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Soil Survey
of
The Brighton Area, Colorado

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and

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Bureau of Chemistry and Soils
In cooperation with the Colorado Agricultural Experiment Station

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SOIL SURVEY OF THE BRIGHTON AREA, COLORADO

By W. G. HARPER, United States Department of Agriculture, in Charge, and LLOYD ACOTT and ELMER FRAHM, Colorado Agricultural Experiment Station

AREA SURVEYED

The Brighton area lies in the north-central part of Colorado (fig. 1). It comprises 448 square miles, or 286,720 acres, in Jefferson, Boulder, and Adams Counties, and includes the more intensively farmed land between Denver, Golden, Boulder, and Brighton. The south-central part of the area includes the northern suburbs of Denver.

The area is wholly within the Plains region and is bordered on the west by the Rocky Mountains. South Platte River, flowing northeasterly, divides the area, about two-thirds of it lying west of the river. This part consists of a series of ridges of water-laid materials, extending in an easterly or northeasterly direction, separated by shallow valleys. The ridges slope toward the river at a gradient ranging from 50 to more than 350 feet in a mile. The land east of the river is characterized by a number of broad rolling ridges that slope more gently to the river in a northerly or northwesterly direction at an average gradient of about 150 feet in a mile. The larger part of the area is about a mile above sea level, the lowest elevation on the river near Brighton is 5,000 feet, and the top of Table Mountain near Golden lies at an elevation of 6,500 feet.

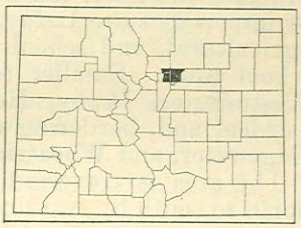

FIGURE 1.—Sketch map showing location of the Brighton area, Colo.

The Plains area, in addition to being divided by South Platte River, has its broad valley floor dissected by a dendritic system of rather mature streams, a few of which have comparatively wide flat valley floors and flow perennially, their headwaters lying in the mountains many miles west of the area; and the others are but small tributary streams, some of which have shallow and others rather deeply cut V-shaped valleys that carry water only following the more rainy months. Regional drainage is well developed, and only a few areas are flooded after heavy rains.

The Brighton area lies in the region of short-grass vegetation, grama and buffalo grasses predominating on the well-drained soils of medium or heavy texture and in most places forming a dense sod. Bunch grass, an Andropogon, is a tall grass which grows on the well-drained sandy lands. Soapweed (*Yucca glauca*) and common cactus, or pricklypear, grow on light- or medium-textured droughty soils. Squirreltail or foxtail (*Hordeum jubatum*) is com-

mon on seepy areas and is usually an indicator of the presence of excess salts. Rabbitbrush and sagebrush are common shrubs; and wire grass, a few sedges, and many weeds are of common occurrence.

Boulder and Jefferson Counties, part of which are included in the western part of the area, were in existence in 1861 under the territorial government and retained their identities as counties after statehood was granted to Colorado Territory in 1876. Adams County was organized from a part of Arapahoe County in 1902.

Most of the people are native whites who came from more eastern States or are natives of Colorado. Many Mexicans and a number of Russians are employed in the sugar-beet fields, and Italians and Japanese grow a large proportion of the truck crops and vegetables. The 1930 census reports a population of 20,245 for Adams County, 21,810 for Jefferson County, and 32,456 for Boulder County, but no census figures are available for the Brighton area alone. Brighton, with a population of 3,394, is the county seat of Adams County; Golden, the county seat of Jefferson County, has a population of 2,426; and Boulder, just outside the area, the county seat of Boulder County, has a population of 11,223. These towns constitute important local markets but are not comparable with the city of Denver, with a population of 287,861, that borders the area and provides the main market for agricultural produce. Other towns of importance are Lafayette and Louisville, which are coal-mining, agricultural, and school centers, and Arvada, an agricultural and school town. Smaller towns are Broomfield, Marshall, Eastlake, Westminster, Derby, Henderson, Adams City, Irondale, Welby, Leyden, and, bordering on the city limits of Denver, are Aurora, Edgewater, and Wheatridge.

The area is traversed from east to west by one line and from north to south by two lines of the Union Pacific Railroad, and from north to south by the Chicago, Burlington & Quincy Railroad and the Colorado & Southern Railway. The Colorado & Southern Railway has a line from Denver through Golden and westward into the mountains through Idaho Springs to Silver Plume. Golden is also connected with Denver by the Denver & Interurban (electric) Railroad. Another electric line connects Denver and Leyden. The area is well supplied with highways, both concrete paved and gravel surfaced. The county roads are, in part, graveled but in the more remote sections are only graded. The area is especially well supplied with schools, churches, and telephones.

Coal mining is probably the most important industry, other than farming, and many producing mines are in the northwestern part of the area. Two oil refineries are north of Denver, and a fire-brick factory is northwest of Golden.

CLIMATE

A uniform continental climate prevails throughout this mile-high area, which is very favorable both for health resorts and for permanent residences. The atmospheric pressure at Denver is 83 percent of that at sea level, and the humidity averages 53 percent, or 21 percent drier than that of Chicago and 27 percent less than the average at Jacksonville, Fla. The area is not visited by hurricanes or extended periods of subzero weather, and temperatures above 100°

F. are very rare, according to records covering many years. Precipitation, though not abundant, is ideally distributed—about three-fourths of the rain falling from March to October, inclusive. The precipitation of the winter months falls as snow and is therefore usually preserved until the warmer weather of spring, when it soaks into the ground shortly before plant growth begins.

The average date of the last killing frost at Boulder is May 2 and of the first is October 12, giving an average frost-free season of 163 days. Frost has been recorded as late as June 2 and as early as September 9. Though the growing season, comparatively, is not long, this is a region in which, owing to intensity of sunlight and a high percentage of sunny days during the growing season, many acclimated plants grow to maturity and produce seed in the short growing season.

The low rainfall, although well distributed, is not sufficient for successful dry farming of many crops. Irrigation is practiced over most of the area, as irrigation is necessary for sugar beets, alfalfa, and the greater part of the truck crops and fruits. Corn, pinto beans, sorghum, and some grains are grown without irrigation on soils best adapted to dry farming.

Table 1 gives the more important climatic data representative of the Brighton area. These data were compiled from the records of the United States Weather Bureau station at Boulder near the northwestern corner.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Boulder, Boulder County, Colo.*

[Elevation, 5,347 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1893)	Total amount for the wettest year (1909)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	33.0	72	−20	0.38	0.39	1.72	11.7
January	33.0	70	−22	.76	.05	.11	6.2
February	33.4	73	−20	1.52	.70	1.21	9.9
Winter	33.1	73	−22	2.66	1.14	3.04	27.8
March	39.8	83	−11	2.59	.25	3.96	12.9
April	48.2	85	10	2.90	1.00	3.60	11.4
May	56.4	88	20	1.53	2.00	1.85	3.4
Spring	48.1	88	−11	7.02	3.25	9.41	27.7
June	65.9	99	32	2.13	.50	1.67	0
July	70.8	98	40	1.56	.60	3.18	0
August	70.4	98	36	1.43	.75	2.42	0
Summer	69.0	99	32	5.12	1.85	7.27	0
September	62.8	93	24	1.66	.60	4.51	.4
October	51.8	88	−2	.81	1.16	.55	5.0
November	42.2	77	−12	.85	.80	1.56	7.9
Fall	52.2	93	−12	3.32	2.56	6.62	13.3
Year	50.6	99	−22	18.12	8.80	26.34	68.8

The climate is especially well suited to the production of such crops as sugar beets and many of the truck crops. The sugar beets grown here have a high sugar content. This is, in large part, owing to the cool summer nights, combined with the high percentage of sunshine.

The average wind velocity is moderate, the stronger winds occurring during March, April, and early May. The prevailing direction is from the west and southwest.

Unfavorable weather includes occasional dry springs when seed germination is poor because of lack of moisture, windy days during extended dry periods when blowing of surface soils occurs, extended dry periods throughout the growing season, and early freezes or snows before the sugar-beet harvest is completed. Though some unfavorable windy weather occurs nearly every spring, extended dry seasons are not numerous, and in many years clear sunny weather continues until late in November.

AGRICULTURE

Settlement of Colorado began with the discovery of gold in 1858, and since that time the population has steadily increased. In 1860 the census of the Territory of Colorado showed a population of 34,277; in April 1930 it was 1,035,791. Some farming started along the river bottoms about 1860, but until 1880, the population centered about the mining districts and the city of Denver. Irrigation began in the river bottoms by use of short canals that irrigated from 10 to 100 acres each. In 1886 canals from Clear Creek were constructed to reach the higher bench lands, and irrigation on a large scale was begun, wheat and alfalfa being the principal crops. Alfalfa was grown as early as 1875, and a large acreage was planted to the crop in the nineties, although the variety was poor and the yield was low. About the year 1900 new strains of proved value were introduced, and in about 1906 Grimm alfalfa proved well suited to this section.

About 1908 dry-land farming started, under which system corn was the principal crop, and the corn acreage was greatly increased throughout the State. Sugar beets were first grown in this section about 1900, and since that time the increase has been gradual. A sugar factory was constructed at Brighton in 1916. The production of truck crops for local market dates back to the early days of farming in Colorado, but the industry was greatly accelerated about 1915 when commercial production for outside markets began. The value of vegetables grown in Adams County increased remarkably between 1909 and 1929, according to the census reports. Large increases in the acreages of spinach, carrots, and cauliflower have been made since 1928. During the period between 1910 and 1920 the acreages devoted to nearly all crops increased and the value of many crops more than doubled, but since 1920 production has not changed markedly.

Up to 1920 the rate of development in dairying, beef raising, and poultry production was similar, but since 1920 poultry production and dairying have increased but the numbers of beef cattle have decreased.

The census shows that more money was expended for fertilizer in 1919 than in either 1909 or 1929, though the number of farms using fertilizer in Jefferson, Boulder, and Adams Counties, combined, did

not change materially. In Jefferson County, in 1930, 198 farms, or 10.8 percent of the total number, reported the use of fertilizer at the rate of $58.23 a farm, or a total of $11,531 for the county. Truck-crop growers use principally manure alone, and sugar-beet growers use treble superphosphate. Mixed fertilizers are not extensively used.

In 1929 about 60 percent of the farms of the three counties combined paid an average of about $600 a farm for labor. A large percentage of the farms in Adams County using hired labor are in the surveyed area. Labor is performed mostly by Mexicans, but some Russians are employed. Most of the laborers are paid under contract. A certain price an acre is paid for thinning and blocking beets, and beans are harvested by the acre. The price paid for piecework depends on the prospective price of the product and the prevailing prices of labor.

The size of farms has decreased with the development of this area during the last 40 years. The average size of farms in Jefferson County in 1930 was 142.9 acres, in Adams County was 291.6 acres, and in Boulder County, only 138 acres. The larger part of Adams County is in a dry-farming section, where many of the farms are 320 or more acres in size. The farms in the irrigated part of the county range from 40 to 160 acres, where alfalfa, beets, and corn are the principal crops, and from 5 to 40 acres, where truck crops are grown.

In 1930, in Adams County, 64.6 percent of the farms were operated by owners, 34.6 percent by tenants, and 0.8 percent by managers; in Jefferson County, 76.3 percent by owners, 21.4 percent by tenants, and 2.3 percent by managers; and in Boulder County, 66.5 percent by owners, 32.5 percent by tenants, and 1 percent by managers. About 90 percent of the leased land is rented for a share of the crops. In the dry-farming areas, the usual cash rental is $1 an acre, but when land is rented on shares the owner receives from one-fourth to one-third of the crop. For irrigated land, cash rent ranges from $8 to $12 an acre; or if the land is worked on shares, where small grains are produced, one-third of the crop goes to the owner, but if the landowner furnishes the seed, he receives one-half of the crop. The farmer receives one-half of the hay crop and from one-fifth to one-fourth of the truck and sugar-beet crops. In all agreements the farmer pays for the water.

