Series 1956, No. 22 Issued April 1964

SOIL SURVEY

Holbrook-Show Low Area Arizona

This is thel ast Survey of the 1956 Series

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

HOW TO USE THE SOIL SURVEY REPORT

THIS REPORT is about the soils of the Holbrook-Show Low Area, Ariz. The soil survey was made to learn the nature and extent of each kind of soil. Soil scientists dug holes and examined the surface soil and subsoil in many places in the Area. They measured slopes with a hand level; observed differences in growth of crops, grass, trees, and weeds; and, in fact, recorded all the things about soils that they believed might affect their suitability for farming and other uses.

The soil scientists placed soil boundaries on aerial photographs. Then, cartographers prepared from the field maps the detailed soil map that is in the back of this report.

Locating the Soils

Use the index to map sheets to locate places on the detailed map. The index is a small map of the county on which numbered rectangles have been drawn to show where each sheet of the large map is located. When the correct sheet of the large map is located, notice that boundaries of the soils are outlined and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they appear on the map. The symbol is inside the area if there is enough room; otherwise, it is outside the area and a pointer shows where the symbol belongs.

Suppose, for example, an area located on the map has the symbol ZfA. The legend for the detailed map shows that this is the symbol for Zeniff fine sandy loam, 0 to 1 percent slopes. This soil and all the others mapped in the county are described in the section "Descriptions of the Soils."

Finding Information

This report contains sections that will interest different groups of readers, as well as some sections that may be of interest to all.

Farmers and those who work with farmers can learn about soils in the section "Descriptions of the Soils;" they will also be interested in the section "Use and Management of the Soils."

The soils have been grouped into capability units; that is, into groups of soils that are similar and that respond to management in about the same way. Zeniff fine sandy loam, 0 to 1 percent slopes, for example, is in capability unit IIIc–1(D). Suggestions are given for use and management of the soils in each capability unit.

The "Guide to Mapping Units and Capability Units," just ahead of the maps, will simplify use of the map and the report. This guide gives the map symbol for each soil, the name of the soil, the page on which the soil is described, the capability unit or units in which each soil has been placed, and the page where each capability unit is described.

Engineers and contractors will want to refer to the section "Engineering Applications of the Soils." Tables in that section show many characteristics of the soils that affect different kinds of engineering work.

People interested in science will want to look at the section "Genesis, Classification, and Morphology of the Soils."

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending on their particular interest.

Newcomers in the Holbrook-Show Low Area will be especially interested in the section "General Soil Map," in which broad patterns of soils are described. Additional information about the Area is provided in the section "Facts about the Holbrook-Show Low Area."

* * * * *

Fieldwork for this survey was completed in 1956. Unless otherwise indicated, all statements in the report refer to conditions in the Area at that time. The soil survey is part of the technical assistance furnished by the Soil Conservation Service to the Navajo County Soil Conservation District.

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SOIL SURVEY OF THE HOLBROOK-SHOW LOW AREA, ARIZONA

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE UNIVERSITY OF ARIZONA AGRICULTURAL EXPERIMENT STATION

THE HOLBROOK-SHOW LOW AREA is in the southern part of Navajo County, Ariz. Its location in the State is shown in figure 1. Elevations in the Area range from 7,575 feet, along the Mogollon Rim, which is the southern boundary, to 4,850 feet, in the valley of the Little Colorado River, near Winslow. The topography consists mainly of gently rolling plains, and to a less extent of mesas, buttes, entrenched streams, and small volcanic cinder cones (*2*).[1] Most streams flow northward.

[1] Italicized numbers in parentheses refer to Literature Cited, p. 75

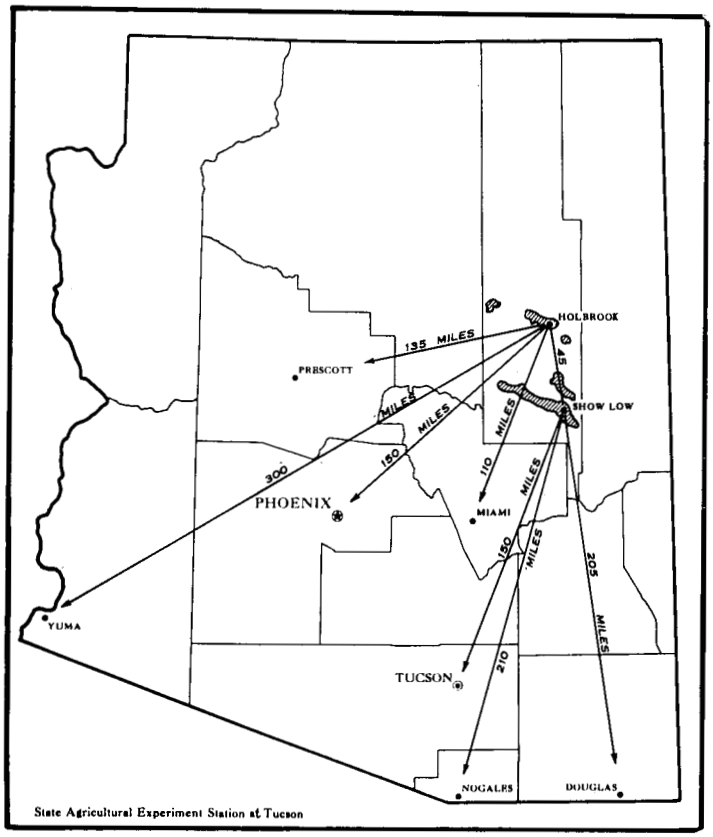

Figure 1.—**Location of the Holbrook-Show Low Area in Arizona.**

A forest, consisting mainly of ponderosa pine, covers the southern edge of the Area. It is adjacent to the Mogollon Rim and at elevations between 7,575 and 6,500 feet. Extending north of this forest, at elevations of less than 6,500 feet, is a belt of pinyon and juniper trees. As the elevation decreases north of this belt, the landscape is predominantly grassland. Ravines, deep canyons, and variously colored eroded badlands with exposed petrified forest add to the scenery of the Area. The badlands are known as the Painted Desert.

Ranching, farming, and lumbering are the most important enterprises. Irrigated farms and dryland farms are operated mainly to produce feed for livestock.

Holbrook, the county seat, is in the northern part of the Area. Winslow, the largest city, is in the northwest corner of the Area. Large cities that provide markets for agricultural products are Phoenix, the State capital, about 150 miles southwest of Holbrook; Tucson, 270 miles south of Show Low; and Los Angeles, Calif., about 600 miles west of the Area.

The Navajo County Soil Conservation District covers slightly less than 2 million acres. This report, however, covers only the tracts in the soil conservation district that were surveyed in detail—a total of 101,196 acres. The tracts surveyed in detail consist of irrigated farms along the large streams, dryland farms in the ponderosa pine forest where crops can be grown without irrigation, and other land owned or operated in conjunction with these types of farms. The location of these tracts is shown on the general soil map at the back of the report.

Facts About the Holbrook-Show Low Area

Geology

The topographical features of the Area are typical of the early stages of erosion, under arid conditions, on nearly horizontal layers of sedimentary rocks of varying degrees of hardness.

Over most of the Area, the bedrock consists of sedimentary rocks, which range in age from the Permian period to the Quaternary period. These rocks are limestone, sandstone, sandy shale, varicolored shale, and shale that contains a small amount of interbedded gypsum.

North of the Little Colorado and Puerco Rivers (A, fig. 2), the Chinle and Shinarump formations are capped in places by unconsolidated Tertiary deposits. Where the Chinle formation is exposed, badlands, known as the Painted Desert, have formed.

Permian and Triassic beds are at the surface in large areas (B, fig. 2). These formations outcrop in a sequence going from south to north, as follows: Yellow-gray limestone, brown to maroon sandy shale, and white or buff crossbedded sandstone.

A small tract in the southeastern part of the Area (C, fig. 2) is covered by basalt flow and volcanic cinders. Buff and gray shale and sandstone of the Upper Cretaceous age (D, fig. 2) occur in a zone 8 to 10 miles wide that extends west from the basalt and cinders along the Mogollon Rim. The shale and sandstone are capped in many places by Tertiary or Quaternary sand and gravel. Remnants of these deposits of sand and gravel extend northward from the Mogollon Rim as much as 14 to 18 miles; they cap the ridges and form the terraces in valleys that were made during the Cretaceous and older periods.

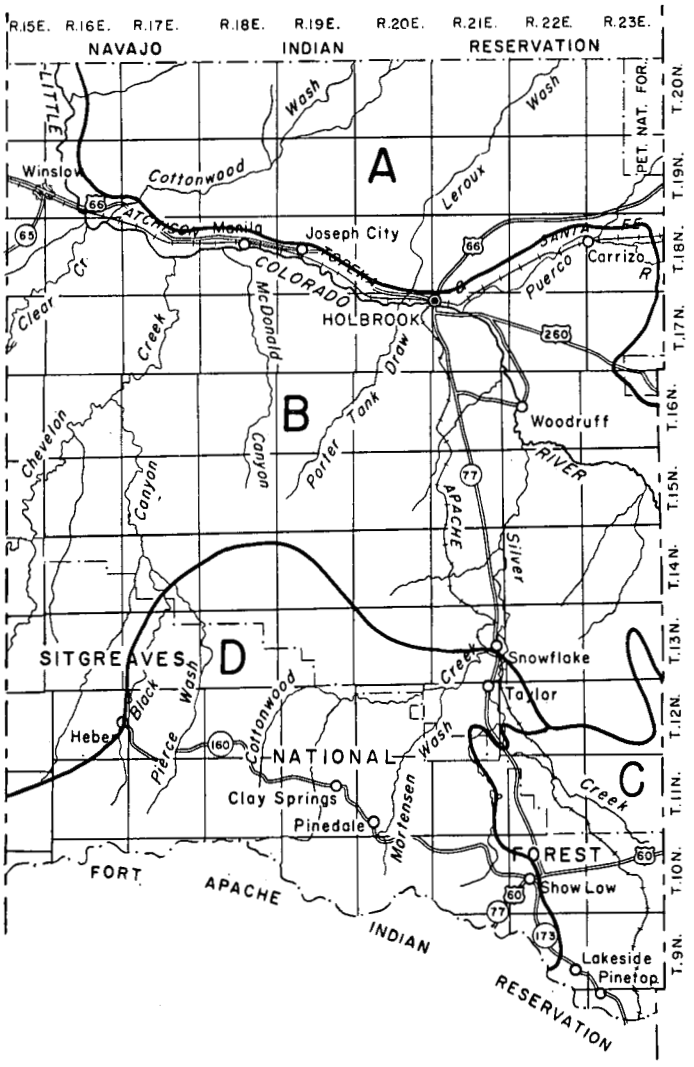

Figure 2.—**Generalized map showing location of geologic formations in the Holbrook-Show Low Area, Ariz.: (A) Triassic Chinle and Shinarump formations with large areas capped by unconsolidated Tertiary deposits; (B) Permian and Triassic sedimentary rocks, mostly limestone, sandstone, shale, and sandy shale; (C) Tertiary basalt flow and volcanic cinders; (D) Upper Cretaceous shale and sandstone capped in places by Tertiary and Quaternary sand and gravel.**

South of the Little Colorado River where the Permian and Triassic beds outcrop, the surface slopes gently to the northeast at the rate of 38 feet per mile, which corresponds with the dip of the underlying rocks. The long dip is interrupted 15 to 20 miles southwest of Holbrook by the Holbrook anticline, which trends to the northwest.

All streams in the Area drain into the Little Colorado River. This stream rises in the White Mountains in Apache County and flows northwest to its junction with the Colorado River in the upper end of Grand Canyon. In the Holbrook-Show Low Area, the main tributaries of the Little Colorado River are a drainage system made up of the Show Low and Silver Creeks, both of which rise in the mountains in the southern part. Near Winslow, Chevelon and Clear Creeks flow into the Little Colorado River. These creeks rise on the Mogollon Plateau and flow through deep, narrow, parallel canyons before joining the Little Colorado River.

Many of the large drainageways are intermittent. Phoenix Park Wash and Decker Wash flow northwestward from the Mogollon Rim and empty into Dry Lake, located against the southwest side of the Holbrook anticline.

Climate

The climate of the Holbrook-Show Low Area is semiarid or subhumid. Data on rainfall, snowfall, and length of the growing season are shown in table 1. The variations in these features are the result of a difference in elevation of 2,775 feet within the Area and the associated influences caused by topography and the prevailing wind. Winters range from moderately cold to severely cold; summers are mild to moderately hot. Low relative humidity and abundant sunshine are associated with the dry climate of the Area. At Winslow, the average relative humidity at 5:30 a.m. is 60.4 percent; at 11:30 a.m., 34.2 percent; and at 5:30 p.m., 29.7 percent. The relative humidity may go as low as 10 percent in the afternoon during June. The sun shines 80 to 85 percent of the total possible time (*6*).

The heaviest rainfall occurs in July, August, and September, in which time there may be torrential thunderstorms. An average of 37 to 48 percent of the total annual precipitation falls in this 3-month period. May and June are the driest months. During this period, 5 to 8 consecutive cloudless days are common. Complete cloud overcast for 2 to 3 days at a time is rare in any part of the year. In the mountains, winter precipitation is mainly snow; in the lower elevations, the precipitation occurs both as gentle rain and light snow.

Snowfall in the low elevations occasionally is severe enough to interfere with, but seldom stop, traffic. In the high elevations, snow may close roads for short periods. Hunters have been marooned during heavy snowfall and, on rare occasions, have perished.

TABLE 1.—*Climatic data from seven stations in the Holbrook-Show Low Area, Ariz.*[1]

Station	Length of record	Elevation	Annual precipitation	Annual snowfall	Frost-free period	Temperature		
						Average maximum	Average minimum	Average
	Years	*Feet*	*Inches*	*Inches*	*Number of days*	*° F.*	*° F.*	*° F.*
Heber	21	6, 600	17. 7	46. 6	115	64. 9	30. 2	47. 6
Holbrook	50	5, 069	8. 8	10. 6	174	72. 1	37. 8	55. 0
Lakeside	22	6, 700	22. 0	64. 4	127	62. 4	32. 1	47. 2
Pinetop	10	7, 500	21. 5	75. 7				
Show Low	22	6, 382	18. 4	52. 1	117	65. 3	35. 6	50. 4
Snowflake	38	5, 644	12. 2	20. 7	132	69. 0	33. 4	51. 2
Winslow	45	4, 880	7. 8	10. 5	173	71. 4	38. 9	55. 2

[1] Data obtained from the work of H. V. SMITH (*5*, *6*).

Wind velocities of 35 to 50 miles per hour for short periods are common in March and April, the windiest period of the year. Velocities higher than these do occur, but the winds are usually of low velocity and cause very little property damage. The average wind velocity is 9.3 miles per hour at the Winslow station. If moisture is deficient in winter, spring winds cause duststorms that are often severe enough to reduce visibility, impede highway traffic, and drift sand in some localities.

The average daily temperature at the Winslow station is 44° F. during May and 27° F. during January.

Vegetation

The four main types of vegetation (*3*) in the Area are: Forest, pinyon-juniper, short grass, and browse. These types occur within fairly short distances and are accounted for chiefly by the variations in climate, soil, and topography.

The forest, pinyon-juniper, and short grass types of vegetation occur in distinct geographical belts. Browse is along streams in the short-grass belt (fig. 3).

The *forest* type of vegetation consists mainly of ponderosa pine. It occurs on the Mogollon Plateau above an elevation of 6,500 feet and in a subhumid climate. Much of the ponderosa pine occurs in pure stands over large areas. Other species mixed with ponderosa pine are pinyon pine, oneseed juniper, Utah juniper, alligator juniper, Gambel oak, Douglas-fir, and quaking aspen. The important species of grass growing in the forest are Arizona fescue, mountain muhly, mountain brome, and pine dropseed. The density of the forest ranges from open stands of ponderosa pine to dense thickets of juniper and young ponderosa pine. Small, scattered, parklike areas of grass, with a few junipers, occur in the eastern part of the forest type of vegetation. Small areas of quaking aspen usually indicate the sites of old fires. A few Douglas-firs grow on the steep, north-facing slopes. Juniper may occur in pure stands or as an understory to ponderosa pine. Ponderosa pine is the only tree that produces sawtimber. The forests are grazed during the summer.

The *pinyon-juniper* type of vegetation occupies a belt, at elevations of 5,500 to 6,500 feet, between the forest type to the south and the short-grass type to the north. Oneseed juniper and Utah juniper are the most abundant trees. Pinyon pine is less abundant and is not so widely distributed as juniper. Juniper steadily invades the short-grass area to the north. This advance of juniper has been attributed to the loss in vigor of the grasses because of overgrazing and also to the control of range fire that would destroy juniper seedlings (*3*). The important grass species in the pinyon-juniper area are western wheatgrass, sand dropseed, mesa dropseed, and galleta, and black, blue, hairy, and side-oats grama. Large areas of grassland occur within the pinyon-juniper type, and grazing is the predominant use. Occasionally, a few fence posts are cut from the pinyon pine and juniper, but otherwise these trees have no economic value.

The *short-grass* type of vegetation occupies elevations ranging from 4,900 to 5,500 feet and is lower than the pinyon-juniper type. It consists mainly of short bunch grasses, and scattered shrubs. The important short grasses are blue, black, and sixweeks grama, galleta, alkali sacaton, sand and mesa dropseed, three-awn, ring muhly, Indian ricegrass, and needlegrass. The important shrubs are Mormon-tea, snakeweed, rabbitbrush, and winterfat. This type of vegetation has developed in a semiarid climate.

The *browse* type occurs on the flood plains in the belt of short-grass vegetation. The soils under browse are saline-alkali, and the water table is usually more than 3 feet from the surface. Plants of this type are mainly those that can tolerate saline-alkali conditions. Fourwing saltbush, greasewood, and shadscale are the important shrubs. Alkali sacaton and saltgrass are the two important grasses. Cottonwood and willow grow along the streams and in old river channels. The production of forage is low; the quality is poor.

The common and scientific names of plants most common in the Holbrook-Show Low Area (a part of Navajo County) are given in the following list.

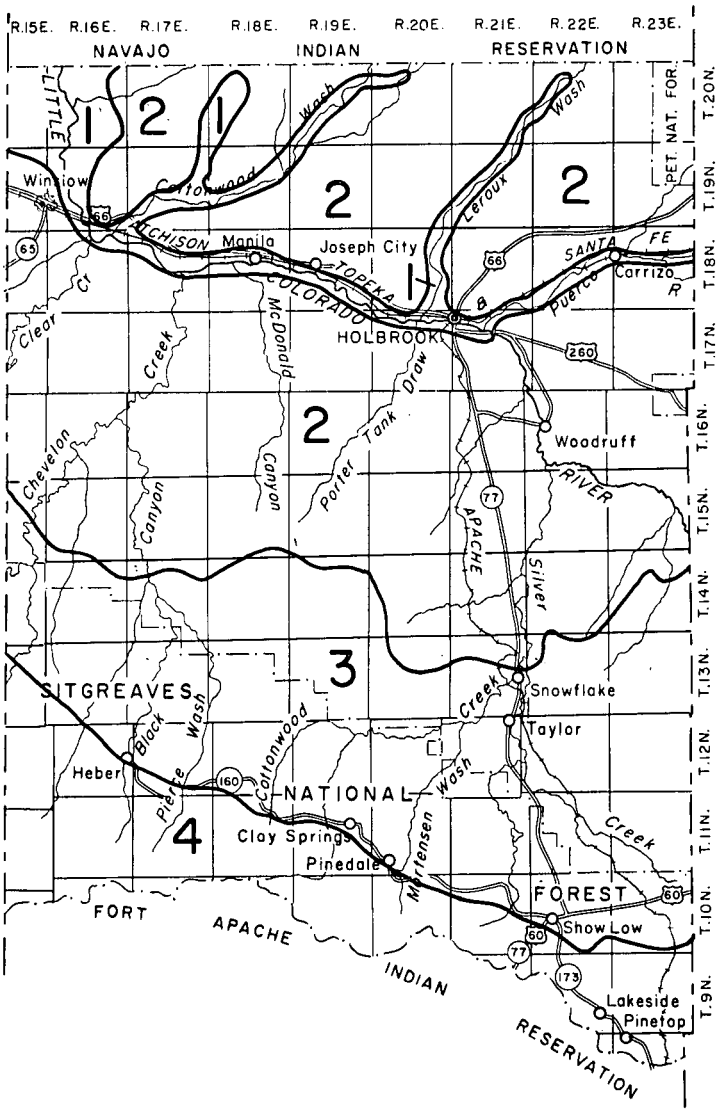

***Figure 3.*—Types of vegetation in the Holbrook-Show Low Area, Ariz.: 1, Browse; 2, short grass; 3, pinyon-juniper; and 4, forest, mainly ponderosa pine.**

GRASSES

Common name	*Scientific name*
Black grama	*Bouteloua eriopoda*
Blue grama	*Bouteloua gracilis*
Side-oats grama	*Bouteloua curtipendula*
Hairy grama	*Bouteloua hirsuta*
Sixweeks grama	*Bouteloua barbata*
Western wheatgrass	*Agropyron smithii*
Galleta	*Hilaria jamesii*
Saltgrass	*Distichlis stricta*
Alkali sacaton	*Sporobolus airoides*
Sand dropseed	*Sporobolus cryptandrus*
Mesa dropseed	*Sporobolus contractus*
Indian ricegrass	*Oryzopsis hymenoides*
Mountain muhly	*Muhlenbergia montana*
Spike muhly	*Muhlenbergia wrightii*
Ring muhly	*Muhlenbergia torreyi*
Deergrass	*Muhlenbergia rigens*
Needlegrass	*Stipa comata*
Three-awn	*Aristida divaricata*
Squirreltail	*Sitanion hystrix*
Mountain brome	*Bromus marginatus*
Arizona fescue	*Festuca arizonica*
Pine dropseed	*Blepharoneuron tricholepis*

SHRUBS

Common name	*Scientific name*
Algerita	*Berberis haematocarpa*
Big sagebrush	*Artemisia tridentata*
Black sagebrush	*Artemisia nova*
Fourwing saltbush	*Atriplex canescens*
Greasewood	*Sarcobatus vermiculatus*
Mormon-tea	*Ephedra* sp.
Rabbitbrush	*Chrysothamnus paniculatus*
Sand sagebrush	*Artemisia filifolia*
Shadscale	*Atriplex confertifolia*
Snakeweed	*Gutierrezia lucida*

TREES

Common name	*Scientific name*
Alligator juniper	*Juniperus deppeana*
Aspen	*Populus tremuloides*
Cottonwood	*Populus* sp.
Douglas-fir	*Pseudotsuga menziesii*
Gambel oak	*Quercus gambelii*
Oneseed juniper	*Juniperus monosperma*
Pinyon pine	*Pinus edulis*
Ponderosa pine	*Pinus ponderosa*
Utah juniper	*Juniperus utahensis*
Willow	*Salix* sp.

WEEDS

Common name	*Scientific name*
Locoweed	*Astragalus* sp.
Russian-thistle	*Salsola kali*

Water Supply

The semiarid part of the Area has so little rainfall that short bunch grasses are the only vegetation. Some localities get only 5 inches of rainfall in dry years. Cultivated crops cannot be grown without irrigation. In the subhumid part, some dryland farming is done where soils and slopes are favorable.

Crop yields are erratic. Many crop failures are caused by drought. Yields are dependable only where enough water is available for irrigation.

The sources of water are permanent streams, springs, storage reservoirs, and deep and shallow wells. Water for irrigation is obtained mainly from storage reservoirs and deep wells. Usually, water from shallow wells is strongly saline and is unsuitable for irrigation and use by livestock. Water from the Little Colorado River is usually of good quality, except when streamflow is low. Water from springs, reservoirs, and deep wells is generally of good quality.

In the Snowflake-Taylor-Shumway vicinity, irrigation water is obtained from a storage reservoir and from deep wells; in the Lakeside-Show Low vicinity, from a reservoir that stores water diverted from intermittent streams; and in Joseph City, from flowing wells and deep pumped wells and through diversion of water from a permanent stream. At Winslow, irrigation water is diverted from a small permanent stream and transported through 17 miles of ditches to the cultivated area. Most irrigation water used near Holbrook and Hay Hollow is pumped from deep wells, but a small amount comes from flowing wells.

Permanent streams supply only a small part of the water used for irrigation and for livestock. They do not supply any of the water that is stored in reservoirs. The Little Colorado River, Silver Creek, and Clear Creek are considered to be the only permanent streams in the Area. The aquifer that supplies water pumped from deep wells is a

highly fractured Permian sandstone known as the Coconino sandstone. It is typically a weakly cemented, generally white to buff, siliceous sandstone. Along the Little Colorado River and in the Snowflake-Taylor-Shumway vicinity, water from Coconino sandstone is lifted approximately 5 to 125 feet. On the Mogollon Plateau, water from this sandstone is lifted 400 feet.

In the area of extrusive basalt and cinders, aquifers occur at varied depths. Pumped water is used only for domestic and livestock purposes. Along many of the intermittent streams, water can be obtained from shallow wells. This water, however, is strongly saline and is of little use for livestock and of no value for irrigation. A few springs are in the area of extrusive basalt and cinders, but only two supply water for irrigation. These springs are above reservoirs, and their entire flow is stored and released as needed to their irrigation systems.

History

Archeologists say the year 200 A.D. was the most likely time that Indians first settled along the headwaters of the Little Colorado River. The Indians could also have been within the Area at this time. They grew corn, beans, and squash for food. Although primitive, they continually advanced in the arts of building houses, supplying food, and making utensils. Droughts, wars, or diseases caused them to migrate in and out of the Area, and each migration changed their pattern of living.

Many Indian ruins are in the Area, but none have been systematically excavated for archeological study. Only the lower parts of the stone walls remain intact, but these indicate that the habitations contained from 2 to about 60 rooms. Indian villages were usually built along flood plains on terraces, knolls, or buttes.

Spanish conquistadores, the first white men in the Area, found the Apache Indians occupying the land. The conquistadores, traversed the southwest many times in search of gold and glory. Juan de Oñate led a small expedition into the Hopi villages in 1598, and his return trip via El Morro, a national monument in western New Mexico, may have taken him through the area. Other early Spanish expeditions in the Southwest also may have passed this way.

"Old Bill" Williams, a guide, trapper, and explorer, roamed Arizona and the Southwest and probably entered the Area various times between 1830 and 1850.

In 1857, Lt. E. F. Beale led an army expedition from Texas to California to test the use of camels in the American desert. The troop passed along the Little Colorado River and through what later became Holbrook and Winslow.

A few Spanish sheepherders entered and settled in the territory in the late 1860's. They were followed by a few cattle ranchers in the early 1870's.

Trading posts were built at Holbrook in 1870, and at Show Low in 1872. After this, Mormons migrated from Utah to establish permanent settlements in Arizona. Joseph City, the first Mormon settlement, was established in 1876. Woodruff was established in 1877; Linden and Snowflake, in 1878; Pinedale, in 1879; Lakeside and Heber, in 1880; and Pinetop, in 1891. Overgaard was established in 1936 by people who worked in a nearby lumbermill.

Navajo County was established by the Arizona Territorial Legislature in 1895 and had been in existence for 17 years before Arizona was granted statehood in 1912.

Little farming was practiced in the Area before the arrival of the Mormons, who began farming wherever they settled. Irrigated agriculture was part of their heritage and was vital to their survival when they first came to Utah. The Mormons purchased a 300-acre irrigated ranch along Silver Creek in 1878.

When they settled along permanent streams, their first task was constructing dams to divert water onto the soil for irrigation. These dams, which were usually constructed of rocks, soil, and brush, were readily destroyed by floods. The dam at Joseph City, built to divert water from the Little Colorado River, is a good example of the problems involved in maintaining this type of structure. First built in June of 1876, it lasted only 1 month. Almost annual rebuilding was necessary until 1894, when the Mormons succeeded in building a more permanent structure that lasted almost 25 years.

Although permanent streams were a fairly dependable source of irrigation water, the supply from them was not adequate. To increase the area irrigated, farmers first had to increase the amount of water available for irrigation during the growing season. This was accomplished by constructing reservoirs to hold winter runoff for use in summer. Thus, the amount of water that could be diverted into the irrigation canals was more than doubled. The increased quantity of water allowed additional and more frequent irrigation of crops. In additon, enough water was available to increase the number of acres under irrigation. Irrigation is practiced in areas around Joseph City, Snowflake, Taylor, Show Low, Woodruff, Lakeside, and Pinetop.

Several areas on the Mogollon Plateau have no dependable source of water. These are near Linden, Pinedale, Clay Springs, Aripine, and Heber. Dryland farming was introduced in these places. Wheat was grown and converted to flour; beans were grown as a food staple; corn fodder and silage were grown to supplement the supply of winter feed for livestock.

There were difficulties with this type of farming. Droughts often reduced crop yields and occasionally caused crops to fail. Dryland farming was mostly a subsistence operation because the driest part of the year was the time when crops needed moisture most.

Most of the people now in the Holbrook-Show Low Area live in towns and small settlements. Farmers and ranchers are predominantly of the Mormon faith. They generally adhere to the European system of living mainly in towns and settlements and traveling to and from their farms and ranches. The small settlements increased in population until about 1940. Since than many people have moved to the larger towns.

The population for the Area is estimated to have increased from 3,800 in 1900 to about 15,400 in 1950. Unlike many rapidly developing parts of Arizona, the Area has had no new industrial enterprises or developments to swell the population.

Crops

Corn, alfalfa, wheat, oats, barley, and pasture forage are the most common crops now grown under irrigation. The acreage of irrigated pasture has increased in the past 10 years as the result of the use of new species of grasses and legumes. These new plants have increased the production of forage and lengthened the pasture season. Smooth brome and alta fescue are seeded in mixtures with alfalfa and harvested for hay. Irrigated crops are used mainly as supplemental feed for range cattle, but a few farmers use their crops to feed dairy herds.

Cucumbers that are high in sugar are grown extensively under irrigation in the Snowflake-Taylor community. They are trucked to Phoenix for processing. Sweet corn and carrots are being grown on an experimental basis. The increase in population in desert areas around Tucson and Phoenix offers new markets for summer vegetables. Improvement in transportation facilities stimulates the growing of new kinds of crops that may be adapted to the soil, climate, and management practices of the Area.

The main dryland crops are wheat, sorghum, corn silage, oats, and pinto beans.

Livestock

Cattle get most of their feed from grazing the short bunch grasses on the range. They are given supplemental feed consisting of alfalfa hay and cottonseed meal during the calving season and in winter when weather is severe and forage is limited. Cattle have little protection from the weather because they spend most of the time on the range.

The range breeding herd is the foundation of the livestock industry. Calves are the marketable product of the herd. Most calves are taken off the range in the fall, when they are 7 to 8 months old; a few are held over another year. Calves are bought by commercial buyers, or they are consigned to feedlots by the owner. As a rule, they are then moved 150 to 200 miles to parts of the State that have mild winters and are fed grain, silage, and hay to gain weight before they are marketed. An estimated 39,000 cattle and calves were in the Holbrook-Show Low Area in 1954.

