Historical Replica — Part II

Issued March 1971

SOIL SURVEY

Arapahoe County, Colorado

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
COLORADO AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1958–63. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1963. This survey was made cooperatively by the Soil Conservation Service and the Colorado Agricultural Experiment Station. It is part of the technical assistance furnished to the West Arapahoe, Agate, Kiowa, and Deer Trail Soil Conservation Districts. Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for agriculture, industry, and recreation.

Locating Soils

All the soils of Arapahoe County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the pages for the range site and the tree planting suitability group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units, range sites, and tree planting suitability groups.

Community planners and others can read about soil properties that affect the choice of sites for homes, small industrial buildings, and other nonfarm uses in the section "Nonfarm Uses of Soils."

Game managers, sportsmen, and others concerned with wildlife can find information of interest in the section "Use of Soils for Wildlife."

Ranchers and others can find, under "Use and Management of Soils for Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Community planners and others concerned with recreational development can find in the section "Use of Soils for Recreation" information about limitations of the soils as sites for recreational and vacation facilities.

Engineers and builders can find, under "Engineering Uses of Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Arapahoe County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the sections "Climate of Arapahoe County" and "Additional Facts About the County."

Cover picture: **Contour stripcropping on Fondis silt loam, 3 to 5 percent slopes.**

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Figure 10.—A housing development on Adena-Colby silt loams, 1 to 5 percent slopes, in the western part of the county.

In this soil survey sites for light industry include shopping centers, industrial buildings that have large parking lots, large buildings not more than two stories high, and large school buildings. Steep soils are less desirable as sites for light industrial construction than as sites for homes (fig. 11) because reshaping of the land is necessary.

The disposal of sewage effluent includes the disposing of effluent from septic tanks. Truckton and other sandy soils have only slight limitations for leaching fields but have severe limitations for lagoons.

In table 3 streets refer to residential streets and roads that are used by light traffic.

In this survey recreational areas include parks, golf courses, and picnic areas.

In evaluating the soils for landscape plantings, the ease or difficulty of establishing and maintaining grasses, ornamental shrubs, and other plants used in landscaping was considered. The ratings are for relatively undisturbed soil material, generally the uppermost 6 to 8 inches.

Use and Management of Soils for Range [4]

In this section the rangeland in Arapahoe County is briefly described, general practices of range management are discussed, and range sites and condition classes are defined. Each range site in the county is discussed, and its annual yield per acre, when in excellent condition, is estimated.

In Arapahoe County, approximately 300,000 acres, or 60 percent of the acreage, is native range. In addition, many formerly cultivated fields have been reseeded to grasses and are used for grazing. Also, the stubble left on the wheat and grainfields after harvesting is grazed. Raising cattle and sheep is the second largest enterprise in the county.

[4] WILLARD D. GRAVES and THOMAS K. EAMAN, range conservationists, Soil Conservation Service, assisted in the preparation of this section.

TABLE 3.—*Limitations of the*

[Absence of ratings indicates that soil is not suited to

Soils	Degree of limitation for—		
	Foundations for small buildings	Homesites with public sewers	Sites for light industries with public sewers
Adena-Colby fine sandy loams, 1 to 5 percent slopes	Moderate	Slight	Slight
Adena-Colby fine sandy loams, 5 to 9 percent slopes	Moderate	Slight	Moderate
Adena-Colby silt loams, 1 to 5 percent slopes	Moderate	Slight	Slight
Adena-Colby silt loams, 5 to 9 percent slopes	Moderate	Slight	Moderate
Ascalon sandy loam, 5 to 9 percent slopes	Slight	Slight	Moderate
Baca loam, 3 to 5 percent slopes	Moderate	Slight	Slight
Baca loam, 5 to 9 percent slopes	Moderate	Slight	Moderate
Baca-Thedalund loams, 3 to 9 percent slopes			
Beckton loam, 0 to 3 percent slopes	Moderate	Severe	Moderate
Bijou sandy loam, 0 to 3 percent slopes	Slight	Slight	Slight
Bijou sandy loam, wet, 0 to 3 percent slopes	Severe	Severe	Moderate
Blakeland loamy sand, 1 to 9 percent slopes, eroded	Slight	Moderate	Moderate
Blakeland loamy sand, 1 to 20 percent slopes	Slight	Moderate	Severe
Bresser loamy sand, terrace, 0 to 3 percent slopes	Slight	Moderate	Slight
Bresser sandy loam, terrace, 0 to 3 percent slopes	Slight	Slight	Slight
Bresser loam, gravelly subsoil variant, 1 to 3 percent slopes	Slight	Slight	Slight
Bresser-Stapleton sandy loams, 3 to 9 percent slopes	Slight	Slight	Moderate
Bresser-Stapleton sandy loams, 9 to 20 percent slopes	Slight	Slight	Severe
Bresser-Truckton sandy loams, 3 to 5 percent slopes	Slight	Slight	Slight
Bresser-Truckton sandy loams, 5 to 20 percent slopes	Slight	Slight	Severe
Bresser and Truckton soils, 3 to 9 percent slopes, eroded	Slight	Slight	Moderate
Buick loam, 3 to 5 percent slopes	Severe	Moderate	Slight
Buick loam, 5 to 9 percent slopes	Severe	Moderate	Moderate
Clayey alluvial land	Severe	Severe	Severe
Colby silt loam, 1 to 5 percent slopes	Moderate	Slight	Slight
Colby silt loam, 5 to 20 percent slopes	Moderate	Slight	Severe
Colby and Adena soils, 1 to 9 percent slopes, eroded	Moderate	Slight	Moderate
Edgewater loam, 0 to 3 percent slopes	Moderate	Severe	Severe
Fondis silt loam, 1 to 3 percent slopes	Severe	Moderate	Slight
Fondis silt loam, 3 to 5 percent slopes	Severe	Moderate	Slight
Fondis-Ascalon, gravelly subsoil variant, complex, 1 to 9 percent slopes		Moderate	Moderate
Fondis-Colby silt loams, 3 to 5 percent slopes	Severe	Moderate	Slight
Fort Collins loam, 0 to 3 percent slopes	Slight	Slight	Slight
Gravelly land	Slight	Moderate	Severe
Heldt clay, 0 to 3 percent slopes	Severe	Moderate	Moderate
Heldt clay, saline, 0 to 3 percent slopes	Severe	Severe	Severe
Litle silty clay loam, 1 to 9 percent slopes	Severe	Moderate	Severe
Litle-Samsil, gypsum, silty clay loams, 3 to 9 percent slopes	Severe	Moderate	Moderate
Loamy alluvial land	Moderate	Severe	Severe
Nunn loam, 0 to 3 percent slopes	Moderate	Moderate	Slight
Nunn-Bresser-Ascalon complex, 0 to 3 percent slopes	Slight	Slight	Slight
Olney fine sandy loam, 5 to 9 percent slopes	Slight	Slight	Moderate
Renohill loam, 3 to 9 percent slopes	Severe	Moderate	Severe
Renohill loam, reddish variant, 5 to 20 percent slopes	Moderate	Moderate	Severe
Renohill-Buick loams, 3 to 9 percent slopes	Severe	Moderate	
Renohill-Buick loams, 9 to 20 percent slopes	Severe	Moderate	Severe
Renohill-Buick complex, 5 to 20 percent slopes, eroded	Severe	Moderate	Severe
Renohill-Litle clay loams, 3 to 9 percent slopes	Severe	Moderate	Severe
Renohill-Litle-Thedalund complex, 9 to 30 percent slopes	Severe	Moderate	Severe
Rock outcrop	Severe	Severe	Severe
Samsil clay, gypsum, 5 to 20 percent slopes	Severe	Severe	Severe
Samsil-Litle stony clays, 20 to 50 percent slopes	Severe	Severe	Severe
Samsil-Renohill clay loams, 3 to 20 percent slopes	Severe	Moderate	Severe
Samsil-Shale outcrop complex	Severe	Severe	Severe

soils for specified nonfarm uses

specified use or that ratings were not made for that soil]

Degree of limitation for—Continued					Limiting soil features
Disposal of sewage effluent into—		Streets	Recreational areas	Landscape plantings	
Leaching fields	Lagoons				
Moderate	Moderate	Moderate	Moderate	Slight	Unstable; limy; liquefies and settles.
Moderate	Moderate	Moderate	Moderate	Slight	Unstable; limy; liquefies and settles; slope.
Moderate	Moderate	Moderate	Moderate	Slight	Unstable; limy; liquefies and settles.
Moderate	Moderate	Moderate	Moderate	Slight	Unstable; limy; liquefies and settles; slope.
Slight	Severe	Slight	Moderate	Moderate	Limy below a depth of 3 feet.
Moderate	Moderate	Moderate	Moderate	Slight	Unstable; limy; shale below a depth of 5 feet.
Moderate	Moderate	Moderate	Moderate	Slight	Unstable; limy; shale below a depth of 5 feet; slope.
Severe	Slight	Moderate	Moderate	Severe	High in salts; occasional flooding; water table below a depth of 6 feet.
Slight	Severe	Slight	Slight	Moderate	Low available water holding capacity; susceptible to soil blowing.
Severe	Severe	Severe	Moderate	Moderate	Water table below a depth of 3 feet; wetness.
Slight	Severe	Moderate	Moderate	Severe	Topsoil removed.
Slight	Severe	Moderate	Moderate	Moderate	Sandy; erodes easily; droughty.
Slight	Severe	Slight	Slight	Severe	Susceptible to soil blowing; hazard of flooding in places.
Slight	Severe	Slight	Slight	Moderate	Susceptible to soil blowing.
Slight	Severe	Moderate	Slight	Moderate	Gravel below a depth of 3 feet; some gravel occurs in surface layers.
Slight	Severe	Slight	Slight	Moderate	Strongly rolling; fine cemented gravel at a depth of 2 to 6 feet.
Slight	Severe	Slight	Slight	Moderate	Strongly rolling; fine cemented gravel at a depth of 2 to 6 feet; slope.
Slight	Severe	Slight	Moderate	Moderate	Susceptible to soil blowing.
Slight	Severe	Slight	Slight	Moderate	Susceptible to soil blowing; slope.
Slight	Severe	Slight	Moderate	Moderate	Topsoil removed.
Severe	Slight	Moderate	Moderate	Slight	High swelling clay below a depth of 2 feet.
Severe	Slight	Moderate	Moderate	Slight	High swelling clay below a depth of 2 feet; slope.
Severe	Severe	Severe	Moderate	Moderate	Frequent flooding; wet; high swelling clay.
Moderate	Moderate	Moderate	Moderate	Slight	Unstable; limy; liquefies and settles.
Moderate	Moderate	Moderate	Moderate	Severe	Unstable; limy; liquefies and settles; slope.
Moderate	Moderate	Moderate	Moderate	Severe	Topsoil removed; unstable; limy; liquefies and settles.
Severe	Severe	Severe	Slight	Slight	High water table; occasional flooding.
Severe	Slight	Moderate	Moderate	Slight	High swelling clay; salts below a depth of 8 inches.
Severe	Slight	Moderate	Moderate	Slight	High swelling clay; salt below a depth of 8 inches; slope.
Severe		Moderate	Moderate	Slight	Fondis soil contains high swelling clay.
Severe		Moderate	Moderate	Slight	Fondis soil contains high swelling clay.
Slight	Moderate	Moderate	Slight	Slight	Occasional flooding.
Slight	Severe	Slight	Moderate	Severe	Steep in most areas.
Severe	Slight	Severe	Moderate	Severe	High swelling clay; very slow rate of water intake.
Severe	Slight	Severe	Severe	Severe	High swelling clay; salty; wet in places.
Severe	Slight	Severe	Moderate	Severe	High swelling clay; salty; shale below a depth of 2½ feet.
Severe	Slight	Severe	Severe	Severe	High swelling clay; salty; shale below a depth of 1½ feet.
Severe	Severe	Severe	Slight	Slight	Frequent flooding.
Moderate	Slight	Moderate	Slight	Slight	Occasional flooding in places.
Moderate	Moderate	Slight	Slight	Moderate	Undulating.
Slight	Severe	Slight	Moderate	Moderate	Strongly rolling; sandstone below a depth of 5 feet.
Severe	Slight	Moderate	Moderate	Moderate	High swelling clay; shale below a depth of 3 feet.
Severe	Slight	Severe	Moderate	Slight	Strongly sloping; shale below a depth of 3 feet.
Severe	Slight	Moderate	Moderate	Moderate	High swelling clay.
Severe	Slight	Moderate	Severe	Severe	High swelling clay.
Severe	Slight	Moderate	Severe	Severe	High swelling clay; eroded.
Severe	Slight	Severe	Moderate	Severe	High swelling clay.
Severe	Moderate	Severe	Severe	Severe	High swelling clay; shale or sandstone below a depth of 2½ feet.
Severe	Severe	Severe	Severe	Severe	Bare rock.
Severe	Moderate	Severe	Severe	Severe	Shale at a depth of less than 18 inches.
Severe	Severe	Severe	Severe	Severe	Slope; stony; high swelling clay.
Severe	Slight	Severe	Severe	Severe	High swelling clay.
Severe	Slight	Severe	Severe	Severe	High swelling clay; shale at a depth of less than 20 inches.

TABLE 3.—*Limitations of the soils*

Soils	Degree of limitation for—		
	Foundations for small buildings	Homesites with public sewers	Sites for light industries with public sewers
Sand pits	Slight	Severe	Severe
Sandy alluvial land	Slight	Severe	Severe
Shale outcrop	Severe	Severe	Severe
Stapleton sandy loam, 9 to 30 percent slopes	Slight	Slight	Severe
Tassel-Rock outcrop complex	Slight	Moderate	Severe
Terrace escarpments	Severe	Severe	Severe
Terry fine sandy loam, 5 to 20 percent slopes	Slight	Slight	Severe
Terry-Olney-Thedalund sandy loams, 5 to 20 percent slopes	Slight	Moderate	Severe
Thedalund clay loam, 9 to 20 percent slopes	Moderate	Slight	Severe
Thedalund clay loam, 9 to 20 percent slopes, eroded	Moderate	Slight	Severe
Truckton loamy sand, 1 to 5 percent slopes	Slight	Slight	Slight
Truckton loamy sand, 5 to 20 percent slopes	Slight	Slight	Severe
Weld fine sandy loam, 1 to 5 percent slopes	Moderate	Slight	Slight
Weld silt loam, 0 to 3 percent slopes	Moderate	Slight	Slight
Weld silt loam, 3 to 5 percent slopes	Moderate	Slight	Moderate
Weld-Deertrail silt loams, 0 to 3 percent slopes	Moderate	Slight	Slight
Wet alluvial land	Severe	Severe	Severe

The largest ranches generally are in the eastern part of the county. Most of these ranches are cow-calf enterprises, but some are cattle-sheep enterprises. Wheat-livestock units are more common in the central and western parts of the county. In the extreme western part, however, the small dairy farms are being replaced by residential, commercial, and industrial developments.

The larger ranches generally produce enough native hay to provide adequate feed during winter storms, but the smaller ranches depend on locally grown feed and on hay shipped from other areas to provide supplemental feed in winter.

Climate influences the production of forage. In the eastern part of the county, the climate is favorable for the growth of short grasses, mainly blue grama, buffalograss, and other warm-season grasses. In the western part of the county, western wheatgrass, green needlegrass, and other cool-season grasses grow better than the short grasses.

Range management practices

Proper grazing is the most important of all range practices. Controlling grazing so as to maintain cover adequate to protect the soils and to encourage the growth of perennial forage plants helps to maintain and improve the range. Generally, this means leaving at least half of the annual growth at the end of the growing season.

In addition to proper degree of use, deferred grazing and distribution of grazing also help to conserve plant cover, soil, and water. In their leaves, grasses manufacture the food they need to grow and reproduce. Grasses must store in their roots the food they need to start vigorous growth in spring. The desirable grasses, therefore, should be given an opportunity to manufacture enough plant food for vigorous growth of tops and for good root development before they are grazed in spring. The vegetation should also be adequate to protect the soil against erosion and to encourage the intake and storage of water. Other beneficial practices are developing adequate water facilities and mechanical treatments that will increase the penetration and storage of moisture.

Range sites and condition classes

Soils differ in their capacity to produce vegetation. The kinds and amounts of native forage plants in an area depend on the combined effect of the soil and climate. A range site is an area where climate and soil are sufficiently uniform to produce about the same kinds and amounts of vegetation.

Grazing use and other management practices affect the kind of vegetation on each range site and the productivity of the site. Range condition is determined mainly by comparing the present vegetation on a given site with the vegetation that originally grew there. The classes of range condition used to indicate the degree to which the vegetation has been changed by grazing or other use are *excellent*, *good*, *fair*, and *poor*. A range in excellent condition is producing the maximum amounts of native plants for the site and the climate. Range in poor condition does not produce optimum yields of forage and is not protected against erosion.

The plants on any given range site can be classified or grouped as decreasers, increasers, and invaders, according to their response to grazing. Decreasers generally are the most desirable and productive plants on any given range site. Livestock seek out the most palatable and nutritious

for specified nonfarm uses—Continued

Degree of limitation for—Continued					Limiting soil features
Disposal of sewage effluent into—		Streets	Recreational areas	Landscape plantings	
Leaching fields	Lagoons				
Slight	Severe	Moderate	Moderate	Severe	Occasional flooding.
Severe	Severe	Moderate	Slight	Severe	Frequent flooding.
Severe	Severe	Severe	Severe	Severe.	
Slight	Severe	Slight	Moderate	Severe	Cemented fine gravel below a depth of 2 feet.
Severe	Severe	Moderate	Moderate	Severe	Sandstone at a depth of less than 18 inches; slope.
Severe	Severe	Severe	Slight	Slight	Flooding.
Slight	Severe	Moderate	Moderate	Moderate	Sandstone below a depth of 3 feet.
Moderate	Severe	Slight	Moderate	Severe	Variable depth to sandstone or shale.
Severe	Moderate	Moderate	Moderate	Severe	Shale or sandstone at a depth of less than 30 inches.
Severe	Moderate	Moderate	Moderate	Severe	Surface soil removed; shale or sandstone at a depth of less than 30 inches.
Slight	Severe	Slight	Moderate	Severe	Sand below a depth of 2 feet; susceptible to soil blowing.
Slight	Severe	Slight	Moderate	Severe	Strongly rolling; sand below a depth of 2 feet; susceptible to soil blowing.
Moderate	Moderate	Moderate	Moderate	Slight	Silty; liquefies.
Moderate	Moderate	Moderate	Moderate	Slight	Silty; liquefies.
Moderate	Moderate	Moderate	Moderate	Slight	Silty; liquefies; slope.
Moderate	Moderate	Moderate	Moderate		Silty; liquefies.
Severe	Severe	Severe	Slight	Slight	Water table at a depth of less than 3 feet; flooding; sand and gravel below a depth of 30 inches.

grasses, and under heavy grazing these plants, or decreasers, tend to give way to less desirable plants or increasers. Increasers generally are shorter and less palatable than the decreasers. They are more capable of withstanding close grazing than the decreasers, and they normally increase in abundance as the most desirable plants are reduced. Under continuous heavy grazing, the increaser plants are weakened and reduced and are replaced by invaders, which are shrubby plants or annual weeds and grasses, that eventually dominate the site.

