Fundamentals of Land Evaluation in Nebraska
Judging Soil and Land

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Introduction

Soil is one of the most, if not most important natural resources of our environment. Soil supports and influences the crops we grow for food and fiber, the water we drink, and the air we breath. The soils of the world fit for plant growth must sustain all the plants, animals and humans that make the Earth their home. The soil acts as a filter for the water entering the groundwater supply, as well as interacting with or being eroded by the water that flows over the surface. Soil has a direct effect on the air we breath when it becomes airborne and is evident when dust settles or obscures vision. Soil takes long periods of time to develop but can be destroyed or eroded away in very short periods. It is only through proper stewardship of soil that life on Earth can be sustained and improved.

Soil and land evaluation, sometimes called land judging, enables each participant to learn how to recognize the physical features of the soil, determine land capability for crop production, and evaluate management practices needed for proper stewardship. Soil, land and home-site evaluation provide a setting for students to investigate the soils in their region, the environment that surrounds them and their effect on their daily lives.

Land judging and home-site evaluation will help you:
Become familiar with terms used to describe soils.
Understand basic soil differences.
Learn how differences in soils affect plant growth.
Recognize influences of land features on plant production and land protection.
Select suitable soil- and water-conservation practices to protect and conserve the land.
Determine land capability class for crop production
Understand interpretive soil classification.
Recommend proper land use and treatment.
Evaluate land for potential non-agricultural uses.
Recognize environmental impacts from agricultural and other uses.

Land is a natural resource that gives us many opportunities to provide for our needs. Most raw materials are provided by the land. The soil provides the basis to produce food and fiber. It can help protect and purify water, which can be used or stored for future use. The soil provides a base on which to live, build, and enjoy the beauty of nature. Soil quantity is limited, and its quality is varied. Decisions we make in land use affect not only how much usable land remains, but how well that which remains will provide for our needs and those of future generations.

The way we use or squander our soil resource is under our control. Our management practices reflect our knowledge, or lack thereof, about soils and the related environmental factors at any given time.

Soil

What is soil?

Soil is the thin, unconsolidated, outer skin of the earth derived from weathered rock fragments and decayed plant and animal remains. Soil forms when climatic and biological factors work on geologic materials (parent materials) over long periods of time. When soil contains the proper proportions of water, nutrients, organic material, and even air, it furnishes support and food for growing plants.

Soil Formation

Differences in climate, parent material, landscape position and living organisms over time influence how a soil forms. Humans are an added factor in soil formation in the modern era because of the great changes we can make with machinery. Because soils occupy different positions on the landscape, are formed in a variety of materials and have had different plant and animal life associated with them, the “ideal” profile is usually modified a great deal as one moves from place to place.

Factors of Soil Formation

- Time
- Topography
- Climate
- Parent Material
- Biological
- Human

Generalized soil characterization by type of deposition

Most of the soils in Nebraska have formed in materials transported from other areas, a few feet to hundreds of miles away. The materials have been moved by wind (eolian), water (alluvial) and glaciers (glacial) or a combination of these processes. Because of these various processes, we cannot say the underlying material of the present soil is like the parent material. In a few cases, the materials have been deposited in thick enough layers that the underlying material is similar to the parent material. The presence of multiple depositional and erosional surfaces in the soil profile causes discontinuities in materials and horizons in many of the soils in Nebraska.

Residual soils formed from bedrock material that has weathered in place to its present condition. These soils are said to have formed in residuum; the residuum being the parent material which was usually a geologic material that was cemented or compacted; such as bedrock. The bedrock has been broken down into smaller fragments by the action of weathering processes. The weathering is both a physical (mechanical) breakdown (such as freezing and thawing) and a result of chemical processes such as compounds going into or precipitating out of solution or a combination thereof. In Nebraska, bedrock includes shale, limestone, chalk, siltstone or sandstone. Only a few soils in Nebraska have formed in residuum because only a few areas have rock material near the surface that has been exposed for a sufficient time. Even the soils formed in this residuum have been influenced by transported materials. These materials include wind-blown dust or volcanic ash which has fallen during soil formation, or of earth materials transported and deposited by water or glaciers, as mentioned above. This accumulation of transported materials thickens the developing soil at an increased rate and change the clay, silt or sand content.

Aeolian soils formed in materials transported by wind. Loess is a wind-blown clayey and silty material found over most of Nebraska. The aeolian sands of the Nebraska Sandhills are an example of sandy wind-blown materials. These wind blown materials may occur in thick deposits, in drifts or as a thin layer on the surface. Usually, the coarsest materials are deposited closest to the source, and the finer materials are deposited farther away.

Alluvial soils form from water-transported materials which are laid down in layers or strata as the water slows and loses its ability to carry the particles in suspension. Usually these layers are characterized as thin bands of materials of varying color, texture and other characteristics. Organic matter in these soils does not decrease uniformly with increased depth. If alluvial soils remain exposed to weathering processes for long periods, without further additions of alluvial deposits, they start to lose many of their alluvial characteristics.

Colluvial soils form from material transported from higher to lower areas by erosional forces of wind and water. They are usually located on footslopes and tend to have thick, dark surface layers because of the additions of highly organic surface soil eroded from higher in the landscape. Like the alluvial soils, these soils may have bands of materials, but the components of the bands have relatively similar characteristics, because the source is similar, unless multiple parent materials are present upslope.

Glacial soils form in materials which have been picked up and transported by glaciers as they moved across an area. The soil and rock trapped within the ice were then deposited as the ice melted and the glacier retreated.. The materials transported by glaciers can range from clay size to boulders larger than houses. Glacial material is often referred to as “till.”

Many soils are formed in combinations of these depositional materials, and many have reworked and redeposited materials derived from these source materials or a combination of materials. As erosion removes soil material from an area, it exposes new materials to the weathering processes. When deposited in a new area, these materials change the weathering of the covered materials, and new soil characteristics develop. These discontinuities of depositional materials cause many of the interpretation problems in evaluating these soils for crops and other uses. Discontinuities between soil layers affect root growth, water movement and our ability to shape the landscape.

The Soil Profile

Because the soil-forming processes work from the top of the soil downward, we usually find the most changes at the top layer and the least change deeper in the soil. The layering this process produces is called “horizonation,” and individual layers are called “soil horizons.”

A soil may have an organic layer over it, which is designated by the letter “O.” The organic layer may be broken into two layers, or “horizons,” if they are significantly thick: an undecomposed

“Oi” horizon (in which the original materials are identifiable: grass, leaves, sticks, etc.) and a decomposed “Oa” horizon (in which the original materials are very hard to identify). Organic horizons only develop over long periods of time wherever large amounts of organic matter are being deposited and decomposition is slower than the rate of deposition. This most commonly occurs where the organic materials are saturated for most the year.

The surface soil is the top horizon of the mineral soil profile and is usually designated by the letter

“A” in profile descriptions. The surface soil has less than 20 percent organic carbon **(USDA [Soil Taxonomy], 1999, p. 19)**. Normally this horizon is rich in organic matter (0.5 to 5 percent organic carbon in Nebraska) and has a friable (easily crumbled) granular structure. The original surface soil may have been removed by erosion, exposing the material from horizons normally lower in the profile. The letter “A” is still used to identify the top layer as the surface horizon, even though it may be more like the subsoil or underlying material. If the area is or has been cultivated, the surface layer is called a “plow layer.” A small letter “p” may be added to make an “Ap” designation. The boundary between a plow layer and the next horizon is usually abrupt (less than 2 cm thick). This abrupt break may indicate the break to the subsoil or underlying material but may only be an interruption in the A horizon caused by the cultivation at a specific depth over a number of years. Characteristics of the A horizon, such as dark color, friable with a granular structure, etc., may extend past the boundary of the plow layer.

The solum of the soil refers to the topsoil and subsoil (transitional layer if no subsoil is present). The topsoil should include all ‘A’ horizons. The ‘A’ horizon is primarily separated from the subsoil (ie, ‘B’), transitional layer (ie. ‘AC’) or underlying material (ie. ‘C’) by one or more of the following indicators;

a. Color changes and becomes significantly lighter, ie. Dark brown to brown
b. Structure changes from granular to subangular or angular blocky
c. Texture shows a definite increase in clay content, may also be determined by significant increase in resistance to penetration.
d. Distinct stratification is present from deposition by wind or water

For the land evaluation these indicators will be used for determining the present thickness of the surface soil. The field instructions may indicate that overburden has been deposited on the surface by wind, water or gravity. It will be inferred that no erosion has taken place on this field when the field instructions state overburden is present. The present surface thickness will then be determined on the profile using the four indicators. It may include the buried original surface if it is not separated from the present surface by any layer which meets the requirements of the four indicators.

Table 1. Thickness of surface soil.

Thick	**Over 12 inches**
Moderately thick	**6-12 inches**
Thin	**0-6 inches**

The subsoil lies beneath the surface soil and is designated by a “B” in soil descriptions. It is usually lighter in color and contains less organic matter, is less friable and contains more clay. The subsoil is defined as a horizon that has increased development because of increased clay content. Clay may have moved downward from the surface soil or may have formed in place. A subsoil usually exhibits a blocky or prismatic structure and is slightly to extremely hard when dry. Subsoils develop as water moves through the profile, carrying clay, organic matter and dissolved minerals downward, which then settle or precipitate out in the subsoil. As the color and structure change, a ‘w’ may be added to make a ‘Bw’ horizon. If enough clay is transported into the subsoil, a ‘t’ may be added, making a ‘Bt’ horizon. Many soils in Nebraska do not have subsoils because they have not had time to form. On steeper landscapes, the developing soil is eroding almost as fast as it forms, and subsoils (B horizons) are rarely seen.

If a profile does not have a subsoil between the surface and the underlying material or bedrock, it may have a transitional horizon that has some characteristics of both the surface soil and the underlying material, exhibiting some development but not enough to form a subsoil. This horizon is usually designated as an “AC” horizon.

The underlying (parent) material lies below the subsoil and surface soil or transitional layer. It is designated by a “C” in soil descriptions. If the underlying material is an unconsolidated bedrock, it may be designated as a “CR” horizon, or, if consolidated, an “R” horizon.

Each of the horizons discussed above may be further broken down into sub-horizons depending on differences in soil characteristics. These are indicated by adding a number after the horizon designation, ie. Bw1, Bw2. If soil materials of a horizon are contrasting enough from the one directly above it, an Arabic numeral may be added at the beginning of the designation, such that “C” would be designated “2C,” to indicate two contrasting materials **(USDA [Soil Survey Manual], 1993, p. 117-130).**

Soil Texture

What is texture?

Texture refers to the relative percentages of sand, silt, and clay that make up a specific soil mass. It is easiest to determine the texture of a moist sample when in the field (laboratory determination uses a different method).

The surface texture is determined for the surface layer of the soil, which in cultivated areas is called the “plow layer.” In native areas, the surface layer can be up to 10 or more inches in thickness. If erosion has removed part or all of the original surface, then the surface layer may include material from the subsoil/transitional layer or underlying material. For the contest, a sample of material, labeled “surface layer,” will be provided for texture determination.

The control section of the soil profile and is that part which determines many of the soil interpretations of that soil. The control section is usually considered the area between 10 and 40 in. and refers to the most limiting layer within those depths. A sample will be provided for determination for the control section texture and permeability, and will be labeled “control section.”

USDA soil texture classes are based on that part of the soil mass that is less than 2 mm in diameter. The part of the soil mass greater than 2 mm is used to determine whether a modifier is attached to the soil texture, if the percentage by volume meets certain criteria. For example, a soil with greater than 15 percent but less than 35 percent gravels by volume would have the modifier “gravelly.”

The particles larger than 2mm are referred to as rock fragments. The modifiers (adjectives) used are shown in the following table.