Farm dairies are located at Taylor, Snowflake, Holbrook, Joseph City, and Winslow. Most of the milk is processed at the individual dairies and is marketed locally. Little milk is sold outside the Holbrook-Show Low Area. An estimated 754 dairy cows were in the Area in 1954. The number of dairy cows is decreasing because fewer families now own milk stock.

An estimated 46,500 chickens were in the Area in 1954. The production of eggs at Joseph City has steadily increased since 1940 and has proved highly successful. A corporation that grades and markets eggs was formed in 1950 so that a standard product could be sold in volume. Many of the eggs are marketed outside the Area.

Horses are used extensively on cattle ranches. Modern machinery has done little to decrease the demand for cow ponies, which continue to be the favored means of "working" the range cattle. Ranchers may transport their saddle horses from local headquarters to distant, outlying ranches by pickup truck or trailer.

Sheep and swine raising are minor enterprises in the Area.

How Soils are Named, Mapped, and Classified

Soil scientists made this survey to learn what kinds of soils are in the Holbrook-Show Low Area, where they are located, and how they can be used.

They went into the Area knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the rock material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Showlow and Mogollon, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in natural characteristics.

Many soil series contain soils that are alike except for texture of their surface layer. According to this difference in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Showlow clay loam and Showlow sandy loam are two soil types in the Showlow series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Showlow clay loam, 0 to 1 percent slopes, is one of several phases of Showlow clay loam, a soil type that ranges from nearly level to steep.

After a fairly detailed guide for classifying and naming the soils had been made, the soil scientists drew soil boundaries on aerial photographs. They used photos for their base map because they show woodlands, buildings, field borders, trees, and other landmarks that greatly help in drawing boundaries accurately. The detailed soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

Some places in the Area are so rocky, so shallow, or so frequently worked by wind and water that they cannot be called soils. These areas are shown on the soil map like other mapping units, but they are given descriptive names, such as Rock land or Riverwash, and are called land types rather than soils.

Only part of the soil survey was done when the soil scientist had named and described the soil series and mapping units, and had shown the location of the mapping units on the soil map. The mass of detailed information he had recorded then needed to be presented in different ways for different groups of users.

To do this, he had to consult with persons in other fields of work and jointly prepare with them groupings that would be of practical value to different users. Such groupings are the capability classes, subclasses, and units, designed primarily for those interested in producing the short-lived crops and tame pasture, and the classifications used by engineers who build highways or structures to conserve soil and water.

Soils of the Holbrook-Show Low Area

The soils of the Holbrook-Show Low Area differ in many characteristics, including color, texture, consistence, reaction, salinity and alkalinity, relief, stoniness, depth to underlying material, permeability, and drainage. These differences are more easily understood if the soils are grouped according to positions on the landscape. The soil series of the Holbrook-Show Low Area are therefore grouped according to physiographic position as follows: Soils of the uplands; soils of old alluvial fans and terraces; and soils of the flood plains and low alluvial fans.

The principal characteristics of the soil series in the Area are given in table 2.

Soils of the Uplands

The Moenkopie, Chevelon, and Elledge soils developed in place on weathered sedimentary bedrocks. The Moffat, Millard, Showlow, and Claysprings soils developed in Tertiary and Quaternary alluvium. The Springerville, McNary, Paiso, and Sponseller soils formed in material that weathered from basalt or from a mixture of basalt and volcanic cinders.

The Moenkopie soils are shallow to very shallow and developed on Moenkopie sandstone and shale under a semiarid climate. They are reddish-brown fine sandy loam throughout and are strongly calcareous. They support short bunch grass vegetation, and a few stunted junipers occur in small areas.

The Chevelon soils formed from the same parent material as the Moenkopie soils but developed under forest vegetation and in a subhumid climate. They are moderately deep and moderately calcareous and have a loam surface soil and clay loam subsoil.

The Elledge soils developed on light-brown, hard sandstone under pine trees. The soils are noncalcareous throughout and are slightly acid. The surface soil is fine sandy loam that is abruptly underlain with clay subsoil.

The Moffat soils formed in slightly stratified, medium to moderately coarse textured, fluviatile sediment of the Tertiary age. The soils are medium textured and have segregated lime in the subsoil. The vegetation is short bunch grass.

The Millard soils are gravelly throughout. They developed in Tertiary or Quaternary gravel under pinyon pine, juniper, and grass. The thin surface soil is gravelly sandy loam, and the subsoil is gravel to clayey gravel.

The Showlow soils occupy a moderately dissected plain. They are associated with the Millard soils but developed in cobbly gravel of Tertiary age. The topography is nearly level to rolling. The climate is subhumid. Rounded cobbles of quartzite are common throughout the profile. The surface soil is clay loam to sandy loam; the subsoil is clay. Low to high amounts of lime have accumulated in the lower subsoil.

The Claysprings soils occur on Tertiary clay deposits. The surface soil is either clay loam or clay and is underlain by highly calcareous, reddish-brown clay subsoil. The topography is moderately rolling. Pinyon pine and juniper are the typical vegetation of these soils.

The Springerville soils are brown and reddish-brown clay and stony clay that weathered from basalt and volcanic cinders. Hard lime concretions occur throughout the profile. A thin layer of accumulated lime is immediately above the bedrock. The typical vegetation of these soils is cool-season grasses and scattered juniper.

The McNary soils are very similar to the Springerville soils, except that they consist of black clay to a depth of 16 to 28 inches from the surface.

The Paiso soils are shallow to very shallow over basalt. The surface layer is reddish-brown stony clay loam, and the subsoil, a thin layer of stony clay. On drying, these soils do not crack as the Springerville soils do.

The Sponseller soils are noncalcareous throughout. They have numerous stones and cobbles of basalt throughout the profile. Boulders and bedrock of basalt are at a depth of 36 to 42 inches and below. The surface layer is reddish-brown silt loam, and the subsoil, stony clay loam. The soils developed under pine forest and in subhumid climate.

Soils of Old Alluvial Fans and Terraces

Soils of Overgaard, Disterheff, Silver, Zeniff, Clovis, Millett, and Sheppard series occur on old alluvial fans and terraces.

The Overgaard soils developed in moderately course textured alluvium, in subhumid climate, and under pines, Gambel oaks, junipers, and cool-season grasses. They have a moderately coarse textured surface soil and a moderately fine textured subsoil and are noncalcareous throughout.

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TABLE 2.—*The principal characteristics of the*

Series	Parent material	Surface soil		
		Color	Texture	Lime [1] content
Bagley	Alluvium from basalt, volcanic cinders, and sedimentary rocks.	Brown	Clay loam; sandy clay loam; loam.	High
Chevelon	Shale and shaly sandstone	Reddish brown	Loam	High to medium
Claysprings	Lakebed clay	Reddish brown	Clay; clay loam	High
Clovis	Mixed gravelly alluvium	Reddish brown	Sandy loam	None
Disterheff	Alluvium from basalt, volcanic cinders, and sedimentary rocks.	Brown	Clay loam	None
Elledge	Sandstone	Dark gray	Fine sandy loam	None
Heber	Alluvium from limestone and sandstone	Very dark grayish brown.	Fine sandy loam	None to low
Ives	Alluvium from shaly sandstone, badland shale, and sandstone.	Gray to brown	Fine sandy loam	Medium
Jacques	Alluvium from basalt, volcanic cinders, and sedimentary rocks.	Dark grayish brown to brown.	Clay loam; silty clay loam.	None
Jocity	Alluvium from shaly sandstone, badland shale and sandstone.	Reddish gray	Sandy clay loam; silty clay.	Medium
Loamy alluvial land and Sandy alluvial land.	Alluvium from sedimentary rock	Reddish brown	Silt loam to loamy sand.	Medium
McNary	Basalt and volcanic cinders	Black to dark gray	Clay	None
Millard	Mixed gravel	Dark brown to brown	Gravelly sandy loam	None
Millett	Mixed gravel	Reddish gray; reddish brown.	Gravelly sandy loam	None
Moenkopie	Shaly sandstone and shale	Reddish brown	Fine sandy loam	Medium
Moffat	Old, stratified mixed alluvium	Reddish brown	Sandy loam	Medium
Mogollon	Alluvium from basalt, volcanic cinders, and sedimentary rock.	Brown	Fine sandy loam	Low
Navajo	Alluvium from shaly sandstone and badland shale.	Reddish brown	Clay; silty clay loam; loam.	Medium
Overgaard	Old alluvium from beds of sand and gravel, basalt, and sedimentary rock.	Grayish brown	Fine sandy loam	None
Paiso	Basalt and volcanic cinders	Grayish brown; reddish gray.	Stony clay loam	None
Pinetop	Alluvium from basalt, volcanic cinders, and sedimentary rock.	Very dark brown	Fine sandy loam	None
Redfield	Alluvium from sandstone and shale	Reddish brown	Very fine sandy loam; sandy loam.	Medium
Sheppard	Windblown sand	Reddish brown	Loamy sand	Medium
Showlow	Old cobbly sand and gravel	Brown to reddish brown.	Clay loam to sandy loam.	None
Silver	Mixed clayey, gravelly alluvium	Grayish brown	Clay	None to low
Sponseller	Basalt and volcanic cinders	Reddish brown	Silt loam; loam	None
Springerville	Basalt and volcanic cinders	Brown to reddish brown.	Clay	None
Tours	Alluvium from shaly sandstone and shale.	Reddish brown	Clay loam	Medium
Trail	Alluvium from sandstone and shaly sandstone.	Reddish brown	Loamy fine sand	Medium
Wet alluvial land	Alluvium from sedimentary rock	Gray	Clay loam	High
Zeniff	Mixed medium-textured alluvium	Brown to reddish brown.	Loam; fine sandy loam	None

[1] "Low, medium, and high" are the relative amounts of lime contained in the surface soil or subsoil. A range in lime content indicates that the amount of lime differs within the layer. For example, "none to high" in the subsoil means that the upper subsoil has no lime, whereas the lower subsoil has accumulated lime.

soil series of the Holbrook-Show Low Area, Ariz.

Subsoil			Position	Topography	Dominant vegetation
Color	Texture	Lime [1] content			
Brown	Clay; clay loam; sandy clay loam.	High	Flood plain	Level to gently sloping.	Grass and pinyon-juniper.
Reddish brown	Clay loam; silty clay loam.	High to medium	Upland	Gently to moderately sloping.	Coniferous forest.
Reddish brown	Clay	High	Upland	Gently to steeply rolling.	Mature pinyon-juniper.
Reddish brown	Sandy clay loam; loam.	None to high	Terrace	Level to moderately sloping.	Pinyon-juniper and grass.
Reddish brown and gray.	Clay	None to high	Old alluvial fan	Level to gently sloping.	Coniferous forest.
Brown, red, yellow	Clay	None	Upland	Gently to strongly sloping.	Coniferous forest.
Very dark grayish brown.	Fine sandy loam	Low	Flood plain	Level to gently sloping.	Coniferous forest.
Gray to brown	Fine sandy loam; sandy clay loam.	Medium	Alluvial fan	Gently sloping	Grass and shrubs.
Very dark grayish brown.	Silty clay loam	None to low	Flood plain and alluvial fan.	Gently to moderately sloping.	Coniferous forest.
Reddish gray	Sandy clay loam; clay loam.	Medium	Flood plain and alluvial fan.	Level to moderately sloping.	Grass and shrubs.
Light reddish brown	Clay to loamy fine sand.	Medium	Flood plain	Level to gently undulating.	Grass and shrubs.
Black to reddish brown.	Clay	None to medium.	Upland plain	Level	Mountain grassland.
Red to reddish brown.	Gravelly clay; gravelly sandy clay loam; gravelly sand.	None to low	Upland plain	Gently to strongly sloping.	Pinyon-juniper and grass.
Reddish brown, brown, and pinkish gray.	Gravelly loam; gravel.	None to high	Terrace	Gently to steeply rolling.	Grass and pinyon-juniper.
Reddish brown	Fine sandy loam; clay loam.	Medium to high.	Upland	Gently to moderately rolling.	Grass.
Reddish brown	Sandy clay loam	High	Upland plain	Gently to moderately sloping.	Grass.
Brown	Sandy clay loam	Low to medium	Flood plain	Level to gently sloping.	Pinyon-juniper and grass.
Reddish brown	Clay	Medium	Flood plain	Level	Grass and shrubs.
Very dark brown to brown.	Sandy clay loam; sandy clay.	None	Terrace	Level to gently sloping.	Coniferous forest with oak.
Reddish brown	Stony clay	None to high	Upland plain	Gently to strongly sloping.	Mixed mountain grassland and forest.
Brown	Loam; fine sandy loam; loamy sand.	None	Flood plain	Gently sloping	Coniferous forest.
Reddish brown	Very fine sandy loam; loam.	Medium	Alluvial fan	Level to moderately sloping.	Grass.
Pale brown	Sand	Medium	Terrace	Level to strongly sloping.	Grass and shrubs.
Reddish brown	Clay	None to high	Rolling to dissected upland plain.	Level to steeply rolling.	Coniferous forest.
Grayish brown; pale brown.	Clay; silty clay loam	Medium to high	High terrace	Gently to moderately sloping.	Grass and pinyon-juniper.
Reddish brown	Clay loam	None	Upland plain	Level to gently sloping.	Coniferous forest.
Reddish gray to reddish brown.	Clay	None to high	Upland plain	Level to gently sloping.	Mountain grasses.
Reddish brown	Clay loam	Medium	Flood plain	Level to gently sloping.	Grass.
Reddish brown	Loamy fine sand	Medium	Alluvial fan	Level to moderately sloping.	Grass.
Red, gray, yellow, and black.	Clay to sand and rock.	High	Flood plain	Level	Wet salt marsh.[2]
Brown to reddish brown.	Sandy clay loam; silty clay loam.	None to low	Old alluvial fan	Level to moderately sloping.	Coniferous forest.

[2] Vegetation consists of sedges, rushes, grasses, and shrubs that tolerate wet, saline soils.

The Disterheff soils developed in moderately coarse textured alluvium that washed from basalt, volcanic cinders, sedimentary rocks, sand, and gravel. They occur in subhumid climate and under pines, junipers, Gambel oaks, and cool-season grasses. Slopes are nearly level to gentle and smooth.

The Silver soils developed under grass and in semiarid climate. The parent material is calcareous, medium-textured to gravelly alluvium. The surface soil and subsoil are clay, and a zone of accumulated lime occurs in the lower subsoil.

The Zeniff soils developed in medium-textured alluvium, under coniferous forests, and in subhumid climate. They are noncalcareous throughout. The surface soil is medium textured; the subsoil, moderately fine textured.

The Clovis soils are on fairly smooth to sloping terraces along Silver Creek. They developed in moderately coarse textured, gravelly alluvium, under grass and juniper trees, and in the semiarid zone. They have a thin, loamy surface soil and a moderately fine textured subsoil. A zone of lime is in the lower subsoil.

The Millett soils are gravelly throughout and are associated with the Clovis soils. The Millett soils, however, are on higher positions on the dissected, gravelly, moderately sloping to steeply rolling terraces. The soils occur in semiarid climate and under grass and juniper.

The Sheppard soils have rolling and dunelike topography. They occur in a semiarid climate and under short-grass vegetation. The parent material is wind-deposited, reddish-brown and pale-brown sand and loamy sand.

Soils of the Flood Plains and Low Alluvial Fans

Soils of the Ives, Jocity, Navajo, Redfield, Trail, Tours, Bagley, Mogollon, Heber, Jacques, and Pinetop series are on flood plains and low alluvial fans.

The Ives soils are medium textured and have some moderately coarse textured strata in the subsoil. They consist of material that washed mainly from Chinle shale and sandstone. They contain small amounts of alkali and are grayish pink and reddish brown.

The Jocity soils are much like the Ives soils, except that they have moderately fine texture.

The Navajo, Redfield, Trail, and Tours soils consist of sediments that washed from sedimentary rock, from Tertiary and Quaternary sand, and from gravel, basalt, and cinders. The sediments differ mainly in texture. Those that washed from the Moenkopi formation have the greatest influence in the development of these soils. The Navajo soils are clay throughout; the Tours are clay loam and silty clay loam; the Redfield are loam and very fine sandy loam; and the Trail are fine sandy loam to loamy fine sand. In places the Navajo, Tours, Redfield, and Trail soils have a high water table, which affects the saline-alkali condition in these soils.

The Bagley and Mogollon soils occur in both semiarid and subhumid zones. The Bagley soils are moderately fine textured, whereas the Mogollon are predominantly medium textured. Both kinds of soils are brown and contain no salts or alkali. The parent material of the Bagley and Mogollon soils washed from several kinds of sedimentary and igneous rocks that contained some sand and gravel.

The Heber, Jacques, and Pinetop soils occur in an area of forest and under subhumid climate. The Heber soils consist of sediment that washed from the Kaibab formation. They are dark gray to light brown and medium to moderately coarse textured.

The parent material of the Jacques soils washed from basalt and volcanic cinders, sandstone, shale, and Tertiary sand and gravel. The soils are dark gray and moderately fine textured.

The Pinetop soils have moderately rapid permeability and are medium to moderately coarse textured, imperfectly drained, and noncalcareous. The parent material washed from basalt and volcanic cinders that contained some material from sandstone and shale and from Tertiary sand and gravel.

Descriptions of the Soils

In this report, the soils are described in approximate alphabetic order. Their acreage and proportionate extent are shown in table 3, and their location can be seen on the detailed map at the back of the report.

The soil series are described first, and after each series, the soils of that series that are mapped in the Area. An important part of each soil description is the soil profile, a record of what the soil scientist saw and learned when he dug into the ground. Since all the soils in one series have essentially the same profile, except for possible differences in texture of the surface layer, it is not necessary to describe the profile of every soil. The profile is therefore described for the first soil of each major type. The reader can assume that all the other soils of one type have essentially the same kind of profile. For example, a detailed profile is described for Bagley clay loam, 0 to 1 percent slopes, and the reader is to conclude that all the Bagley clay loams mapped have essentially this kind of profile. The differences, if any, are indicated in the soil name or are mentioned in describing the particular soil.

The profile description is in smaller type than the rest of the description of the soil. Those who want to have only a working knowledge of the soil and its management need read only the part set in larger type.

The *texture* of the soil refers to the content of sand, silt, and clay. It is determined by the way the soil feels when rubbed between the fingers, and it is checked by laboratory analyses. Each mapping unit is identified by a textural name, such as "fine sandy loam." This refers to the texture of the surface layer.

Structure is indicated by the way the individual soil particles are arranged in large grains, or aggregates, and the amount of pore space between the grains. The structure of the soil is determined by the strength or grade, the size, and the shape of the aggregates. For example, a horizon may have "weak, fine, blocky structure."

Consistence refers to the feel of the soil when wet, moist, or dry.

Calcareous refers to the presence of free lime in each horizon. The intensity of soil acidity or alkalinity is expressed in pH—the logarithm of the reciprocal of the H-ion concentration. In this part of the report, pH was determined on soil-water paste.

Soil color is related to the amount of organic matter, to the different oxides of iron, and to the amount of lime

that has accumulated. Darkness of the surface layer is generally governed by the amount of organic matter. Red and brown in the subsoil are oxides of iron; pink, light red, light brown, and white are the result of lime accumulations. Streaks or spots of gray, yellow, red, brown, or blue in the deep layers of the profile indicate poor natural drainage and poor aeration. Unless otherwise indicated, colors given in the soil descriptions are those when the soil is dry.

Other features, such as pores, clay coatings, and insect activity, are also described.

The capability unit or units in which each soil in the Area have been placed is stated at the end of each soil description. Soils suitable for dry farming are in capability classes III and IV and have the letter "D" in parentheses in their capability unit designations. These soils can also be used for range. Soils mainly suitable for range are in capability classes V, VI, and VII. Some soils in capability classes III, IV, V, VI, and VII, however, have a source of water available and can be used safely for irrigation farming. These soils, where water can be obtained, are given an additional capability classification, generally higher, that is identified by the letters "Ir" in parentheses following the capability unit designation.

The technical descriptions of soil profiles are given in the section "Genesis, Classification, and Morphology of the Soils," to which readers are referred who desire more detailed descriptions and laboratory analyses of soil profiles. In this technical section, soil color is described by use of Munsell notations.

Bagley series

Soils of the Bagley series occupy nearly level to gently sloping flood plains on the Mogollon Plateau, near Snowflake, Taylor, and Shumway. They are associated mainly with the Mogollon, Tours, Millett, Moenkopie, and Showlow soils.

The Bagley soils have formed in alluvium derived mainly from sandstone, limestone, shale, basalt, volcanic cinders, sand, and gravel. The vegetation is blue grama, sand dropseed, western wheatgrass, and a few scattered juniper, black sagebrush, and ponderosa pine. Elevations range from 5,600 to 6,500 feet. Most of the soils are in semiarid climate; a few small areas are in subhumid climate. The average annual precipitation is 13 to 19 inches. Snowfall is 12 to 30 inches per year.

The Bagley soils are brown or light brown and calcareous throughout. In most places the surface soil is clay loam; in others it is loam or sandy clay loam. The subsoil ranges in texture from sandy clay loam to light clay and is typically underlain by loam to depths of more than 60 inches.

The Bagley soils are among the most fertile and productive in the Area. They are well drained, are moderately permeable, and have a high water-holding capacity. Runoff is very slow to slow. All except the Bagley loam have an extremely stable, granular structure in the surface soil and do not erode easily.

The Bagley soils are used for dryland and irrigated farming and for grazing.

Bagley clay loam, 0 to 1 percent slopes (BaA).—One large area of this soil is west of Silver Creek surrounding the townsite of Snowflake. The rest of the soil is in long, narrow bands on the flood plain of Silver Creek.

Representative profile:

0 to 9 inches, brown clay loam; moderate, granular structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.5); strongly calcareous; abundant roots.

9 to 24 inches, brown clay loam to light clay; strong subangular or angular blocky structures; hard when dry, friable when moist, sticky and plastic when wet; mildly alkaline (pH 7.7); strongly calcareous; abundant roots.

24 to 39 inches, brown clay loam to light clay; moderate, subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; mildly alkaline (pH 7.8); strongly calcareous; abundant roots.

39 to 64 inches, brown loam; moderate, prismatic structure breaking to moderate, subangular blocky; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.8); strongly calcareous; few roots.

Natural drainage is good, runoff is very slow, and the erosion hazard is slight. Root penetration is deep. The available water-holding capacity is high. Permeability is moderate.

The soil is used mainly for irrigated farming, in which alfalfa, corn for silage, oats, wheat, barley, mixed pasture, cucumbers, and sweet corn are grown. Little grazing is done.

This soil is moderately fertile and is one of the highest producing soils in the area. It recovers rapidly from tillage pans and puddling. Special management practices are not needed to control erosion. *Capability units I–1(Ir) and VIc–1.*

Bagley clay loam, 1 to 3 percent slopes (BaB).—This soil occurs near Snowflake, Taylor, and Shumway and occupies long, narrow, gentle slopes at the edges of the flood plain next to the upland. Except for steeper slopes and slightly greater runoff, it is similar to Bagley clay loam, 0 to 1 percent slopes. The two soils are used in the same way.

When this soil is irrigated, proper control of irrigation water is needed to prevent excessive losses of soil and water. *Capability units IIe–1(Ir) and VIc–1.*

Bagley clay loam, high rainfall, 0 to 1 percent slopes (BhA).—This soil occurs near Clay Springs. It is similar to Bagley clay loam, 0 to 1 percent slopes, except that it occurs in subhumid climate instead of the semiarid climate characteristic of the Bagley series. The annual precipitation is 17 to 19 inches and is adequate for dryland farming. The frost-free period is 118 to 125 days.

Winter wheat and grain sorghum are the adapted crops. Rough tillage and stubble mulching increase the infiltration and storage of moisture. Areas of this soil are not of the right size or slope for contouring or terracing. *Capability unit IIIc–2(D).*

Bagley clay loam, high rainfall, 1 to 3 percent slopes (BhB).—This soil occurs on the Mogollon Plateau along intermittent streams. It is similar to Bagley clay loam, high rainfall, 0 to 1 percent slopes, except that it occurs on steeper slopes and has slightly greater runoff.

The soil is used for dryfarming and for grazing. The adapted crops are winter wheat and grain sorghum. Rough tillage, stubble mulching, and contouring are needed to conserve soil and moisture. *Capability unit IIIc–2(D).*

TABLE 3.—*Acreage and proportionate extent of soils mapped in Holbrook-Show Low Area, Ariz.*

Soil	Area mapped	Proportionate extent	Soil	Area mapped	Proportionate extent
	Acres	*Percent*		*Acres*	*Percent*
Bagley clay loam, 0 to 1 percent slopes	1, 322	1. 3	Moenkopie fine sandy loam, 1 to 3 percent slopes	1, 938	1. 9
Bagley clay loam, 1 to 3 percent slopes	173	. 2	Moenkopie fine sandy loam, 3 to 5 percent slopes	1, 661	1. 6
Bagley clay loam, high rainfall, 0 to 1 percent slopes	61	. 1	Moenkopie fine sandy loam, very shallow, 1 to 3 percent slopes	1, 293	1. 3
Bagley clay loam, high rainfall, 1 to 3 percent slopes	182	. 2	Moenkopie fine sandy loam, very shallow, 3 to 10 percent slopes	4, 109	4. 1
Bagley sandy clay loam, 0 to 1 percent slopes	319	. 3	Moffat sandy loam, 1 to 3 percent slopes	100	. 1
Bagley sandy clay loam, 1 to 3 percent slopes	136	. 1	Moffat sandy loam, 3 to 5 percent slopes	338	. 3
Bagley loam, 1 to 3 percent slopes	285	. 3	Mogollon fine sandy loam, 0 to 1 percent slopes	1, 241	1. 2
Chevelon loam, colluvial variant, 1 to 3 percent slopes	76	. 1	Mogollon fine sandy loam, 1 to 3 percent slopes	302	. 3
Chevelon loam, colluvial variant, 3 to 5 percent slopes	287	. 3	Mogollon fine sandy loam, high rainfall, 1 to 3 percent slopes	320	. 3
Chevelon loam, 1 to 3 percent slopes	186	. 2	Navajo clay, 0 to 1 percent slopes	991	1. 0
Chevelon loam, 3 to 5 percent slopes	1, 162	1. 1	Navajo clay, moderately saline-alkali, 0 to 1 percent slopes	3, 237	3. 2
Chevelon loam, 5 to 10 percent slopes	87	. 1	Navajo clay, moderately saline-alkali, 1 to 3 percent slopes	444	. 4
Claysprings clay, 1 to 3 percent slopes	66	. 1	Navajo clay, poorly drained variant, slightly saline, 0 to 1 percent slopes	797	. 8
Claysprings clay, 3 to 5 percent slopes	261	. 3	Navajo clay, shallow over loam, moderately saline, 0 to 1 percent slopes	70	. 1
Claysprings clay, 5 to 20 percent slopes	61	. 1	Navajo loam, moderately saline, 0 to 1 percent slopes	245	. 2
Claysprings clay loam, 3 to 5 percent slopes	196	. 2	Navajo clay loam, strongly saline-alkali, 0 to 1 percent slopes	630	. 6
Claysprings clay loam, 5 to 20 percent slopes	170	. 2	Navajo clay, shallow over sand, moderately saline, 0 to 1 percent slopes	116	. 1
Clovis sandy loam, 0 to 1 percent slopes	443	. 4	Overgaard fine sandy loam, 0 to 1 percent slopes	44	(1)
Clovis sandy loam, 1 to 3 percent slopes	2, 431	2. 4	Overgaard fine sandy loam, 1 to 3 percent slopes	474	. 5
Clovis sandy loam, 3 to 5 percent slopes	974	1. 0	Paiso stony clay loam, shallow, 1 to 3 percent slopes	2, 201	2. 2
Disterheff clay loam, 0 to 1 percent slopes	142	. 1	Paiso stony clay loam, shallow, 3 to 5 percent slopes	509	. 5
Disterheff clay loam, 1 to 3 percent slopes	549	. 5	Paiso stony clay loam, shallow, 5 to 10 percent slopes	1, 317	1. 3
Dune land, loamy	52	. 1	Pinetop fine sandy loam, 1 to 3 percent slopes	211	. 2
Dune land, sandy	506	. 5	Redfield sandy loam, 1 to 3 percent slopes	250	. 2
Elledge fine sandy loam, deep, 1 to 3 percent slopes	530	. 5	Redfield sandy loam, 3 to 5 percent slopes	137	. 1
Elledge fine sandy loam, deep, 3 to 5 percent slopes	417	. 4	Redfield very fine sandy loam, 0 to 1 percent slopes	214	. 2
Elledge fine sandy loam, 1 to 3 percent slopes	421	. 4	Redfield very fine sandy loam, 1 to 3 percent slopes	2, 138	2. 1
Elledge fine sandy loam, 3 to 5 percent slopes	413	. 4	Redfield very fine sandy loam, 3 to 5 percent slopes	142	. 1
Elledge fine sandy loam, 5 to 10 percent slopes	131	. 1	Riverwash	3, 186	3. 2
Elledge stony fine sandy loam, 3 to 5 percent slopes	567	. 6	Rock land, basalt	1, 299	1. 3
Elledge stony fine sandy loam, 5 to 10 percent slopes	452	. 4	Rock land, limestone	1, 338	1. 3
Heber fine sandy loam, 0 to 1 percent slopes	364	. 4	Rock land, sandstone	3, 454	3. 4
Heber fine sandy loam, 1 to 3 percent slopes	200	. 2	Rock land, shale and sandstone	4, 370	4. 3
Heber loamy fine sand, 0 to 1 percent slopes	136	. 1	Sandy alluvial land	635	. 6
Heber loamy fine sand, 1 to 3 percent slopes	393	. 4	Sandy alluvial land, strongly saline	710	. 7
Ives fine sandy loam, slightly alkali, 1 to 3 percent slopes	78	. 1	Sandy alluvial land, moderately saline	1, 012	1. 0
Jacques clay loam, 1 to 3 percent slopes	568	. 6	Sheppard fine sand, 3 to 10 percent slopes	421	. 4
Jacques clay loam, 3 to 5 percent slopes	101	. 1	Showlow clay loam, 0 to 1 percent slopes	70	. 1
Jocity sandy clay loam, slightly alkali, 1 to 3 percent slopes	1, 269	1. 3	Showlow clay loam, 1 to 3 percent slopes	1, 389	1. 4
Jocity sandy clay loam, slightly alkali, 3 to 5 percent slopes	220	. 2	Showlow clay loam, 3 to 5 percent slopes	1, 173	1. 2
Jocity silty clay, 0 to 1 percent slopes	127	. 1	Showlow clay loam, 5 to 20 percent slopes	1, 913	1. 9
Jocity silty clay, slightly alkali, 0 to 1 percent slopes	449	. 4	Showlow cobbly sandy clay loam, 1 to 3 percent slopes	289	. 3
Jocity silty clay, slightly alkali, 1 to 3 percent slopes	369	. 4	Showlow cobbly sandy clay loam, 3 to 5 percent slopes	1, 240	1. 2
Loamy alluvial land	409	. 4	Showlow cobbly sandy clay loam, 5 to 20 percent slopes	3, 330	3. 3
Loamy alluvial land, strongly saline	699	. 7	Showlow loam, 0 to 1 percent slopes	160	. 2
Loamy alluvial land, moderately saline-alkali	1, 868	1. 8	Showlow loam, 1 to 3 percent slopes	2, 121	2. 1
McNary clay, 0 to 1 percent slopes	101	. 1	Showlow loam, 3 to 5 percent slopes	1, 985	2. 0
Millard gravelly sandy loam, 1 to 3 percent slopes	652	. 6			
Millard gravelly sandy loam, 3 to 10 percent slopes	1, 429	1. 4			
Millett gravelly loamy sand, 1 to 3 percent slopes	150	. 1			
Millett gravelly loamy sand, 3 to 5 percent slopes	497	. 5			
Millett gravelly loamy sand, 5 to 20 percent slopes	1, 361	1. 3			

See footnote at end of table.

