the faces of surrounding peds. For the purposes of this contest crumb structure is included with granular structure.
Subangular blocky	**SBK**	Polyhedron-like structural units that are approximately the same size in all dimensions. Peds have mixed rounded and flattened faces with many rounded vertices. These structural units are casts of the molds formed by the faces of the surrounding peds.
Angular blocky	**ABK**	Similar to subangular blocky but block-like units have flattened faces and many sharply angular vertices.
Platy	**PL**	Plate-like with the horizontal dimensions significantly greater than the vertical dimension. Plates are approximately parallel to the soil surface**. Note: this does not apply to weathered rock structure.**
Wedge	**WEG**	Elliptical, interlocking lenses that terminate in acute angles, bounded by slickensides. Wedges are not limited to vertic materials.
Prismatic	**PR**	Prism-like with the two horizontal dimensions considerably less than the vertical. Vertical faces are well defined and arranged around a vertical line with angular vertices. The structural units have angular tops.
Columnar	**COL**	Same as prismatic but with rounded tops or caps.
Massive	**MA**	No structure is apparent and the material is coherent. The individual units that break out of a profile have no natural planes of weakness.
Single grain	**SGR**	No structure is apparent. Soil fragments and single mineral grains do not cohere (e.g., loose sand). In some cases where weak cohesive/adhesive forces with water exist, some seemingly cohesive units can be removed. However, under very slight force, they fall apart into individual particles.

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 9.

Table 9. 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.

Soil Features (Redox Concentrations and Depletions and Matrix Concentrations)

Redoximorphic Features

Redoximorphic (redox, RMF) features are caused by the reduction and oxidation of iron and manganese associated with soil wetness/dryness and not rock color. Characteristic color patterns are created by these processes. Redox features are colors in soils resulting from the concentration (gain) or depletion (loss) of pigment when compared to the soil matrix color. Reduced iron (Fe^{2+}) and manganese (Mn^{2+}) ions may be removed from a soil if vertical or lateral fluxes of water occur. Wherever iron and manganese is oxidized and precipitated, they form either soft masses or hard concretions and nodules. Redox features are used for identifying aquic conditions and determining soil wetness class. For this contest, only the presence or absence of redoximorphic features (Y or N [will also allow a dash or blank]) in terms of redox concentrations and redox depletions will be evaluated. Movement of iron and manganese as a result of redox processes in a soil may result in redoximorphic features that are defined as follows:

a. Redox concentrations – These are zones of apparent pedogenic accumulation of Fe-Mn oxides, and include: nodules and concretions (firm, irregular shaped bodies with diffuse to sharp boundaries); masses (soft bodies of variable shapes in the soil matrix); zones of high chroma color ("red" for Fe and "black" for Mn); and pore linings (zones of accumulation along pores). Dominant processes involved are chemical dissolution and precipitation; oxidation and reduction; and physical and/or biological removal, transport and accrual.

Presence:	**Yes (Y)**	**RMF concentrations are present**
	No (N, -, or blank)	**RMF concentrations are not present**

b. Redox depletions – These are zones of low chroma (2 or less) and normally high value (4 or more) where either Fe-Mn oxides alone or Fe-Mn oxides and clays have been removed by eluviation.

Presence:	**Yes (Y)**	**RMF depletions are present**
	No (N, -, or blank)	**RMF depletions are not present**

The color of the redox feature must differ from that of the soil matrix by at least one color chip in order to be described. For determination of a seasonal high water table, depletions of chroma 2 or less and value of 4 or more must be present. If this color requirement is not met, the depletions should be described, but the depletions do not affect the soil wetness class or site interpretations. Low chroma (≤ 2) in the soil may be due to drainage, parent material, or other features. However, parent material variations and other such features should not be considered in evaluating soil wetness or soil drainage characteristics. Colors associated with the following features will **not** be considered as redox features: carbonates, concretions, nodules, krotovina, rock colors, roots, or mechanical mixtures of horizons such as B horizon materials in an Ap horizon. Redox features can be retained as relic features in soils (now called "mottles") from prior soil moisture regimes.. If no redox features are present, enter an "N" or dash. Specific definitions may be found in *Soil Taxonomy* (1999) in the "Aquic Conditions" section of "Other Diagnostic Soil Characteristics."

