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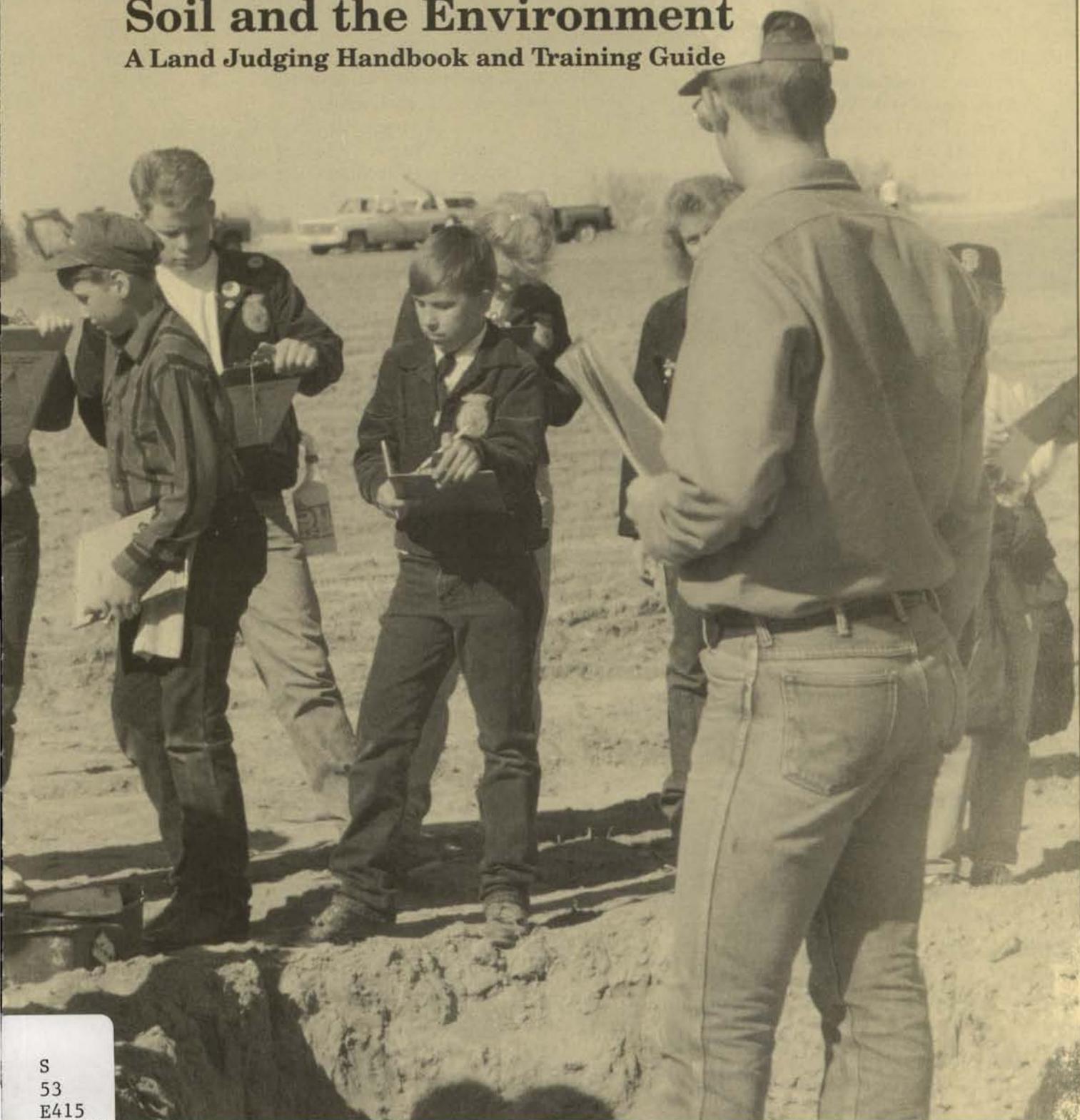
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Soil Ecological System

Soil and the Environment

A Land Judging Handbook and Training Guide



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Preface

The Idaho State Land Judging Contest program is a cooperative effort of many individuals and organizations. The program was initiated in Burley in 1971 when Soil Conservation soil scientist Glen Logan worked with a group of Future Farmers of America at a state contest. He also went with them to Oklahoma City to compete in the national contest. Since that time the program has grown to include nearly 500 FFA and 4-H youth competing each year in contests throughout the state.

The agencies and organizations involved in the Idaho Land Judging program include:

- **University of Idaho Cooperative Extension System** — The Extension soil specialists work to coordinate the overall state program, schedule and organize area contests and the state contest, and maintain the bulletin, *Soil Ecological System: Soil and the Environment, a Land Judging Handbook and Training Guide*. County Extension faculty work with FFA and 4-H leaders and members in preparing and competing in area and state contests. In 1985 an endowment fund (Maynard Fosberg) was established to help support the program financially.

Contributions to the endowment come from individuals and organizations.

- **U.S. Department of Agriculture, Soil Conservation Service** — USDA-SCS soil scientists and soil conservationists work to organize, provide technical support, and conduct the area and state contests.
- **State Vocational Education** — The Idaho Vocational Education Office assists in the development and coordination of area and state contests. Idaho vocational agriculture teachers and FFA state and district organizations support the program.
- **Idaho Association of Soil Conservation Districts** — The Idaho Association of Soil Conservation Districts, IASCD Auxiliary, and individual Soil Conservation Districts each support the program through planning and conducting contests and contributing money to the contests and/or to the Land Judging Endowment. The East and West Cassia Soil Conservation Districts have been major sponsors of the state contest in Burley for many years.

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Soil Ecological System

Soil and the Environment

A Land Judging Handbook and Training Guide

T. A. Tindall, P. A. McDaniel, A. L. Falen, and M. A. Fosberg

Introduction

Idaho has approximately 53 million acres of land area. Only about 10 percent of the entire area is suitable for crop production. All soil and land, including that suitable for cultivation, is subject to one or more natural limitations such as adverse soil texture or permeability, erosion hazard, wetness, restricted rooting depth and climate. Climatic factors are important in Idaho because some areas lack sufficient natural precipitation (mostly southern Idaho) and some areas, because of elevation and latitude (eastern Idaho and portions of northern Idaho), lack sufficient heat unit input for good crop production.

Soil may be defined as a natural body developed from a mixture of broken and weathered mineral material (rocks) and decaying organic material (remains of living organisms). Soil covers the earth in a relatively thin layer. It supplies air, water, and nutrients for plant growth. Soil also provides mechanical support for plants, buildings, and other types of construction.

Plants and animals derive support and nutrients directly or indirectly from the soil. As plants and animals live and die, their waste products and remains are returned to the earth to form the organic fraction of the soil. Development of 1 inch of "soil" may require many hundreds of years under natural conditions.

Soils differ in their potential to produce food and fiber and in their usefulness for construction sites and other nonagricultural uses. These differences are contained in the soil profile with specific characteristics indicated in each soil horizon. The best use and management of any given plot of land is based upon characteristics of the soil comprising that plot of land. Knowledge of soil characteristics is necessary to determine potential land value, select adapted crops, recommend proper management, and determine necessary conservation measures to ensure proper land use.

Based on soil characteristics and potential management problems, soils are grouped into eight land capability classes. These eight land capability classes are used by many agricultural workers and others to plan and practice wise use of the land.

Soil engineering properties and interpretations may also be determined using the soil characteristics and potential problems as a basis. These properties and interpretations may be used for selecting suitable sites for building houses and septic tank drainage systems, locating roads and streets, planning parks and playground areas, and many other construction uses of soil.

What Is Land Judging?

Land judging is a contest designed to "judge" a soil or set of soils. The purpose of land judging is to teach an individual to recognize soil factors and to evaluate soil characteristics. This will allow the individual to make wise decisions in managing and using the soil or the land. Wise decisions in land use will help conserve Idaho's most valuable natural resource — our soils. Land judging can help individuals understand:

1. Basic soil differences.
2. How physical and chemical soil properties affect crop growth.
3. Why different soils respond differently to management practices.
4. The influence of land topographic features on production, land protection, geology, and native vegetation.
5. Soil and water conservation practices.
6. Proper land use and treatment.
7. How soil properties may be used as a basis for making a better selection of homesites.

Organization

The Idaho Land Judging Program includes five or six area contests and a state contest. The state contest is restricted to FFA and 4-H teams or individual contestants in open class that have competed and won at area contests.

State Contest

The state contest is held in October each year. The site and date of the state contest is determined by the State Land Judging Committee.

At least two FFA teams from each FFA district and two 4-H teams from each area contest is eligible to compete in the state contest. If more than 10 FFA teams from any single FFA district compete in an area contest, that district may send three teams to the state contest. The teams in the state contest, both FFA and 4-H, include not less than three nor more than five members, with no alternates.

The State Land Judging Committee includes a University of Idaho Extension soil specialist as chair, a Soil Conservation Service (SCS) soil scientist from the state office, SCS area soil scientists, the Idaho State Vo-Ag Director, a representative of the Idaho Association of Soil Conservation Districts (IASCD), the state 4-H director, and others appointed by the chair. Members of the state committee work closely with individuals of the University of Idaho County Extension faculty, SCS, SCD, and FFA responsible for conducting the area and state contests.

Area Contests

The area contests are held in the fall before the state contest. Area contests are held in northern Idaho, southwestern Idaho, southcentral Idaho, and two in southeastern

Idaho. Locations of the area contests are rotated within the region to take advantage of assistance from local representatives of SCS, SCD, Cooperative Extension, FFA, and other organizations.

The number of contestants comprising a team at an area contest shall be a minimum of three, with the maximum to be set by the FFA advisers and others conducting or participating in the contest. The winning teams are determined by totaling the scores of the three highest individuals for each team. There is no limit on the number of alternates (nonteam members) who may participate in the area contests. Official scorers may grade the scorecards of alternates or may leave the grading to advisers and 4-H leaders.

Local or Practice Contests

Local contests may be held for practice. These can be arranged by the team adviser or coach if they feel there is a need. Help in conducting such contests for training team advisers or contestants can be obtained from SCS, SCD, UI, or other soil scientists.

Local advisers should attempt to involve local organizations such as a Chamber of Commerce, Soil Conservation District, and Irrigation District or individuals such as agriculture businessmen. They should be involved in obtaining and presenting awards, supporting banquets, etc.

Setting Up a Contest

1. The date of the contest should be set several weeks or months in advance.
2. Estimate the expected participation, if possible.



Fig. 1. Young land judges determine a soil profile.



Fig. 2. Urban soils are evaluated by FFA'ers.

3. Locate a farm or adjacent farms that have different soil and landscape conditions that can provide a variety of sites for judging.
4. Secure permission from the owner(s) to use the selected site(s).
5. Several days before the contest, select sites and prepare pits or other soil profile exposures. Road cuts, stream banks, and other such soil profile exposures can be used. Make official scorings and evaluations of each site. Prepare extra copies of official scorecards for use by scorers and for pit monitors to use in explaining the scoring to contestants.
6. Obtain scorecards and prepare packets consisting of a practice card, three land judging cards, and one homesite card for each contestant. A tabulating card to serve as a registration card should be prepared for each team.
7. Prepare a few extra packets for alternates or advisers and coaches who wish to compete.
8. Arrange for transportation of contestants to the fields and between sites as necessary. (During the contest allow 15 to 20 minutes at each contest site.)
9. When possible, break contestants into groups so that no two members of the same team are in the same group. Prohibit talking between contestants during judging.
10. Where possible, provide an individual at each contest site to explain special features, answer questions, collect scorecards, and monitor contestants. This individual, or pit monitor, can give the official scoring for the site after the contestants have turned in their scorecards. This will enhance the educational experience.
11. If it has not been done beforehand, select leaders and tabulators (graders) the morning of the contest.
12. Arrange for a place to conduct the grading and designate someone to collect the scorecards as contestants finish the different fields to speed the grading process as much as possible.

How Land Judging Works

A land judging contest is a training method similar to livestock judging, using classes of "fields" instead of classes of animals. These "fields" are evaluated according to established criteria for their suitability and limitations for various uses. The term "field" refers to a plot of land 100 feet square selected from a uniform portion of a farm or other area (Fig. 3). A land judging contest consists of four "fields." The "fields" are evaluated by the contestants using the criteria in this handbook and by entering their evaluations and interpretations on the scorecards.

Only those features within the boundaries of the "fields" will be considered in judging each field with the exception that **surface runoff, flooding hazard, and wetness hazard** are considered in the evaluation of a homesite field. Consideration of features beyond the field boundaries are necessary to properly evaluate the homesite for these factors.

The soil profile is exposed to allow contestants to examine soil depth, topsoil depth, and soil structure. Fig. 4 shows samples of the topsoil and subsoil placed in containers for determination of textures and permeability. The official scoring of the fields is done by an official judge or judges.

Official judges may include one or more soil scientists, agricultural Extension agents, vocational agriculture instructors, soil conservationists, or any other individuals who understand the criteria in the handbook.

The judges set climatic conditions, soil test information and other factors that are not obvious. This information is given on a placard located at each judging site.

A sample placard may look like this:

Field number 1 .	
Original depth of A horizon	22 inches ¹
Present depth of A horizon	10 inches ²
Climate	
Annual precipitation	8 inches
Frost-free days	125
Soil analysis	
pH	7.5
Nitrogen (NO ₃ N ⁻)	30 ppm
Phosphorus (P ₂ O ₅)	9 ppm
Potassium (K ₂ O)	300 ppm
Zinc (Zn)	1.5 ppm
Other factors ³	

¹Since variation will occur from area to area and with judges' interpretation, the original depth given here should be specified as "...depth of **soil** 22 inches," "...depth of **A horizon** 22 inches" or other designation to prevent confusion for contestant.