Table 2. Soil textural class modifiers

Shape and size	Noun	Adjective
Spherical or cube-shaped		
2-75 mm diameter	**Pebbles**	**Gravelly**
2-5 mm	**Fine**	**Fine gravelly**
5-20 mm	**Medium**	**Medium gravelly**
20-75 mm	**Coarse**	**Coarse gravelly**
75-250 mm	**Cobbles**	**Cobbly**
250-600 mm	**Stones**	**Stony**
Flat (tablet shaped fragments)		
(longest horizontal length)		
2-150 mm	Channers	Channery
150-380 mm	Flagstones	Flaggy
380-600 mm	Stones	Stony
>600 mm	Boulders	Bouldery

-(USDA [Soil Surv. Manual], 1993, p. 143)

Use of soil texture modifiers:

0-15% - No adjective used. “Slightly” may be used in some instances to recognize these soils for special purposes.
15-35% - Use adjective for dominant fragment.
35-60% - Use adjective for dominant fragment and use modifier “very.”
>60% - If greater than 10 percent fine earth by volume is present, use the adjective for dominant fragment and use the modifier ”extremely.” If less than 10 percent fine earth by volume, use the noun describing the dominant fragment.

Particle size

Particles less than 2 mm in diameter are called the "fine earth." Organic matter is not considered in the USDA texture classification and is removed by washing or by (chemical) digestion prior to laboratory texture determination. For more information on laboratory texture determination, refer to **USDA Soil Investigations Report No. 42 (1996)**. For soil texture, sand particles of very fine, fine, medium coarse and very coarse are combined for most determinations. When determining texture by feel, large amounts of very fine sand, may result in estimating the silt too high, but experience with these textures helps correct the method.

Illustration of particle size comparison; calculate sizes if clay 0.0015 = one period across;
silt 0.03 = 20 periods across; sand 0.25 = 166 periods across

Table 3. Diameter of particle size separates for textural determination

Particle	Diameter
Very coarse sand	2.0-1.0 mm
Coarse sand	1.0-0.5 mm
Medium sand	0.5-0.25 mm
Fine sand	0.25-0.10 mm
Very fine sand	0.10-0.05 mm
Silt	0.05-0.002 mm
Clay	<0.002 mm

— Soil Survey Manual, USDA, 1993, p. 136

Sand particles are the largest particles in the fine earth. These particles are relatively large. Fine sand and larger particles can be felt with the fingers, and individual grains may be observed with the naked eye. Very fine sand can be observed with a small hand lens. These particles do not pack together very tightly, and many voids occupy the spaces between the particles. The voids may be filled with air, smaller silt and clay particles, organic matter or water. If the soil is not saturated, only a thin film of water will coat the sand particles and the excess will move downward as gravitational water. Sand particles do not have a very large surface area, so relatively little water is held by sand particles and their weak hold on the water makes it easy for plants to absorb the water that is present. Water is also lost more quickly through evaporation from sands than from the finer soil particles. Sand particles, having a relatively small surface area also have less capacity for holding plant nutrients and chemical compounds.

Silt particles are between sand and clay in size. Silt particles have a substantially higher attraction for water than sand particles. Silt can pack tightly and have a much larger surface area than sand particles. Consequently, silt particles hold more water and hold it tighter. Plants cannot remove as high a percentage of the water from silt-size particles as from sand particles. Silt particles hold more nutrients and chemical compounds than sand but less than clay particles.

Clay particles are so small they cannot be seen with the naked eye. They fit closely together and have a very high surface area, consequently they can hold more water, nutrients and chemicals than silt particles. Clay particles are usually platy (flat) in nature, and water can be adsorbed (can stick) between the layers of the clay particle, as well as to the surface of the clay particle. The water between the layers is held very tightly. Plants have difficulty removing some of the water held by clay particles. The water may contain nutrients and other chemicals in solution.

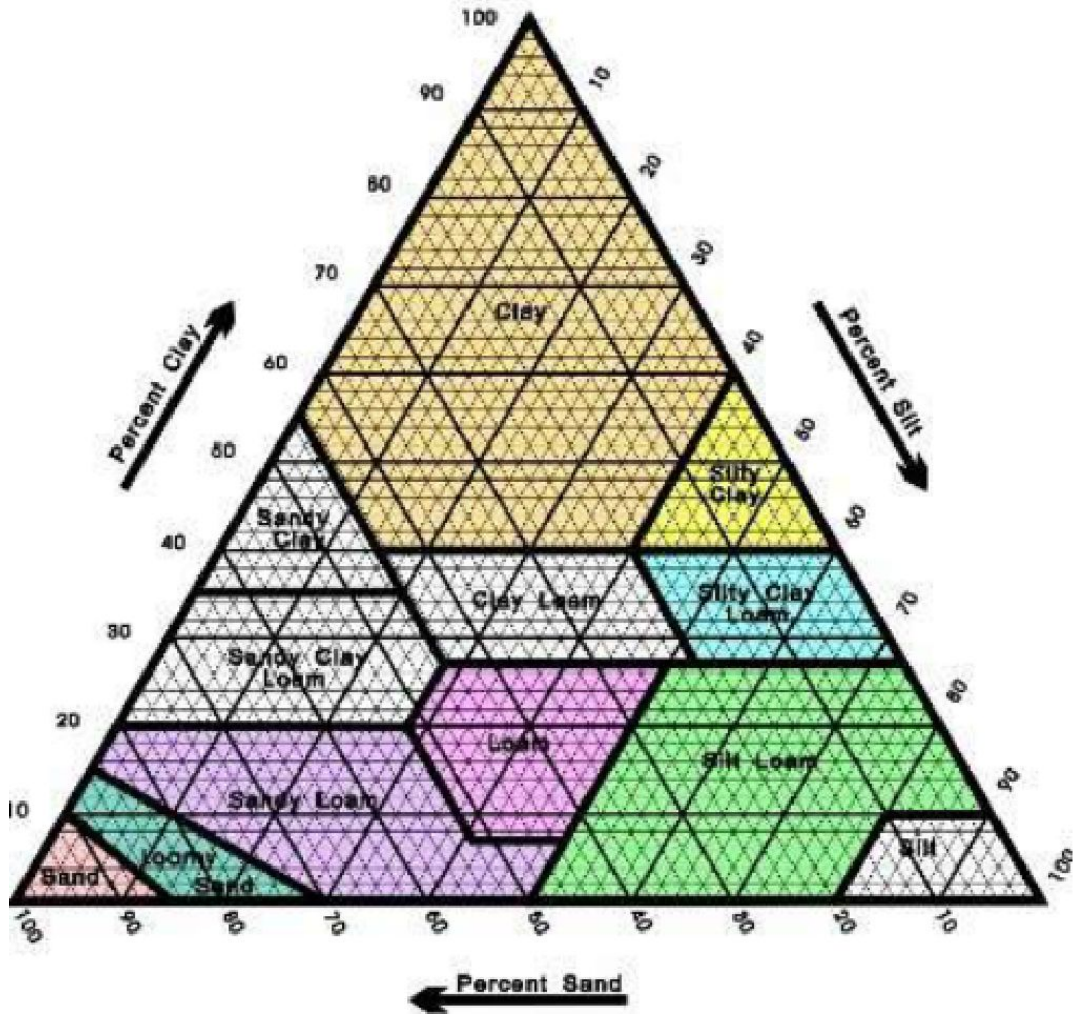
Surface area also relates to charged sites on the surface of the soil particles where plant nutrients and other ionic components of the soil may be held. These nutrients and chemicals are available for plants or are subject to degradation from biological actions. Clay particles have the most storage capacity of any soil component except organic matter, which has even higher capacity.

Clay is a term that refers to several different things associated with soils. When discussing clay, it is important to give a frame of reference for the term.

1. Clay texture is defined as a mixture of various particle size grains according to the USDA Texture Classification system, usually having more than 40 percent of the clay particle-size class.
2. A clay particle-size class is any particle (clay mineral, quartz, etc.) that is less than .002 mm in size.
3. Clay minerals are layer silicates, made up of silica crystal lattice layers. Clay mineral crystals may be larger than .002 mm is size. Vermiculite for gardening is vermiculite clay that has been heated and “puffed” by turning the water trapped between the layers to steam (like popcorn).
4. Clayey soil refers to those with clay, silty clay and sandy clay textures.

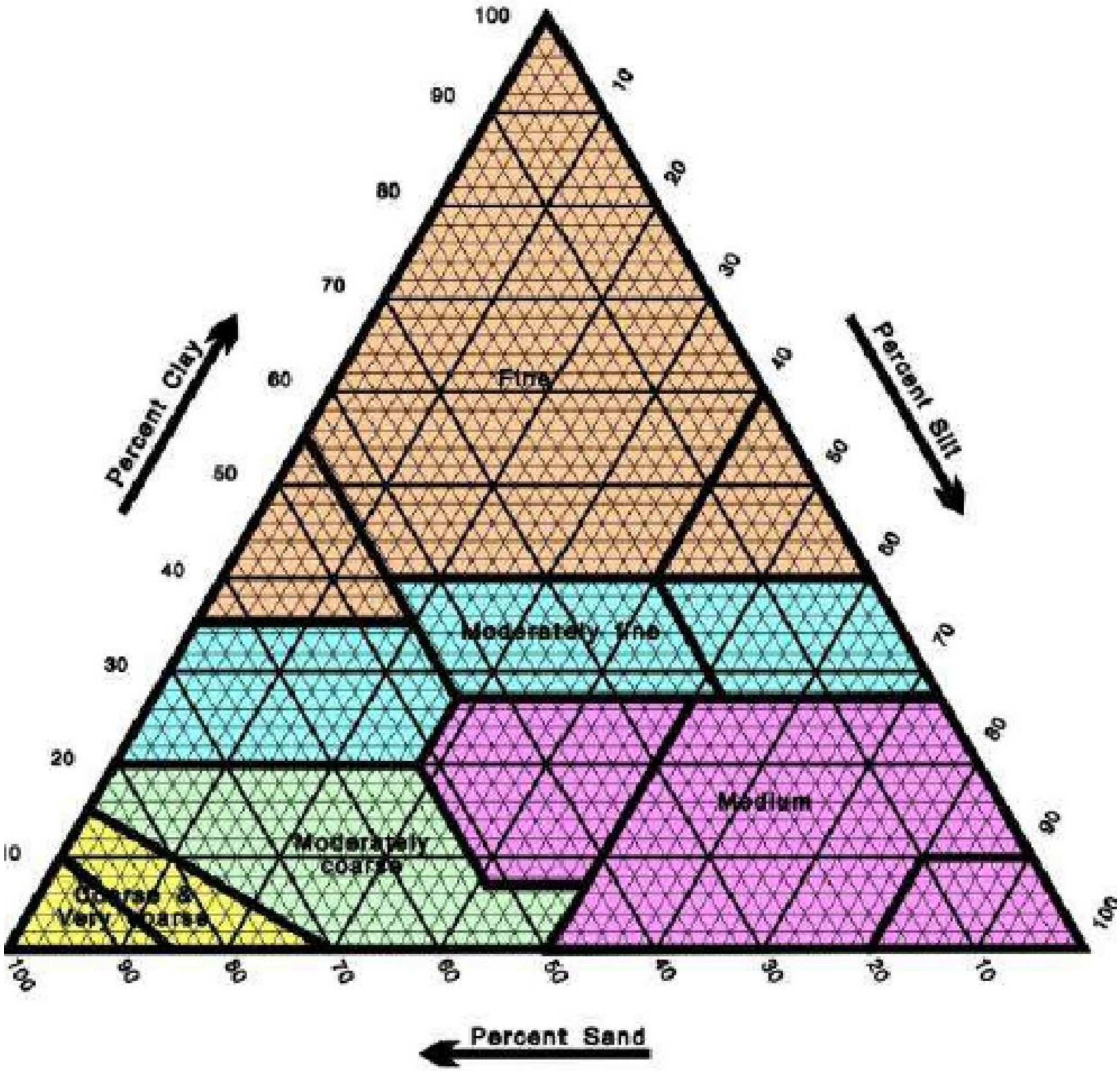
It should be noted that in a soil body there is a gradation of particle sizes and those near the border of another group will share characteristics with that group such as a clay particle which is nearly as large as a silt particle. This is important when evaluating soil texture by feel because a soil with a high percentage of particles close to the border of a coarser or finer particle size may feel much like that in the category next to it. This is typical if the soil is poorly graded in particle-size distribution. Another example is the very fine sand particle class, which acts more like a silt particle in many of its physical and chemical properties. For USDA texture determination, very fine sands are classed with the sand particle sizes, but soils that have very high percentages of very fine sand have characteristics more like medium-textured soils that have higher silt contents. Because of this the soil family classification classes very fine sands with silt particles.