Descriptions of range sites

The 14 range sites in Arapahoe County are described in the following pages. Also given for each site is the total annual yield of herbage in years of favorable moisture and in years of unfavorable moisture. To determine the soils in any given range site, refer to the "Guide to Mapping Units" at the back of this soil survey. Seven mapping units have not been placed in any range site. They are Samsil-Litle stony clays, 20 to 50 percent slopes, Stapleton sandy loam, 9 to 30 percent slopes, Gravelly land, Rock outcrop, Sand pits, Sandy alluvial land, and Terrace escarpments.

LOAMY PLAINS RANGE SITE

This range site occurs in the eastern part of the county, mainly on the larger ranches. It consists of deep to moderately deep, level to steep soils that have a fine sandy loam, loam, or silt loam surface layer.

Short grasses, mainly blue grama and buffalograss, are dominant on this site. If the site is in excellent condition, small amounts of western wheatgrass, junegrass, needlegrass, and other mid grasses appear during years when moisture is favorable. These plants, however, are weakened and eliminated during dry periods. Among the common forbs are scarlet globemallow, wild alfalfa, and groundsel.

On this site the ratio of blue grama to buffalograss indicates range condition. As the condition of the range declines, the percentage of buffalograss increases. Under continuous overgrazing, blue grama grows in dense sod rather than in spaced bunches, and the range takes on a sodlike appearance. If the range is overgrazed in years of unfavorable moisture, there is a decrease of perennial plants and an increase of six-weeks fescue, cheatgrass, wild barley, wooly plantain, gumweed, and other less desirable plants.

This range site is suitable for grazing the year round, but topography gives livestock little protection during snowstorms. Supplemental feeding is needed if this site is grazed in winter.

A protective cover of litter, or a layer of plant residue, is essential in improving a poor or fair range condition or in maintaining a good or poor condition. Litter is increased by controlling grazing and by occasionally resting the range.

When this site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,200 pounds per acre in years of favorable moisture to 400 pounds per acre in years of unfavorable moisture. Nearly all of this yield is forage suitable for cattle.

LOAMY SLOPES RANGE SITE

This range site is adjacent to the Loamy Plains range site in the eastern part of the county. It consists of gently sloping to steep soils that have a surface layer of silt loam or clay loam that contains large amounts of lime. Runoff is rapid, and the surface layer is dry much of the time.

Figure 11.—**A housing development on Buick loam, 5 to 9 percent slopes. Erosion is a severe hazard during construction.**

This range site is better suited to deep-rooted grasses and other plants than to shallow-rooted plants (fig. 12). Western wheatgrass, side-oats grama, little bluestem, and needle-and-thread are dominant, but blue grama grows in bunches throughout the site. Also present are small amounts of sand dropseed, threadleaf sedge, and three-awn.

When this site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,200 pounds per acre in years of favorable moisture to 400 pounds per acre in years of unfavorable moisture. Nearly all of this yield is forage suitable for cattle.

CLAYEY PLAINS RANGE SITE

This range site occupies small areas on stream terraces and side slopes in the eastern part of the county. In most places it is surrounded by the Loamy Plains range site. It consists of moderately deep to shallow, level to steep soils that have a clay loam or clay surface layer and subsoil. Included in this site are a few abandoned fields where erosion has removed much of the original surface layer and has exposed the clayey subsoil.

Western wheatgrass is the principal decreaser and the most important key grass on this range site. Other decreasers are fourwing saltbush and winterfat, but these plants are difficult to maintain if they are grazed the year round. Blue grama and buffalograss are the main increasers, and low rabbitbrush, dryland sedges, and red three-awn are less common increasers. Annual grasses and weeds are the most common invaders. Six-weeks fescue invades areas where the grass cover is thinned by drought or overgrazing. Among the less desirable increasers are gumweed, fringed sage, snakeweed, and pricklypear cactus.

When this site is in excellent condition, the total annual yield of air-dry herbage ranges from 950 pounds per acre in years of favorable moisture to 400 pounds per acre in years of unfavorable moisture. About three-fourths of this yield is forage suitable for cattle.

ALKALINE PLAINS RANGE SITE

This range site is in the eastern one-fourth of the county. It consists of very shallow to moderately deep, rolling to steep soils that formed in material weathered from saline Pierre shale. These soils have a surface layer of silty clay loam, clay, or silt loam. Gypsum crystals and outcrops of shale are common on the soils that have slopes of more than 10 percent.

This range site is suited to plants that are tolerant of alkali. Alkali sacaton is dominant (fig. 13), but western

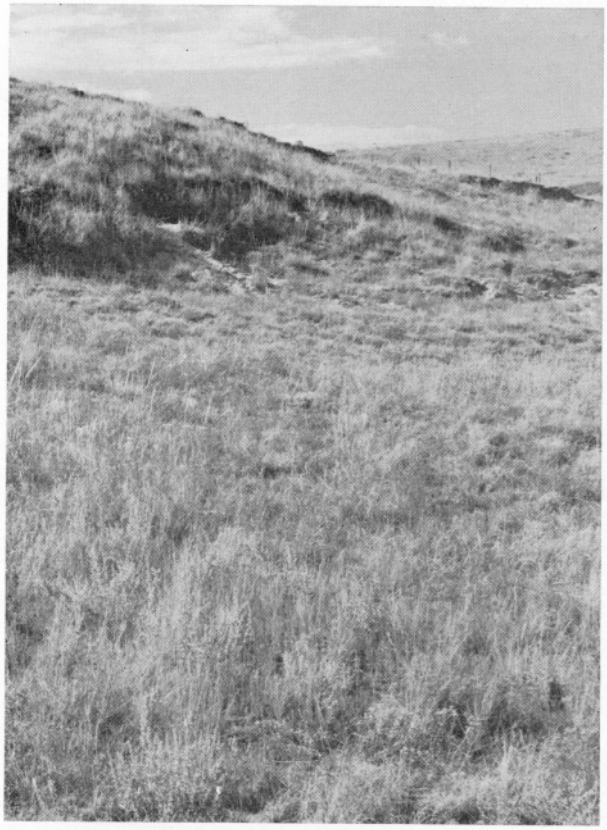

Figure 12.—**Loamy Slopes range site on Colby silt loam, 5 to 20 percent slopes.**

wheatgrass also helps to provide good cover and suitable forage. Short grasses are the principal increasers. Blue grama and buffalograss are the most common increasers. Saltgrass and dryland sedges are less important increasers, and ring muhly, pricklypear cactus, and annual weeds and grasses are the least desirable increasers.

Because this range site generally is closely intermingled with the Loamy Plains range site, management should be based on the larger or dominant site. Management is needed that encourages the growth of mid grasses, particularly western wheatgrass and alkali sacaton. The soils in this range site are subject to water erosion, but a protective cover of litter or plant residue can be kept on the surface by controlling grazing and resting the site periodically.

When this site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,000 pounds per acre in years of favorable moisture to 500 pounds per acre in years of unfavorable moisture. About three-fourths of this yield is forage suitable for cattle.

SANDY PLAINS RANGE SITE

This range site occurs in the eastern half of the county (fig. 14). It consists of undulating to steep, generally deep soils that have a surface layer of sandy loam or fine sandy loam and a subsoil of sandy loam to sandy clay loam. These soils take in water readily, have good available water holding capacity, and can support fairly large amounts of mid grasses.

Figure 13.—**Alkali sacaton and fourwing saltbush growing on a Deertrail silt loam on the Alkaline Plains range site.**

This range site is suited to a larger variety of grasses than the Loamy Plains range site. Little bluestem, needle-and-thread, side-oats grama, junegrass, and other mid grasses are dominant. Of the tall grasses, sand reedgrass is the most prevalent, but there are small amounts of sand bluestem and big bluestem. If the range is overgrazed or otherwise abused, the mid grasses decrease and blue grama and dryland sedges increase. Other common increasers are western wheatgrass, sand dropseed, and three-awn. Wormwood sage, fringed sage, and other sages are also increasers. Pricklypear cactus and annual weeds and grasses are the most common invaders.

Forbs are more common on this site than on the Loamy Plains range site. American vetch and prairie-clover grow in the higher areas. Wild buckwheat is the main plant for identifying this range site after the key grasses have been eliminated.

The grasses best suited to this site are better suited to grazing in spring and summer than in winter. Most ranchers, therefore, plan for grazing this range site in spring and summer where possible. If this practice continues, grazing pressure will be on the more palatable grasses and grasses that turn green earliest. These desirable grasses will decrease, short grasses and weeds will take their place, and openings will appear in the plant cover. Then these soils will be susceptible to soil blowing and water erosion. It is essential, therefore, to rest this site periodically so that growth of desirable plants is maintained and damage from erosion is reduced.

When this site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,800 pounds per acre in years of favorable moisture to 600 pounds per acre in years of unfavorable moisture. About three-fourths of this yield is forage suitable for cattle.

Figure 14.—**Mid grasses, tall grasses, and blue grama growing on the Sandy Plains range site. The soil is Terry fine sandy loam, 5 to 20 percent slopes.**

DEEP SAND RANGE SITE

This range site is on uplands and occurs in narrow bands on the eastern side of major drainageways. It makes up only a small acreage of the county and consists of deep, nearly level to steep soils that have a loamy sand surface layer. These soils take in water readily, but their available water holding capacity is relatively low. They are susceptible to severe soil blowing.

Tall grasses, mainly sand bluestem and sand reedgrass, are dominant on this site. Switchgrass may appear during years when moisture is favorable, but it is difficult to keep on this site. Of the mid grasses, little bluestem and needle-and-thread are the main decreasers. Under continuous heavy grazing, particularly late in spring and in summer, the more productive and desirable grasses give way to blue grama, sand dropseed, sedges, and other less desirable plants. Continued abuse causes an increase in sand muhly, stickleaf, perennial ragweed, hairy goldaster, many annual weeds and grasses, and other undesirable plants.

Keeping litter and a cover of growing plants is especially important on this range site because the wind can quickly gouge blowouts and pile up sand in raw dunes.

When this site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,500 pounds per acre in years of favorable moisture to 1,200 pounds per acre in years of unfavorable moisture. About two-thirds of this yield is forage suitable for cattle.

SANDSTONE BREAKS RANGE SITE

Tassel-Rock outcrop complex, the only mapping unit in this range site, occurs in broken areas at the upper ends of drainageways. The soils generally are shallow, but pockets of deeper soils are intermixed with the shallow soils in some places. The stones and fractured rock in and on the soils increase the amount of water that is available to plants.

On this site most of the vegetation consists of tall grasses, mainly big bluestem and prairie sandreed, and of little bluestem, side-oats grama, needle-and-thread, blue grama, threadleaf sedge, and prairie-clover.

When this site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,700 pounds per acre in years of favorable moisture to 800 pounds per acre in years of unfavorable moisture. About two-thirds of this yield is forage suitable for cattle.

SHALE BREAKS RANGE SITE

This range site generally occurs at the upper end of narrow drainageways. It consists partly of shallow, steep soils and partly of areas where shale outcrops are numerous.

On this site side-oats grama, western wheatgrass, and green needlegrass are the main decreasers. If the condition of the range declines, blue grama and buffalograss increase. The less common increasers include wild rose, skunkbush, wild currant, chokecherry, wormwood, and wild buckwheat. Buffalograss, blue grama, and sedges are the dominant increasers in the areas where shale crops out. The less desirable increasers are fringed sage, gumweed, hairy goldaster, pricklypear cactus, and snakeweed.

When this site is in excellent condition, the total annual yield of air-dry herbage ranges from 800 pounds per acre in years of favorable moisture to 600 pounds per acre in years of unfavorable moisture. About three-fourth of this yield is forage suitable for cattle.

SALT FLAT RANGE SITE

Beckton loam, 0 to 3 percent slopes, is the only soil in this range site. It is along the larger drainageways in the county and is subject to occasional flooding. This soil is deep and is alkaline. Bare, slick spots are common in areas where the condition of the range has declined or in areas where the accumulation of salts is too high for the growth of plants.

When this site is in excellent condition, western wheatgrass and alkali sacaton are the most prevalent, but green needlegrass is also an indicator of range in good condition. If the condition of the range declines, the key grasses are replaced by blue grama, buffalograss, native bluegrass, and low rabbitbrush. The invaders are snakeweed, pricklypear cactus, mouse-ear poverty weed, and annual weeds and plants.

When this site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,500 pounds per acre in years of favorable moisture to 750 pounds per acre in years of unfavorable moisture. About two-thirds of this yield is forage suitable for cattle.

OVERFLOW RANGE SITE

This range site occurs along drainageways and receives extra moisture from floods. It consists of soils that have a loam, sandy loam, or clayey surface layer.

Because of the periodic flooding, forage and hay plants grow well on this range site, particularly in winter and early in spring. Western wheatgrass and switchgrass are the key grasses for indicating range condition, and they can be used in determining the kind of management needed. On this site western wheatgrass generally is more prevalent and is more easily grown than switchgrass. If the key plants are weakened or eliminated, buffalograss, sedges, low rabbitbrush, and blue grama become dominant. Continued deterioration of the site results in the invasion of fringed sage, Kentucky bluegrass, saltgrass, cheatgrass, and other less desirable plants.

When this site is in excellent condition, the total annual yield of air-dry herbage ranges from 3,000 pounds per acre in years of favorable moisture to 1,500 pounds per acre in years of unfavorable moisture. About two-thirds of this yield is forage suitable for cattle.

WET MEADOW RANGE SITE

This range site occurs on bottom lands and is flooded occasionally (fig. 15). It consists mostly of level to nearly level soils that have a sandy loam or loam surface layer and a high water table. Included in this site are a few small seeps on hillsides. These areas are indicated on the soil map by the standard symbol for wet spots. The water table is the major factor that affects the kind and growth of plants on this site.

When this range site is in excellent condition, switchgrass, cordgrass, wild licorice, indiangrass, and bluestem generally are dominant. Common increasers generally are western wheatgrass, saltgrass, and wild barley. In the wetter spots, sedges, rushes, and horsetail are common increasers. The invaders include blue grama, Kentucky bluegrass, cocklebur, gumwood, and annuals.

When this site is in excellent condition, the total annual yield of air-dry herbage is 4,000 pounds per acre in most years. About three-fourths of this yield is suitable forage for cattle.

LOAMY FOOTHILL RANGE SITE

This range site occurs in the western half of the county. It consists of moderately deep and deep soils that have a surface layer of loam or silt loam and slopes ranging from 0 to 25 percent.

On this site the moisture in winter and spring and the elevation are favorable for the growth of cool-season grasses. Western wheatgrass and, to a lesser extent, green needlegrass are the most productive plants. Junegrass and native bluegrass also grow on this site, but in amounts that vary according to the season. Blue grama is the dominant increaser, but three-awn and soapweed are also increasers. Continuous overgrazing, particularly early in spring, causes blue grama to form a dense sod and to replace the preferred grasses. The invaders, or undesirable plants, include fringed sage, hairy goldaster, and cheatgrass.

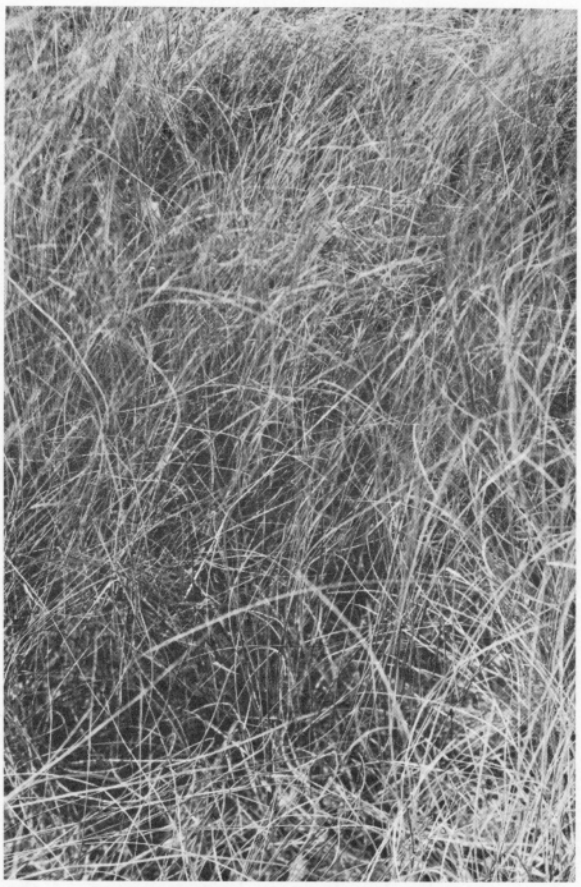

Figure 15.—**An area of the Wet Meadow range site. The soil is Edgewater loam, 0 to 3 percent slopes.**

When this site is in excellent condition, the total annual yield of air-dry herbage ranges from 1,500 pounds per acre in years of favorable moisture to 700 pounds per acre in years of unfavorable moisture. Nearly all of this yield is forage suitable for cattle.

CLAYEY FOOTHILL RANGE SITE

This range site occurs in the western half of the county, mainly in small areas that are closely intermingled with larger areas of the Loamy Foothill range site. The Clayey Foothill range site consists of shallow to deep soils that have a clay or clay loam surface layer and slopes ranging from 0 to 25 percent. Cultivated areas and severely eroded areas in the adjacent Loamy Foothill site are grazed with this range site.