The farm equipment used includes small or medium-sized tractors, small combine-harvesters or stationary threshing outfits, plows used with both tractors and horses, large and small disks, corrugated rollers, harrows, listers, cultivators, weeders, drills, and trucks. Both tractors and horses are used extensively in plowing and preparing the seed bed.

In Adams County, in 1930, 70 percent of the total farm value was in land, 16.4 percent in buildings, 6.6 percent in implements, and 7 percent in domestic animals. The average acre value of farm land was $41.61. In most of the area surveyed, however, the value of land, because of the availability of irrigation water, is much higher than this figure. Except on dairy farms, the buildings, other than the dwelling house, are not expensive. Concrete silos are used, but pit silos, constructed in the ground, are more numerous.

Dairying is important in those parts of the Brighton area where irrigation is practiced and large quantities of green feed and grain are produced. Cattle are fed hay, corn, and beet pulp, a byproduct of the beet-sugar factories. In 1930, Adams County had 6,760 head of dairy cattle, and Jefferson County had 4,596 head.[1]

A few purebred cattle are kept, but the greater number of dairy cattle are grades of Holstein-Friesians, with a few Guernseys, Jerseys, and Shorthorns. Milk and cream, excluding that for home use, are sold in Denver; to butter and cheese factories in Brighton, Golden, Boulder, and other towns of the area; and to a malted-milk factory in Golden. In 1930, dairy products in Jefferson County were valued at $569,243.

In Jefferson County in 1930, range cattle numbered 16,750; horses, 3,469; mules, 186; sheep, 5,026; goats, 583; and swine 2,519. Horses and mules are kept for farm use. The feeding of cattle, sheep, and hogs is an important industry in the south-central part of the area, near many of the packing houses. Some cattle and sheep are fed during the winter in the northwestern part of the area, where an abundance of alfalfa is grown. Hogs are raised on the farms for a home supply of meat and for sale as local feeders and packers.

Poultry raising, mainly of chickens, together with a few turkeys, is an important industry, and Denver supplies a nearby market for poultry products. The 1930 census reports 158,856 chickens in Jefferson County, 134,488 in Adams County, and 133,980 in Boulder County, on April 1 of that year. The value of chickens and other poultry in the three counties was $719,198 in the same year. At present Leghorns are more numerous, but Buff Orpingtons are popular, and many poultrymen are changing to the latter breed. Some Rhode Island Reds and Wyandottes are raised.

Crop yields differ greatly, depending on the amount of rainfall. Acre yields of wheat range from less than 4 bushels to as high as 30 bushels on the same land, but the average yield is about 15 bushels. Oats yield about 30 bushels, barley about 25 bushels, potatoes about 65 bushels, pinto beans about 8 bushels, sorghums for fodder from one-half to 3 tons, and corn about 25 bushels. Without irrigation, on the hard land, yields are somewhat less, corn yielding from 5 to 12 bushels, although during seasons of exceptionally heavy rainfall the yield may exceed 25 bushels. Wheat on the hard land yields about 12 bushels. Acre yields of these crops, under irrigation, are much higher, wheat averaging about 35 bushels; corn, 40 bushels; oats, 46 bushels; barley, 40 bushels; potatoes, 160 bushels; and pinto beans, 17 bushels.

Wheat probably occupies a larger acreage than the other crops commonly grown. The favorite varieties are Turkey, Kanred, and Marquis, and some Macaroni is used for spring seeding. Most of the crop is fall sown, although about one-third is seeded in the spring. Part of the crop is harvested with combines, part is headed and threshed with a stationary thresher, and part is cut with binders, shocked, and threshed later. The grain is sold to local dealers, and most of it is milled at Denver or at nearby mills. Smut is controlled by treatments with copper-carbonate dust or formaldehyde solution.

[1] Data given in this section are taken from reports of the 1930 Federal census, or from Colorado Cooperative Crop Reporting Service Bulletin 89.

Rust may cause considerable damage in moist years, but the average loss from this cause is not serious. Grasshoppers are numerous during some seasons, but efficient control measures have been worked out, and the damage to the regular farm crops is small.

Alfalfa, a very important crop in the Brighton area, makes the best hay for feeding and is considered a soil builder. Grimm and Common are the most commonly grown varieties. The crop is usually left about 3 years and then plowed under and a different crop planted. Alfalfa yields from 2 to 4 tons an acre. Some of it is stacked and fed to livestock during the winter, and some fed on dairy ranches, but most of it is sold, either loose or baled, to feeders near Denver. In years past, alfalfa was left on the land 10 or more years, but in recent years alfalfa wilt, a fungous disease, reduces the yield about the third year. Besides wilt, grasshoppers reduce the yield in some years. In 1932 the webworm, which is reported to visit this section of the country about every 7 years, ate leaves from fields of alfalfa for a period of 2 weeks. Webworm is controlled by suitable sprays.

Sugar beets are particularly well adapted to this section. From 1911 to 1929, inclusive, Colorado produced more sugar beets, averaged a higher acre yield, and, with the exception of Idaho, Montana, and Wyoming, produced higher percentages of sugar than other States. In 1930 there were planted in Adams County 10,640 acres to sugar beets that averaged 13.4 tons an acre. The average acre yield in the Brighton area is between 13 and 15 tons, although on some soils and with good care yields of 25 tons have been harvested. Sugar beets are grown on nearly all the irrigated soils, and average yields on the different soil types are not greatly different, although many of the heavy soils west of South Platte River yield less than the sandy soils east of the river if phosphate is not applied. The sugar content ranges from 10 to 20 percent, with an average of about 15 percent. Sugar beets are grown under contract with the sugar mills, the seed being sold by the company and the growing of the beets supervised by their representative who makes recommendations for care of the crop. Soil tests are made by the company to determine whether the soil is deficient in phosphorus. Phosphatic fertilizer is usually applied at the rate of 125 pounds an acre, drilled in to a depth of about 2 inches, just below the seed. Treble superphosphate is used, and in 1931 the cost was about $4 an acre. Blackheart, a disease which appears to be partly physiological but in the later stages is associated with a fungus, may be kept from the fields by the use of phosphatic fertilizer. When the company advises, the beets are dug by the grower and delivered to the factory. Payments are based on the sugar content and the current price of sugar.

Corn, an important cash and feed crop, is grown on the sandy dry land and on a wide range of soils under irrigation. Reid Yellow Dent, Minnesota 13, and Iowa Silvermine are the principal varieties. Corn is marketed as grain, used for silage, or fed as dry fodder. Corn smut, which may be controlled by crop rotation, occurs in some fields. Corn was harvested for grain in Jefferson County, in 1929, from 1,220 acres, cut for silage from 2,170 acres, and cut for dry forage from 1,364 acres.

Barley and oats are less important crops produced for grain and for hay. Other hay crops, including timothy and mixed grasses, are also important.

In the sandy dry-farming area some Black Amber and Orange Amber sorghums are grown for fodder, yielding from one-half to 3 tons an acre.

The truck crops grown in the Brighton area are concentrated on the recent alluvial lands of the stream bottoms and on Greeley fine sandy loam where this soil occurs close to Denver, Brighton, or other towns, as the deep, friable, and, in many places, sandy surface soil is especially well adapted to the production of most truck crops.

Early potatoes are grown for home use and to supply the local markets.

Strawberries are becoming more important in this area, but they, unlike most of the truck crops, are grown on the hard uplands. Most of the berries are marketed locally. The 1930 census reports 326 acres of strawberries grown in Jefferson County in 1929, yielding 473,482 quarts. Raspberries are grown on many different soils. Apples produced in Jefferson County in 1929 amounted to 50,000 bushels, pie cherries about 15,000 bushels, and Concord grapes only about 15 tons.

The climate and soils in this area are favorable to the production of truck crops of good quality. Many of the products are shipped to eastern cities, the local demand is supplied, and local canneries buy and can large quantities each year. Peas and carrots are sold locally for livestock feed when prices do not justify shipment.

The Colorado Cooperative Crop Reporting Service reports truck crops grown in 1929 for commercial canning or shipping, in order of their importance, with their average acre yields, as follows: Cabbage, about 11 tons; tomatoes, 300 bushels; string beans, 250 bushels, or 4 tons; cucumbers, 120 bushels; garden peas, 90 bushels; celery, 260 bushels; lettuce, 100 crates; cauliflower, 360 crates, carrots, 240 bushels; spinach, 200 bushels; and cantaloups, 200 bushels.

SOILS AND CROPS

In the Brighton area the adaptation of certain crops to particular types of soils is recognized, and the utilization of the different soils for purposes most advantageous to the farmer is common practice. The soils of the Larimer series in dry-land areas are largely used for pasture, but some dry-land areas are planted to grain. Under irrigation either grain or alfalfa is grown. The soils locally known as "hard land" include members of the Larimer, Fort Collins, Terry, and Weld series. Locally these are also called "grainland", and the sandy soils of the Greeley series are called "cornland." Wheat is an extensive crop on the hard land, but very little of it is grown on the sandy land, and, conversely, little corn is grown on the hard land unless irrigation water is available. The dark-colored soils of the Cass series are recognized as good truck-producing soils and are largely used for truck crops and vegetables. The character of the soil, however, is not the only factor that determines the utilization of land, as drainage, nearness to market, and the commercial value of a crop are important factors in determining the kind of

crop grown, though the land itself is adapted to the production of a variety of crops. On the sandy lands, where irrigation water is not available, corn is the principal crop, followed by grain, pinto beans, and sorghums.

In this report and on the accompanying soil map, the soils are grouped in series and types on the basis of their physical characteristics, so far as these could be ascertained by observation in the field or by simple laboratory tests. The characteristics considered are not of an extremely technical character but are for the most part only those features and properties of the soil, which are considered by the farmer in judging land.

The soil series is a broad grouping made to include soils which have a number of characteristics in common, such as color, texture, lime content, and the thickness and arrangement of the different layers. The series is subdivided into soil types on the basis of the texture of the upper layer of the soil, or its relative proportion of sand, silt, and clay. A soil series is given a name, usually of the place near which the soils were first recognized. Thus the Fort Collins series, first mapped near Fort Collins, Colo., includes soils that are characterized by dark-brown surface layers, lighter brown upper subsoil layers high in lime, and lower subsoil layers of gravelly material filled with lime. The name Fort Collins loam indicates that a soil having the general characteristics of the Fort Collins series has a surface soil with a loam texture.

The character of the undisturbed soils of any region is controlled by the composition of the material from which they are derived, the processes of soil formation to which they have been subjected during their development, and the length of time during which these processes have acted. The character of the soil-forming processes and the rapidity with which they act are determined largely by the climate and the native vegetation.

The soils of the Brighton area have been grouped on the soil map in 13 series, and the series have been subdivided into 37 types and 12 phases, which are minor variations from the type, and in addition 4 classes of miscellaneous material are mapped.

With the exception of a few minor types, which are developed directly from the rock or from recently deposited alluvial material, the soils are developed on the material of outwash plains and terraces. These soils have a general resemblance in several respects. The surface soils are moderately light colored, indicating that no large quantities of organic matter have accumulated. Nearly all the soils are characterized by the presence of lime in some layer. In many places where conditions are favorable, an accumulation of lime occurs, usually at a depth of 12 or more inches below the surface. The lime content is abundant for the needs of plants, and soil acidity is not a problem.

The Larimer soils are characterized by brown surface soils, deeper reddish-brown upper subsoil layers, and grayish-brown gravelly lower subsoil layers containing spots of purplish-brown outwash material and large quantities of lime. Gravel, both sharp and waterworn, are abundant on the surface and throughout both surface soil and subsoil. These soils occupy old outwash fans, the material of which has come from both the granitic materials of the higher moun-

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tains and the red sandstone of the foothills, which have been carried down by the streams and spread out over the plain below the steeper slopes. Soils of this series include areas that are fairly productive, but, as a whole, they are of lower value than are soils of either the Fort Collins or the Weld series.