TABLE 3.—*Acreage and proportionate extent of soils mapped in Holbrook-Show Low Area, Ariz.*—Continued

Soil	Area mapped	Proportionate extent	Soil	Area mapped	Proportionate extent
	Acres	*Percent*		*Acres*	*Percent*
Showlow loam, 5 to 20 percent slopes	2, 202	2. 2	Tours clay loam, moderately saline-alkali, 0 to 1 percent slopes	1, 318	1. 3
Showlow sandy loam, 5 to 20 percent slopes	189	. 2	Tours clay loam, deep over loam, moderately saline-alkali, 0 to 1 percent slopes	317	. 3
Showlow sandy loam, 1 to 3 percent slopes	724	. 7	Trail loamy fine sand, 0 to 1 percent slopes	153	. 2
Showlow sandy loam, 3 to 5 percent slopes	177	. 2	Trail loamy fine sand, 1 to 3 percent slopes	136	. 1
Silver clay, 1 to 3 percent slopes	593	. 6	Trail loamy fine sand, 3 to 5 percent slopes	88	. 1
Silver clay, 3 to 5 percent slopes	45	(1)	Trail fine sandy loam, 0 to 1 percent slopes	331	. 3
Sponseller silt loam, 0 to 1 percent slopes	74	. 1	Trail fine sandy loam, 1 to 3 percent slopes	113	. 1
Sponseller silt loam, 1 to 3 percent slopes	174	. 2	Trail fine sandy loam, shallow over gravel, 0 to 1 percent slopes	160	. 2
Sponseller gravelly loam, 1 to 3 percent slopes	325	. 3	Wet alluvial land	476	. 5
Sponseller gravelly loam, 5 to 10 percent slopes	34	(1)	Zeniff fine sandy loam, 0 to 1 percent slopes	1, 188	1. 2
Springerville clay, 0 to 1 percent slopes	294	. 3	Zeniff fine sandy loam, 1 to 3 percent slopes	1, 850	1. 8
Springerville clay, 1 to 3 percent slopes	503	. 5	Zeniff fine sandy loam, 3 to 5 percent slopes	121	. 1
Springerville stony clay, 0 to 1 percent slopes	958	. 9	Zeniff fine sandy loam, 5 to 10 percent slopes	210	. 2
Springerville stony clay, 1 to 3 percent slopes	634	. 6	Zeniff loam, 0 to 1 percent slopes	1, 565	1. 5
Terrace escarpments, loamy	56	. 1	Zeniff loam, 1 to 3 percent slopes	765	. 8
Terrace escarpments, sandy	600	. 6	Zeniff loam, 3 to 5 percent slopes	301	. 3
Tours clay loam, deep over clay, 0 to 1 percent slopes	92	. 1	Total	101, 196	100. 0
Tours clay loam, 0 to 1 percent slopes	2, 735	2. 7			
Tours clay loam, 1 to 3 percent slopes	1, 489	1. 5			
Tours clay loam, 3 to 5 percent slopes	144	. 1			

[1] Less than 0.1 percent.

Bagley sandy clay loam, 0 to 1 percent slopes (BsA).—This soil is on nearly level slopes of the Silver Creek flood plain. It is sandy clay loam to a depth of 34 to 42 inches, and loam below this. The sandy clay loam surface soil consists of materials that were washed from the adjacent Moenkopie fine sandy loam soils of the upland and mixed with the finer textured sediment carried by floodwaters of the main stream.

All of this soil is irrigated. Alfalfa, corn for silage, oats, wheat, barley, mixed pasture, cucumbers, and sweet corn are the principal crops. Yields are high. Because this soil warms up earlier, crops can be planted on it earlier in the spring than on the finer textured Bagley soils. For this reason Bagley sandy clay loam, 0 to 1 percent slopes, is preferred to the Bagley clay loams for truck crops. Special management practices are not needed to control erosion. *Capability units I–1(Ir) and VIc–1.*

Bagley sandy clay loam, 1 to 3 percent slopes (BsB).—This soil is near Shumway and occupies gentle slopes in the narrow part of the valley on the flood plain of Silver Creek. Except for stronger slopes and slightly greater runoff, it is similar to Bagley sandy clay loam, 0 to 1 percent slopes.

All of this soil is irrigated. More of this soil is in pasture than of Bagley sandy clay loam, 0 to 1 percent slopes. Crops and yields, however, are similar. Proper control of irrigation water is needed to reduce soil and water losses. *Capability units IIe–1(Ir) and VIc–1.*

Bagley loam, 1 to 3 percent slopes (BmB).—This soil is southwest of Clay Springs. The surface layer to a depth of 8 to 12 inches is massive loam that washed from nearby soils. Below a depth of 12 inches, this soil is similar to Bagley clay loam, 0 to 1 percent slopes.

Bagley loam, 1 to 3 percent slopes, is used only for dry-farming and grazing. Corn, winter wheat, and pinto beans are grown. Much of the soil that was formerly cultivated is now in range. The yields of forage and crops are low.

Runoff can develop quickly during torrential summer storms and is a problem. Stubble mulching, rough tillage, and contour cultivation help to reduce losses of soil and water when this soil is dry-farmed. *Capability unit IIIc–2(D).*

Chevelon series

The Chevelon soils are on the gently to strongly sloping uplands of the Mogollon Plateau. They are associated with the Showlow, Elledge, Claysprings, and Zeniff soils. The Chevelon soils developed from weathered calcareous sandy shale containing strata of gypsum. The native vegetation is ponderosa and pinyon pines, juniper, blue grama, side-oats grama, and mountain muhly. The Chevelon soils are at elevations of 6,300 to 6,500 feet. The climate is subhumid. The annual precipitation is 17 to 19 inches. Snowfall is 46 to 49 inches per year. The frost-free period is about 125 days.

The Chevelon soils are reddish brown and in most places are calcareous throughout. The surface soil is loam, and the subsoil is heavy loam or clay loam. Sandy shale bedrock of the Moenkopi formation is at a depth of more than 15 inches from the surface. The Chevelon soils are well drained and are moderately permeable to moderately slowly permeable. The water-holding capacity ranges from low to high, depending on depth of the soil. Runoff is slow on the nearly level, deeper soils and rapid on the steep, shallower soils.

The Chevelon soils are used for dryland farming, grazing, and forestry.

Chevelon loam, 3 to 5 percent slopes (CaC).—This shallow to moderately deep soil occurs mainly on long, smooth slopes.

Representative profile:

0 to 3 inches, reddish-brown very fine sandy loam; moderate, platy structure; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.8); moderately to strongly calcareous.
3 to 10 inches, reddish-brown loam; weak, prismatic and platy structure; hard when dry, friable when moist, nonplastic and nonsticky when wet; moderately alkaline (pH 8.2); strongly calcareous.
10 to 15 inches, reddish-brown clay loam; strong, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately alkaline (pH 8.2); strongly calcareous.
15 to 25 inches, reddish-brown clay loam; strong, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately alkaline (pH 8.4); strongly calcareous; prominent splotches of lime.
25 inches +, soft, reddish-brown sandy shale, partially decomposed.

Sandy shale is 15 to 28 inches from the surface. In places where the subsoil formed from sandstone, it is a heavy loam.

Natural drainage is good, and runoff is medium. The surface soil is moderately permeable; the subsoil is moderately slowly permeable. The available water-holding capacity is low. Root penetration is shallow to moderately deep. There is a moderate erosion hazard.

This soil is used for dryland farming and for spring, summer, and early fall grazing. The grass cover is moderately dense and is predominantly blue grama and western wheatgrass. Forage yields are low to fair. Dryland crops are winter wheat and corn for silage. The soil is droughty and low in fertility. Many areas formerly cultivated are now idle, are reverting to native grasses, and are used for grazing.

During summer storms, the soil does not absorb rainfall as rapidly as it falls; consequently, runoff develops quickly and causes excessive sheet erosion. Stubble mulching, rough tillage, and contour cultivation should be practiced to help reduce soil and water losses. The low water-holding capacity is a special problem because all the moisture that falls in winter and summer is needed to grow the summer-annual crops. *Capability unit IVe-3(D)*.

Chevelon loam, 1 to 3 percent slopes (CaB).—This soil is similar to Chevelon loam, 3 to 5 percent slopes, but it has gentle slopes and the underlying shale is at a depth of 27 to 30 inches. Runoff is slow, and the erosion hazard is slight.

Most of this soil is dry-farmed; the rest is used for spring, summer, and fall grazing. Forage yields are low to fair. Dryland crops are winter wheat and corn for silage. Yields of these crops are slightly higher than from Chevelon loam, 3 to 5 percent slopes. *Capability unit IVs-1(D)*.

Chevelon loam, 5 to 10 percent slopes (CaD).—This soil occupies small breaks and is also at the bases of shale buttes. Except for slopes, the soil is like Chevelon loam, 3 to 5 percent slopes. It occurs in only a few small areas, some of which have rock outcrops. Shale bedrock is at a depth of 15 to 22 inches. Runoff is rapid, and the erosion hazard is severe.

None of this soil is cultivated. It is used for grazing in spring, in summer, and early in fall. Forage yields are low. Forestry is the best use. *Capability unit VIe-2*.

Chevelon loam, colluvial variant, 3 to 5 percent slopes (CbC).—This soil is on long, smooth slopes below the Elledge and Showlow soils. It has developed from reworked material derived from the Moenkopi formation. The typical Chevelon soils, however, developed in place on this formation.

Representative profile:

0 to 7 inches, reddish-brown loam; moderate, platy structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.8); strongly calcareous; plentiful roots.
7 to 40 inches, reddish-brown clay loam; strong, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; moderately alkaline (pH 7.9); strongly calcareous; plentiful roots.
40 to 60 inches, reddish-brown, heavy clay loam; strong, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; moderately alkaline (pH 7.9); strongly to very strongly calcareous; distinct lime splotches; few roots.
60 to 70 inches +, reddish-brown to light reddish-brown loam; weak, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately alkaline (pH 8.2); strongly calcareous.

Two miles east of Pinedale there is a small area with a slope of 9 percent that is included in mapping this soil.

Natural drainage of Chevelon loam, colluvial variant 3 to 5 percent slopes, is good. Runoff is medium, and the hazard of erosion is moderate. Permeability is moderate in the surface soil and moderately slow in the subsoil. Root penetration is deep. The soil is moderately fertile and has a high available water-holding capacity.

This soil is used for forestry, dryland farming, and spring, summer, and early fall grazing. Dryland crops are winter wheat and corn for silage. Several areas that were previously farmed are revegetating to native plants and are now used for grazing.

This soil is low in productivity. Runoff and erosion are problems. Stubble mulching, rough tillage, and contour cultivation are needed to reduce soil and water losses in dry-farmed areas. *Capability unit IVe-3(D)*.

Chevelon loam, colluvial variant, 1 to 3 percent slopes (CbB).—This soil is similar to Chevelon loam, colluvial variant, 3 to 5 percent slopes, but has gentler slopes and less active erosion. The soil is limited in extent. It occurs on long, narrow areas in small swales. These areas are usually too small to farm as separate fields. Runoff is slow, and the hazard of erosion is slight.

Except for one small area, this soil borders Rock land and is not cultivated. Grazing is its principal use. *Capability unit IIIc-1(D)*.

Claysprings series

The Claysprings series consists of nearly level to steep soils that are forming in very deep Tertiary or Quaternary clay beds. The Claysprings soils occur near Burton, Linden, Pinedale, and Clay Springs and are associated with the Showlow, Millard, Zeniff, and Bagley soils. The vegetation is juniper, pinyon pine, oak brush, blue grama, and western wheatgrass. Elevations range from about 6,200 to 6,500 feet. The climate is subhumid. The annual precipitation is 16 to 19 inches; the frost-free season is about 130 days. Snowfall ranges from 72 to 78 inches per year.

The Claysprings soils are reddish brown and calcareous throughout the profile. They have clay loam or clay surface soil and clay subsoil. A few areas contain small

waterworn pebbles. In places splotches of lime are in the subsoil. The soils are well drained, are slowly permeable to very slowly permeable, and have a good water-holding capacity. Runoff ranges from slow to rapid, depending upon slope and cover.

The Claysprings soils are used mainly for grazing.

Claysprings clay, 3 to 5 percent slopes (CcC).—This soil has smooth slopes that are dissected in a few places by shallow drainageways. It occurs near Clay Springs and Pinedale and is below the steeper Claysprings soils.

Representative profile:

0 to 2 inches, reddish-brown clay; moderate, granular structure; hard when dry, firm when moist, sticky and very plastic when wet; mildly alkaline (pH 7.8); strongly calcareous.
2 to 9 inches, reddish-brown clay; moderate, prismatic structure breaking to strong, angular blocky; extremely hard when dry, extremely firm when moist, sticky and very plastic when wet; moderately alkaline (pH 7.9).
9 to 60 inches +, reddish-brown clay; strong, angular blocky structure; extremely hard when dry, extremely firm when moist, sticky and very plastic when wet; mildly alkaline (pH 7.7); few, faint lime splotches.

Lime mottles are numerous and distinct in some places but are absent in others. This soil is well drained and moderately fertile. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Permeability is slow in the surface soil and very slow in the subsoil. Root penetration is moderately deep to deep. The available water-holding capacity is good.

This soil is used only for grazing. A few areas that were formerly dry-farmed are now revegetating to native grass. The forage is grazed chiefly late in spring, in summer, and early in fall. Winter grazing is limited when snow covers the grass. Yields of forage are high when grazing is properly managed. The eradication of thick stands of juniper and pinyon pine has greatly increased forage production. *Capability unit VIs–2.*

Claysprings clay, 1 to 3 percent slopes (CcB).—This soil is limited in extent. It is in a gently sloping shallow swale west of Clay Springs. The native vegetation is predominantly blue grama and western wheatgrass. Runoff is slow, and the hazard of erosion is slight. Except for having less slope and a thicker, granular clay mulch on the surface, this soil is like Claysprings clay, 3 to 5 percent slopes.

Claysprings clay, 1 to 3 percent slopes, is used only for grazing and has been fenced into small pastures. Cattle are grazed most of the year, but little forage is available in the winter. Overuse of the range has lowered forage production. *Capability unit VIs–2.*

Claysprings clay, 5 to 20 percent slopes (CcD).—This soil is inextensive and occupies moderately sloping to strongly sloping ridges near Clay Springs and Pinedale. Runoff is medium to rapid, and the hazard of erosion is moderate. Except for slopes, the soil is similar to Claysprings clay, 3 to 5 percent slopes.

The vegetation is a dense stand of mature juniper trees and some pinyon pine and a sparse cover of grass. Juniper and pinyon pine (fig. 4) are occasionally cut for fenceposts. The forage is grazed mostly in summer, and yields are low. Where the grass cover is very sparse, moderate sheet erosion occurs, and a few shallow gullies have formed. *Capability unit VIIe–1.*

***Figure 4.*—Western wheatgrass growing on Claysprings clay, which has been cleared of juniper to improve forage yields.**

Claysprings clay loam, 3 to 5 percent slopes (CmC).—This soil is in two principal localities. One is near Burton, and the other is east of Linden. Included is a 20-acre area in the valley west of Burton that has slopes of less than 3 percent.

This soil has a clay loam surface layer, 4 to 7 inches thick. This layer formed in material that washed from the nearby, higher lying Showlow soils. Under this layer, the soil is like Claysprings clay, 3 to 5 percent slopes. The vegetation is a dense cover of juniper, some pinyon pine, and a moderate cover of grass.

Three small areas near Burton are dry-farmed. Small grain and corn for silage are the main crops. Yields vary widely, depending on moisture conditions; crop failures are common. Many areas that were farmed previously and are too small to manage separately are now used for grazing. Forage yields are low in these areas. Overuse also causes forage yields to be low in areas that have never been cultivated. *Capability unit VIs–2.*

Claysprings clay loam, 5 to 20 percent slopes (CmD).—This soil occurs near Burton and lies below the Showlow soils. The surface layer consists of 4 to 7 inches of clay loam with some quartzite pebbles. This layer formed from medium-textured material that washed from the Showlow soils and mixed with the clay. Runoff is medium to rapid, and the hazard of erosion is moderate. Except for the surface layer and slopes, Claysprings clay loam, 5 to 20 percent slopes, is like Claysprings clay, 3 to 5 percent slopes.

The soil is used for spring, summer, and fall grazing. Winter grazing is not dependable when the ground is covered with snow. *Capability unit VIIe–1.*

Clovis series

The Clovis soils are on the nearly level to moderately sloping first terrace above the Silver Creek flood plain in the vicinities of Snowflake, Taylor, and Shumway. They are between the Bagley soils of the flood plains and the Millett and Moenkopie soils of the high, dissected terraces and uplands. The Clovis soils have formed in mixed,

gravelly alluvium derived chiefly from quartzite, sandstone, shale, limestone, and basalt. The vegetation (fig. 5) is blue, black, and side-oats grama, sand dropseed, needlegrass, snakeweed, three-awn, and a few junipers. Elevations range from 5,600 to 5,700 feet. The climate is semiarid. The average annual precipation is 12 to 13 inches; snowfall is 18 to 20 inches a year. The frost-free period is about 132 days.

The surface layer is typically reddish-brown, noncalcareous sandy loam. In some uncultivated areas, however, the surface layer is 2 or 3 inches of loamy fine sand. In many cultivated areas, it is sandy clay loam. The subsoil is reddish-brown or light-brown sandy clay loam that is underlain at a depth of 24 to 54 inches by calcareous loamy sand, sandy loam, or fine sandy loam. A few small range areas are calcareous on the surface. The Clovis soils may be calcareous throughout where lime-charged irrigation water has been used for many years.

The Clovis soils are used for irrigated crops and range.

Clovis sandy loam, 1 to 3 percent slopes (CsB).—This soil is on gently sloping and undulating terrace plains adjacent to, but below, the Millet and Moenkopie soils.

Representative profile:

0 to 6 inches, reddish-brown sandy loam; upper 1 to 3 inches has moderate, granular structure; lower 3 to 6 inches has weak, platy structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.6); noncalcareous; plentiful roots.

6 to 23 inches, reddish-brown sandy clay loam; moderate, coarse, prismatic structure that breaks to moderate, subangular blocky; hard when dry, friable when moist, sticky and plastic when wet; moderately alkaline (pH 7.9); noncalcareous; plentiful roots.

23 to 31 inches, reddish-brown sandy clay loam; moderate, prismatic structure breaking to moderate, subangular blocky; hard when dry, friable when moist, slightly sticky and plastic when wet; moderately alkaline (pH 8.3); slightly calcareous; few roots.

31 to 54 inches, light-brown sandy clay loam with white nodules and splotches of lime; moderate, subangular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; moderately alkaline (pH 8.3); strongly calcareous; few roots.

54 to 62 inches +, reddish-brown sandy loam; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 8.2); strongly calcareous; few roots.

Natural drainage is good, and runoff is slow. Permeability is rapid in the surface soil and moderately slow in the subsoil. Root penetration is deep. The soil has a good water-holding capacity and is moderate in fertility. There is a slight erosion hazard.

Most of this soil is used for year-round grazing. The forage is palatable, and yields are moderately high to high. The composition and condition of the grass are easily maintained under grazing, if the range is rested in summer. Most areas of Clovis sandy loam, 1 to 3 percent slopes, are above the irrigation canals; consequently, very little of the soil was irrigated by the pioneers when they began farming along Silver Creek. A few small areas, however, are now irrigated by water pumped from wells. The principal crops are alfalfa, pasture, and corn for silage. Yields of crops from this soil are variable because irrigation and soil management are not the same in all areas of this soil. Deep cuts made in land leveling have exposed small areas of the strongly calcareous subsoil. Barnyard manure and commercial fertilizers are used to counteract the effects of the lime. *Capability units IIe–1 (Ir) and VIc–1.*

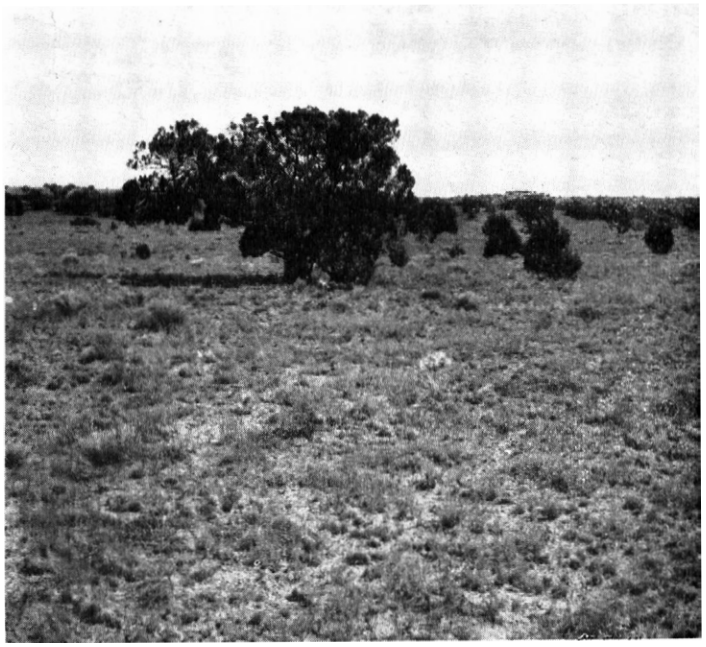

***Figure 5.*—Blue grama, black grama, galleta, sand dropseed, ring muhly, snakeweed, and juniper growing on gently rolling Clovis sandy loam.**

Clovis sandy loam, 0 to 1 percent slopes (CsA).—This soil occurs above the Bagley soils of the flood plains. The surface soil is 2 to 3 inches thicker than that of Clovis sandy loam, 1 to 3 percent slopes. In addition, the slopes are not so steep and runoff is very slow. The soils are otherwise similar.

Most of Clovis sandy loam, 0 to 1 percent slopes, is irrigated. It is the only soil of the Clovis series that is below the irrigation canals constructed by pioneers. Alfalfa, small grains, pasture, and cucumbers are the principal crops. The soil is exceptionally productive. Yields are nearly as high as those obtained from the Bagley sandy clay loams and Bagley clay loams. However, this soil does not recover so readily from puddling and compaction as the Bagley soils. The strongly calcareous subsoil horizons are seldom exposed when this soil is leveled. *Capability units I–1 (Ir) and VIc–1.*

Clovis sandy loam, 3 to 5 percent slopes (CsC).—This soil occurs mostly on moderately sloping escarpments and along swales that dissect the gently rolling terrace plain. It has a greater accumulation of lime nearer the surface (fig. 6) than the nearly level and gently sloping Clovis soils. In addition, it tends to erode more. Clovis sandy loam, 3 to 5 percent slopes, has a strongly calcareous layer within 14 inches of the surface. Runoff is medium, and the erosion hazard is moderate.

This soil occurs in areas that are too small and irregular to be managed separately. It is used for range. If management is good, forage yields are moderately high. On this soil better management is required to maintain the composition and condition of range grasses than is needed on the more nearly level Clovis soils. *Capability units IIIe–1 (Ir) and VIc–1.*

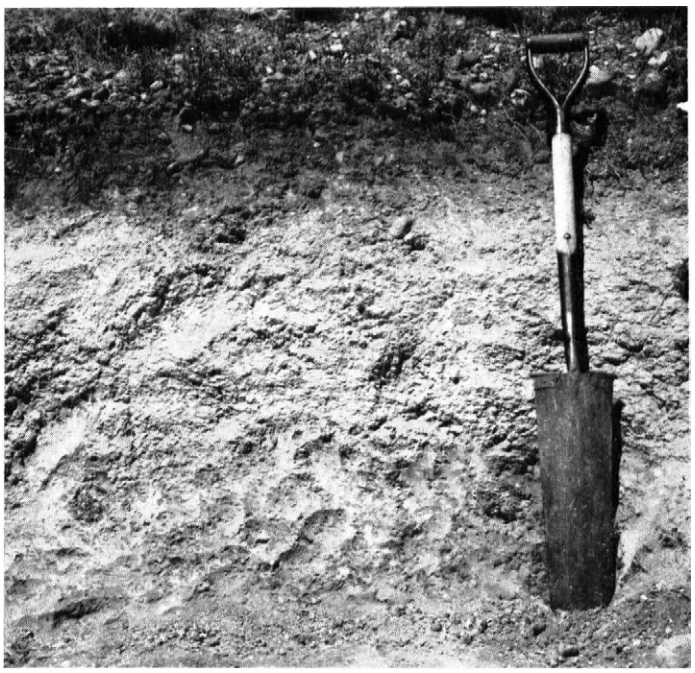

Figure 6.—**Profile of Clovis sandy loam in an area that has a slope of 5 percent. The shallow, pebbly surface layer is underlain by reddish-brown sandy clay loam subsoil. This soil has a thick, limy zone between 3 and 36 inches below the surface. At 36 inches, the texture changes to gravelly loam.**

Disterheff series

The Disterheff soils are in nearly level to gently sloping, narrow valleys and on upland plains near Lakeside and Show Low. They are associated with the Sponseller, Paiso, Showlow, and Elledge soils. They have formed in alluvium derived chiefly from basalt and volcanic cinders and also from sandstone, shale, and quartzite. The vegetation is western wheatgrass, blue grama, Gambel oak, juniper, and ponderosa pine. Elevations range from about 6,000 to 7,000 feet. The climate is subhumid. The average annual precipitation is 20 to 22 inches. Snowfall ranges from 46 to 64 inches per year. The frost-free period is approximately 127 days.

In undisturbed areas, the upper 2 to 4 inches of the profile is granular loam. Under this layer is mildly alkaline, noncalcareous clay loam. In cultivated areas, the surface soil is clay loam throughout. The subsoil is slowly permeable, neutral to mildly alkaline, noncalcareous clay underlain by calcareous clay loam sediment. Fragments of basalt are common throughout the profile, and in a few areas, quartzite cobbles are on the surface. In a few places, basalt bedrock is more than 3 feet from the surface.

The Disterheff soils are well drained and have good water-holding capacity. Runoff is very slow from the nearly level areas and slow from gently sloping areas.

The Disterheff soils are used for irrigated farming and for grazing.

Disterheff clay loam, 1 to 3 percent slopes (DrB).—This soil is in the vicinity of Lakeside and Show Low. The areas around Lakeside were cleared and developed for irrigation by the pioneers. The soil occurs mainly on gently sloping upland plains and in narrow valleys bordered by the Paiso soils on basalt, the Elledge soils on sandstone and by the Showlow soils on sand and gravel. The vegetation consists chiefly of ponderosa pine, juniper, and Gambel oak. There is very little blue grama or western wheatgrass.

Representative profile:

1 inch to 0, pine needles, oak leaf litter, and mulch.
0 to 3 inches, dark grayish-brown loam; very fine, granular to thin, platy structure; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; neutral (pH 6.8); noncalcareous.
3 to 7 inches, dark reddish-gray clay loam; weak, prismatic structure breaking to weak, angular blocky; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly acid (pH 6.3); noncalcareous.
7 to 26 inches, reddish-brown clay; moderate, prismatic structure breaking to strong, angular blocky; extremely hard when dry, extremely firm when moist, sticky and plastic when wet; slightly acid (pH 6.1); noncalcareous.
26 to 44 inches, reddish-brown clay; weak, prismatic structure breaking to moderate, subangular blocky; extremely hard when dry, extremely firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.5); strongly calcareous; distinct lime splotches.
44 to 57 inches +, brown clay loam; moderate, angular and subangular blocky structure; very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.5); strongly calcareous.

Quartzite cobbles are on the surface where this soil borders the Showlow soils. In many areas fragments of basalt are distributed throughout the profile. In places, basalt bedrock is more than 3 feet below the surface.

The soil is well drained and moderately fertile. Runoff is slow, and the hazard of erosion is slight. Permeability is moderate in the surface soil and slow in the subsoil. Root penetration is moderately deep to deep. The available water-holding capacity is good.

This soil is used for grazing and irrigated farming. The areas in native vegetation are grazed mainly during spring, summer, and fall. Forage yields are low to fair. The main crops are oats, winter wheat, and pasture. Yields are fair. Fertilizers have been used very little. The cool, short growing season limits the kinds of crops that can be grown. In spring, irrigations should be light to allow soil temperature to increase rapidly. Heavy applications waterlog the soil and keep it cold. Much of the soil south of Lakeside is being subdivided for the building of summer homes. *Capability units IIIe–5(Ir) and IVs–5(D).*

Disterheff clay loam, 0 to 1 percent slopes (DrA).—This soil occurs north of Show Low, adjacent to Show Low Creek, and southwest of Lakeside. It contains no quartzite cobbles and has less slope than Disterheff clay loam, 1 to 3 percent slopes. Runoff is very slow, and there is a slight erosion hazard.

Near Show Low, this soil is used for irrigated farming. Alfalfa, oats, winter wheat, and pasture are the dominant crops. Yields are slightly higher than those on Disterheff clay loam, 1 to 3 percent slopes, but management problems are similar. Commercial fertilizers are used by a few farmers.

Near Lakeside the vegetation is a dense forest of ponderosa pine mixed with some Gambel oak. This area is being subdivided for summer homes. *Capability units IIIs–5(Ir) and IVs–5(D).*

Dune land

Dune land, loamy (Du).—This miscellaneous land type occurs west of Joseph City and is surrounded by Jocity soils. It occurs as dunes that are 4 to 15 feet high (fig. 7). The dunes have a sparse cover of fourwing saltbush and

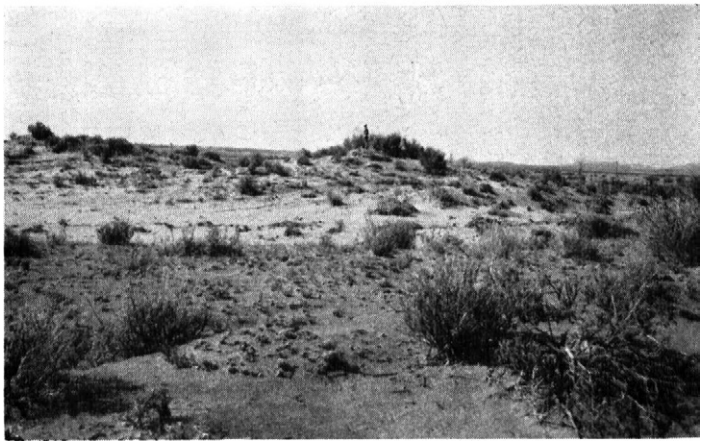

Figure 7.—**Dune land consisting of sandy clay loam that has blown from Jocity soil nearby. When dry, this material has the loose consistency of sand; when wet, it is sticky and plastic.**

shadscale, which makes them moderately stable. The soil material is sandy clay loam, which has been transported by wind from adjacent Jocity sandy clay loam soils. The properties of Jocity sandy clay loam soils and of Dune land, loamy, are very similar, except for slope and erosion. The seed clusters of fourwing saltbush furnish a small amount of winter forage. *Capability unit VIIe–1.*

Dune land, sandy (Dy).—This miscellaneous land type consists mainly of narrow bands of sand dunes that are adjacent to the Little Colorado River and Cottonwood Wash. The soil material is brown and pale-brown, mildly alkaline and calcareous, fine sand and loamy fine sand that has blown from the nearby dry streambeds and sandbars during the spring months when wind velocities are high. The dunes are 5 to 12 feet high. Many of them are bare of vegetation and are moving. Tamarisk and willow protect some dunes from the wind.