²If not obvious to contestant, the present depth of the designated portion of the profile zone can also be given and thus only a simple calculation is necessary to determine erosion losses.

³Factors given to contestant where information is not obvious. Examples are irrigation water availability, flooding frequency, water table depth, and manure availability.

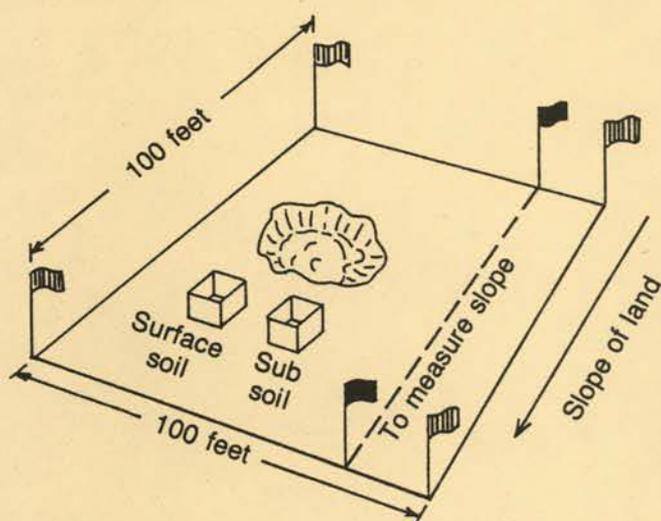


Fig. 3. A uniform area 100 x 100 feet will represent the "field" to be judged. Samples of surface soil and subsoil will be placed in containers for judging. Generally only features occurring within the boundaries of the field will be considered in judging the site.



Fig. 4. Some type of container, such as a plastic pan, will be used at each site to hold samples of surface soil and subsoil material. This ensures that all contestants will be considering the same horizon of the exposed soil profile.

Scoring the Contest

The judges will determine the official scores for each entry on the scorecard. The following is an example of how a field could be scored.

PART I	
Soil and Land Characteristics	
Factors	Points
A. Surface texture	4
B. Subsoil texture	4
C. Subsoil permeability	4
D. Depth of soil	3
E. Slope	3
F. Erosion loss	3
G. Surface runoff	3
H. Drainage	3
I. Climate	3
J. Major factors	<u>10</u> ¹
Total points, Part I	40

PART II	
Land Capability Class and Recommended Land Treatments	
Treatments	Points
K. Land capability class	5
L. Vegetative	13 ¹
M. Mechanical	9 ¹
N. Fertilizer/soil amendment	8 ¹
Total points, Part II	35
Total points, both parts	75

¹One point given for each item (correctly marked or not marked).

Definition of a Team

Four or five contestants normally comprise a team in the **area contest**, although the number can be set higher if desired and additional contestants can compete as alternates. At the state contest, no more than four members are allowed for any competing chapter or club with no alternates. The scores of the high three members make up the team score. A team of only three members is permissible.

In Case of Ties

In case of ties for individual scoring honors, the scores on different parts of the scorecards will be used to break the tie. Starting with the score on Field 1, Part I, the individual having the highest score would be declared the winner. This would be used as a first "tiebreaker." If this does not break the tie, the evaluation will continue to Part II of Field 1 and continue on numerically through Field 2, Part I, and Field 2, Part II, and so on through Field 3.

In case of a tie in a team score (using the top three scores), the score of the fourth individual will be used as the tiebreaker. If a team having only three members is tied with a team having four members, a composite score from the top three team members will be used in a manner similar to that used to break a tie for individuals.

Learning More About Soils

The primary purpose of the Land Judging Contest is to provide an educational experience to youth in the area of soil science. This is done through understanding the criteria and principles involved in competing in the contest. It is enhanced by having the official placing explained at the conclusion of competition at each field. Added teaching can come by allowing contestants to trade cards and grade the cards in the field. Each placing and factor can be discussed at this time.

Study of Soils

Since many vocational agriculture teachers use this handbook as a text for teaching soils to their students, this section has been added to make a more complete text. Much of this information is not necessary to the actual land judging contest, but it can enhance the understanding of basic soils information.

Much information can be obtained from the study of soils. One of the better definitions of "soil" indicates some of the important aspects of this valuable resource.

SOIL: A living, dynamic system at the interface between air and rock. Soil forms in response to forces of climate and organisms that act on parent material in a specific landscape over a long period of time.

This definition is especially good because each key word says something important about the soil. Why living? Because the soil is full of living organisms: roots large and small, animals and insects, millions of microscopic fungi and bacteria, etc.

Equally important are the decaying remains of dead plants and animals. They form soil organic matter, or humus, which is vitally important for good soil tilth and productivity.

Dynamic says that the soil is constantly changing. Idaho soils change from very wet and cold in the winter to very dry and hot in the summer. Even under irrigation, the amount of water in the soil and soil temperature can vary widely.

Soil organic matter and nutrients increase when crop residues are worked into the soil, and decrease as fresh plant materials decay. Soil nutrients increase as soil minerals break down and decrease as water moving through the soil carries certain nutrients away. Even soil acidity or alkalinity (soil pH) changes seasonally.

The word **system** says that all parts of the soil work together to make up the dynamic whole. A change in one part may cause changes in many other parts.

Suppose, for example, we add water until the soil is very wet. That reduces the amount of air available to plant roots. It makes the soil colder, and the activity of roots and soil microbes (very small plants and animals) slows down. The wet soil is sticky and cannot bear as much weight as when it is dry.

When the excess water is removed by drainage, the whole system changes to a warmer and drier soil. This is better for plant growth, and the soil is easier for farmers to till and plant.

The word **interface** stresses the idea that soil is indeed a very thin "skin" at the earth's surface. When air meets rock, especially if the air is warm and the rock is moist, the rock begins to change. Some changes are **physical**. Physical changes are obvious when rocks are broken down into

smaller pieces. Other changes are **chemical**. Chemical changes can destroy some of the original minerals and create new ones.

These physical and chemical changes are called **weathering**. Weathering occurs only in the first few feet of the earth's surface. Examples of strongly weathered soils can be found in the Idaho Soils Atlas. Soil 26 is a remnant of a highly weathered soil that has been nearly lost by erosion. Soil 51 is also a highly weathered soil that has developed in volcanic ash material.

Now consider the size of the earth. The distance from the surface to the center of the earth is about 4,000 miles. Thus, 10 feet of weathered rock out of 4,000 miles is something less than .00005 percent. Soil does indeed occur at the point of contact between earth and atmosphere!

Factors of Soil Formation

The rest of the key words in this definition of soil tell something about how soil forms. There are five **soil-formation factors**. Two of these factors — climate and organisms — are called **active** factors. They provide the forces that cause soil to form. The other three — parent material, topography, and time — are called **passive** factors. They respond to the forces exerted by climate and organisms.

Together, the interactions between the forces (active factors) and the responses (passive factors) result in a new product, a unique natural resource, called soil.

Climate

Climate affects soil most directly through temperature and precipitation. In warm, moist climates, rocks and minerals weather very quickly. The soil that forms often has a reddish color. This reddish color is due to the iron that iron takes in the weathering process.

High precipitation or irrigation also causes **leaching** — the removal of soil materials (including chemicals and nutrients) by water flowing through the soil. Free lime is completely leached from most northern Idaho soils. These soils are acid (pH less than 7.0). Free lime is still present in most southern Idaho soils because precipitation is needed to move this relatively insoluble material out of the soil. Leaching also moves $\text{NO}_3\text{-N}$ out of the soil system and may contribute to degradation of groundwater quality.

Warm, moist climates encourage lush plant growth, which means large amounts of soil organic matter. The opposite is true in hot, dry climates. Soils in northern Idaho are generally dark-colored because they have a high content of organic matter. Soils in southern Idaho are generally light-colored because they have little organic matter.

Organisms

Organisms come in several different forms and types: large plants, large animals, and tiny plants and animals (microorganisms). Roots of large plants help break apart

rocks and mix soil materials. Root channels provide pathways for water and air movement through the soil. When plants die, the above-ground plant parts decay, thereby building up the organic matter in the soil.

Microscopic organisms, or **microorganisms**, are an extremely important part of the soil. They are the primary decomposers of organic material added to the soil. They change raw plant material into a complex, black substance called "humus." At the same time they release nitrogen from proteins in the organic material. Nitrogen is an essential nutrient that plants need in large quantities. Thus, rich, fertile topsoils are rich and fertile because they are well supplied with humus. Some soils are composed almost entirely of organic material. Even the earthy smell of moist, rich topsoil is caused by a microorganism.

Microorganisms and the humus they produce also act as a kind of glue to hold soil particles together in clumps or "aggregates." Well-aggregated soil is ideal for providing the right combination of air and water to plant roots.

Without microorganisms, therefore, soil would be a virtually inert (lifeless) body. With microbes, soil is truly a living, dynamic system.

Animals, including large burrowing animals, small earthworms, and insects, are important because they help mix the soil. Undoubtedly man is the most important human animal influencing soil development in areas where he tills and manages the soil. Mixing by animals carries raw plant debris from the soil surface down into the topsoil. Only then can the microorganisms do their job of changing plant material to humus.

Parent Material

Parent material is the original geologic material that has been changed into the existing soil. Parent material is passive because it simply responds to the changes brought about by weathering and biological activity.

Parent materials can be a bedrock (residuum) like sandstone, basalt, or granite. Other parent materials are transported deposits of sediments carried by water, wind, or ice. Volcanic ash, lake-laid silts, stream deposits, loessal silts, dune sand, glacial till, and glacial gravels are all examples of transported parent materials.

Time

Time from the standpoint of soil formation may be measured in centuries rather than years. The years of man's lifetime are rather brief when compared to the age of soil. Many soils are thousands and even tens of thousands of years old. Time is the great equalizer. Young soils inherit the properties of their parent materials. They tend to have the same color, texture, and chemical composition as their parent materials. The older the soil the less impact parent material has on soil characteristics.

As soils age, many original minerals are destroyed. Many new ones are formed. Soils become more leached, more acid, and more clayey with advancing age. In short, the soil becomes more strongly developed with the passage of time.

Topography

Topography, or landscape position, causes localized changes in such factors as parent material, moisture, and temperature. When rain falls on a hillslope, for example, water runs away from the top of the hill. Excess water collects at the bottom of the hill. The drier soils at the top are quite different from the wetter soils at the bottom, even though both soils formed under the same overall conditions of climate, organisms, parent material, and time.

Another effect of topography is due to the direction that a slope faces. Soils on north-facing slopes, for example, tend to be cooler and wetter than soils on south-facing slopes. The drier and warmer south-facing slopes usually produce less vegetation and thus have lower organic matter content and are more subject to erosion.

Soil Profile

A soil has unique and distinctive layers called soil horizons. The various horizons or sequence of horizons make up a soil profile. The soil profile developed is the result of the interaction of the five soil-forming factors. The soil profile is usually not over 5 feet thick as this is usually as deep as weathering processes go. Further discussion on horizons follows in a later section.

Processes of Soil Formation

The definition of soil has identified five **factors** of soil formation. We can also think in terms of four major **processes** that change parent material into life-sustaining soil. They are **additions, losses, translocations, and transformations.**

Additions

The most obvious addition of materials to the soil is the addition of organic matter. As soon as plant life begins to grow in fresh parent material, organic matter begins to accumulate. Organic matter gives a black or dark brown color to surface soils. Therefore, even very young soils often have a dark-colored surface layer.

Other additions come with precipitation. On the average, precipitation adds about 5 pounds of nitrogen each year to every acre of soil. Precipitation can also be acid, as it dissolves various natural or man-made chemicals. Precipitation, by causing soils to erode and rivers to flood, is responsible for the addition of new sediments to the soil at the bottoms of slopes and on stream floodplains.

Losses

Most losses occur by leaching. Water moving through the soil dissolves certain minerals and carries them out of the soil profile. Some minerals or salts are readily soluble and are completely removed from the profile even in areas of relatively low precipitation. Other minerals, such as lime, are only slightly soluble, so moderate to high amounts of precipitation are necessary to remove them completely from the profile. Man's influence can be a big factor as his use of irrigation can change a sparsely vegetated and low-

producing desert (with 8 to 10 inches of annual precipitation) to a lush-growing, highly productive cropland when 24 to 36 inches of irrigation water are applied each summer.

Many fertilizers, especially nitrogen and sulfur fertilizers, are highly soluble in water. They, too, are readily lost by leaching, either by natural rainfall or from irrigation water. These materials can also drastically alter chemical properties of soils by altering soil pH (increasing acidity).

Other minerals, such as iron and aluminum oxides and silica grains, dissolve very slowly. These minerals remain in very old and highly weathered soils.

Losses also occur as gases or solids. Oxygen and water vapor are lost from soil as fresh organic matter decays. When soils are very wet, nitrogen can be changed to a gas and lost to the atmosphere. Solids are lost by erosion that removes mineral soil particles and organic materials as well as dissolved and undissolved salts. Such losses are very serious, for the soil lost by erosion is usually the most productive part of the soil profile. Erosion losses also reduce the thickness or depth of the profile.

Translocations

Translocation means movement from one place to another. Usually we think of movement out of a horizon near the soil surface and into another horizon that is deeper in the soil.

In low rainfall areas, leaching often is incomplete. Water starts moving down through the soil profile, dissolving soluble minerals (salts) as it goes. But there isn't enough water to move the minerals all the way through the soil profile. When the water stops moving, due to surface evaporation losses or plant use, salts are left behind. That is how subsoil accumulations of free lime are formed. These layers are often referred to as caliche layer in southern Idaho. When these layers become cemented with lime and/or silica, they are hardpans or duripans. Hardpans are often similar to concrete, limiting the useful depth of the soil.