Matrix Concentrations

Identify the type of visible pedogenic concentrations, if present, that occur in the soil matrix (including soft, non-cemented masses, threads or other bodies; excluding soft rock fragments) for each horizon.. 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 the purposes of this contest, four types of concentrations (based on composition) will be described: 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 % gypsum will be provided when needed for each horizon. The concentration types recognized for this contest include:

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 distinction [subhorizon] 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 distinction [subhorizon] 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 distinction [subhorizon] designation.)

B. SOIL HYDROLOGY AND PROFILE PROPERTIES

Hydraulic Conductivity

In this contest, the vertical, saturated hydraulic conductivity of the surface horizon (Hydraulic Conductivity/ Surface Layer) and the most limiting horizon (Hydraulic Conductivity/Limiting Layer) within the depth specified to be described by the official judges 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 used in this contest are found in Table 10.

Table 10: Hydraulic conductivity classes, flow rates and descriptions.

Class	Hydraulic Conductivity	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, we will combine 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 this contest, 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 11). 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 11. Soil depth classifications based upon depth to restrictive feature.

Depth Class	**Depth to Restrictive Feature**
Very deep	> 150 cm
Deep	100.1 to 150 cm
Moderately deep	50.1 to 100 cm
Shallow	25 to 50 cm
Very shallow	< 25 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 12), and the content of rock fragments in the soil.

Table 12. Soil texture and water retention difference values.

Texture class	**Water retention (cm water / cm soil)**
All sands and loamy coarse sand	0.05
Loamy sand, loamy fine sand, loamy very fine sand, and coarse sandy loam	0.10
Sandy loam, fine sandy loam, sandy clay loam, sandy clay, silty clay, and clay	0.15
Very fine sandy loam, loam, silt loam, silt, silty clay loam, and clay loam	0.20

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 13. An example water retention difference calculation and classification for a theoretical soil profile can be found in Table 14.

Table 13. 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	< 7.5 cm
Low	7.5 to 15.0 cm
Medium	15.1 to 22.5 cm
High	> 22.5 cm

Table 14. Sample of calculation of water retention difference (WRD) for a theoretical profile.

Horizon	**Depth (cm)**	**Texture class**	**Rock fragment (%)**
A	20	SL	5
Bt1	60	CL	10
Bt2	80	L	10
2C	150	S	50

Horizon	**Horizon thickness (cm)**		**Texture WRD**		**Rock Fragment Correction**		**cm of water per horizon**
A	20	*	0.15	*	0.95	=	2.9
Bt1, Bt2	60	*	0.20	*	0.90	=	10.8
2C	70	*	0.05	*	0.50	=	1.8
					Total WRD	**=**	**15.5**
					WRD Class	**=**	**medium**

Soil Wetness Class

Soil wetness classes as defined in the *Soil Survey Manual* (1993) will be used (Table 15). 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 this contest.

Table 15. Soil wetness classes based upon depth to pertinent wetness features

Class	Depth to wetness features (from soil surface)
1	>150 cm
2	100.1 to 150 cm
3	50.1 to 100 cm
4	25 to 50 cm
5	<25 cm

C. SITE CHARACTERISTICS

Landform

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. Only one landform should be identified at each site. Contestants should select the landform that best describes the situation. Landforms that will be recognized in this contest are found in Table 16.

Table 16. Landforms found in Kansas and their descriptions.

Landform	Description
Upland	Upland refers to geomorphic landforms, not otherwise designated, that are generally above present-day valleys and which may be underlain by bedrock or sediments of glacial, eolian, or colluvial/pedisediment materials.
Upland 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.
Alluvial fan	A body of alluvium whose surface forms a segment of a cone (fan-shaped in plan view) that radiates downslope from the point where a stream emerges from a narrow valley into a broader valley.
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) and can contain hillslope position of footslope..
Floodplain	A nearly level alluvial plain that borders a stream and is subject to flooding 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.
Paleoterrace	An erosional remnant of a terrace which retains the surface form and alluvial deposits of its origin but was not emplaced by, and commonly does not grade to a present-day stream or drainage network.
Dunes/Interdunes	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 this landscape have an irregular appearance. If present, this landform will take precedence over "upland", "upland depression", and "footslope" in the contest.

Parent Material

Parent material refers to the material in which soils form. Parent materials include bedrock, various kinds of sediments, and "pre-weathered" materials. Soils may be developed in more than one parent material, and this should be indicated on the scorecard. For this contest, a parent material should be ≥30 cm thick if it is on the surface or ≥10 cm thick if at least 30 cm below the soil surface to be indicated on the scorecard. Multiple parent materials are common for the soils of Kansas (Table 17). A different parent material should also be indicated if it is present in the last horizon of the described profile.