Fig. 1. Textural triangle



The textural triangle shows the relative percentages of sand, silt and clay in each soil textural group. A more detailed breakdown of requirements is available in the **USDA Soil Survey Manual, Agricultural Handbook 18 (Citation, 1993, p. 137-140).**

Fig. 2 Textural triangle showing relationship of soil texture classes used in the Land Evaluation Contest.



Keys to U.S.D.A. defined textures based on relative proportions of the particle size classes.

Sand-textured soils contain more than 85 percent sand-sized particles, and their percentage of silt, plus 1.5 times the percentage of clay, must be less than 15. Sand textures are coarse sand , sand, fine sand and very fine sand. Water will soak into and run through sandy soils very fast, but less will be held than by silty or clayey soils.

Coarse sand: 25 percent or more very coarse and coarse sands, and less than 50 percent any other one grade of sand.

Sand: 25 percent of more very coarse, coarse and medium sand and less than 50 percent fine or very fine sand.

Fine sand: 50 percent or more fine sand (or) less than 25 percent very coarse, coarse and medium sand and less than 50 percent very fine sand.

Very fine sand: 50 percent or more very fine sand.

Loamy sand-textured soils have between 70 and 90 percent sand, and the percentage of silt plus 1.5 times the percentage of clay must be 15 percent or more, with a percentage of silt plus two times the percentage of clay that is less than 30 percent. Loamy sand textures are loamy coarse sand, loamy sand, loamy fine sand and loamy very fine sand.

Loamy coarse sand: 25 percent or more very coarse and coarse sand and less than 50 percent any other one grade of sand.

Loamy sand: 25 percent or more very coarse, coarse and medium sand and less than 50 percent fine or very fine sand.

Loamy fine sand: 50 percent or more fine sand (or) less than 25 percent very coarse, coarse and medium sand and less than 50 percent very fine sand.

Loamy very fine sand: 50 percent or more very fine sand.

Sandy loam-textured soils contain 7 to 20 percent clay, more than 52 percent sand and a percentage of silt, plus twice the percentage of clay, of more than 30. Or they may contain less than 7 percent clay, less than 50 percent silt and more than 43 percent sand. Sandy loam textures are coarse sandy loam, sandy loam, fine sandy loam and very fine sandy loam.

Coarse sandy loam: 25 percent or more very coarse, coarse and medium sand and less than 50 percent any other grade of sand.

Sandy loam: 30 percent or more very coarse, coarse and medium sand but less than 25 percent very coarse sand and less than 30 percent very fine or fine sand.

Fine sandy loam: 30 percent or more fine sand and less than 30 percent very fine sand (or) between 15 and 30 percent very coarse, coarse and medium sand.

Very fine sandy loam: 30 percent or more very fine sand (or) more than 40 percent fine sand and very fine sand at least half of which is very fine sand and less than 15 percent very coarse, coarse and medium sand.

Loam-textured soils contain 7 to 27 percent clay, 28 to 50 percent silt and 52 percent or less sand.

Silt loam-textured soils contain 50 percent or more silt and 12 to 27 percent clay, or 50 to 80 percent silt and less than 12 percent clay.

Silt-textured soils contain 80 percent or more silt and less than 12 percent clay.

Sandy clay loam-textured soils contain 20 to 35 percent clay, less than 28 percent silt and more than 45 percent sand.

Clay loam-textured soils contain 27 to 40 percent clay and 20 to 46 percent sand.

Silty clay loam-textured soils contain 27 to 40 percent clay and 20 percent or less sand.

Sandy clay-textured soils contain 35 percent or more clay and 45 percent or more sand.

Silty clay-textured soils contain 40 percent or more clay and 40 percent or more silt.

Clay-textured soils contain 40 percent or more clay, 45 percent or less sand and less than 40 percent silt.

Texture determination by feel

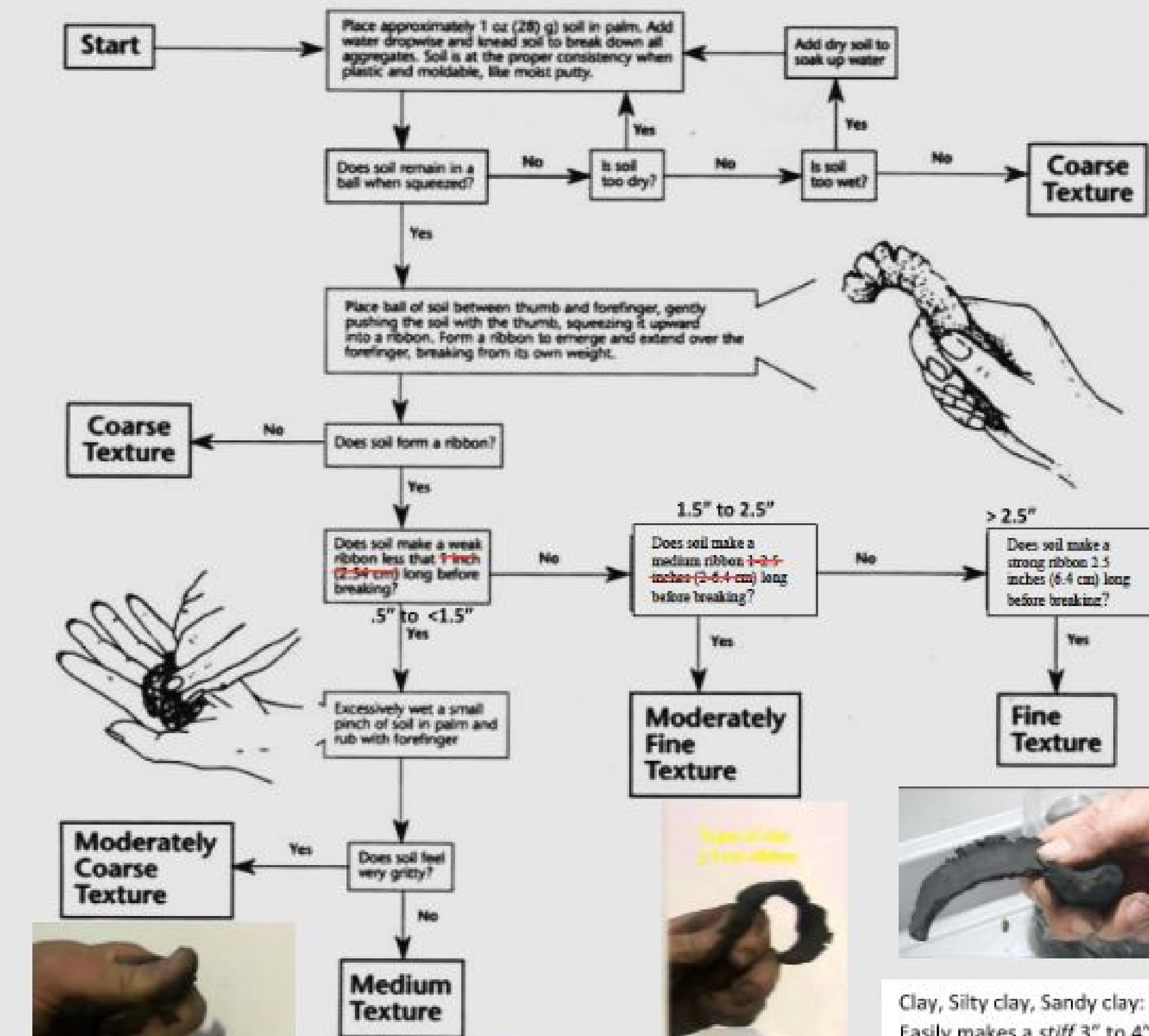
Each of the three major particle-size groups (ie. Sand, silt and clay) have a distinct feel when rubbed between the thumb and fingers. They also have distinct characteristics when subjected to simple manipulation. It is with a knowledge of these differences and through experience that texture and composition can be estimated by soil scientists. Anyone can learn the basics and through experience may develop skill at texture approximation. Even experienced soil scientists may experience difficulties in making proper texture approximations when moving from one locality to another. The experience gained while working with the soils from one locality may cause a tendency to over- or underestimate the percentages of the particle-size classes when classifying soils from another locality. This difficulty is caused by the differences in distribution of the grain sizes from one locality to another, as well as the different clay types (schmectitic, kaolinitic, etc.) and the mixture of those types.

With some practice and comparison using known samples from the new locality, one can adjust for these differences. Regarding the table of textures above, it should be noted that laboratory data is often required to make some of the separations shown. This is particularly true where soils have silt and clay percentages that place them close to the borders between texture classes. Soil scientists take a number of representative samples from the locality for laboratory analysis so as to determine the dominant texture class for each map unit used in the field.

Sand tends to impart a grittiness to the feel of the sample. Sand particles do not tend to stick together and usually are loose when dry. Silts tend to impart a smooth, floury feel to the sample. Silts will tend to clump together but usually will crack and crumble when disturbed. Clay particles tend to be sticky when wet and form a hard mass when dry. When these particle sizes are combined to form a soil texture, they each impart certain characteristics to the feel of the sample. The USDA soil texture classes have been grouped into five categories that have similar physical characteristics when using feel to determine texture. Table 3. below shows how the textures are grouped for the land-evaluation contest.

The field method for determining soil texture uses a "ribboning" of the soil. Ribboning is the practice of squeezing the soil between the thumb and forefinger to form a thin, even ribbon of soil material. This process may be done with the soil at several moisture states to obtain the best quality ribbon from the sample. Soils containing substantial amounts of clay may require working the soil material like dough after adding a small amount of water to the entire mass uniformly. By working with various soil samples of known particle-size distribution, one can begin to train oneself to distinguish soil textures in the field. During the contest, samples will be provided for judging the soil texture. It is important to use the samples provided, as these were used to make the official determinations. Most soils vary both laterally and vertically, so taking a sample from the pit may give a different result than that in the sample boxes.

Fig. 3. Ribboning soils for field texture determination



Clay, Silty clay, Sandy clay:
Easily makes a *stiff* 3" to 4" ribbon
(*Quite firm*, even when moist)

Sandy loam, Fine sandy loam:
Difficult ribbons--often breaks up less than 1"

Loam, Silt loam:
Characteristic weak ribbon 1" to 1.5"
(Generally breaks off before it can curl back on itself)

Clay loam, Silty clay loam
Sandy clay loam:
Characteristic *curling* ribbon >1.5" to 2.5"
(From its own weight)

Brief descriptions of the six textural groups

Fine-textured soils form very hard lumps or clods when dry and are quite plastic and sticky when wet. When the moist soil is squeezed out between the thumb and forefinger, it will form a long ribbon that will support itself. When moist, the soil may feel slightly gritty, in the case of sandy clay, or even velvety, in the case of silty clay.

Moderately fine-textured soils usually break into clods or lump when dry. When the moist soil is squeezed out between thumb and forefinger, it will form a short well-formed ribbon. The surface may appear shiny but quickly dulls as the surface water is reabsorbed. The ribbon will tend to break or bend downward. The sandy clay loam texture has a slightly gritty or velvety feel when moist.

Medium-textured soils have a slightly smooth or velvety feel when moist. Squeezed when dry, form a mold that can bear careful handling. The mold formed by squeezing when moist can be handled freely, without breaking. When the moistened soil is squeezed out between the thumb and forefinger, it will form a poor ribbon with a dull surface.

Moderately coarse-textured soils feel gritty but contain enough silt and clay to make moist soil hold together. Individual grains can be readily seen and felt. Squeezed when dry, it will form a mold that breaks readily upon handling. If squeezed when moist, a mold can be formed that can be carefully handled without breaking. It forms no ribbon or a very poor ribbon that breaks and crumbles.