Upward translocation is also possible. Even in the dry areas of southern Idaho, some soils have high water tables. This means that plant roots are adversely affected by the water in the profile, and only certain plants will grow. In some cases the water may be at the surface for extended periods of time, creating a "marsh" or "swamp." Evaporation at the surface causes water to move upward continually. Salts are dissolved on the way up through the profile and are left behind as the water evaporates. Salty soils are difficult to manage and are usually not productive.

Another kind of translocation involves extremely fine sized (less than 0.002 mm) clay particles. Water moving through the soil can physically carry these particles from one horizon to another, or from place to place within a horizon. When the water stops moving, the clay particles are deposited on the surface of soil aggregates. These coatings of clay particles are called **clay skins**. Clay skins have a dark, waxy appearance.

Transformations

Transformations are changes that take place in the soil. Microorganisms that live in the soil feed on fresh organic matter and change it into humus. Chemical weathering changes the original minerals of the parent materials. Some minerals may be destroyed completely while others are changed into new minerals. Many of the clay particles in soils are actually new minerals that form during soil development.

Still other transformations change the form of certain elements. Highly oxidized forms of iron (iron oxides) usually give soils a yellowish-brown or reddish-brown color. In water-logged soils, however, iron oxides become **reduced**. The reduced forms of iron give soils bluish, greenish, or grayish colors. Reduced forms of iron are quite easily lost from the soil through leaching.

Repeated cycles of wetting and drying create a multi-colored soil material or "mottling." Part of the soil is grayish because of the loss of iron, and part where the iron oxides are not reduced remains yellow-brown. Mottling is an important clue when identifying soils on associated riparian zones, which occur along streams, ponds, or other areas of free or unbound water.

Rock to Soil

How do all these processes work together to form soil? Let's start with a fresh parent material. Climate starts acting on it immediately. Weathering begins to change minerals. Leaching removes the more soluble salts, then the less soluble free lime. As soon as plants begin growing in the soil, they add organic matter and organic acids. Biological activity increases, and humus forms. After several years a dark-colored surface horizon is present.

Weathering and leaching continue to change soil minerals and remove soluble components. More horizons develop beneath the surface. The soil becomes more acid. Clay minerals begin to form. Clay is translocated and clay skins become evident.

As the amount of clay in subsoil horizons increases, the rate of water movement through the soil decreases. Weathering continues but leaching is not as rapid. As time progresses, further change is very slow, and the soil-plant-landscape system is in a relatively stable condition.

Kinds of Soil Horizons

A soil horizon is a layer of soil usually lying parallel to the surface. It has a unique set of physical, chemical, and biological properties. The properties of soil horizons are the results of soil forming processes. These properties distinguish each horizon from adjacent horizons.

Soil horizons are named using combinations of letters and numbers. Six general kinds of horizons may occur in soil profiles (Fig. 5). These general kinds of horizons, called master horizons, are named with capital letters: O, A, E, B, C, and R.



- O** Litter layer
- A** Mineral surface horizon, dark colored, granular structure
- E** Strongly leached horizon, light-colored, platy structure
- B** Subsoil horizon of maximum development, "brown," blocky structure
- C** Weathered "parent material," "brown," massive structure
- R** Hard bedrock

Fig. 5. Schematic of theoretical soil profile showing the six master horizons. Rarely do national soils contain all six of these master horizons.

Gradual changes from one master horizon to another give rise to transition horizons. These are named with two letters (for example, AB, BA, BC). Special kinds of master horizons are named by adding lower-case letters (for example, Ap, Bt, Cr). Thick horizons may be subdivided using Arabic numbers, as in A1, A2, or Bw1, Bw2, Bw3.

A single soil profile probably never has all the master horizons. Most Idaho soils have A, B, C and one or two transition horizons. Other Idaho soils may have an A horizon resting directly on a C horizon, or an A-E-B-C horizon sequence or even an O-E-B-C sequence.

Because all six master horizons occur somewhere in Idaho, students need to recognize each horizon and understand how it differs from the others.

Master Horizons

Each master horizon has a distinct set of properties. These properties are summarized in the following section.

O Horizon

An O horizon is composed of organic material. It does not have to be 100 percent organic material, but most are nearly so. Forest soils usually have thin organic horizons at the surface. They consist of leaves, twigs, and other plant materials in various stages of decay. Wet soils in bogs or drained swamps often have only O horizons.

A Horizon

The A horizon is the surface horizon of a mineral soil. The unique characteristic of an A horizon is the dark color which is due to the humus content. Granular structure (small rounded aggregates) and ease of crushing are also typical.

The thickness of A horizons ranges from a few inches in low precipitation (desert) rangeland soils to 20 inches or more in the Palouse area of northern Idaho. Steeper slopes have less of an A horizon than lower areas or areas of accumulations.

The A horizons are extremely important in maintaining soil fertility and providing a favorable environment for root growth. They should be protected from damage by erosion or compaction. The A horizons are usually the horizons referred to as "topsoil." Topsoil is a less definitive term. It is usually the surface 6 to 12 inches of the profile and may actually include no A horizon, as in the case of severely eroded or scraped areas.

E Horizon

This horizon has a light gray or whitish color. It is present only in areas of relatively high precipitation. It usually occurs immediately beneath an O or an A horizon or immediately above a very slowly permeable horizon.

E horizons are light-colored because nearly all the iron and organic matter has been removed. Remember the E as meaning exit or leaching.

B Horizon

The B horizon is the subsoil layer that changes the most because of the soil-forming processes. Several kinds of changes are possible.

In some soils, the B horizon has the brightest yellowish-brown or reddish-brown color. In others, it has the most evident blocky or prismatic structure. Many B horizons have more clay than any other horizons in the profile and show evidence of clay skins. Each of these major kinds of B horizons is discussed more fully in the next section, "Special Kinds of A, B, and C Horizons."

The B horizons are part of the subsoil. In cases where the A horizons have been completely lost by erosion or other man-caused reason, the B horizon may be at the surface and thus constitutes the "topsoil."

C Horizon

The C horizon is weathered geologic or parent material below the A or B horizon. Any material that can be dug with a shovel but which has not been changed appreciably by soil forming processes is considered C horizon. The C horizon is also considered part of the subsoil.

R Horizon

The R horizon designation is used for bedrock. Bedrock is relatively unweathered rock material. Depending on the depth to bedrock, the R horizon may occur directly beneath any of the other master horizons.

Special Kinds of A, B, and C Horizons

Many horizons are the result of unique processes that leave a distinct mark on the horizon. These horizons are identified with a lower-case letter immediately following the master horizon symbol. More than 25 letters and combinations of letters are possible. This discussion will only cover the most common symbols used in Idaho.

Ap Horizon

The surface horizon of any soil that has been plowed or cultivated is called the plow layer. This is designated with the small letter p. Cultivation thoroughly mixes the upper 8 to 12 inches of the soil and destroys any natural horizons that may have been present.

If the original A horizon was very thick (more than 8 to 12 inches), plowing converts the upper part of the horizon into an Ap horizon, and the lower part remains an A horizon. If the original A horizon was very thin, the Ap could rest on a B, C, or transition horizon. In areas where the A horizon was less than plow depth, the term "topsoil" will be synonymous with Ap horizon.

Even when a soil has been so severely eroded that all the original A is gone, plowing an exposed B or C horizon would automatically make the surface horizon an Ap.

Bt Horizon

The t designation indicates that the B horizon has been enriched with clay and is a "textural" B horizon. Textural B horizons have distinctly more clay than the horizons above or below. The "feel" method of texture determination should show this difference.

Some of the clay comes from the horizons above the Bt horizon. Water moving down through the soil carries with it some very fine clay particles. When the downward movement stops, the clays are deposited, building up the waxy coatings of clay skins. Some of the clay may also come from the weathering of original minerals in the Bt. The Bt horizons are quite common in soils of high precipitation. They usually have well developed blocky or prismatic structure.

Bg Horizon

The g designation indicates that a horizon is strongly gleyed. Gleying occurs when iron in the soil is chemically reduced, and much of it has been leached out of the soil. As a result, gleyed horizons are usually dark gray, bluish, or greenish in color. They may also be mottled.

Gleyed horizons indicate that the soil is poorly or very poorly drained for long periods of time each year. Gleying is not restricted to the Bg; other gleyed horizons include Ag, BA_g, BC_g, and C_g. These horizons are associated with wetlands and may be restricted from being drained.

Bs Horizon

The s designation indicates a distinctive, bright yellowish-brown or reddish-brown color that fades with depth. The Bs horizon forms when iron, aluminum, and organic

matter all are leached out of surface horizons, carried downward, and deposited in the subsoil.

Bw Horizon

The w reflects a weathered horizon. The Bw horizons have been changed by weathering, but not enough to form a Bt, B_g, or B_s. The Bw horizon differs from the C horizons by having weak or moderate blocky structure. The Bw may also have a brighter color and be more leached than the C horizon. The Bw horizons are common in soils of moderate precipitation or in young soils in high precipitation areas.

Bx Horizon

This designation reflects a special feature called a **fragipan**. A fragipan is a massive, dense soil horizon that is not sufficiently cemented to be called a hardpan. The fragipan is often mottled and has streaks of gray silt scattered throughout. It is often overlain by an E horizon. The fragipan is so dense that neither plant roots nor water can penetrate, except in cracks or root channels. Soils with these horizons occur primarily in high precipitation areas under timber.

Bk Horizon

This horizon has an accumulation of calcium or other carbonates, or free lime. Carbonates leached from upper horizons have been redeposited in the Bk horizon. White streaks, seams, or nodules of lime should be evident. These will bubble violently when a drop of hydrochloric acid (HCl) is placed on them.

Some soil parent materials originally contained free lime and would react to the acid. The k is used only to indicate a horizon enriched in carbonates by translocation. A Bk horizon may have an ordinary C horizon beneath that contains only its original amount of lime.

Bkqm Horizon

This horizon is called a hardpan or, in more scientific language, a duripan. It is enriched with silica (q) and calcium carbonate (k) and is strongly cemented (m).

Duripans are common in many soils in southern Idaho. Limited rainfall leaches lime and silica from the upper 10 to 15 inches of the soil profile and redeposits it in the Bkqm horizon. Thin, pinkish coatings may be present on the upper surfaces of duripan fragments. The duripan can be as thin as 1/8 inch but is usually 6 to 10 inches thick. It is so cemented that plant roots cannot penetrate.

A dense mat of roots, spreading horizontally, is a good indicator of a duripan. Sometimes, however, there are fractures in the duripan that will allow some plant roots to find a way down into and through the horizon. If the pan is shallow enough it can be broken by ripping, but this requires heavy equipment.

Cr Horizon

Weathered bedrock, or rock that is soft enough to slice with a knife or a shovel, is designated as a Cr horizon. It is rock material, with evidence of the original rock structure, but it is not hard enough to be designated R.

Transition Horizons

Master horizons rarely change abruptly from one to another. Instead, the changes occur gradually throughout a zone that may be 5 or 10 inches thick. These zones are called transition horizons. Three transition horizons are commonly seen.

AB Horizon

This transition horizon occurs between the A and B horizons. It is dominated by properties of the A horizon, but some of the properties of the B horizon are evident. Dark colors associated with organic matter are fading because organic matter is decreasing. The structure often changes from granular to subangular blocky.

BA Horizon

This horizon also occurs between the A and B horizons, but it has more of the characteristics of the B horizon. Generally, the structure will be the same type as the B horizon, but less strongly expressed. The color may be a little darker than the B horizon, or the clay content may be less than the maximum in the B horizon.

BC Horizon

This is a transition from the B horizon to the C horizon. Properties of the B horizon are dominant, but some influence of the C horizon is evident. Often the clay content will be less than the maximum in the B horizon but more than in the C horizon, or the color will be fading. If the C horizon is massive (no evidence of structure) and the BC horizon has definite evidence of structure, the transitional BC horizon should have larger units and be more weakly expressed than in the B horizon.

Subdivisions of Thick Horizons

Sometimes one or two of the horizons in a soil are so thick that they need to be subdivided. Small changes in

texture, color, or structure are commonly used to make the subdivision.

Subdivisions, or vertical sequences within any single kind of horizon, are always indicated by a number immediately following the letter symbol(s). Here are a few examples of how some thick soil horizons can be subdivided:

Thick A horizon — A1, A2

Thick Bg horizon — Bg1, Bg2

Thick Bt horizon — Bt1, Bt2

Thick Bw horizon — Bw1, Bw2

Thick C horizon — C1, C2

More Than One Kind of Parent Material

Parent material is the geologic materials from which soils form. It may be a river deposit, volcanic ash, clays weathered from rock in place, or one of many other kinds of materials. When all the horizons of a soil have formed in a single kind of parent material, the master horizon designations are simply A, B, C, and R.

Some soils, however, have formed in more than one kind of parent material with one overlying the other. As examples, wind-deposited silts (loess) can be laid down over bedrock; fine alluvium (water-deposited material) over coarse alluvium or over bedrock, and volcanic ash may be deposited on top of glacial deposits.

If soil horizons are developed in more than one parent material, the number 2 is placed in front of the master horizon designation of the second parent material. The geologic material at the surface is always assumed to be the first one, and the number 1 is never used.

A third parent material is designated 3, and so on. Thus a soil developed in silt loam over gravel could have the following set of horizons: A-AB-B-2BC-2C.

Definitions of Terms and Criteria for Land Judging

The following is an interpretation of the terms and criteria used on the land judging scorecard.

Part I. Soil and Land Characteristics

Soil Texture (Surface Soil and Subsoil)

Texture is the proportion of sand-, silt-, and clay-sized soil particles (Fig. 6) making up the soil minerals. (In contests, a sample of soil material taken from the profile will be placed in a container at the contest site to be used for judging textures as in Fig. 4.)