Soils of the Fort Collins series are characterized by dark-brown or slightly reddish brown surface soils, distinctly lighter brown subsoils containing light-colored spots of lime material, and purplish-brown and gray limy and gravelly materials in the deeper part of the subsoils. They are well drained, have good or fair underdrainage, are comparatively free from alkali, and are highly productive. They occupy broad stream terraces, or bench lands, adjacent to the larger streams. The Fort Collins soils are second to the Larimer soils in age. They include 6 soil types and 4 phases and, taken as a whole, are the most extensive soils in the area.

Soils of the Weld series are characterized by dark-brown or olive-brown surface soils, lighter colored olive-gray subsoils containing white spots of lime accumulation, and lower subsoil layers of the same color but of lighter texture. They are for the most part well drained and free from alkali. They are rather easy to cultivate and are productive.

Soils of the Terry series have dark-brown or dark olive-brown surface soils, slightly lighter olive-brown or olive-gray upper subsoil layers with light-colored spots of lime accumulation, and partly disintegrated shale or sandstone of about the same color in the lower part of the subsoils. The material from which these soils have developed came from the weathering in place of shales and sandstones, principally of the Pierre shale formation. They occupy undulating gravel and basinlike upland areas and are closely associated with the soils of the Weld series. In many places they contain alkali in harmful quantities, are difficult to cultivate, and are only moderately productive.

Soils of the Berthoud series are characterized by dark olive-brown surface soils and lighter olive-brown upper subsoil layers containing white spots, indicating an accumulation of lime. They have a nearly level or gently sloping surface relief and occur on outwash fans deposited by small streams.

Soils of the Cass series are characterized by nearly black, dark-brown, or dark reddish-brown surface soils and very slightly lighter brown and, in many places, heavy subsoils. Water-worn gravel, fine sand, and finely divided mica are distributed throughout the surface soils and subsoils.

The Laurel soils are light-colored soils of the first bottoms, developed over recently deposited material. They differ in composition from place to place but, in general, are composed of alternating layers of sand, silt, and clay.

The soils of the Greeley series have brown or dark grayish-brown surface soils underlain by a layer of brown slightly heavier material which is, in turn, underlain by lighter textured material. These soils have developed on recent alluvial material and occupy uneven terraces or ridges. Some areas are productive, but, on the whole, these soils are less productive than the soils of the Fort Collins series.

The soils of the Gilcrest series are developed from the terraces and benches of the large stream valleys. They are nearly level and

smooth, and the surface soils, for the most part, are sandy and more or less mixed with gravel. In many places, the heavier subsoil has a well-defined layer of lime accumulation and the deep subsoil is gravelly.

The soils of the Table Mountain series are thin soils developed in place from the decomposition products of basalt. They are dark brown or nearly black in the surface layers and become lighter with depth. Little or no lime is present. These soils occur both on the flat tops of hills and on the more gentle slopes. Bedrock lies at a depth of less than 4 feet.

The Neville soils are characterized by red, dull-red, or brick-red surface soils, heavier and redder subsoils, and red sandstone or shale parent material which is reached at a slight depth in many places. They occupy the small valleys and glades between the red sandstone and shale ridges and, where farmed, are rather productive.

The soils of the Kuner series have brown or dark grayish-brown stratified surface soils and fine sandy loam subsoils which are underlain at a comparatively slight depth by soft yellowish-brown sandstone. The surface soils are in most places developed largely from alluvial material which was deposited over the sandstone.

The soils of the area differ widely in those features of texture and composition that determine their capability of producing crops. Other factors, however, determine in part the use made of a particular soil. In a region of low rainfall the supply of water available for irrigation is a most important consideration. The irrigated land in this area may support a wide range of crops, but where dryland farming must be practiced only a few crops can be successfully grown. The nearness to roads and markets is an important factor in determining the use of land for market gardening. Water supply, transportation facilities, and markets are such important factors in land utilization that soils are not everywhere used for the purpose to which they are naturally best adapted. For example, a soil well adapted to the production of a certain truck crop may not be used for that purpose on account of its distance from roads and markets, but an inferior soil near the city of Denver may be used for the same crop because of the proximity to markets.

In the following pages, the soils of the Brighton area are described, and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 2.

TABLE 2.—*Acreage and proportionate extent of the soils mapped in the Brighton area, Colorado*

Type of soil	Acres	Percent	Type of soil	Acres	Percent
Larimer gravelly clay loam	11,968	4.2	Fort Collins stony clay loam, light-textured phase	2,496	0.9
Larimer gravelly clay loam, shallow phase	4,864	1.7	Weld fine sandy loam	13,312	4.6
Larimer gravelly loam	7,808	2.7	Weld loam	4,800	1.7
Larimer clay	704	.2	Weld clay loam	3,584	1.3
Fort Collins clay loam	51,392	17.9	Berthoud loam	576	.2
Fort Collins clay loam, shallow phase	2,048	.7	Gilcrest sandy loam	1,280	.4
Fort Collins loam	16,256	5.7	Gilcrest clay loam	1,664	.6
Fort Collins loam, shallow phase	384	.1	Gilcrest gravelly loam	896	.3
Fort Collins clay	23,040	8.0	Gilcrest gravelly sandy loam	2,048	.7
Fort Collins clay, shallow phase	1,472	.5	Nunn clay loam	384	.1
Fort Collins fine sandy loam	2,176	.8	Greeley loamy fine sand	27,968	9.7
Fort Collins loamy fine sand	4,864	1.7	Greeley fine sandy loam	11,776	4.1
Fort Collins stony clay loam	768	.3	Greeley loam	2,944	1.0
			Greeley clay loam	3,392	1.2

TABLE 2.—*Acreage and proportionate extent of the soils mapped in the Brighton area, Colorado*—Continued

Type of soil	Acres	Percent	Type of soil	Acres	Percent
Greeley stony clay loam	1,920	0.7	Terry clay	9,152	3.2
Cass loam	5,056	1.8	Terry clay loam	5,312	1.8
Cass loam, deep phase	1,920	.7	Terry fine sandy loam	960	.3
Cass fine sandy loam	3,520	1.2	Neville sandy loam, brown phase	320	.1
Cass fine sandy loam, deep phase	960	.3	Table Mountain loam	384	.1
Cass clay loam	1,024	.4	Table Mountain loam, heavy phase	320	.1
Cass clay loam, deep phase	640	.2	Kuner fine sandy loam	192	.1
Cass clay	1,280	.4	Rough broken land	29,056	10.1
Laurel clay	1,216	.4	Rough mountainous land	3,200	1.1
Laurel clay, colluvial phase	4,544	1.6	Mine dumps	64	.1
Laurel clay loam	2,240	.8	River wash	1,664	.6
Laurel clay loam, colluvial phase	1,024	.4			
Laurel very fine sandy loam	3,264	1.2	Total	286,720	
Laurel loam	1,024	.4			
Laurel fine sand	1,600	.6			

Larimer gravelly clay loam.—The soils developed from old, weathered materials are members of the Larimer series. Of this series Larimer gravelly clay loam is the most wide-spread. The 8-inch surface soil consists of rich-brown or dark-brown noncalcareous clay loam containing a few pebbles and rounded gravel. Below a depth of 8 inches and extending to an average depth of 15 inches, the soil material ranges from dark-brown to reddish-brown noncalcareous clay having a vertical breakage. A few pebbles occur throughout the entire profile. Below a depth of 15 or 20 inches the material is grayish-brown heavy clay loam or light clay, high in lime carbonate. The grayish-brown color of this and of the lower horizons is caused by lime carbonate. At a depth ranging from 30 to 45 inches, this horizon grades into a horizon of still higher lime content, which is gray, imperfectly cemented by lime carbonate, and extends to a depth ranging from 4 to 6 feet below the surface, where the lime content decreases and the gravel content increases. This underlying material in many places consists of light-brown moderately or highly calcareous loose sand and gravel. At a depth ranging from 6 to probably more than 20 feet, sandstone or shale is present.

This soil is mapped on the high smooth-surfaced mesas. It appears that in former times these high flats extended over an exceptionally large area, but erosion has now left only a few high mesas extending from 3 to 8 miles into the plains from the mountain foot. Remnants of mesas occur on the tops of small ridges or on comparatively high knolls throughout the entire area, although their occurrence is less frequent toward the east. Because of its position above irrigation ditches and because of its gravelly surface soil, the larger part of the land is used principally for pasture, as it produces a fair growth of grama and buffalo grasses. Wheat and corn are the principal crops grown on the cultivated areas, and fair yields are obtained.

Larimer gravelly clay loam is hard to work because of its heavy texture and the presence of gravel, but it is well drained and free from excessive accumulations of salts. In some areas the presence of large stones (indicated on the map by stone symbols) make the land unsuited for cultivation. The eastern half of the body lying about 1½ miles northwest of Louisville and the area about 1 mile

east of Semper are free from gravel, but otherwise they are similar to the typical soil. They are used for grain farming.

Larimer gravelly clay loam, shallow phase.—The shallow phase of Larimer gravelly clay loam has the same profile as the typical soil, except that the surface soil averages a heavy loam in texture and the soil is underlain at a depth ranging from 2 to 5 feet by sandstone. This shallow soil is mapped in a large body southwest of Standley Lake and in several smaller areas, mainly in Jefferson County.

Areas of this soil occupying slopes are well drained, and the more level areas are well drained where permeable sandstone forms the substratum and poorly drained where the substratum consists of dense shale. The deeper and less stony areas are cultivated in places where irrigation water is available. The soil, because of the gravel content, is not easy to cultivate and because of the closeness of the underlying rock is rather droughty. Most of it is unproductive.

Larimer gravelly loam.—Larimer gravelly loam is very similar to Larimer gravelly clay loam, except that the surface layer has a gravelly loam or a gravelly sandy loam texture. The subsoil is identical in character with that of Larimer gravelly clay loam. Much of this soil contains enough stone to render it unfit for cultivation. This soil occupies the same general position as the gravelly clay loam, but the larger areas lie farther west and closer to the source of the soil material than do the areas of clay loam. The body just south of Base Line Lake differs to some degree from the typical soil, as the surface soil appears to have been covered by a recent deposition of material. Though the dense lime carbonate horizon and the lower part of the profile are typical, the surface and subsurface layers are moderately or highly calcareous.

Larimer clay.—The topsoil of Larimer clay, extending to a depth of about 10 inches, is dark-brown or black clay. To a depth of 1 inch the surface soil is slightly laminated, and below this the structure is cloddy and somewhat columnar. The soil material shows either none or very slight effervescence on application of dilute hydrochloric acid. Between depths of 10 and 20 inches the color is grayish brown, the material is moderately or highly limy and clayey, and it breaks into rough prisms. This material grades into a gray very highly calcareous and somewhat lime-cemented horizon of gravel and sand, with interstitial soil material that averages clay loam in texture. The stones in this horizon are basaltic, subangular, and range in size from fine gravel to stones about 8 inches in diameter. This layer extends to a depth of about 4½ feet, below which loose gravel and boulders occur, with the interstices filled with gritty loam or sandy clay loam. This finer material, to a depth of more than 7 feet below the surface, is brown and is moderately calcareous, except in a few grayish-brown spots where lime carbonate has accumulated and the material is highly calcareous.

This soil has developed from materials, partly colluvial and partly alluvial, which have had their origin in basic igneous rocks, presumably from South Table Mountain, as the material shows signs of having been transported only a short distance. Following

transportation and deposition, the debris weathered in place, together with a possible accumulation of soluble material brought in by seepage and stream waters, and later the present soil developed.

Larimer clay occurs in two areas on the gentler slopes immediately below the steep slopes and nearly perpendicular cliffs of South Table Mountain. The surface is comparatively smooth, but the degree of slope ranges from 100 to 350 feet to the mile. Drainage of this soil is good, and no accumulations of salts occur.

The land is used principally for pasture, but some of it is producing alfalfa. It is a very stubborn soil to cultivate because of the heavy plastic surface clay. The northern half of the area on the east side of the mountain has a clay loam surface soil and is slightly more easy to cultivate.