Coarse-textured soils are loose and very friable, and the individual grains can be readily seen and felt. When squeezed between thumb and forefinger, the soil feels gritty and will not ribbon or stain fingers. If squeezed when dry, it will fall apart when released. When moist and molded, the molded shape will be unstable and will crumble as the soil is handled.

Very coarse-textured soils are very loose and individual grains are easily seen with the eye. They usually do not clump together when squeezed, even when wet.

Table 4. Contest texture group and USDA texture classes

Contest texture group	USDA texture classes
Fine	**Sandy clay, clay, silty clay**
Moderately fine	**Sandy clay loam, clay loam, silty clay loam**
Medium	**Loam, silt loam, silt, very fine sandy loam**
Moderately coarse	**Sandy loam, fine sandy loam, coarse sandy loam**
Coarse	**Loamy very fine sand, loamy fine sand, loamy sand, loamy coarse sand, very fine sand**
Very coarse	**Fine sand, sand, coarse sand, gravel**

Soil Depth

Soil depth is important to plant growth. The thickness of soil material that is favorable to plant root penetration determines the amount of moisture and nutrients available. The soil depth also may limit certain plants that cannot anchor well enough to hold the plant in position. Soil depth is usually limited to the depth that fibrous-rooted plants can penetrate. Large tap-rooted plants and stray roots that follow narrow cracks may penetrate a root-restricting material. Usually a matting of fibrous roots occurs directly on the restricting layer. A depth-limiting soil layer should not be confused with some other characteristic that could cause roots to stop, like the presence of a water table or toxic material. Materials that restrict root growth include bedrock, shale, limestone, chalk, siltstone and sandstone. Depth-limiting materials cannot be easily dug using a hand spade. These materials will usually remain hard even when wetted. Coarse sand and gravel are not considered depth limiting under the current criteria for soil mapping. Sand and gravel restrict root growth due to the lack of moisture and not the ability of the roots to penetrate. The soil depth classes are in the following table.

Table 5. Soil depth classes

Depth class	Depth from surface to depth-limiting layer
Very deep	**Greater than 60 in. of unrestricted soil material**
Deep	**40 to 60 in. of unrestricted soil material**
Moderately deep	**20 to 40 in. of unrestricted soil material**
Shallow	**10 to 20 in. of unrestricted soil material**
Very shallow	**Less than 10 in. of unrestricted soil material**

- **(USDA [Soil Survey Manual], 1993, p. 135)**

Slope

One of the most important physical features of land is the slope. Slope is measured as a percentage. It is the number of feet of rise or fall over a horizontal distance of 100 feet. If there is a 5-foot difference in elevation over 100 horizontal feet, this is a 5-percent slope. Slope influences the speed at which water flows over the surface. The steeper the land, the faster the water tends to flow downslope. This affects the time the soil surface is exposed to the water and the amount of infiltration. Even a coarse soil has runoff if it has enough slope. Also, the faster water flows, larger and more soil particles can be carried by the water.

Slope also affects the soil-formation process and the ability of machinery to negotiate the landscape. The choice of irrigation method is dependent on the slope. Gravity systems can only be used on very slight slopes, or the land must be graded to provide a suitable slope. Grading adds to the cost of installation. Sprinkler systems can be used on more sloping landforms. Sprinkler irrigation systems and farm equipment are also limited by steepness of slope. In general, as slope increases, suitability for farming decreases.

Land-evaluation sites will have two stakes, 100 feet apart, driven into the ground to approximately the same height. Estimate the number of feet of rise or fall between the stakes. This will be the percentage of slope. Stakes may be 50 feet apart if slopes do not allow for a 100-foot spacing. In this case, students should double the estimated feet of rise or fall to determine the slope. Official judges will place the slope stakes in such a manner that they represent the actual landscape and correspond to a path runoff would follow.

Landscape, rainfall, and erosion hazards vary across Nebraska. To simplify land evaluation contests, the following slopes and descriptive terms are used for each of the two major areas. The following table shows the slope groupings for the land evaluation areas in Nebraska and the groupings currently used in the national contest in Oklahoma City, Oklahoma.

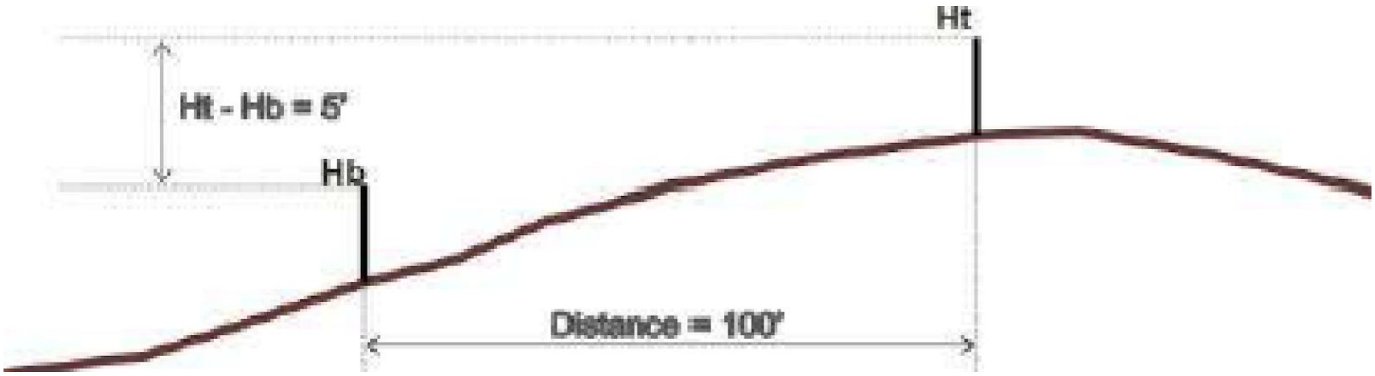
Table 6. Percentages of slope and landscape descriptive terms

Judging Area	Nearly level	Gently sloping	Moderately sloping	Strongly sloping	Steep	Very steep
1. Southwest, South Central	**0-1**	**1-3**	**3-6**	**6-11**	**11-30**	**30+**
2. North Central, Northeast, East Central, & Southeast	**0-2**	**2-6**	**6-11**	**11-17**	**17-30**	**30+**
3. West	**0-1**	**1-3**	**3-6**	**6-9**	**9-30**	**30+**
National Contest Oklahoma	**0-1**	**1-3**	**3-5**	**5-8**	**8-15**	**15+**

Example for interpretation:

0-2% is 0-1.99%　　2-6 is 2-5.99%　　6-11 is 6-10.99%

Fig. 4. Slope determination.



At 100 foot spacing of stakes the difference in the elevation of the stakes equals the percentage of the slope. In this case the slope would be 5%.

% slope = ((Ht-Hb)/Distance)*100 5% slope = (5/100)*100

If the spacing of the stakes was 50 feet, then the slope would be 10%. 10% slope = (5/50)*100

Erosion

Erosion is the process where soil particles are detached from the surface and transported by wind or water. Detachment of the soil particle must occur before it can be transported. During water erosion soil particles are detached when raindrops strike the unprotected soil surface. During wind erosion, wind bombards the surface with airborne soil particles, which in turn hit and detach more particles. Once a soil particle is detached from the soil mass, it can be transported by the flow of water or wind currents. This is why protecting the soil surface from detachment forces is important to proper management of the soil resource. Surface residue, cloddiness and windbreaks are used to minimize these effects.

Gullies are formed by water erosion. Because they affect the management of the land, they are important considerations in land evaluation. Gullies may be crossable or uncrossable with normal farm machinery. Frequent gullies are less than 100 feet apart. Occasional gullies are more than 100 feet apart.

The following are classes of erosion used for the contest:

None to slight (1): Soils of this class show no obvious effect of erosion. The plow layer (surface soil) exhibits the characteristics of the A horizon. Less than 25 percent of the surface soil has been removed and no gullies are present. In some places, deposition may be occurring and is included in this class for contest purposes.

Moderate (2): Soils of this class have 25 to 75 percent of the original surface (A horizon) removed. The plow layer may consist of a mixture of A and the next horizon (B if present, AC if not). Some small, occasional crossable gullies may be present. It may or may not change the land capability class but would not be allowed in Class I.

Severe (3): Soils of this class have had more than 75 percent of the original surface soil removed. The plow layer exhibits the characteristics of the B horizon if present or the AC or C horizon if the B is not present. Frequent crossable gullies or occasional uncrossable gullies or blown-out areas may be present. Land capability class is usually reduced when this erosion is present. Soils with severe erosion in Nebraska are commonly designated as eroded in the map unit name, and the soil symbol may carry the suffix “2,” such as MnD2, which could stand for Marshall silty clay loam, 6 to 11 percent slopes, eroded.

Very Severe (4): Soils of this class have more than 75 percent of the original surface removed. Frequent uncrossable gullies and/or large accumulations of material eroded and redeposited by wind are present. The plow layer exhibits the characteristics of the C horizon or underlying material. If wind is the main erosion force, blown-out areas are numerous and deep. Areas with this erosion are generally unfit for cultivation without extensive reclamation. Soils with very severe erosion in Nebraska have been designated as severely eroded in the soil map unit name and may have the suffix “3.” (USDA, Soil Survey Manual, 1993, p. 82-89)

% erosion = ((original surface thickness–current surface thickness)/original surface thickness)*100

The original thickness of the surface will be given at each field in the contest.

Deposition/Fill Soil Structure

Deposition is the process where soil particles are transported and laid down over an existing soil surface. This action is driven by an agent such as wind, water, ice, or some other natural process. In some places this material becomes very thick. It is generally characterized as material that is lighter in color (not to be confused with an E horizon) or is alternating light and dark color above a dark colored original soil surface. Soil structure would be very fine platey and the material should break on horizontal planes. This change in the soil structure near the surface will affect the permeability and can decrease the rate at which water can enter the soil profile.

On floodplains, deposition occurs commonly as a result of flood events. In these situations there would not be any change or decrease in the original soil surface unless some scouring occurs during the flood event. This deposition material is called overwash. In some situations, if the material has been there for a long time, a new A horizon form on this new material. In these situations it will not be noted that any overwash exists because there is an A horizon at the surface and not covered by new material.

On upland drainageways deposition can also be found where erosion from sideslopes washes down and covers the footslope position. There would generally not be any eroded surfaced on this landscape.

On uplands, particularly in the sand-hills area, wind can transport soil material and redeposit it. This deposition material is called overblown. Depending on where the deposition occurs there may or may not be an eroded surface below the new material. If this occurs on soils in inter-dunal basins or on floodplains there would not be any possibility for erosion. On uplands and in the sand-hills there could be an eroded soil surface below the blown in material.

Fill can occur on any landform and is the result of human influence. Some fill is found where land leveling on floodplains involves grading the surface for flood irrigation or where a swale is filled so that the area can be cropped. In uplands this occurs where a gully has been filled or where other disturbance has occurred. Sometimes the fill material contains natural earthen materials and sometimes it contains debris from construction sites such as chunks of concrete, brick, and wood.

Soil Structure

Soil structure is not judged in the contest, but it is very important because of its effect upon permeability and soil use. It also relates to how well crops grow. Structure refers to the shape, size and arrangement of soil particles into clusters or aggregates. Each of these aggregates has a particular shape, size and set of properties that determine the type of structure. It is best to observe structure in the soil profile, because the soil in the sample box has been disturbed. **(USDA, Soil Survey Manual, 1993, p. 157-166)**

Shape

Single grained: Each soil particle functions as an individual unit due to the lack of binding material. This structureless condition is usually found in coarse-textured soils and helps make them readily erodible.

Granular and/or subangular blocky: Granular means sphere-like or rounded aggregates with no flat surfaces that have been caused by contact pressure from the faces of surrounding aggregates. Subangular blocky is block-like or tending toward six-faced aggregates having mixed, rounded and flat surfaces with rounded vertices or corners.

Blocky: Block-like or tending toward six-faced aggregates having flat surfaces with mostly sharp, angular vertices or edges that are mold casts formed from surrounding aggregates. Blocky structure can be separated into angular blocky, the ped faces intersect at relatively sharp angles or subangular blocky, ,if the faces are a mixture of rounded and plane faces and the corners are mostly rounded.