Table 17. Parent materials found in Kansas 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. For this contest, contestants will not differentiate between old and recent alluvium.
Colluvium/ Pedisediment	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/ Eolian 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. Bedrock types typically observed in the contest area typically include limestone and shale.

Slope

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. Slope classes are based on the gradient. The percentage limits for slope classes pertinent for Kansas topography 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. <u>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</u>. 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.

Hillslope Profile Position

Hillslope position (Figure 2, from R. V. Ruhe. 1969. *Quaternary Landscapes in Iowa,* p 130-133) represents the geomorphic segment of the topography on which the soil is located (Table 18). These slope components have characteristic geometries and greatly influence soils through differences in slope stability, water movement, and other slope processes. Not all profile elements may be present on a given hillslope. The landscape unit considered when evaluating hillslope profile position should be relatively large and include the soil pit and/or the area between the slope stakes. Minor topographic irregularities are not considered for this contest. Note that you could also have a backslope and a footslope component in an upland depression. Illustrations of simple hillslope profile components can be found in Figure 2.

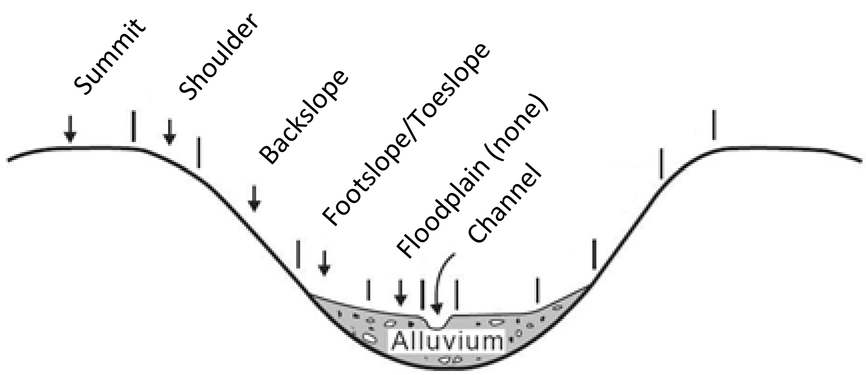

Figure 2. Hillslope profile components, as modified from Ruhe, 1969.

Table 18. Hillslope profile positions recognized in this contest and their general descriptions.

Hillslope position	Description
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.
None (gradient <2%)	This designation should only be used when the slope at the site is < 2%, and the site is not in a well-defined example of one of the slope positions given above (e.g., within a terrace or floodplain of large extent).

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. In this contest, six runoff classes as described in the *Soil Survey Manual* (1993) will be used (Table 19). 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.

Table 19. Surface runoff classes in relation to slope and surface hydraulic conductivity.

	Surface Hydraulic Conductivity					
Slope (%)	**VH**	**H**	**MH**	**ML**	**L**	**VL**
< 2%	P	P	VL	L	L	M
2-6%	P	VL	L	L	M	H
6-12%	VL	L	L	M	H	VH
12-18%	L	L	M	H	VH	VH
18-30%	L	M	H	VH	VH	VH
> 30%	M	H	VH	VH	VH	VH

P = ponded, VL = very low, L = low, M = medium, H = high, and VH = very high

Brief descriptions of the six runoff classes used in this contest can be found in Table 20.

Table 20. 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 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.
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 (See Table 10). 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.
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 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.

D. 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 the *Illustrated Guide to Soil Taxonomy* (Soil Survey Staff, 2014). Only the diagnostic horizons and features, orders, suborders, and great groups that exist or are plausible for mineral soils in the contest area of Kansas are included on the scorecard. The total carbonate content (% by weight), SAR, % gypsum, EC, % organic C, and pH will be provided for each horizon at each site if the information is necessary for soil classification. If none of these data are given, contestants should assume high base saturation, low or no salt content, no gypsum, low SAR, and <15% calcium carbonate equivalent. These are the common situations in most soils in the contest area. Since the contest area is transitional from the udic to the ustic moisture regime, we will simplify the determination of moisture regime. For this contest, the soil moisture regime is ustic unless the soil has aquic conditions, in which case the soil moisture regime is aquic.

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.

Epipedons

The kind of epipedon will be determined for each judged soil. If the moist soil meets the color, base saturation, thickness, lack of stratification, and organic carbon criteria for a mollic epipedon, contestants should assume all other criteria for the mollic epipedon and Mollisols are met. If contestants select more than one epipedon, no points will be given even if the correct epipedon is checked. For distinguishing between mollic and umbric epipedons, chemical data will be provided.