Dune land, sandy, produces no usable forage and is of little value to wildlife. *Capability unit VIIIe–1.*

Elledge series

The Elledge soils occupy scattered areas from Lakeside to Heber on gentle to strong slopes of the Mogollon Plateau. They are associated with the Showlow, Chevelon, Disterheff, and Zeniff soils. They have formed from buff to brown material that weathered from noncalcareous sandstone. The vegetation is ponderosa pine, juniper, Gambel oak, and a sparse cover of cool-season grasses. Elevations range from 6,300 to 6,700 feet. The climate is subhumid. The average annual precipitation is 17 to 22 inches. Snowfall ranges from 46 to 64 inches a year. The frost-free period is 115 to 127 days.

The Elledge soils typically have a dark-gray fine sandy loam surface soil and a brown, reddish-brown, and reddish-yellow clay subsoil. The subsoil is very hard when dry and very sticky and very plastic when wet. The profile is noncalcareous throughout, and in most areas it is neutral to slightly acid. The soils are moderately deep to deep over sandstone. Fragments of sandstone may occur throughout the profile, and in places the soils are too stony for cultivation.

The Elledge soils are moderately well drained. They are low in fertility and water-holding capacity and are poor for cultivated crops. The subsoil is often wet for long periods late in winter and early in spring. Runoff is slow to rapid. Permeability is moderately rapid in the surface soil and very slow in the subsoil.

The Elledge soils are used for irrigated farming, some dryfarming, grazing, and forestry.

Elledge fine sandy loam, deep, 1 to 3 percent slopes (EdB).—This soil occurs throughout the area in which the Elledge soils were mapped.

Representative profile:

0 to 6 inches, dark-gray fine sandy loam; moderate, platy structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; neutral (pH 7.1); noncalcareous; plentiful roots.

6 to 13 inches, light brownish-gray loamy fine sand; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; neutral (pH 6.6); noncalcareous; plentiful roots.

13 to 25 inches, varicolored brown, reddish-brown, or reddish-yellow clay; strong, blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; medium acid (pH 6.0); noncalcareous; few roots.

25 to 35 inches, varicolored brown, reddish-brown, and reddish-yellow fine sandy clay; moderate, blocky structure; hard when dry, firm when moist, sticky and plastic when wet; medium acid (pH 6.0); noncalcareous; few roots.

36 inches +, decomposing buff sandstone.

The depth to bedrock seldom exceeds 4 feet. There are a few angular fragments of sandstone up to 12 inches in diameter on the surface and throughout the profile. The amount of clay in the subsoil varies from place to place. Clay is dominant in the subsoil, but heavy sandy clay loam and sandy clay are common. In places the surface layer is no more than 1 inch thick. The layer of light brownish-gray loamy fine sand immediately below the surface is highly variable in thickness. In some of the cultivated areas, stones have been removed from the surface.

The soil is moderately well drained but low in fertility and available water-holding capacity. Runoff is slow. Permeability is moderately rapid in the surface soil and very slow in the subsoil. Root penetration is shallow to moderately deep. There is a slight erosion hazard.

Most of this soil has been cleared, but many areas that were previously farmed are now reverting to native vegetation (fig. 8). A few areas near Show Low and Lakeside are irrigated. The principal crops are corn for silage, oats, and winter wheat. Yields are low, but operators have not used fertilizer. Emphasis on the use of commercial fertilizer and good soil and irrigation management would help to increase production.

Much of this soil is used for grazing during the spring, summer, and fall. The cover of grass is sparse, and forage yields are low. *Capability units IIIe–6 (Ir) and IVs–5(D).*

Elledge fine sandy loam, deep, 3 to 5 percent slopes (EdC).—This soil averages 30 inches in thickness to sandstone bedrock. Runoff is medium, and the erosion hazard is moderate. Except for thickness and slopes, this soil is like Elledge fine sandy loam, deep, 1 to 3 percent slopes.

Figure 8.—**Field of Elledge fine sandy loam and Elledge fine sandy loam, deep, that is no longer used for dryfarming. Under the trees is Rock land, sandstone.**

Approximately 15 percent of this mapping unit consists of small patches of Elledge fine sandy loam, 3 to 5 percent slopes.

Elledge fine sandy loam, deep, 3 to 5 percent slopes, is used for grazing in the spring, summer, and fall. Forage yields are low. A few areas are irrigated; and in these corn, oats, and winter wheat are the principal crops. Because of the moderate slopes and the very slowly permeable subsoil, this soil is poor for irrigation. It is difficult to level properly because the subsoil should not be exposed. Consequently, very little soil material can be moved safely. The soil is generally irrigated by running the water straight down the slope. This causes large losses of soil and water. Short runs, small heads of water, and long periods of irrigation should be used to conserve soil and water. *Capability units IVe–1 (Ir) and VIe–1.*

Elledge fine sandy loam, 1 to 3 percent slopes (EaB).—This soil is similar to Elledge fine sandy loam, deep, 1 to 3 percent slopes (fig. 9), except that it is only 18 to 30 inches thick, and the horizons, particularly in the subsoil, are thinner.

Elledge fine sandy loam, 1 to 3 percent slopes, is used mainly for spring, summer, and fall grazing. Forage yields are low. A few small areas below the irrigation canals in the vicinity of Lakeside and Show Low are irrigated. In these places oats, winter wheat, and corn for silage are the main crops. The soil is farmed intermittently and without the use of fertilizer. Yields of crops are low. Fertility and soil management problems are similar to those of Elledge fine sandy loam, deep, 1 to 3 percent slopes. Irrigation practices must be adjusted to fit the lower water-holding capacity of this soil. *Capability units IIIe–6 (Ir) and IVs–5 (D).*

Elledge fine sandy loam, 3 to 5 percent slopes (EaC).—Except for slopes, this soil is similar to Elledge fine sandy loam, 1 to 3 percent slopes. In many places the two soils are adjacent to each other. Runoff is medium, and there is a moderate erosion hazard.

This soil is used mostly for spring, summer, and fall grazing. Forage yields are low. Two small areas, one in Lakeside and the other in Show Low, are irrigated. In these areas, the principal crops are oats, winter wheat, and corn for silage. This soil is too shallow for leveling; and consequently, it is difficult to irrigate properly. Operators do not use fertilizer, so crop yields are low. *Capability units IVe–1 (Ir) and VIe–1.*

Elledge fine sandy loam, 5 to 10 percent slopes (EaD).—This soil occurs in one large area near Lakeside. Runoff is rapid, and the erosion hazard is severe. Except for numerous rock outcrops and steeper slopes, the soil is similar to Elledge fine sandy loam, 1 to 3 percent slopes.

Elledge fine sandy loam, 5 to 10 percent slopes, has never been farmed and is used to a limited extent for grazing in the spring, summer, and fall. Forage yields are low. The characteristic vegetation consists of Gambel oak, a sparse stand of grass, scattered large ponderosa pines, and a fairly dense stand of juniper. Forestry is the best and most important use for this soil. *Capability unit VIe–1.*

Elledge stony fine sandy loam, 3 to 5 percent slopes (EsC).—This soil is on ridges and moderately rolling topography near Lakeside and Show Low. It is similar to Elledge fine sandy loam, 1 to 3 percent slopes, but it has steeper slopes and numerous buff-colored stones in and on the soil. In addition, about 10 percent of this soil has a heavy, sandy clay loam subsoil instead of the more typical clay subsoil. The vegetation consists mainly of thick

Figure 9.—**Profile of Elledge fine sandy loam. The surface layer consists of 4 to 7 inches of dark-gray fine sandy loam that is underlain by 5 to 10 inches of light brownish-gray loamy fine sand. Under this is 12 to 14 inches of strong, angular blocky clay. Sandstone is 26 to 30 inches below the surface.**

stands of juniper and Gambel oak and a few ponderosa pines. Grass is sparse. Runoff is medium, and the hazard of erosion is moderate.

Some areas are too stony for cultivation and are used only for grazing and forestry. The forage is grazed during spring, summer, and fall; yields are low. Forestry is the best use for this soil. *Capability unit VIs-1.*

Elledge stony fine sandy loam, 5 to 10 percent slopes (EsD).—This soil is adjacent to sandstone outcrops and breaks near Lakeside and Show Low. Except for slopes, it is similar to Elledge stony fine sandy loam, 3 to 5 percent slopes, but more stones are on and in the soil. The vegetation is mainly mature ponderosa pine and a few junipers and Gambel oaks. Grass is sparse. About 15 percent of the area consists of sandstone outcrops. Runoff is rapid, and the hazard of erosion is severe.

This soil is best suited to forestry, which is the major use. It is grazed to a limited extent in spring, summer, and fall. Forage yields are low. *Capability unit VIs-1.*

Heber series

Soils of the Heber series are in side drainageways on nearly level to gently sloping, narrow flood plains, and on alluvial fans of intermittent streams on the Mogollon Plateau near Heber and Overgaard. The soils consist of alluvium derived chiefly from sandstone and limestone of the Kaibab formation. The vegetation is ponderosa pine, juniper, blue grama, hairy grama, and sand dropseed. The Heber soils are at elevations of 6,200 to 6,800 feet. The climate is subhumid. The average annual precipitation is 17 to 19 inches. Snowfall is 46 to 49 inches per year. The frost-free season is approximately 125 days.

The Heber soils typically have a fine sandy loam to loamy fine sand surface soil and subsoil. At a depth of more than 3 feet from the surface, they are underlain by stratified layers of fine sandy loam, sandy loam, or loamy sand. In some areas the profile is calcareous throughout; in others it is noncalcareous. The Heber soils are well drained to somewhat excessively drained but at times are flooded by the main streams and by side drainageways. They are moderately rapid to very rapid in permeability and good to low in water-holding capacity. Runoff is very slow to slow.

The Heber soils are used for dryland farming and for grazing.

Heber fine sandy loam, 0 to 1 percent slopes (HoA).—This soil is on nearly level, narrow flood plains along intermittent streams. It occasionally receives a small amount of floodwater from side drainageways, and it is infrequently flooded from the main streams.

Representative profile:

0 to 6 inches, very dark grayish-brown fine sandy loam; moderate, subangular blocky or weak, granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.4); noncalcareous; abundant roots.

6 to 18 inches, very dark gray fine sandy loam; weak, prismatic structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.6); noncalcareous; abundant roots.

18 to 38 inches, very dark grayish-brown fine sandy loam; moderate, prismatic structure; slightly hard when dry; friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.6); noncalcareous except for thin, gray veins of lime; abundant roots.

38 to 60 inches, dark grayish-brown fine sandy loam; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 8.1); calcareous; abundant roots.

In many areas this soil is noncalcareous. In places the surface soil is very fine sandy loam. Strata of sandy loam and loamy fine sand are common below a depth of 3 feet. In many areas the subsoil and substratum are massive.

Natural drainage is good. Runoff is very slow, permeability is moderately rapid, and root penetration is deep. The available water-holding capacity is good, and fertility is moderate. There is a slight erosion hazard.

Most of this soil is used for dryfarming; the rest is used for grazing. Winter wheat, oats, and corn for fodder are the chief crops. Yields are highly variable and depend upon the amount and distribution of precipitation and the level of management. Although the soil is deep, the water-holding capacity is no more than adequate for the production of dryland crops. Range areas have been cleared of pine and juniper and are grazed in the spring, summer, and fall. Forage yields are fairly high. *Capability unit IIIc-1(D).*

Heber fine sandy loam, 1 to 3 percent slopes (HoB).—This soil is in side drainageways and on alluvial fans. Layers of loamy fine sand are more common in the substratum of this soil than in the substratum of Heber fine sandy loam, 0 to 1 percent slopes, but the profiles of the two soils are otherwise similar. Runoff is more rapid on Heber fine sandy loam, 1 to 3 percent slopes, because of stronger slopes.

Most of this soil is used for dryland farming. Winter wheat, oats, and corn for fodder are the principal crops. Yields are variable, depending on the amount and distribution of precipitation and the tillage practices used to hold the moisture where it falls. Considerable water is lost through runoff during torrential summer storms. Practices that reduce runoff, such as rough tillage and stubble mulching, are not used enough. Consequently, crops are affected by drought more often than they need be. The wooded areas are used for grazing in spring, summer, and fall. The forage is palatable, and yields are fairly high. *Capability unit IIIc-1(D).*

Heber loamy fine sand, 1 to 3 percent slopes (HfB).—This soil occurs in two distinct topographic positions: On alluvial fans and in narrow drainageways that have irregular shapes and no clearly defined channels and that are bordered by escarpments of Kaibab limestone.

Representative profile:

0 to 6 inches, grayish-brown loamy fine sand; weak, granular structure; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; moderately alkaline (pH 8.0); mildly calcareous, lime disseminated; plentiful roots.

6 to 14 inches, grayish-brown loamy fine sand; massive; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; moderately alkaline (pH 8.0); mildly calcareous, lime disseminated; plentiful roots.

14 to 60 inches, light brownish-gray loamy fine sand; massive; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; moderately alkaline (pH 8.0); mildly calcareous, lime disseminated; few roots.

In places the soil is light yellowish brown or pale brown. In many areas it is noncalcareous throughout. In many places the soil contains a few angular and subangular fragments of white or light-gray Kaibab limestone and also many tiny crystalline particles of quartz. Two small areas having slopes of 5 percent are included in this map-

ping unit. One of these areas is 15 miles southwest of Heber, and the other is 2 miles south of Show Low.

Natural drainage is somewhat excessive. Permeability is very rapid in the surface soil and rapid to very rapid in the subsoil. Runoff is very slow. Root penetration is deep. The available water-holding capacity and natural fertility are low. There is a slight erosion hazard.

More than 85 percent of this soil is dry-farmed; the rest is used for spring, summer, and fall range. Severe snows occasionally prevent winter grazing. Winter wheat is the principal dryland crop, but oats and corn for fodder are grown occasionally. Fertilizers and crop rotations have not been used. Yields are variable, depending upon the amount and distribution of precipitation and on the level of management. Because the surface soil texture is coarse and the water-holding capacity low, crops are often affected by drought. Failures are common. The soil is farmed sporadically. Fields are often idle and weeds are allowed to grow. *Capability unit IVs-2(D).*

Heber loamy fine sand, 0 to 1 percent slopes (HfA).—This soil occurs in narrow bands along wide, intermittent streams adjacent to escarpments of Kaibab limestone. Except for slopes, it is like Heber loamy fine sand, 1 to 3 percent slopes. In about half the areas of Heber loamy fine sand, 0 to 1 percent slopes, quartzite cobbles occur below a depth of 42 inches. This soil is flooded occasionally during torrential storms, but the floods cause little damage. Old cottonwood trees grow in the wide, cobbly streambeds adjoining this soil, and a few willow thickets are along stream banks.

This soil is used chiefly for dryfarming, and winter wheat, oats, alfalfa, and occasionally, corn for fodder are the main crops. Fertilizer and rotation of crops have not been used, and yields are low. Alfalfa is grown in one area along an intermittent stream in a narrow valley. Subirrigation from streamflow in wet years provides enough additional moisture to benefit this crop, but in dry years, alfalfa will not survive.

Crops are planted on this soil when moisture appears to be favorable for producing a satisfactory yield. Rough tillage and stubble mulching are used very little. When the soil is idle, annual weeds are allowed to grow. Areas not cultivated are used for spring, summer, and fall grazing. Winter grazing is not dependable, because snowfall is occasionally heavy. *Capability unit IVs-2(D).*

Ives series

Soils of the Ives series are on gently sloping, somewhat undulating, old alluvial fans or terraces adjacent to Manila Wash, a tributary of the Little Colorado River. They are associated with the Jocity and Navajo soils, and with loamy and sandy alluvial lands. They consist of alluvium that washed from sandstone and Chinle shale. The vegetation is alkali sacaton, fourwing saltbush, big rabbitbrush, and greasewood. The soils occur at an elevation of 4,900 to 5,000 feet. The climate is semiarid. The average annual precipitation is 8 to 9 inches. Snowfall averages about 10 inches per year. The frost-free period is approximately 174 days.

The Ives soils are deep. They are calcareous throughout and contain some alkali. The surface layer is fine sandy loam. The subsoil is stratified with layers of gray or brown loamy fine sand to sandy clay loam. The Ives soils are well drained but low in fertility. Runoff is slow; the water-holding capacity, good; and permeability, moderate to moderately rapid.

The Ives soils are used for irrigated farming and for grazing.

Ives fine sandy loam, slightly alkali, 1 to 3 percent slopes (IaB).—This soil occurs 3 to 4 miles west of Joseph City on long, smooth to slightly undulating slopes. It is erratically stratified and crossbedded.

Representative profile:

0 to 10 inches, brown fine sandy loam containing white and light-gray grains of sand that appear to be partially coated with clay; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 8.1); mildly calcareous; plentiful roots.

10 to 72 inches, gray to brown stratified layers of loamy fine sand to sandy clay loam; massive; soft to hard when dry, very friable to friable when moist, nonsticky and nonplastic to sticky and plastic when wet; moderately alkaline (pH 8.0); mildly calcareous; roots decrease gradually with depth, and few are below 60 inches.

Stratification is more prominent in some areas than in others. The layers are 3 to 20 inches thick. Loam to loamy fine sand predominates.

Natural drainage is good; permeability is moderately rapid in the surface soil and moderate in the subsoil. Root penetration is deep, and the available water-holding capacity is good. There is a moderate erosion hazard. The soil is low in fertility.

Although a few small areas are irrigated, this soil is used mostly for grazing. The range areas are grazed all year. Forage yields are fair. The principal irrigated crops are barley, corn for silage, and alfalfa for hay. Yields from this soil vary greatly because infiltration rates differ widely, and moisture is distributed unevenly. Variations in the infiltration rate are caused chiefly by differences in amounts of alkali and in the puddling and compaction of the surface layer. Moderate applications of gypsum, additions of barnyard manure or green manure, and deep leaching are practices that will increase the infiltration rate and make this soil more productive. *Capability units IIe-1(Ir) and VIIs-4.*

Jacques series

Soils of the Jacques series occupy alluvial fans and the gentle to moderate slopes along intermittent drainageways. They are on the Mogollon Plateau at Burton, Pinedale, Lakeside, and Pinetop. They are associated with the Showlow, Claysprings, Paiso, and Sponseller soils and have formed in alluvium that washed from these soils. The vegetation is juniper, ponderosa pine, pinyon pine, blue grama, sand dropseed, and galleta. Elevations range from 6,200 to 6,700 feet. The climate is subhumid. The average annual precipitation is 17 to 22 inches. Snowfall is 46 to 64 inches a year; the frost-free period is 125 to 130 days.

The Jacques soils are typically mildly alkaline and have dark grayish-brown clay loam surface soil and dark grayish-brown, heavy clay loam or clay subsoil. In most places the profile is calcareous below a depth of 15 to 22 inches. The Jacques soils are well drained. They are moderately slow to slow in permeability and high in water-holding capacity. Runoff is slow to medium. Sheet erosion and gullying occur when dryfarming is practiced.

The Jacques soils are used for dryfarming and grazing.

Jacques clay loam, 1 to 3 percent slopes (JaB).—This soil is in narrow swales and on gently sloping flood plains of small intermittent streams.

Representative profile:

0 to 3 inches, dark grayish-brown clay loam; strong, granular structure; slightly hard when dry, friable when moist, sticky and plastic when wet; mildly alkaline (pH 7.4); noncalcareous; abundant roots.
3 to 10 inches, dark grayish-brown loam; weak, prismatic structure breaking to moderate, subangular blocky structure; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.4); noncalcareous; plentiful roots.
10 to 21 inches, dark grayish-brown, heavy clay loam; moderate, prismatic structure that breaks to strong, blocky; hard when dry, firm when moist, very sticky and very plastic when wet; mildly alkaline (pH 7.4); noncalcareous; plentiful roots.
21 to 44 inches, dark grayish-brown, heavy clay loam; moderate, prismatic structure breaking to moderate, blocky; very hard when dry, firm when moist, very sticky and very plastic when wet; mildly alkaline (pH 7.6); weakly to strongly calcareous; few roots.

In a few places at Burton, the subsoil is clay. A few areas are included that have slopes of less than 1 percent.

Natural drainage is good. Permeability is moderate in the surface soil and moderately slow to slow in the subsoil. Runoff is slow, and the erosion hazard is slight. Root penetration is deep; the available water-holding capacity, high; and fertility, moderate.

The area at Burton is used mainly for dryfarming. Those in the vicinities of Lakeside and Pinetop are used for irrigated pasture. Corn for fodder, oats, and winter wheat are the main dry-farmed crops. Yields are variable because rainfall is erratic and management is not so good as it should be. Fertilizers are not used. Irrigated pastures consisting of mixtures of grasses and legumes appear to yield well. However, accurate yields are difficult to determine because this soil occurs in small patches with other soils.

Areas not farmed by dryland or irrigated methods are used for spring, summer, and fall grazing. Snowfall limits winter grazing. Forage yields are moderately high to high. Some range areas have been partly cleared of trees to increase the yields of forage. Those not cleared are covered by a dense stand of juniper and pinyon pine. *Capability units IIe–1(Ir) and IIIc–2(D).*

Jacques clay loam, 3 to 5 percent slopes (JaC).—This soil is on the edge of broad swales that join the upland near Burton and in broad swales near Pinedale. It has stronger slopes and a wider range in texture than Jacques clay loam, 1 to 3 percent slopes. Its texture ranges from sandy clay loam to heavy silty clay loam, and in places there is a thin layer of loam on the surface. Runoff is medium, and erosion is a moderate hazard.

This soil is used for dryfarming and for spring, summer, and fall grazing. Species of grass and the density of cover are highly variable, but where the juniper has been removed, yields of forage are fairly high. Most of the areas that were previously dry-farmed are reseeding to native grasses. Dryfarming has not succeeded, because of excess runoff, sheet erosion, small size of fields, and a lack of mechanization. *Capability unit IVe–3(D).*

Jocity series

Soils of the Jocity series are on low, nearly level to moderately sloping fans and river terraces, north of the Little Colorado River near Joseph City. They are associated with the Redfield, Ives, and Navajo soils. The parent material is alluvium that washed from shale in the badlands of the Painted Desert and from beds of fine gravel, sand, and loam. The natural vegetation consists of a sparse cover of alkali sacaton, galleta, fourwing saltbush, shadscale, and Russian-thistle. Elevations range from 4,850 to 5,000 feet. The climate is semiarid. The average annual precipitation is 8 to 9 inches; snowfall averages about 10 inches per year. The frost-free season is approximately 170 days.

The Jocity soils are deep, are weakly to strongly calcareous, and, in most areas, contain excess amounts of alkali. Their profile is typically sandy clay loam throughout, but in places the surface soil is silty clay loam or clay loam and the substratum is loam. Splotches and specks of gypsum commonly occur in the subsoil. The Jocity soils are well drained. They are moderately slow in permeability and high in water-holding capacity. Runoff is very slow to medium.

The Jocity soils are used for irrigated farming and for grazing.

Jocity sandy clay loam, slightly alkali, 1 to 3 percent slopes (JcB).—This soil is on long, gently sloping fans and terraces near Joseph City. The surface is slightly hummocky because of small accumulations of wind-laid soil around shrubs or clumps of grass.

Representative profile:

0 to 9 inches, reddish-gray sandy clay loam; massive to weak, granular structure; slightly hard when dry, very friable when moist, sticky and plastic when wet; moderately alkaline (pH 8.1); slightly calcareous; few, fine roots.
9 to 41 inches, reddish-gray sandy clay loam; few, fine, white flecks of gypsum; weak, prismatic structure; very hard when dry, friable when moist, sticky and plastic when wet; moderately alkaline (pH 7.9); strongly calcareous; few, fine roots.
41 to 60 inches +, gray fine sandy loam; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 7.9); calcareous; few, fine roots.

In places the surface soil is silty clay loam or clay loam, and the substratum, loam. In many areas the substratum is reddish gray.

The soil is well drained but low in fertility. Permeability is moderately slow; runoff is slow. Root penetration is deep, and the available water-holding capacity is high. There is a slight erosion hazard.

Except for one small area of pump irrigation, all of this soil is used for range. It is suitable for yearlong grazing, but the yields of forage are moderately low and the quality of forage is poor to fair.

The irrigated area has been farmed only a short time. Alkali is present in small amounts but requires attention. Excess tillage, poor distribution of irrigation water, and trampling by livestock tend to puddle the soil. This seals the surface and results in poor penetration of irrigation water. *Capability units IIe–1(Ir) and VIIc–1.*

Jocity sandy clay loam, slightly alkali, 3 to 5 percent slopes (JcC).—This soil is inextensive and occurs along shallow swales and on moderately sloping hills adjacent to the uplands. It has a slightly hummocky surface relief, which formed through the accumulation of soil around clumps of grass. Runoff is medium, and the hazard of erosion is moderate. Except for slopes, this soil is

similar to Jocity sandy clay loam, slightly alkali, 1 to 3 percent slopes.

This soil is used only for grazing, and the forage is grazed all year. Yields of forage are moderately low, and the quality of the forage is poor to fair. *Capability units IIIe–1(Ir) and VIIc–1.*

Jocity silty clay, 0 to 1 percent slopes (JdA).—This soil is in the old established irrigated areas that were developed by the Mormon pioneers in and near Joseph City. The surface layer is silty clay, 10 to 20 inches thick. It was deposited by muddy waters of the Little Colorado River. Below the surface layer, the profile is like that of Jocity sandy clay loam, slightly alkali, 1 to 3 percent slopes. Irrigation water, which has been applied in excess amounts over a long time, has leached the alkali out of the soil, and salts are no longer a problem. Permeability is slow in the surface soil and moderately slow in the subsoil. Runoff is very slow. The soil is moderate in fertility.

Garden vegetables, truck crops, and field crops are grown. The truck crops are produced on a semicommercial basis and consist of watermelons, peppers, sweet corn, and squash. Field crops are alfalfa, corn, oats, sudangrass, and barley. Some fertilizer is used, but the kinds and amounts are so variable that information on crop response is limited. The silty clay surface soil is plastic when wet, and the soil puddles and compacts readily. Careful tillage under the right conditions and additions of organic matter are needed to keep this soil permeable to air and water. *Capability unit IIIs–2(Ir).*

Jocity silty clay, slightly alkali, 0 to 1 percent slopes (JeA).—This soil has a silty clay surface layer, 6 to 15 inches thick. Under the surface layer, the profile contains more alkali but otherwise is like that of Jocity sandy clay loam, slightly alkali, 1 to 3 percent slopes. The silty clay material was carried mainly in disposal water from adjoining irrigated soils affected by alkali. Little leaching has occurred in this soil; consequently, it still contains alkali.

All of Jocity silty clay, slightly alkali, 0 to 1 percent slopes, is irrigated. Alfalfa, corn, and barley are the crops most commonly grown. Yields are highly variable, depending on the level of management provided.

The surface soil is slowly permeable, absorbs water slowly, and is easily dispersed, puddled, and compacted. Consequently, it needs long irrigations if it is to absorb enough water for the production of good crops. Most irrigation water is applied too rapidly, and operators lose considerable disposal, or tail water. Grass-legume rotations, deep leaching, and additions of organic matter and gypsum are needed to make this soil more productive. *Capability unit IIIs–4(Ir).*

Jocity silty clay, slightly alkali, 1 to 3 percent slopes (JeB).—Except for steeper slopes, more rapid runoff, and a slight erosion hazard, this soil is similar to Jocity silty clay, slightly alkali, 0 to 1 percent slopes.

All of Jocity silty clay, slightly alkali, 1 to 3 percent slopes, is irrigated. Wild flooding is used on areas of native grass, which are grazed in summer. Water is turned in these areas late in winter and early in spring, before it is needed for cultivated crops. About 75 percent of the soil is irrigated this way.

Controlled irrigation is used in areas where alfalfa and corn are the predominant crops. Yields are highly variable and depend largely on management. The problems of management and irrigation are almost the same as for Jocity silty clay, slightly alkali, 0 to 1 percent slopes, except that on the steeper slopes more care is required in the handling of irrigation water. *Capability unit IIIe–4(Ir).*

Loamy alluvial land

Loamy alluvial land (La).—This land type is a stratified mixture of the Navajo, Tours, Redfield, and Trail soils. The various thin strata typically are loamy very fine sand, fine sandy loam, very fine sandy loam, silt loam, and silty clay loam. In a few places, there are strata of sand and clay.

Loamy alluvial land occurs on the flood plain of Hay Hollow Wash. The vegetation is alkali sacaton, fourwing saltbush, greasewood, shadscale, big rabbitbrush, camelthorn, Russian-thistle, and an occasional cottonwood tree.

The land is used for irrigated farming and for grazing. Corn, barley, alfalfa, and sudangrass are the most commonly grown crops. The native vegetation can be grazed on a yearlong basis, but rotation grazing is practiced in the summer and winter seasons.

For the first several years after land is developed for farming, the yields of crops are moderate. This is the result of land leveling, which pulverizes and packs the soil and causes poor penetration of water.

After 3 to 4 years of cultivation, the permeability of the surface soil improves so that irrigation water can penetrate deeper into the soil. As a result, the yields of crops increase. *Capability unit IIs–1(Ir) and VIIc–1.*

Loamy alluvial land, moderately saline-alkali (Lb).—This land type occurs along Hay Hollow Wash and on the Little Colorado River flood plain from Holbrook to Winslow. It is like Loamy alluvial land except that it contains moderate amounts of toxic salt and alkali and has a fluctuating water table, which is usually more than 6 feet from the surface. An area of this land type south of Joseph City was irrigated by the pioneers but was abandoned after the irrigation system failed. It has since reverted to woody shrubs and grasses.

Irrigated areas of this land type became uneven or slightly undulating on the surface because silt in the soil causes uneven settling. As a result, the surface should be releveled every 5 to 7 years to maintain the proper irrigation grade. Alfalfa, barley, oats, and pasture are the most commonly grown crops. Crop yields are moderately low because salts and alkali interfere with plant growth. Areas in native vegetation can be grazed yearlong. The yields and quality of forage are poor. *Capability units IIs–2(Ir) and VIIs–4.*

Loamy alluvial land, strongly saline (Lc).—This land type differs from Loamy alluvial land, moderately saline-alkali, in that reddish-brown sand occurs 12 to 20 inches from the surface. The land type occurs in old abandoned river channels that are slightly elevated from the Little Colorado River. Consequently, the water table is from 3 to 6 feet below the surface and is nearer the surface than it is in the other Loamy alluvial lands.