On this site elevation and the pattern of rainfall are favorable for the growth of cool-season grasses and forbs that include western wheatgrass, green needlegrass, prairieclover, and small pod vetch. The dominant increaser is blue grama, but other increasers are buffalograss, three-awn, dryland sedge, and native bluegrass.

Continued heavy grazing results in the invasion of snal weed, fringed sage, rabbitbrush, ring muhly, and annu grasses and weeds.

Water erosion is a continuous hazard on this site. organic matter is depleted and a protective cover of lit is not maintained, the soils tend to seal. This sealing duces the penetration of moisture and increases runc After the vegetation deteriorates, recovery is slow.

When this site is in excellent condition, the total annu yield of air-dry herbage ranges from 1,200 pounds p acre in years of favorable moisture to 600 pounds per a in years of unfavorable moisture. About three-fourths this yield is forage suitable for cattle.

SANDY FOOTHILL RANGE SITE

This range site occurs in the western half of the coun It consists of level to steep soils that have a sandy loam loamy sand surface layer and a sandy clay loam subs These soils formed in noncalcareous sand deposited wind and water.

Tall grasses grow better on this range site than on t Sandy Plains site. The potential vegetation is dominat by bluestem, sand reedgrass, and needlegrass. If the ran is overgrazed, the tall grasses decrease and blue gran dryland sedge, western wheatgrass, and junegrass increa As the condition of the range declines, pricklypear cact cheatgrass, and six-weeks fescue invade.

When this site is in excellent condition, the total annu yield of air-dry herbage ranges from 1,500 pounds p acre in years of favorable moisture to 800 pounds per a in years of unfavorable moisture. About three-fourths this yield is forage suitable for cattle.

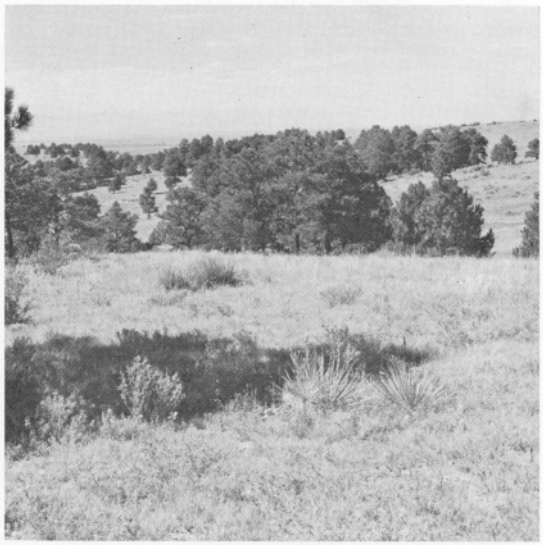

Figure 16.—Native ponderosa pine growing on Stapleton sandy loam, 9 to 30 percent slopes.

Use and Management of Soils for Trees [5]

Most of Arapahoe County was treeless when it was first settled, but since then trees have been planted both for protection and for beautification. The wooded areas now consist mainly of windbreaks, landscape plantings, and a few stands of native trees.

Native woodland makes up about 1 percent of the county. The trees are of little or no commercial value, but they provide shade for livestock and some wooded areas can be developed for recreational uses. A few native stands, consisting mainly of cottonwoods and willows, grow along the South Platte River, Cherry Creek, and intermittent drainageways. Native ponderosa pine grows on the Stapleton soils along South Cherry Creek (fig. 16).

Trees can be planted to provide protection for homes and livestock against wind and cold weather; to add to the beauty of the landscape; to control drifting snow; and to provide shade in summer and food and cover for song birds and game birds. Trees and shrubs are also used as screens to reduce noise and to help protect streambanks and control erosion.

Trees and shrubs can be established and maintained successfully in this county if planning and care are good and if the seedlings are properly planted. It is essential that the seedlings come from good stock and have well-developed roots. Because moisture is limited, competing grass and weeds should be controlled. Tillage helps to control trees. Additional water can be obtained by diverting runoff from higher ground into areas where the trees are planted. Stubble-mulch tillage and summer fallow are necessary to store moisture in the sandy loams and clay loams before the site is planted. Planting seedlings in narrow strips and leaving vegetation between the strips is advisable on the loamy sands and sands; the vegetation that is left helps to keep these soils from blowing and, by trapping snow, increases the amount of moisture that enters the soil. The vegetation can be removed when the trees are large enough to protect the soil.

Particularly important in planning windbreaks or shelterbelts is determining the proper spacing of trees and shrubs for maximum growth and good density. Enough spacing between the rows is needed to allow growing space for the trees and shrubs and to allow enough room for cultivation. Rows should be at least 20 feet apart on dryland sites and in windbreaks or shelterbelts that have more than 2 rows. Good density is provided by suitable spacing of trees and shrubs in the rows. The seedlings should be planted close enough to provide protection, yet far enough apart to allow growing room. A spacing of 3 or 4 feet is needed for shrubs, 6 to 8 feet for pine, juniper, and other evergreens, and 8 to 10 feet for tall, broad-leaved trees.

Evergreens provide protection throughout the year, and they withstand droughts better than other trees and shrubs. They generally live longer than the broad-leaved trees, but they are more difficult to establish, and they grow more slowly for the first few years. Seedlings are more likely to survive the shock of planting if they are potted.

Further information about the soils and their suitability for trees is available from a representative of the Soil Con-

[5] By WILFRED S. SWENSON, woodland conservationist, Soil Conservation Service.

servation Service and the County Agricultural Extension Service. Assistance in planting trees and shrubs for windbreaks and in securing planting stock at low cost can be obtained from the Colorado State Forest Service at Fort Collins. Residents in the cities and towns can obtain assistance in selecting and planting trees and shrubs from the Horticulture Department of the Colorado State University at Fort Collins and from local nurserymen and landscape specialists.

Tree planting suitability groups

The kind of soil largely determines the trees and shrubs most suitable for planting, the growth of these trees and shrubs, and the management needed for their upkeep. On the basis of their suitability for trees and shrubs and the management needed, the soils of this county have been placed in five tree planting suitability groups. Each group differs from the others in the care and practices used in establishing and managing trees and shrubs and also in their rate of growth. The soils in each tree planting suitability group can be identified by referring to the "Guide to Mapping Units" at the back of this soil survey.

The tree planting suitability groups are described in this section. For each group, the expected growth of broad-leaved trees, evergreens, and shrubs is rated *good*, *fair*, or *poor*. These terms are explained in the following paragraphs, and the trees and shrubs suitable for planting are listed.

Broad-leaved Trees.—A rating of *good* for broad-leaved trees means that the trees are well formed and that their growth is vigorous for at least 20 years, during which time Siberian elm is expected to reach a height of 30 feet or more. A rating of *fair* indicates that these trees are not so well formed and vigorous as those rated good and that Siberian elm is expected to attain a height of 25 to 30 feet at 20 years of age. *Poor* means that these trees are poorly formed and grow slowly and that at 20 years of age Siberian elm generally is less than 25 feet tall and shows signs of failing.

The most suitable broad-leaved trees for planting on nonirrigated sites are Siberian elm and common hackberry. Trees that can be grown successfully only on irrigated sites or in other areas where supplemental moisture is available are white ash, green ash, white birch, flowering crab, elm, honeylocust, horsechestnut, linden, Norway maple, silver maple, mountain-ash, plains popular, Bolleana poplar, Carolina poplar, Lombardy poplar, golden willow, and weeping willow.

Evergreens.—A rating of *good* for evergreens indicates that an average yearly growth of 1 foot or more is expected for the first 20 years. *Fair* means that the average growth is ¾ to 1 foot for the first 20 years. If the rating is *poor*, the average yearly growth is expected to be less than ¾ foot for the first 20 years.

The most suitable evergreens for planting on nonirrigated sites are ponderosa pine, Austrian pine, Rocky Mountain juniper, and eastern redcedar. Evergreens that can be grown successfully only on irrigated sites or in other areas where supplemental moisture is available are concolor fir, Savin and Pfitzer junipers, Mugho Swiss mountain pine, and Colorado blue spruce.

Broad-leaved Shrubs.—For shrubs, a rating of *good* means that 90 to 100 percent of the planted seedlings are expected to live and that the shrubs are dense and have vigorous growth. A rating of *fair* indicates that 80 to 90 percent of the seedlings live and that the shrubs are only moderately dense and their growth is fair to good. *Poor* means that no more than 70 percent of the seedlings live and that the shrubs are poorly formed and their growth is poor to fair.

The most suitable shrubs for planting on nonirrigated sites are squawbush, Siberian peashrub, lilac, Russian-olive, and sand cherry. Shrubs that can be grown successfully only on irrigated sites or in other areas where supplemental moisture is available are bridalwreath, butterfly bush, chokecherry, cinquefoil, cranberry bush, dogwood, forsythia, honeysuckle, maple, mockorange, ninebark, plum, privet, snowberry, snowball, spirea, sumac, and winged euonymus.

TREE PLANTING SUITABILITY GROUP 1

This group consists of deep, level to sloping soils that have a sandy loam to clay loam surface layer and a clayey subsoil. After the seedlings are established, the growth of shrubs and of broad-leaved trees is fair to good and that of evergreens is good.

Wind, drought, and soil blowing are the chief hazards on nonirrigated sites. To overcome these hazards, the soils should be summer fallowed before the seedlings are planted. After planting, clean cultivation is needed for as many years as possible. If practical, water should be diverted from other areas to the planting site. Where water is available for irrigation, summer fallow is not needed, the growth and survival rates of trees and shrubs are better than on dryland sites, and more kinds of trees and shrubs are suitable for planting.

TREE PLANTING SUITABILITY GROUP 2

This group consists mainly of deep, level to steep soils that have a loamy sand or sandy loam surface layer. Also in this group are a few shallow soils in which the content of moisture is adequate for the growth of trees. Broad-leaved trees, evergreens, and shrubs grow well on the soils in this group.

On nonirrigated sites soil blowing and loss of water, which are the main hazards to establishing trees and shrubs, can be lessened by leaving a cover of stubble or growing vegetation near the seedlings; by placing shingles on the south and west sides of each plant for the first 2 or 3 years; by building snow fences; by allowing weeds to grow after mid-August; and by clean cultivation during the period April through July, which is the period of most rapid growth. Generally, all of the adapted trees and shrubs grow better in irrigated areas than on dryland sites. The water should be applied with special care to avoid erosion.

TREE PLANTING SUITABILITY GROUP 3

This group consists of wet, level to gently sloping, loamy soils on which the growth of broad-leaved trees is poor to good and that of evergreens and of shrubs is fair to good.

Establishing trees and shrubs on these soils is difficult in some places. On some sites cultivation and watering are essential for the first 2 or 3 years, but after that the trees can compete successfully with other vegetation.

The water-tolerant trees and shrubs that are most suitable on the soils in this group include willow, cottonwood,

chokecherry, green ash, and honeylocust. Among the suitable evergreens, Colorado blue spruce grows better than ponderosa pine or Austrian pine.

TREE PLANTING SUITABILITY GROUP 4

This unit consists of shallow to deep, level to steep, sandy, loamy, and clayey soils. On most of the soils in this group the growth of broadleaved trees and of shrubs is poor to fair and that of evergreens is fair. Their growth, however, is good to fair in the drainageways and in the small areas that consist of deep, gently sloping soils.

Trees and shrubs are difficult to plant on the soils in this group, and they generally are expected to have poor survival and growth rates. Before trees are planted, a careful onsite examination should be made to find the deep, well-drained, and nonsaline soils. On steep slopes the seedlings should be planted in contour rows.

TREE PLANTING SUITABILITY GROUP 5

This group consists mostly of shallow, level to steep, loamy and clayey soils. There are, however, a few small areas of deep soils along the drainageways and small areas of deep, gently sloping, loamy soils in other places. These areas can be located only by a careful onsite examination; trees and shrubs can be planted in these areas, but their growth is poor to fair. Generally, the soils in this group are not suitable for planting most trees and shrubs; if trees are planted their growth is poor.

Growing trees and shrubs is not practical on these soils. They are too difficult to plant and to keep alive because the soils are steep, shallow, saline, alkaline, and have a high or fluctuating water table, or inadequate moisture content. Some areas can be reclaimed for trees and shrubs by correcting the salinity or alkalinity of the soils, by hauling in soil material, or by increasing the depth of the soils.

Use of Soils for Wildlife [6]

Wildlife is a product of the soil on which it lives. The habitat largely determines the kinds and numbers of wildlife present in any area. It must be in an area where various kinds of wildlife can find food, cover, and water. Generally, the largest number of wildlife frequent areas that provide enough of the kind of food and cover necessary for their survival. Because the expanding metropolitan areas have affected the land use in the county, the natural habitat has been altered for wildlife in this county, and much of it has been practically destroyed, particularly in the western part. These changes in land use have altered the numbers and kinds and also the distribution of wildlife in the county.

Table 4 shows the suitability of the soils, by soil associations, as habitat for the major kinds of wildlife in this county. The general soil map at the back of this survey shows, in color, the location of the soil associations in the county. For descriptions of the soil associations, see the section "General Soil Map" in this survey. Because the ratings shown in table 4 are based on soil associations, which is a broad classification for this use, additional information about developing and managing wildlife habitat and assistance for onsite investigations should be obtained from the local office of the Soil Conservation Service.

Use of Soils for Recreation [7]

The development of outdoor recreational areas is closely related to the soils. Most of the soils in Arapahoe County have properties that limit their suitability for recreational uses. It is important, therefore, to know the limitations that affect use of soils for recreational areas. Table 5 indicates the degree of limitations of the soil associations in the county for vacation farms or dude ranches; picnic and sports areas; fishing, camping, and hunting areas; and shooting preserves; and as sites for rural cottages and homes.

Because rating of limitations by soil associations are broad, the ratings given in table 5 do not eliminate the need for careful onsite investigations. The general soil map at the back of this survey shows the location of the soil associations in the county, which are described in the section "General Soil Map."

Factors other than soil characteristics to consider in evaluating the soil associations for recreational purposes are those that concern health, safety, and economic returns.

The limitations of the soil associations shown in table 5 are rated slight, moderate, and severe. A rating of *slight* means that the soils in the association have no important limitations to the specified use or that the limitations are not difficult to overcome. *Moderate* means that the soils have some limitations to the specified use, but that these limitations generally can be overcome. Some of the limiting factors are unfavorable soil texture and soil depth, stoniness, and other soil deficiencies that slow the growth of plants. A rating of *severe* indicates that the soils have serious limitations to the specified use. The limiting features include steep slopes, a high water table, flooding, unfavorable soil texture, acidity, and stoniness or rockiness.

Additional information useful in planning recreational developments can be found in this soil survey in the sections "Engineering Uses of Soils," "Nonfarm Uses of Soils," and "Use and Management of Soils for Trees." Technical assistance in planning recreational enterprises and for onsite investigations can be obtained from the local representative of the Soil Conservation Service.

Engineering Uses of Soils [8]

This section provides information of special interest to engineers, contractors, farmers, and others who use soil as structural material and as foundation material upon which structures are built. Some properties of soils are of special interest to the engineer because they affect construction and maintenance of roads, airports, pipelines, building foundations, water storage facilities, erosion control structures, drainage systems, and sewage disposal systems. Among the properties most important to the engineer are permeability,

[6] By ELDIE W. MUSTARD, biologist, and O. A. PARSONS, soil scientist, Soil Conservation Service.

[7] By ELDIE W. MUSTARD, biologist, and O. A. PARSONS, soil scientist, Soil Conservation Service.

[8] RONALD I. BLEWITT, conservation engineer, Soil Conservation Service, assisted in preparing this section.

TABLE 4.—*Suitability of soil associations for wildlife habitat*

Soil association	Wildlife	Suitability for—			
		Food	Cover	Water	
				Natural streams, lakes, and ponds	Developed lakes and ponds
1. Alluvial land-Nunn.	Mule deer	Moderately well suited.	Moderately well suited.	Well suited	Moderately well suited.
	Antelope	Moderately well suited.	Not applicable	Well suited	Moderately well suited.
	Cottontail rabbit	Well suited	Moderately well suited.	Not applicable	Not applicable.
	Jackrabbit	Well suited	Not applicable	Not applicable	Not applicable.
	Pheasant	Moderately well suited.	Moderately well suited.	Not applicable	Not applicable.
	Mourning dove	Well suited	Well suited	Well suited	Moderately well suited.
	Bobwhite	Moderately well suited.	Moderately well suited.	Not applicable	Not applicable.
	Waterfowl	Moderately well suited.	Moderately well suited.	Moderately well suited.	Moderately well suited.
	Fish	Not applicable	Not applicable	Poorly suited	Poorly suited.
2. Litle-Samsil.	Antelope	Moderately well suited.	Not applicable	Poorly suited	Well suited.
	Jackrabbit	Moderately well suited.	Not applicable	Poorly suited	Well suited.
	Mourning dove	Poorly suited	Poorly suited	Poorly suited	Well suited.
	Fish	Not applicable	Not applicable	Poorly suited	Well suited.
3. Weld-Adena-Colby.	Antelope	Moderately well suited.	Not applicable	Poorly suited	Moderately well suited.
	Jackrabbit	Moderately well suited.	Not applicable	Not applicable	Not applicable.
	Pheasant	Moderately well suited.	Poorly suited	Poorly suited	Not applicable.
	Mourning dove	Moderately well suited.	Moderately well suited.	Poorly suited	Moderately well suited.
	Fish	Not applicable	Not applicable	Poorly suited	Moderately well suited.
4. Thedalund-Baca.	Antelope	Well suited	Not applicable	Poorly suited	Poorly suited.
	Jackrabbit	Well suited	Not applicable	Not applicable	Not applicable.
	Mourning dove	Moderately well suited.	Poorly suited	Poorly suited	Poorly suited.
	Fish	Not applicable	Not applicable	Poorly suited	Poorly suited.
5. Terry-Olney-Thedalund.	Antelope	Well suited	Not applicable	Poorly suited	Poorly suited.
	Jackrabbit	Well suited	Not applicable	Not applicable	Not applicable.
	Mourning dove	Moderately well suited.	Poorly suited	Poorly suited	Poorly suited.
	Fish	Not applicable	Not applicable	Poorly suited	Poorly suited.
6. Renohill-Buick-Litle.	Antelope	Moderately well suited.	Not applicable	Poorly suited	Moderately well suited.
	Jackrabbit	Moderately well suited.	Not applicable	Not applicable	Not applicable.
	Mourning dove	Moderately well suited.	Poorly suited	Poorly suited	Moderately well suited.
	Fish	Not applicable	Not applicable	Poorly suited	Moderately well suited.
7. Nunn-Bresser-Ascalon.	Antelope	Well suited	Not applicable	Moderately well suited.	Moderately well suited.
	Jackrabbit	Well suited	Not applicable	Not applicable	Not applicable.
	Pheasant	Moderately well suited.	Moderately well suited.	Not applicable	Not applicable.
	Mourning dove	Moderately well suited.	Moderately well suited.	Moderately well suited.	Poorly suited.
	Fish	Not applicable	Not applicable	Moderately well suited.	Poorly suited.