Fort Collins clay loam.—Fort Collins clay loam is the most extensive soil of the Fort Collins series and is characteristic of the maturely developed soil of this region. In the virgin condition, the 2-inch surface layer consists of grayish-brown mellow fine sandy loam and very fine sandy loam. Although it is filled with grass roots, the material is slightly laminated. The next layer, between depths of 2 and 8 inches, is slightly laminated in the upper part, but the rest breaks into clods having no regular cleavage. At an average depth of 8 inches, the color changes to brown, dark brown, or reddish brown, the texture changes to clay, and the structure becomes decidedly prismatic. This horizon, which extends to a depth of about 22 inches, like the surface soil, has been leached of lime carbonate, but it contains an accumulation of decomposed organic residue which is responsible for the darker color. Below a depth of 22 inches and extending to a depth of 38 inches, the material is grayish-brown compact clay of prismatic structure. This horizon is similar to the one above but is grayer because of the accumulation of lime carbonate. Grass roots are very numerous in the upper horizons but become somewhat fewer in this horizon. Between depths of 38 and 54 inches is friable gray clay loam of massive structure and high lime content, and between depths of 54 and 96 inches the lime content becomes slightly less and the color grayish pink. The lime occurs principally in streaks and pockets, and the soil material between the streaks is brown. The texture is heavy clay loam or clay that tends toward a prismatic structure. Below a depth of 96 inches the material is light-brown highly calcareous fine sandy loam. A few water-worn pebbles or gravel occur throughout the entire profile.

An area extending about a mile southward from Hazeltine has been included with this soil on the soil map, but it is not typical. It contains an appreciable quantity of lime in the surface soil, but in some places the subsoil consists of heavy puttylike clay. Because of these characteristics, this land is agriculturally inferior to other areas of this soil.

A large part of the Fort Collins clay loam has been cultivated, and in cultivated fields the gray surface horizon has been removed to greater or less extent, either by water or wind.

This soil has developed from materials brought by water from the mountains west of the Brighton area and deposited on the sandstones and shales of the plains. Since deposition, the present profile,

which is characteristic of a rather mature soil for this climatic region, has developed. In the west-central part of the area, this soil lies just below the Larimer soils, where it occupies gently sloping ridges that extend to the lowlands of South Platte River, and, in other parts of the area, it occupies similar ridges or sloping lands. Nearly all this soil lies on slopes favorable for farming.

Drainage is generally good, but in a few places on hillsides or where a slope merges with a valley floor or a nearly level terrace, seepage waters are a hindrance to cultivation and uniform crop production, as salts accumulate at the surface in amounts detrimental to crop growth.

Nearly all this soil is cultivated. Some of it does not receive irrigation water and is used principally for the production of wheat and corn. Under irrigation, the principal crops are alfalfa, corn, and sugar beets, and some fruit and truck crops are produced for home use and to a small extent, for sale. It is necessary to be familiar with this soil in order to cultivate it efficiently, as it is heavy and must be plowed at the proper moisture content to promote pulverization and desirable seed-bed preparation. It requires only a moderate amount of irrigation water, and satisfactory yields are obtained when sufficient water is used.

Fort Collins clay loam, shallow phase.—The shallow phase of Fort Collins clay loam differs from the typical soil in that the subsoil is replaced by sandstone or shale. Soil of the shallow phase occurs on the tops of ridges in a few places but more commonly on slopes. It is not extensive, and its utilization is similar to that of the typical soil. Crop yields, because of the shallowness of this soil are not so good as on the typical soil. Deep-rooted crops are not recommended for this shallow soil.

Fort Collins loam.—Fort Collins loam differs slightly from Fort Collins clay loam in the color and texture of all layers. The surface soil has a gritty loam texture and contains both well-rounded and angular sand fragments. The lower part of the surface soil is lighter in texture than that of the clay loam, and the columnar clay layer beneath contains a few more angular fragments than the clay loam.

The adaptation to crops is about the same and yields are nearly equal to those on the clay loam. This soil, however, is much easier to cultivate, irrigate, and handle. The largest area is mapped near Louisville and Lafayette, but many bodies occur in other places. The occurrence, topography, and drainage of this soil are very similar to those of Fort Collins clay loam.

Fort Collins loam, shallow phase.—The shallow phase of Fort Collins loam bears the same relationship to the typical soil as the shallow phase of Fort Collins clay loam does to its typical soil. This phase differs from the shallow phase of Fort Collins clay loam in having a loam rather than a clay loam texture in the surface soil. Sandstone or shale occurs at a depth ranging from 12 inches to 5 feet below the surface. Only crops that can exist on shallow soils are grown on soil of this phase.

Fort Collins clay.—Fort Collins clay is heavier in texture than Fort Collins clay loam and is a difficult soil to cultivate unless worked at most favorable moisture conditions, but otherwise it is similar to that soil.

The area about Mud Lake differs from other areas of this soil in that it has an exceptionally heavy surface soil and the subsoil lacks the reddish-brown color and is exceptionally heavy. The soil of this area has characteristics much like those of Terry clay, but here the clay extends to a depth of more than 6 feet and a few water-worn gravel occur throughout the profile. Adaptations and recommendations for Terry clay are applicable to the soil of this area.

A few bodies differing from the typical soil are mapped in the western part of the area. The soil materials are calcareous throughout the entire profile, are slightly more compact, and lack some of the reddish-brown color of the subsurface columnar clay horizon. One such body is mapped about a mile south of Long Lake, and two others occur just north of Table Mountain. These areas are comparatively low in productivity.

Fort Collins clay, shallow phase.—Like the shallow phase of Fort Collins clay loam, the shallow phase of Fort Collins clay is mapped where sandstone or shale occurs within 5 feet of the surface. With the exception of the heavier texture, this soil is similar to the shallow phase of Fort Collins clay loam, and adaptations and recommendations given for the shallow phase of the clay loam apply to the shallow phase of the clay.

Fort Collins fine sandy loam.—Fort Collins fine sandy loam corresponds very closely in characteristics with Fort Collins loam, but the surface material is of fine sandy loam texture to a depth of 16 inches. Occurrence in relation to other soils, topography, uses, drainage, and recommendations for this soil are similar to those given for Fort Collins loam.

The largest body of Fort Collins fine sandy loam is near Lafayette, and areas are about 1¼ miles south of Baker, north of Golden, and near Barr Lake.

Fort Collins loamy fine sand.—Fort Collins loamy fine sand differs from the other types of the Fort Collins series in having a high content of fine sand, due, in most places, to its origin. With the exception of the area mapped near Lafayette, where the material from which the soil is derived is wholly water-laid, the surface soil material has been largely deposited by wind. The surface soil, which ranges from a few inches to 2 feet in thickness, and in a few places is thicker, has been blown onto the surface of the older soil. Below this surface soil, which is grayish-brown noncalcareous friable or loose loamy fine sand, the horizons are very similar to those of Fort Collins loam or Fort Collins clay loam. In a few small areas, Fort Collins loamy fine sand has developed from an accumulation of loamy fine sand materials that appear to be mainly of wind-borne origin. In these localities, the material below the surface layer becomes rich-brown noncalcareous compact and heavy sandy clay. This horizon grades into a highly calcareous compact sandy clay or clay loam that is somewhat pink, and below this, at a depth between 4 and 5 feet, the lower subsoil layer is friable highly calcareous fine sandy loam.

The surface relief of this soil is more undulating than that of other soils of this series. Drainage is generally good, but a few areas occurring in basins or narrow draws below irrigation ditches receive excessive quantities of seepage water and contain some accumulations of salts. This is a good soil under irrigation, if properly cared for,

as careful management is necessary to prevent soil blowing. The larger part of this soil, both under irrigation and dry farming, is used for the production of corn.

Fort Collins stony clay loam.—The surface soil of Fort Collins stony clay loam consists of an 8-inch layer of brown noncalcareous stony clay loam. The stones, which are of highly mixed origin, range from 2 to 8 inches in diameter, and they are both subangular and well water-worn. Below this layer and continuing to a depth of 16 inches is rich-brown columnar noncalcareous clay that contains much gravel and a few stones. Below a depth of 16 inches is grayish-brown stony loam which extends to a depth of about 5 feet and is feebly cemented by lime carbonate, the substance responsible for the grayness of the material in this horizon. Below a depth of 60 inches are light-brown loose stones, gravel, and sand, that are moderately calcareous.

This soil has been developed from materials that have been washed out of the mountains and deposited along the present stream channels. It is mapped on terraces that range from a few feet to about 50 feet above the level of the present streams. The surface relief is smooth, with a gentle slope conforming to the present fall of the nearby streams. Because of its open gravelly character, this soil, except in a few areas, is well drained, and no salt accumulations occur. Because of its stone content, the soil is practically unsuited to farming. Only a small acreage is farmed, and attempts at cultivation have been unsuccessful.

Fort Collins stony clay loam, light-textured phase.—A light-textured phase of Fort Collins stony clay loam occupies several areas, most of which adjoin the bodies of typical Fort Collins stony clay loam. This light-textured soil differs from the typical soil mainly in having a higher content of fine sand. Although in most places the texture is clay loam, the sand content renders the surface soil more mellow. The abundance of stones, however, makes cultivation so difficult that the agricultural value of this land is no higher than that of the typical soil, and, like that soil, it is used only for pasture. One poorly drained body 2 miles southeast of Boulder is indicated by swamp symbols.

Weld fine sandy loam.—The 2½-inch surface layer of Weld fine sandy loam consists of light fine sandy loam thickly matted with grass roots. It is dark brown, is noncalcareous, and the structure is slightly laminated, or the material is so matted with grass roots that the structure cannot be distinguished. Below a depth of 2½ inches and extending to an average depth of 10 inches, the material is light-brown noncalcareous firm but friable fine sandy loam or loam. Below a depth of 10 inches and extending to a depth of about 18 inches is rich-brown noncalcareous slightly columnar clay loam or clay, and below a depth of 18 inches is olive-brown friable or loose fine sandy loam or loamy fine sand, that is moderately or highly calcareous. Grass roots are numerous in the upper 18 inches, and some reach a depth of more than 4 feet. Worm casts occur throughout much of the profile.

The origin of this material is similar to that of the Fort Collins soils, with the possibility that a part of the surface soil, or, in a few places, material of the entire soil mass has been either laid down or

reworked by wind. No proof is available that the material is of alluvial origin, but no gravel were observed in the profile.

This soil occurs in the eastern and northeastern parts of the area east of South Platte River, on smooth or slightly undulating gentle slopes, where most of it is associated with soils of the Greeley series and Fort Collins loamy fine sand. The land is naturally well drained, although accumulations of salts occur on a few slopes below canals or in depressed areas where water has seeped from irrigation canals or storage reservoirs. Some salt has moved with the seepage water and, on evaporation of the water, has been deposited on the surface. Because of its texture, this is a desirable soil to cultivate. Under irrigation it is used for alfalfa, corn, sugar beets, grain, and truck crops, and very good yields are reported.

The area extending about one-fourth mile east and northeast from the southwest corner of sec. 8, T. 1 S., R. 65 W., is developed over shallow material underlain by sandstone and is less productive than typical areas of this soil.

Weld loam.—Weld loam is similar to Weld fine sandy loam. In the virgin condition it is characterized by a 2-inch layer of brown friable loam well filled with grama grass roots. The soil material breaks into small angular clods or crumbs that cling to the grass roots. In many places it is slightly darker than the next horizon below, because of a slight accumulation of organic residues. Below this depth and extending to an average depth of 9 inches, the material is of the same friable consistence but is of light-brown color. At a depth of about 9 inches or, in a few places, deeper, the material changes to rich-brown light clay having a prismatic breakage. The rich-brown color of this horizon, as in the Fort Collins soils, is caused by an accumulation of organic substances that have leached from the upper soil layers and have accumulated on the outsides of the soil aggregates. When very finely pulverized, the soil of this horizon becomes lighter brown or olive brown. These upper horizons are well filled with grass roots, are noncalcareous, and contain a few wormholes and worm casts. Below a depth of 18 inches is light-brown or olive-brown moderately calcareous clay loam that gradually becomes lighter in texture with depth. This horizon contains worm casts that are less calcareous than the rest of the soil material. At a depth of about 38 inches is olive-brown moderately calcareous mellow fine sandy loam. Some stratification is apparent in the lower material. The lime content differs slightly, and it is difficult to determine whether the lime of the lower horizon is accumulated or is residual from very calcareous parent material. A few water-worn quartz gravel indicate that this material is water-laid.