Loamy alluvial land, strongly saline, is associated with Navajo clay, shallow over sand, moderately saline, 0 to 1 percent slopes, and with Sandy alluvial land, strongly saline. It is used only for grazing, but the yield and quality of forage are poor. The vegetation consists of tamarisk, camelthorn, alkali sacaton, saltgrass, grease-

wood, and willow sprouts. Grazing occurs throughout most of the year because water is available for livestock. Grazing areas should be rested in summer to help increase forage production. *Capability unit VIIs-4.*

McNary series

Soils of the McNary series are on nearly level upland plains in the vicinity of Lakeside. They are associated with the Springerville, Paiso, and Disterheff soils. They have formed from weathered basalt and basaltic cinders. The vegetation is dominantly western wheatgrass, but there is some ponderosa pine and Gambel oak. The McNary soils are at an elevation of about 6,700 feet. The climate is subhumid. The average annual precipitation is 22 inches. Snowfall is about 64 inches per year. The frost-free period is 127 days.

The soil profile is clay throughout and is very dark gray to black to a depth of 16 to 28 inches. At this depth, the color changes abruptly to reddish brown. The profile has many tiny fragments or specks of lime and a few large concretions of lime. The soil alternately shrinks and swells upon drying and wetting. When dry, the soil forms cracks that are ½ inch to 2 inches wide and about 30 inches deep. A thin layer of fine granular clay mulch is generally on the surface. The McNary soils are well drained, but late in winter and early in spring they may be saturated for short periods. Runoff is very slow. Permeability is slow to very slow, and the water-holding capacity is good.

The McNary soils are used for irrigated farming and for grazing. Only one McNary soil was mapped in the Holbrook-Show Low Area.

McNary clay, 0 to 1 percent slopes (MaA).—This soil is smooth and nearly flat.

Representative profile:

0 to 4 inches, black clay; strong, fine, angular blocky structure; very hard when dry, very firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.6); noncalcareous except for lime concretions.

4 to 18 inches, black clay; weak, prismatic structure breaking to moderate, subangular blocky; extremely hard when dry, extremely firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.7); noncalcareous except for many lime concretions.

18 to 30 inches, reddish-brown clay; moderate, subangular blocky structure; extremely hard when dry, extremely firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.6); noncalcareous except for lime concretions.

30 to 56 inches, reddish-gray clay; moderate, angular blocky to subangular blocky structure; extremely hard when dry, extremely firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.6); strongly calcareous; many concretions and splotches of lime.

The surface layer is dark gray to black and ranges from 16 to 28 inches in thickness.

Natural drainage is good; runoff is very slow. Permeability is slow in the surface layer and very slow in the subsoil. Root penetration is moderately deep to deep. The soil has a good water-holding capacity and is moderate to high in fertility. There is a slight hazard of erosion.

There are three areas of this soil. Two are irrigated, and the other is grazed mostly in summer and early in fall. Irrigated crops are winter wheat, oats, barley, and pasture. Crop yields are fairly high; fertilizer has not been used. Forage yields are high during years of average precipitation.

This soil is difficult to till when too wet or too dry. Care is needed to prevent waterlogging during spring irrigations. When wet in spring, the soil warms up very slowly. *Capability units IIIs-1(Ir) and IVs-4(D).*

Millard series

Soils of the Millard series occupy nearly level to strong slopes on rolling plains along the north edge of the Mogollon Plateau near Burton and Aripine. They are associated chiefly with the Showlow and Zeniff soils. The parent material is alluvium composed chiefly of sand, gravel, and cobble that washed from sandstone and quartzite. The vegetation is a moderately dense stand of juniper mixed with a few pinyon pine and an understory of blue grama, galleta, and small amounts of western wheatgrass. The Millard soils are at an elevation of 6,300 to 6,500 feet. The climate is subhumid. The average annual precipitation is 16 to 19 inches. Snowfall is 46 to 49 inches a year. The frost-free period ranges from 117 to 132 days.

The Millard soils are gravelly throughout and are underlain by very gravelly, coarse-textured layers 42 inches or more from the surface. The surface soil is neutral, noncalcareous gravelly sandy loam. The subsoil is neutral to mildly alkaline gravelly clay loam or very gravelly sandy clay and is calcareous in the lower depths. Many pebbles in the substratum are coated with lime. The Millard soils are somewhat excessively drained. The surface soil is rapidly permeable; the subsoil, moderately permeable. The water-holding capacity is low. Runoff is very slow to slow.

Millard soils are used mainly for grazing. The substrata containing gravel are frequently used as a source of road-building material.

Millard gravelly sandy loam, 1 to 3 percent slopes (MbB).—This soil is in the vicinities of Burton and Aripine. It occupies shallow swales and long, narrow bands adjoining the Zeniff soils. The more strongly sloping Millard soils and the Showlow soils may also adjoin this soil. The latter soils are higher on the landscape than this soil.

Representative profile:

0 to 3 inches, brown gravelly sandy loam; moderate, granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; neutral (pH 6.8); noncalcareous; plentiful roots.

3 to 9 inches, reddish-brown gravelly sandy clay loam; strong, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.9); noncalcareous; plentiful roots.

9 to 14 inches, reddish-brown very gravelly sandy clay loam; moderate, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.9); noncalcareous; few roots.

14 to 42 inches, dark-red clayey gravel; moderate, granular structure; hard when dry, friable when moist, sticky and plastic when wet; mildly alkaline (pH 7.4); calcareous; few roots.

42 to 60 inches +, reddish-brown very gravelly loamy sand; massive; hard when dry, very friable when moist, nonsticky and nonplastic when wet; neutral (pH 6.8); noncalcareous, except there is lime on the bottoms of pebbles in a few places; few roots.

Approximately 5 to 10 percent of this mapping unit consists of soils of the Showlow series that were included in mapping.

Natural drainage is somewhat excessive. Runoff is very slow. Permeability is rapid in the surface soil and moderate in the subsoil. Root penetration is moderately

deep. Fertility and the water-holding capacity are low. There is a slight erosion hazard.

This soil is used for range, except for a few acres at Burton that are used for dryfarming. The forage is mainly blue grama, and it is grazed all year. Snowfall often prevents winter grazing. Yields of forage are fair. Most of the area has been overgrazed, which has resulted in a severe invasion of juniper. The juniper is already a problem and will be an even greater problem if the grass continues to deteriorate. A few small areas have been cleared of juniper, and in these, forage yields have increased. *Capability unit VIs–1.*

Millard gravelly sandy loam, 3 to 10 percent slopes (MbC).—This soil occurs most extensively in the vicinity of Aripine and is associated mainly with the Showlow soils. It is similar to Millard gravelly sandy loam, 1 to 3 percent slopes, but it occupies long, moderate to steep slopes and ridges and is underlain by gravel at a depth of 24 to 40 inches. In addition, the subsoil ranges in texture from gravelly sandy clay loam to very gravelly sandy clay. Runoff is slow, and there is a slight to moderate erosion hazard.

This soil is used for range. Use and management problems are similar to those on Millard gravelly sandy loam, 1 to 3 percent slopes. *Capability unit VIs–1.*

Millett series

Soils of the Millett series occupy gentle to steep slopes on rolling, gravelly terraces above the Silver Creek flood plain in the vicinities of Snowflake, Taylor, and Shumway. They are closely associated with the Moenkopie soils and Rock land, shale and sandstone, of the upland, and with the Clovis soils on the low terraces. The parent material consists of sandy and gravelly alluvium, high in material from quartzite and containing some basic igneous rock. The vegetation is blue grama, black grama, ring muhly, black sage, and scattered juniper. Elevations range from about 5,400 to 5,600 feet. The climate is semiarid. The average annual precipitation is 12 to 14 inches. Snowfall is 16 to 20 inches per year. The average frost-free period is 130 days.

The Millett soils are typically shallow to moderately deep over the underlying sand and gravel. The surface soil is thin, reddish-gray to reddish-brown gravelly loamy sand or sandy loam. The subsoil is thin, reddish-brown gravelly sandy loam. There is a pinkish-gray zone of accumulated lime between the subsoil and the underlying sand and gravel.

The Millett soils are somewhat excessively drained and are low to very low in water-holding capacity. Runoff is very slow to medium. Permeability is very rapid in the surface soil and rapid in the subsoil.

The Millett soils are used for grazing and as a source of gravel (fig. 10).

Millett gravelly loamy sand, 5 to 20 percent slopes (MdD).—This soil is on dissected slopes, breaks, and steeply rolling caps above Moenkopi sandstone and shale.

Representative profile:

0 to 3 inches, reddish-gray to reddish-brown gravelly loamy sand; moderate, granular structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.4); noncalcareous; plentiful roots.

3 to 9 inches, reddish-brown gravelly sandy loam; moderate, subangular blocky structure; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.6); noncalcareous; few roots.

9 to 24 inches, pinkish-gray very gravelly sandy loam; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.8); very strongly calcareous—the lime occurs as large splotches or tongues; few roots.

24 to 56 inches +, brown sand and gravel; single grained; loose; moderately alkaline (pH 8.1); very strongly calcareous; very few roots.

***Figure 10.*—Native vegetation on Millett gravelly loamy sand. This soil is typically shallow over the underlying sand and gravel.**

This soil is somewhat excessively drained, and it is low in fertility. Runoff is slow to medium. Permeability is very rapid in the surface soil and rapid in the subsoil. Root penetration is shallow to moderately deep. The water-holding capacity is very low to low. There is a moderate erosion hazard (fig. 11).

This soil is all in range and can be grazed throughout the year. Ranchers generally rotate the grazing of pastures during the summer and the winter seasons. In summer, pastures are rested at a different time each year to maintain the vigor and density of the grasses and to insure seed production. The forage is palatable, and yields are moderately high. *Capability unit VIIe–2.*

Millett gravelly loamy sand, 1 to 3 percent slopes (MdB).—This soil is similar to Millett gravelly loamy sand, 5 to 20 percent slopes, except that the slopes are smooth and gentle, and the depth to layers of sand and gravel is more than 40 inches in most places. Runoff is very slow, and the erosion hazard is slight.

This soil is all in range, but it occurs in scattered areas too small to be managed separately. Consequently, it is used and managed the same as Millett gravelly loamy sand, 5 to 20 percent slopes. Yields of forage are moderately high and of good quality. *Capability unit VIIs–5.*

Millett gravelly loamy sand, 3 to 5 percent slopes (MdC).—This soil is on smooth, moderately rolling ridges adjacent to the flood plains of Silver Creek and Millett Swale. Runoff is very slow to slow, and there is a slight to moderate erosion hazard. Except for slope, the soil

Figure 11.—**Profile of Millett gravelly loamy sand. The surface layer is up to 3 inches of reddish-brown gravelly loamy sand that is underlain by about 6 inches of dark reddish-brown gravelly sandy loam. Under this is about 15 inches of pinkish-gray very gravelly sandy loam with accumulations of lime. Clean gravel (not shown in photo) generally occurs 24 inches below the surface.**

is like Millett gravelly loamy sand, 5 to 20 percent slopes. Use and management of the two soils are similar. *Capability unit VIIs–5.*

Moenkopie series

Soils of the Moenkopie series are on gently sloping and rolling to strongly sloping uplands adjacent to the flood plains and terraces of the Little Colorado River and Silver Creek. They are associated with the Navajo, Tours, Redfield, Trail, Moffat, and Millett soils. The parent material is mainly interbedded, brown to reddish-brown sandy shale and sandstone of the Moenkopi formation. The vegetation is galleta, blue grama, alkali sacaton, threeawn, and snakeweed. Elevations range from 4,900 to 5,600 feet. The climate is semiarid. The average annual precipitation is 7 to 12 inches. Snowfall is 10 to 12 inches per year. The frost-free period is 132 to 172 days.

The Moenkopie soils are reddish-brown, shallow to very shallow over bedrock, and strongly calcareous. They are typically fine sandy loam throughout, but they range widely in texture because the parent material is variable in texture. In places the surface soil is sandy loam and the subsoil is a thin, light sandy clay loam. The Moenkopie soils are well drained to somewhat excessively drained. They are low in fertility and low to very low in water-holding capacity. Runoff is slow to medium. Summer thunderstorms cause serious erosion where the cover of grass is sparse. When bare and wet, these soils form a weak crust that greatly retards infiltration of water.

The Moenkopie soils are used mainly for grazing, but a few small areas are irrigated.

Moenkopie fine sandy loam, 1 to 3 percent slopes (MeB).—This soil is in broad bands on the lower parts of long slopes that border the flood plains of drainageways. It has developed from the soft, weathered strata of sandstone and shale of the Moenkopi formation.

Representative profile:

0 to 3 inches, reddish-brown fine sandy loam; weak, platy structure; vesicular porosity; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 8.1); calcareous; few roots.

3 to 8 inches, reddish-brown fine sandy loam; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 8.0); strongly calcareous; very few roots.

8 to 15 inches, reddish-brown fine sandy loam; massive; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; moderately alkaline (pH 8.2); strongly calcareous; very few roots.

15 inches +, decomposing shale and sandstone gradually grading to undecomposed shale and sandstone at a depth of 24 to 32 inches.

In many areas this soil is high in gypsum, which is in thin lenses or veins in the subsoil and in the parent material. Shale or sandstone is 12 to 22 inches below the surface. Fine sandy loam sediment that washed down the slopes has been deposited in a thin layer on the surface in many places.

Natural drainage is good to somewhat excessive. Permeability is moderately rapid in the surface soil and subsoil. Root penetration is shallow. Fertility and the water-holding capacity are low. Runoff is slow, and there is a slight erosion hazard.

This soil is used mainly for grazing, but a few small areas bordering the flood plain of the Little Colorado River west of Holbrook are irrigated. This is the only soil of the Moenkopie series that is cultivated. Alfalfa is the principal crop; barley is grown occasionally. Fertilizer has not been used. This soil is difficult to level because it is shallow.

The areas used for range can be grazed all year. Ranchers rotate the grazing of pastures during the summer and winter seasons. Forage yields are low. The grass improves in condition very slowly after it has been grazed heavily. Pastures should be rested at varying times during the growing season to maintain plant vigor and density and to allow for seed production. *Capability units IVe–7 (Ir) and VIIs–1.*

Moenkopie fine sandy loam, 3 to 5 percent slopes (MeC).—This soil is 10 to 18 inches thick over sandstone. Runoff is medium, and the erosion hazard is moderate. The soil is otherwise like Moenkopie fine sandy loam, 1 to 3 percent slopes. About 10 percent of the total area consists of very shallow phases of the Moenkopie series, which were included with this soil in mapping.

This soil is not suited to irrigation because it is shallow and has moderate slopes. All of it is used for grazing. Management is similar to that on Moenkopie fine sandy loam, 1 to 3 percent slopes. *Capability unit VIIs–1.*

Moenkopie fine sandy loam, very shallow, 1 to 3 percent slopes (MgB).—This soil is 6 to 12 inches thick over hard sandstone and shale of the Moenkopi formation. Slopes are long and gentle or gently undulating. The subsoil in most places is thin, light sandy clay loam, but fine sandy loam also occurs. Small areas of thicker Moenkopie soils are included with this soil. There is a

slight to moderate erosion hazard. The water-holding capacity is very low.

This soil is used only for grazing. Management is similar to that on Moenkopie fine sandy loam, 1 to 3 percent slopes. However, the density and vigor of the grasses improve much slower on Moenkopie fine sandy loam, very shallow, 1 to 3 percent slopes, than on the thicker Moenkopie soils having the same slopes. *Capability unit VIIs–1.*

Moenkopie fine sandy loam, very shallow, 3 to 10 percent slopes (MgC).—Most of this soil is on long, smooth to undulating slopes adjacent to outcrops of Moenkopi sandstone and shale. The plant cover is sparse to very sparse and consists mainly of alkali sacaton, galleta, and snakeweed. There are a few junipers near Snowflake. Bedrock is 6 to 10 inches below the surface; small areas of eroded shale or of sandstone outcrops are common. Runoff is medium, and there is a moderate to severe erosion hazard. In other characteristics, this soil is like Moenkopie fine sandy loam, 1 to 3 percent slopes. The water-holding capacity is very low.

This soil is used only for grazing. Management is similar to that on Moenkopi fine sandy loam, 1 to 3 percent slopes, but forage yields are higher and recovery of the grasses is more rapid than on this very shallow soil. *Capability unit VIIs–1.*

Moffat series

Soils of the Moffat series are on nearly level to moderately sloping old terraces adjacent to and high above the flood plains of the Little Colorado River. They are associated mainly with the Moenkopie and Redfield soils. The parent material is stratified alluvium composed of fine gravel, sand, loam, and thin strata of clay derived from a mixture of many kinds of rocks. The vegetation consists mainly of galleta, alkali sacaton, Indian ricegrass, and snakeweed. The elevation ranges from 4,900 to 5,100 feet. The climate is semiarid. The average annual precipitation is 8 to 9 inches. Snowfall averages 10 inches per year. The frost-free season is 170 to 177 days.

The surface soil is weak, platy to granular, mildly to moderately alkaline sandy loam; the subsoil, weak, subangular blocky, moderately permeable, moderately alkaline sandy clay loam; and the substratum, massive loamy sand or gravel. The profile is calcareous throughout. The soils are low in fertility and have a good water-holding capacity. Runoff is slow to medium.

The Moffat soils are used chiefly for grazing, but a few small areas are irrigated.

Moffat sandy loam, 3 to 5 percent slopes (MhC).—This soil occupies areas, mostly 30 to 70 acres in size, at Hay Hollow and southwest of Holbrook. It is interspersed with Moffat sandy loam, 1 to 3 percent slopes, and with Terrace escarpments, sandy.

Representative profile:

0 to 6 inches, reddish-brown sandy loam; weak, platy structure breaking to weak, granular; soft when dry, very friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.8); strongly calcareous; few roots.

6 to 15 inches, reddish-brown, heavy sandy loam; weak, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately alkaline (pH 7.9); strongly calcareous; few roots.

15 to 34 inches, light reddish-brown sandy clay loam; massive; hard when dry, firm when moist, sticky and plastic when wet; moderately alkaline (pH 8.0); strongly calcareous—contains small accumulations of lime; few roots.

34 to 58 inches, reddish-brown loamy sand; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.7); strongly calcareous; very few roots.

The surface soil ranges from 3 to 8 inches in thickness. In places it is loam. The subsoil includes heavy loam and contains slight to very large amounts of lime.

This soil is well drained, low in fertility, and good in water-holding capacity. Permeability is moderately rapid in the surface soil and moderate in the subsoil. Roots penetrate deeply. Runoff is medium, and there is a moderate erosion hazard.

All of this soil is in range, and it can be used for year-long grazing. Pastures are not grazed continuously but are rotated for summer and winter use. Forage yields are moderately high and of good quality if management is good. The condition and composition of vegetation do not change rapidly when the range is overgrazed. Recovery of the range from poor condition is rapid. *Capability units IIIe–2(Ir) and VIIc–1.*

Moffat sandy loam, 1 to 3 percent slopes (MhB).—This well-drained, reddish-brown soil occurs southwest of Holbrook in small areas on ridgetops and saddles. It is like Moffat sandy loam, 3 to 5 percent slopes, except that slopes are gentle, the sandy loam surface soil is 5 to 10 inches thick, and runoff is slow.

Most of the soil is in range; but one small area is irrigated through use of pumped water. Corn, wheat, barley, and alfalfa are grown. Fertilizer has not been used. The soil is easily prepared for irrigation because brush is not a problem and little subsoil is exposed in leveling. Bare soil that is soft and powdery on the surface may be severely damaged through blowing late in winter and early in spring.

The range areas are too small to be managed separately. Management and yields are much the same as on Moffat sandy loam, 3 to 5 percent slopes. *Capability units IIe–2 (Ir) and VIIc–1.*

Mogollon series

Soils of the Mogollon series are on nearly level to gently sloping alluvial fans and flood plains along Silver Creek and Cottonwood Wash in the vicinities of Snowflake, Taylor, Shumway, and Linden. They are associated mainly with the Clovis, Showlow, Zeniff, Bagley, and Tours soils. The Mogollon soils consist of alluvium that originated from basalt, sandstone, shale, volcanic cinders, and sand and gravel. The vegetation is blue grama, black grama, sand dropseed, black sagebrush, ponderosa pine, and Gambel oak. Elevations range from 5,600 to 6,500 feet. The average annual precipitation is 13 to 19 inches. Snowfall is 12 to 30 inches per year. The frost-free season is approximately 118 to 132 days.

The Mogollon soils are typically brown to reddish brown, and there is little change of color in a given profile. The surface soil is fine sandy loam; the subsoil, sandy clay loam; and the substratum, loam or fine sandy loam.

When irrigated, these soils are the most productive in the Holbrook-Show Low Area. They recover rapidly from compaction and puddling caused by cultivation and

trampling. They are deep, are well drained, and have good water-holding capacity. Runoff is very slow to slow. The Mogollon soils are used for irrigated farming, dryland farming, and grazing.

Mogollon fine sandy loam, 0 to 1 percent slopes (MkA).—This soil is on the nearly level flood plains of Silver Creek and Cottonwood Wash. It is occasionally flooded for brief periods, but floods cause little damage.

Representative profile:

0 to 11 inches, brown to reddish-brown fine sandy loam; moderate, granular structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.8); mildly calcareous; plentiful roots.

11 to 20 inches, brown to reddish-brown sandy clay loam; weak, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately alkaline (pH 8.0); moderately calacareous; plentiful roots.

20 to 36 inches, brown to reddish-brown sandy clay loam; weak, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately alkaline (pH 8.1); strongly calcareous; few roots.

36 to 60 inches +, brown to reddish-brown loam or fine sandy loam; weak, subangular blocky structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; moderately alkaline (pH 8.0); weakly to moderately calcareous; few roots.

Natural drainage is good, and runoff is very slow. Permeability is moderately rapid in the surface soil, and moderate in the subsoil. Root penetration is deep. The soil is moderate in fertility and has a good water-holding capacity. There is a slight erosion hazard.

This soil is used for irrigated farming and grazing. It was first irrigated in the 1870's, and yields have been consistently high since then. The principal crops are corn for silage, small grains, alfalfa, pasture forage, sweet corn, and cucumbers. Nitrogen and phosphate fertilizers have been used the past few years, generally with satisfactory results. Special management practices are not needed to prevent erosion.

More than one-third of this soil is in range. The range areas occur where water is not available for irrigation. Forage production is high, and yearlong grazing is practiced. Because they are small, the range areas are not managed as separate units. *Capability units I–1 (Ir) and VIc–1.*

Mogollon fine sandy loam, 1 to 3 percent slopes (MkB).—This soil is on the flood plains of Cottonwood Wash and Silver Creek in the vicinities of Snowflake and Taylor. Except for slopes and slightly more rapid runoff it is similar to Mogollon fine sandy loam, 0 to 1 percent slopes.

Mogollon fine sandy loam, 1 to 3 percent slopes, is used for irrigated farming and grazing. Corn for silage, small grains, alfalfa, and tame pasture are the adapted crops. Where irrigation is practiced, water must be applied properly to prevent excessive losses of soil and water.

The areas in range are managed like those of Mogollon fine sandy loam, 0 to 1 percent slopes. *Capability units IIe–2 (Ir) and VIc–1.*

Mogollon fine sandy loam, high rainfall, 1 to 3 percent slopes (MmB).—This soil occurs on alluvial fans near Linden. It is similar to Mogollon fine sandy loam, 0 to 1 percent slopes, except that it is on gentle slopes and occurs under a subhumid climate instead of under the semiarid climate that is characteristic of the series. Precipitation is 17 to 19 inches a year. The frost-free period is 118 to 125 days. A small, nearly level area was mapped with this soil.

All of this gently sloping soil is used for dryfarming. Corn for silage, winter wheat, pinto beans, and grain sorghum are the adapted crops. For highest yields, rough tillage and terracing are necessary. *Capability unit IIIc–1 (D).*

Navajo series

The Navajo soils are on nearly level to gently sloping flood plains along the Little Colorado River. They are associated with the Tours, Redfield, and Jocity soils. The parent material consists of alluvium that washed from shale, sandstone, limestone, and basalt. The vegetation is principally fourwing saltbush, alkali sacaton, and shadscale. Elevations range from 4,800 to 5,600 feet. The climate is semiarid. The average annual precipitation is 8 to 12 inches. Snow amounts to 10 to 20 inches per year. The frost-free period is 132 to 172 days.

The profile of the Navajo soils is typically reddish-brown, calcareous clay to a depth of more than 60 inches. In places the clay is interbedded with thin silty strata, and in some areas the clay is underlain by massive sand or fine sandy loam below a depth of 16 to 28 inches. A few areas have loam or clay loam surface soil. In most places salts are present in amounts that are harmful to many plants. The soils contain thin, white veins of lime and gypsum.

The Navajo soils are low in fertility. Most of them are moderately well drained and very slowly permeable. Runoff ranges from very slow to slow.

The Navajo soils are used for irrigated farming and grazing.

Navajo clay, moderately saline-alkali, 0 to 1 percent slopes (NcA).—This soil occurs in small tracts throughout the flood plains.

Representative profile:

0 to 10 inches, reddish-brown clay; strong, granular structure in upper 1 or 2 inches, moderate, subangular blocky structure below 2 inches; very hard when dry, very firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.6); strongly calcareous; faint white veins of gypsum and lime; few roots.

10 to 60 inches, reddish-brown clay; massive; extremely hard when dry, very firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.5); strongly calcareous; faint white veins of gypsum and lime; few roots.

A small area with a pinkish-gray silty clay surface soil was mapped with this soil in the vicinity of Joseph City.

The permeability of both the surface soil and the subsoil is very slow. Root penetration is shallow to moderately deep. This soil is low in available water-holding capacity and fertility. Runoff is very slow, and there is a slight erosion hazard.

This soil is used mostly for grazing, but a few areas are irrigated. The principal irrigated crops are wheatgrasses, grain sorghum, sudangrass, and alfalfa, which are used for hay, pasture, or silage. Yields are low. The range may be grazed all year. Summer grazing, however, is preferred where alkali sacaton is predominant and winter grazing is preferred where fourwing saltbush is predominant.

Removal of the excess salts by leaching would improve this soil. This process is slow and costly and is seldom used. *Capability units IIIs–4 (Ir) and VIIs–4.*

Navajo clay, moderately saline-alkali, 1 to 3 percent slopes (NcB).—This soil is like Navajo clay, moderately saline-alkali, 0 to 1 percent slopes, but it occurs on gentle slopes. It is in bands along the edges of flood plains adjacent to terrace escarpments, rock escarpments, and soils of the uplands. Runoff is slow, and there is a slight to moderate erosion hazard.

This soil is used only for grazing. Fourwing saltbush provides most of the forage during the winter, and alkali sacaton provides most of the forage during summer. The soil is suited to irrigation but requires land leveling and installing an irrigation system. *Capability units IIIs–4(Ir) and VIIs–4.*

Navajo clay, 0 to 1 percent slopes (NcA).—This soil is similar to Navajo clay, moderately saline-alkali, 0 to 1 percent slopes, but it is not affected by excess salts and alkali. In addition, the surface soil does not disperse so readily by the action of irrigation water, and it has a higher infiltration rate. Navajo clay, 0 to 1 percent slopes, occurs at Woodruff and in the Snowflake-Taylor area.

The area at Woodruff was moderately saline before it was irrigated, but the abundant use of good-quality irrigation water for many years has leached the salts from the root zone of most crops. In the Snowflake-Taylor vicinity the area irrigated is an old irrigation reservoir, and the soil consists of clayey sediment that had accumulated to a thickness of 2 to 6 feet before the reservoir was drained and cultivated. All of this soil is irrigated. The principal crops are alfalfa, corn, grain sorghum, and pasture forage. Little fertilizer is used. *Capability unit IIIs–2(Ir).*

Navajo clay, poorly drained variant, slightly saline, 0 to 1 percent slopes (NbA).—This soil is similar to other Navajo clay soils, except that it has been altered by flooding for long periods. It may be completely inundated for 2 to 4 months and then not flooded for 4 to 6 months. The water table fluctuates from the surface to a depth of 6 feet. The reddish-brown soil is mottled with faint red, yellow, and gray below a depth of 6 inches. It has a slight concentration of salts but is not affected by alkali.

The soil occurs in old reservoirs near Woodruff and Joseph City. At Woodruff, the soil is flooded with disposal water from irrigation. At Joseph City, it is flooded to maintain water-tolerant grasses and sedges. The soil is used for summer grazing when not flooded. Winter grazing is poor because of the low quality of the herbage. *Capability unit Vw–1.*

Navajo clay, shallow over loam, moderately saline, 0 to 1 percent slopes (NdA).—This soil occurs between Holbrook and Joseph City. It contains a moderate amount of salts. It differs from other Navajo soils in that it is underlain 16 to 28 inches below the surface by moderately coarse textured material similar to that in which the Redfield soils have formed. The vegetation is Russian-thistle, seepweed, tamarisk, and alkali sacaton.

The soil is used for irrigated farming and grazing. Pastures of alfalfa and grass are the main crops. The vegetation is generally grazed throughout the year. The forage is of poor quality and of low yield. Pastures of alkali sacaton should be rested in summer to help improve the yield of forage. *Capability units IIIs–4(Ir) and VIIs–4.*

Navajo loam, moderately saline, 0 to 1 percent slopes (NkA).—This soil is similar to Navajo clay, moderately saline-alkali, 0 to 1 percent slopes, except that the surface soil is loam to a depth of 6 to 12 inches. The loam on the surface comes from three different places: (a) Adjacent exposed escarpments of Coconino sandstone, as windblown material; (b) the dry bed of the Little Colorado River, as windblown material, and (c) the Redfield and Moenkopie soils, as water-transported material.

The soil occurs in the vicinities of Woodruff, Holbrook, and Joseph City and occupies narrow bands adjacent to the uplands and the lower ends of alluvial fans. The clay below the surface layer is saline; the surface layer is not saline in all areas, however. The vegetation is a moderate cover of alkali sacaton and fourwing saltbush.

This soil is used for grazing and irrigated farming. The small areas under irrigation are adjacent to other Navajo clay soils and are not managed as separate units. Alfalfa and corn for silage are the main crops. *Capability units IIIs–4(Ir) and VIIs–4.*

Navajo clay loam, strongly saline-alkali, 0 to 1 percent slopes (NhA).—This soil is similar to Navajo clay, moderately saline-alkali, 0 to 1 percent slopes, except that it has a clay loam surface soil, is strongly saline-alkali, and is gray to grayish brown in the upper subsoil. The surface is mostly bare and has a high rate of dispersion from the impact of rain, and it readily seals. Consequently, most of the scanty precipitation is lost in runoff. The vegetation is sparse and consists mainly of shadscale, alkali sacaton, and greasewood.

Navajo clay loam, strongly saline-alkali, 0 to 1 percent slopes, occurs along the Little Colorado River between Holbrook and Winslow. It is adjacent to the river and near wet saline meadows. It is used only for grazing. The scanty plant cover produces forage of poor quality, and yields are very low. *Capability unit VIIs–4.*

Navajo clay, shallow over sand, moderately saline, 0 to 1 percent slopes (NeA).—This soil is similar to the other Navajo clay soils, but it is underlain by light reddish-brown coarse sand 10 to 20 inches below the surface. The clay has been deposited on the sand in old abandoned river channels. This soil occurs south of Joseph City along the Little Colorado River. Tamarisk is the predominant vegetation. Willow, camelthorn, alkali sacaton, and saltgrass are the minor species.