An epipedon is a diagnostic horizon that forms at the surface. Only one epipedon can be present in mineral soils. An epipedon is not synonymous with an A horizon (e.g., a mollic epipedon may include part of the B horizon). To avoid changes in classification due to plowing, the properties of an epipedon should be determined after the soil has been mixed to a depth of 18 cm.

Epipedons potentially present in the contest area include:

1) Mollic - thick, dark colored horizon with high base status that contains soil structure.
   a. Structure cannot be both massive and hard when dry.
   b. Does not contain rock structure or fine stratification in more than ½ of the volume.
   c. Color value is ≤ 3 moist and ≤ 5 dry. Chroma is ≤ 3 moist.
   d. B.S. ≥ 50% by NH_4OAc sum of bases.
   e. OC > 0.6% (1% OM).
   f. Thickness requirement
      i. ≥ 10 cm if underlain directly by R or Cr horizon.
      ii. ≥ 18 cm and 1/3 of the thickness between the soil surface and the upper depth of pedogenic carbonates if pedogenic carbonates occur <75 cm below soil surface (e.g., if pedogenic carbonates occur at 60 cm, the thickness requirement = 20 cm).
      iii. ≥ 25 cm for all other situations.
2) Umbric - thick, dark colored horizon with <u>low</u> base status that contains soil structure. Requirements are the same as for mollic except base saturation is < 50%
3) Ochric - an epipedon not classified as mollic or umbric.
4) None – use 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.

Diagnostic Subsurface Horizons or Features

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.

Diagnostic subsurface horizons form below the soil surface. They can be exposed at the surface due to truncation. Typically, diagnostic subsurface horizons are B horizons, but may include parts of A or E horizons. Diagnostic subsurface horizons or features potentially present in the contest area include:

1) Albic - an eluvial horizon in which clay and Fe have been removed to the extent that the color of the horizon is determined by the color of the primary sand and silt particles rather than by coatings on these particles. Has value and chroma of 4/1, 4/2, 5/1, 5/2, 6/1, 6/2, 7/1, 7/2, 6/3, or 7/3.
   E, B/E, E/B

2) Argillic - contains illuvial clay.
   a. Must contain a significant clay increase.
      i. If eluvial horizon has <15% clay, must have at least a 3% absolute increase (e.g., from 10 to 13%).
      ii. 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%).
   b. Contains clay films.
   Bt, Btk, Btg, Btn, Btss, etc.

3) Cambic - has features representing genetic soil development (alteration) without illuvial accumulations or extreme weathering.
   a. >15 cm think
   b. Texture that is VFS, LVFS, or finer.
   c. Evidence of alteration
      i. Contains soil structure
      ii. If aquic conditions occur < 50 cm (soil wetness class 4 or 5)
         1. Colors that do not change on exposure to air
         2. Gray colors for one of the following situations
            a. Value of 3 or less and chroma of 0 or
            b. Value of 4 or more and chroma of 1 or less
            c. Any value with chroma of 2 or less and redox concentrations
         3. If aquic conditions do not occur < 50 cm, one of the following situations
            a. Higher chroma, higher value, redder hue, or higher clay content than the underlying horizon or an overlying horizon.
            b. Removal of carbonates or gypsum.
   d. Is not part of an epipedon or another diagnostic subsurface horizon
   e. Is not part of an Ap horizon
   Bw, Bg, Bk, Bss, etc.

4) Calcic - contains an accumulation of $CaCO_3$
   a. Has a $CaCO_3$ equivalent ≥ 15% and contains ≥ 5% more $CaCO_3$ equivalent than the C horizon or
   b. Has a $CaCO_3$ equivalent ≥ 15% and contains ≥ 5% identifiable pedogenic $CaCO_3$ forms such as concretions, soft powdery forms, threads, pendants on pebbles, etc.
   Bk, Btk, Ck, etc.

5) Natric - a special kind of argillic horizon with a high content of sodium.
   a. Usually has columnar or prismatic structure
   b. Thickness requirement of 7.5 to 15 cm depending on texture

c. One of the following:
    i. 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).
    ii. 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

Btn

6) Lithic contact - the contact between soil and a coherent underlying material that is impractical to dig with a spade. The underlying material cannot include diagnostic soil horizons. Usually, it is strongly cemented material like hard limestone or hard sandstone.
R

7) 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.
Cr, Crk, Crkt, etc.