This soil is mapped principally in the eastern part of the area, where it is associated with soils of the Greeley series and with Weld fine sandy loam and Weld clay. It has a smooth and, in most places, gently sloping surface relief. It is an easy soil to cultivate and is used largely for the production of alfalfa, under irrigation, and of grain and corn, under dry farming. Good yields are reported in favorable years.

The area included with Weld loam that extends from Lafayette to near Base Line Lake is not typical of this soil but has more of the characteristics of Fort Collins loam. In the adjoining Longmont area this soil was mapped with Weld loam.

Weld clay loam.—Weld clay loam has a profile almost identical with that of Weld loam, except that the surface soil is heavier in texture. This soil is more difficult to cultivate and is used more for grain, under dry farming, and for alfalfa and sugar beets, under irrigation. Although not quite so productive as Weld loam, the crop adaptations and yields are about the same as those given for Weld loam.

The two areas west of South Platte River are not typical but have some characteristics similar to those of Fort Collins clay loam.

Berthoud loam.—Berthoud loam is a member of another series belonging to the Weld and Fort Collins general group. It has a profile much like a Fort Collins soil, except that the surface soil is calcareous and the subsoil contains a little more lime. The virgin soil consists of a 12-inch layer of dark-brown calcareous gravelly loam underlain by grayish-brown highly calcareous gravelly clay loam or gravelly clay, that is slightly cemented. The cementation gives the appearance of a massive structure, but the pebbles may be broken out without difficulty. This horizon extends to a depth of about 4½ feet where it grades into brown or light-brown highly calcareous clay. Plant roots are numerous near the surface but are fewer in the lime horizon. Worm casts are plentiful from near the surface to a depth of 2½ feet below.

In the area of this soil which includes Boulder Cemetery, it is possible that the soil was originally like a Fort Collins soil, but seepage for a long period of time has brought about an accumulation of lime at or near the surface. In the area just across the creek to the east, the surface soil materials have been recently transported from another soil area, as the gravel on the surface are lime coated on one or more sides, which indicates they have previously occupied a position in the lower horizon of another soil.

This soil is mapped in a few small bodies only in the northwestern part of the area. It occurs on steep hillsides and in gently sloping areas where the surface relief is smooth. A part of the land is cropped, mainly to corn and wheat, but yields are not so heavy as on the Fort Collins soils.

Gilcrest sandy loam.—In undisturbed virgin areas of Gilcrest sandy loam, the 2- to 4-inch surface layer consists of gray very fine sandy loam or silty material which is slightly laminated where the structure is not obscured by dense grass roots. Below this is grayish-brown noncalcareous friable sandy loam that contains a few water-worn gravel of mixed origin. At a depth of about 8 inches, and continuing to a depth of about 20 inches, is rich-brown mildly calcareous gritty clay loam or clay, which is slightly compact, with a tendency toward prismatic breakage. Below this depth and extending to a depth of 6 feet or deeper are loose noncalcareous gravel and sand of light olive-brown color.

This soil has been developed from old river-terrace materials that were deposited by the South Platte River. The gravel are well rounded, of mixed origin, and range from fine to 3 inches in diameter. The surface relief is smooth and slopes gently toward South Platte River, with a gradient ranging from 20 to 50 feet a mile. Because of the loose gravelly subsoil, this soil is well or excessively drained, and no accumulations of salts occur. The land is used

largely for truck-crop farming, partly because of its closeness to a commercial cannery and partly because, owing to the loose gravelly material of the lower part of the subsoil, it is better adapted to the production of shallow-rooted crops than to other purposes.

Gilcrest clay loam.—Gilcrest clay loam is similar to Gilcrest sandy loam, except that the topsoil is heavier. This soil is mapped in several bodies on the old river terrace, near and 6 miles south of Brighton. The land is irrigated and is used principally for growing truck crops, of which good yields are reported.

Gilcrest gravelly loam.—Gilcrest gravelly loam has a brown gravelly loam surface soil and an upper subsoil layer which is slightly heavier than the surface soil. The gravelly lower subsoil layer, which is reached at a depth ranging from 24 to 30 inches, consists of light-colored loam filled with coarse sand and sharp granitic and quartz gravel, with very little finer material.

In occurrence, crop utilization, crop adaptation, and crop yields, this soil is similar to Gilcrest sandy loam.

Gilcrest gravelly sandy loam.—Gilcrest gravelly sandy loam, because of its large content of gravel and coarse sand, is a porous soil of low productivity. It has a profile development corresponding very closely to that of Gilcrest sandy loam, although the content of gravel is larger. The soil is not extensively utilized for crop production but is recognized as a comparatively unproductive soil requiring large applications of irrigation water. Where cultivated it is used principally for the production of truck crops.

Nunn clay loam.—Nunn clay loam, as mapped in this area, differs very little from Gilcrest clay loam. In bodies of Nunn soils in the Longmont area and Greeley area, the soil is typically darker than the Gilcrest soils, and the stratum of exceptionally gravelly material occurs at a greater depth than in the Gilcrest soils. Five bodies of this soil occur in the Brighton area—3 near Brighton, 1 west of Pleasant Plains School, and 1 near Henderson. The last two have clay topsoils. These heavier textured soils are stubborn lands to farm, and smaller yields are obtained than on the more typical areas. Crop adaptations, yields, and recommendations for this soil are similar to those given for Gilcrest clay loam.

Greeley loamy fine sand.—Greeley loamy fine sand is the most extensive soil of the Greeley series in this area. To a depth of 15 inches it is grayish-brown noncalcareous mellow fine sand. This horizon contains many plant roots and has a slightly dark staining caused by accumulations of humus. Between depths of 15 and 30 inches the material is rich-brown noncalcareous loam or heavy loam, high in content of fine sand. It is firm and slightly cemented and tends toward a massive prismatic structure, but it breaks into clods that slake rapidly on application of water. The lower part of this horizon is slightly lighter in color and breaks easily into loose and mellow slightly loamy fine sand that has a faint yellowish olive-brown color. The material in this horizon is noncalcareous in some places, but in most places it effervesces mildly, and a few lime spots or lime-carbonate nodules occur at a depth ranging from 4 to 6 feet below the surface.

This soil has been formed from a deposit of angular and rounded fine sands that are light colored, highly siliceous, and contain some mica particles. The material composing the soil originates mainly

from the soft sedimentary beds of the mountains a few miles south of the Brighton area in the formation geologically known as the Monument Creek formation, and the many tributaries of South Platte River probably have contributed part of the sandy material. These materials have probably been accumulated in this area after being transported by streams and then blown from the stream beds by south and west winds. Some stratification in the profile may be wind stratification, or it may indicate that a part of the material has been deposited by more ancient streams from the mountains that have built up their channel beds by deposition of the sandy material. In a few areas the material is undoubtedly water-laid, as small quartz gravel, too large to have been transported by the wind, occur in the sandy material. The larger part of this material, however, has at least been reworked by wind. The surface relief ranges from comparatively smooth gentle slopes to somewhat hummocky and rolling ridges that appear to be partly wind formed and partly formed as a result of the normal erosion cycle. In the southeastern part of the area, the surface relief is marked by a series of ridges, ranging from a few feet to more than 50 feet in height, above the general level of the surface, and extending in a northwest-southeast direction. The depressions between the ridges are not continuous but are closed in places by sands that appear to be wind blown. Drainage of this soil is good, but in a few depressions or directly below large canals, some salt has accumulated at the surface because of seepage water.

This soil is mapped extensively east of South Platte River. It is spoken of as cornland, as corn is the principal crop produced. It is the most highly favored soil for corn production in the dry-farming areas, and more satisfactory yields are obtained than on the harder soils of the Fort Collins or Weld series. This sandy soil, with its favorable consistence, holds much capillary moisture, is easily penetrated by plant roots, and gives to the plant a higher percentage of the total soil moisture present than do the heavier textured tighter soils. Under dry farming, dry beans and sorghum are other important crops. Under irrigation, alfalfa, corn, sugar beets, and truck crops are produced, and favorable yields are reported. This soil is not potentially so productive as most of the heavier textured soils of the area, and it is necessary to practice crop rotation or farming methods that will add to the organic-matter supply of the soil. Careless farming has caused losses from blowing of the surface soil in the spring of the year. In a few places, where the compact subsoil is close to the surface, deep plowing has turned up a small quantity of the heavier material, and after this has been mixed with the sandier surface material, blowing has not been serious.

Included with this soil are a few areas of Valentine soils which, owing to their small extent, are mapped with Greeley loamy fine sand. The soil in these areas consists of friable loamy fine sand extending to a depth of more than 6 feet, with little or no heavier material in the subsoil. One area, nearly a mile in length and about one-fourth mile wide, is near Sable, on a ridge about one-fourth mile north of the southwest corner of sec. 24, T. 3 S., R. 67 W.; a very small body is about one-half mile farther north; a third occurs along the road 1 mile northwest of Roydale; and a fourth lies between two lakes in sec. 6, T. 1 S., R. 65 W.

Greeley fine sandy loam.—Greeley fine sandy loam is similar in profile to Greeley loamy fine sand, but each horizon is of fine sandy loam or loam texture. The original material forming the surface layer of this soil may be of wind-borne origin in some places, but most of it contains a few water-worn pebbles, indicating that it is water-laid. It is mapped both on old terraces, or remnants of old outwash plains, and on comparatively recent stream terraces having smooth surface relief. The more extensive bodies are east of South Platte River near the highway between Derby and Henderson, large areas lie near Wheatridge School and near Mapleton School, and many small bodies are in the southeastern part of the area. This soil is associated with Greeley loamy fine sand and other Greeley soils; also with soils of the Fort Collins, Weld, and Gilcrest series.

Drainage is good, and almost no accumulation of salts occurs. The body near Mapleton School occurs on an old gravelly terrace, and the sandy Greeley material extends to a depth of about 15 inches in many places, or to a depth of 4½ feet or deeper where the gravelly loam of the old terrace extends to a depth of more than 6 feet. In this body the soil is more porous than elsewhere, and, owing to the thin mantle of soil above the gravelly layer, the soil here is potentially less productive.

Greeley fine sandy loam is recognized as one of the best soils in the area. It is an easy soil to cultivate, is smooth enough to irrigate without difficulty, and is suited to the production of many different crops, such as truck crops, alfalfa, small fruits, orchard fruits, flowers, and grain. Good yields are reported.

Greeley loam.—Greeley loam differs from Greeley fine sandy loam only in having a slightly heavier texture in each horizon. This soil has been developed from water-laid material deposited principally by small streams. The material, from which the soil is derived, differs considerably from place to place, as most of it was laid down in beds ranging in texture from fine sandy loam to clay. In the places where the heavier beds are near the surface, areas with loam texture in both surface soil and subsoil are developed. In general, such areas are not quite so productive and adaptable as are the few areas in which the subsoil is uniformly heavy loam or light clay loam.

Greeley loam is mapped largely east of South Platte River on the first bench above the creek bottoms, where the streams have deposited their sediments on an old terrace of the river, and in small bodies in the first bottoms of small streams. The land has a smooth surface relief, and most of it occurs on very gentle slopes with a gradient ranging from 10 to 30 feet a mile.

Drainage of the greater part of this soil is good, but a few bodies occur in depressed areas below higher irrigated land where seepage occurs and variable quantities of salts have accumulated. This soil is regarded as a very adaptable soil and is used for growing many different crops. Very good yields are obtained.