Definition of Terms Used

Depending on how much sand, silt, and clay are present, we give the texture a name like sandy loam, clay loam, or silty clay loam (Fig. 6).

Texture is an important soil property because it is closely related to many aspects of soil behavior. The ease of tilling the soil and the ease of plant root development within the soil are both influenced by soil texture. Texture affects the amounts of air and water a soil will hold and the rate of water movement into and through the soil.

Plant nutrient supplies are also related to soil texture. Tiny silt and clay particles provide more mineral nutrients to plants than large sand grains. Sandy soils can be managed to improve their productivity, but they require more fertilizer and more frequent irrigation than soils with higher amounts of silts and clays.

Sand, silt, and clay are the three size classes of soil particles. Sand particles range in size from 0.05 mm to 2 mm. They are large enough to see each grain with the naked eye, and they feel gritty.

Silt particles cannot be seen without a hand lens or microscope. Silt has a smooth feeling, like flour or corn starch. It is not sticky.

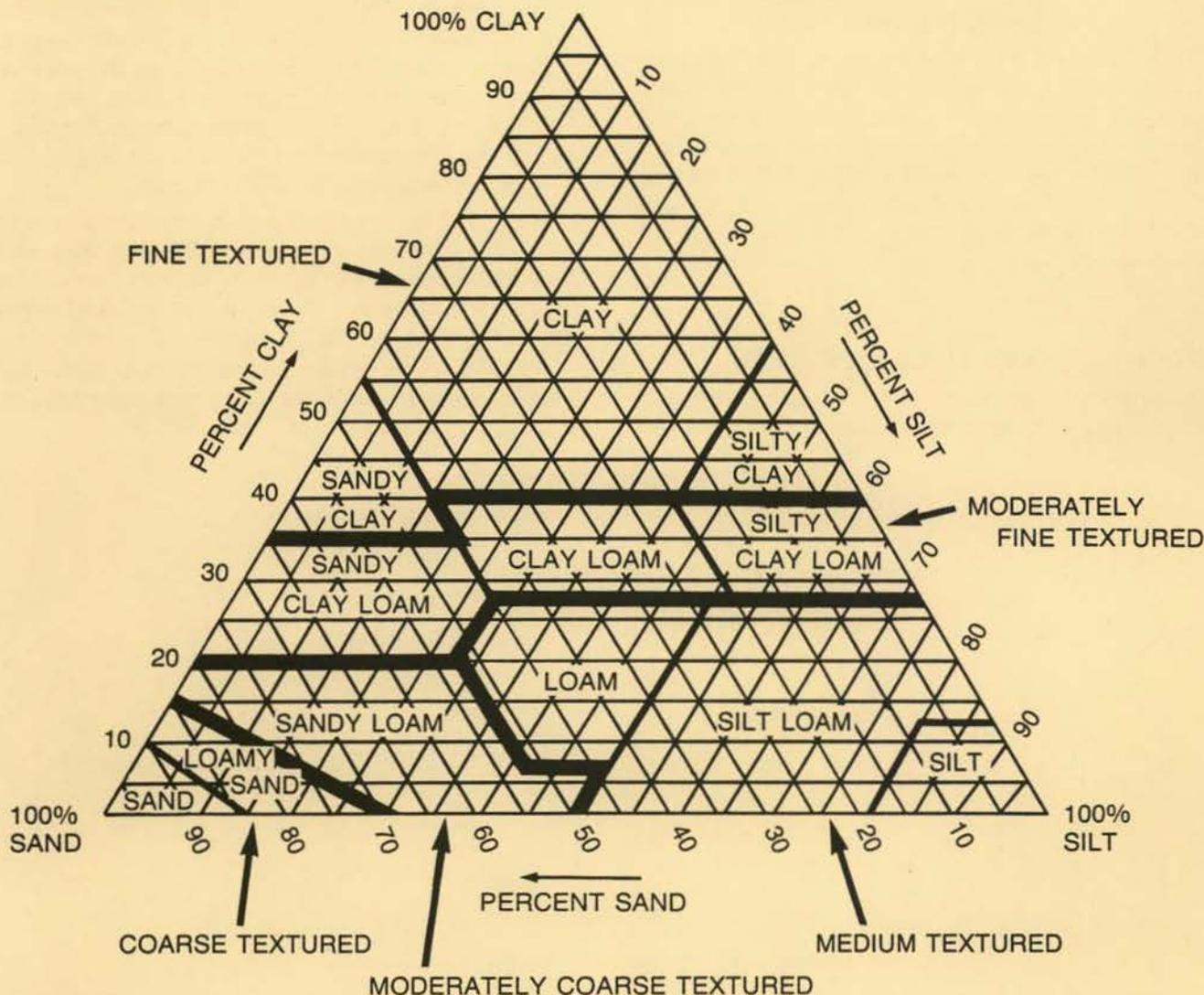


Fig. 6. Soil texture triangle with 12 textural classes. For land judging purposes, the 12 textural classes are grouped into five categories — coarse, moderately coarse, medium, moderately fine, and fine.

Clay particles are less than .002 mm in size. They can be seen only with extremely high-powered microscopes. When wet, clay feels sticky and can be molded into “ribbons” or “wires” or other forms much like modeling clay used in grade school.

Every soil contains a mixture of various amounts of sand, silt, and clay. Since there are three size classes of particles, a three-sided **textural triangle** is used to show all the possible combinations (Fig. 6). We also use the triangle to form groups, or classes, of soil texture, which are identified with a textural class name.

A soil that is primarily sand-sized particles would lie very close to the sand corner of the triangle. Its textural class name would simply be **sand**.

Similarly, a soil dominated by clay would lie near the clay corner of the triangle and is called **clay**.

Now consider a **mixture** of sand, silt, and clay. All three separates are present, though not in exactly equal proportions. (Actually, it takes less clay to balance the mixture than either sand or silt.) These soils lie in the lower center portion of the triangle and are called **loams**.

Now suppose we were to alter a mixture of sand, silt, and clay by adding more sand (Fig. 7). As sand begins to dominate, the texture class moves away from the center of the triangle toward the sand corner. The texture would change from loam to sandy loam and ultimately to a sand.

If we were to add clay to a loam, the textural class will move first to a clay loam, then a clay. If we were to add both silt and clay to a loam, the textural class moves away from the center toward something intermediate between silt and clay. The textural class becomes a silty clay loam.

Precise boundaries between textural classes are shown in Fig. 6. Each side of the triangle is a base line, or zero point, for the particle size in the opposite corner. If we know how much sand, silt, and clay a soil has, we can easily plot its location on the triangle and see which textural class it falls into.

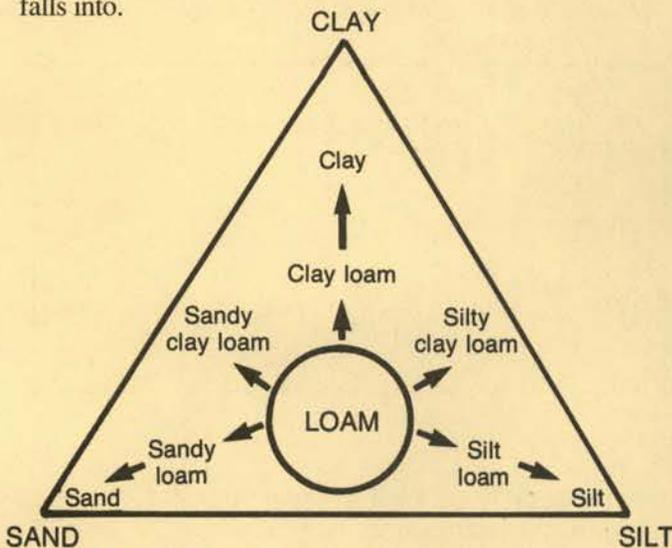


Fig. 7. Generalized texture triangle showing how theoretical additions of sand, clay, and silt move textural classes away from the centrally located loam textural class.

Here's a simple example. Suppose we have a soil that contains 40 percent sand, 45 percent silt, and 15 percent clay. Start with the clay content. Go to the midpoint of the baseline running from sand to silt. Then go vertically up to the third horizontal line. Every soil along this horizontal line contains 15 percent clay.

Next, along with the baseline between silt and sand, locate the 40 percent sand line, which runs diagonally up and to the left. Follow this line up until it intersects the 15 percent clay line. Mark that point.

If you wish, you can find the 45 percent silt line (along the baseline between silt and clay) and follow it diagonally down and to the left to the same point. Note, however, that it only takes **two** points to determine the texture. This sample is a loam.

Field Determination of Texture

Determine soil texture in the field by wetting a table-spoon size portion of soil with water and working the soil between thumb and fingers. The “feel” of the different sized soil particles is used in estimating the amounts of sand, silt, and clay. Estimate sand by the gritty feeling. Estimate clay by the length of the ribbon formed (see Figs. 8, 9, and 10). The procedure for doing this is highlighted on page 16 in the next section, “Texture by Feel.”

Four key points on the textural triangle provide guidelines to classify textures. These include: 27 percent clay, 40 percent clay, 20 percent sand, and 50 percent sand. These points don't exactly match the textural class boundaries on Fig. 6, but they're close enough to make good estimates.

Study the locations of these key values carefully. Note that none of the texture names below 27 percent clay contains the word **clay**. Texture names between 27 and 40 percent clay contain both the words **clay** and **loam**. Textural class names above 40 percent clay contain the word **clay**, but not the word **loam**.

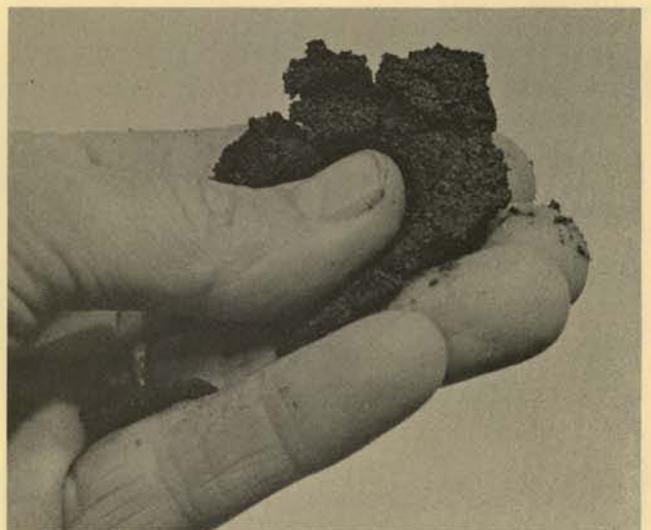


Fig. 8. A sandy loam textured soil, with 73 percent sand, 23 percent silt, and 4 percent clay, forms only a short, easily broken ribbon when squeezed between the thumb and fingers.



Fig. 9. A silty clay loam textured soil, with 3 percent sand, 68 percent silt, and 29 percent clay, forms a smooth ribbon about an inch in length before it breaks off.



Fig. 10. A silty clay textured soil, with 2 percent sand, 54 percent silt, and 44 percent clay, can be squeezed up and between thumb and fingers to form a ribbon 2 to 3 inches long before it breaks.

Similarly, soils having more than 50 percent sand all have names that include the words **sand** or **sandy**. If there is less than 20 percent sand, **silt** or **silty** is usually part of the name. If the soil contains between 20 and 50 percent sand, neither silt nor sand is part of the name.

Other clues to the way each kind of soil texture feels are highlighted in the following section and in Table 1.

Texture by Feel

1. Fill the palm of your hand with dry soil.
2. Moisten the soil enough so that it sticks together and can be worked with the fingers. *Don't saturate it to runny mud.* If the soil sticks to your fingers, it's too wet to feel texture. Add more dry soil.
3. Knead the soil between your thumb and fingers. Take out the pebbles and crush all the soil aggregates. You may need to add a little more water.
4. Continue working the soil until you crush all the aggregates.
5. Estimate the sand content by the amount of textural grittiness you feel.
 - a. More than 50 percent — Sand dominates. The textural name contains the word **sandy**.
 - b. 20 to 50 percent — Sand is noticeably present but not dominant. The texture is most likely **loam** or **clay loam**, though **silt loam** or **clay** are possible.
 - c. Less than 20 percent — Silt and clay dominate. The textural name is **silt loam**, **silty clay loam**, or **clay**.
6. Estimate the clay content by pushing the sample up between your thumb and index finger to form a ribbon.

- a. Less than 27 percent (Fig. 8) — The ribbon is less than 1 inch long. Textural names contain the word **loam** but not the word **clay**.
- b. 27 to 40 percent (Fig. 9) — The ribbon is 1 to 2 or 2 1/2 inches long. Textural names contain both the words **clay** and **loam**.
- c. More than 40 percent (Fig. 10) — Clay dominates. The ribbon is more than 2 1/2 inches long. The textural name contains the word **clay** but not the word **loam**.

7. Combine your estimates of sand and clay.

Clay (%)	Sand (%)		
	>50%	20 to 50%	<20%
>40	Sandy clay	Clay	Clay Silty clay
27 to 40	Sandy clay loam	Clay loam	Silty clay loam
<27	Sandy loam Loamy sand Sand	Loam	Silt loam

Soil scientists recognize 12 soil textural classes (Fig. 6). For the purpose of Land Judging Contests, soils are grouped into five broad textural categories. As you will see later, only three categories are used in the home site evaluation. The moderately coarse, medium, and moderately fine soils are combined into the loamy textured category.