Grazing is the only use of this soil. The quantity and quality of forage are low. Willow provides a small amount of browse. Alkali sacaton and saltgrass are fairly palatable during the growing season, but they may also be grazed throughout the year. *Capability unit VIIs–4.*

Overgaard series

Soils of the Overgaard series occur on nearly level to gentle slopes near Pinedale. They are associated with the Elledge, Showlow, and Zeniff soils. They have formed from mixed alluvium that originated from quartzite, basalt, shale, and sandstone. The vegetation is mainly ponderosa pine, Gambel oak, and juniper. Elevations range from 6,400 to 6,600 feet. The climate is subhumid. The average annual precipitation is 19 to 21 inches; snowfall is 44 to 50 inches a year. The frost-free period is 127 to 131 days.

The Overgaard soils are deep and noncalcareous. In cultivated areas the surface layer is fine sandy loam, and in undisturbed areas it is 2 to 4 inches of loamy fine sand.

The subsoil is sandy clay loam or clay loam and is underlain by sandy loam about 7 feet from the surface.

The Overgaard soils are well drained and have a good water-holding capacity. Subsoil permeability is slow. Runoff is slow to very slow. These soils are used for dryfarming and grazing.

Overgaard fine sandy loam, 1 to 3 percent slopes (ObB).—This soil is the most extensive of the Overgaard series. It occurs in several separate areas around Pinedale, between the Elledge and Showlow soils of the uplands and the Zeniff soils of the alluvial fans and flood plains.

Representative profile:

1 inch to 0, slightly decomposed pine needles.
0 to 3 inches, dark grayish-brown loamy fine sand; weak, platy structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; medium acid (pH 5.9); noncalcareous; plentiful roots.
3 to 9 inches, grayish-brown fine sandy loam; weak, subangular blocky structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; neutral (pH 6.6); noncalcareous; plentiful roots.
9 to 13 inches, dark-brown sandy clay loam; weak, prismatic structure that breaks to strong, angular blocky; extremely hard when dry, very firm when moist, sticky and plastic when wet; slightly acid (pH 6.1); noncalcareous; plentiful roots.
13 to 27 inches, dark-brown clay loam; strong, prismatic structure that breaks to moderate, angular blocky; very hard when dry, firm when moist; slightly sticky and plastic when wet; slightly acid (pH 6.5); noncalcareous; plentiful roots.
27 to 45 inches, brown sandy clay loam; strong, prismatic structure; very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.8); noncalcareous; plentiful roots.
45 to 68 inches, brown sandy clay loam; weak, prismatic structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 7.0); noncalcareous; few roots.
68 to 80 inches +, reddish-brown sandy loam; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; neutral (pH 7.3); noncalcareous; few roots.

Included with this soil are two small areas west of Pinedale that have slopes of 3 to 5 percent. These two areas were gullied when they were used for dryfarming. The gullies, however, have healed because the areas are now in grass.

Natural drainage is good, and runoff is slow. Permeability is moderately rapid in the surface soil and slow in the subsoil. Root penetration is deep. The soil has a good water-holding capacity. Fertility is low. There is a slight erosion hazard.

This soil is used for dryfarming and for grazing. Most of the areas that were farmed have returned to native vegetation. Fertilizer has never been used, but its value should be determined through field trials. Furthermore, improved methods of tillage are needed if this soil is to be cultivated. At present, the soil is farmed only during years of above-average precipitation. The main crops are corn for silage and oats for hay. Yields are low.

Areas of this soil in range produce a moderate amount of forage, but many areas are overgrazed. The forage is grazed chiefly in spring, summer, and fall. Deep snow and cold weather interfere with winter grazing. A rotation-deferred system of grazing would help to maintain or improve the yields of forage. *Capability unit IVs–5(D)*.

Overgaard fine sandy loam, 0 to 1 percent slopes (ObA).—This soil occurs east of Pinedale. It is similar to Overgaard fine sandy loam, 1 to 3 percent slopes, but it is nearly level and in most places has a thicker subsoil. Also, runoff is very slow.

All of this soil is used for grazing in spring, summer, and fall. It was used for dryfarming by the early settlers but is now in native vegetation, mainly annual grasses and weeds. The homesteaders moved away from this area during years of drought, and many did not return. Experimental reseeding trials have been successful, but reseeding has not been practiced on a general scale. *Capability unit IVs–5(D)*.

Paiso series

The Paiso series consists of gently sloping to strongly sloping soils that are widely distributed in the southern part of the Area. They are associated with Springerville, McNary, Sponseller, and Showlow soils. The parent materials are basalt and volcanic cinders. The vegetation is ponderosa pine, juniper, Gambel oak, blue grama, and western wheatgrass. Elevations range from 6,400 to 7,400 feet. The climate is subhumid. The average annual precipitation is 18 to 22 inches. Snowfall is 52 to 64 inches per year. The frost-free period is 117 to 127 days.

The surface soil is typically noncalcareous, reddish-brown, granular stony clay loam. The subsoil is dark reddish-brown, slowly permeable to very slowly permeable, stony clay. It is very hard when dry and sticky and plastic when wet. In some areas, the lower part of the subsoil is calcareous. Basalt bedrock is 14 to 20 inches below the surface. The Paiso soils are well drained. They are low in water-holding capacity because they are shallow and stony. Runoff is slow on the gentle slopes and rapid on the strong slopes.

The Paiso soils are used for grazing and forestry.

Paiso stony clay loam, shallow, 1 to 3 percent slopes (PaB).—This soil is in the basalt area near Lakeside, Pinetop, and Show Low, and it extends northeastward along Show Low Creek to Shumway. It is the most extensive soil of the Paiso series. Near Show Low and Shumway, the vegetation is mainly blue grama, western wheatgrass, and juniper. Near Lakeside and Pinetop, ponderosa pine and a sparse cover of grass predominate.

Representative profile:

0 to 2 inches, reddish-brown stony clay loam; moderate, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.8); noncalcareous; abundant roots.
2 to 8 inches, dark reddish-brown stony clay loam; moderate, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.8); noncalcareous; plentiful roots.
8 to 18 inches, dark reddish-brown stony clay; strong, angular blocky structure; very hard when dry, very firm when moist, sticky and plastic when wet; neutral (pH 6.9); noncalcareous.
18 inches +, basalt rock.

Basalt stones may cover 15 percent of the surface. Very shallow soils are included with this mapping unit, and in these, the subsoil is clay between the basalt stones. Some areas having a loam surface soil are also included.

Natural drainage is good. Runoff is slow. Permeability is moderate to moderately slow in the surface soil

and slow to very slow in the subsoil. Root penetration is very shallow to shallow. The soil is low in fertility and water-holding capacity. There is a slight erosion hazard.

This soil is used for grazing and forestry. Grazing occurs chiefly in the summer, but short periods of grazing are possible in winter at the lower elevations. As a rule, snow interferes with grazing in winter. Pastures should be rested in summer to maintain the vigor and density of the grass and to provide for seed production. Forage yields are moderately high where the range is in good condition. *Capability unit VIIs–2.*

Paiso stony clay loam, shallow, 3 to 5 percent slopes (PaC).—This soil occurs near Lakeside and occupies long, narrow bands adjacent to the steeper Paiso soils and steep basalt escarpments. Except for stronger slopes and more rapid runoff, this soil is similar to Paiso stony clay loam, shallow, 1 to 3 percent slopes. Basalt stones cover 25 to 40 percent of the surface. The vegetation consists chiefly of thick stands of juniper, a few ponderosa pine, and a sparse understory of grass.

This soil is used for summer grazing and for forestry. Deep snow prevents grazing in the winter. Forage yields are low to moderate. Pastures should be rested or grazing deferred in summer to help maintain the condition and composition of the grass and provide for seed production. *Capability unit VIIs–2.*

Paiso stony clay loam, shallow, 5 to 10 percent slopes (PaD).—This soil is similar to Paiso stony clay loam, shallow, 1 to 3 percent slopes, but it is not so thick, is more stony, and has stronger slopes and more rapid runoff. It resembles Rock land, basalt. As much as 50 percent of the surface is covered by basalt stones; outcrops of bedrock are common. The vegetation is predominantly ponderosa pine or juniper and a moderate to thin cover of grass.

This soil is used for forestry and for summer grazing. Forage yields are low to moderately low. The stony surface interferes with the proper movement of cattle and results in spotty grazing. *Capability unit VIIs–2.*

Pinetop series

Soils of the Pinetop series are on slightly undulating to smooth, gentle slopes. They occur mainly along Show Low Creek near the town of Show Low, but there is also a small area west of Pinetop. The Pinetop soils are associated with the Showlow, Elledge, and Paiso soils. They consist of alluvium, derived from basalt, volcanic cinders, sandstone, and old sand and gravel. The vegetation probably consisted of cottonwood, willow, poderosa pine, and cool-season grasses. Elevations range from 6,400 to 7,500 feet. The climate is subhumid. The average annual precipitation is 18 to 22 inches. Snowfall is 52 to 64 inches a year. The frost-free period is 117 to 127 days.

The Pinetop soils are imperfectly drained. The surface soil is neutral to mildly alkaline, noncalcareous, granular fine sandy loam. The subsoil in many places is stratified and consists predominantly of neutral to slightly acid, massive layers of fine sandy loam. The subsoil is noncalcareous and mottled below a depth of 12 to 30 inches.

The Pinetop soils are used for irrigated crops.

Pinetop fine sandy loam, 1 to 3 percent slopes (PtB).—This is a gently sloping, smooth to slightly undulating soil. The water table was at a depth of 4 to 5 feet before irrigation was introduced, but now the water table fluctates between 1 and 4 feet from the surface.

Representative profile:

0 to 12 inches, dark grayish-brown fine sandy loam; moderate, granular structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.5); noncalcareous; abundant roots.

12 to 22 inches, dark grayish-brown sandy loam; massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; neutral (pH 7.1); noncalcareous; plentiful roots.

22 to 37 inches, dark grayish-brown, light fine sandy loam; distinct gray and dark reddish-brown mottles; massive; soft when dry, loose when moist, nonsticky and nonplastic when wet; slightly acid (pH 6.5); noncalcareous; few roots.

37 to 60 inches +, grayish-brown fine sandy loam; many, distinct mottles of gray and reddish brown; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly acid (pH 6.5); noncalcareous; few roots.

Natural drainage is imperfect, runoff is very slow, and permeability is moderately rapid. Root penetration is moderately deep to deep. The soil has a good water-holding capacity and is moderate in fertility. There is a slight erosion hazard.

All of this soil is irrigated. Forage and hay are the principal crops (fig. 12), but corn for silage and oats are grown where the water table is at least 30 inches below the surface. The high water table in most places is a problem that requires attention. If it can be kept more than 4 feet from the surface, yields will increase. Some fertilizer has been used on corn, but the response is not conclusive. *Capability unit IIw–1(Ir).*

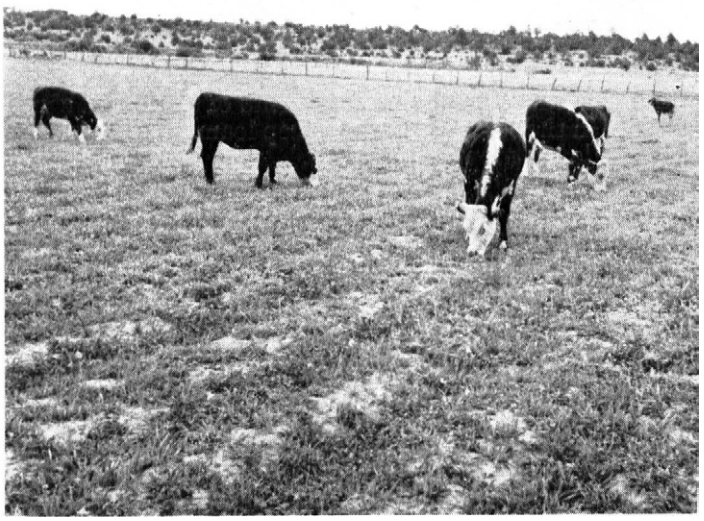

***Figure 12.*—Pinetop fine sandy loam in irrigated pasture. This soil is subject to a fluctuating water table.**

Redfield series

Soils of the Redfield series are on nearly level to moderately sloping alluvial fans and flood plains adjacent to the Little Colorado River and its nearby tributaries and in the vicinity of Snowflake. They are associated with the

Moenkopie, Tours, and Trail soils. The parent material consists of some wind-laid sandy material and of alluvium that washed from sandstone, shale, and the adjacent Moenkopie soils. The vegetation is chiefly alkali sacaton, galleta, sand dropseed, rabbitbrush, and snakeweed. Elevations range from 4,900 to 5,600 feet. The climate is semiarid. The average annual precipitation is 8 to 12 inches. Snowfall is 10 to 20 inches per year. The frost-free period is 132 to 175 days.

The Redfield soils typically have a deep, uniform very fine sandy loam profile. In places, however, the surface soil is sandy loam or loam, and in some areas sandstone and shale are at a depth of about 3 feet. The profile is calcareous throughout, and gypsum commonly occurs as veins or splotches.

The Redfield soils are well drained and have a good water-holding capacity. Runoff is very slow to medium. Permeability of the subsoil is moderate.

The Redfield soils are used for irrigated farming and for grazing.

Redfield very fine sandy loam, 1 to 3 percent slopes (RbB).—This uniformly textured, reddish-brown soil is on the gently sloping alluvial fans of intermittent streams adjacent to the Little Colorado River.

Representative profile:

0 to 10 inches, reddish-brown very fine sandy loam; massive; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 7.9); strongly calcareous.

10 to 72 inches +, similar to above layer except that the lower part of this horizon contains a few, fine, distinct, white veins of lime and a few thin veins of gypsum.

In a few small areas fine fragments of shale and sandstone are in the soil. An area of deep loam near Snowflake was included in mapping this soil.

Natural drainage is good, runoff is slow, and permeability is moderate. The soil is low in fertility and good in water-holding capacity. Root penetration is deep. There is a slight erosion hazard.

This soil is used mostly for grazing. Few areas are irrigated, because the soil is mostly above the old, established irrigation systems. Pump irrigation is practiced on the flood plains and low alluvial fans. The small areas that are irrigated do not produce well for the first 2 or 3 years because leveling pulverizes and compacts the soil. In addition, the surface layer disperses readily, and the sealing interferes with the absorption of water. Moreover, the soil is low in organic matter, and nonleguminous crops need nitrogen. These conditions gradually are alleviated by a few years of cropping. Irrigated crops are barley, corn for silage, and alfalfa for hay.

The range areas can be grazed all year, but alternating the grazing of pastures by seasons is the common practice. This allows the plants to maintain their vigor. Forage yields are fair. *Capability units IIe–2(Ir) and VIIc–1.*

Redfield very fine sandy loam, 0 to 1 percent slopes (RbA).—This is an inextensive soil on the lower parts of alluvial fans that border the flood plains. Runoff is very slow. Except for slopes, this soil is similar to Redfield very fine sandy loam, 1 to 3 percent slopes.

Slightly more than half of Redfield very fine sandy loam, 0 to 1 percent slopes, is irrigated; the rest is in range. The principal irrigated crops are barley, corn for silage, and alfalfa for hay. Yields are fairly high. Truck farming was attempted in the vicinity of Taylor, but it was not successful.

Areas used for grazing are managed much the same as range areas of Redfield very fine sandy loam, 1 to 3 percent slopes. *Capability units I–1(Ir) and VIIc–1.*

Redfield very fine sandy loam, 3 to 5 percent slopes (RbC).—This soil is in the vicinity of Snowflake on moderately sloping fans below the steep, shallow Moenkopie soils. Except for slopes, it is similar to Redfield very fine sandy loam, 1 to 3 percent slopes. In most areas, Redfield very fine sandy loam, 3 to 5 percent slopes, is more than 5 feet thick, but in some places sandstone and shale are only about 3 feet from the surface. Runoff is medium, and the erosion hazard is moderate.

All of this soil is used for grazing. Forage yields and management are similar to those on Redfield very fine sandy loam, 1 to 3 percent slopes. *Capability units IIIe–2(Ir) and VIIc–1.*

Redfield sandy loam, 1 to 3 percent slopes (RaB).—This soil occurs as small areas adjacent to other Redfield soils. It is like Redfield very fine sandy loam, 1 to 3 percent slopes, except that the surface layer is coarser and is less likely to puddle and compact. However, it blows more readily if the plant cover gets thin.

The surface layer of Redfield sandy loam, 1 to 3 percent slopes, consists of 10 to 16 inches of rapidly permeable sandy loam, which was deposited by wind and by water. Runoff is slow. There is a moderate hazard of wind erosion.

Except for one irrigated area near Joseph City, all of this soil is used for grazing. Most areas have a good cover of grass, and forage yields are slightly better than those obtained from the Redfield very fine sandy loams. Grazing in summer is preferred because the grass is more palatable at that time. *Capability units IIe–2(Ir) and VIIc–1.*

Redfield sandy loam, 3 to 5 percent slopes (RaC).—This soil occupies the upper ends of fans adjacent to Moenkopie soils or the outcroppings of Moenkopi sandstone. Except for slopes and the texture of the surface soil, it is similar to Redfield very fine sandy loam, 1 to 3 percent slopes. Its surface layer consists of 10 to 24 inches of rapidly permeable sandy loam. This material has been deposited by wind and water. The surface is slightly hummocky in places. There is a moderate erosion hazard.

This soil is used only for grazing. The forage can be grazed at any time of the year but is more palatable in summer. Pastures should be rested during the growing season to help the grasses maintain their vigor. When the vegetation thins, the soil is subject to wind and water erosion. *Capability units IIIe–2(Ir) and VIIc–1.*

Riverwash

Riverwash (Rv).—This land type consists of material that ranges from cobbly gravel to fine sand. It has no agricultural value. It occurs along permanent streams or in dry washes. Areas of Riverwash are flooded by runoff from heavy rains. Along the Little Colorado River, the shifting channel frequently alters the size and shape of these areas. Annual weeds, willow, and tamarisk are the predominant vegetation. *Capability unit VIIIw–1.*

Rock land

Rock land, basalt (Rk).—This land type occurs on low ridges and knolls and on the steep breaks at the edges of lava flows. Numerous areas are in the basalt flow that extends north from Pinetop to Shumway. The surface is almost covered by large, rounded boulders and stones that in many places interfere with the movement of cattle. Between the large boulders are small pockets of soil. Juniper, ponderosa pine, pinyon pine, and a moderate understory of bunch grasses are the typical vegetation. Tree growth and forage production are low. Plants are grazed mainly in summer, when they are most palatable. *Capability unit VIIs–2.*

Rock land, limestone (Rl).—This land type is made up of cliffs, breaks, and steep slopes consisting mainly of earthy limestone. Some sandstone is present. Rock land, limestone, occurs on the Mogollon Plateau near Heber. Small, isolated patches extend as far east as Linden.

This land type is about 30 percent exposed bedrock. The rest is covered by 2 to 8 inches of soil material that contains many fragments of limestone. The vegetation is mature ponderosa pine, juniper, and a thin to moderately dense cover of grass. In some parts there are pure stands of juniper and thin stands of grass. Forestry is the main use of this land type. A small amount of grazing can be done in summer. Deep snow and cold weather interfere with winter grazing. *Capability unit VIIs–2.*

Rock land, sandstone (Rs).—This land type is 30 to 80 percent large, angular stones and outcrops of light-brown sandstone. Loamy sand, 2 to 8 inches thick, occurs between stones and outcrops. The land type is on the Mogollon Plateau, on slopes ranging from 5 to 100 percent, between Show Low and Clay Springs. Runoff is rapid during torrential summer rains. The vegetation is ponderosa pine and a thin cover of cool-season grasses. Forestry is the main use. A little grazing is obtained from the grasses. *Capabiliy unit VIIs–2.*

Rock land, shale and sandstone (Rt).—This land type occurs in both the subhumid and semiarid zones, and it is made up of ledges, breaks, mesas, and ridges of rock outcrop (fig. 13). The rock is reddish-brown, chocolate-brown, brown, and buff sandstone, shale, and shaly sandstone. In some places thin beds of gypsum are in the rock. Where buff sandstone is exposed, many parallel joints or fracture planes can be seen in the irregular, wavy, sloping surface. A thin mantle of loose fine sand fills the fine parallel cracks and small, shallow depressions. The relief often interferes with the movement of livestock.

The vegetation in the subhumid zone is scrubby juniper and pinyon pine with a sparse understory of grasses. That in the semiarid section is stunted juniper and occasional clumps of grass growing in pockets of soil and in crevices. Included with this land type are areas of the very shallow Moenkopie fine sandy loams. Little economic use is made of Rock land, shale and sandstone. *Capability unit VIIIs–1.*

Sandy alluvial land

Sandy alluvial land (Sa).—This land type occurs along Hay Hollow Wash. It consists of stratified silt loam, silty clay loam, fine sandy loam, very fine sandy loam, loamy very fine sand, and, in a few places, sand and clay

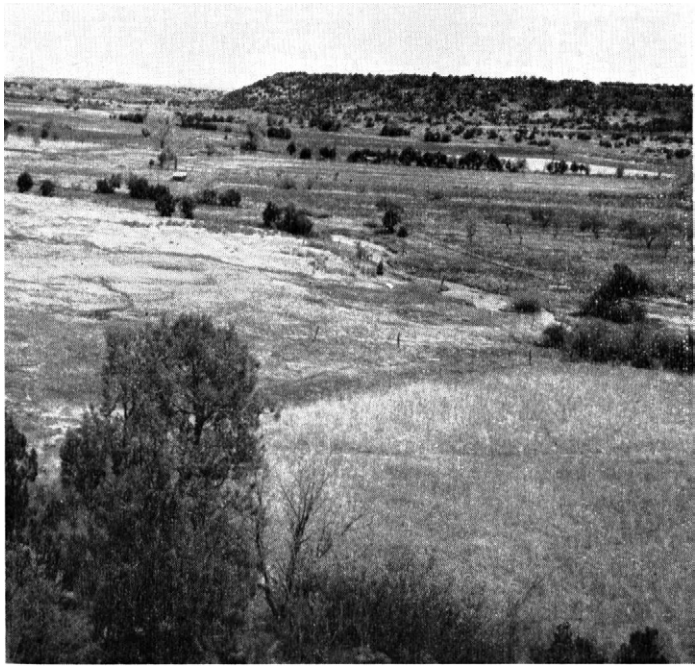

***Figure 13.*—In the background is an old basalt flow, the sides of which are occupied by Rock land, and the top by the Paiso soils. Bagley sandy clay loam is in the narrow valley along Silver Creek. In the foreground are the shallow Moenkopie soils on slopes of 4 to 6 percent.**

covered by 8 to 32 inches of wind-deposited sandy loam and loamy sand. The stratified material under the surface layer is the same kind of material from which the Tours, Navajo, Redfield, and Trail soils formed. The topography is slightly hummocky; areas are nearly level to gently sloping.

The vegetation is sand dropseed, galleta, Indian ricegrass, and Russian-thistle. Very little of the land type has been developed for irrigation because extensive leveling, intricate systems of irrigation, and the delivery of pumped irrigation water are needed. A limited amount of grazing is available in winter. *Capability units IIIs–3(Ir) and VIIc–1.*

Sandy alluvial land, moderately saline (Sb).—This land type is similar to Sandy alluvial land, but it contains a moderate amount of toxic salts and has smooth, nearly level to gentle slopes. In addition, the surface soil has been deposited by water. The soil occurs on the flood plain of the Little Colorado River. The water table fluctuates to a depth below 6 feet.

This land type is used for irrigated farming and for grazing. Alfalfa, corn, and pasture are the principal irrigated crops. Yields are moderate. Better yields could be obtainted if the toxic salts were leached from the root zone of most crops. The part in range can be used for yearlong grazing. Pastures are rested during the growing season to improve the grass. Forage yields are low and of poor quality, and the vegetation improves very slowly, even under good range management. *Capability units IIIs–3(Ir) and VIIs–4.*

Sandy alluvial land, strongly saline (Sc).—This land type is similar to Sandy alluvial land, except that it is strongly saline, has a high water table part of the year, and has a thick subsurface layer of sand or clay. The surface soil is water-deposited fine sand and loamy fine sand. A fluffy layer of salt is generally on the surface.

The vegetation is saltgrass, alkali sacaton, willow, camelthorn, and greasewood. It is grazed the year round. The forage is of poor quality and of low yield. The loamy fine sand surface soil is often compacted by the trampling of livestock. Alternating the grazing by periods during the growing season reduces the severity of compaction and increases forage production. *Capability unit VIIs–4.*

Sheppard series

The Sheppard series consists of nearly level to moderately sloping soils on ridges above the flood plain of the Little Colorado River. The soils consist of windblown and water-laid sediments derived mainly from sandstone and partly from limestone and shale. They are associated mainly with the Moffat, Navajo, and Trail soils. The vegetation is sand dropseed, Indian ricegrass, black grama, and snakeweed. Elevations range from 4,900 to 5,100 feet. The climate is semiarid. The average annual precipitation is 8 to 9 inches. Snowfall is about 10 inches per year. The frost-free period is about 172 days.

The surface layer is 5 to 10 inches of fine sand or sandy loam that commonly contains pebbles of quartzite. The subsoil is relatively clean sand and extends to a depth of more than 60 inches from the surface. Sheppard soils are excessively drained. Runoff is very slow. Permeability is very rapid, and the water-holding capacity is low to very low.

The Sheppard soils are used for grazing.

Sheppard fine sand, 3 to 10 percent slopes (SdC).—This soil is in the vicinity of Joseph City on a moderately dissected terrace that adjoins the flood plain of the Little Colorado River.

Representative profile:

0 to 8 inches, reddish-brown fine sand that contains some pebbles of quartzite; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 8.0); strongly calcareous; few roots.

8 to 60 inches +, pale-brown sand; stratified; single grained; loose when moist and dry, nonsticky and nonplastic when wet; moderately alkaline (pH 8.1); strongly calcareous; very few roots.

In places the surface soil is hard when dry but is very friable when wet. In one small area the subsoil is reddish brown. In another area, north of Woodruff, 12.5 acres on slopes of 1 to 3 percent and consisting of loamy sand, moderately deep over loam, have been included with this soil.

Sheppard fine sand, 3 to 10 percent slopes, is excessively drained, has a low to very low water-holding capacity, and is low in fertility. Root penetration is deep. Permeability is very rapid in the subsoil, but a few pebbles on the surface tend to stabilize the soil against blowing. The pebbles help to protect the cover of grass and to hold the sandy material that has blown in from the dry beds of the Little Colorado River.

This soil is used only for grazing. It produces more forage than many finer textured soils that receive the same amount of precipitation, because very little moisture is lost through runoff. The forage can be grazed all year, but pastures should be rested in alternate periods during the growing season to maintain plant vigor and density. The utmost precaution should be taken to preserve the grass cover. If the cover is destroyed, the soil would become moving sand dunes and produce little, if any, forage. *Capability unit VIIe–3.*

Showlow series

Soils of the Showlow series are the most extensive in the Area. They are on the nearly level to steep uplands of the Mogollon Plateau and extend from Lakeside to Overgaard. They are associated with the Elledge, Chevelon, Claysprings, and Zeniff soils. The parent material is alluvium containing large amounts of sand, gravel, and cobbles. The vegetation is ponderosa pine, pinyon pine, juniper, some Gambel oak, and a sparse cover of cool-season grasses. The Showlow soils are at elevations of 6,000 to 7,000 feet and have a subhumid climate. The average annual precipitation is 17 to 22 inches. Snow amounts to 48 to 64 inches a year. The frost-free period is 115 to 127 days.

The Showlow soils characteristically have a thick, slowly permeable to very slowly permeable clay subsoil with color variations of reddish brown, dark reddish brown, and dark red. Under the subsoil is typically a massive, gravelly sandy clay loam or gravelly clay loam substratum that extends to a depth of more than 60 inches from the surface. The surface soil is loam, clay loam, sandy loam, or cobbly sandy clay loam. Most of the Showlow soils have cobbles and pebbles on the surface and throughout the profile.

The Showlow soils are well drained, are moderately fertile, and have a good water-holding capacity. Runoff ranges from very slow to rapid.

The Showlow soils are used for irrigated farming, dryland farming, grazing, and forestry.

Showlow loam, 1 to 3 percent slopes (SlB).—This soil is on gently rolling upland plains. It occurs in large areas.

Representative profile:

1 inch to 0, forest litter, mostly pine needles.

0 to 1 inch, brown loam; weak, platy structure; slightly hard when dry, very friable when moist, nonplastic when wet; noncalcareous; neutral (pH 6.9); few roots.

1 to 3 inches, dark grayish-brown loam; moderate, platy structure; slightly hard when dry, very friable when moist, slightly plastic when wet; neutral (pH 6.9); noncalcareous; few roots.

3 to 12 inches, reddish-brown clay loam; moderate, subangular blocky structure; hard when dry, friable when moist, plastic when wet; neutral (pH 6.9); noncalcareous; few roots.

12 to 31 inches, reddish-brown clay; angular blocky structure; extremely hard when dry, extremely firm when moist, very plastic and very sticky when wet; mildly alkaline (pH 7.5); noncalcareous; very few roots.

31 to 44 inches, reddish-brown gravelly sandy clay loam; massive; very hard when dry, firm when moist, plastic when wet; mildly alkaline (pH 7.5); calcareous; faint lime mottles; very few roots.

44 to 52 inches +, reddish-brown gravelly sandy clay loam; massive; very hard when dry, firm when moist, slightly plastic when wet; mildly alkaline (pH 7.7); calcareous; very few roots.

Natural drainage is good. Runoff is slow. Permeability is moderately slow in the surface soil and very slow in the subsoil. Root penetration is moderately deep to deep. The water-holding capacity is good, and fertility is moderate. There is a slight erosion hazard.

This soil is used only for grazing and forestry (fig. 14). Snow and severe weather prevent grazing during the winter. Forage yields are greatly variable. The density of the forest cover influences the amount of forage produced. The denser the trees, the lower the forage yields. A deferred rotation system of grazing that includes rest periods every 3 to 5 years during the growing season helps to maintain the cover of grass.