Greeley clay loam.—Greeley clay loam has profile characteristics very similar to those of Greeley loam, except that the texture of the soil materials is clay or clay loam. This soil has been developed from deposits of small streams and from river deposits on an old terrace of South Platte River. With the exception of the small

body about three-fourths mile northeast of Hazeltine, all this soil west of the Chicago, Burlington & Quincy Railroad and the area in secs. 32 and 33, T. 1 S., R. 66 W., have clay topsoils. The other areas have clay loam topsoils. In some parts of the areas having clay topsoils, a small quantity of secondary soil material has been deposited on the surface, consisting of sheet wash brought down from the adjacent higher lying lands. In some of the areas that lie close to the channels of small creeks or streamways, the surface soil, ranging from 12 to 36 inches in thickness, is clay and the subsoil is fine sandy loam or fine sand. The surface relief is smooth, but the rate of slope is about 10 feet a mile in some areas and about 25 feet in others. Drainage is good, although a few bodies occupy depressions in which some seepage accumulates. The heavier textured areas are rather hard to cultivate, but the lighter textured ones are only moderately difficult. This soil is used largely for growing truck crops and sugar beets, and good yields are reported. It is a desirable soil, although it is not valued so highly as Greeley loam.

Greeley stony clay loam.—Greeley stony clay loam in some respects differs from the other soils of the Greeley series. The soil materials from which it has developed are derived largely from granites and have been accumulated near mountain canyon mouths where streams have spread out on the plains, dropped their loads of sediment, and built up alluvial fans. The 15-inch surface layer consists of dark-brown noncalcareous loam containing much granitic gravel and stones. Between depths of 15 and 48 inches, the material is reddish-brown compact clay of large cloddy or slightly prismatic structure. A freshly broken clod appears shiny on the breakage surface, which indicates the accumulation of oxidized minerals and colloids on breakage surfaces and seams. Some gravel and stones occur in this horizon. Between depths of 48 and 60 or more inches, are noncalcareous granitic gravel, stones, and sand, that are slightly compacted. The stones throughout the soil mass range from large gravel to 5 or more inches in diameter, and most of them are somewhat water-rounded.

The surface relief, for the most part, is smooth, but in some places the land is rough, owing to the presence of large angular boulders. The soil is well drained and free from salts. Because of the large content of stones and gravel the land is largely uncultivated. The area about one-half mile east of Boulder Cemetery is gritty loam or clay loam, that contains some angular gravel and stones. The soil here is of more favorable texture for cultivation, and part of it is used for the production of alfalfa.

Cass loam.—Cass loam is the most important of the recently formed soils. The topsoil consists of a 10-inch layer of dark-brown or black noncalcareous friable loam which is high in mica. Below a depth of 10 inches, the material in many places is stratified and variable in texture, usually of brown or dark-brown color, and has a smaller content of organic matter. At a depth ranging from about 10 inches to about 5 feet, the material either grades into or breaks abruptly to a gravelly sandy loam layer. The gravelly layer extends to a depth of 6 feet or deeper, and provides free but not excessively rapid drainage. The soil throughout the entire profile is typically

noncalcareous, although some areas may be included that effervesce mildly in the surface soil or subsoil, or in both.

This soil has developed over stream materials deposited on the bottom lands adjacent to or nearly on a level with the present streams. This alluvium was composed of debris washed down from a variety of rocks, the granites probably contributing the larger part. The surface relief of the bottom lands is smooth, and the rate of slope ranges from 10 to 25 feet a mile. Drainage is good, except where the soil occurs below and adjacent to large areas of irrigated land, where badly seeped spots occur, and where excesses of both water and salts render the land unfit for crop production. This soil, where well drained, is prized because of its productivity and ease of cultivation. It is largely used for the production of truck crops, although a few areas distant from towns are used for alfalfa or corn. Where truck-crop farming is practiced, especially along South Platte River north of Denver, large quantities of manure are applied.

The depth to the gravelly layer is not uniform, but it averages about 3 feet. In some places this layer lies at a depth of about 5 feet, and in other places it is near or at the surface. Places in which the gravelly layer is very near the surface and where some of the gravel occur on the surface are indicated on the map by gravel symbols. These areas, because of their shallowness and the hindrance to cultivation caused by the gravel, are much less desirable. Such areas occur along Clear Creek and along Ralston Creek. In the uppermost areas along Ralston Creek, gravel and some stones occur throughout the entire soil mass.

Cass loam, deep phase.—Cass loam, deep phase, is mapped along the larger streams where the finer soil is more than 6 feet thick above the gravelly layer. Other areas along some of the small streams where no gravelly layer occurs even in the deeper strata have been included with this soil, on account of their small extent. Soil of the deep phase, as a whole, is more productive than typical Cass loam. It is a desirable soil, well suited to the production of truck crops and alfalfa, the crops for which it is most used. The occurrence of this soil, its drainage, and salt accumulations are very similar to like conditions in typical Cass loam.

Cass fine sandy loam.—The surface soil of Cass fine sandy loam, to a depth of about 10 inches, consists of brown or dark-brown friable noncalcareous fine sandy loam which in most places is high in mica content. Below the surface horizon the soil may continue uniform in texture until a gravelly loam layer is reached, or it may be stratified with alternate layers of heavier and lighter textured material.

In origin, mode of formation, and surface relief, this soil is similar to Cass loam. Bodies are mapped along Clear, Van Bibber, Coal, and South Boulder Creeks. Drainage is good in most areas, other than those along South Boulder Creek, which receive much seepage from the adjacent upland slopes, and during much of the year the water table is so near the surface that pasture grasses are the principal cover. These areas contain a number of gravelly spots, in which the gravel and soil materials are similar to those in Fort Collins gravelly loam on the higher land to the west.

In the area near and southwest of Marshall, subangular stones, ranging from 4 to 8 inches in diameter, are numerous, and because of these the land is used only for pasture.

Cass fine sandy loam, besides its use for pasture, is utilized for the production of truck crops, alfalfa, corn, and wheat. It is an easy soil to cultivate and care for under irrigation, and favorable yields are reported.

The area of Cass fine sandy loam extending about 2½ miles northeast and about 4 miles southwest of Fruitdale School and the area south of Clear Creek about one-fourth mile wide and about 3½ miles long are much more leachy than the typical soil. The color of the topsoil in these areas is typical, but the texture is light fine sandy loam. The gravelly layer of the subsoil is comparatively loose and leachy, and the depth to this layer is variable, in most places being within 3½ feet of the surface, but in places it is much closer to or reaches the surface. Such areas are shown on the map by gravel symbols, but others, smaller than those shown, occur.

Partly because of its location, and partly because of the ease of cultivation and the earliness of this warm light-textured soil, it is used largely for the production of truck crops and small fruits. It is a leachy soil requiring large quantities of irrigation water. In a few places seepage water from adjacent higher land lessens the amount of water necessary for irrigation.

Cass fine sandy loam, deep phase.—In Cass fine sandy loam, deep phase, the gravelly subsurface layer and substratum of the typical soil are replaced by nongravelly soil material. This phase, because of the greater depth of the finer soil material, has higher potential fertility. The area mapped just west of the State Industrial School at Golden is somewhat red, both in the surface soil and subsoil.

Cass clay loam.—Cass clay loam is similar to Cass loam, except that it is heavier in texture both in the surface soil and subsurface soil. The clay loam is not quite so easy to cultivate, but when it occurs in the same vicinity as the loam it is used for similar crops. Most of the land is well drained, but in a few areas seepage waters from higher land or from canals keep the land too moist for crop use, and in some places harmful quantitites of salts have accumulated at or near the surface. Such areas are shown on the soil map by alkali symbols and marsh symbols.

Cass clay loam, deep phase.—Cass clay loam, deep phase, differs from the typical soil in that it contains fine soil material to a depth of more than 6 feet instead of having a gravelly loam subsoil. Other characteristics and crop adaptations are similar to those of typical Cass loam.

Cass clay.—Cass clay has a 10-inch topsoil consisting of dark-gray or black noncalcareous clay. It is underlain by dark-brown loam that extends to an average depth of 30 inches below the surface. Below this, and extending to a depth of 6 feet or deeper, is dark-brown or olive-brown noncalcareous gravelly loam.

This soil occurs in many bodies on both sides of South Platte River. It has a smooth surface relief, is in most places well drained, and is free from salt accumulations. This soil is somewhat sticky to cultivate, but it is used largely for truck crops, corn, and sugar beets, and excellent yields are reported.

Laurel clay.—Laurel clay, to a depth of about 10 inches, consists of grayish-brown clay, and below this and continuing to a depth of 6 feet or deeper is gray slightly compact clay. In most places the soil material at all depths is mildly calcareous, but in other places effervescence is hardly perceptible. The subsoil in some areas consists of alternate layers of light- and heavy-textured grayish-brown material.

This soil has developed over materials that occupy the lower stream-bottom land, principally along small streams, although some areas occur in the bottom land of South Platte River. The source of the material is in rocks mixed in composition, but mainly sandstones or shales. The soil material is a recent deposit along the margins of streams. The surface relief is generally smooth, and the degree of slope ranges from 10 to 25 feet a mile. Drainage is imperfectly developed in many places, and many marshy areas occur where salt has accumulated.

The soil of the areas just west of Hazeltine School and about 1 mile west of Pleasant Plains School consists of a layer of gray clay from 12 to 40 inches thick, overlying a gravelly loam layer which extends to a depth of 6 feet or deeper.

This soil is not so desirable as most of the Cass soils, as it is difficult to cultivate because of its heavy texture, and it is less productive, owing probably to the smaller quantity of nitrates and less air space that promotes oxidation of essential plant-food constituents. It is used mainly for growing truck crops, sugar beets, and alfalfa. Fair yields are obtained if plenty of irrigation water is available.

Laurel clay, colluvial phase.—Laurel clay, colluvial phase, has a surface soil about 12 inches thick, that consists of grayish-brown compact noncalcareous clay. Below this is gray compact puttylike mildly calcareous clay. The soil material at all depths is uniform, except for a slight accumulation of lime carbonate in the lower part of the profile. A variation of this soil has a lower substratum of porous gravelly loam.

Soil of this phase occurs either on the same level with the more recent soils or on a slight slope that joins the bottoms to the breaks of the upland. Its position indicates that much of the soil material has been brought down from the nearby adjacent uplands by small streams and has been deposited where the uplands merge with the lowlands, deposition occurring where the short intermittent streams spread out and drop their load of sediment. The soil has a smooth surface relief and occupies nearly level bottoms or very gentle slopes.

One large body extends from a point about 2 miles west of Brighton southward below the margin of the uplands for a distance of about 15 miles. Other areas are mapped along Clear Creek. Surface drainage, although restricted in some places, is generally good, but internal drainage is poor, and in places where excessive water seeps into this soil the land remains wet, hindering cultivation, and salts accumulate in amounts harmful to crops. This soil, though very difficult to handle, is extensively farmed. On many small farms truck crops are grown, which yield well and are marketed in Denver. Large applications of manure are made. This soil is productive under the special care practiced, but without such special

care and plenty of irrigation it would be a difficult and poor-yielding soil.

Laurel clay loam.—Laurel clay loam differs from Laurel clay mainly in the texture of the surface soil which contains a larger percentage of fine sand and very fine sand. This difference in texture is not very marked, but cultivation is not so difficult as on the clay, and drainage is slightly better. This soil occurs in the lower bottoms along several of the larger creeks.

Laurel clay loam, colluvial phase.—Laurel clay loam, colluvial phase is similar to Laurel clay, colluvial phase, except that the surface texture is somewhat lighter and cultivation is correspondingly less difficult. This soil is not very extensive, only a few areas occurring in association with the corresponding phase of Laurel clay just west of South Platte River, and other areas lying along Clear, Leyden, and Ralston Creeks. The soil of a part of the area about 1½ miles west of Maple Grove School and that of a part of the area at Prospect Valley School, near the stream channels, are dark brown and of light clay loam texture. These characteristics make for much more productiveness, and these areas are more valuable than the average soil of this phase.

Laurel very fine sandy loam.—Laurel very fine sandy loam, to a depth of about 8 inches, consists of friable mildly calcareous micaceous very fine sandy loam or fine sandy loam. Between depths of 8 and 60 or more inches, the material is irregularly stratified with layers of material ranging from loamy fine sand to clay in texture and from gray to black in color. Two areas have a gravelly loam subsoil that begins at a depth ranging from 15 to 40 inches below the surface and extends to a depth of 5 feet or deeper. One of these is along the river west of Dupont, and the other extends southward about a mile along the west side of the river from a point east of the Brighton Country Club.