1. Coarse-textured soils	Sands Loamy sands
2. Moderately coarse-textured soils	Sandy loam Fine sandy loam Very fine sandy loam
3. Medium-textured soils	Loam Silt loam Silt
4. Moderately fine-textured soils	Clay loam Sandy clay loam Silty clay loam
5. Fine-textured soils	Sandy clay Silty clay Clay

Permeability

Soil permeability is the ability of the soil to transmit water or air. Soils are placed into relative permeability classes based on soil texture and degree of cementation found in the horizon and based on the most limiting of these properties. Soil structure (see Fig. 11 and Table 1), bulk density (relationship between air and mineral volume),

organic matter content, and other characteristics relating to pore space are also considered to a lesser extent. As the soil compaction increases, bulk density increases. Water infiltration, a term used to express the rate of water movement into a soil's surface, is related to soil permeability. Low infiltration rate of a soil, accompanied by low permeability subsoil horizon(s), may result in water runoff, erosion, and limited root development.

Soil Structure

Soil structure forms when individual grains of sand, silt, and clay are bound together in larger units called **peds** or **aggregates**. Plant roots, soil organic matter, and clay particles all provide physical and chemical binding agents. The shape of the peds formed determines the type of structure. The extent of ped formation and how distinctly the peds can be recognized together determine the **grade** of the structure.

Soil structure is important because it modifies some of the undesirable effects of texture on soil behavior. Strong granular structure creates relatively large pores that favor water entry into the soil and water movement within the soil. Even clayey soils, which tend to have very small pores, can have good rates of water movement if they have strong granular structure.

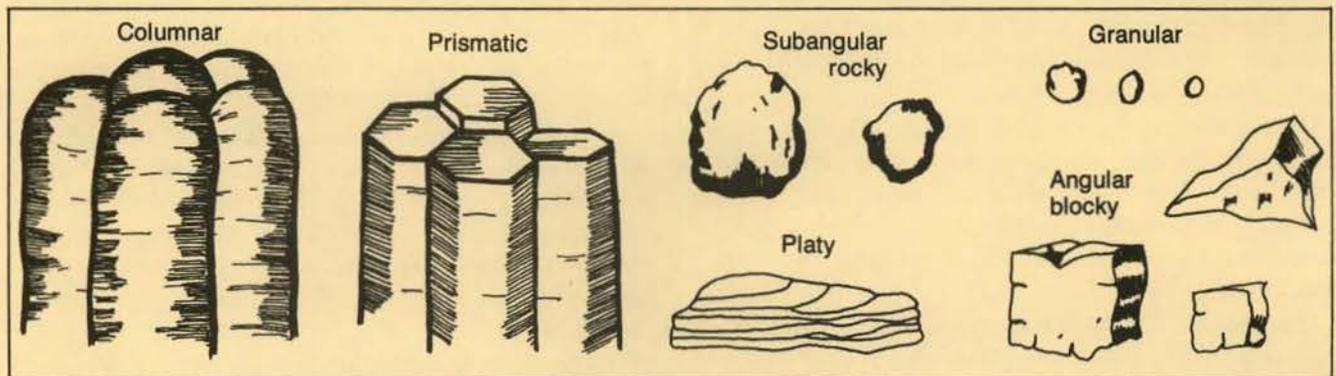


Fig. 11. Diagrammatic representations of various soil structure types.

Table 1. Structural and textural characteristics commonly associated with each of the classes of permeability.

Permeability class	Soil characteristics	Type of structure	Texture class
1. Rapid over 6.0 inches/hr	Many large pores, no hardpan, low percentage of silt, very small amount of "sticky" clays	Subangular blocky, single grain	Loamy sand, sand
2. Moderate 0.2 to 6.0 inches/hr	High percentage of silt, weakly cemented hardpan, moderate amount of "sticky" clays	Prismatic, platy, angular and subangular blocky, granular	Silt, silt loam, loam, sandy clay loam, sandy loam
3. Slow 0.06 to 0.2 inch/hr	High bulk density, few pores, high amount of "sticky" clays	Prismatic, platy, angular blocky	Silty clay loam, clay loam, sandy clay
4. Very slow less than 0.06 inch/hr	Cemented hardpan, high bulk density, few pores, very high amount of "sticky" clay	Massive, columnar angular blocky	Clay, silty clay

Good granular soil structure also means good aeration and a favorable balance between pores that contain air and pores that store water for plant use. Soils with good structure are easy to work and provide ideal environments for plant root growth. In short, good structure means good tilth.

Organic matter is vital to the formation and maintenance of good soil structure. The horizon of northern Idaho soils are naturally high in organic matter. Soil structure in these horizons tends to be well-developed, and peds resist breakdown from tillage and raindrop impact.

The horizons of southern Idaho soils are naturally low in organic matter. Soil structure tends to be weakly formed and unstable. These soils have slower entry of water (infiltration) and have a higher erosion hazard.

Keeping up the organic matter level is essential if you want to maintain good soil structure. Incorporation of animal wastes and crop residues into the soil is an excellent way to increase soil tilth. One of the real benefits of conservation tillage programs is that crop residues are used to form stable soil structure. You can determine both the type and the grade of soil structure by carefully observing the soil and by gently breaking it apart. The first step is to examine the subsoil sample in the container to see if structural peds are evident. If you can detect the shapes of individual peds, then the grade is probably strong.

The next step is to fill your hand with a large chunk of soil. Observe how easily the soil breaks and falls apart. The easier it breaks, the stronger the structure. Observe also the shapes of the peds that lie in your hand.

Then hold a large piece of the soil in both hands and gently apply pressure to break the soil apart. If the soil breaks easily along a natural plane of weakness, you've separated it into distinct peds. If the soil fractures randomly leaving an irregular, dull surface, you've simply forced a break through a ped.

The ease with which the soil mass breaks into peds and the amount of unaggregated soil that remains in your hand together indicate the structural grade. The shapes of the peds you broke out of the soil indicate the structural type.

Common types (or shapes) of soil structure include **granular**, **platy**, **blocky**, and **prismatic** (Fig. 11). Soils

lacking peds are said to be either **massive** or **single grain** and represent the lack of structure.

Soil Depth

The depth of the soil includes the total thickness of the soil horizons readily penetrated by plant roots, water and air. A restrictive layer may be dense clay (if it restricts roots), hardpan, or bedrock. Water, however, is not a restrictive layer.

1. **Very Shallow** — Soils less than 10 inches deep.
2. **Shallow** — Soils 10 to 20 inches deep.
3. **Moderately Deep** — Soils 20 to 40 inches deep.
4. **Deep** — Soils 40 to 60 inches deep.
5. **Very Deep** — Soils over 60 inches deep.

Slope

Slope, given in percent, is the number of feet of rise (or fall) in 100 feet of horizontal distance (**run**). This is one of the most important factors to be considered in good land management. Runoff increases with slope, which contributes to an increase in the erosion hazard for most uses of the land.

Slope can be measured by several methods. A transit or other surveying instrument gives the most precise measurement. Hand-held devices such as a clinometer or an Abney level are faster and usually precise enough for most purposes. Contestants and advisers should practice with a clinometer before the contest.

Slope-measuring devices of any kind are not permitted in a contest. The slope must be estimated by visual observation. This may be difficult, especially in areas of rolling topography. Looking up a slope or down a slope can sometimes create an illusion of excess steepness or lack of steepness.

To estimate a slope (Fig. 12), stand at one end of the slope line (Point A) and project a horizontal line to the other end of the slope line (Point B). The theoretical horizontal line can be determined with the aid of the horizon or by selecting a distant point on the horizon that appears to be at an equal elevation. Estimate the distance from the top of

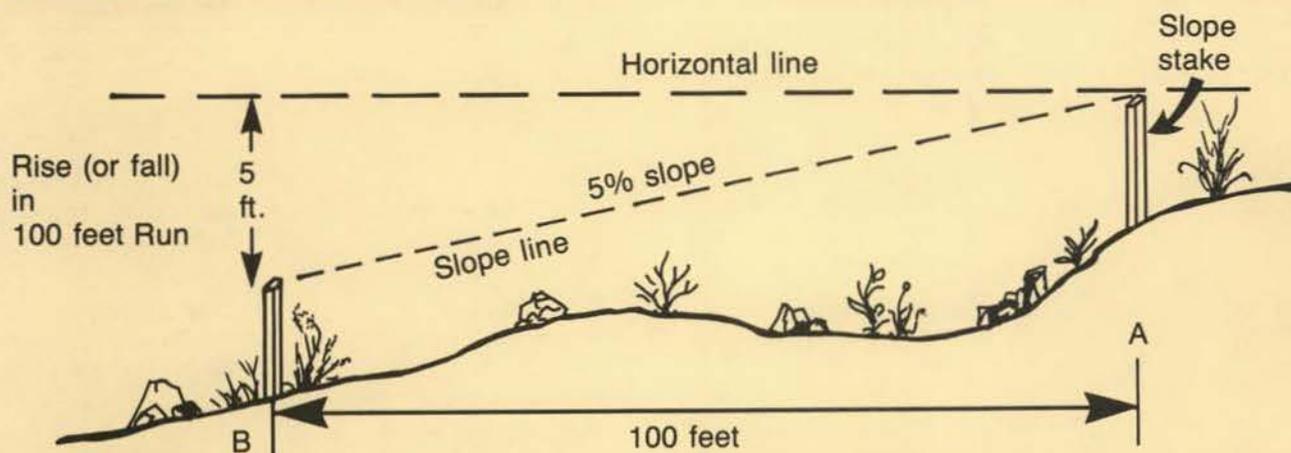


Fig. 12. Using the tops of the two slope stakes and ignoring the irregularities of the ground surface between the stakes, the fall from the top of stake A to the top of stake B is 5 feet. This translates into a 5 percent slope.

stake B to the point on the theoretical horizontal line immediately above stake B. This is the feet of fall, and since the two slope stakes are 100 feet apart, the feet of rise (or fall) is the same as percent slope.

Move to point B, look back at point A and use the same method to estimate the distance from the top of stake A to the theoretical horizontal line. If the estimated slopes obtained from point A and point B are the same, this is probably a good estimate of the slope. If they are not the same, take the average of the two values.

If the two slope stakes are not 100 feet apart, this formula is used to calculate the percent slope:

$$\frac{\text{Rise (or fall) in feet}}{\text{Run in feet}} \times 100 = \% \text{ slope}$$

Note: When the horizontal run is 100 feet, the two 100s cancel so that the feet or rise (or fall) is the same as percent slope.

A further check of the estimated slope can be obtained by standing to the side of the slope line (perpendicular) and trying to establish a theoretical horizontal line from the top of one of the two slope stakes. Again the distance from the theoretical horizontal line to the top of the other stake will give the feet of rise (or fall) from the top of one stake to the other. Establishing the theoretical horizontal line can be aided by the earth's horizon that can be observed behind the two stakes. Averaging the three estimates may give the closest approximation of the actual slope. If a big discrepancy exists, rechecking one or more of the estimates may be warranted.

There are two possible slope groupings: (1) grouping for nonirrigated cropland, rangeland, and woodland, and (2) grouping for irrigated cropland. *All irrigated cropland is considered to be surface-irrigated.* Irrigated cropland is much more likely to have erosion problems so the permitted slopes are necessarily much more gentle.

	Nonirrigated cropland, range, and woodland	Irrigated cropland
1. Nearly level	0 to 3%	0 to 1%
2. Gently sloping	3 to 8%	1 to 3%
3. Moderately sloping	8 to 12%	3 to 5%
4. Strongly sloping	12 to 20%	5 to 8%
5. Steep	20 to 45%	8 to 12%
6. Very steep	more than 45%	more than 12%

Erosion — Wind and Water

Erosion is the loss of soil by wind and water. Loss of soil can be highly detrimental to crop production. The surface soil, which is usually the soil material lost, is the most productive portion of the soil. It is a fact that less productive soils are usually more erosive, thus the more a soil is eroded the more susceptible it becomes to erosion.

Soils in the Land Judging Contest will be judged on erosion that has occurred in the past. Determining the

amount of erosion will be a simple calculation based on original depth of soil material and the depth of soil material existing at present. The original depth of soil material will be given on the placard.

Note: Since soil horizons will vary from area to area and the official judges may interpret the depths of soil material differently, the information given on the placard may vary from contest to contest.

As an example, the original depth of topsoil given on the placard may be given as “. . .depth of topsoil 22 inches,” which represents the soil layers readily penetrated by plant roots, water, and air. This is the most productive portion of the soil profile. This information will help the contestant decide what part of the existing profile needs to be measured (estimated) to calculate the soil loss. Where the presently existing depth may be difficult to determine, this value may also be given on the placard. In such cases, only a few simple mathematical calculations are needed to determine the erosion loss. If for an example the remaining depth is 10 inches and the original depth given on the placard is 22 inches, then the formula for calculations is $10/22 \times 100 = 45$ percent soil loss from erosion. The following categories will be used in judging:

1. **None to Slight** — Less than 25 percent of the soil has been removed.
2. **Moderate** — 25 to 75 percent of the soil removed.
3. **Severe** — More than 75 percent of the soil removed.
4. **Very Severe** — More than 75 percent of the soil removed with frequent uncrossable gullies or severe accumulation by wind.

Surface Runoff or Surface Drainage

Surface runoff results from a combination of natural factors including land slope and water infiltration rate of the soils. Surface runoff refers to the relative rate at which water is removed by flow over the surface of the soil when no vegetation is present on the soil.

1. **Rapid** — Surface water flows rapidly. A considerable amount of precipitation is lost from the surface, which increases the hazard of erosion and reduces available water for plants. This may be critical under nonirrigated cropland. Fields with slopes of 3 percent and above (except for coarse-textured and moderately coarse-textured surface soils) would go in this category.
2. **Moderate** — This is considered as “normal” runoff from soils with slopes of 1 to 3 percent (except for coarse-textured and moderately coarse-textured surface soils).
3. **Slow** — Surface water flows away slowly and surplus water may be a problem. This category includes nearly level areas (less than 1 percent slope) with medium- and moderately fine-textured surface soils. Included in this category are all soils with coarse-textured or moderately coarse-textured surfaces with all slopes.