Prismatic: Prism-like or vertically oriented aggregates with the vertical axis longer than the horizontal. Flat faces or surfaces are well defined.

Columnar: Modified prismatic aggregate. But the tops of the prisms are noticeably rounded or dome shaped. If the overlying material is carefully removed, the surface appears much like a cobblestone pavement. This structure is usually suggestive of salty conditions.

Platy: Plate-like or relatively thin horizontal plates or leaflets.

Massive: Medium- to fine-textured soils with indistinct or no apparent aggregation. This type is characteristic of clayey, very slowly permeable soils or in horizons where little development has taken place.

Size: Refers to the area of extent each aggregate occupies.

Fig. 5. Drawings to illustrate the common types of soil structure. A – Prismatic, B – Columnar, C – Angular blocky, D – Subangular blocky, E – Platy, F – Granular. -(USDA, Soil Survey Manual, 1962, p. 227, Figure 44)

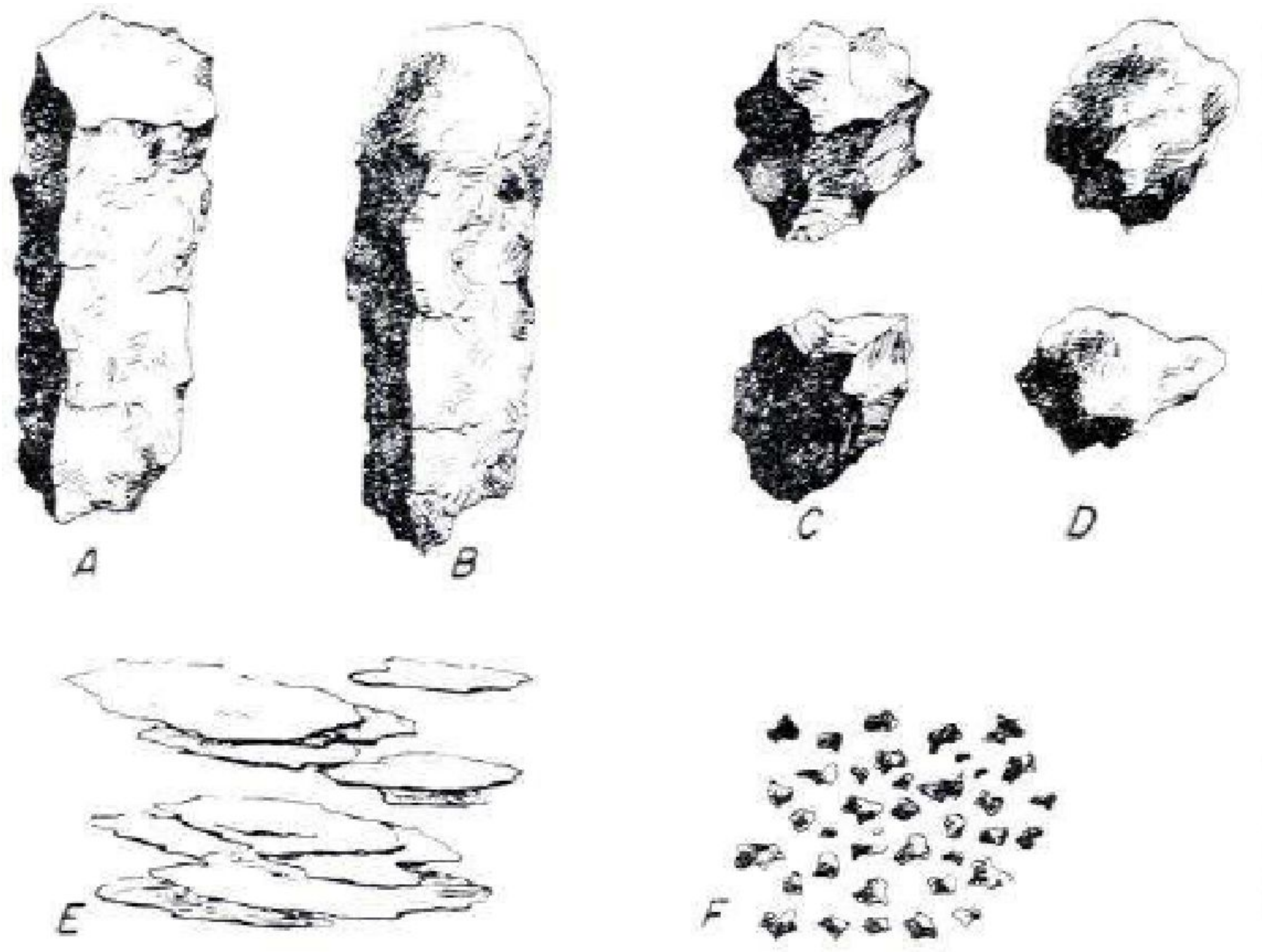


Table 7. Size Classes of Soil Structure

	Shape of Structure			
Size Classes	Platy	Prismatic & Columnar	Blocky	Granular
	mm	mm	mm	mm
Very Fine	<1	<10	<5	<1
Fine	1-2	10-20	5-10	1-2
Medium	2-5	20-50	10-20	2-5
Coarse	5-10	50-100	20-50	5-10
Very course	>10	>100	>50	>10

-(USDA, Soil Survey Manual, 1993, p. 162, table 3-13)

Grade: Refers to the distinctness of the aggregates in the soil.

Weak: Units are barely observable in place and readily break down if removed from the profile.

Moderate: The units are well formed and are evident in the undisturbed soil profile. When disturbed, the units separate into whole units or some broken units but distinct face characteristics of the ped (aggregate) remain and are different than the broken surface faces.

Strong: The units are distinct in the undisturbed soil profile and separate cleanly into whole units when removed from the profile.

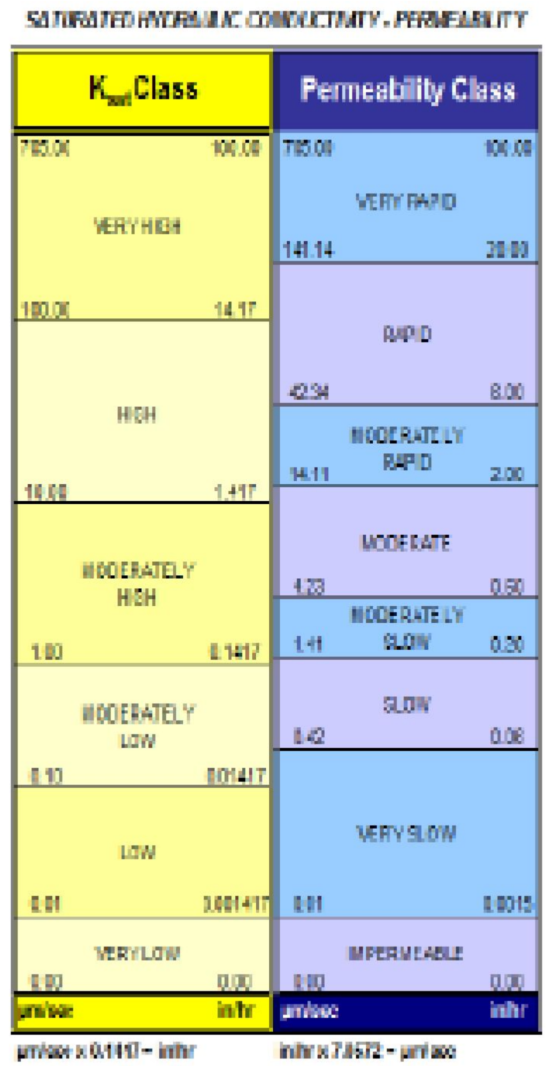
Because of the way structure is formed, many soils have compound structures. This occurs when the soil profile exhibits one distinct structure but can be separated into a smaller structure of the same shape or different shape. Medium-textured subsoils or control sections often show a weak coarse subangular blocky structure that can be separated into a medium-fine subangular blocky structure.

Permeability

Permeability refers to the movement of air and water through the soil. Permeability is affected by many soil characteristics. Soil permeability is important because it affects the availability of air, water, and nutrients. Permeability can be estimated from other soil properties, such as texture, structure and consistence. If any of these characteristics are changed, the permeability will change. Usually the range of the permeability ratings will cover the changes that normally take place over the year. As an example, the permeability will increase in the spring due to the freezing and thawing cycles that loosen the consistency of the soil, but it will be lower during the growing season due to surface traffic.

Each soil layer has a permeability rating, but a soil's permeability rating is based on the most restrictive layer in the upper 40 in. of the soil profile. The texture and structure of this layer are the most important characteristics in determining the permeability. For the purpose of the contest, a boxed sample will be used for texture and permeability determination. The sample is labeled as "Control section."

Very slow permeability or Impermeable: Dense, fine-textured clay-pan "control sections," indurated bedrock. They have angular blocky structure, massive, or are indurated bedrock, (all) with very few visible cracks or pores (when wet). Clay-pan soils are plastic and/or sticky when wet, very firm when moist and very hard when dry. Roots are mostly absent (within the clay-pan or bedrock). Peds tend to part easier along the horizontal axis above the clay-pan. Mottling and grayish control section colors are often present (clay-pan soils) but are not required [for the national contest] for a soil to have very slow permeability. Permeability rate: less than 0.06 in./hour. Ksat Classes: Primarily Very low and Low.



Slow permeability: Fine-textured "control section" with angular-blocky parting to subangular blocky structure. Also, Moderately-fine textured blocky or massive clay-pans. They are firm-to-very firm and moderately plastic when moist and hard when dry. Roots are common (within the "control section"). Peds tend to part more easily along the vertical axis. Permeability rate: 0.06 to 0.2 in./hour. Ksat Class: Moderately low.

Moderately slow permeability: Moderately fine-textured "control section" with subangular blocky structure. They are firm when moist and hard when dry. Roots are common (within the "control section"). This permeability class is combined with slow permeability for the national contest. Permeability rate: 0.2 to 0.6 in./hour. Ksat Class: Moderately high.

Moderate permeability: Medium-textured "control section" usually with prismatic structure parting down to subangular blocky structure. Individual peds have friable moist consistence and usually have large pores. Roots are common (within the "control section"). Permeability rate: 0.6 to 2 in./hour. Ksat Class: Primarily Moderately high.

Moderately rapid permeability: Soils with moderately coarse-textured "control sections," regardless of structure, are moderately rapidly permeable. They are very friable or friable and usually have large pores. Roots are common (within the "control section"). This class is combined with the rapidly permeable class for the national contest for home site or moderately permeable for the rest. Permeability rate: 2 to 6 in./hour. Ksat Class: High.

Rapid permeability: Soils with coarse-textured "control sections" that have granular or single-grained structure. They tend to be very friable or loose when moist, and exhibit little restriction to movement of air and water. Permeability rate: 6 to 20 in./hour. Ksat Class: High, Very high.