Topographic features, mode of formation, and the crops grown on this soil are similar to those of Laurel clay, but the very fine sandy loam is much more desirable because it is very easy to cultivate and, because of the more permeable surface soil and subsoil, crop yields are larger. Some areas along the river lie so low that the water table rises to a height within 1 or 2 feet of the surface in the spring, when the water is high in South Platte River. Because of the high water table, salt is accumulating in some fields.

Laurel loam.—Laurel loam is like Laurel very fine sandy loam, but it has a slightly heavier textured surface soil. The area on the east side of South Platte River, about 1 mile south of Brantner School, has a gravelly loam subsoil, the upper part of which is about 2 feet below the surface.

Laurel fine sand.—Laurel fine sand ranges in texture from fine sand to coarse sand. It consists of more or less stratified gray noncalcareous sands to a depth of 6 feet or deeper. Because of the coarse texture and the loose leachy character of the soil material, almost none of the land is used for crop production. The texture is especially coarse in the area near the mouth of Sand Creek, where the sand is being screened, then loaded and hauled into Denver for use in concrete construction.

Terry clay.—The upper 3-inch layer of Terry clay is grayish-brown granulated noncalcareous clay. The granules of this ma-

terial are from 1 to 2 millimeters in diameter, and the mass of them forms a surface mulch. Below a depth of 3 inches, and continuing to a depth of about 12 inches, is mildly calcareous clay, ranging from grayish brown to rich brown in color, which breaks into somewhat angular granules or clods. Below a depth of 12 inches, and extending to a depth of about 3 feet, the material is mildly calcareous and of about the same color. On drying, the material shrinks and large cracks form, causing the soil to break into irregularly shaped angular clods. This material grades into the undecomposed sandstone or shale at a depth ranging from 15 inches to about 4 feet below the surface. The sandstone materials differ somewhat in texture but in general are of fine sand or slightly coarser texture, and most of them are moderately permeable. The color of the shale ranges from light gray to dark gray, in many places being streaked with yellowish brown. The shale is moderately calcareous and contains some gypsum.

This soil is mapped in large areas where the higher land breaks to the bottom land west of South Platte River. Other bodies are scattered throughout most of the area west of South Platte River. The sandstones and shales from which the soil has been derived differ somewhat in color, texture, and other characteristics, and similarly, the soil differs, but in relation to crop growing the differences are not very important.

The surface relief of this soil is smooth, although in many places small streams have cut V-shaped drainageways to a depth ranging from 1 to 5 feet below the surface. The larger part of this soil occurs on hill slopes where the old alluvium has been removed, exposing the shales or sandstones, many of the slopes having a gradient ranging from 200 to 300 feet in a mile. Because the soil occurs on slopes, drainage in most places is rather rapid, and much of the rain passes over the surface and is lost from the soil.

This is recognized as one of the least desirable soils of the area, as it is low in fertility, very hard to cultivate, droughty, and in many places too shallow to be of much agricultural value. Corn and grain are grown on a small acreage, and under irrigation a larger variety of crops is produced. A few cherry trees have been planted where irrigation water is available. Poor yields are obtained under dry farming, but yields ranging from fair to good are obtained on irrigated farms.

Terry clay loam.—Terry clay loam differs from Terry clay principally in surface texture. A larger proportion of the clay loam is cultivated, with grains as the principal crops. It is easier to handle under cultivation than Terry clay, but it is rather sticky and more clods are formed than on similar or lighter soils of other series. A large part of the area north of Burn Lee School is of light clay texture.

Terry fine sandy loam.—Terry fine sandy loam is derived largely from sandstones. To a depth of 10 inches the surface soil is dull-brown noncalcareous friable loam or fine sandy loam. From a depth of 10 inches to a depth of about 24 inches is brown or olive-brown noncalcareous clay loam. The surface horizon is darker brown, owing to the accumulation of organic matter or to organic staining on the outsides of fine particles. Below a depth of 2 feet, or at various depths of less than 6 feet, the sandstone bedrock occurs.

The parent material of this soil is a product of sandstones weathering in place. Color, texture, and depth to sandstone are variable. The soil occupies rather steep slopes on points of ridges where the surface relief is in general smooth, although in some areas a few rock outcrops protrude from 1 to several feet above the surface. Drainage is very good, and no accumulations of salts occur. Some bodies, where the soil material is thicker, are used for grain or alfalfa, but unless a large quantity of irrigation water is applied yields are unsatisfactory.

The areas in secs. 10, 11, and 12, T. 1 S., R. 70 W., the body near Lakeside Park, and the areas east of Brighton have fine sandy loam topsoils, and the other bodies have loam topsoils. The bodies along the northern margin of the area east of Brighton have a covering of alluvium and are probably more productive than the average. The gravel symbols on the soil map indicate the presence of a few erratic surface gravel. These have remained on the surface after the fine-earth material, with which they were deposited on top of the sandstone, has been removed by erosion.

Neville sandy loam, brown phase.—The 12-inch surface soil of Neville sandy loam, brown phase, consists of dark-brown noncalcareous friable fine sandy loam having a slight granular structure. Below this depth and extending to a depth of about 32 inches, the material is dull-brown or light-brown very mildly calcareous gritty heavy loam or clay loam, that is slightly firm but not cemented or compact. Below a depth of 32 inches, is light-brown very mildly calcareous slightly compact heavy clay loam or light clay that contains a few angular sandstone fragments. This material continues to a depth of 5 feet or deeper, where it rests on sandstone bedrock.

This soil is in part residual and in part derived from colluvial rock debris that has been moved only a few hundred feet. It occurs in a few long narrow bodies northwest of Golden, where it occupies troughlike depressions between rough hills of sandstone. A few areas having a sandy loam surface soil are included with this soil as mapped.

Neville sandy loam, brown phase, is a better soil for farming than the Terry soils. Wheat and corn are grown under dry-farming methods, but yields are only fair.

Table Mountain loam.—Table Mountain loam has a 10-inch surface layer of dark-brown or black noncalcareous friable loam that breaks into small angular crumbs. Mixed with the soil material are a few small angular fragments of basic igneous origin. Below a depth of 10 inches, and continuing to a depth of about 20 inches, is black heavy clay loam or clay of columnar structure. This horizon is either noncalcareous or very mildly calcareous. Below a depth of 20 inches is brown gritty very mildly calcareous clay loam which continues to a depth of about 4 feet, where solid basaltic bedrock occurs.

This soil has developed as a result of the disintegration and decomposition of basalt in place. It is mapped in a few small areas on the top and on the slopes of North Table Mountain, in one area on South Table Mountain, and in one area between North Table Mountain and Long Lake. The areas on the slopes and at the bases of the mountains are partly colluvial.

This soil has a smooth surface relief and occurs on level or comparatively steep sloping land where drainage is good. It is dry farmed to grains, and fair yields of corn, wheat, and rye are reported.

Table Mountain loam, heavy phase.—Several areas of Table Mountain loam, heavy phase, are mapped on the slopes of North Table Mountain, and one body occurs on South Table Mountain. Soil of this phase differs from the typical soil principally in having a clay loam surface soil. Part of this heavy land is irrigated, and good yields of alfalfa, corn, truck crops, and fruit are produced.

Kuner fine sandy loam.—Kuner fine sandy loam, to a depth ranging from a few inches to about 12 inches, consists of light-brown fine sandy loam. It overlies light-brown mildly calcareous loam or clay that is loose or slightly compact. This material may extend to a depth of more than 6 feet, but in most places it is underlain, within a depth of 5 feet, by solid strata of sandstone or shale.

This soil occurs in small stream valleys or near lakes where it receives large quantities of seepage water, and this has resulted in salt accumulations in many places. In places the soil has been formed from sediments recently washed upon strata of sandstone or shales, where the strata are within 5 feet of the surface.

Because of seepage, accumulations of salt, and the slight depth to sandstone or shale, this soil is of practically no value for growing crops. Cattails grow on much of it, as well as on seepy areas of other soils. Mats made from cattails are used to protect plants in hotbeds from wind and frost.

Only a few small areas of this soil are mapped—one about a mile north of Gallup, another about a mile east of Lafayette, and a few others in the northeastern part of the area.

Rough broken land.—Rough broken land includes steep, rocky, or rough land that, because of these features, is useful only for pasture. In some places it consists of precipitous rocky cliffs, in other places of smooth sloping land covered with large rocks or boulders, and in still others of smooth-surfaced areas covered with grasses but too steep for the use of farm machinery.

Rough mountainous land.—Rough mountainous land in the Brighton area is confined to the rough and rugged slopes and valleys of the Rocky Mountains. Several bodies of this land occur at the western margin of the area, where the elevation increases from 5,000 feet to 6,500 or 7,000 feet above sea level within a distance of about 1 mile. These areas are too rough to be of any agricultural value other than for a small amount of grazing.

Mine dumps.—Mine dumps include small areas at coal mines, where waste material, consisting of very low grade coal and clay debris, has been dumped. These dumps in some places cover several acres and range from a few feet to as much as 60 feet or more in height.

River wash.—River wash includes the present stream bottoms that are periodically covered with flood water. This land consists of stony, gravelly, or sandy areas that are not valuable for crop production.

SOILS AND THEIR INTERPRETATION

The features of environment to which the soil material in the Brighton area have been subjected since its geological accumulation have been in part enumerated in the first part of this report. The

range in elevation above sea level is between 5,000 and 6,500 feet. The mean annual precipitation at Boulder is 18.12 inches. Near the mountains the precipitation during the winter and spring is mainly in the form of snow, and the average annual snowfall at Boulder is 68.8 inches. The maximum temperature recorded during a period of many years is 99° F., and the minimum recorded is −22°. Humidity is low, being 53-percent saturation at Denver. The native vegetation is an association of short grasses, mainly buffalo and grama in the plains section, and an association in which bunch grass is dominant in the valleys to the west.

The area covered by this survey lies mainly within the Great Plains, but its western edge extends into the foothills of the Rocky Mountains. The soil materials have accumulated through a long period of sedimentation, metamorphism, and erosion. The surface features of the Great Plains were developed on a series of soft rocks, mainly shales and sandstones. Although the region had been uplifted and depressed a number of times, these beds had not been subjected to folding until the end of the Cenozoic era. The beginning of the Tertiary period was marked by a rapid succession of uplifts of the Rocky Mountains mass, and the beds of the plains were upturned and exposed along the western side of this area. Although lowered and smoothed by erosion, the upturned edges of rock still protrude in ridges and buttes above the level of the plain and form striking topographic features. This foothill belt consists of parallel ridges and valleys, dissected outwash slopes, and a few isolated buttes. During the denudation subsequent to the uplift of the Rocky Mountains front, wash and fluviatile deposits were spread out over the nearly horizontal sedimentary formations to the east.

In the Pleistocene epoch, glaciers occupied the higher valleys of the eastern front of the Rocky Mountains, and their debris added to the alluvium of the river valleys. In recent times, the Pleistocene deposits of the foothills have been dissected into a series of disconnected terraces and colluvial fans, and, as the normal erosion cycle has progressed, drainage waters have been more confined to stream channels, and much of the newly deposited material removed from the foothill slopes has been carried to the outwash aprons farther east. Further erosion has cut into the sandstones and shales, forming valleys ranging from a few feet to 500 feet below the level of the Plains. At a time when South Platte River carried much more water than at present, a series of extensive gravelly terraces, which now stand about 100 feet above the present bed of the river, were laid down.

The result of the factors of soil formation are best expressed in the mature soils of the Fort Collins series, which have, in general, the following profile:

0 to 2 inches, grayish-brown or brown noncalcareous fine sandy loam and very fine sandy loam. This material is a mellow mulch and, though matted with grass roots, shows slight lamination.

2 to 8 inches, grayish-brown or brown noncalcareous loam or heavy loam. The upper part of the layer is slightly laminated, and the rest is single grained and firmed together in a mass that breaks easily with no regular cleavage.