TABLE 4.—*Suitability of soil associations for wildlife habitat*—Continued

Soil association	Wildlife	Suitability for—			
		Food	Cover	Water	
				Natural streams, lakes, and ponds	Developed lakes and ponds
8. Truckton-Bresser.	Antelope	Well suited	Not applicable	Poorly suited	Poorly suited.
	Jackrabbit	Well suited	Not applicable	Not applicable	Not applicable.
	Pheasant	Moderately well suited.	Moderately well suited.	Not applicable	Not applicable.
	Mourning dove	Moderately well suited.	Moderately well suited.	Moderately well suited.	Poorly suited.
	Fish	Not applicable	Not applicable	Moderately well suited.	Poorly suited.
9. Stapleton-Bresser.	Antelope	Well suited	Not applicable	Poorly suited	Poorly suited.
	Mule deer	Well suited	Well suited	Poorly suited	Poorly suited.
	Jackrabbit	Well suited	Not applicable	Not applicable	Not applicable.
	Cottontail rabbit	Well suited	Well suited	Not applicable	Not applicable.
	Mourning dove	Moderately well suited.	Well suited	Poorly suited	Poorly suited.
	Fish	Not applicable	Not applicable	Poorly suited	Poorly suited.
10. Fondis-Weld.	Antelope	Moderately well suited.	Not applicable	Poorly suited	Poorly suited.
	Mule deer	Poorly suited	Poorly suited	Poorly suited	Poorly suited.
	Cottontail rabbit	Well suited	Well suited	Not applicable	Not applicable.
	Jackrabbit	Moderately well suited.	Moderately well suited.	Not applicable	Not applicable.
	Pheasant	Moderately well suited.	Poorly suited	Not applicable	Not applicable.
	Mourning dove	Moderately well suited.	Well suited	Poorly suited	Poorly suited.
	Fish	Not applicable	Not applicable	Poorly suited	Poorly suited.

TABLE 5.—*Limitations of the soil*

Soil association	Degree of limitation for—			
	Vacation farms or dude ranches	Picnic and sports areas	Fishing	
			Natural	Developed
1. Alluvial land-Nunn	Severe	Moderate	Severe	Moderate
2. Litle-Samsil	Severe	Severe	Severe	Moderate
3. Weld-Adena-Colby	Moderate	Moderate	Severe	Moderate
4. Thedalund-Baca	Moderate	Severe	Severe	Severe
5. Terry-Olney-Thedalund	Moderate	Severe	Severe	Severe
6. Renohill-Buick-Litle	Severe	Severe	Severe	Moderate
7. Nunn-Bresser-Ascalon	Moderate	Moderate	Severe	Severe
8. Truckton-Bresser	Moderate	Moderate	Severe	Severe
9. Stapleton-Bresser	Moderate	Moderate	Severe	Severe
10. Fondis-Weld	Severe	Severe	Severe	Severe

shear strength, density, shrink-swell potential, compaction characteristics, grain-size distribution, plasticity, and reaction. Depth to water table, depth to bedrock, water holding capacity, and slope are also important.

The information in the survey can be used to—

1. Assist in designing drainage and irrigation systems and in planning farm ponds, terraces and diversions, and other structures for controlling water and conserving soil.
2. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables, and in planning detailed investigations at the selected locations.
3. Locate probable sources of sand, gravel, and other construction material.
4. Make soil and land use studies that will aid in selecting and developing sites for industry, business, homes, and recreation.

With the use of the soil map for identification, the engineering intrepretations in this section can be useful for many purposes. It should be emphasized, however, that the interpretations do not eliminate the need for sampling and testing at the site of specific engineering works where loads are heavy and where the excavations are deeper than the depths of layers reported. Even in these situations, however, the soil map is useful in planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Much of the information in this section is given in tables 6, 7, and 8. Additional information useful to engineers can be found in other sections of this soil survey, particularly the section "Descriptions of the Soils" and "Formation and Classification of Soils."

Some of the terms used by soil scientists may not be familiar to the engineer, and some commonly used terms may have special meaning in soil science. Several of these terms are defined in the Glossary at the back of this survey.

Engineering classification systems

Two systems of soil classification are in general use by engineers. Both of these systems are used in this survey.

Many highway engineers classify soil materials according to the AASHO system (*1*). In this system the soils are placed in seven basic groups, designated A–1 through A–7. In group A–1 are gravelly soils of high bearing capacity, or the best soils for road subgrade, and in group A–7 are the poorest soils, clays that have low strength when wet. Groups A–1, A–2, and A–7 can be further divided to indicate more precisely the nature of the soil material. Within each group the relative engineering value of the soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest. Index numbers are shown in parentheses following the group symbol, for example, A–4 (8), as is shown for the surface layer of Buick loam in table 8.

In the Unified classification, the soils are grouped on the basis of texture and plasticity and their performance as material for engineering structures (*7*). Soil materials are identified as gravels (G), sands (S), silts (M), clays (C), organic (O), and highly organic (Pt). Clean sands are identified by the symbols SW and SP; sands mixed with fines of silt and clay are identified by the symbols SM and SC; silts and clay that have a low liquid limit are identified by the symbols ML and CL; and silts and clays

associations for selected recreational uses

Degree of limitation for—Continued					
Campsites, scenic areas, and nature areas	Hunting areas			Shooting preserves	Sites for rural cottages and homes
	Big game	Upland game	Waterfowl		
Slight	Moderate	Moderate	Moderate	Moderate	Severe.
Moderate	Severe	Severe	Severe	Severe	Severe.
Moderate	Moderate	Severe	Severe	Severe	Severe.
Moderate	Moderate	Severe	Severe	Severe	Severe.
Moderate	Moderate	Severe	Severe	Severe	Severe.
Moderate	Moderate	Severe	Severe	Severe	Moderate.
Moderate	Moderate	Severe	Severe	Moderate	Moderate.
Moderate	Moderate	Severe	Severe	Severe	Slight.
Moderate	Moderate	Moderate	Severe	Severe	Slight.
Moderate	Severe	Moderate	Severe	Moderate	Moderate.

TABLE 6.—*Estimated engineering*

[Absence of data indicates estimate was not made. The

Soil and map symbols	Depth to bedrock	Depth from surface	Classification		
			Dominant USDA texture	Unified	AASHO
	Inches	*Inches*			
Adena: AcC, AcD, AdC, AdD (For properties of the Colby soils in these mapping units, refer to the Colby series.)	>60	0–60	Silt loam, silty clay loam	ML–CL or CL	A–4 or A–7
Ascalon: AsD	>60	0–17	Sandy clay loam	SC or CL	A–6
		17–60	Sandy loam, loamy sand	SM or SC	A–2
Baca: BcC, BcD, BhD (For properties of the Thedalund soil in mapping unit BhD, refer to the Thedalund series.)	48–60	0–46	Silty clay loam and clay loam	ML–CL or CL	A–7 or A–6
		46–60	Sandy loam	SM	A–2
Beckton: BkB	>60	0–60	Clay loam and silty clay loam to clay.	CL or CH	A–7
Bijou: BlB, BmB	>60	0–44	Loamy sand, sandy loam	SM–SC or SC	A–2
		44–60	Stratified silt loam and sand.		
Blakeland: BoD2, BoE	>60	0–60	Sand and loamy sand	SP–SM or SM	A–2
Bresser: BrB, BsB, BuD, BuE, BvC, BvE, BwD2 (For properties of the Stapleton soils in mapping units BuD and BuE, refer to the Stapleton series. For properties of the Truckton soils in BvC, BvE, and BwD2, refer to the Truckton series.)	>60	0–28	Sandy loam and sandy clay loam	SM or SC	A–2,A–6, or A–4
		28–50	Loamy sand and sandy loam	SP–SM or SM	A–2
Bresser loam, gravelly subsoil variant: BtB	>60	0–30	Clay loam	CL	A–6 or A–7
		30–60	Sand and gravel	SP	A–1
Buick: BxC, BxD	48–72	0–22	Loam to clay loam	CL	A–6 or A–7
		22–56	Sandy clay loam	CL	A–7
Clayey alluvial land: Ca	>60	0–40	Stratified clay and loam	ML or CL	A–6 or A–7
Colby: CoC, CoE, CyD2 (For properties of the Adena soil in mapping unit CyD2, refer to the Adena series.)	>60	0–60	Silt loam	ML or CL	A–4 or A–6
Deertrail (mapped only with Weld soils)	>60	0–12	Clay	CH	A–7
		12–55	Silty clay loam to silt loam	CL or ML	A–7 or A–6
Edgewater: EdB	>60	0–28	Loam and sandy clay loam to clay loam.	SC or MH	A–6 or A–7
		28–60	Gravel with some sand	SP	A–1
Fondis: FdB, FdC, FgD, FoC (For properties of the Ascalon soil in mapping unit FgD, refer to the Ascalon series. For properties of the Colby soil in FoC, refer to the Colby series.)	>60	0–32	Clay and silty clay loam	CH or CL	A–7
		32–60	Clay loam and silt loam	CL or CH	A–7
Fort Collins: FrB	>60	0–60	Stratified fine sandy loam to clay loam.	ML or CL	A–6
Gravelly land: Gr	>60	0–30	Sandy loam, gravelly clay loam	SP–SM, SM and SC	A–2
		30–60	Gravel, silt and sand	GP–GM	A–1
Heldt: HlB, HsB	>40	0–23	Silty clay to clay	CL or CH	A–7
		23–54	Stratified fine sandy loam to clay.	ML or CL	A–6, A–7

properties of soils

sign < means less than, and > means more than]

Percentage passing sieve—				Permeability	Available water holding capacity	Reaction	Salinity	Shrink-swell potential
No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	*Inches per hour*	*Inches per inch of soil*	*pH*		
----------	100	90–100	70–95	0. 20–2. 0	0. 20–0. 25	6. 8–9. 0	Slight----------	Low to moderate.
100	90–100	70–90	35–70	0. 63–6. 3	0. 18	6. 6–7. 3	None----------	Low to moderate.
100	50–95	30–60	10–25	0. 63–6. 3	0. 07	7. 9–8. 4	None----------	Low.
----------	100	90–100	70–95	0. 63–6. 3	0. 20–0. 25	6. 8–9. 0	Slight to moderate-----	Low to moderate.
85–95	80–90	50–65	25–35	0. 63–6. 3	0. 07	7. 8–8. 5	None to slight---------	Low.
----------	100	90–100	70–90	<0. 63	0. 15–0. 25	7. 0–9. 0	Slight----------	Moderate.
----------	100	50–70	15–35	>6. 3	0. 05–0. 08	6. 2–7. 5	None to slight---------	Low.
----------	100	50–70	5–15	>6. 3	0. 08	6. 2–7. 2	None----------	Low.
----------	100	60–80	20–50	0. 63–6. 3	0. 20	6. 4–7. 5	None----------	Low.
----------	100	40–70	5–25	>6. 3	0. 08	7. 4–9. 0	None----------	Low.
90–100	85–100	85–100	60–80	0. 63–6. 3	0. 20	6. 5–7. 5	None----------	Low.
50–70	10–40	25–50	0–5	>6. 3	0	6. 5–7. 5	None----------	Low.
----------	100	90–100	70–85	0–63–6. 3	0. 20	6. 8–8. 0	None----------	Moderate.
----------	100	90–100	70–90	0. 63–6. 3	0. 20	8. 0–9. 0	None----------	High.
----------	100	85–100	60–95	<0. 63	0. 18–0. 25	7. 5–8. 5	Slight----------	Moderate.
----------	100	100	85–95	0. 63–6. 3	0. 21	7. 5–9. 0	Slight to moderate-----	Low.
----------	100	100	85–100	<0. 63	0. 25	6. 8–7. 5	None----------	High.
----------	100	100	85–100	0. 63–6. 3	0. 20	8. 0–9. 5	Slight to moderate-----	Low.
----------	80–100	70–100	35–80	<0. 63	0. 18–0. 20	6. 5–7. 5	None to slight---------	Low to moderate.
50–70	10–40	25–50	0–5	>6. 3	0	6. 5–7. 5	None----------	Low.
100	95–100	90–100	80–100	<0. 63	0. 25	6. 4–7. 5	None----------	High.
100	90–100	90–100	75–100	<0. 63	0. 25	7. 5–9. 0	None to moderate-----	Moderate.
100	90–100	70–90	50–90	0. 63–6. 3	0. 20	7. 0–8. 5	None----------	Low.
50–80	30–50	20–40	5–20	0. 63–6. 3	<0. 08	6. 6–8. 4	Slight----------	Low.
30–50	20–30	15–25	5–10	>6. 3	<0. 08	6. 6–8. 4	Slight----------	Low.
----------	100	95–100	75–95	<0. 63	0. 25	7. 0–9. 5	Moderate to strong----	High.
----------	100	70–90	40–90	0. 63–6. 3	0. 20	7. 0–9. 0	Moderate to strong----	Moderate.

TABLE 6.—*Estimated engineering*

Soil and map symbols	Depth to bedrock	Depth from surface	Classification		
			Dominant USDA texture	Unified	AASHO
	Inches	*Inches*			
Litle: LcD, LsD	20–40	0–39	Clay	CH	A–7
(For properties of the Samsil soil in mapping unit LsD, refer to Samsil clay, gypsum.)		39	Clayey beds of shale.		
Nunn: NlB, NrB	>60	0–22	Clay	CL	A–6 or A–7
(For properties of the Bresser soil and of the Ascalon soil in mapping unit NrB, refer to the Bresser and Ascalon series, respectively.)		22–60	Stratified sands and loams	SM, ML, and CL	A–4, A–2
Olney: OnD	>60	0–42	Fine sandy loam	SC or SM	A–2 or A–4
Renohill: RdD, RhD, RhE, RkE2, RlD, RtE	20–40	0–36	Clay loam	CL	A–6 or A–7
(For properties of the Buick soils in mapping units RhD, RhE, and RkE2, refer to the Buick series. For properties of the Litle soil in RlD and of the Litle and Thedalund soils in RtE, refer to the Litle and Thedalund series, respectively.		36	Shale.		
Renohill, reddish variant: ReE	20–40	0–40	Clay loam and silty clay	MH	A–7
		40–50	Loam	ML	A–4
Samsil: SlF, SrE Ss	6–14	0–12	Clay or clay loam	CH or CL	A–7
(For properties of the Litle soil in mapping unit SlF and of the Renohill soil in SrE, refer to the Litle and Renohill series, respectively. For properties of Shale outcrop in Ss, refer to Shale outcrop.)		12	Shale	CH or CL	A–7
Samsil clay, gypsum: SaE	6–12	0–10	Silty clay	CL	A–6 or A–7
		10	Shale.		
Sand pits: St	>60	0–60	Loamy sand to sand	SM or SM–SP	A–2
Shale outcrop: Sv	0–12	0–12	Clay loam to clay	CL	A–6
		12	Shale and sandstone.		
Stapleton: SwE	20–40	0–25	Sandy loam	SM–SC	A–2
		25	Arkosic sandstone.		
Tassel: Ta	12–18	0–18	Fine sandy loam	SM	A–2
(Estimates are for Tassel soils only. Estimates were not made for the Rock outcrop part of this mapping unit.)		18	Soft sandstone.		
Terry: TdE, TeE	24–60	0–26	Fine sandy loam	SC–SM	A–4
(For properties of the Olney soil and of the Thedalund soil in mapping unit TeE, refer to the Olney and the Thedalund series, respectively.)		26	Partly decomposed sandstone (hard sandstone at 50 inches).		
Thedalund: ThE, ThE2	20–40	0–30	Silty clay loam; disintegrated sandstone and shale.	CL	A–7
		30	Shale and sandstone.		
Truckton: TrC, TrE	>60	0–30	Sandy loam	SC	A–2
		30–50	Loamy sand	SM or SP–SM	A–2
Weld: WdC, WeB, WeC, WrB	>60	0–26	Silty clay loam to silty clay	CL or CH	A–7
(For properties of the Deertrail soil in mapping unit WrB, refer to the Deertrail series.)		26–60	Silt loam	ML–CL	A–4
Wet alluvial land: Wt	>60	0–48	Loam to sand and gravel	SM or SM–SP	A–4, A–3, or A–2

[1] Little or none.

properties of soils—Continued

Percentage passing sieve—				Permeability	Available water holding capacity	Reaction	Salinity	Shrink-swell potential
No. 4 (4.76 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	*Inches per hour*	*Inches per inch of soil*	*pH*		
	100	90–100	80–90	<0. 63	0. 15–0. 21	7. 5–8. 5	Slight	High.
	100	90–100	85–95	<0. 63	0. 20	6. 5–7. 0	Slight	Moderate.
100	90–100	50–90	10–70	0. 63–6. 3	0. 20	7. 5–8. 5	Slight	Low.
	100	65–80	30–50	0. 63–6. 3	0. 12–0. 15	7. 4–8. 0	None	Low.
90–100	80–100	85–100	60–80	<0. 63	0. 20	7. 5–8. 5	None	Moderate.
	100	90–100	75–95	<0. 63	0. 20	6. 4–7. 4	None	Low.
100	90–100	85–95	60–70	0. 63–6. 3	0. 15	7. 0–7. 8	None	Low.
	100	90–100	80–90	<0. 63	0. 25	8. 0–8. 5	Slight	High.
	100	90–100	80–90	<0. 63	(1)	7. 5–8. 5	Slight.	
	100	95–100	85–100	<0. 63	0. 25	8. 0–9. 5	Strong	Moderate to high.
	100	50–75	5–15	>6. 3	<0. 07	6. 2–7. 2	None	Low.
100	85–100	80–100	50–90	<0. 63	0. 20	7. 5–8. 5	Slight	Low.
90–100	50–80	30–70	15–35	0. 63–6. 3	0. 11	6. 0–7. 0	None	Low.
100	95–100	60–85	5–35	>6. 3	0. 08–0. 11	6. 8–7. 5	Slight	Low.
	100	60–80	35–50	0. 63–6. 3	0. 11	6. 8–7. 5	None	Low.
100	85–100	60–95	50–90	0. 63–6. 3	0. 20	7. 5–8. 5	Slight	Low to moderate.
	100	65–75	15–35	0. 63–6. 3	0. 11	6. 5–7. 2	None	Low.
	100	60–70	5–15	>6. 3	0. 06	7. 0–8. 0	None to slight	Low.
	100	100	85–100	<0. 63	0. 25	6. 5–9. 0	Slight to moderate	Moderate.
	100	100	85–100	0. 63–6. 3	0. 20	8. 0–9. 0	Slight to moderate	Low.
100	95–100	50–70	5–40	0. 63–6. 3	0. 08–0. 15	6. 5–7. 5	Slight	Low.