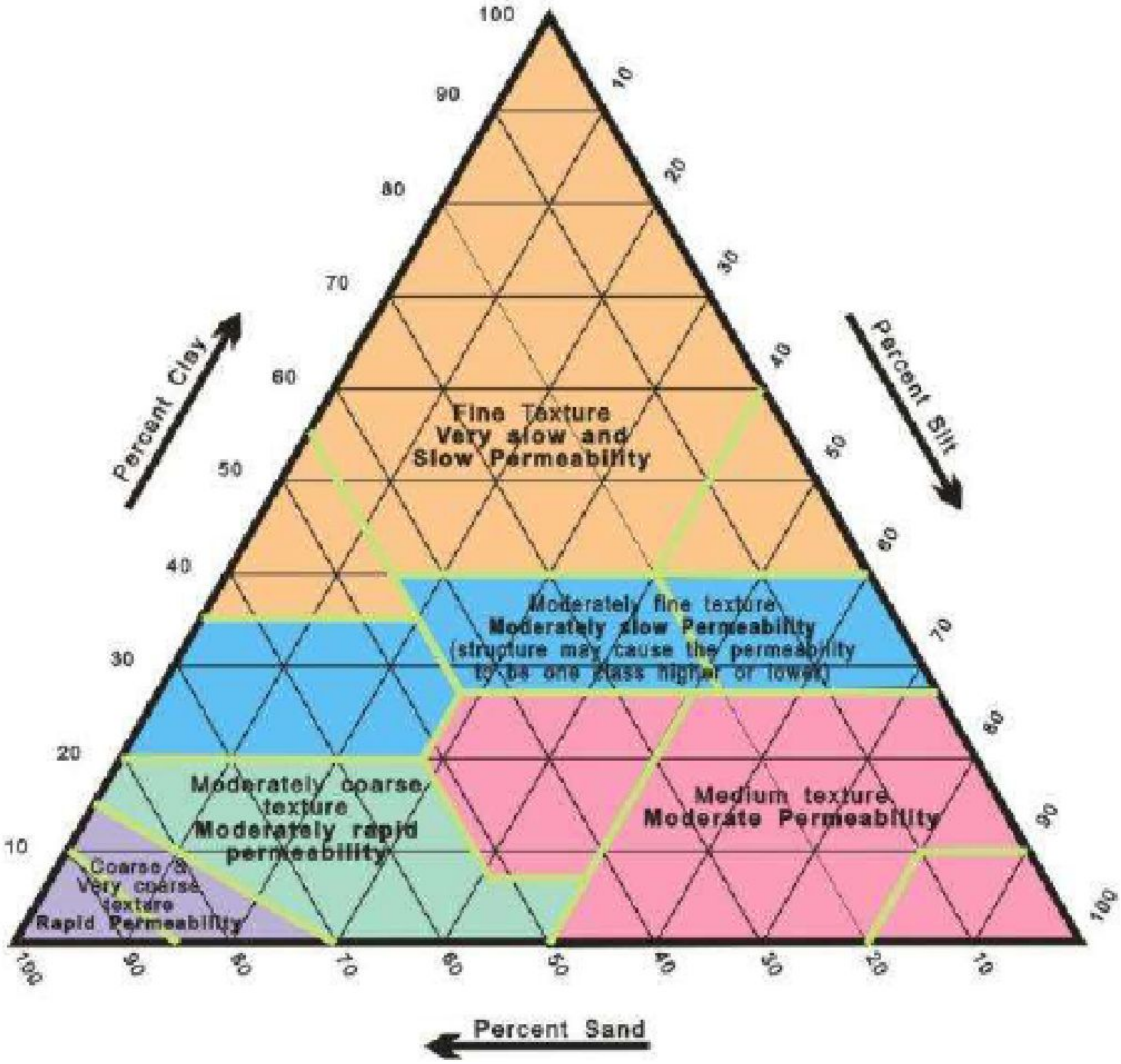
Very rapid permeability: Soils with very coarse-textured "control sections." They are usually loose and exhibit little restriction to air and water movement. Permeability rate is greater than 20 in./hour. Ksat Class: Very high.

Table 8. Soil permeability rate in inches per hour, relative to soil texture and structure

Soil	Rate in	Probable characteristics	
Permeability	**inches/hour**	**Texture**	**Structure**
Very slow	**Less than 0.06**	**Fine (claypan), (or bedrock)**	**Angular blocky, massive, (indurated bedrock)**
Slow	**0.06-0.2**	**Fine (not claypan)**	**Angular blocky parting to subangular blocky structure**
		Moderately fine (clay-pan)	**w/Blocky or massive structure**
Moderately Slow	**0.2-0.6**	**Moderately fine**	**Subangular blocky structure**
Moderate	**0.6-2.0**	**Medium**	**Prismatic parting down to subangular blocky structure**
Moderately Rapid	**2.0-6.0**	**Moderately coarse**	**(Regardless of structure)**
Rapid	**6.0-20.0**	**Coarse, Very coarse (>35% gravel)**	**Granular or Single-grain**
Very Rapid	**Greater than 20.0**	**Very coarse (>35% gravel)**	**Single grain**

(-after USDA, National Soil Survey Handbook, 1993, pt. 618.35)

Fig. 6. Textural triangle showing relationship of permeability groups.



Organic Matter

Although organic matter is not a factor in determining land capability, it is very important in conservation farming. Organic matter will not be evaluated in the contest but it is important to making proper judgments in soil evaluation. Color in most soils in Nebraska is a good indicator of organic matter, except when the soils are derived from dark-colored parent materials, such as Pierre Shale, which is normally a very dark gray to black. Other materials that affect color are free carbonates, salts and reduced and oxidized iron.

HIGH organic matter content in soils is desirable because it means higher water-holding capacity, better tilth and usually a higher level of fertility. Very dark brown (10YR 2/2), black (10YR 2/1), very dark gray (10YR 3/1), very dark grayish-brown (10YR 3/2), dark brown

(10YR 3/3), dark gray (10YR 4/1), and dark grayish-brown (10YR 4/2) soils are usually high in organic matter.

MEDIUM organic matter in a soil is indicated by brown (10YR 5/3, 10YR 4/3), grayish-brown (10YR 5/2), gray (10YR 5/1, 10YR 6/1), light brownish-gray (10YR 6/2) soils.

LOW organic matter in a soil is indicated by light gray (10YR 7/1, 10YR 7/2), very pale brown (10YR 7/3, 7/4, 8/2, 8/3, 8/4), or pale brown (10YR 6/3) soils. Low organic matter is not desirable.

Saline Or Alakli Conditions

High saline or alkaline conditions severely limit the ability of the soil to produce crops. The following guidelines will be used in determining the land class for soils containing excessive amounts of sodium or alkali. Areas with these conditions usually appear scabby (patchy areas of vegetation and bare soil) because of poor plant growth and may have a whitish salt accumulation on the surface of the soil. Common grasses on affected areas are alkali sacaton, inland saltgrass, nuttall alkaligrass, alkali muhly and other flora tolerant of the soil condition.

Slight or moderate saline or alkaline conditions: Reduce land class (use official chart for your area).

Strong or very strong alkali conditions: Usually placed in Class VI land (use official chart for your area).

Water Relationships

Water relationships refers to free water that is present in or on soils at some time during the year. This includes water tables, flooding and ponding. Usually, more information is required than would be available for the contest. The classes of these three relationships will be given by the official judges.

Natural Drainage Classes

Seasonal high water table refers to saturation that is internal to the soil profile and usually extends below the soil to some impervious or very slowly permeable material. The exception is a perched water table with the restrictive layer in the soil profile. The water table is not directly affected by rains, runoff, flooding or ponding. These events will only affect the water table after the water filters through the soil and adds to the current water table.

Table 9. Drainage categories, profile descriptions and planting options

Drainage Class	Soil and water table characteristics	Effects
Somewhat excessively (SE) & Excessively (E) drained	Soil is droughty, usually due to very low water-holding capacity	Planting choice of crops is limited by available water due to droughty nature of soils.
Well (W) drained	Soil profile is not saturated within 6 feet of the surface	Planting and choice of crops is not affected.
Moderately well (MW) drained	Soil profile is usually saturated to within 4 feet due to seasonal high water table or water that may be perched on a more slowly permeable layer (usually having a high clay content).	Planting is usually not affected, but choice of crops may be affected.
Somewhat poorly (SP) drained	Soil profile is usually saturated to within depths of 2 to 4 feet due to Seasonal high water table.	Planting and choice of crops is affected.
Poorly (P) drained	Poorly drained, soil is usually saturated to within 0 to 2 feet of the surface due to the seasonal high water table.	These soils usually are not cultivated due to wetness.
Very Poorly (VP) drained	Soil is usually saturated at the surface	Usually the soils have water over the surface due to a seasonally high water table. Used for hay production, pasture or wildlife.

-(USDA, National Soil Survey Handbook, 1993, pt. 618.14)

Flooding

Flooding refers to water that flows over the surface of the soil and comes from neighboring soil areas or drainage. Floods may cause damage by removing plants and soil, depositing debris and soil material or creating gullies.

Table 10. Flooding classes, frequency and effects

Flooding Class	Frequency	Effects
None	**Never floods (nearly 0 percent chance)**	**Planting or choice of crop is not affected.**
Rare	**Floods less than 5 times in 100 years (<5%)**	**Planting or choice of crop is not usually affected.**
Occasional (OCC)	**Floods 5 to 50 times in 100 years (5-50%)**	**Planting or choice or crop is affected and land class is usually reduced one class.**
Frequent (FREQ)	**Floods more than once in 2 years (>50%)**	**Planting or choice of crop is affected and land class is usually Reduced to class VI.**

Common; occasional and frequent can be grouped for certain purposes and called common. Occasional and frequent flooding will reduce land capability class.

Ponding

Ponding refers to water that stands on the surface of the soil for long periods of time. This water usually comes from surrounding higher areas. Ponded areas are usually lower areas in the landscape that do not have an outlet for the water to drain away. These areas may be filled by water that can only slowly enter the soil profile. Ponding of occasional or greater frequency will reduce the land capability class of a soil. Land capability class examples given in the table are typical if no other adverse factors are present; otherwise they will reduce the land capability class an additional class for occasional and two classes for frequent. Note that land capability class V is reserved for soils affected by high seasonal water tables, so reducing a class IV soil one class would make it a class VI soil. **(USDA, National Soil Survey Handbook, 1993, pt. 618.37)**

Table 11. Ponding classes, frequency and effects

Ponding class	Frequency	Effects
None/Rare	**Never ponds or less than once in 10 years.**	**Planting and choice of crop not affected.**
Occasional (OP)	**Ponds once in 5 to 10 years**	**Planting and choice of crop somewhat affected, usually land Class III.**
Frequent (FP)	**Ponds once in 2 to 5 years**	**Planting and choice of crop moderately affected, usually land Class IV.**
Very frequent (VFP)	**Ponds more than once in 2 years.**	**Generally unsuited for cultivated crops, land class V or VIII.**

Surface Runoff

Runoff is a combination of surface slope and the permeability of the upper 1 meter of soil as criteria. Additional assumptions and information is available in the *USDA Soil Survey Manual.* Determine the minimum permeability of the upper 1 meter of soil. If the minimum permeability occurs at or above .5 meters, use the table below. If the minimum permeability occurs between .5 and 1 meter, use the following table, but reduce the runoff by one runoff class (medium to low as an example).

Table 12. Index of Surface Runoff Classes, NRCS National Soils Handbook, Part 618.

Index of Surface Runoff Classes

	Saturated Hydraulic Conductivity (µm s-1) Ksat					
Slope Percent	**≥100**	**10-100**	**1.0-10**	**0.1-1.0**	**0.01-0.1**	**<0.01**
Concave	N	N	N	N	N	N
<1	N	N	N	L	M	H
1-5	N	VL	L	M	H	VH
5-10	VL	L	M	H	VH	VH
10-20	VL	M	H	VH	VH	VH
≥20	L	M	H	VH	VH	VH

Abbreviations; Negligible – N; Very low – VL; Low – L; Medium – M; High – H; Very high – VH.

Overhead 'Runoff ' water: Overhead water is water flowing across the area from a higher landscape position. Overhead water is normally only present during the storm event when excess water is flowing off the higher landscape position. Diversion or sediment basins are usually constructed on a large scale and are not farmed. Practice no.13 is not used for diversion. Diversion or sediment basins are not constructed on floodplains for control of flooding. This condition does not take the area out of Class I but would require a diversion or sediment basin. Flooding is overflow water from natural drainage system. Flooding may occur a significant time after the storm event and may remain for an extended amount of time.

The purpose of terraces are to control runoff *while it is still sheet flow*. We terrace soils, therefore, (preferably) from the top of a drainage basin first and then progressively further down. They are used to slow down the water ***before** it becomes concentrated* into rills and gullies. In contrast, a diversion structure is used ***after** the runoff water has become concentrated* and terracing can no longer prevent or control this concentration. A diversion is constructed to protect highly valuable farmland from gully erosion and or sedimentation below the steeper hill(s).