8) Slickensides – polished and grooved surfaces on peds. Occurs in soils high in clay of the shrink-swell type.
Bss, Btss, Btkss, etc.

9) Abrupt textural change – characterized by a considerable increase in clay content within a very short vertical distance.
    a. Doubles within 7.5 cm if clay content of epipedon is <20% (e.g., an increase from 4 to 8%)
    b. Increase by 20% or more (absolute) within 7.5 cm (e.g., an increase from 24 to 44%)

10) Albic materials - in which clay and Fe have been removed to the extent that the color of the horizon is determined by the color of the primary sand and silt particles rather than by coatings on these particles. Has value and chroma of 4/1, 4/2, 5/1, 5/2, 6/1, 6/2, 7/1, 7/2, 6/3, or 7/3.
E, B/E, E/B

11) Lamellae - consist of two or more thin layers with an accumulation of illuvial clay.
    a. Lamellae contain illuvial clay.
    b. Thickness of individual lamella is < 7.5 cm.
    c. Lamellae occur in vertical series of two or more.
    d. Each lamella has an eluvial layer above it
    e. Classifies as argillic if cumulative thickness of lamellae ≥15 cm
    f. Classifies as cambic if cumulative thickness of lamellae <15 cm

E & Bt, Bt & E

12) Lithological discontinuities - major changes in texture or mineralogy that represent differences in lithology. Often, it is change in parent material, but sometimes a lithological discontinuity can occur in layers of alluvium.

13) Aquic conditions - continuous or periodic saturation and reduction.
    a. In the contest area, two kinds of saturation occur:
        i. Endosaturation – soil is saturated in all layers from the upper boundary of saturation to a depth > 200 cm, i.e., no perched water table and saturation is from the bottom up.
        ii. Episaturation – soil is saturated in one or more layers < 200 cm and has one or more unsaturated layers above 200 cm, i.e. a perched water table occurs < 200 cm.
    b. Can be implied based on the presence of redoximorphic features that are shallow enough for class 4

or 5 wetness
  i. Redox concentrations
  ii. Redox depletions
  iii. Reduced matrix

None – no diagnostic subsurface horizon or feature

Classification to the Order Level

The classification of Alfisols and Mollisols is based on an evaluation of the base saturation at a specified depth. We will call this the "check depth", although this term is not used in Soil Taxonomy.

The "check depth" typically is:

1) For soils with a sandy or sandy-skeletal particle size class, the deepest of the following:
   a) 125 cm below the top of the argillic (but no deeper than 200 cm)
   b) 180 cm below the soil surface
   c) Immediately above a lithic or paralithic contact if shallower than 1 and 2
2) For other soils without a fragipan, the shallowest of the following:
   a) 125 cm below the top of the argillic or natric
   b) 180 cm below the soil surface
   c) Immediately above a lithic or paralithic contact

The following classification keys follow a "fall-out first principle."

1) Vertisols - can have any kind of epipedon. Must contain the following: Slickensides within 100 cm of soil surface, high clay content (>30%), and major cracks that open and close periodically and almost go all the way to the surface.

2) Mollisols - mollic epipedon and ≥50% base saturation at the check depth.

3) Alfisols - other soils with an argillic horizon and base saturation ≥35% at the check depth.

4) Inceptisols - other soils with a cambic horizon within 100 cm of the soil surface

5) Entisols – other soils.

E. SOIL INTERPRETATIONS

This section illustrates applications of soil information to land use. For this contest, there will be three interpretations determined for each soil judged: 1) septic tank absorption fields, 2) rangeland ecological site, and 3) dwellings without basements.

For septic tank absorption fields and dwellings without basements, soil 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 base of the pit does not extend to the required interpretive depth (e.g., 150 or 180 cm for some criteria), contestants should assume that the lowest horizon in the pit extends to the depth of interest.