TABLE 7.--*Engineering*

[Interpretations were not made for Loamy alluvial land (Lv),

Soils and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Road fill	Highway location
Adena: AcC, AcD, AdC, AdD (For interpretations for the Colby soils in these mapping units, refer to the Colby series.)	Fair	Unsuitable	Fair to poor: low to moderate shrink-swell potential; low shear strength.	Silty and plastic material.
Ascalon: AsD	Fair to good	Sand is good for roads but is unsuitable for concrete.	Fair to good	No unfavorable features.
Baca: BcC, BcD, BhD (For interpretations for the Thedalund soil in mapping unit BhD, refer to the Thedalund series.)	Fair to good	Unsuitable	Poor to fair: low to moderate shrink-swell potential.	Plastic material
Beckton: BkB	Poor: saline; slow drainage.	Unsuitable	Poor: plastic material; slow internal drainage.	Flood hazard; plastic material.
Bijou: BlB, BmB	Fair: droughty; susceptible to soil blowing.	Unsuitable	Good: moderately to severely susceptible to soil blowing.	Seasonal high water table in some areas; susceptible to soil blowing.
Blakeland: BoD2, BoE	Poor: droughty; highly susceptible to soil blowing.	Sand is excellent for roads but is poor for concrete.	Good	No unfavorable features.
Bresser: BrB, BsB, BuD, BuE, BvC, BvE, BwD2. (For interpretations for the Stapleton soils in mapping units BuD and BuE, refer to the Stapleton series. For interpretations for the Truckton soils in mapping units BvC, BvE, and BwD2, refer to the Truckton series.)	Fair to a depth of 18 inches.	Sand is good for roads below a depth of 2 feet but is unsuitable for concrete.	Good to fair	No unfavorable features.
Bresser, gravelly subsoil variant: BtB	Good	Clean sand and gravel below a depth of 3 feet; suitable for concrete if washed.	Poor to a depth of 3 feet; low shear strength. Good below a depth of 3 feet.	Plastic material
Buick: BxC, BxD	Fair to good	Unsuitable	Poor: moderate to high shrink-swell potential.	Plastic material
Clayey alluvial land: Ca	Fair	Unsuitable	Poor: moderate shrink-swell potential.	Flood hazard; plastic material.
Colby: CoC, CoE, CyD2 (For interpretations for the Adena soil in mapping unit CyD2, refer to the Adena series.)	Fair: susceptible to water erosion and to soil blowing.	Unsuitable	Fair to poor: low shear strength; poor compaction; susceptible to erosion.	Susceptible to erosion; plastic material.

interpretations of soils

Rock outcrop (Ru), Sandy alluvial land (Su), and Terrace escarpments (Tc)]

Soil features affecting—Continued				
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions
Reservoir area	Embankment			
Moderate seepage; holes are common; fair to poor compaction.	Moderately pervious; poor to fair stability; piping in places; low shear strength; fair to poor compaction.	Silty; unstable for ditchbanks.	Moderate water intake; high available water holding capacity; deep.	Poor to fair stability; susceptible to soil blowing.
Pervious material below a depth of 18 inches.	Moderate permeability if compacted for sandier material; fair stability.	Moderate to moderately rapid permeability; drainage not needed.	Undulating to sloping; moderate to low available water holding capacity; high water intake rate; susceptible to soil blowing.	Susceptible to soil blowing.
Shale or sandstone at depth of 5 feet.	Fair to poor stability; piping in places; fair to poor compaction.	Moderate to moderately rapid permeability; drainage not needed.	Moderate water intake; high available water holding capacity.	Susceptible to soil blowing.
Gypsum layer; low seepage.	Moderate shrink-swell potential; fair stability; fair to poor compaction.	Salinity; slow internal drainage; slow permeability.	Drainage needed; salts must be leached; slow permeability.	Salinity.
Pervious material; seasonal high water table in some areas.	Moderate permeability; susceptible to soil blowing; fair stability.	Seasonal high water table in some areas.	Low available water holding capacity; susceptible to soil blowing.	Susceptible to soil blowing.
Pervious material	Moderate to rapid permeability; fair to poor stability; piping in some places.	Rapid permeability; drainage not needed.	Low available water holding capacity; highly susceptible to soil blowing; undulating to hilly.	Highly susceptible to soil blowing; undulating to hilly.
Pervious material below a depth of 16 inches.	Moderate permeability if compacted for sandier material; fair stability.	Moderate to moderately rapid permeability; drainage not needed.	Undulating to strongly rolling; low available water holding capacity below a depth of 2 feet.	Susceptible to soil blowing.
Pervious material below a depth of 2 feet.	Variable	No unfavorable features. Water table generally below a depth of 8 feet; gravel occurs below a depth of 3 feet.	Limited rooting depth	No unfavorable features.
Moderate seepage if material is compacted; high content of lime at a depth of 12 inches.	Moderate to high shrink-swell potential; fair to good stability.	No unfavorable features	Gently sloping to steep; high available water holding capacity.	Variable.
Stratified layers of pervious and impervious material.	Moderate shrink-swell potential to a depth of 2 feet and high below; fair stability; fair to poor compaction.	Layers of stratified clay and loam.	Flood hazard	Variable.
Moderate seepage; holes are common; high content of lime; poor compaction.	Moderate permeability if compacted; poor stability; piping in some places; susceptible to erosion.	Poor stability	Moderate water intake; moderate available water holding capacity; low fertility; nearly level to steep.	Poor compaction; low shear strength; susceptible to water erosion and to soil blowing.

TABLE 7.—*Engineering*

Soils and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Road fill	Highway location
Deertrail (mapped only with Weld soils)	Poor: clayey material.	Unsuitable	Poor: high shrink-swell potential; slow internal drainage; poor compaction.	Fair to poor compaction; fair to poor stability; plastic material.
Edgewater: EdB	Good	Good below a depth of 28 inches.	Poor to a depth of 28 inches; low shear strength. Good below a depth of 28 inches.	Water table at a depth of 2 to 6 feet; plastic material; flood hazard in some places.
Fondis: FdB, FdC, FgD, FoC (For interpretations for the Ascalon soil in mapping unit FgD, refer to the Ascalon series. For interpretations for the Colby soil in mapping unit FoC, refer to the Colby series.)	Fair to good	Unsuitable	Poor: high shrink-swell potential; slow internal drainage.	Plastic material
Fort Collins: FrB	Fair	Unsuitable	Poor: low shear strength.	Plastic material
Gravelly land: Gr	Poor: sandy material.	Good	Good	6 to 50 percent slopes
Heldt: HlB, HsB	Poor: clayey material; saline.	Unsuitable	Poor: high shrink-swell potential; low shear strength; poor compaction; slow internal drainage.	Plastic material
Litle: LcD, LsD (For interpretations for the Samsil soil in mapping unit LsD, refer to the Samsil, gypsum.)	Poor: clayey material.	Unsuitable	Poor: high shrink-swell potential; low shear strength; poor compaction; slow internal drainage.	Plastic material
Nunn: NlB, NrB (For interpretations for the Bresser soil and the Ascalon soil in mapping unit NrB, refer to the Bresser and Ascalon series, respectively.)	Fair	Unsuitable	Poor: poor compaction.	Plastic material
Olney: OnD	Fair	Unsuitable for gravel; good for sand for roads.	Fair: low shrink-swell potential.	No unfavorable features.
Renohill: RdD, RhD, RhE, RkE2, RlD, RtE. (For interpretations for the Buick soils in mapping units RhD, RhE, and RkE2, refer to the Buick series. For interpretations for the Litle soils in mapping units RlD and RtE and for the Thedalund soil in mapping unit RtE, refer to the Litle and Thedalund series, respectively.)	Poor: shaly	Unsuitable	Poor: poor compaction; slow drainage; moderate shrink-swell potential.	Plastic material to a depth of 2 feet; shale below a depth of 2 feet.

interpretations of soils—Continued

Soil features affecting—Continued				
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions
Reservoir area	Embankment			
Moderate seepage below a depth of 18 inches; holes are common; poor compaction; high content of lime.	High shrink-swell potential; fair to poor stability; piping in some places; poor compaction; susceptible to water erosion and to soil blowing.	Fair to poor stability; surface ponding; moderate salinity; slow permeability.	Very slow water intake; high available water holding capacity; clayey topsoil; slow permeability.	High shrink-swell potential; moderate salinity; piping in some places.
Pervious material below a depth of 28 inches; water table at a depth of 2 to 6 feet.	Variable; low to moderate shrink-swell potential.	Water table at a depth of 2 to 6 feet; sand and gravel at a depth of 28 inches; flood hazard.	Limited rooting depth; flood hazard.	No unfavorable features.
High content of lime; moderate to low seepage.	High shrink-swell potential; fair to poor compaction; fair stability.	Moderate to slow permeability; slow permeability at a depth of 8 to 16 inches.	High available water holding capacity; slow to moderate water intake; slow to moderate permeability.	High shrink-swell potential.
Moderate seepage; strata of sand below a depth of 3 feet in some places.	Fair to poor stability; piping in some places.	Moderate permeability; unstable ditchbanks.	High available water holding capacity; moderate water intake; 0 to 3 percent slopes.	Susceptible to soil blowing.
Not applicable	Not applicable	Not applicable	Not applicable	Not applicable.
Low seepage to a depth of 3 feet and variable below; stratified sand and loam below a depth of 3 feet.	High shrink-swell potential; fair to poor stability; poor compaction.	Slow water intake; slow permeability.	High available water holding capacity; difficult to till; salinity.	High shrink-swell potential.
Low seepage; beds of shale at a depth of 20 to 40 inches.	High shrink-swell potential; poor compaction; fair stability.	Slow permeability	Very slow water intake; moderate available water holding capacity.	High shrink-swell potential.
Moderate seepage; lenses of sand occur below a depth of 3 feet; high content of lime.	Moderate shrink-swell potential; poor compaction; fair to good stability.	Medium internal drainage; sandy below a depth of 3 feet; banks may slough; water table at a depth of 5 to 10 feet in some areas; flood hazard in some areas.	Moderate water intake; high available water holding capacity.	Variable.
Pervious material below a depth of 2 feet.	Moderate permeability; fair stability.	Moderate to moderately rapid permeability; drainage not needed.	Moderate available water holding capacity.	Susceptible to soil blowing.
Low seepage below a depth of 2 feet.	Moderate shrink-swell potential; fair to good stability.	Moderately slow to slow permeability; shale and sandstone below a depth of 2 feet.	Limited rooting depth; shale and sandstone below a depth of 2 feet; 3 to 20 percent slopes.	3 to 20 percent slopes; susceptible to soil blowing and to siltation.

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TABLE 7.—*Engineering*

Soils and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Road fill	Highway location
Renohill, reddish variant: ReE	Poor: shaly	Unsuitable	Poor to fair: poor compaction; low shear strength.	No unfavorable features.
Samsil: SlF, SrE, Ss (For interpretations for the Litle soil in mapping unit SlF, refer to the Litle series. For interpretations for the Renohill soil in mapping unit SrE and for Shale outcrop in mapping unit Ss, refer to the Renohill series and to Shale outcrop in this table.)	Poor: clayey; shaly.	Unsuitable	Poor: low shear strength; poor compaction; poor drainage; shale at a depth of 6 to 14 inches.	Plastic material over shale; shale at a depth of 6 to 14 inches; seepage in a few places.
Samsil, gypsum: SaE	Poor: clay texture; shaly; contains gypsum.	Unsuitable	Poor: shale at a depth of 0 to 14 inches.	Plastic material over shale; shale at a depth of 0 to 14 inches.
Sand pits: St	Poor: sandy	Unsuitable for gravel. Excellent for sand for roads; in some places sand is suitable for concrete if washed.	Fair to good	Susceptible to soil blowing.
Shale outcrop: Sv	Poor: shaly	Unsuitable	Poor: very shallow	Shale and sandstone below a depth of 1 foot; 9 to 50 percent slopes.
Stapleton: SwE	Fair: shallow	Poor for concrete. Good for roads.	Good	9 to 30 percent slopes
Tassel: Ta (Interpretations were not made for the Rock outcrop part of this mapping unit.)	Fair: sandy	Unsuitable for concrete. Fair for sand for roads.	Good: sandstone is at a depth of 15 to 18 inches; 3 to 20 percent slopes.	Sandstone is at a depth of 15 to 18 inches; 3 to 20 percent slopes.
Terry: TdE, TeE (For interpretations for the Olney soil and for the Thedalund soil in mapping unit TeE, refer to the Olney series and to the Thedalund series, respectively.)	Poor: sandy	Unsuitable for gravel. Fair for sand for roads. Poor for sand for concrete.	Fair to good	Sandstone is at a depth of 2 to 5 feet; 5 to 20 percent slopes.
Thedalund: ThE, ThE2	Poor: clayey	Unsuitable	Poor: low shear strength; medium to high compressibility.	Plastic material; 9 to 20 percent slopes; sandstone and shale below a depth of 1 foot; slow internal drainage.
Truckton: TrC, TrE	Fair	Unsuitable for gravel. Good for sand for roads. Poor for sand for concrete.	Good	No unfavorable features.

interpretations of soils—Continued

Soil features affecting—Continued				
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions
Reservoir area	Embankment			
Pervious material	Poor stability; poor compaction.	Moderately slow to slow permeability; shale and sandstone below a depth of 2 feet.	Moderate available water holding capacity; 5 to 20 percent slopes.	Not applicable.
Shallow over shale	High shrink-swell potential; fair to poor stability; poor compaction.	Shale at a depth of 6 to 14 inches.	Shale at a depth of 6 to 14 inches; steep.	Shale at a depth of 6 to 14 inches; high shrink-swell potential; not applicable for terraces.
Shallow over shale; contains gypsum and sodium salts.	Moderate to high shrink-swell potential; poor stability.	Shale at a depth of 0 to 14 inches.	Shale at a depth of 0 to 14 inches; slow water intake; 5 to 20 percent slopes; salinity.	Shale at a depth of 0 to 14 inches; salinity; not applicable for terraces.
Not applicable	Not applicable	Not applicable	Not applicable	Not applicable.
Shallow over shale	Poor stability	Shale and sandstone below a depth of 1 foot.	Not applicable	Not applicable for terraces.
Pervious material; seals with sediments in some areas.	Moderate permeability if compacted; fair stability.	Poorly consolidated fine gravel and siltstone at a depth of 12 to 42 inches; 9 to 30 percent slopes.	Low available water holding capacity; shallow rooting depth; 9 to 30 percent slopes.	9 to 30 percent slopes; susceptible to soil blowing.
Not applicable	Not applicable	Rapid permeability; sandstone is at a depth of 15 to 18 inches; drainage not needed.	Not applicable	3 to 20 percent slopes; susceptible to soil blowing.
Pervious material; sandstone is at a depth of 2 to 5 feet.	Moderate to rapid permeability if compacted; fair stability; susceptible to soil blowing.	Sandstone is at a depth of 2 to 5 feet; restricted drainage in some places.	Low available water holding capacity; rapid water intake.	5 to 20 percent slopes; susceptible to soil blowing.
Shallow to interbedded shale and sandstone; high content of lime in many areas.	Fair stability; medium compressibility.	Generally shallow to impervious material; 9 to 20 percent slopes.	9 to 20 percent slopes; shallow rooting depth.	9 to 20 percent slopes; sandstone and shale below a depth of 1 foot.
Pervious material	Good stability to a depth of 30 inches, but fair to poor stability below; piping in some places; moderate to moderately rapid permeability if compacted.	Moderate to moderately rapid permeability; drainage not needed.	Moderate to low available water holding capacity; undulating; 1 to 20 percent slopes.	Undulating; susceptible to soil blowing; 1 to 20 percent slopes.

TABLE 7.—*Engineering*

Soils and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Road fill	Highway location
Weld: WdC, WeB, WeC, WrB (For interpretations for the Deertrail soil in mapping unit WrB, refer to the Deertrail series.)	Good	Unsuitable	Poor: low to moderate shrink-swell potential; low shear strength; medium to high compressibility.	Plastic material
Wet alluvial land: Wt	Fair	Sand and gravel is available below a depth of 18 inches in some places.	Fair: water table at a depth of 0 to 4 feet.	Flood hazard; water table at a depth of 0 to 4 feet.

that have a high liquid limit are identified by the symbols MH and CH. Liquid limit and plastic limit are defined in the subsection "Soil Test Data."

The United States Department of Agriculture classifies soils according to texture, which is determined by the proportion of sand, silt, and clay in the soil material (*5*). The terms "sand," "silt," and "clay" are defined in the Glossary at the back of the survey.

Engineering properties of soils

Table 6 shows some estimates of soil properties that are important to engineering, and it gives estimated engineering and textural classifications for the soils. The data in table 6 are based on field classifications and descriptions, on the test data given in table 8, on test data obtained from similar soils in adjacent counties, and on past experience in engineering construction. Not included in table 6 are Loamy alluvial land (Lv), Rock outcrop (Ru), Sandy alluvial land (Su), and Terrace escarpments (Tc).