Fertilizer and soil amendments

Fertilizer and soil amendments are essential to the economical production of crops. No set of limits with regard to lime and fertilizer requirements fits all areas of the country and all crops. The intent of this section is to familiarize the contestants with soil fertility requirements and terminology and identify deficiencies from given soil test values.

pH

pH-soil amendments. For the contest, when any pH value given for a field is 6.4 or less or above 8, soil amendments need to be applied **(Neb-Guide G92-1096-A, Understand Your Soil Test: pH-Excess Lime-Lime Needs).**

Soils with pH's of 5.5 or less are usually soils requiring lime. However, lime is recommended on soils with pH's up to and including 6.4. Above this pH, no lime is recommended as profitability is reduced. Soils with pH's above 8 are alkaline and may indicate a salinity problem. The use of sulfur or similar amendment should be applied to reduce the pH to a more favorable level. The treatment of saline/alkali conditions can be very complicated, and results are not always economically successful.

Nitrogen (N)

Nitrogen. Nitrogen for the land evaluation will be given as adequate or deficient without a numerical value.

No established level of nitrogen in the soil adequately indicates sufficiency or deficiency for all crops. Any value that would be deficient for corn or small grains may be adequate for alfalfa. On the other hand, adequate levels of nitrogen for corn may be deficient for maximum production of irrigated pasture grasses. The adequate level of nitrogen in the soil is dependent on the yield goals.

Phosphorous (P2O5)

Phosphorous. For the contest, when the phosphorous value given is less than 60 lb./ac. for Bray P-1, Phosphorous should be applied **(Neb-Guide G74-174A, Fertilizer Suggestions For Corn)**

Low levels of phosphorous in Nebraska soils are 30 lb./ac. or less(Bray P-1. However, soils with phosphorus levels up to 60 lb./ac. Bray P-1 do require the addition of phosphate for maximum production.

Potassium (K2O)

Potassium For the contest, when the potassium value given is less than 250 lb./ac. Potassium should be applied. **(Neb-Guide G74-174A, Fertilizer Suggestions For Corn).**

Soils with potassium levels of 250 lb/ac. or less are considered deficient and require the addition of potassium. Potassium is recommended to some extent on soils with as much as 250 lb./ac. for certain crops, but above that level no potassium is added.

Example

Soil test information shows:

(If phosphorous or potassium are given in ppm, it is assumed that this applies to the top 6 in. of soil, which has a weight of about 2 million lbs./ac.; 1 lb./ac. = 2 ppm)

pH - 5.5
Nitrogen - Deficient
Phosphorus - 30 lb./ac.
Potassium - 325 lb./ac.

Landscape Position

Landscape position is the relative position soils occupy. Most soils only occupy one position, since the factors of soil formation that led to development of a particular soil is only met with one set of circumstances. Nebraska has some soil series that occur on more than one landscape position. This occurs because a soil series covers a range of soil properties and some landscape positions have had the factors of soil formation close enough together to form soils with soil properties within one series criteria. “Landscape position,” as it is used in soils, refers to the present or recent past of the area. “Geologic landscape position” refers to the ancient landforms, which are usually much broader in scope than the modern landscape.

Landscape position is sometimes very hard to determine, especially when only a small area is observed in a short time span. Therefore, landscape position is given for the contest. It is important to understand how landscape position affects other land-evaluation criteria, to be familiar with the landscape positions commonly recognized in Nebraska and the Great Plains.

“Floodplain” is a broad term used to describe the area from the stream channel to the highest level that is expected to flood. It historically was referred to as bottomland which may have included stream terraces that were subject to flooding, the term is no longer used.

The floodplain is the lowest position in the landscape. The floodplain can be divided into different levels called steps. It is usually adjacent to the stream channel, but may include abandoned ox-bows and stabilized sandbars. The soil profiles of soils on this position are characterized by distinct bands or layers that have been deposited by flooding (commonly called stratification). The soils are subject to rare, occasional or frequent flooding. Common flooding is a term that combines frequent and occasional flooding.

The stream terraces are on the next higher level or levels. They have no flooding hazard. Stream terraces are often characterized by soil profiles with distinct layering in the upper layers. Relief may range from nearly level to strongly sloping. Wind has reworked some terraces and formed low ridges and hummocks. Some of the most well-developed soils in Nebraska are on terraces. These soils have low relief and long expanses of time to develop.

Footslopes are the transition from the terraces to the uplands. They occur along the bottom of the upland sideslopes and may overlay some terrace positions. Deposition of organic-rich materials from the soils higher in the landscape have thickened the surface layers. Soils on footslopes usually receive overhead water.

Uplands are the highest areas in the landscape and are not subject to flooding. These soils have slopes from nearly level to very steep and are usually dissected by drainageways. Most soils in Nebraska occupy upland positions. Uplands may be further divided into sideslope, shoulder and summit positions. The summit is at the top of the upland and is usually the most stable area in the upland landscape position. The shoulder is on the break from the summit to the sideslopes and is the least stable position on the upland. The sideslopes are below the shoulder and have a stability intermediate between the shoulder and summit.

Depressions are lower, bowl-shaped areas that occur on upland summits and in some cases on terraces. They are characterized by soils with thick, very well-developed subsoils. The subsoils usually have high amounts of clay in the control section and very slow permeabilities. Water tends to be ponded and is only removed by percolation or evaporation. In some cases, the depressions have been breached by a drainageway or dug channel.

Land Capability Class

The standard soil survey map is an inventory of the soils and their properties. It shows the location of these soils in their relationship to the landscape and other relative features. Soil maps are designed to provide information that meets the needs of users with diverse objectives and therefore contains considerable detailed information showing soil differences and similarities.

This information must be grouped so as to have meaning for the user. These groupings are called interpretations and are based on observed or interpreted soil properties. Most users are not interested in all of the detailed information available on the soil map unit but want a more generalized interpretation. Soils with similar response to a chosen management or treatment are grouped together. The resulting map provides interpretations to meet the specific needs of the user.

The USDA Land Capability Classification System is one such interpretative grouping of specific soil properties. It is made primarily for agricultural purposes. Arable land (suited for sustained cultivation) is grouped according to its potentials and limitations for sustained production of cultivated crops that do not require specialized site conditioning or site treatment. Nonarable soils (unsuited for sustained cultivation) are grouped according to their potential and limits for production of permanent vegetation and according to their risks of soil damage if mismanaged. **(USDA, National Soil Survey Handbook, 1993, pt. 618.27)**

The land capability classification system provides three major categories of soil groupings: capability unit, capability subclass and capability class. The capability unit is the narrowest interpretative grouping and groups soils with very similar responses to systems of management of common cultivated crops or pasture. Long-term yields from soils in each group should not vary by more than 25 percent. The capability subclass is a grouping of the capability units into four general kinds of limitations: (1) erosion, (2) wetness, (3) rooting zone limitations (coarse material, alkalinity, salinity, etc.), and (4) climate. The broadest category is the capability class, which is broken into eight classes.

Description of Land Capability Classes

The capability class is the category we evaluate in the contest. By evaluating the physical characteristics of the soil and the landscape on which it exists, all land can be placed in one of the eight classes. Each class is determined by the number and severity of the limitations placed on its use by physical characteristics, Class I being the best and Class VIII the poorest.

Land Generally Suitable for Cultivation

Class I land is on well-drained, nearly level soils where wind or water erosion is very low.

These soils can be farmed intensively under a sequence of adapted crops, using barnyard manure or commercial fertilizer, subsurface tillage, and cover or green manure crops that maintains or improves fertility and soil structure.

Class II land has a few limitations that reduce the choice of crops and require moderate conservation practices. Some of these include gentle slopes, moderate susceptibility to wind or water erosion, less than ideal soil depth, occasional damaging overflow, and/or somewhat unfavorable soil structure and workability.

Production can be sustained at a high level by applying one or more good conservation practices. This would include planting crops in approved sequence, contour tillage, terraces, occasional diversion terraces, grassed waterways, cover or green manure crops, stubble mulching, and proper fertilization.

Class III land has severe limitations that reduce the choice of plants and require special conservation practices. The amount of cultivation is restricted, and the cultural practices are more intensive on this type of land.

Limitations placed on Class III land are the result of the effects of one or more of the following factors: moderate slopes; high susceptibility to water and wind erosion; wetness; shallow depths of soil favorable to root development; occasional ponding of surface water, low water-holding capacity; low fertility potential; salinity or alkali problems; and sometimes climatic conditions.

Conservation treatments on Class III land include: approved cropping sequence, including grasses and legumes; grassed waterways; contour farming; terracing; cover and green manure crops; stubble mulching; wind strip cropping; and proper fertilization.

Class IV land has very severe limitations that restrict the choice of plants and require very careful management. Many of the soils in this class are suited only for occasional cultivation. This limitation is the result of the effects of one or more of the following: strong slopes; very severe susceptibility to water and wind erosion; severe effects of past erosion; shallow soils; low water-holding capacity; frequent overflows causing severe crop damage; excessive wetness; alkaline or saline conditions; and moderately adverse climate.

Conservation treatment practices for Class IV land include: occasional cultivation (not more than 25 percent of the time), grasses and legumes; terracing; contour farming; strip cropping; cover and green manure crops; stubble mulching.

Land Generally Not Suited for Cultivation

Class V land has little or no erosion hazard, but has other factors that limit its use largely to pasture, range, woodland, or wildlife food and cover. Class V soils are on bottomlands of streams or in meadowlands of the Sandhills. Soils subject to frequent overflow or ponded areas where drainage for cultivated crops is not feasible are usually placed in class VI in Nebraska.

Good grazing and hayland management practices are considered adequate conservation measures on Class V soils.

Class VI land has very severe limitations that make it generally unsuited for cultivation and limit its use to pasture or range, woodland, or wildlife food and cover. Limitations that cannot be corrected in these soils are: steep slopes; severe erosion hazard; effects of past erosion; stoniness; shallow rooting zone; excessive wetness; low water-holding capacity; salinity; or alkalinity. In Nebraska, soils that have frequent flooding are usually placed in Class VI.

Deterioration may occur unless the intensity of grazing is restricted and special conservation measures are applied. One or more of the following practices are usually required to maintain or improve Class VI land:

1. Seeding grass in drainageways and fencing where continuous grazing will prevent establishing grass stands.
2. Introducing desirable grasses and legumes.
3. Arranging intensity of grazing and time of use to leave a protective cover of grass at the end of the growing season.
4. Adjusting grazing periods to permit natural reseeding of desirable species of grass and to allow plants to store food reserves.
5. Arranging water supply and location of salting stations to guarantee uniform grazing over entire pasture.

Class VII land has very severe limitations that make it unsuited for cultivation and that restrict its use largely to grazing, woodland, or wildlife.

The physical conditions or limitations of soils in Class VII consist of one or more of the following: very steep slopes; erosion; shallow or very shallow soil; stones; salts or alkali.

This land usually has a sparse growth of vegetation and requires very severe restrictions in use.

Class VIII land consists of landforms that have conditions that severely limit their use for commercial plant production and restrict their use to wildlife, recreation, water supply or aesthetic purposes. It includes badlands, rock outcrops, sandy beaches, river wash, marshes and other nearly barren lands.

Land Treatment

After examining and determining the physical features of the soil profile, one can determine the land capability class. The land capability class indicates the most intensive agricultural use for which it is suited. Part 2 of your scorecard contains a some of the common land treatments used in Nebraska. *From the listed land treatments, choose the proper conservation practices that should be used or considered for use to conserve both the soil and water and to maintain or improve the productivity of the land.*

Nebraska has a wide variation in climate and soils. Therefore, recommendations for land treatment may vary across the state.

General Instructions and Interpretations

Contestants are usually familiar with conditions in their own area. However, depending on where contests are held, or in the cases of the state and national contests, some explanation is need to detail those items that may have local variations. These will be given before the judging. The field instructions that are read just before judging each area contains important information concerning the field you will be judging. Listen carefully and make notes you feel you need. You may ask the field instructor to repeat any of the information that was read.

Land Capability Class

PLEASE REFER TO THE MOST UPDATED VERSION OF THE GUIDE FOR APPLYING CONSERVATION TREATMENTS FOR LAND EVALUATION FOR EACH AREA CONTEST.