4. **Very Slow** — Surface water flows away very slowly. Includes soils on nearly level slopes (less than 1 percent) with fine-textured surface soil.

Subsoil or Internal Drainage

Subsoil drainage is that quality of a soil that permits the downward flow of excess water through the profile. Free water (a water table) is sometimes present in a soil profile. Where not obvious, the depth of the water table will be given on the placard. The definitions below consider both movement of water through the soil profile and the presence of a water table:

1. **Excessively** — Rarely saturated with water and excess amounts drain away quickly, causing droughty conditions. Includes only rapidly permeable soils.
2. **Well** — Saturation with water is limited to only a few days, and plant roots are not injured.
3. **Somewhat Poorly** — Saturation with water (water table) in root zone (upper 4 feet of profile) is limited to 1 or 2 weeks each year during the growing season. This will injure plant roots.
4. **Poorly** — Saturation with water (water table) in root zone (upper 4 feet of profile) for 2 to 12 weeks each year during the growing season. This will severely injure plant roots so that crop yield is appreciably reduced or the crop is destroyed. Few visible mottles observed.
5. **Very Poorly** — Saturation with water (water table) in root zone during most of growing season (more than 12 weeks). Suitable only for grazing and hay production. These soils have many visible mottles.

Climate

Climatic limitations affect crop production and thus are considered in land capability classification. A short growing season and low natural precipitation are limitations in many parts of Idaho. Low natural precipitation is not a factor when irrigation water is available. Availability of irrigation water will be given on the placard.

1. **Good** — More than 140 frost-free days along with 14 or more inches of average annual precipitation. If less than 14 inches of average annual precipitation occurs, irrigation water must be available.
2. **Fair** — 100 to 140 frost-free days and/or 10 to 13 inches of average annual precipitation. If less than 10 inches of average annual precipitation occurs, irrigation water must be available.
3. **Poor** — Less than 100 frost-free days and/or less than 10 inches of average annual precipitation with irrigation water not available.

Major Factors

The following major factors are considered in selecting the land capability class. Any one or more factors that would keep the area out of Class I land will be checked.

1. **Surface Texture** — Surface soil texture is a major factor for coarse-textured, moderately coarse-textured,

and fine-textured soils. Coarse-textured soils can be no better than Class III because of wind erosion hazard.

2. **Subsoil Texture** — Subsoil texture is a major factor for coarse-textured and fine-textured soils only.
3. **Permeability** — Only rapid and very slow permeabilities will be major factors.
4. **Depth** — Only shallow and very shallow soils will be major factors.
5. **Slope** — Any slopes more than nearly level will be major factors.
6. **Erosion** — All conditions except none to slight will be major factors.
7. **Surface Runoff** — Only rapid or very slow will be major factors.
8. **Subsoil or Internal Drainage** — Excessive, somewhat poor, poor, and very poor drainage conditions will all be major factors.
9. **Climate** — Fair and poor climates will be major factors.
10. **None** — Class I land, with no major factors.

Land Capability Classes

The following are broad definitions of the land capability classes. See "General Guide for Selecting Land Capability Classes" (page 23).

Land suited for cultivation and other uses such as grassland, forestry, wildlife, and recreation.

Class I — These soils have few limitations that restrict their use.

Class II — These soils have some limitations that reduce the choice of plants, or require special conservation practices, or both.

Class III — These soils have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

Class IV — These soils have very severe limitations that restrict the choice of plants, or require careful management, or both.

Land suited for grassland, forestry, wildlife, and recreation. Not suited for cultivation.

Class V — These soils have little or no erosion hazards (nearly level slopes) but they have very poor drainage, which limits their use largely to grassland, hayland, wildlife habitat, or wetlands area.

Class VI — These soils have severe limitations that make them generally unsuited for cultivation and limit their use largely to grassland, woodland, or wildlife habitat. They may be cultivated sufficiently to establish permanent cover.

Class VII — These soils have very severe limitations that restrict their use largely to grassland, woodland, or wildlife habitat. Restricted use to pasture grasses, wildlife, recreation, woodland watershed, and aesthetics.

Class VIII — These soils and land forms have limitations that preclude their use for commercial plant production and restrict their use to wildlife, recreation, water supply, or aesthetic purposes.

Part II. Recommended Land Treatments

Recommendations for land treatments are *based on the highest and best potential use of the land*. Regardless of the present use of the "field," recommended land treatments should be *based on the land capability class*. The following are land treatment considerations to be applied in the management of different land capability classes:

Vegetative

- 1 through 4. **Conservation Cropping Systems** — These practices apply to the use of rotations that contain grasses and legumes (soil conserving and/or improving crops) as well as sequences in which the desired benefits are achieved without use of such crops. Soil-conserving crops are close-seeded crops that tend to prevent or retard erosion and maintain organic matter. Soil-improving crops are grasses and legumes that improve soil structure and tilth, organic matter levels, and water infiltration. Use soil conserving and/or improving crops as follows:
- Not necessary — applicable to Class I.
 - Every fourth or fifth year — applicable to Class II.
 - Every third or fourth year — applicable to Class III.
 - Every second or third year — applicable to Class IV.
5. **Crops Residue Use** — Use plant residues in cultivated fields to prevent erosion and improve the soil. *Do not burn residues*. Applies only to potential cultivated soils (classes I, II, III, or IV). Even if the "field" is not presently used for cultivated crops, but the soil has the potential for cultivated crops, this category should be marked.
6. **Weed Control** — Could apply to all land classes. Should be used any time there is any indication of a weed problem. Five or more weed plants within the boundary of the "field" being judged will be considered to be a weed problem. Any noxious weed is a weed problem and will be indicated on the placard.
7. **Strip Cropping** — Using alternate strips of land for various crops or fallow conditions to control water and wind erosion. Would apply to land classes III and IV (nonirrigated).
8. **Brush and Tree Control** — This implies the use of chemical sprays and/or specialized machinery. The purpose is to improve the desirable vegetative cover by removing or killing undesirable brush, trees, or timber so that the land can be farmed as is the case for land classes I to IV. This practice should not be used when brush material can be controlled by normal farm plowing — Sagebrush, rabbitbrush, and similar plants

can usually be removed with normal land preparation, so their removal would not be considered to be brush control. For pasture, range, wildlife or woodland (class V and VI). In wetland or riparian areas the planting of brush and trees is encouraged especially in land classes VII and VIII and should not be removed.

9. **Grasses and Legumes** — This practice is to be used on lands not producing suitable permanent vegetation or on idle or cultivated lands not suitable for cultivated crops. Because of differences in interpretation as to what is considered suitable and practical, this practice will be used for all land classes V, VI, and VII except where tree plantings are made.
10. **Pasture, Range, Hay Management** — Proper treatments and use of grasses and legumes to maintain optimum production. This applies only to reseeding on land Classes V and VI.
11. **Tree Planting** — Planting tree seedlings or cuttings to establish a stand of forest trees. *Not suitable for Class V lands*.
12. **Woodland Harvest Cutting** — Removing marketable trees from woodland.
13. **Wildlife, Recreation, and Watershed** — Retaining, establishing, or managing wildlife habitats and watersheds and installing needed structures or revegetation for recreation, wetland, and riparian management (also includes Class VIII).

Mechanical — Irrigated/Dryland Only

For Classes I, II, III, and IV, Irrigated Land Only

14. **Land Leveling and Smoothing for Surface Irrigation** — Reshaping the surface of the land to be irrigated to a uniform grade (limited to land of <3 percent slope) or removing irregularities on the land surface by use of special land leveling equipment. This does not include a simple float, harrow, or land plane.
15. **Irrigation Water Management** — Use and management of irrigation water so that the quantity of water used for each irrigation is determined by the moisture-holding capacity of the soil and the need of the crop (evapotranspiration). This means applying the water at such a rate and in such a manner that the crops can use it efficiently, and significant erosion and leaching does not occur.
16. **Water Control Structures (for slopes of <3 percent)** — For water management in a surface irrigation system, structures are needed to convey water. They may include diversions, canals, ditches to control direction or rate of flow, maintain a desired water surface elevation, and remove excess tailwater and sediments at the end of the field. If all of these are not included in the field, mark this category.

For Classes I, II, III, and IV, Dryland Only

17. **Diversion or Terrace** — A channel with a supporting ridge on the lower side constructed across the

slope, or an earth embankment or ridge and channel constructed across the slope at a suitable spacing and grade. Used on moderately sloping land.

18. **Grass Waterway** — A natural waterway or outlet shaped or graded with suitable vegetation as needed for the safe disposal of runoff. Used on moderately sloping lands.
19. **Contour Farming** — Conducting farming operations on sloping land in such a way that plowing, land preparation, planting, and cultivation are done on the contour. Used on moderately or strongly sloping land ranging from 8 to 20 percent.
20. **Plow Uphill** — Severe tillage erosion occurs on moderately and strongly sloping land (8 to 20 percent slopes) when the plow furrow-slice is continually thrown downhill. On these lands all moldboard plowing should be limited and done only by throwing the furrow slice uphill. In addition to preventing tillage erosion, this also tends to leave more surface residue and a rougher surface, which reduces runoff on moderately and strongly sloping land.

Mechanical — Irrigated and Dryland

*For Classes I, II, III, and IV,
Both Irrigated and Dryland*

21. **Subsurface Drainage System** — A graded ditch or buried tile of a designated size for collecting subsurface water within a field or area. Used on somewhat poorly and poorly drained areas and only where these systems have been used historically. Installation of a drainage system is no longer allowed because of federal wetland regulations. Very poorly drained areas should be restored to their original conditions.
22. **Minimum Tillage** — Limiting the number of cultural operations to those that are properly timed and essential to produce a crop and prevent soil erosion, compaction, and structural changes. Minimum tillage is also essential to decreasing soil erosion by increasing the amount of crop residue left on the soil surface.

Fertilizers and Soil Amendments

Use fertilizer materials and soil amendments as determined by soil tests to achieve economical responses, optimum production, and improve the soil.

Soil test information for the "field" pertaining to need for lime or gypsum and to correct deficiencies of nitrogen (N), phosphorus (P), potassium (K), and zinc (Zn) will appear on the placard. Information given will include soil pH and concentrations (ppm) of N, P, K, and Zn. Also, the availability of organic materials, such as manure, which can be applied to the "field," will be given on the placard.

No limits on lime, gypsum, or fertility requirements will fit all areas and all crops. Each has its own levels. This is to acquaint the contestants with present day terminology and provide some practical knowledge about soil amendment and soil fertility needs for Idaho crops and soils.

Levels of nutrients needed in soils (indexes) to produce crops depend on extraction methodology and have to be correlated to field response in research trials.

23. **Nitrogen** — Low levels of N in Idaho soils are less than 20 ppm $\text{NO}_3\text{-N}^-$ in the plant root zone. However, soils up to 40 ppm of $\text{NO}_3\text{-N}^-$ do require additional N as commercial fertilizers for most crops (other than legumes). When values of less than 40 ppm are shown on the placard, check No. 23 on the scorecard. Excessive N fertilizer should be avoided to decrease the $\text{NO}_3\text{-N}^-$ leaching potential.
24. **Phosphorus** — Low levels of P in Idaho vary with the soil characteristics and the crop being grown. In general, apply P fertilizer when a soil test in the sample taken to the 12-inch soil depth is below 6 ppm on acid soils (pH less than 7.0) and 15 ppm on alkaline soils (pH greater than 7.0). When P fertilizer is needed, check No. 24 on the scorecard.
25. **Potassium** — Low levels of K in Idaho also vary with the soil characteristics and the crop being grown. In general, apply K fertilizer when the soil test in the sample taken to the 12-inch soil depth is below 80 ppm on acid soils (pH less than 7.0) and below 150 ppm on alkaline soils (pH greater than 7.0). Check No. 25 on the scorecard when K is needed.
26. **Micronutrients** — Zinc is the most common micronutrient for which deficiencies have been observed in Idaho soils. When zinc levels are shown below 0.6 ppm in the soil sample taken from the 0- to 12-inch soil depth, check No. 26 on the scorecard.
27. **Lime** — Soils with pH values of 4 to 5 usually require lime for maximum crop production. When field pH values are less than 5.7, check No. 27 on the scorecard.
28. **Gypsum** — Soils having pH values above 8.5 are called alkali (sodic or sodium-affected) soils and may require a source of calcium to replace the sodium to allow correction of the problem. Gypsum is a good source of calcium. If the soil pH is 8.5 or above, check No. 28 on the scorecard.
29. **Organic Matter** — Livestock manures, composts or other organic materials are valuable in increasing soil organic matter. When any organic material is shown on the placard as being available for use, check No. 29 on the scorecard.
30. **Fertilizer or Amendments Not Needed** — When all nutrients are high in the soil, no organic material is available and pH values are between 5.7 and 8.5, check No. 30 on the scorecard.

Example — Information on the placard shows:

Soil pH	7.5 ppm
Nitrogen (NO_3N^-)	20 ppm
Phosphorus (P_2O_5)	8 ppm
Potassium (K_2O)	300 ppm
Zinc	2 ppm

No statement that manure or compost is available. On the scorecard, check No.'s 23 (nitrogen) and 24 (phosphorus).