The loam surface layer is very stable and does not erode readily. When this soil is cultivated, the surface layer is mixed with subsoil. The soil is then mapped as Showlow clay loam. *Capability units IIIe–5(Ir) and IVs–5 (D).*

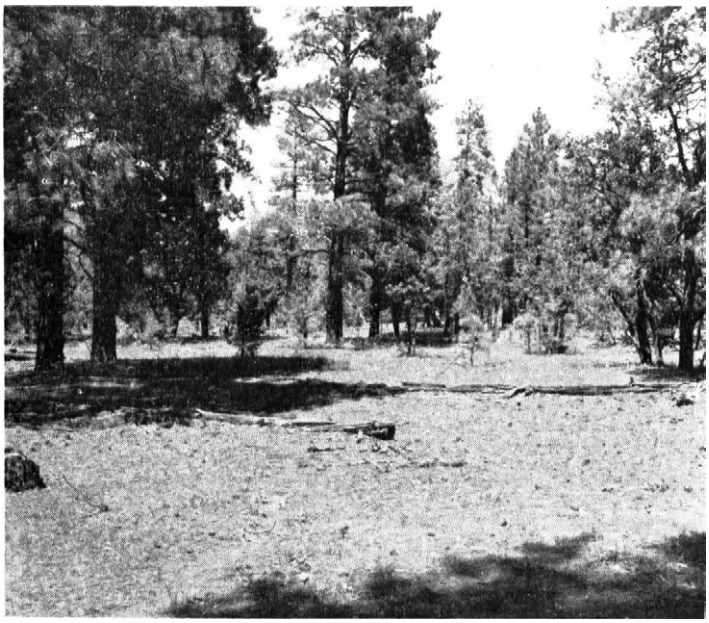

***Figure 14.*—Ponderosa pine, juniper, Gambel oak, and a thin cover of cool-season grasses growing on Showlow loam. The area is grazed in summer.**

Showlow loam, 0 to 1 percent slopes (SlA).—This soil is like Showlow loam, 1 to 3 percent slopes, except for slopes. Present use and management of the two soils are similar. However, Showlow loam, 0 to 1 percent slopes, could be cultivated more economically and would require less intensive management than Showlow loam, 1 to 3 percent slopes. *Capability units IIIs–5(Ir) and IVs–5(D).*

Showlow loam, 3 to 5 percent slopes (SlC).—This soil is similar to Showlow loam, 1 to 3 percent slopes, except that it has stronger slopes and not so much lime in the lower subsoil. The two soils are used and managed the same. If cultivated, Showlow loam, 3 to 5 percent slopes, would need more careful management because runoff and the hazard of erosion are greater. *Capability units IVe–1 (Ir) and IVe–6(D).*

Showlow loam, 5 to 20 percent slopes (SlD).—This soil is on moderate to steep breaks and on side slopes of intermittent drainageways. A few quartzite cobbles are on the surface. Runoff is rapid, and there is a severe erosion hazard. There is less lime in the substratum than in Showlow loam, 1 to 3 percent slopes, and the clay subsoil is less than 15 inches thick. The soils are otherwise similar.

Showlow loam, 5 to 20 percent slopes, is used only for range and forestry. Forest trees are more mature, and stands are more dense than on other Showlow loams. There is less grass, however, and a lower yield of forage. *Capability unit VIe–1.*

Showlow clay loam, 0 to 1 percent slopes (ShA).—This soil is on a nearly level plain north of the town of Show Low. The surface soil is clay loam and is 6 to 10 inches thick. The subsoil is reddish-brown, dark reddish-brown, or dark-red clay. The substratum is strongly calcareous.

Natural drainage is good. Permeability is moderately slow in the surface soil and slow to very slow in the subsoil. Root penetration is moderately deep to deep. The soil is good in water-holding capacity and moderate in fertility. Runoff is very slow, and there is a slight erosion hazard.

The soil was irrigated by the early pioneers, and it is still being irrigated. The principal crops are alfalfa, corn for silage, sweet corn, oats, and pasture forage. Tillage and irrigation need to be done carefully because the surface soil is easily compacted and puddled. Irrigation should be light during spring to prevent waterlogging, which causes the soil to warm up slowly. *Capability units IIIs–5(Ir) and IVs–5(D).*

Showlow clay loam, 1 to 3 percent slopes (ShB).—This soil is on gently rolling plains. It has more runoff and a greater erosion hazard than Showlow clay loam, 0 to 1 percent slopes, but it is otherwise similar.

Showlow clay loam, 1 to 3 percent slopes, is fairly extensive and occurs throughout the area of Showlow soils. It is used for irrigated farming, dryland farming, grazing, and forestry. The principal irrigated crops are alfalfa, corn for silage, sweet corn, oats, and pasture forage. When irrigated, this soil requires more care than Showlow clay loam, 0 to 1 percent slopes, so as to prevent excessive losses of water and soil from the lower ends of the fields.

The chief dry-farmed crops are winter wheat, corn, grain sorghum, and pinto beans. This soil, however, is not well suited to dryland farming. The penetration of water from slow winter rains and the melting of snow is adequate, but considerable water is lost through runoff during severe summer storms, This moisture that is lost is often the critical amount needed for the satisfactory production of crops. Proper tillage is essential. Compaction of the surface soil can cause a crop failure by decreasing the absorption of water, and it can prevent satisfactory establishment of crops.

Areas in native vegetation are used for grazing and forestry. They are grazed in spring, summer, and fall. Forage yields are influenced by the density of the tree cover. Moderately high yields are obtained where the tree cover is light. *Capability units IIIe–5(Ir) and IVs–5(D).*

Showlow clay loam, 3 to 5 percent slopes (ShC).—This soil is on moderate slopes along shallow swales or is adjacent to strongly sloping breaks. Runoff is medium, and the erosion hazard is moderate. This soil is similar to Showlow clay loam, 0 to 1 percent slopes, but the slopes are steeper and the surface has a greater number of cobbles. There are more trees and less grass on Showlow

clay loam, 3 to 5 percent slopes, than on the less steeply sloping Showlow clay loam soils.

This soil is used for irrigated farming, dryland farming, grazing, and forestry. Farmers use nitrogen and phosphate fertilizers. The soil is well suited to irrigated pasture, and yields of forage are high. Row crops must be grown with care because this soil erodes readily.

The chief dry-farmed crop is winter wheat, but grain sorghums and corn for silage are occasionally grown. Rough tillage and stubble mulching should be practiced to reduce excessive runoff from summer rains.

The native vegetation is grazed in spring, summer, and fall. Yields of forage are low. *Capability units IVe–1 (Ir) and IVe–6 (D).*

Showlow clay loam, 5 to 20 percent slopes (ShD).—This extensive soil occurs along drainageways that dissect the rolling plains of the Mogollon Plateau. The clay loam surface soil is 3 to 6 inches thick. It is underlain by 10 to 15 inches of clay that overlies calcareous, heavy sandy clay loam or clay. Slopes are stronger and there is less lime in the substratum than in Showlow clay loam, 0 to 1 percent slopes. In addition, some places have cobbles on and in the soil. Runoff is rapid and the erosion hazard is severe. Considerable ponderosa pine grows on this soil, and in some places it occurs as pure stands. The cover of grass is sparse.

The soil is used for spring, summer, and fall grazing and for forestry. Forage yields are low. Grazing is like that on Showlow clay loam, 1 to 3 percent slopes, but there is less forage available on this steeper soil. *Capability unit VIe–1.*

Showlow cobbly sandy clay loam, 5 to 20 percent slopes (SkD).—This soil is along drainageways that dissect the rolling plains of the Mogollon Plateau. It has the largest area of the Showlow soils.

Representative profile:

1 inch to 0, forest litter, mostly pine needles.
0 to 5 inches, dark reddish-brown cobbly sandy clay loam; moderate, granular structure; slightly hard when dry, friable when moist, slightly plastic when wet; neutral (pH 7.4); few roots.
5 to 22 inches, dark reddish-brown clay; weak, prismatic structure breaking to strong, blocky; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; neutral (pH 7.3); very few roots.
22 to 46 inches, dark reddish-brown to dark-red gritty and cobbly clay; moderate, subangular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; mildly alkaline (pH 7.5); very few roots.
46 to 60 inches +, reddish-brown to red gritty and cobbly clay; weak, subangular blocky structure; slightly hard when dry, slightly firm when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.5); calcareous; very few roots.

In some places lime is within 18 inches of the surface. It increases in amount in the subsoil in areas toward the top of the slopes that border the rolling plains. The surface layer is 3 to 6 inches thick.

Natural drainage is good and runoff is rapid. Permeability is moderately slow in the surface soil and slow to very slow in the subsoil. Root penetration is moderately deep to deep. The water-holding capacity is good, and fertility is moderate. There is a severe erosion hazard.

This soil is used only for forestry. There is little forage for grazing. *Capability unit VIs–1.*

Showlow cobbly sandy clay loam, 1 to 3 percent slopes (SkB).—This soil is similar to Showlow cobbly sandy clay loam, 5 to 20 percent slopes, but it occurs on gentle slopes, has fewer cobbles on the surface and in the profile, and has a surface layer that is 6 to 8 inches thick. Runoff is slow, and the erosion hazard is slight. Fewer trees and more grass are on this soil than on the steeper Showlow cobbly sandy clay loams.

This soil is used for spring, summer, and fall grazing and for forestry. Forage yields are moderate. A few small fields were cleared of cobbles and cultivated by the homesteaders. Where cultivation has mixed the surface soil with finer textured subsoil, the areas are mapped as Showlow clay loam. *Capability unit VIs–1.*

Showlow cobbly sandy clay loam, 3 to 5 percent slopes (SkC).—This soil is on moderate slopes near shallow drainageways. Quartzite cobbles comprise 10 to 15 percent of the surface soil, and there are a few cobbles throughout the profile. Runoff is medium, and the erosion hazard is moderate. Except for slopes this soil is similar to Showlow cobbly sandy clay loam, 5 to 20 percent slopes.

This soil is used for grazing and forestry. Forage yields are moderate to moderately low, but the forage is of good quality. *Capability unit VIs–1.*

Showlow sandy loam, 1 to 3 percent slopes (SmB).—This is the most extensive of the Showlow sandy loams. The surface layer is 6 to 18 inches of porous, friable, and moderately rapidly permeable material that has been deposited by wind. It absorbs water rapidly. The origin of some areas of this material has not been determined, but wind-deposited materials in other areas originated from the nearby Elledge soils and the other Showlow soils.

The soil is well suited to irrigated farming and dryland farming, and approximately half the areas are used for these purposes. The irrigated crops are corn, small grains, and an alfalfa-grass mixture grown for forage. No set rotation is followed. The use of fertilizer is increasing. Corn responds to nitrogen and phosphate, and alfalfa, to phosphate. This soil warms up earlier in the spring than the finer textured soils. This is an important characteristic where the growing season is short.

The principal dry-farmed crops are corn (fig. 15), grain sorghum, and winter wheat. Crops fail at intervals of about 6 to 7 years, because they are short on moisture. Commercial fertilizer has not been used on dry-farmed crops, but in years of above average precipitation, yields should increase if fertilizer is applied. *Capability units IIIe–6 (Ir) and IIIs–7 (D).*

Showlow sandy loam, 3 to 5 percent slopes (SmC).—This inextensive soil occurs mostly in small areas at the bases of steep slopes. Except for stronger slopes, more rapid runoff, and a greater erosion hazard, it is similar to Showlow sandy loam, 1 to 3 percent slopes.

Showlow sandy loam, 3 to 5 percent slopes, is used for dryland farming, grazing, and forestry. Corn, winter wheat, and grain sorghum are the main dryland crops. Erosion and loss of water during severe summer storms are problems. Careful management is needed to reduce excessive soil losses.

Pastures are grazed during the spring, summer, and fall. Forage yields are higher on this soil than on Showlow

Figure 15.—**A dry-farmed area of Showlow sandy loam in corn. The surface layer, which is 10 to 17 inches of moderately rapidly permeable sandy loam, absorbs most of the moisture that falls as summer rain. The shortage of moisture in May and June increases the hazards of dryland farming in this area, although the total precipitation is 18 inches a year.**

sandy loam, 1 to 3 percent slopes. Forestry is of minor importance. *Capability units IVe–1 (Ir) and IVe–6 (D).*

Showlow sandy loam, 5 to 20 percent slopes (SmD).—The surface layer of this soil is 6 to 12 inches of sandy loam. Except for slopes, the soil is similar to Showlow sandy loam, 1 to 3 percent slopes. Runoff is medium, and there is a severe hazard of erosion. The stands of ponderosa pine are more dense and the cover of grass is thinner on this soil than on the other Showlow sandy loams.

This soil is used for forestry and grazing. Forestry is the best use. The soil is of little value for grazing, because the grass is so sparse. *Capability unit VIe–1.*

Silver series

Soils of the Silver series are on gently to moderately rolling high plains west of Taylor and are associated with soils of the Millett series. They have formed in mixed alluvium. The vegetation is ring muhly, three-awn, snakeweed, and Russian-thistle. Elevations range from 5,600 to 5,700 feet. The climate is semiarid. The average annual precipitation is 11 to 13 inches. Snowfall is approximately 20 inches per year. The frost-free period is approximately 132 days.

The Silver soils are grayish-brown to very pale brown clay to a depth of about 48 inches. They are underlain by massive sandy clay loam to a depth of more than 60 inches from the surface. The upper several inches of the surface layer in many undisturbed areas is a granular clay mulch. In parts of the area covered by the Silver soils, a thin layer of clay below the surface layer contains excessive amounts of sodium.

The Silver soils are well drained and slowly permeable to very slowly permeable. Those affected by excessive amounts of sodium are almost impermeable. Runoff is slow to medium. The water-holding capacity is good. Fertility is low to moderate.

The Silver soils are used mostly for range. One area is irrigated.

Silver clay, 1 to 3 percent slopes (SnB).—This soil comprises more than 90 percent of the acreage of the Silver soils. The slopes are gently undulating.

Representative profile:

0 to 4 inches, grayish-brown clay; moderate, granular structure; very hard when dry, firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.5); noncalcareous; plentiful roots.

4 to 29 inches, light brownish-gray clay; very weak, prismatic structure that breaks to strong, subangular blocky; very hard to extremely hard when dry, very firm when moist, very sticky and very plastic when wet; mildly alkaline (pH 7.7); upper few inches noncalcareous, lower part strongly calcareous; few roots.

29 to 46 inches, very pale brown clay, not so fine textured as in layer above; moderate, subangular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; mildly alkaline (pH 7.5); very strongly calcareous; common large white splotches of calcium carbonate; few roots.

46 to 60 inches +, very pale brown gravelly sandy clay loam; massive; hard when dry, firm when moist, very sticky and very plastic when wet; mildly alkaline (pH 7.5); very strongly calcareous; prominent white splotches of calcium carbonate; very few roots.

This soil is well drained. Permeability is slow in the surface soil and slow to very slow in the subsoil. Root penetration is moderately deep to deep. The soil is low to moderate in fertility and good in water-holding capacity. Runoff is slow. There is a slight erosion hazard.

Most of this soil is in range. One small area has been irrigated for 3 or 4 years, but yields have not been satisfactory. Land leveling has exposed the subsoil in many places, and many areas are affected by excessive amounts of sodium. These areas affected by sodium have very slow infiltration, and most intertilled crops fail. Grass crops are better suited to this soil than tilled crops, but even these have not done well.

Forage is grazed in spring, summer, and fall. Yields are low. Rotation grazing, or complete summer deferment, is necessary to improve the vigor and density of the present grass cover. *Capability units IIIe–4 (Ir) and VIIs–4.*

Silver clay, 3 to 5 percent slopes (SnC).—This soil occurs in narrow bands adjacent to the rolling uplands. Runoff is slow to medium, and there is a slight to moderate erosion hazard. Except for slopes, the soil is like Silver clay, 1 to 3 percent slopes.

No attempt has been made to develop this soil for irrigation; it is used only for grazing. Forage is of poor quality, and yields are low. Grazing management is the same as for Silver clay, 1 to 3 percent slopes. *Capability units IVe–5 (Ir) and VIIs–4.*

Sponseller series

The Sponseller soils occupy nearly level to strong slopes on the mountain plateau near Lakeside and Pinetop. They have formed in a mixture of volcanic cinders and basalt slag. The vegetation is a pure stand of ponderosa pine and a sparse understory of grass. The Sponseller soils are at elevations of approximately 7,000 feet. The climate is subhumid. The average annual precipitation is 21 to 23

inches, and the annual snowfall is 62 to 75 inches. The frost-free period is about 125 days.

These soils are reddish brown and noncalcareous. The surface soil is mainly silt loam or gravelly loam, but in places 10 to 15 percent or more of it is volcanic cinders and basalt stones and cobbles. The subsoil is heavy loam to heavy clay loam, and basalt stones and cobbles make up to 60 percent of the total mass. At a depth of 24 to 44 inches, the subsoil is underlain by basalt bedrock, stones, boulders, cobbles, and volcanic cinders. The Sponseller soils are well drained, moderately fertile, and moderately slowly permeable. Runoff is very slow to medium, and the water-holding capacity is low.

These soils are used for irrigated farming, grazing, forestry, and homesites.

Sponseller silt loam, 1 to 3 percent slopes (SrB).—Small tracts of this soil were cleared of the forest cover by pioneers who first settled in the region. The tracts were either farmed or used as homesites or townsites. Farming was on a subsistence basis. Irrigation was used to supplement the rainfall during dry periods late in spring and in summer.

Representative profile:

1 inch to 0, undecomposed to partially decomposed pine needles.
0 to 4 inches, reddish-brown silt loam; moderate, platy structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; neutral (pH 6.8); noncalcareous; few roots.
4 to 11 inches, reddish-brown light cobbly clay loam; weak, angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly acid (pH 6.3); noncalcareous; few roots.
11 to 20 inches, reddish-brown very cobbly clay loam; moderate, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly acid (pH 6.3); noncalcareous; few roots.
20 to 42 inches, reddish-brown very stony clay loam containing many small, partially decomposed cinders; weak, angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.7); noncalcareous; few roots.
42 inches +, basalt boulders, cobbles, and cinders.

The soil is well drained. Runoff is slow. Permeability is moderate in the surface soil and moderately slow in the subsoil. Root penetration is moderately deep to deep. The water-holding capacity is low, and fertility is moderate. There is a slight erosion hazard.

This soil occurs in an area that is popular for the construction of summer homes, and much of it has been subdivided for development. A small area is in irrigated pasture that is grazed by calves and saddle horses. The horses are ridden by summer vacationers. The uncleared areas are used for recreation and forestry. Forestry is the most impotant use. *Capability units IIIe-3(Ir) and IVs-6(D).*

Sponseller silt loam, 0 to 1 percent slopes (SrA).—Except for slopes, this soil is like Sponseller silt loam, 1 to 3 percent slopes. The two soils are used in the same ways. *Capability units IIIs-6(Ir) and IVs-6(D).*

Sponseller gravelly loam, 1 to 3 percent slopes (SpB).—This soil is similar to Sponseller silt loam, 1 to 3 percent slopes, but the surface layer is gravelly loam containing 10 to 15 percent of fine to coarse volcanic cinders. In addition, the subsoil is 20 to 25 percent cinders coated with clay. Below a depth of 24 to 30 inches from the surface are basalt stones and boulders and many partially weathered cinders. The soil is moderately permeable, and root penetration is moderately deep. The largest area of the soil is in the vicinity of Lakeside; a smaller area is near Pinetop.

Forestry is the most important use of this soil, but some areas are grazed. In addition, there are a few irrigated commercial apple orchards and family gardens at Lakeside, and a small irrigated pasture at Pinetop. This soil occurs where the weather is cool in spring, so it is desirable to irrigate lightly at that time. Frequent and heavy irrigations are unnecessary and keep the soil too cold. *Capability units IIIe-3(Ir) and IVs-6(D).*

Sponseller gravelly loam, 5 to 10 percent slopes (SpC).—Except for having stronger slopes, more rapid runoff, and a greater hazard of erosion, this soil is similar to Sponseller gravelly loam, 1 to 3 percent slopes. It occurs in two small areas along the strongly sloping boundaries of a basalt flow. One area is at Lakeside, and the other is at Pinetop. The one at Lakeside has no agricultural use. The one at Pinetop is immediately below a high irrigation canal and is used for irrigated permanent pasture. Water is allowed to flow across the soil, and the excess is used for irrigating other soils in the valley below. *Capability units IVe-2 (Ir) and VIe-2.*

Springerville series

The Springerville soils are on nearly level to gently sloping upland plains throughout the basalt and cinder plateaus and mountains in the southeastern part of the Area. They are associated chiefly with the McNary, Disterheff, and Paiso soils. They have developed in place on volcanic cinders and on basalt slag and bombs. The vegetation consists of western wheatgrass, mountain brome, juniper, and a few ponderosa pines (fig. 16). Elevations range from 6,700 feet to 7,200 feet. The climate is subhumid. The average annual precipitation is 21 to

Figure 16.—Native vegetation consisting of western wheatgrass, mountain brome, and juniper growing on Springerville clay and Springerville stony clay.

23 inches, and the annual snowfall is 62 to 75 inches. The frost-free period is about 127 days.

The surface soil and subsoil are noncalcareous clay that contains, in most places, numerous basalt cobbles and stones. The substratum is strongly calcareous, stony clay underlain by basalt bedrock.

These Springerville soils shrink and swell markedly upon wetting and drying. Surface cracks, ½ inch to 1½ inches wide and 15 to 20 inches deep, form when the soil is dry. Surface soil often falls into the cracks. When saturated, the soil expands, the cracks close, and the soil churns. The churning has resulted in an irregular surface of valleys and ridges. Stones, 5 to 24 inches in diameter, cover 5 to 20 percent of the surface of most areas. Stones in the profile may comprise 25 percent of the soil mass below a depth of 30 inches from the surface.

The Springerville soils are well drained to moderately well drained. Runoff ranges from very slow to slow. Movement of water through the profile is slow to very slow. The water-holding capacity is good.

The soils are used for dryland farming, irrigated farming, and grazing.

Springerville stony clay, 0 to 1 percent slopes (StA).—This soil is on broad, nearly level basinlike areas between cinder cones and basalt flows (fig. 17).

Representative profile:

0 to 2 inches, dark-brown stony clay mulch; strong, granular structure; hard when dry, friable when moist, very sticky and very plastic when wet; slightly acid (pH 6.4); noncalcareous; few roots.
2 to 14 inches, dark reddish-brown stony clay; weak, prismatic structure breaking to moderate, angular blocky; very hard when dry, very firm when moist, very sticky and very plastic when wet; slightly acid (pH 6.2); noncalcareous; abundant roots.
14 to 28 inches, dark reddish-brown stony clay; strong, angular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; neutral (pH 6.7); noncalcareous; roots common.
28 to 46 inches, dark-brown stony clay; weak, angular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; mildly alkaline (pH 7.6); strongly calcareous; few roots.
46 inches +, basalt bedrock.

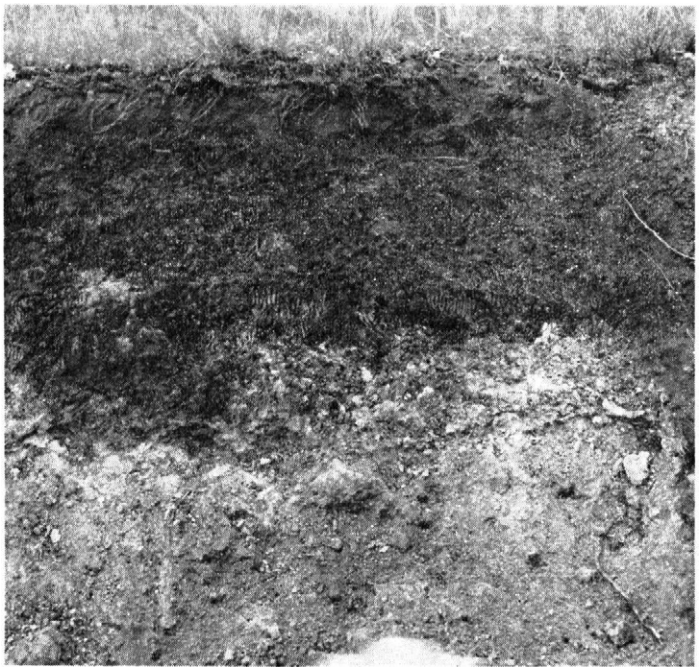

Figure 17.—**Profile of a Springerville soil showing a 2-inch surface mulch of granular clay. This is underlain by 24 to 30 inches of dark reddish-brown clay, over 8 to 12 inches of brown clay mixed with light-brown segregated and disseminated lime. The parent material is volcanic cinders and basalt.**

Natural drainage is good. Runoff is very slow. Permeability is slow in the surface soil and slow to very slow in the subsoil. Root penetration is moderately deep to deep. The soil has a good water-holding capacity and moderate to high fertility. There is a slight erosion hazard.

Except in a few small areas, the soil is too stony for cultivation. The stones are 5 to 24 inches in diameter and cover 5 to 20 percent of the surface. They occupy as much as 25 percent of the soil mass below a depth of 39 inches. The forage is commonly grazed late in spring and in summer to make the best use of western wheatgrass, the dominant vegetation. Deep snow prevents winter grazing. Yields of forage are high, and the grass is easily maintained. The grass deteriorates slowly and recovers rapidly from overuse if pastures are rested in summer. *Capability unit VIIs–2.*

Springerville stony clay, 1 to 3 percent slopes (StB).—This soil is similar to Springerville stony clay, 0 to 1 percent slopes, except that it has stronger slopes and more rapid runoff. The composition and condition of the vegetation are variable. In some places pure stands of ponderosa pine occur, and in other places western wheatgrass is essentially the only vegetation. In still other areas, the cover is mainly juniper, with small amounts of ponderosa pine and western wheatgrass.

This soil is used for grazing and forestry. Forage yields and range management are much like those for Springerville stony clay, 0 to 1 percent slopes. *Capability unit VIIs–2.*

Springerville clay, 0 to 1 percent slopes (SsA).—This soil is similar to Springerville stony clay, 1 to 3 percent slopes, except that it has few, if any, stones in the surface soil. Either the stones have been removed, or none were present originally.

This soil is used for irrigated farming (fig. 18) and for grazing. One large area east of Lakeside was dry-farmed by pioneers but has since reverted to western wheatgrass and a few annual weeds. The main irrigated crops are barley, winter wheat, oats, and pasture forage. Yields are highly variable, depending on the degree of management. This soil can be adequately tilled only under a narrow range of moisture content. It is difficult to work when too wet or too dry. If tilled when too wet, the surface soil compacts and puddles, and tillage pans develop. However, the soil recovers readily if it undergoes a thorough wetting and drying. *Capability units IIIs–1(Ir) and IVs–4(D).*

Springerville clay, 1 to 3 percent slopes (SsB).—This soil occurs between areas of the nearly level Springerville soils on lower slopes and the shallow, stony Paiso soils on the higher escarpments. It is like Springerville stony clay, 1 to 3 percent slopes, but it has few, if any, stones in the surface layer. The stones have been removed, or they were not present originally. The vegetation in uncultivated areas is mainly western wheatgrass and a few juniper trees.

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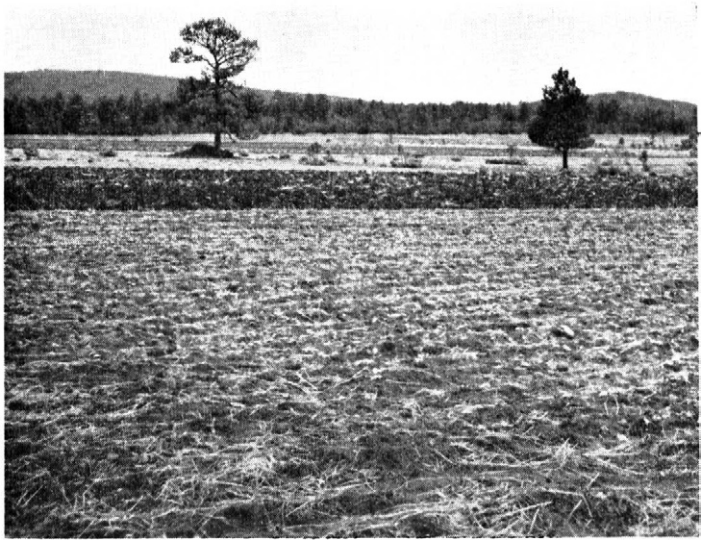

Figure 18.—**Springerville clay under irrigation. Elevation 7,000 feet. Basalt stones were removed from the surface before the soil was farmed. Mainly ponderosa pine forest in background.**

This soil is used for irrigated farming, dryland farming, and grazing. Barley, winter wheat, oats, and pasture forage are the main irrigated crops. Careful handling of irrigation water is necessary. As a rule, water is allowed to run down the slopes. In this way, excessive amounts of water and soil are lost. Because it is absorbed slowly, water should be applied in small amounts over long periods.

The loss of large amounts of summer moisture through runoff interferes with the success of dryland farming. Forage yields and range management are like those practiced on Springerville stony clay, 0 to 1 percent slopes. *Capability units IIIe–4(Ir) and IVs–4(D).*

Terrace escarpments

Terrace escarpments, loamy (Ta).—This land type occurs on steep escarpments, about 10 to 25 feet high, in the vicinity of Joseph City. The escarpments are rapidly eroding and are almost bare of vegetation. In texture and color, the loamy material is similar to that of the Jocity soils. Little or no use is made of this land type. *Capability unit VIIIs–1.*

Terrace escarpments, sandy (Tb).—This land type is on steeply sloping, eroded remnants of old river terraces and breaks between the Moffat soils and the flood plain. The material is a reddish-brown mixture of clay loam, loamy sand, and loamy gravel. It has a pebbly surface in most places. It supports a moderate cover of vegetation consisting mainly of blue grama, galleta, alkali sacaton, and snakeweed.

Grazing is the only use of this land type. Summer grazing is generally preferred to winter grazing because galleta and alkali sacaton, the dominant grasses, are more palatable in the summer. *Capability unit VIIs–5.*

Tours series

The Tours soils occupy nearly level to moderate slopes in low swales and on alluvial fans and flood plains, near Snowflake and Taylor and along the Little Colorado River. They are associated with the Moenkopie, Redfield, Navajo, and Trail soils. The Tours soils consist of alluvium derived mainly from Moenkopi sandstone and shale but also locally from Chinle shale and basalt. The vegetation is chiefly alkali sacaton, but, in overgrazed areas, this has been replaced by fourwing saltbush. Elevations range from 5,000 to 5,600 feet. The climate is semiarid. The average annual precipitation is 8 to 13 inches. Snowfall is 10 to 21 inches per year. The frost-free period is 132 to 174 days.

The Tours soils are typically reddish-brown, strongly calcareous clay loam or silty clay loam to a depth of more than 60 inches from the surface. In a few areas, however, the lower layers are stratified with silt and very fine sandy loam. In one area the subsoil is light clay. In other areas the clay loam surface soil was deposited over material similar to that of Redfield fine sandy loam. In places a high water table has caused harmful salts to accumulate in the soil. These salts are toxic to many plants.

Except in the areas having a high water table, the Tours soils are well drained. Permeability is moderately slow. The water-holding capacity is high. Runoff ranges from very slow to medium, depending on the slope and cover.

The Tours soils are used for irrigated farming and grazing.

Tours clay loam, 0 to 1 percent slopes (TcA).—This soil occurs (fig. 19) in smooth, nearly level swales and on alluvial fans and flood plains.

Representative profile:

0 to 8 inches, reddish-brown clay loam; weak, platy structure; hard when dry, friable to firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.5); strongly calcareous; abundant roots.

8 to 60 inches, reddish-brown silty clay loam; massive; hard when dry, friable to firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.5); strongly calcareous; plentiful roots.

Natural drainage is good, runoff is very slow, and permeability is moderately slow. Root penetration is deep.