The depth to bedrock is indicated in table 6. Depth to a seasonal high water table refers to the highest level at which the ground water stands for a significant period of time. Soils that have a high water table are limited in their use for highways and for other construction. Bedrock is at a depth of less than 2 feet in some of the soils of Arapahoe County, but some soils are more than 5 feet deep to bedrock. Depth to bedrock is important to the engineer because it may greatly affect designing, constructing, and maintaining structures.

In Arapahoe County the depth to the water table ranges from 2 to 6 feet for Edgewater soils, from 0 to 4 feet for Wet alluvial land, and from 2 to 5 feet for Bijou sandy loam, wet. For the other soils in the county, the water table remains at such a great depth that it is not significant to engineering.

The column headed "Depth from surface" indicates the depth of the soil material for which estimates were made. For these estimates, layers given in the technical profiles in the section "Descriptions of the Soils" were combined.

Listed for the soils in table 6 are the USDA textural classification, the Unified and AASHO engineering classifications, and the estimated percentages of material that passes Nos. 4, 10, 40, and 200 sieves.

Permeability refers to the rate that water moves downward through undisturbed and uncompacted soil material. It does not include lateral seepage. The estimates in table 6 are based mainly on the texture, structure, and porosity of the soils.

The available water holding capacity, expressed in inches of water per inch of soil, is the approximate amount of water that a soil can hold available for plants. It is the water held in a soil between field capacity and permanent wilting point.

Reaction is given in pH values and indicates the degree of acidity or alkalinity of the soil material. Higher values indicate alkaline material and lower values acid material, as defined in the Glossary.

Estimates of salinity are based on the electrical conductivity of saturated soil extract, as expressed in millimhos per centimeter at 25° C. In table 6, salinity is expressed in words—none, slight, moderate, or high. Most of the soils are not saline or are only slightly saline. The salinity of a soil affects its suitability for crops, its stability when it is used as construction material, and its corrosiveness when other materials are placed in it.

Shrink-swell potential indicates the expected volume change of soil material when its moisture content changes. The ratings given in table 6 were estimated primarily on the basis of the kind and amount of clay that a soil contains. In general, soils classified CH and A–7 have a high shrink-swell potential. The shrinking and swelling of a soil causes damage to foundations of buildings, to roads, and to other structures. Structures built on, in, or with a soil having a high shrink-swell potential are difficult to maintain.

Engineering interpretations of soils

In table 7, the soils of Arapahoe County are rated according to their suitability as a source of topsoil, sand and gravel, and road fill. In addition, the table lists soil features that affect location of highways and the construction and maintenance of farm ponds, drainage systems, irrigation systems, and terraces and diversions. The interpretations are based on the estimated soil properties shown in table 6, the actual test data shown in table 8, other available test data, and field experiences. Not in-

interpretations of soils—Continued

Soil features affecting—Continued				
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions
Reservoir area	Embankment			
Moderately slow permeability; holes are common; high in content of lime below a depth of 18 inches.	Fair to poor stability; piping in some places; poor compaction.	Moderately slow permeability; unstable ditchbanks.	High available water holding capacity; deep; salinity at a depth of 1 to 2 feet.	No unfavorable features.
Pervious material; water table at a depth of 0 to 4 feet.	Fair to poor stability; piping in some places.	Wet; drainage generally not feasible.	Not applicable	Not applicable.

cluded in table 7 are Loamy alluvial land (lv) Rock outcrops, Sandy alluvial land (Su), and Terrace escarpments (Tc).

The suitability of soil material as a source of topsoil, sand and gravel, and road fill is rated *good*, *fair*, or *poor* in table 7. Topsoil is fertile soil or soil material, ordinarily rich in organic matter, that is used to topdress lawns, gardens, roadbanks, and the like. The ratings given for the suitability of a soil as a source of sand and gravel are based on the probability of a soil to contain deposits of sand and gravel. They do not indicate the quality or quantity of the deposits. The suitability ratings for road fill are based on the performance of the soil material that is excavated and used for highway embankments and subgrades.

In estimating the soil features that affect selection of highway location, evaluation is for the profile of an undisturbed soil that has not been drained but that has had its organic surface layer removed, if one occurs. Some of the features considered are the height of the water table, the hazard of flooding, the stability of the soil material, particularly under heavy loads of pressure, depth to and kind of bedrock, and slope.

Where farm ponds are constructed, suitability of soils for both reservoirs and for embankments is considered. The choice of a site for the reservoir of a farm pond depends largely on the rate of seepage that can be expected through undisturbed soil. Among the soil features affecting use of soils for reservoir areas and embankments for farm ponds are susceptibility to seepage, the sealing potential of the soil material, depth to a high water table, depth to and nature of the bedrock, stability, permeability, shrink-swell potential, and compactibility. Susceptibility to soil blowing affects embankments. Both the subsoil and the underlying material are considered when the soil material is excavated and used as borrow for embankments. Heldt clay, saline, 0 to 3 percent slopes, is one of the most suitable soils in the county for use as sites for farm ponds. This soil has a high content of sodium, and ponds on it seal rapidly and lose very little water through seepage.

Soil features affecting agricultural drainage are texture, stability, salinity, permeability, and a high water table.

Some of the features considered in evaluating a soil for irrigation purposes are rate of water intake, available water holding capacity, slope, and susceptibility to soil blowing.

Stability, slope, susceptibility to water erosion and to soil blowing, shrink-swell potential, shear strength, and compactibility are some of the soil features affecting terraces and diversions.

Soil test data

To help to evaluate the soils for engineering purposes, samples were taken from the soils of the Bresser, Buick, Deertrail, Fondis, Litle, Nunn, Renohill, Truckton, and Weld series and were tested by the Colorado Department of Highways, in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*). The results of these tests and the classification of each sample according to both the AASHO and the Unified systems are given in table 8.

The engineering soil classifications in table 8 are based on data obtained by mechanical analyses and by tests to determine liquid limit and plastic limit. The mechanical analyses were made by the combined sieve and hydrometer methods. The percentage of clay obtained by the hydrometer method should not be used in naming the textural classes of soils.

The liquid limit and plasticity index given in table 8 indicate the effect of water on the consistence of soil material. As the moisture content of a clayey soil is increased from a very dry state, the material changes from a solid to a semisolid to a plastic state. As the moisture content is further increased, the material changes, when disturbed, from a plastic state to a liquid state. The plastic limit is the moisture content at which the material changes from a semisolid to a plastic state. The liquid limit is the moisture content at which the material changes, when disturbed, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Specific gravity refers to the ratio of the weight of the soil material to the weight of pure water.

TABLE 8.—*Engineering test data*

[Tests performed by the Colorado Department of Highways in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Soil name and location	Depth	Mechanical analyses[1]			Liquid limit	Plasticity index	Specific gravity	Moisture density[2]		Classification	
		Percentage passing sieve—						Optimum moisture	Maximum dry density	AASHO[3]	Unified[4]
		No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)							
	Inches							*Percent*	*Lbs. per cu. ft.*		
Bresser sandy loam:											
1,321 feet north and 44 feet west of S¼ corner of sec. 23, T. 4 S., R. 61 W.	0–6	100	69	32	[5] NV	[6] NP	2.57	10	121	A–2–4(0)	SM
	10–18	100	77	39	31	13	2.63	14	116	A–6(2)	SC
	29–40	100	60	12	NV	NP	2.65	10	117	A–2–4(0)	SP–SM
Buick loam:											
2,300 feet south and 89 feet east of northwest corner of sec. 2, T. 4 S., R. 60 W.	0–3	100	98	79	NV	NP	2.56	16.2	104	A–4(8)	ML
	6–10	100	98	83	35	14	2.65	19.4	105	A–6(10)	CL
	42–55	100	98	82	42	23	2.70	16.4	107	A–7–6(14)	CL
Deertrail silt loam:											
521 feet east and 252 feet north of northeast corner of sec. 23, T. 5 S., R. 59 W.	2–9	------	100	97	48	27	2.69	23	99	A–7–6(16)	CL
	12–23	------	100	98	42	20	2.70	23	101	A–7–6(12)	CL
	32–44	------	100	98	36	13	2.71	23	100	A–6(9)	CL–ML
Fondis silt loam:											
750 feet north and 150 feet west of the E¼ corner, sec. 25, T. 4 S., R. 64 W.	0–5	[7] 99	94	85	25	4	2.57	18	106	A–4(8)	ML–CL
	8–12	100	99	96	66	39	2.72	22	90	A–7–6(20)	CH
	44–54	[7] 99	91	80	46	25	2.77	20	105	A–7–6(15)	CL
Litle silty clay loam:											
220 feet north and 2,820 feet east of southwest corner of sec. 23, T. 5 S., R. 57 W. (Modal)	0–3	------	100	98	37	12	2.60	24	94	A–6(9)	ML–CL
	6–13	------	100	99	49	26	2.69	22	99	A–7–6(16)	CL
	31–43	------	------	100	54	32	2.81	24	100	A–7–6(19)	CH
Nunn loam:											
1,100 feet north and 600 feet east of southwest corner of sec. 23, T. 4 S., R. 61 W.	0–4	100	82	56	21	3	2.62	14	114	A–4(4)	ML
	8–16	100	91	70	41	22	2.67	18	107	A–7–6(12)	CL
	32–60	100	82	36	19	3	2.70	11	122	A–4(0)	SM
Renohill loam:											
1,300 feet east of northwest corner of sec. 27, T. 5 S., R. 59 W. (Shallow phase)	0–5	------	100	94	37	15	2.67	22	100	A–6(10)	CL
	5–13	------	100	92	41	16	2.66	22	98	A–7–6(11)	ML–C
	22–48	------	100	89	54	22	2.83	30	91	A–7–5(16)	MH
Truckton loamy sand:											
1,350 feet north of S¼ corner of sec. 23, T. 4 S., R. 61 W.	0–5	100	71	34	NV	NP	2.57	12	118	A–2–4(0)	SM
	5–12	100	65	21	24	6	2.64	11	119	A–2–4(0)	SM–SC
	20–60	100	65	14	NV	NP	2.63	12	118	A–2–4(0)	SM
Weld silt loam:											
2,162 feet south and 184 feet east of northwest corner of sec. 16, T. 4 S., R. 59 W.	0–3	------	100	91	NV	NP	2.56	18	100	A–4(8)	ML
	6–12	------	100	97	49	24	2.65	23	95	A–7–6(15)	CL
	43–56	------	100	97	30	8	2.70	20	106	A–4(8)	ML–CL

[1] Mechanical analyses according to AASHO Designation T 88 (*1*). Results obtained by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

[2] Based on AASHO Designation: T 99–57, Method A (*1*).

[3] Based on AASHO Designation: M 145–49 (*1*).

[4] Based on the Unified Soil Classification System, Tech. Memo. No. 3–357, v. 1, Corps of Engineers (*7*). SCS and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points of the A-line are to be given a borderline classification. Examples of borderline classifications obtained by this use are SP–SM and ML–CL.

[5] NV = No value.

[6] NP = Nonplastic.

[7] 100 percent of the material passed the No. 4 sieve.

Moisture density, or the relation between moisture content and the density of compacted soil material, also is given in table 8. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the optimum moisture content is reached. After that, the density decreases with increase in moisture. The highest dry density obtained in the compaction test is termed maximum dry density. Moisture density data are important in earthwork, for as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

Formation and Classification of Soils

In this section, the major factors of soil formation are discussed in terms of their effect on the development of the soils in Arapahoe County. The current system of soil classification is briefly described, and the soil series are placed in some classes of that system and in great soil groups of an older system. The soil series in the county, including a profile typical for each series, are described in the section "Descriptions of the Soils."

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on parent material that was deposited or accumulated by geologic forces. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material accumulated and weathered; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are the active factors of soil formation. They act on the accumulated parent material and slowly change it into a soil that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of soil profile that forms and, in extreme instances, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. The time needed may be long or short, but some time is always required for the development of horizons. Generally, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes that affect soil development are unknown.

Parent material

The soils in Arapahoe County formed in a wide variety of parent material, mainly material that weathered from hard shale and sandstone and loose material deposited by water and wind. The formations underlying the county and the kinds of material from which the parent material weathered are described in the section "Geology and Soil Development."

In the smoother uplands the parent material is a thin mantle of loose silty and sandy material deposited by wind. The silty material contains a large amount of lime, but the sandy material is essentially free of lime.

The wind-laid material consists mainly of sediments that have been deposited by water on the flood plains along the larger streams, but mixed with these sediments are deposits blown from weathered beds of shale and sandstone. In the western four-fifths of the county, these mixed wind-laid deposits range from 1 to 10 feet in thickness, and in some places they are underlain by older material that was deposited by water and contains a developed profile of a buried soil. The Fondis soils, for example, have formed over a buried soil consisting of calcareous loam to clay loam that has various amounts of fine gravel. The texture, structure, and color of the buried soil indicate that the soil developed under grass, but in a climate that is wetter and warmer than the present climate. The soils on the steeper slopes along drainageways developed from material weathered from shale and sandstone because erosion removed the material deposited by wind and water.

Climate

Precipitation, temperature, and wind are climatic factors that have affected the formation of soils in this county. Climatic data for the county are given in the section "Climate of Arapahoe County," beginning on page 73.

When the windblown material accumulated in its present location, the precipitation probably was greater than it presently is and silt-laden floodwaters frequently deposited material on the broad stream channels. Strong winds probably blew from the north and west, the same direction that they generally blow today. This is indicated by the position of the material. The deepest, sandiest material is closest to the streams, on the eastern side, and the finer textured material is farther east of the streams. Shale, sandstone, or water-deposited materials occur at the surface on the western side of the streams.

The present climate of the county is gradational from west to east and from south to north. The average temperature is a little less, rainfall a little more, and elevation a little higher in the south and west than they are in the north and east. Most of the strong winds blow from the west and the northwest.

These differences in climate have affected the formation of soils to some extent. The soils in the western and southern parts of the county have a little darker surface layer and lime 1 to 3 inches deeper than have similar soils in the northern and eastern parts. Because of strong winds and soil blowing, soils are thinnest at the crest of ridges that face north and west. Lime has been leached to a greater depth in soils on slopes that face east and south than in soils on slopes that face north and west. These differences partly result from the fact that more drifting snow was deposited on south- and east-facing slopes and that more soil material was blown from north- and west-facing slopes. The depth to lime indicates the depth to which the soil material is saturated during most of the storms. In this county, however, lime is leached to a depth of more than 20 inches in only a few places.

Plants and animals

Grasses, trees, shrubs, micro-organisms, and other forms of plants and animals that live on and in the soils are active in the soil-forming processes.

In Arapahoe County the plant cover consists mainly of short and tall grasses and a few pine trees that are growing on the Stapleton soils on the eastern side of Cherry Creek along the southern edge of the county. Soils that form under grass generally have a dark-colored, granular surface layer that is easily penetrated by water and roots. The short grasses grow on the medium-textured and clayey soils, and the tall grasses grow on the sandy soils. Because the short grasses obtain much of the water they need from near the surface of loamy soils their roots are closer to the surface than those of tall grasses, which send their roots deeper into the sandy soils in search of moisture. When grasses decay, they add organic matter, high in calcium and other bases, to the surface soil, which tends to hold the clay particles together and helps to form aggregates and granules.

In this county domestic and wild animals return organic matter to the soil in the form of manure. Many micro-organisms live in the soil and are active in helping to decompose plant and animal residue and in releasing nutrients, such as nitrogen and phosphorus, that can be used again by plants; they also help to return carbon dioxide to the air. The remaining humus helps to bind the soil material together and gives it a distinctive dark color.

Relief

Relief, including direction of slope, affects soil formation through its influence on drainage, erosion, vegetation, and soil temperature. The topography of this county is nearly level to very steep, and the slopes range from 0 to 50 percent.

South-facing slopes receive more direct sunshine and are warmer than north-facing slopes. The amount of water that runs off a soil increases as steepness increases. The amount of runoff also is affected by the texture of the soil material. Little water runs off from slopes of less than 3 percent where plants grow on the soils. The less sloping soils, therefore, have a darker surface layer and more dense vegetation than steeper soils, and lime is at a greater depth. Slips or catsteps, about 3 to 12 inches high, occur on clayey soils that have slopes of more than 8 percent. In contrast, slips do not occur on sandy soils unless the slope is more than 15 percent. Rills, 2 to 6 inches deep, form in some places in soils having slopes of more than 3 percent. Gullies, a foot to many feet deep, may form where water collects and runs off. In areas where the surface layer is removed by blowing, slipping, or washing, the soils are thinner than in undisturbed areas and the soil-forming processes are slowed.

Time

Time is required for the formation of soils. The length of time that was required for the soils to form as they now occur in the county is unknown, but probably this time should be measured in thousands of years. In a few hundred years, some soil material was removed from nearly all slopes by wind and water. Also, some material was deposited in low areas and on slopes that face south and east. Soil horizons form faster in loose material that has been redeposited than they do in material weathered in place from hard sandstone or shale that water and plant roots cannot penetrate so easily.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and used in managing farms and ranches; in developing residential, industrial, and recreational areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and later revised (*4*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. It is under continual study. Therefore, readers interested in developments of this system should refer to the latest literature available (*3*, *6*). In table 9, the soil series of Arapahoe County are placed in some categories of the current system and in the great soil groups of the older system.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system soil properties that are observable and measurable are used as a basis for classification. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. The classes that make up the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized in this system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Three exceptions are the Entisols, Inceptisols, and Histosols, which occur in many different climates. Three of the soil orders are represented in Arapahoe County. They are Entisols, Aridisols, and Mollisols.

Entisols are recent soils in which there has been little, if any, horizon development.

Aridisols formed in dry climate. They have a light-colored surface layer, and some have a clay-enriched B horizon high in base saturation. Others have free carbonates throughout their profile.

Mollisols have a thick, dark-colored surface layer, moderate to strong structure, and base saturation of more than 50 percent.