General Guide for Selecting Land Capability Classes

Soil factor	Best land class possible
A. Surface Texture	
Coarse-textured	III
Moderately coarse-textured	II
Medium-textured	I
Moderately fine-textured	I
Fine-textured	II
B. Subsoil Texture	
Coarse-textured	II
Moderately coarse-textured	I
Medium-textured	I
Moderately fine-textured	I
Fine-textured	II
C. Permeability	
Rapid	III
Moderate	I
Slow	I
Very slow	III
D. Depth — Surface and Subsoil	
Very shallow	VII
Shallow	III
Moderately deep	II
Deep	I
Very deep	I
E. Slope	
Nearly level	I
Gently sloping	II
Moderately sloping	III
Strongly sloping	IV
Steep	VI
Very steep	VII
F. Erosion Loss	
None to slight	I
Moderate	II
Severe	VI
Very severe	VIII
G. Surface Runoff	
Rapid	III
Moderate	I
Slow	I
Very slow	II
H. Drainage	
Excessively	III
Well	I
Somewhat poorly	II
Poorly	IV
Very poorly	V
I. Climate	
Good	I
Fair	II
Poor	III

Homesite Evaluation

This part of the contest is designed to emphasize the importance of soils and their limitations for nonagricultural purposes. Many of the soil and land characteristics used in judging soils for agricultural use will also be used in evaluating an area for a homesite. The contest is based on use of the site for a single family dwelling without a basement, and related uses.

While this contest is limited to homesites, the importance of a soil's suitability for parks and playgrounds, roads streets, and other nonagricultural uses could also be stressed.

Limitations for Nonagricultural Use

The discussion of individual soil characteristics to be considered are related to limitations for a specific use. The limitations are defined as follows:

Slight — Those soils or locations that have properties favorable for the planned use with little or no problems.

Moderate — Those soils or locations that have properties only moderately favorable for the planned use. Limitations can be overcome or modified with special planning,

design, or maintenance. Special treatment of the site for the desired use may be necessary.

Severe — Those soils or locations that have one or more properties unfavorable for the planned use. Limitations are difficult and costly to modify or overcome for the use desired.

Very Severe — Those soils or locations that have one or more features so unfavorable for a particular use that overcoming the limitation is very difficult and expensive. For the most part, these kinds of soils should not be used for the purpose for which they are being rated.

Factors Affecting Suitability

Texture

This refers to the texture of the surface soil. (See Land Judging section for help in determining soil texture). Surface texture is not a factor for sewage lagoons because lagoons are dug below the surface, and most of the surface soil is used to make the banks around the lagoon. You will

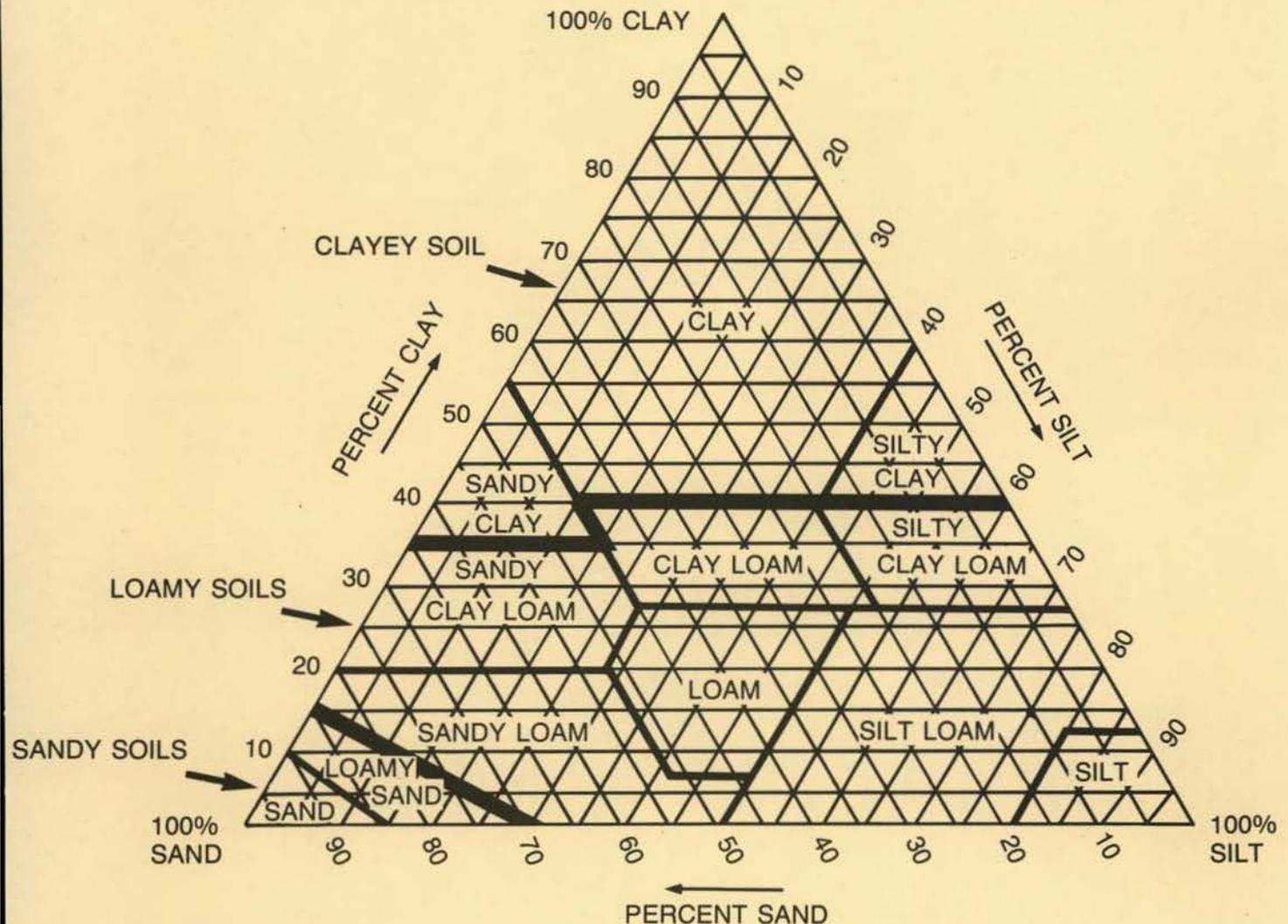


Fig. 13. Soil texture triangle for homesite evaluation with the three textural groupings — sandy, loamy, and clayey.

notice that the textural groupings for homesite evaluation are different from those used in land judging. In homesite evaluation, only three soil textural groupings are used (Fig. 13) instead of the five soil textural groupings used in land judging.

- | | |
|--|--|
| 1. Sandy soils (coarse-textured soils) | Sands
Loamy sands |
| 2. Loamy soils (moderately coarse-, medium-, and moderately fine-textured soils) | Sandy loam
Loam
Silt loam
Clay loam
Sandy clay loam
Silty clay loam |
| 3. Clayey soils (fine-textured soils) | Sandy clay
Silty clay
Clay |

Sandy Soils — Moderate limitations for all uses. May require stabilization with organic material and/or loamy topsoil to improve capability of the soil to hold and supply moisture and nutrients for desired plant growth. Water and wind erosion may be a problem during construction. Shrink-swell potential is very low.

Loamy Soils — None to slight limitations for all uses. Care should be exercised during construction to be sure the surface soil is not covered by less desirable subsoil material.

Clayey Soils — Severe limitations for uses other than sewage lagoons. Soil is sticky when wet, hard when dry, and difficult to work when used for lawns, flower beds, shrubs, and gardens. The soils crack when dry and swell when wet. Clayey soils have a high shrink-swell potential. Special planning and design are required for foundations. May be droughty and need frequent additions of low rates of water for establishing and maintaining vegetative growth.

Permeability

This refers to the rate of movement of water or air through the subsoil. This is considered internal drainage and is based on soil texture and soil structure. (For help in determining soil permeability, refer to Land Judging section.)

Laterals for septic systems may be located below the subsoil in some soils. For that reason, this should serve as a warning, and final design should be based on a detailed on-site evaluation to determine suitability where soils are slowly permeable. It is an important factor in deciding between a septic tank system or a sewage lagoon. Soil percolation tests would be required before making further plans.

Rapid Permeability — Soils generally are sandy loam or sandy textured throughout. Permeability is greater than 6.0 inches per hour. *Slight limitations* exist in use for septic tank system disposal field due to the fact that sewage water may be percolated away too rapidly, (1) *slight limitations* also exist for foundations, (2) *moderate limitations* for lawns, shrubs and gardens, and (3) *very severe limitations* for sewage lagoons. Seepage from lagoons would make it difficult to maintain adequate depth of water and could contribute to pollution of groundwater.

Moderate Permeability — *Slight to moderate limitations*. Soils are generally medium textured, but also includes silty clay loam or clay loam with strong structure or compacted sandy loam, (1) *none to slight limitations* for septic tank systems, lawns, shrubs, and gardens. Permeability ranges (0.2 to 6.0 inches per hour) would indicate a need for a percolation test if thought to be on the low side of the range, (2) *moderate limitations* for sewage lagoon as leakage may occur. *None to slight limitations* for foundations.

Slow Permeability — *Severe limitations for septic tank systems*. Soils generally would include moderately fine-textured soils with weak to moderate structure and fine-textured soils with strong structure. Water movement is 0.06 to 0.2 inch per hour. Percolation tests would be required for design of septic tank disposal field. Limitations would be (1) *none to slight* for sewage lagoons, (2) *moderate* for foundations and lawns, shrubs, and gardens.

Very Slow Permeability — *Very severe limitations for septic tank systems*. Soils are fine-textured (silty clay, sandy clay, and clay). Soil structure is usually not well developed with tendency toward massive (without structure). Water movement is less than 0.06 inch per hour. Percolation tests would be required for design of septic tank disposal field. Limitations would be (1) *none to slight* for sewage lagoon, (2) *moderate* for foundations, and (3) *severe* for lawns, shrubs, and gardens.

Soil Depth

The depth of the soil includes the total thickness of soil layers readily excavated for construction purposes. These are also the soil layers that are readily penetrated by plant roots, water, and air. A restrictive layer is clay, hardpan, or bedrock. The degree of limitation due to restricted soil depth will vary greatly for different uses. Use Table 2 as a guide for evaluation of soil depth for desired uses.

Slope

Slope of the land, given in percent, is the number of feet of rise (or fall) in 100 feet of horizontal distance (run). For further explanation and guides to estimating slope, see discussion of slope under the Land Judging section (page 18). Broader and different slope groupings are used for homesite consideration than normally apply to agricultural uses of the land. Table 3 will aid in the interpretation of limitations based on the slope of the site.

Erosion

Erosion is the loss of soil material due to the action of wind and water. Loss of soil can be highly detrimental to homesite and other uses of the land. The surface soil, which is usually the soil material lost, is the most productive portion of the soil. The loss of topsoil or surface soil is not as critical for homesite uses as it is for agricultural uses. This is true because the small area involved in a homesite allows developers to haul in topsoil to replace the loss.

Soils in the contest will be judged on erosion that has occurred in the past. The determination of the amount of erosion will be a simple calculation based on original depth of soil material (given on the placard) and the amount of soil lost to reach the presently existing depth. For further information on calculating losses, see discussion of erosion under Land Judging section (page 19).

None, Slight, and Moderate (less than 75 percent of soil lost) — None to slight limitations for all uses.

Severe (75 to 100 percent of soil lost) — Slight limitations for foundations and lagoons. Moderate limitations for other uses. May require leveling, modification of surface, or bringing in topsoil for lawns, gardens, septic systems, etc.

Very Severe (75 to 100 percent soil lost with gullies) — Severe limitations to all uses.

Surface Runoff

This is generally an important factor in connection with drainage, permeability and erosion. Special attention needs to be given to surrounding areas including features outside the site or "field" being judged. Runoff from adjacent areas onto contemplated building site and the possibility of ponding and water accumulations on the homesite need consideration. Surface runoff is not a factor for sewage lagoons because they will be protected from outside water.

Rapid — Occurs on slopes greater than 3 percent but does not include sandy-textured surface soils. Severe limitations require care to maintain and prevent erosion on lawns. None to slight limitations for foundations or septic system.

Moderate — None to slight limitations for all uses. Occurs on slopes of 1 to 3 percent, but does not include sandy surface textures.

Slow — Occurs on sandy-textured surface soils on all slopes. None to slight limitations for all uses.

Very Slow — Occurs on nearly level areas (less than 0.3 percent), but does not include sandy-textured surface soils. Severe limitations may require costly modification for foundations and special design of septic tank disposal fields. Moderate limitations for lawns, shrubs, and gardens.

Shrink-Swell

Shrink-swell is the property of soil to swell when it is wetted and to shrink when it dries. The tendency to shrink and swell is related to the amount and type of clay present. Because it is important in foundation design, this factor should have special consideration. The most clayey layer in the profile is generally considered in relation to shrink-swell. In the contest, consider the shrink-swell of the heaviest (most clayey) of the surface soil or subsoil. Shrink-swell is not generally a factor for lawns, shrubs and gardens.

Low — Soil texture classes included in this category are sands, loamy sands, and fine sandy loam. There are none to slight limitations for all uses.

Moderate — Soil texture classes included in this category are silt, loam, silt loam, clay loam, and silty clay loam. There are none to slight limitations for sewage lagoons and moderate limitations for other uses.

High — Sandy clay, silty clay, and clay texture classes fall into this category. These have severe limitations for foundations, septic systems, and other uses except none to slight limitations for sewage lagoons.

Water Table

The internal wetness of an area is influenced by most of the factors previously discussed. Generally, internal drainage is a reflection of permeability and topographic posi-

Table 2. Effect of soil depth on limitations of a site for a homesite.