8 to 22 inches, brown, dark-brown, or reddish-brown compact noncalcareous clay of prismatic structure. It is apparent that the material in this horizon has been darkened by an accumulation of organic derivatives that have been, in part, leached from the horizons above. Oxidation

of both mineral and organic material probably shares with the accumulation of carbonaceous material in influencing the darker color. This is suggested on fine pulverization of the material. On the surfaces of natural breakage planes the material is rich reddish brown, but when this same material is crushed very finely, a light-brown or olive-brown color is dominant. Grass roots are plentiful, and a few worm casts occur in this horizon.

22 to 38 inches, grayish-brown compact clay of prismatic structure, which is much like the material in the horizon above but grayer in color. It is mildly or moderately calcareous, and plant roots are less abundant.

38 to 54 inches, gray friable clay loam that is very high in lime carbonate and tends to have a massive structure.

54 to 96 inches, pinkish-gray heavy clay loam or clay, high in lime but containing less than the horizon above. The lime carbonate occurs principally in streaks or pocket accumulations. The color of the more lime-free material is rich brown. The structure tends toward prismatic.

96 to 120 inches, the parent material which consists of light-brown highly calcareous friable fine sandy loam.

A few water-worn gravel of light or dark colors are scattered throughout the entire solum. This soil has developed, for the most part, from alluvial deposits, that have been washed from the Rocky Mountain region, and debris resulting from the erosion of sandstone and shale formations that join the mountainous area. The deposits were laid down, probably, both as sheet wash and as stream-terrace material.

Nearly all the soils of the area, including those of the Berthoud, Greeley, Gilcrest, and Weld series, have profiles similar to those of the Fort Collins soils, and differences are due to differences in the texture of the material and to the time that has elapsed since deposition. The soils of the Berthoud, Greeley, Gilcrest, and Weld series are essentially like the Fort Collins soils in profile features, but soils of the Table Mountain, Neville, and Terry series have somewhat different profiles because of the differences in the parent materials. The Larimer soils have developed from the oldest material, and soils of the Cass and Laurel series from freshly deposited materials.

pH determinations of several of the soils of this area have been made in the laboratories of the Bureau of Chemistry and Soils by the hydrogen-electrode method. The data in table 3 indicate that the materials in nearly all horizons of all the soils tested are alkaline in reaction.

TABLE 3.—*pH determinations of several soils in the Brighton area, Colorado*[1]

Soil type and sample no.	Depth	pH	Soil type and sample no.	Depth	pH
Weld loam:	*Inches*		Fort Collins loam:	*Inches*	
491104	0– 2	7.20	491167	0–15	8.02
491105	2– 9	7.33	491168	15–36	7.27
491106	9–16	8.02	491169	36–60	8.62
491107	16–38	8.57	Terry fine sandy loam:		
491108	38–84	9.03	491176	0–10	7.42
Gilcrest sandy loam:			491177	10–24	6.65
491137	0– 8	7.75	491178	24–60	6.49
491138	8–20	7.83	Fort Collins clay loam:		
491139	20–60	8.12	4911115	0– 2	7.25
Greeley loam:			4911116	2– 8	6.15
491144	0– 8	8.35	4911117	8–22	7.59
491145	8–28	8.35	4911118	22–38	8.43
491146	28–38	8.43	4911119	38–54	9.09
491147	38–60	8.60	4911120	54–96	9.09
			4911121	96–120	9.09

[1] Determinations made by E. H. Bailey, Bureau of Chemistry and Soils.

The Weld soils, as mapped in this area, though similar in some respects to the Fort Collins soils, have some important differences. These soils are not so ideally developed in this area as they are farther east. They belong more nearly with the brown soils group than with the dark-brown soils. Weld fine sandy loam, which is more representative of this development, has the following profile:

0 to 2½ inches, a dark-brown mulch of friable noncalcareous fine sandy loam and plant roots. The material is either slightly laminated or is so densely filled with plant roots that the structure is not noticeable.

2½ to 10 inches, light-brown firm but friable noncalcareous fine sandy loam or light loam. No structure is developed, but the material is easily crushed to single grains of gunpowder size.

10 to 18 inches, rich-brown noncalcareous slightly prismatic clay loam or clay, which contains many grass roots and some worm casts.

18 to 90 inches, olive-brown moderately calcareous friable fine sandy loam and loamy fine sand. The material in this horizon is firm but without structural development. It stands up for long periods in a straight cut bank but is easily cut or broken into small angular clods.

The lime carbonate appears as mottlings in some places, and in other places it is finely divided and distributed rather evenly. However, a concentration of the lime carbonate and a grayish-brown color usually occur between depths of 24 to 34 inches. The profile of this soil differs from that of the Fort Collins soils principally in having less development of the prismatic clay, the calcareous horizon is closer to the surface, and the material in the lower subsoil layer is more friable and in general of lighter texture. Farther east the red prismatic clay horizon gradually disappears. The parent material of the Weld soils is, in some places, partly or entirely wind-laid, but in most places in this area it has been water-laid.

The Terry soils and the Table Mountain soils do not show the various horizons present in the Fort Collins and Weld soils. The gray surface mulch is very thin in the Terry soils and is absent in the Table Mountain soils. The lower horizons of the profile have some characteristics similar to those in the Fort Collins soils, although they are not so obvious. The Terry soils, because of their parent material and the climatic factors, are gray or grayish brown. The parent material, a basalt, of the Table Mountain soils has been effective in coloring the soils which are dark brown or black. These soils have developed on top of a comparatively level mountain, where underground water could have no influence. Although basic material is supposedly high in the parent rock, very little lime carbonate occurs in the soil. This could occur if the rock had decomposed slowly, allowing the soluble materials to leach from the soil.

The soils developed from recent alluvium—Cass and Laurel soils—consist of materials of mixed origin that have been deposited so recently that soil-building forces have not had time to impress their influences.

IRRIGATION, DRAINAGE, AND ALKALI

The beginning of irrigation in the Brighton area dates back to the first farming. The land along the river and small streams was irrigated by use of comparatively short ditches that irrigated from 10 to 100 acres each. A number of ditches were constructed about 1860, and during the 20 years following several long ditches reaching

the uplands were constructed. In 1929, 159,428 acres were irrigated in Boulder County, 66,826 acres in Adams County, and 58,124 acres in Jefferson County, the water distribution system including 304 miles of ditches and laterals in Adams County, 582 miles in Boulder County, and 269 miles in Jefferson County. The capital invested in this system in Adams County is $2,759,587, in Boulder County is $1,790,211, and in Jefferson County is $2,510,326. Water for irrigation of land in the Brighton area comes from a mountain section along South Platte River, Clear Creek, Ralston Creek, Coal Creek, South Boulder Creek, and North Boulder Creek. A system of diversion canals, as shown on the map, leads from these streams to supply water for most of the land in the area. Priority water rights and water costs differ considerably under the different systems. Most of the water in these streams is of good quality, although the water diverted from South Platte River at short distances below Denver is affected somewhat by sewage from the city. The water in Clear Creek at present carries large quantities of gray fine or colloidal mineral material washed into the stream from the many mining activities in the mountain section through which this creek passes, but many farmers have constructed settling basins where they allow the water to stand before being used for irrigation. Not all the colloidal material settles, and some is deposited on the land with the water, causing many farmers to complain that this gray material has made the land less productive. However, no experiments have been made to determine whether this material is detrimental, to what extent it lowers yields, if the sediment has a smothering effect on the growing plant, or if it displaces pore space, thereby lowering the water-holding capacity, capillary water movement, and oxidation.

With the exception of a part of the soils of the Terry series, all the soils of the area are readily permeable to water. Poor drainage occurs in only comparatively flat areas below extensive areas of irrigated land, a few bodies just below lakes or irrigation ditches, and in the bottom land along streams where the water table is high, owing to the water level of the streams. Such areas are indicated on the map by use of marsh symbols and by use of the letter A printed in red, where salts have accumulated. No drainage districts exist in the Brighton area, though drainage systems have been installed on some farms. In the poorly drained areas of flat stream-bottom land, where water approaches the surface from a water table that rises with the stream, corrective measures are almost impossible. The water table of many of these areas, however, does not remain high throughout the year but fluctuates with the rise and fall of the stream. Such a condition, though it allows evaporation which results in salt accumulation at the surface, is not highly detrimental to most crops. In areas where salt is accumulating, improvement is possible by flooding after the water table lowers.

Other salty lands of the area are caused by seepage from lakes, streams, or large bodies of irrigated land. Many such poorly drained and salty areas are very small, and the expense of drainage to correct the condition is not practical at this time, but the larger areas probably justify the expense of drainage. Some of these areas occur in the bottom lands along South Platte River and along Clear Creek. Intercepting drains that will cut off the seepage flow at the bases of slopes or on sidehill slopes before it approaches the surface

are most effective, but in some areas supplementary open drains through the poorly drained area may be necessary. The removal of salts from the soils of these areas may be effected as described above, and comparatively unproductive soils may be reclaimed. It is probable that, owing to the characteristics of the soil in the poorly drained area along South Boulder Creek, reclamation by drainage is not feasible there.

SUMMARY

The Brighton area includes the important irrigated land and some dry-farmed land west of Denver and extending north and northeast of Denver to the Longmont area. The area is about a mile above sea level, in the high plains, and merges with the Rocky Mountains on the west.

The climate, which is continental, is desirable for homes and for the production of a large variety of high-quality farm products.

The soils belong mostly to the dark-brown and brown soil groups that are developed in a short-grass region in a semiarid climate. Most of the soils have developed from rock debris that has been eroded from various rock strata in the Rocky Mountains and to less extent from rock strata on the plains section. Climatic forces, combined with other effective agencies, have developed certain soil characteristics, most of which are similar, yet sufficiently different that 49 soil types and phases have been recognized. Most of the soils are well adapted to irrigation and to farming.

About 90 percent of the land is irrigated and intensively farmed. Alfalfa, wheat and other grains, sugar beets, corn, and a large number of truck crops and vegetables are produced. On the dry-farmed land, the growing of corn, wheat, and pinto beans is important. Much of the produce is used locally or in nearby towns, and some is shipped to eastern cities.

Sugar is manufactured locally from the sugar beets and is sold in various United States markets. Most of the byproducts are sold locally. A canning company cans many truck crops and vegetables, which are shipped to various markets.

Dairying and poultry raising are extensive industries engaged in to supply Denver and the local demand for these products. Cattle feeding and hog feeding in the section adjacent to packing plants are important industries.

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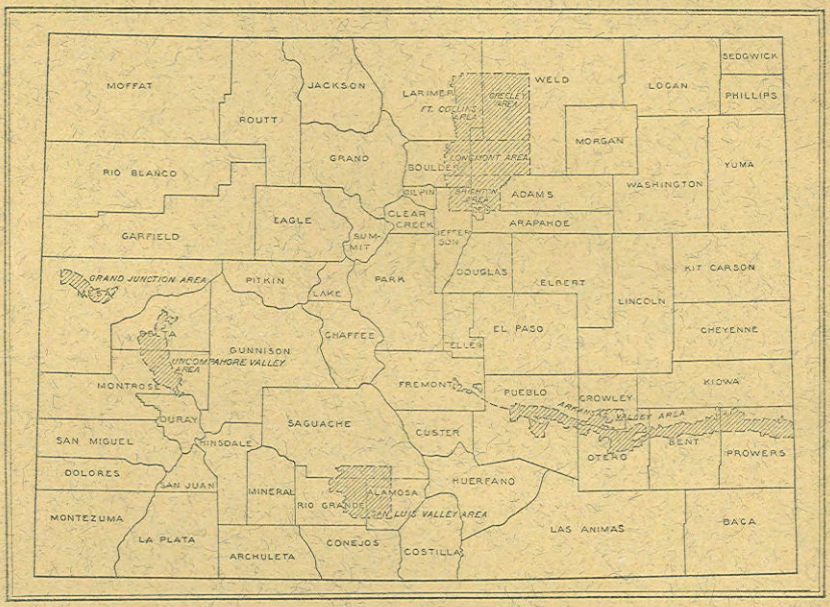

Areas surveyed in Colorado, shown by shading.

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