Septic Tank Absorption Fields

In Kansas, septic tank systems are regulated at the county level. The criteria vary by county and are quite variable. For this contest, we will use simplified criteria in Table 21 for evaluating soil limitations for septic tank absorption fields. The assumed application is for a conventional septic tank effluent system with gravity distribution. In Kansas, the infiltrative surface (trench bottom) for a lateral field is usually placed 45 to 75 cm below the surface. Table 21 **assumes that all conventional laterals (infiltrative surfaces) will be placed at 45 cm below the surface.**

Table 21. Criteria for Evaluating Soil Limitations for Septic Tank Effluent Treatment Areas (modified from Missouri Onsite Wastewater code regulated by the Missouri Department of Health and Senior Services)

Criteria	Suitability		
	Suitable	**Provisionally Suitable**	**Unsuitable**
Average hydraulic conductivity (45-180 cm depth)	MH, ML	------	VH, H, L, VL
Depth to wetness (cm)	105+	75-105	< 75
Coarse fragments (45-105 cm depth)	< 15%	15-50%	> 50%
Depth to bedrock (Cr or R)	> 165 cm	105-165 cm	< 105 cm
Slope	< 15%	15-30%	> 30%
Flooding/ponding	none	------	any

Dwellings without Basements

The criteria below were modified from those given in the *National Soils Handbook* (1996), so that interpretations based on site observations can be made. Table 23 contains criteria for evaluating soil limitations for dwellings without basements. The soil between the depths of 25 and 100 cm should be considered for dwellings without basements. If the profile is not visible to 100 cm, assume the last visible horizon continues to the 100 cm depth.

Table 23. Criteria for Evaluating Soil Limitations for Dwellings without Basements.

Criteria	Limitations		
	Slight	**Moderate**	**Severe**
Texture of most limiting horizon (25-100 cm depth)	S, LS, SL, L, SIL	CL, SICL, SCL	SIC, SC, C
Average rocks >7.5 cm diameter (0-100 cm depth)	< 25%	25-50%	> 50%
Wetness class	1, 2	3	4, 5
Depth to hard bedrock (R)	> 100 cm	50-100 cm	< 50 cm
Depth to soft bedrock (Cr)	> 50 cm	< 50 cm	-------
Slope	< 9%	9-15%	> 15%
Flooding/ponding	none	none	any

ABBREVIATIONS

Modifiers for Coarse Fragments							
Gravelly	**GR**	Cobbly	**CB**	Stony	**ST**	Bouldery	**BD**
Channery	**CH**	Flaggy	**FL**	Very*	**V**	Extremely*	**X**

*Used to modify rock fragment terms as needed

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**		

Distinctness of Boundary							
Abrupt	**A**	Clear	**C**	Gradual	**G**	Diffuse	**D**

Structure (Grade)							
Structureless	**0**	Weak	**1**	Moderate	**2**	Strong	**3**

Structure Type (Shape)	
Angular blocky	**ABK**
Columnar	**COL**
Granular	**GR**
Massive	**MA**
Platy	**PL**
Prismatic	**PR**
Single grain	**SGR**
Subangular blocky	**SBK**
Wedge	**WEG**

Moist Consistence	
Loose	**LO**
Very friable	**VFR**
Friable	**FR**
Firm	**FI**
Very firm	**VFI**
Extremely Firm	**EF**
Slightly rigid	**SR**
Rigid	**R**
Very rigid	**VR**

EXAMPLE OF INFORMATION TO BE POSTED AT EACH JUDGING SITE

SITE # 1

Horizon	%OC	pH	%BS	% $CaCO_3$
1	2.5	5.7	55	0
2	0.5	5.9	60	0
3	0.3	6.0	65	0
4	0.2	6.2	65	0
5	0.1	6.3	70	0
6	0.1	7.0	80	0

Describe 6 horizons between the soil surface shown by the top of the tape and a depth of 150 cm.
The third horizon marker is at a depth of 44 cm. The yellow scorecard will be used at this site.
(Any additional instructions or data will be indicated here.)

SITE and ROTATION PROCEDURES

Each site will have its own scorecard indicated by a unique border or color. Each contestant will be given a packet during the contest that has scorecards, plus a sheet of abbreviations, interpretation tables, and a textural triangle. Extra copies of the scorecard will be available at each site for emergencies. The information posted at each site will include scorecard border/color information.

Individual Sites

A full contestant number is as follows: 1ALi. The "1" is the team number and the "A" is the contestant number. Each contestant ID number will contain either an "L" or an "R." This indicates whether the left or the right face is to be judged. Lastly, there is an "i" or "o." This designates whether the contestant starts in or out first at the first site.

Each contestant will be in the pit first one time and out of the pit first one time during the individual part of the contest. In addition, two team members of each team will describe the left face and two team members will describe the right face. Alternates will be assigned to even out contestant numbers at each site.

REFERENCES

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5. USDA-Soil Survey Division Staff. 1993. Soil Survey Manual. USDA Agricultural Handbook 18. Superintendent of Documents, US Government Printing Office, Washington, DC 20402.

APPENDICES

Textural Triangle