SUBORDER: Each order is divided into suborders, primarily on the basis of those soil characteristics that produce classes having the greatest genetic similarity. The suborders narrow the broad climatic range permitted in

TABLE 9.—*Soil series classified according to the current system of classification and the 1938 system with its later revisions*

Series	Current classification [1]			1938 classification with later revisions
	Family	Subgroup	Order	Great soil group
Adena	Fine, montmorillonitic, mesic	Ustollic Paleargids	Aridisols	Brown soils.
Ascalon	Fine-loamy, mixed, mesic	Aridic Argiustolls	Mollisols	Chestnut soils.
Baca	Fine, montmorillonitic, mesic	Ustollic Haplargids	Aridisols	Brown soils.
Beckton	Fine, montmorillonitic, mesic	Typic Natrustolls	Mollisols	Solonetz soils.
Bijou	Coarse-loamy, mixed, mesic	Ustollic Haplargids	Aridisols	Brown soils.
Blakeland	Sandy, mixed, mesic	Torriorthentic Haplustolls	Mollisols	Chestnut soils.
Bresser	Fine-loamy over sand or sandy skeletal, mixed, mesic.	Aridic Argiustolls	Mollisols	Chestnut soils.
Buick	Fine-silty, mixed, mesic	Ustollic Haplargids	Aridisols	Brown soils.
Colby	Fine-silty, mixed, calcareous, mesic	Ustic Torriorthents	Entisols	Regosols.
Deertrail	Fine, montmorillonitic, mesic	Haplustolic Natrargids	Aridisols	Solonetz soils.
Edgewater	Fine-loamy over sand or sandy skeletal, mixed, noncalcareous, mesic.	Cumulic Haplaquolls	Mollisols	Chestnut soils.
Fondis	Fine, montmorillonitic, mesic	Abruptic Aridic, Paleustolls	Mollisols	Chestnut soils.
Fort Collins	Fine-loamy, mixed, mesic	Ustollic Haplargids	Aridisols	Brown soils.
Heldt	Fine, montmorillonitic, mesic	Ustertic Camborthids	Aridisols	Brown soils.
Litle	Fine, montmorillonitic, mesic	Ustollic Camborthids	Aridisols	Brown soils.
Nunn	Fine, montmorillonitic, mesic	Aridic Argiustolls	Mollisols	Chestnut soils.
Olney	Fine-loamy, mixed, mesic	Ustollic Haplargids	Aridisols	Brown soils.
Renohill	Fine, montmorillonitic, mesic	Ustollic Haplargids	Aridisols	Brown soils.
Samsil	Clayey, mixed, calcareous, mesic, shallow.	Ustic Ustorthents	Entisols	Lithosols.
Stapleton	Coarse-loamy, mixed, mesic	Aridic Haplustolls	Mollisols	Chestnut soils.
Tassel	Loamy, mixed, calcareous, mesic, shallow.	Ustic Ustorthents	Entisols	Lithosols.
Terry	Coarse-loamy, mixed, mesic	Ustollic Haplargids	Aridisols	Brown soils.
Thedalund	Fine-loamy, mixed, calcareous, mesic	Ustic Torriorthents	Entisols	Lithosols.
Truckton	Coarse-loamy, mixed, mesic	Aridic Argiustolls	Mollisols	Chestnut soils.
Weld	Fine, montmorillonitic, mesic	Abruptic Aridic Paleustolls	Mollisols	Chestnut soils.

[1] Placement of some series in the current system of classification, particularly in families and subgroups, may change as more precise information becomes available.

the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUP: Suborders are separated into great groups according to the presence or absence of genetic horizons and the arrangement of these horizons. The horizons used to make separations are those in which clay, iron, or humus has accumulated or those that have pans that interfere with the growth of roots or the movement of water. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium) and the like. The great group is not shown separately in table 9, because it is the last word in the name of the subgroup.

SUBGROUP: Each great group is subdivided into subgroups. One of these subgroups represents the central, or typic, segment of a group, and the others, called intergrades, contain those soils that have properties mostly of one great group, but also one or more properties of soils in another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order.

FAMILY: Each subgroup is divided into families, primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

Geology and Soil Development

From oldest to youngest, the geologic formations exposed in Arapahoe County are Pierre shale and the Fox Hills and Laramie formations of Upper Cretaceous age, the Dawson formation of Pleistocene age, and sand of Recent age.

Pierre shale crops out only in the eastern part of the county, mainly in the area drained by Beaver Creek. It is olive silty clay that has much crystalline gypsum. The Litle and Samsil soils were derived from Pierre shale. Colby and Adena soils formed on the tops of most ridges and on east-facing slopes, which are gently sloping and mantled with eolian silt (loess). Beaver Creek and its tributaries that drain this area have many vertical banks more than 30 feet high. Along the upper parts of the tributaries are small flood plains on which the material is clay. Terraces as much as a half mile wide occur above the flood plains and on them Heldt and Beckton soils are dominant.

The upper part of the Pierre shale and the lower 100 feet of the Fox Hills formation form a zone of transition

that extends from north to south across the eastern part of the county and crops out in a narrow band that is drained mainly by Badger Creek. This zone is dominantly light olive brown and consists of interbedded sandy shale, shale, and sandstone. The beds are calcareous and have some gypsum. In this area, the Baca and Thedalund soils occur on rolling topography and the Weld, Colby, and Deertrail soils are on the higher, gently sloping, west-facing slopes. In many parts of this area, water has cut deep, narrow drainageways that have many vertical banks 10 to 30 feet high.

A sandstone bed, 150 to 200 feet thick, forms the upper part of the Fox Hills formation, and it crops out in a narrow strip that extends from north to south across the eastern part of the county, mainly between Beaver Creek and Deer Trail Creek. The sandstone is fine grained, buff to white, and mainly calcareous. The soils derived from this sandstone in rolling areas are Terry fine sandy loam and Olney fine sandy loam. In gently sloping areas, Weld fine sandy loam occurs where loess has been deposited. Resistant sandstone crops out in a hilly area where the Thedalund, Tassel, and Terry soils are closely associated. Deer Trail and Badger Creeks have flood plains 100 to 1,000 feet wide on which the soils are of medium to heavy texture. On terraces above the flood plains, Beckton loam is dominant.

The Laramie formation overlies the Fox Hills formation, and the contact line between the two formations is approximately along Deer Trail Creek. The Laramie formation underlies most of the area between Deer Trail Creek and West Bijou Creek. It commonly crops out along the streams and the lower slopes of drainageways on side hills. This formation consists of gray to black shale and thin beds of sandstone. The shale is highly carbonaceous in places. The sloping Samsil and Renohill soils developed in these areas, generally on slopes that face west.

Pleistocene alluvium consisting of loam and clay loam and varying amounts of gravel has been deposited on the Laramie formation from Deer Trail Creek westward. This alluvium is thicker to the west and south than it is to the north and east. Over this older alluvium is a younger eolian silty mantle that is 8 to 10 inches thick in the smoother areas. The highest lying soils developed in the loess. They include the nearly level to gently rolling Weld, Colby, Adena, and Deertrail soils. The more deeply weathered Buick soils developed next to the drainageways and below the loessal soils. The Buick soils normally are in bands less than 300 feet wide around the upper parts of drainageways. They grade to Renohill soils that developed in material weathered from the Laramie formation near the base of the drainageways on east-facing slopes and well up on west-facing slopes. In most of these areas, the Buick and Renohill soils are closely associated on sloping and rolling topography. The shallow Samsil soils occur in broken areas of the side slopes close to the drainageways.

In the area that extends westward from East Bijou Creek to Kiowa Creek, the soils developed mainly in a mixture of sand and silt deposited by the wind. These deposits are probably of Pleistocene or Recent age and were carried by water from the Dawson formation, deposited, and then reworked by the wind. The Nunn soils developed in the more nearly level areas, and the Bresser soils developed in the rolling areas or on small humps. The topography is gently undulating. Sandy materials deposited by the wind in dunes, 20 to 50 feet high, are common at the southern edge of the county, but the dunes are less numerous or disappear at the northern border. The Blakeland, Bresser, and Truckton soils developed in these areas. The Buick and Renohill soils formed in the sloping to rolling areas along the drainageways where the sandy deposits are thinnest. The valleys along Kiowa Creek and East Bijou, Middle Bijou, and West Bijou Creeks are similar. In these valleys are wide, barren, sandy stream channels that are generally dry and a few sandy flood plains and low terraces. The streams are 50 to 300 feet below the surrounding uplands. In these valleys are deposits of Recent age in which the Bresser, Nunn, Beckton, and Heldt soils formed. The major drainageways between Bijou Creek and Kiowa Creek are Rattlesnake, Comanche, and Wolf Creeks. They are a little lower than the surrounding uplands, and their flood plains blend into the surrounding uplands.

Near East Bijou Creek is the contact line between the Laramie and the overlying Dawson formation. The lower part of the Dawson formation is made up of clay and sandy shale, thin beds of fine- to medium-grained arkosic sandstone, and some conglomeratic sandstone. Several thin beds of coal also occur. The dominant colors range from various shades of gray and brown to brown and black.

West of Kiowa Creek the wind-deposited sand is not so dominant as it is east of the creek. In the Pleistocene alluvial mantle, which is thicker than the mantle farther east, at least two kinds of buried soils have formed. Where the loessal mantle occurs, it is thinner and in some places older than that in the eastern part of the county. In this area the gently sloping to sloping Fondis and Weld soils formed on uplands. On sloping and rolling topography, the Buick soils formed in material deposited by wind and water and the Litle, Renohill, and Thedalund soils formed in material weathered from the Dawson formation. All of these soils are closely associated. Outcrops of shale and sandstone of the Dawson formation are visible close to the drainageways in some places.

The sandy Truckton and Bresser soils and the Nunn soils overlie more clayey older soils in bands as much as 2 miles wide along the eastern sides of Box Elder (fig. 17), Coal, Toll Gate, and Cherry Creeks and of the South Platte River. These soils formed on Recent sand that was blown out of the channels and deposited on uplands adjacent to the streams.

Just east of the Box Elder Creek, along the southern boundary of the county is a layer of red clay about 200 feet above the line of contact between the upper and lower parts of the Dawson formation. From the southern boundary, this layer extends about 6 miles northward in the county, then goes west and south in a rough semicircle, and leaves the county just east of Cherry Creek. It closely follows the 6,000-foot contour. The reddish variant of the Renohill series developed on this layer.

The upper part of the Dawson formation occurs in the southwestern part of the county above an elevation of about 5,900 feet. It consists of poorly consolidated, noncalcareous beds of coarse sand and fine gravel mixed with layers of siltstone. Colors range from buff to white. The gravel, mainly feldspar and mica, is evident throughout these beds. More resistant beds of arkosic conglomerate are exposed. The Bresser and Stapleton soils were derived from the upper part of the Dawson formation. The Stapleton soils are moderately steep and support the only pine

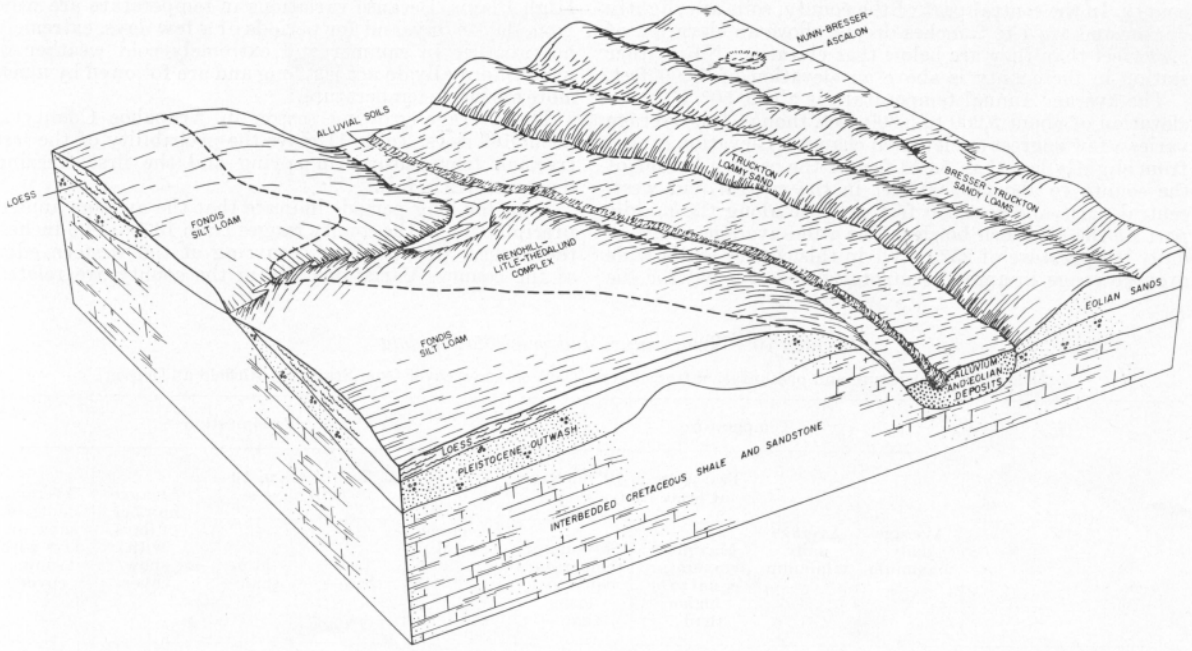

Figure 17.—**Cross section of Box Elder Creek and vicinity.**

trees in this county. The Bresser soils are residual and developed on mixed eolian and colluvial material. These soils occur with the Stapleton soils on rolling topography. Some Pleistocene outwash is present on side slopes.

All of the creeks from Wolf Creek westward to the South Platte River have small flood plains and narrow gently sloping terraces. The Nunn and Fort Collins soils occur in these areas, and there are small areas of Heldt soils on loamy alluvium along Piney Creek. Bresser and Bijou soils formed in alluvial and eolian sandy materials. The colors of these soils generally are darker than those of the soils east of Wolf Creek, and more feldspar and mica are in the materials.

Along the South Platte River, the alluvium of the flood plains is somewhat finer textured than that along the other streams in the county, and it stays wet the year round because the river flows all year. The terrace above this flood plain is underlain by medium to fine gravel, is as much as 1 mile wide, and is wider than the terraces along other streams in the county. Along the South Platte River on flood plains and terraces are the Nunn, Bresser, and Edgewater soils and Wet alluvial land.

Dominant west of the South Platte River are soils developed from Pleistocene alluvium in which the lower part of the Dawson formation is exposed in places on the steeper slopes. Some geologists subdivide the lower part of the Dawson formation into the Denver and Arapahoe formations. West of the South Platte River, more gravel is present in the alluvial material, which may be of different geologic age than the material on uplands east of the river. Heldt, Fondis, and Ascalon soils and Wet alluvial land occur on the Pleistocene alluvium west of the South Platte River.

Climate of Arapahoe County[9]

Arapahoe County has a semiarid climate that is somewhat characteristic of the climate of the High Plains but is modified by the Rocky Mountains to the west and by the high areas of the Black Forest to the south. Data on temperature and precipitation are given in table 10.

The effect of the Rocky Mountains on the climate of the county lessens as distance eastward from the western boundary increases. The county, which from west to east is about 72 miles long, lies in a belt where there is a fairly rapid change from the climate of the foothills to that of the plains.

From south to north in the western half of the county, there is a noticeable change from the climate of the foothills to that of the plains. This change is largely caused by the increase in elevation from north to south and by the effect of the higher area of the Black Forest to the south. Generally, the climate of the plains ranges from an elevation of about 5,300 feet at the western edge of the county to about 5,600 feet in the south-central part of the county. The boundary of the plains climate is indicated by native shrubs, such as snowberry and mountain-mahogany, above an elevation of 5,600 feet, and by the disapperance of sand sage in the southwestern part of the

[9] J. W. Berry, State climatologist, U.S. Weather Bureau, assisted in preparing this section.

county. In the central part of the county, soils are slightly darker and are 1 to 2 inches deeper above an elevation of 5,600 feet than they are below that elevation. No weather station in the county is above an elevation of 5,600 feet.

The average annual temperature is about 50° F. at an elevation of about 5,200 to 5,300 feet, though this average varies a few degrees as elevation changes. Elevation ranges from slightly less than 5,000 feet at the eastern border of the county to about 5,500 feet in the central and west-central parts and to 6,000 feet or more along the middle part of the southern border. The wide average range in daily temperature of 25° to 30° in this county and a wide average range in annual temperature are typical for the High Plains. Because variations in temperature are wide from day to day, and for periods of a few days, extremely hot weather in summer and extremely cold weather in winter normally do not last long and are followed by much more moderate temperature.

The average growing season in Arapahoe County is about 160 days. Table 11 gives the probability of the last freezing temperatures in spring and the first freezing temperatures in fall.

Data for long periods indicate that the average annual precipitation in the county ranges from 13.5 to 14.5 inches, the highest precipitation occurring at the western edge of the county. Variations within the county are related

TABLE 10.—*Temperature and precipitation data*

[Data for temperature and precipitation from Byers. Data on snow cover from Stapleton Airfield at Denver]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average total	Two years in 10 will have—		Average number of days with snow cover	Average depth of snow on days with snow cover
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—		
	°F.	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*		*Inches*
January	43	14	61	−6	0.43	0.1	0.8	8	2
February	47	18	64	−2	.47	.2	.7	9	3
March	52	23	70	4	.87	.4	1.6	7	3
April	62	33	79	19	1.86	.7	2.8	3	4
May	71	42	86	32	2.54	.9	3.7	1	3
June	84	51	96	40	1.58	.7	2.6	0	0
July	91	57	99	50	2.01	1.0	3.2	0	0
August	89	56	98	49	1.49	.7	2.1	0	0
September	80	47	94	35	1.14	.2	1.7	(1)	4
October	69	36	83	25	.72	.1	1.5	1	2
November	54	23	71	7	.54	.2	.9	5	3
December	46	18	64	2	.40	.1	.6	7	3
Year	66	35	[2] 101	[3] −14	14.05	9.2	18.3	41	3

[1] Less than one-half day.
[2] Average annual highest temperature.
[3] Average annual lowest temperature.

TABLE 11.—*Probable dates of last freezing temperatures in spring and first in fall*

[Based on data at Byers]

Probability	Dates for a given probability at a temperature of—				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	April 17	April 23	May 4	May 13	May 29
2 years in 10 later than	April 11	April 18	April 28	May 7	May 23
5 years in 10 later than	March 31	April 7	April 17	April 27	May 11
Fall:					
1 year in 10 earlier than	October 24	October 14	October 3	September 25	September 13
2 years in 10 earlier than	October 29	October 19	October 8	September 30	September 18
5 years in 10 earlier than	November 8	October 29	October 18	October 10	September 29

to the terrain, including elevation and slope. Particularly in spring and summer, precipitation may vary from year to year and in different areas in the same year. Averages for long periods are so affected by chance occurrences of precipitation that these averages are not easily interpreted in terms of actual differences in precipitation in a year or in a locality.