Site characteristic	Depth in inches	Foundations w/o basement	Lawn, shrubs, and gardens	Septic system	Sewage lagoon
V. shallow	less than 10	Severe	V. severe	V. severe	V. severe
Shallow	10 to 20	Moderate	Severe	V. severe	V. severe
Moderately deep	20 to 40	None to slight	None to slight	Severe	Severe
Deep	40 to 60	None to slight	None to slight	Moderate	Moderate
Very deep	over 60	None to slight	None to slight	None to slight	None to slight

Table 3. Effect of slope on limitations for a homesite.

Site characteristic	Slope (%)	Foundations w/o basement	Lawn, shrubs, and gardens	Septic system	Sewage lagoon
Near level	0 to 3	None to slight	Moderate	None to slight	None to slight
Gently sloping	3 to 5	None to slight	None to slight	None to slight	None to slight
Moderately sloping	5 to 8	Moderate	Moderate	None to slight	Moderate
Strongly sloping	8 to 15	Severe	Severe	Moderate	Severe
V. strongly sloping	over 15	V. severe	V. severe	Severe	V. Severe

tion. For example, a very slowly permeable soil exhibits poor to very poor internal drainage. The presence and depth of a water table is not necessarily a reflection of soil permeability. It must be evaluated on the basis of depth and permanency, frequently requiring study during different seasons of the year. Attention should be given to features outside the "field" being judged with special attention to topographic position, stream channels, and evidence of a water table. Unless obvious, water table depth or seasonal fluctuations will be given on the placard. Use Table 4 as a guide for water table depth.

Deep — None to slight limitations for all uses. No evidence of water table above 72 inches.

Moderate — Moderate limitations for all uses. Temporary or permanent water table present at depth of 48 to 72 inches.

Shallow — Severe limitations for all uses. Temporary or permanent water table at depths less than 48 inches.

Flooding

The occurrence of floods is a factor frequently overlooked. Flooding may not occur on an area for many years; then a serious flood may occur. Urban development on a small stream watershed can increase runoff up to 75 percent, thus greatly increasing flooding hazard. Soils can give an indication, but records must be studied to determine the true condition. Position on the landscape and proximity to nearby streams are good indicators of frequency of flooding. Attention should be given to features outside the "field" being judged. Frequency of flooding will be given on the placard at the site.

None — No flooding. Limitations none to slight for all uses.

Occasional — Less than 1 year in 2. Severe limitations for septic tank drain fields and sewage lagoons. Moderate limitations for foundations, lawns, and shrubs.

Frequent — Greater than 1 year in 2. Very severe limitations for development.

Table 4. Depth to water table.

Degree of limitations	Foundations for buildings	Lawns and landscaping	Septic systems absorption fields	Sewage lagoons
	(inches)	(inches)	(inches)	(inches)
Slight	less than 36	less than 24	less than 72	less than 60
Moderate	24 to 36	12 to 24	48 to 72	36 to 60
Severe	over 24	over 12	over 48	over 36

How To Use the Scorecards

Land Judging Scorecard — Part I

1. Part I (left side) of the scorecard deals with characteristics of the soil and land that the contestant must determine about the field.
2. Place an "X" in the appropriate box or boxes to mark your answers.

Land Judging Scorecard — Part II

1. Part II (right side) of the scorecard deals with selecting the land capability class and picking appropriate recommended land treatments or conservation practices that you decide are necessary based on characteristics found in Part I.
2. Using the information from major factors, select the Land Capability Class by placing an "X" in the appropriate box.
3. In the Vegetative, Mechanical, and Fertilizer/Soil Amendment sections, place an "X" in the box preceding the treatment that should be used. (Note: For scoring, any incorrectly marked or incorrectly not-marked item will be counted wrong.)

Homesite Evaluation Scorecard

1. Part I of the scorecard deals with soil and land characteristics that the contestant must determine about the field. Place an "X" in the appropriate box to indicate site characteristics. With the exception of shrink-swell, water table, and flooding, the factors are similar to those for land judging. Do not make a straight checkoff from the land judging to homesite scorecard, however. While the factors are the same, different separations are made.
2. After selecting the site characteristic in Part I, determine the severity of limitations that the characteristic imposes on the planned uses listed in Part II of the scorecard and mark the appropriate box with an "X."
3. Summarize the limitations for each of the four uses by selecting the worst degree of limitation for a use and carrying it down to the bottom of the column and marking the appropriate box with an "X."
4. The "final evaluation" of the site, in the lower left box, is a summary of the limitations of the four uses.

References

- Barker, Raymond J., Robert E. McDole, and Glen Logan. 1983. *The Idaho Soils Atlas*. Univ. of Idaho Press, Moscow, ID, \$18.95.
- County Soil Survey Reports (available for many of Idaho counties). Published by USDA Soil Conservation Service in cooperation with Univ. of Idaho Ag Exp. Sta.

Idaho Land Judging Scorecard



Field No. _____

Contestant No. _____

Name _____

(Indicate answer by placing an X in the appropriate box)

PART I — Soil and Land Characteristics				
A. SURFACE TEXTURE				
<input type="checkbox"/> 1. Coarse <input type="checkbox"/> 2. Moderately coarse <input type="checkbox"/> 3. Medium <input type="checkbox"/> 4. Moderately fine <input type="checkbox"/> 5. Fine				
B. SUBSOIL TEXTURE				
<input type="checkbox"/> 1. Coarse <input type="checkbox"/> 2. Moderately coarse <input type="checkbox"/> 3. Medium <input type="checkbox"/> 4. Moderately fine <input type="checkbox"/> 5. Fine				
C. PERMEABILITY				
<input type="checkbox"/> 1. Rapid <input type="checkbox"/> 2. Moderate <input type="checkbox"/> 3. Slow <input type="checkbox"/> 4. Very slow				
D. DEPTH OF SOIL				
<input type="checkbox"/> 1. Very shallow (less than 10") <input type="checkbox"/> 2. Shallow (10" to 20") <input type="checkbox"/> 3. Moderately deep (20" to 40") <input type="checkbox"/> 4. Deep (40" to 60") <input type="checkbox"/> 5. Very deep (over 60")				
E. SLOPE				
	<table border="0"> <tr> <td></td> <td style="text-align: center;">Dry</td> <td style="text-align: center;">Irrigated</td> </tr> </table>		Dry	Irrigated
	Dry	Irrigated		
<input type="checkbox"/> 1. Nearly level 0 to 3% 0 to 1% <input type="checkbox"/> 2. Gently sloping 3 to 8% 1 to 3% <input type="checkbox"/> 3. Moderately sloping 8 to 12% 3 to 5% <input type="checkbox"/> 4. Strongly sloping 12 to 20% 5 to 8% <input type="checkbox"/> 5. Steep 20 to 45% 8 to 12% <input type="checkbox"/> 6. Very steep over 45% over 12%				
F. EROSION LOSS				
<input type="checkbox"/> 1. None to slight (less than 25% lost) <input type="checkbox"/> 2. Moderate (25 to 75% lost) <input type="checkbox"/> 3. Severe (over 75% lost) <input type="checkbox"/> 4. Very severe (uncrossable gullies)				
G. SURFACE RUNOFF				
<input type="checkbox"/> 1. Rapid <input type="checkbox"/> 2. Moderate <input type="checkbox"/> 3. Slow <input type="checkbox"/> 4. Very slow				
H. DRAINAGE				
<input type="checkbox"/> 1. Excessively <input type="checkbox"/> 2. Well <input type="checkbox"/> 3. Somewhat poorly <input type="checkbox"/> 4. Poorly <input type="checkbox"/> 5. Very poorly				
I. CLIMATE				
<input type="checkbox"/> 1. Good <input type="checkbox"/> 2. Fair <input type="checkbox"/> 3. Poor				
J. MAJOR FACTORS				
Any that keep area out of Class I				
<input type="checkbox"/> 1. Surface texture <input type="checkbox"/> 6. Erosion <input type="checkbox"/> 2. Subsoil texture <input type="checkbox"/> 7. Surface runoff <input type="checkbox"/> 3. Permeability <input type="checkbox"/> 8. Drainage <input type="checkbox"/> 4. Depth <input type="checkbox"/> 9. Climate <input type="checkbox"/> 5. Slope <input type="checkbox"/> 10. None				

Part II — Land Capability Class and Recommended Land Treatments
K. LAND CAPABILITY CLASS
<input type="checkbox"/> 1. Class I <input type="checkbox"/> 2. Class II <input type="checkbox"/> 3. Class III <input type="checkbox"/> 4. Class IV <input type="checkbox"/> 5. Class V <input type="checkbox"/> 6. Class VI <input type="checkbox"/> 7. Class VII <input type="checkbox"/> 8. Class VIII
L. VEGETATIVE
Use soil conserving and/or improving crops:
<input type="checkbox"/> 1. Not necessary (Class I) <input type="checkbox"/> 2. Every 4-5th year (Class II) <input type="checkbox"/> 3. Every 3-4th year (Class III) <input type="checkbox"/> 4. Every 2-3rd year (Class IV) <input type="checkbox"/> 5. Crop residue use <input type="checkbox"/> 6. Weed control <input type="checkbox"/> 7. Strip cropping <input type="checkbox"/> 8. Brush and tree control <input type="checkbox"/> 9. Grasses and legumes <input type="checkbox"/> 10. Pasture, range, hay management <input type="checkbox"/> 11. Tree planting <input type="checkbox"/> 12. Woodland harvest cutting <input type="checkbox"/> 13. Wildlife, recreation, and watershed
M. MECHANICAL
Irrigated Only
<input type="checkbox"/> 14. Land leveling and smoothing <input type="checkbox"/> 15. Irrigation water management <input type="checkbox"/> 16. Water control structures
Dryland Only
<input type="checkbox"/> 17. Diversion or terrace <input type="checkbox"/> 18. Grass waterway <input type="checkbox"/> 19. Contour farming <input type="checkbox"/> 20. Plow uphill
Both Dryland and Irrigated
<input type="checkbox"/> 21. Subsurface drainage system <input type="checkbox"/> 22. Minimum tillage
N. FERTILIZERS AND SOIL AMENDMENTS
<input type="checkbox"/> 23. Nitrogen (N) <input type="checkbox"/> 24. Phosphorus (P) <input type="checkbox"/> 25. Potassium (K) <input type="checkbox"/> 26. Micronutrients <input type="checkbox"/> 27. Lime <input type="checkbox"/> 28. Gypsum <input type="checkbox"/> 29. Organic matter <input type="checkbox"/> 30. Fertilizer or amendments not needed

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_____ SCORE PART I (Possible 40)
 _____ SCORE PART II (Possible 35)
 _____ SCORE (TOTAL) (Possible 75)

The land judging scorecard is used to record your judgment. This is your record and should be marked carefully.

Homesite Evaluation Scorecard



Field No. _____

Contestant No. _____

Name _____

(Indicate answer by placing an X in the appropriate box.)

PART I — Soil and Land Characteristics	PART II — Limitations for various uses of site for a single family dwelling without a basement.				
Features of the Site Being Considered	Degree of limitation	Foundation w/o basement	Lawns, shrubs, and gardens	Septic system	Sewage lagoon
A. SURFACE TEXTURE <input type="checkbox"/> Sandy <input type="checkbox"/> Loamy <input type="checkbox"/> Clayey	Slight Moderate Severe	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
B. SUBSOIL PERMEABILITY <input type="checkbox"/> Rapid (over 6.0"/hr) <input type="checkbox"/> Moderate (0.2" to 6.0"/hr) <input type="checkbox"/> Slow (0.06" to 0.2"/hr) <input type="checkbox"/> Very slow (less than 0.06"/hr)	Slight Moderate Severe Very severe	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
C. SOIL DEPTH <input type="checkbox"/> Very shallow (less than 10") <input type="checkbox"/> Shallow (10" to 20") <input type="checkbox"/> Moderately deep (20" to 40") <input type="checkbox"/> Deep (40" to 60") <input type="checkbox"/> Very deep (over 60")	Slight Moderate Severe Very severe	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
D. SLOPE <input type="checkbox"/> Nearly level (0 to 3%) <input type="checkbox"/> Gently sloping (3 to 5%) <input type="checkbox"/> Moderately sloping (5 to 8%) <input type="checkbox"/> Strongly sloping (8 to 15%) <input type="checkbox"/> Steep (over 15%)	Slight Moderate Severe Very severe	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
E. EROSION <input type="checkbox"/> None/Slight/Moderate (less than 75% lost) <input type="checkbox"/> Severe (over 75% lost) <input type="checkbox"/> Very severe	Slight/moderate Severe Very severe	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
F. SURFACE RUNOFF <input type="checkbox"/> Rapid (slopes over 5%) <input type="checkbox"/> Moderate (slopes 3 to 5%) <input type="checkbox"/> Slow (sandy surface texture) <input type="checkbox"/> Very slow (nearly level areas)	Slight Moderate Severe	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
G. SHRINK-SWELL (heaviest layer) <input type="checkbox"/> Low <input type="checkbox"/> Moderate <input type="checkbox"/> High	Slight Moderate Severe	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
H. WATER TABLE (permanent or temporary) <input type="checkbox"/> Deep (none evident above 72") <input type="checkbox"/> Moderately deep (48" to 72") <input type="checkbox"/> Shallow (less than 48")	Slight Moderate Severe	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
I. FLOODING <input type="checkbox"/> None <input type="checkbox"/> Occasional (less often than 1 year in 2) <input type="checkbox"/> Frequent (more often than 1 year in 2)	Slight Moderate Severe Very Severe	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
FINAL EVALUATION <input type="checkbox"/> All factors none to slight <input type="checkbox"/> One or more factors moderate; none severe <input type="checkbox"/> One or more factors severe; none very severe <input type="checkbox"/> One or more factors very severe	Slight Moderate Severe Very Severe	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

This scorecard is used to record your decisions and should be marked carefully.

Revised 8/93

Score _____



 University of Idaho
College of Agriculture

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