1. Row crop/occasional soil conserving crop. Cultivation including row crops three-quarters of the time (nine out of 12 years): Use a cropping system of row crop in rotation with stubble (left standing) Use conservation over winter until seedbed preparation.

2. Row crop not more than 2 out of 4 years. Cultivation including row crops half the time (six out of 12 years): Use a conservation cropping system of row crop rotation. With stubble left standing over winter, use a conservation tillage system of 20 percent ground cover after crops are planted.

3. Row crop not more than 2 out of 6 years. Cultivation including row crops one-third of the time (four out of 12 years): Use a conservation system of row crop rotation. With stubble left standing over winter, use a conservation tillage system of 50 percent ground cover after crops are planted.

4. Row crop not more than 1 out of 4 years. Occasional cultivation, including row crops one-quarter of the time (three out of 12 years): Use a conservation cropping system of row crops, close growing crops and meadow crops in a rotation. Maintain a conservation tillage system of 75 percent ground cover after crops are planted.

5. Continuous cultivation, wheat fallow and/or chemical fallow:

6. Permanent vegetation.

7. Use only for wildlife and recreation.

Cropland

8. Practice conservation tillage.

9. Do not burn crop residue; Practice crop residue management.

10. Return Crop residue to the soil. Use of stubble mulch farming system and leaving crop residue on the surface to provide a protective cover.

11. Practice field/contour strip cropping:

12. Plant a field windbreak for wind erosion control:

13. Terrace and farm on contour:

14. Maintain terraces:

15. Establish and maintain grassed waterways or tile outlets.

16. Construct diversion or sediment basin: A diversion or sediment basin is a channel with a supporting ridge on the lower side or a structure that crosses an upland drainage way. It usually has greater horizontal and vertical spacing and is constructed to handle a larger flow of water than normal field terraces. Normally not installed on flood plains.

17. No mechanical treatment needed:

Rangeland – Wildlife

18. Use prescribed burning;

19. Mow or spray for weed control: if invasive or noxious weeds are present.

20. Control brush or trees: This may be accomplished with chemicals and/or use of machinery. Use with Class V, VI, VII land when undesirable brush and trees are a problem. Brush and trees are defined as woody perennials. Woody perennials are not always undesirable. Red cedars, Elm, Russian olive, Salt cedar, sand sagebrush, serviceberry, buckbrush and yucca are common woody plants across Nebraska's range and pastureland. (Salt cedars are always undesirable.) However, cedars, elm, and Russian olive are often present in windbreak plantings. These are desirable instances of these plants. Undesirable instances are where seedlings establish outside a windbreak planting and any one individual tree either gets too large to control by grazing [trunk diameter at 4 foot: greater than 1 inch] or percentage of ground cover [brush and/or trees] is in excess of 10% of the area being judged. In the drier parts of Nebraska (SW-area, West-Area, North Central area) where doughtiness is a constant threat to the range; woody species such as yucca, sand sagebrush, service berry, and even buckbrush become a *desirable* part of the prairie (capturing snow and reducing wind scouring—even preserving remnants of more palatable species during drought within their canopy) where the range is thin due to very steep slopes and or wind erosion.

21. Proper pasture or range management: To encourage the growth of desirable grasses and legumes to crowd out weeds and brush.

22. Establish recommended grasses or grass legume: Poor stand is defined as less than 25% of the ground area is covered by desirable grasses.

23. Defer use until cover is adequate: if grasses are under 6 inches.

24. Use to utilize up to 60 percent of total forage production: if grasses are over 12 inches.

25. Control gullies: Gullies need control if there is enough erosion that some vegetation is missing or head cuts are present. Use one or more conservation practices that will adequately control runoff and erosion

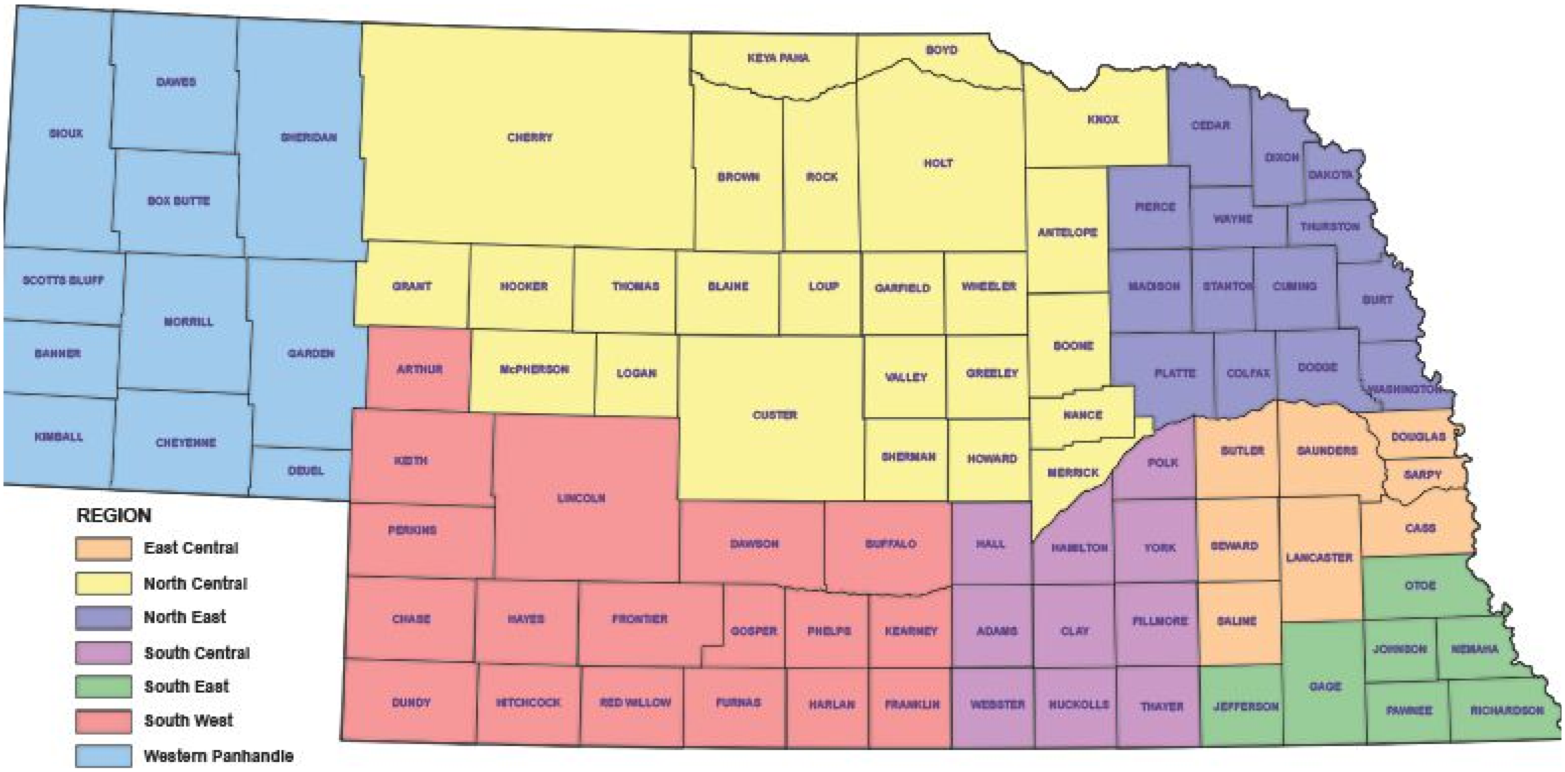
26. Enhance wildlife habitat and recreation.

Present Practices or Cover on the Land

Disregard practices on the land at the time of the contest. Vegetation (ie; weeds, brush and trees) in the judging site are used to judge the practices on class I to VII. For evaluation purposes the whole field that is delineated will be used. If an area is being used for a less intensive use than its potential, it is necessary to remove trees and timber to reach the most intensive use. If terraces are already in place on the field and they would be recommended, then "install terraces" would be checked, even though they already exist.

Land Evaluation Areas in Nebraska

Fig. 7. Land Evaluation Areas in Nebraska



Guide to Terms, Interpretations and Abbreviations

SOIL DEPTH

Very Deep (>60") (historically included in deep)
Deep (40 to 60 in.)
Moderately deep (20 to 40 in.)
Shallow (10 to 20 in.)
Very shallow (0 to 10 in.)

SOIL TEXTURE

Clayey soils — **Fine textured**

- **Clay C**
- **Silty Clay SiC**
- **Sandy Clay SC**

Loamy soils — **Moderately fine textured**

- **Silty Clay loam SiCL**
- **Clay loam CL**
- **Sandy Clay loam SCL**

Medium textured

- **Silt loam SiL**
- **Loam L**
- **Very fine sandy loam VFSL**
- **Silt Si**

Moderately coarse textured

- **Fine sandy loam FSL**
- **Sandy loam SL**
- **Coarse sandy loam COSL**

Sandy soils — **Coarse textured**

- **Loamy very fine sand LVFS**
- **Loamy fine sand LFS**
- **Loamy sand LS**
- **Loamy coarse sand LCOS**
- **Very fine sand VFS**

Very coarse textured

- **Fine sand FS**
- **Sand S**
- **Coarse sand COS**
- **Gravel GR**

Alkali or Saline — **Moderate - drop one land class**
Strong or very strong - Class VI

PERMEABILITY
Very slow (VS)
Slow (S)
Moderate (M)
Moderately rapid (MR)
Rapid (R)
Very rapid (VR)

PONDING SURFACE WATER
occasional ponding (OP)
frequent ponding (FP)
very frequent ponding (VFP)

FLOODING
rare (R)
occasional (OCC)
frequent (FREQ)

DRAINAGE
Very poorly drained (VP)
Poorly drained (P)
Somewhat poorly drained (SP)
Moderately well drained (MW)
Well drained (W)
Somewhat excessively drained (SE)
Excessively drained (E)

EROSION
None or slight - (0 - 25% of surface soil lost)
Moderate - (25 - 75% of surface soil lost)
Severe - (75% or more of surface soil to 25% of subsoil lost)
Very severe - very severely gullied or land destroyed by gullies or blowouts; 75% of surface soil and from 25% to all of subsoil is lost.

Runoff (NRCS Soils Handbook)

N	**Negligible**
VL	**Very Low**
L	**Low**
M	**Medium**
H	**High**
VH	**Very High**

Using the Capability Charts for Land Evaluation in Nebraska

The following is a brief explanation of how to follow through the Capability Charts to arrive at the Land Capability Class. Examples will be developed and added when the review of the charts has been completed.

The Capability Charts are a hierarchical elimination style chart. You start with the proper landscape position as given in the Field Instructions. From there you will eliminate each section as you go and do not return to a previous section once you have passed it.

A. **Check that you have the proper Capability Chart for the area you are evaluating**
   The chart is provided at the contest

B. **Select the landscape position as given in the *field instructions***
   - **a.** Upland and stream terrace
   - **b.** Upland and terrace depressions
   - **c.** Floodplains and sandhill meadows

C. **Select the proper depth of the soil *you determined***
   - a. Deep and very deep
   - b. Moderately deep
   - c. Shallow
   - d. Very shallow

D. **Select the Surface texture *you determined* from the provided sample box**
   - a. As you move down the chart to find the proper texture, you eliminate each section as you pass it by. So if you have a moderately coarse texture you will use the section indicated, or move lower in the chart as you look at the next property.

E. **Select the permeability *you determined,* remember, only go down or across in the chart.**

F. **Select the Drainage, Flooding and Ponding as provided in *the field instructions.***

G. **Select the row with the slope *you determined.***

H. **Select the erosion which *you determined.***

I. **Read the land capability class from the row. Check for any exception statements.**

J. **As a check for the determination, a general description is offered in the last column. *Read through this description.* Compare it to what you have observed in the field and soil pit. If this does not fit what you saw, you may want to go back and try working through the chart again, check your field determinations, or check the information you noted from the field instructions (you can ask the field instructor to repeat the information).**