The probability of annual precipitation, however, is significant because it is the chance of receiving specified amounts of precipitation in any year. Figure 18 shows this probability, in percent, at Byers.

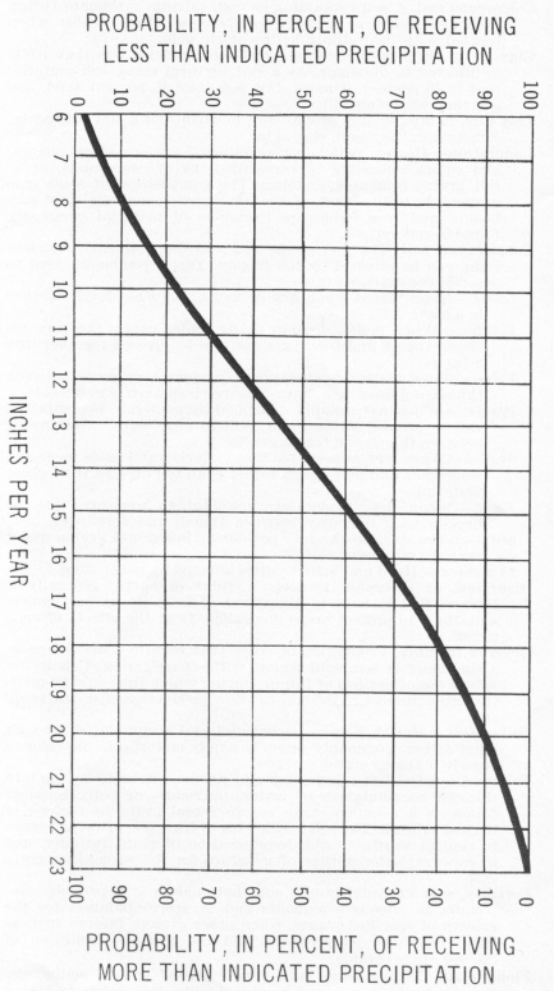

Figure 18.—**Probability, in percent, of receiving less and more than specified amounts of annual precipitation at Byers.**

Precipitation in winter is more in the western part of the county than it is in other parts. These differences are sometimes small but are consistent from October to May. The annual snowfall is about 59 inches at Denver and is about 46 inches at Byers. The eastern part of the county, however, usually receives more rainfall in summer than the rest of the county, but local rainfall varies widely from year to year.

From the western border eastward, variations in the climate of Arapahoe County include (1) increased average windspeed because the shielding effect of the Rocky Mountains is reduced, (2) slightly lower average annual precipitation, (3) smaller amounts of precipitation in winter and early in spring, (4) an increase in amount and variability of precipitation in summer, (5) greater average variation in daily and annual temperatures, and (6) somewhat less cloudiness and more sunshine.

The relative humidity averages 39 percent during the day and 62 percent at night, but these averages are slightly higher in winter than in summer. In an average year, the percentage of sunshine is about 69 percent.

Hailstorms cause some local damage to crops almost every year. The hail generally falls in strips 1 mile wide and 6 miles long. These storms are more common in the eastern part of the county than in the western part, and they are most common at an elevation of less than 5,600 feet. They generally occur from about May 15 to September 1 but are most common in June and July.

Additional Facts About the County

The first settlers in Arapahoe County were gold miners who moved into the area just west of the present town of Englewood in 1857. Irrigation farming began in about 1859, when an irrigation ditch was built along Bear Creek. Irrigation farming grew rapidly along the South Platte River between 1859 and 1872. Most of the acreage east of the South Platte River was occupied by large cattle ranches from 1860 until 1885, when settlers were allowed to homestead the open range.

Although many of the soils in the county are suitable for farming, the lack of water limits their use for that purpose. Water from streams and wells is used mainly for domestic purposes.

The quarrying of gravel is important along the South Platte River. The gravel is used for the construction of roads and buildings in the metropolitan area of Denver. A small amount of coal has been mined in the central part of the county. Natural rock, limestone, sandstone, and rhyolite are also available for local use.

The population of Arapahoe County is steadily increasing, particularly in the western 15 percent of the county where much of the acreage is used for nonfarm purposes. Several incorporated towns are in the Denver metropolitan area. According to reports of the U.S. Bureau of the Census, the population of the county was about 32,150 in 1940, 52,125 in 1950, and 113,426 in 1960. About 105,000 of these people lived in the Denver metropolitan area, or the western 15 percent of the county, in 1960. Littleton, the county seat, had a population of 13,670 in 1960.

According to the U.S. census of agriculture, about 96.3 percent, or 501,802 acres of Arapahoe County was farmland in 1964. The number of farm units has decreased since

1940, but the average size of farms has increased. The average size of farms increased from 417 acres in 1940 to 1,107 acres in 1959. The number of farms decreased from 463 in 1959 to 321 in 1964, but the average size increased to 1,563 acres.

Winter wheat is the major crop grown in the county. Because of acreage controls, however, grasses, particularly wheatgrass, and barley are now grown on much of the acreage that was used for wheat. In 1959 about 59,782 acres were planted to winter wheat, compared to 47,895 acres in 1964. In 1959 about 19,028 acres were planted to barley, but this acreage decreased to 11,030 in 1964. From 1930 to 1964 the acreage in beans decreased from about 20,000 acres to 273 acres. In the same period, the number of acres planted to corn decreased from 25,000 to 806. Grass is excellent for the control of erosion, as well as for grazing livestock. Barley, beans, and corn do not protect the soil against erosion as well as winter wheat, and they do not withstand droughts so well.

According to assessments and levies in Arapahoe County, more than 22,000 acres were irrigated in 1950, but only 2,200 acres were irrigated in 1961. This decrease has been caused by residential and industrial development and by an increase in recreational facilities and in highway construction. Also, much of the water from the South Platte River that was once used to irrigate crops is now used for domestic purposes.

The U.S. census of agriculture reports that from 1959 to 1964 the number of cattle and calves in the county increased from 15,127 to 19,261, and the number of sheep and lambs decreased from 14,097 to 8,362. There were 1,688 hogs and pigs in 1959 and only 1,543 in 1964.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Arkose (petrography). A term to describe sandstone derived from disintegrated granite or gneiss and characterized by fragments of feldspar. An arkosic conglomerate is one in which the fine material, or matrix containing the boulders or pebbles, is arkose.

Available water holding capacity. The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Buried soil. A developed soil, once exposed but now overlain by more recently formed soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: Clay coat, clay skin.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Dryland farming. Production of crops that require some tillage in a subhumid or semiarid region, without irrigation. Usually involves use of periods of fallow, during which time enough moisture accumulates in the soil to allow production of a cultivated crop.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Fallow. Cropland left idle in order to restore productivity, mainly through accumulation of water, nutrients, or both. Summer fallow is a common stage before cereal grain in regions of limited rainfall. The soil is tilled for at least one growing season to control weeds, to aid decomposition of plant residues, and to encourage the storage of moisture for the succeeding grain crop.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Fragipan. A dense, brittle, subsurface horizon that is very low in organic matter and clay but is rich in silt or very fine sand. The layer is seemingly cemented. When dry, it is hard or very hard and has a high bulk density in comparison with the horizon or horizons above it. When moist, the fragipan tends to rupture suddenly if pressure is applied, rather than to deform slowly. The layer is generally mottled, is slowly or very slowly permeable to water, and has few or many bleached fracture planes that form polygons. Fragipans are a few inches to several feet thick; they generally occur in the B horizon, 15 to 40 inches below the surface.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. It may be limited either by the infiltration capacity of the soil or by the rate at which water is applied to the surface soil.

Internal soil drainage. The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by the height of the water table, either permanent or perched. Relative terms for expressing drainage are *none, very slow, slow, medium, rapid,* and *very rapid.*

Leaching. The removal of soluble material from soils or other material by percolating water.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Natural soil drainage. Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and in Podzolic soils commonly have mottlings below 6 to 16 inches, in the lower A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value alkalinity; and a lower value, acidity.

Plowpan. A compacted layer formed in the soil immediately below the plowed layer.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline.	9.1 and higher

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slick spots. Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); silt (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting of winter grains.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Upland (geologic). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

Water spreading. Diverting runoff from a gully or watercourse onto gently sloping, absorptive land to conserve waste water or to increase plant growth, to reduce flood peaks, or to replenish ground-water supplies.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit or a range site, read the introduction to the section it is in for general information about its management. For information on the use and management of soils for trees, see the section beginning on page 50. Other information is given in tables as follows:

Acreage and extent, table 1, p. 7.
Predicted yields, table 2, p. 40.
Nonfarm uses of soils, table 3, p. 42.
Use of soils for wildlife, table 4, p. 53.
Use of soils for recreation, table 5, p. 54.
Engineering uses of soils, tables 6, 7, and 8, pp. 56 through 68.

Map symbol	Mapping unit	Described on page	Capability unit		Range site		Tree planting suitability group
			Symbol	Page	Name	Page	Number
AcC	Adena-Colby fine sandy loams, 1 to 5 percent slopes	8	IVe-6	37	Loamy Plains	45	1
AcD	Adena-Colby fine sandy loams, 5 to 9 percent slopes	8	VIe-1	38	Loamy Plains	45	1
AdC	Adena-Colby silt loams, 1 to 5 percent slopes	9	IVe-1	36	Loamy Plains	45	1
AdD	Adena-Colby silt loams, 5 to 9 percent slopes	9	VIe-1	38	Loamy Plains	45	1
AsD	Ascalon sandy loam, 5 to 9 percent slopes	9	IVe-4	36	Sandy Plains	47	1
BcC	Baca loam, 3 to 5 percent slopes	10	IVe-1	36	Loamy Plains	45	1
BcD	Baca loam, 5 to 9 percent slopes	10	VIe-1	38	Loamy Plains	45	1
BhD	Baca-Thedalund loams, 3 to 9 percent slopes	10	VIe-1	38	Loamy Plains	45	4
BkB	Beckton loam, 0 to 3 percent slopes	11	VIs-2	39	Salt Flat	48	5
BlB	Bijou sandy loam, 0 to 3 percent slopes	12	IIIe-1	35	Sandy Foothill	50	2
BmB	Bijou sandy loam, wet, 0 to 3 percent slopes	12	IVw-1	37	Wet Meadow	49	3
BoD2	Blakeland loamy sand, 1 to 9 percent slopes, eroded	12	VIe-4	38	Deep Sand	48	2
BoE	Blakeland loamy sand, 1 to 20 percent slopes	13	VIe-4	38	Deep Sand	48	2
BrB	Bresser loamy sand, terrace, 0 to 3 percent slopes	13	IVe-7	37	Sandy Foothill	50	2
BsB	Bresser sandy loam, terrace, 0 to 3 percent slopes	13	IIIe-1	35	Sandy Foothill	50	2
BtB	Bresser loam, gravelly subsoil variant, 1 to 3 percent slopes	13	IIIc-1	36	Loamy Foothill	49	1
BuD	Bresser-Stapleton sandy loams, 3 to 9 percent slopes	14	IVe-4	36	Sandy Foothill	50	2
BuE	Bresser-Stapleton sandy loams, 9 to 20 percent slopes	14	VIe-3	38	Sandy Foothill	50	4
BvC	Bresser-Truckton sandy loams, 3 to 5 percent slopes	14	IVe-3	36	Sandy Foothill	50	2
BvE	Bresser-Truckton sandy loams, 5 to 20 percent slopes	14	VIe-3	38	Sandy Foothill	50	4
BwD2	Bresser and Truckton soils, 3 to 9 percent slopes, eroded	15	VIe-3	38	Sandy Foothill	50	2
BxC	Buick loam, 3 to 5 percent slopes	15	IIIe-2	35	Loamy Foothill	49	1
BxD	Buick loam, 5 to 9 percent slopes	15	IVe-2	36	Loamy Foothill	49	1
Ca	Clayey alluvial land	16	VIw-2	38	Overflow	49	5
CoC	Colby silt loam, 1 to 5 percent slopes	16	IVe-1	36	Loamy Plains	45	1
CoE	Colby silt loam, 5 to 20 percent slopes	16	VIe-1	38	Loamy Slopes	45	4
CyD2	Colby and Adena soils, 1 to 9 percent slopes, eroded	17	VIe-1	38	Loamy Plains	45	1
EdB	Edgewater loam, 0 to 3 percent slopes	18	IVw-1	37	Wet Meadow	49	3
FdB	Fondis silt loam, 1 to 3 percent slopes	19	IIIc-1	36	Loamy Foothill	49	1
FdC	Fondis silt loam, 3 to 5 percent slopes	19	IIIe-2	35	Loamy Foothill	49	1
FgD	Fondis-Ascalon, gravelly subsoil variant, complex, 1 to 9 percent slopes	19	VIe-1	38	Loamy Foothill	49	1
FoC	Fondis-Colby silt loams, 3 to 5 percent slopes	19	IIIe-2	35	Loamy Foothill	49	1

Map symbol	Mapping unit	Described on page	Capability unit		Range site		Tree planting suitability group
			Symbol	Page	Name	Page	Number
FrB	Fort Collins loam, 0 to 3 percent slopes---	20	IIIc-1	36	Loamy Plains	45	1
Gr	Gravelly land----------	20	VIIs-1	39	----------	--	5
HlB	Heldt clay, 0 to 3 percent slopes----------	21	IVs-1	37	Clayey Foothill (western part)	49	4
					Clayey Plains (eastern part)	46	
HsB	Heldt clay, saline, 0 to 3 percent slopes--	21	VIs-1	39	Alkaline Plains	46	5
LcD	Litle silty clay loam, 1 to 9 percent slopes----------	21	VIs-1	39	Clayey Foothill (western part)	49	4
					Alkaline Plains (eastern part)	46	
LsD	Litle-Samsil, gypsum, silty clay loams, 3 to 9 percent slopes----------	22	VIs-1	39	Alkaline Plains	46	5
Lv	Loamy alluvial land----------	22	VIw-2	38	Overflow	49	1
NlB	Nunn loam, 0 to 3 percent slopes----------	23	IIIc-1	36	Loamy Foothill (western part)	49	1
					Loamy Plains (eastern part)	45	
NrB	Nunn-Bresser-Ascalon complex, 0 to 3 percent slopes----------	23	IIIc-1	36	Loamy Foothill	49	1
OnD	Olney fine sandy loam, 5 to 9 percent slopes----------	23	VIe-3	38	Sandy Plains	47	1
RdD	Renohill loam, 3 to 9 percent slopes-------	24	VIe-1	38	Loamy Plains	45	4
ReE	Renohill loam, reddish variant, 5 to 20 percent slopes----------	24	VIe-1	38	Loamy Foothill	49	4
RhD	Renohill-Buick loams, 3 to 9 percent slopes----------	24	VIe-1	38	Loamy Foothill (western part)	49	4
					Loamy Plains (eastern part)	45	
RhE	Renohill-Buick loams, 9 to 20 percent slopes----------	25	VIe-1	38	Loamy Foothill (western part)	49	5
					Loamy Plains (eastern part)	45	
RkE2	Renohill-Buick complex, 5 to 20 percent slopes, eroded----------	25	VIe-2	38	Clayey Foothill	49	5
RlD	Renohill-Litle clay loams, 3 to 9 percent slopes----------	25	VIe-2	38	Clayey Foothill	49	4
RtE	Renohill-Litle-Thedalund complex, 9 to 30 percent slopes----------	25	VIe-2	38	Clayey Foothill	49	5
Ru	Rock outcrop----------	25	VIIIs-1	39	----------	--	5
SaE	Samsil clay, gypsum, 5 to 20 percent slopes----------	26	VIs-1	39	Alkaline Plains	46	5
SlF	Samsil-Litle stony clays, 20 to 50 percent slopes----------	26	VIIs-1	39	----------	--	5
SrE	Samsil-Renohill clay loams, 3 to 20 percent slopes----------	26	VIe-2	38	Clayey Plains	46	5
Ss	Samsil-Shale outcrop complex----------	26	VIIs-1	39	Shale Breaks	48	5
St	Sand pits----------	26	VIIIs-1	39	----------	--	5
Su	Sandy alluvial land----------	27	VIIw-1	39	----------	--	2
Sv	Shale outcrop----------	27	VIIs-1	39	Shale Breaks	48	5
SwE	Stapleton sandy loam, 9 to 30 percent slopes----------	27	VIe-3	38	----------	--	5
Ta	Tassel-Rock outcrop complex----------	28	VIIs-1	39	Sandstone Breaks	48	4
Tc	Terrace escarpments----------	28	VIIs-1	39	----------	--	5
TdE	Terry fine sandy loam, 5 to 20 percent slopes----------	28	VIe-3	38	Sandy Plains	47	2

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Range site		Tree planting suitability group
			Symbol	Page	Name	Page	Number
TeE	Terry-Olney-Thedalund sandy loams, 5 to 20 percent slopes	28	VIe-3	38	Sandy Plains	47	4
ThE	Thedalund clay loam, 9 to 20 percent slopes	29	VIe-1	38	Loamy Slopes	45	5
ThE2	Thedalund clay loam, 9 to 20 percent slopes, eroded	29	VIe-2	38	Clayey Plains	46	5
TrC	Truckton loamy sand, 1 to 5 percent slopes	30	IVe-5	37	Sandy Foothill	50	2
TrE	Truckton loamy sand, 5 to 20 percent slopes	30	VIe-3	38	Sandy Foothill	50	4
WdC	Weld fine sandy loam, 1 to 5 percent slopes	31	IVe-6	37	Loamy Plains	45	1
WeB	Weld silt loam, 0 to 3 percent slopes	31	IIIc-1	36	Loamy Plains	45	1
WeC	Weld silt loam, 3 to 5 percent slopes	31	IIIe-2	35	Loamy Plains	45	1
WrB	Weld-Deertrail silt loams, 0 to 3 percent slopes	31	IVs-1	37	Loamy Plains (Weld part) Alkaline Plains (Deertrail part)	45 46	4
Wt	Wet alluvial land	31	VIw-1	38	Wet Meadow	49	3