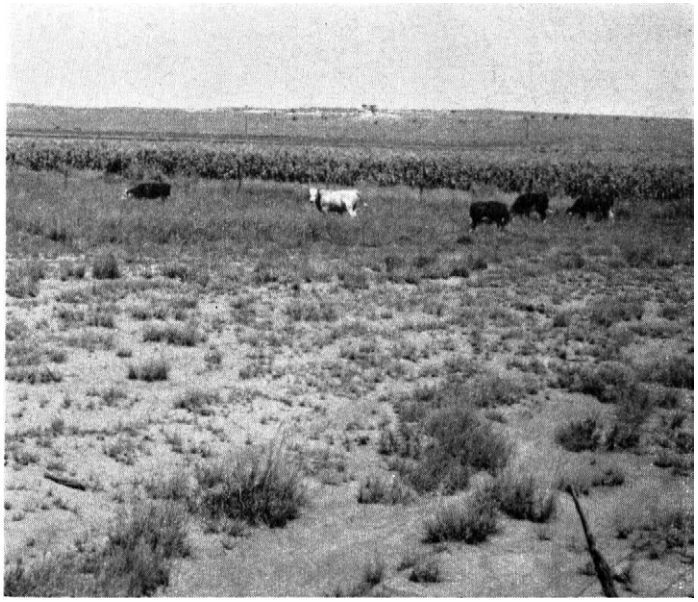

Figure 19.—**Cattle grazing alkali sacaton growing in a broad swale on Tours clay loam. Field of irrigated corn is in center of photograph. Moenkopie soils in background.**

The soil is low in fertility and high in water-holding capacity. There is a slight erosion hazard, if there is a moderate cover of grass. Gully erosion is severe where vegetation is depleted.

The soil is used for irrigated farming and for summer grazing. Forage yields, in general, are moderately high. The main irrigated crops are alfalfa for hay, corn for silage, and barley. Crop yields are fair to high, depending on the level of management. Nitrogen and phosphate fertilizers are used with satisfactory results.

Clearing, leveling, and seedbed preparation leave the surface powdery and massive and cause it to absorb water slowly when fields are first developed for irrigation. However, with the minimum amount of tillage and the return of crop residues, the soil improves with each successive farming season. *Capability units IIs–1(Ir) and VIIc–1.*

Tours clay loam, 1 to 3 percent slopes (TcB).—This soil occurs in narrow swales or on alluvial fans. Except for stronger slopes and more rapid runoff, it is similar to Tours clay loam, 0 to 1 percent slopes.

Tours clay loam, 1 to 3 percent slopes is used only for grazing mostly in summer when alkali sacaton is most palatable. The prevention of overgrazing is essential because alkali sacaton recovers with difficulty if its density is reduced. Where the grass has been depleted and bare soil is exposed, water penetrates the soil very slowly. Consequently, runoff starts quickly and severely erodes the soil. *Capability units IIe–1(Ir) and VIIc–1.*

Tours clay loam, 3 to 5 percent slopes (TcC).—This soil occurs on moderately sloping alluvial fans that border the uplands or the terrace breaks. Runoff is medium, and the erosion hazard is moderate. Except for stronger slopes, it is similar to Tours clay loam, 0 to 1 percent slopes.

This soil is used only for range. Management problems are similar to those for Tours clay loam, 1 to 3 percent slopes, but erosion is an even greater hazard on these stronger slopes. *Capability units IIIe–1 (Ir) and VIIc–1.*

Tours clay loam, moderately saline-alkali, 0 to 1 percent slopes (TdA).—This soil is fairly extensive and occurs along the Little Colorado River between Holbrook and Winslow. It is similar to Tours clay loam, 0 to 1 percent slopes, but it is stratified with thin layers of silt and very fine sandy loam. In addition, it contains salts and alkali in amounts harmful to many plants. A high water table has caused the saline-alkali condition. The vegetation consists mainly of alkali sacaton, big rabbitbrush, saltgrass, tamarisk, and camelthorn. Two small areas underlain by Navajo clay are included with this soil.

The soil is used only for grazing, mostly in the winter because the thickets of tamarisk and entrenched drainageways protect the cattle. The soil has only a 10 to 15 percent plant cover; yields are low, and forage is of poor quality. No economical method is known to improve the kind and amount of palatable forage. In the large bare areas, the soil readily disperses and severely erodes. When this soil dries, a moderately hard, impervious crust forms on its surface. *Capability units IIs–2(Ir) and VIIs–4.*

Tours clay loam, deep over clay, 0 to 1 percent slopes (TeA).—This soil is in the vicinity of Woodruff. It is similar to Tours clay loam, 0 to 1 percent slopes, but it is underlain by reddish-brown, gray, or grayish-brown clay 32 to 40 inches below the surface. The main area of Tours clay loam, deep over clay, 0 to 1 percent slopes, is in a narrow band along the edge of the valley between Navajo clay on the valley floor and other Tours clay loams on alluvial fans formed by side drainageways. One isolated area in the middle of the valley is surrounded by Navajo clay.

All of Tours clay loam, deep over clay, 0 to 1 percent slopes, is irrigated. It was put under irrigation soon after the Mormons established the town of Woodruff. The soil probably was slightly to moderately saline before it was irrigated, but the continual use of good-quality water has leached the salts to a depth that is below the root zone of most crops. The principal crops are alfalfa for hay, corn for silage, and barley. Yields are fairly high. Commercial fertilizer has not been applied, but favorable results would probably be obtained from its use. *Capability unit IIs–1(Ir).*

Tours clay loam, deep over loam, moderately saline-alkali, 0 to 1 percent slopes (TfA).—This soil is like Tours clay loam, moderately saline-alkali, 0 to 1 percent slopes, except that it has a moderately permeable layer of fine sandy loam instead of moderately slowly permeable clay at a depth below 28 to 34 inches from the surface.

Tours clay loam, deep over loam, moderately saline-alkali, 0 to 1 percent slopes, is strongly calcareous throughout and is high in salts. It occurs on the flood plain of the Little Colorado River. The vegetation is a sparse cover of alkali sacaton, big rabbitbrush, saltgrass, tamarisk, and camelthorn.

This soil is used for irrigated farming and for winter grazing. The condition of the range is similar to that of the Tours clay loam, moderately saline-alkali, 0 to 1 percent slopes. Forage yields are low, and the forage is of poor quality.

Irrigated crops are alfalfa, barley, and pasture. Commercial fertilizer has not been used, and yields generally are low. The soil can be improved for crops by leaching the harmful salts. *Capability units IIs–2(Ir) and VIIs–4.*

Trail series

Soils of the Trail series occupy nearly level to moderate slopes on flood plains and alluvial fans in the vicinities of Snowflake, Holbrook, and Hay Hollow. They are associated with the Redfield, Tours, Bagley, and Mogollon soils. They consist of alluvium that washed from sandstone, shale, sand, gravel, basalt, and volcanic cinders. The vegetation is sand dropseed, sand sagebrush, rabbitbrush, alkali sacaton, and juniper. Elevations range from 5,000 to 5,800 feet. The climate is semiarid. The average annual precipitation is 9 to 13 inches. Snowfall is 10 to 21 inches a year. The frost-free period is 132 to 172 days.

The Trail soils are typically mildly to moderately alkaline and reddish brown to dark reddish brown. They are calcareous throughout, and vary in texture from fine sandy loam to loamy fine sand, with occasional strata of fine sand in the subsoil. The Trail soils are somewhat excessively drained. They are rapid to very rapidly permeable and low in water-holding capacity. Runoff is very slow, and the hazard of wind erosion is moderate to severe.

The Trail soils are used for grazing and irrigated farming.

Trail loamy fine sand, 0 to 1 percent slopes (TtA).—This soil occurs on the flood plain of the Little Colorado River. Areas in range are slightly hummocky and are covered mainly with grass and sagebrush.

Representative profile:

0 to 12 inches, reddish-brown loamy fine sand; massive to weak, thick, platy structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 7.9); calcareous; plentiful roots.
12 to 28 inches, reddish-brown loamy fine sand; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.7); calcareous; few roots.
28 to 60 inches, dark reddish-brown sandy loam to loamy sand; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 7.9); strongly calcareous; few roots.

Gravel occurs 36 inches or more from the surface in small areas. Below the surface soil, strata of sandy loam, loamy sand, and gravel are common.

The soil is somewhat excessively drained. It is low in water-holding capacity and in fertility. Root penetration is deep to moderately deep. Runoff is very slow. There is a moderate to severe hazard of wind erosion.

The soil is used for irrigated farming and grazing. Alfalfa is the most important crop. Corn, small grains, and pasture forage are secondary crops. Four cuttings of alfalfa are obtained if pastures are not grazed in winter. Fertilizer is not used systematically.

This soil needs frequent, light irrigation because its water-holding capacity is low. Large applications of irrigation water penetrate below the root zone and beyond the reach of crops. The range areas are small and are usually isolated by irrigated fields. Overuse of the vegetation has occurred because range areas are not managed as a unit. *Capability units IIIs–3(Ir) and VIIs–3.*

Trail loamy fine sand, 1 to 3 percent slopes (TtB).—This soil is similar to Trail loamy fine sand, 0 to 1 percent slopes, except that it occurs on gentle slopes. It occupies small areas in long, narrow bands in the vicinity of other Trail soils.

The soil is used for irrigated farming and grazing. The small acreage in cultivation produces alfalfa, corn, and small grains. Except in the application of irrigation water, management of the soil is similar to that of Trail loamy fine sand, 0 to 1 percent slopes. Forage production is low, mainly because the range has been severely overused. The soil occurs in irrigated areas and is not managed separately for the production of native vegetation. *Capability units IIIs–3(Ir) and VIIs–3.*

Trail loamy fine sand, 3 to 5 percent slopes (TtC).—This soil is similar to Trail loamy fine sand, 0 to 1 percent slopes, but it occurs on moderate slopes, and hummocks of fine sand, partially stabilized by clumps of grass, are scattered on its surface. It occurs as long, irregular bands in the vicinity of Hay Hollow.

The soil is used entirely for grazing. Forage yields are low, and the forage consists mainly of fourwing saltbush and a sparse cover of grass. Deferred grazing in summer, to improve the vigor of the grass, has not been practiced. *Capability units IVe–4 (Ir) and VIIs–3.*

Trail fine sandy loam, 0 to 1 percent slopes (TgA).—This soil is similar to Trail loamy fine sand, 0 to 1 percent cent slopes, except for the texture of the surface soil. It occurs in the vicinity of Snowflake and occupies narrow bands adjacent to Silver Creek and Cottonwood Wash.

The soil is used mostly for irrigated farming, but a few small areas are in native vegetation. Several climatically adapted crops are grown. These are alfalfa, corn, oats, barley, cucumbers, sweet corn, and pasture forage. A small amount of commercial fertilizer is used, but the results have not been accurately determined. The use of fertilizer is becoming more important as the production of truck crops increases. Large quantities of irrigation water are wasted when water penetrates below the root zone. The soil requires light and frequent irrigations because it has a low moisture-holding capacity. There is no specific grazing management used for the small areas remaining in native vegetation. *Capability units IIIs–3(Ir) and VIIs–3.*

Trail fine sandy loam, 1 to 3 percent slopes (TgB).—This soil occurs along Cottonwood Wash near Snowflake. Except for gentle slopes, it is similar to Trail fine sandy loam, 0 to 1 percent slopes.

About one-third of this soil is cultivated; the rest is in native vegetation. The crops on this soil are comparable to those grown on Trail fine sandy loam, 0 to 1 percent slopes, but the stronger slopes require that more control be given to the application of irrigation water. The small areas in native vegetation are grazed without specific management. *Capability units IIIs–3(Ir) and VIIs–3.*

Trail fine sandy loam, shallow over gravel, 0 to 1 percent slopes (TsA).—This soil is similar to Trail fine sandy loam, 0 to 1 percent slopes, except that it has sand and gravel below a depth of 20 to 32 inches. It occupies numerous small areas bordering Cottonwood Wash. The soil consists of fine sandy loam material deposited over sand and gravel bars in Cottonwood Wash. Included with this soil are two small areas, with slopes of 1 to 3 percent, at the confluence of Silver Creek and Cottonwood Wash.

The soil is used for grazing, but the areas are too small to be managed as separate units. Some areas get irrigation disposal water that greatly increases the production of forage. *Capability units IVs–3(Ir) and VIIs–3.*

Wet alluvial land

Wet alluvial land (Wa).—This land type occupies nearly level areas along the Little Colorado River south of Joseph City and southwest of Holbrook. It is associated with other alluvial land and with soils of the Navajo and Moenkopie series. Wet alluvial land is alluvium dedrived from sandstone, shale, shaly sandstone, and limestone. The vegetation consists of wiregrass, saltgrass, sedge, cattail, and other water-tolerant plants.

Wet alluvial land is strongly calcareous and moderately to strongly saline. The surface soil is typically clay loam and is underlain by strata of clay, silty clay, clay loam, loamy fine sand, and muck. The arrangement and number of these layers is variable. Below a depth of 10 to 20 inches, the soil has faint to prominent mottles of reddish, bluish, and yellowish hues. The water table is at or near the surface most of the time. Water comes from natural seeps or springs in the underlying Coconino sandstone.

This land type is heavily grazed for long periods each year. Forage yields are high, but overuse is causing deterioration in quality of the forage. The more palat-

able plants are decreasing and are being replaced by the wiregrasses and other unpalatable, related species. Better management is needed to increase the quality and production of forage. However, little is known about the length and time of rest periods that grasses on this land type require. *Capability unit Vw–1.*

Zeniff series

Soils of the Zeniff series are on nearly level to strongly sloping fans and low terraces or on high flood plains of the Mogollon Plateau between Show Low and Overgaard. They are associated with the Showlow, Chevelon, Claysprings, Elledge, Mogollon, and Millard soils and have formed in materials that washed mainly from these soils. The vegetation is ponderosa pine, pinyon pine, juniper, western wheatgrass, blue grama, and hairy grama. Elevations range from 6,200 to 6,500 feet. The average annual precipitation is 18 to 20 inches. Snowfall is 46 to 49 inches per year. The frost-free period is 115 to 130 days.

The surface soil is typically light-brown to reddish-brown fine sandy loam or loam; the subsoil is brown, dark-brown, or reddish-brown sandy clay loam or clay loam. In most areas the lower subsoil is noncalcareous.

The Zeniff soils are deep and well drained. Runoff is very slow to rapid. Permeability is moderate. The water-holding capacity is medium to high.

The Zeniff soils are used for dryfarming, grazing, and forestry. They are the most extensively dry-farmed soils in the Area.

Zeniff fine sandy loam, 0 to 1 percent slopes (ZfA).—This extensive soil occurs on nearly level, broad fans and along large intermittent streams throughout the area of Zeniff soils.

Representative profile:

0 to 6 inches, light-brown fine sandy loam; weak, platy structure breaking to moderate, granular; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 7.2); noncalcareous; abundant roots.

6 to 14 inches, brown fine sandy loam; weak, prismatic structure breaking to weak, granular; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 7.2); noncalcareous; plentiful roots.

14 to 28 inches, brown clay loam; weak, prismatic structure breaking to weak, subangular blocky; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 7.1); noncalcareous; few roots.

28 to 47 inches, brown clay loam; moderate, subangular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.4); most of this horizon is noncalcareous, but there are spots of disseminated lime; few roots.

47 to 60 inches +, brown silt loam; weak, subangular blocky structure; slightly hard to hard when dry, friable when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.4); mostly noncalcareous, but there are spots of disseminated lime; few roots.

In places this soil is reddish brown or dark brown and the subsoil is sandy clay loam or silty clay loam.

Natural drainage is good, and runoff is very slow. Permeability is moderately rapid in the surface soil and moderate in the subsoil. Root penetration is deep. The water-holding capacity is good to high. Fertility is moderate. There is a slight erosion hazard.

Almost half of this soil is used for dryfarming. The rest is used for grazing. Fewer crop failures occur on this soil than on any other dry-farmed soil in the Area. The chief crops are winter wheat, corn for silage, grain sorghum, and pinto beans (fig. 20). Where deep and rough tillage, terracing, and contouring are applied, high yields of crops are obtained. Fertilizer has not been used, except on an experimental basis.

The forage is grazed late in spring, in summer, and early in fall. Yields are high and the forage is of good quality where the grasses are in good condition. *Capability unit IIIc–1(D).*

Zeniff fine sandy loam, 1 to 3 percent slopes (ZfB).—This soil is similar to Zeniff fine sandy loam, 0 to 1 percent slopes, except that it is on long, smooth, gentle slopes along small intermittent drainageways. It is used for dryland farming and for grazing late in spring, in summer, and early in fall. Several areas that were previously farmed have reverted to native vegetation. Forage yields are variable and depend on the condition of the range.

***Figure 20.*—Dry-farmed area of Zeniff fine sandy loam in pinto beans. This area is at an elevation of 6,500 feet, has a frost-free period of 130 days, and gets 18 inches of precipitation a year. Other crops that can be grown here are oats, grain sorghum, winter wheat, and corn for silage.**

Wheat and corn for silage are the principal dryland crops. All management practices, except terracing, that apply to Zeniff fine sandy loam, 0 to 1 percent slopes, also apply to this soil. Yields on this soil are slightly lower than on Zeniff fine sandy loam, 0 to 1 percent slopes. In addition, the steeper slopes result in more rapid runoff and a high hazard of erosion. Contouring and stripcropping help to reduce losses of soil and water. *Capability unit IIIc–1(D).*

Zeniff fine sandy loam, 3 to 5 percent slopes (ZfC).—This soil occupies short, smooth slopes on small fans or in narrow swales adjacent to steep slopes of the uplands. Gullies have formed in a few places. The surface layer is fine sandy loam, 6 to 12 inches thick. Runoff is medium, however, and the erosion hazard is moderate. Except for the thickness of surface layer, this soil is similar to Zeniff fine sandy loam, 0 to 1 percent slopes.

This soil is used for dryland farming and for grazing late in spring, in summer, and early in fall. Forage yields are variable and depend on the condition of the range. Winter wheat is the most important dry-farmed crop. Moisture is frequently deficient in the summer because heavy rains cause excessive runoff. This loss of moisture discourages the growing of summer row crops. Stubble mulching, rough tillage, and the limiting of row crops to

favorable years help to reduce losses of soil and water. *Capability unit IVe-3(D).*

Zeniff fine sandy loam, 5 to 10 percent slopes (ZfD).—This soil is on strongly sloping terrace escarpments and along entrenched streams. The surface soil is 4 to 8 inches of fine sandy loam. The subsoil is 20 to 24 inches of clay loam. Except for these characteristics, this soil is similar to Zeniff fine sandy loam, 0 to 1 percent slopes.

Shallow gullies have formed in places on the terrace escarpments. Runoff is rapid, and the erosion hazard is moderate to severe. Much of this soil has been cleared and was once used for dryfarming. Now, the native vegetation or the introduced grasses are grazed in spring, summer, and fall. Forage yields are high where the grass cover is dense. Forestry is important in the uncleared areas. *Capability unit VIe-2.*

Zeniff loam, 0 to 1 percent slopes (ZnA).—This soil occurs mainly in the vicinity of Aripine. The surface layer is moderately permeable loam, 6 to 11 inches thick. Under this layer, the profile is similar to that of Zeniff fine sandy loam, 0 to 1 percent slopes. However, the surface soil disperses and crusts more readily, absorbs less water, and sheds more runoff when tilled, trampled by cattle, or pounded by rain than that of Zeniff fine sandy loam, 0 to 1 percent slopes. Consequently, this soil is more droughty than Zeniff fine sandy loam, 0 to 1 percent slopes, although it has a high available moisture-holding capacity.

This soil is used for dryfarming and for grazing late in spring, in summer, and early in fall. Snow interferes with winter grazing. Forage yields are highly variable and depend on the composition and condition of the grasses.

Wheat, corn for silage, grain sorghum, and pinto beans are the principal dryland crops. Yields are fair to high when moisture is adequate, which is about 4 years out of 5. Crops are not rotated. Terracing; rough, deep tillage; and the use of crop residues have not been practiced. These practices, however, have improved the yields on comparable soils. Commercial fertilizer has never been used, but field trials are warranted. *Capability unit IIIc-1(D).*

Zeniff loam, 1 to 3 percent slopes (ZnB).—This soil occurs in small, widely scattered tracts of 4 to 12 acres and lies adjacent to other Zeniff soils. Except for stronger slopes, this soil is similar to Zeniff loam, 0 to 1 percent slopes. However, it is subject to more runoff and erosion. The two soils are used and managed the same. *Capability unit IIIc-1(D).*

Zeniff loam, 3 to 5 percent slopes (ZnC).—This soil is on moderately sloping fans adjacent to the uplands. Runoff is medium, however, and the erosion hazard is moderate. Except for slopes, the soil is similar to Zeniff loam, 0 to 1 percent slopes.

Some of this soil was cleared and used for dryfarming. Runoff and erosion were excessive and caused poor yields. As a result, dryfarming was almost abandoned. Most of these old dry-farmed areas have reverted to grasses and woody shrubs. Other areas of this soil were partially cleared of trees to improve the production of forage. The forage is grazed in spring, summer, and fall. Yields of forage are higher than on other Zeniff loam soils because the native vegetation has been disturbed little by dryfarming in the past 20 years. *Capability unit IVe-3(D).*

General Soil Map

A general soil map of the Holbrook-Show Low Area is in the back of this report. The map is a schematic one that outlines nine separate general soil areas, within which are the tracts that were mapped in detail. Each general soil area has a characteristic pattern of soils and a narrow range of climate, vegetation, topography, and soil parent material. Most soils in the general soil areas occur in the tracts that were mapped in detail. The descriptions of soils in tracts that were mapped in detail are in the section "Descriptions of the Soils."

1. Deep Loamy and Sandy Soils of the Mesas

These soils are mainly members of the Moffat and Sheppard series. The Sheppard soils are very deep and sandy, and they are on broad, high ridges of old dunes that are stabilized by a moderate cover of grass. The Moffat soils are on more gently rolling topography. They have loamy or sandy surface soil, sandy clay loam subsoil, and a zone of segregated lime in the lower subsoil.

Together the Moffat and Sheppard soils occupy the tops of long, narrow mesas with rims that slope steeply to the eroded shale in the badlands of the Painted Desert. Closed basins, without drainage outlets, are on some of the larger mesas. The drainage pattern is poorly defined in this general soil area. Slopes range from 1 to 4 percent, except for occasional dunelike ridges with slopes of 8 to 10 percent. The sandy areas are subject to some wind erosion in the spring, but there are only a few active dunes.

The parent materials of the Moffat and Sheppard soils consist of strata of fine gravel, sand, loam, and silt ranging from 2 to 18 inches in thickness. This material was deposited on top of the Chinle shale during the Tertiary period and is commonly known as the Bidahochi formation. Clay is in thin strata, but it has little influence on the characteristics of the soils that have formed in this parent material.

Elevations in this general soil area range from 5,000 to 5,700 feet. The 8- to 10-inch average annual rainfall is almost entirely absorbed by the sandy surface soil.

The vegetation is short bunch grass mixed with very few woody plants and weeds. Forage production is fairly high, and the grass cover resists deterioration, even under severe use.

2. Shale Badlands

This area consists of dissected sandy, silty, and clayey shale and it occurs below the sandy mesas. Approximately 85 percent of the area is bare of vegetation and is classed as badlands. The area is known as the Painted Desert because of the red, maroon, blue, green, purple, gray, and brown colors of the eroding Chinle shale. It has long been considered to be one of America's most colorful and picturesque attractions.

Most of the remaining 15 percent of the area consists of deep alluvial soils that are members of the Navajo, Jocity, and Ives series. These soils are on narrow flood plains and fans. Very shallow soils have formed on the shale in small, scattered areas where the surface has been

stabilized by an accumulation of lag gravel. All of the soils are affected to some degree by the salts and alkali inherited from the shale parent material.

Elevations range from 4,500 to 5,500 feet. Most of the annual rainfall of 8 to 10 inches is lost through runoff from the eroding shale material. Many of the small alluvial swales are deeply cut by arroyos and gullies.

The vegetation in this general soil area is a moderate cover of galleta, alkali sacaton, sand dropseed, three-awn, and blue grama grasses.

3. Soils of the Flood Plains

The alluvial soils on the flood plains of the Rio Puerco and the Little Colorado River are members of the Navajo, Tours, Jocity, and Ives series. The texture of these soils ranges from clay to loamy fine sand. A permanent water table is 6 feet or more from the the surface of the flood plain of the Little Colorado River. Almost all soils in this area are affected to some degree by salinity and alkali. Salinity ranges from slight to severe; alkali, from slight to moderate.

The topography is level to gently sloping and is generally hummocky because windblown material has accumulated around clumps of grass and shrubs. The vegetation consists mainly of woody shrubs, with a sparse cover of grasses that tolerate salt and alkali.

4. Shallow Soils on Sandstone and Sandy Shale

Most of the soils in this area consist of the very shallow, shallow, and stony phases of the Moenkopie series. The soils are on interbedded sandstone and shale of the Moenkopi formation. This formation is characteristically reddish-brown, chocolate-brown, and brown sandstone with thin strata of bluish-green siltstone or clay and white crystalline gypsum. Where gypsum is exposed, the soil is powdery and forms a soft crust that resists the penetration of water. Scattered throughout the western and central parts of this general soil area are a few outcroppings and low ridges of dense, buff-colored sandstone. If present, the soil on this sandstone is very shallow. The eastern part of the area consists of shallow soils on sand and clay shale.

This general soil area has an elevation of 5,000 to 5,500 feet, and it receives an average annual rainfall of 8 to 12 inches. The topography is gently rolling, and slopes range from 1 to 4 percent. The vegetation is a moderate cover consisting mainly of short bunch grasses—galleta, alkali sacaton, sand dropseed, three-awn, and blue grama. Mormon-tea and snakeweed are the main woody shrubs.

5. Brown Sandy Soils on Sandstone

Few of the soils in this area have been classified or studied in detail, although areas of the Chevelon or similar soils have been recognized in the southern part. The soils are generally shallow to bedrock and in many places are stony. The surface soil is commonly loam or fine sandy loam, and the subsoil, loam and light clay loam. Most soils on sandstone or sandy limestone are calcareous throughout the profile. Some small areas of soil on old outwash material have noncalcareous clay loam or clay subsoil. About 20 percent of the area consists of outcrops of sandstone, which are on ridges or on breaks along entrenched drainages. The surface of these sandstone outcrops may be partly covered by a thin layer of windblown sand or loamy sand that has accumulated in low dunes or hummocks around juniper trees or in clumps of grass.

Elevation at the northern edge of the area is about 5,500 feet, and it increases southward to about 6,500 feet. The average annual precipitation is about 12 inches in the northern part and about 20 inches in the southern part. Part of it falls as snow.

The vegetation includes juniper, which ranges in density from thick, mature stands to a few, scattered trees, and a sparse stand of short bunch grasses. The grasses are blue grama, black grama, galleta, three-awn, and sand dropseed.

6. Hilly, Gravelly, Shallow Soils

These soils are in an area of small, rounded hills and sharp breaks. The parent material is a mixture of old gravelly outwash that was deposited on shallow sandstone and on silty or clayey shale. The entire area has been thoroughly dissected. Present thickness of the gravelly material over the bedrock ranges from a few inches to several feet.

The soils are usually shallow to gravel or to bedrock, and they are noncalcareous in the surface soil and upper subsoil. Surface soil texture ranges through loam, fine sandy loam, sandy loam, gravelly loam, and gravelly sandy loam. Subsoil texture ranges through clay loam, sandy clay loam, and gravelly sandy clay loam. The topography is gently to moderately rolling; slopes range from 2 to 8 percent. These soils are at elevations of 5,500 to 6,000 feet. The average annual precipitation ranges from 14 to 17 inches and is enough to support a moderate cover of short bunch grass. Galleta, alkali sacaton, blue grama, and three-awn grow on the fine-textured soils; side-oats grama and black grama grow on the gravelly soils. Juniper trees are scattered throughout the area.

7. Shale and Sandstone Rock Land

This general soil area consists of small buttes, ledges, and knolls where erosion is active. More than 70 percent of it can be classified as Rock Land, shale and sandstone. Most of the rest is made up of very shallow soils that belong to the Moenkopie series. About half the area has numerous rounded pebbles on the surface. The vegetation is sparse, and large areas are barren. Juniper, pinyon pine, cliff rose, and small woody plants are the dominant vegetation. A small amount of grass grows in the bedrock crevices or beneath woody shrubs. The area is difficult to cross.

8. Soils on Basalt and Cinders

This general soil area is in southeastern Navajo County. It is a plateau that ranges in elevation from 6,000 to 7,500 feet and is completely covered with basalt flows and cinder

cones. Cinder cones cover only a small part of the total area, however. The topography is variable and has such features as gently rolling to strongly rolling plains, breaks, and small canyons, as well as cinder cones with steep slopes.

The soils are very shallow to deep. Texture of the surface soil and subsoil range from clay to loam. The Springerville and Paiso soils are dominant in this area. Many small outcrops of basalt rock occur throughout the area.

The average annual rainfall is 17 to 25 inches and is enough to support a stand of ponderosa pine, pinyon pine, and juniper, with a ground cover of western wheatgrass, mountain brome, and Arizona fescue. The vegetation aspect varies from forest to mountain grassland and reflects the influence of soil texture.

9. Shallow to Deep Soils of the Mogollon Plateau

Soils in this area have formed from different kinds of parent material. Within fairly short distances, the material changes from sandstone, shale, or limestone to sand and gravel. The pattern of occurrence is complex. Some of the soils in the area belong to the Showlow, Millard, Elledge, Chevelon, Zeniff, and Overgaard series. The alluvial soils are members of the Mogollon, Heber, and Jacques series. In addition, shallow to moderately deep, sand or clay loam soils on limestone, sandstone, and shale are in this area.

Elevations range from 6,000 to 7,000 feet. The average annual precipitation is 20 to 25 inches. The vegetation is forest trees, mainly ponderosa pine mixed with pinyon pine, juniper, Gambel oak, and Douglas-fir. The area is one of rolling plains dissected by narrow valleys.

Use and Management of the Soils

This section of the report describes the use and management of the soils in considerable detail. The first several parts deal with the general principles of soil management; the system of classifying soils according to capability; descriptions of the capability units; and the estimated yields of crops that can be expected from soils in the Holbrook-Show Low Area. Following these is the part that deals with engineering uses of the soils.

General Principles of Soil Management

Crop rotation

Crop rotation, as practiced on irrigated soils in the Holbrook-Show Low Area, consists more of alternating the crops than of systematically rotating them. Three rather distinct groups of crops are grown in the Area: cultivated crops, small grains, and mixtures of grasses and legumes. The cultivated crops are mainly corn and a small acreage of truck crops. Small grains are wheat, barley, and oats. Alfalfa and mixtures of grasses and legumes are part of any rotation on irrigated land. The alfalfa is used mostly for hay, but a small amount is harvested for silage. The grass-legume mixture is used as pasture. These forage and hay crops are grown for 3 to 6 years and are followed by cultivated crops.

The supply of water for irrigation is a factor that causes crops to be alternated rather than rotated. When water is in short supply, pastures usually are not seeded, because they need lots of water and frequent irrigation. In times of shortage, oats or barley may be substituted for corn or for truck crops because small grains need less water.

Crop rotation in dryland farming differs from that in irrigated farming. The dryfarming rotation consists of selecting either cultivated crops or small grains to fit the moisture conditions at planting time. Corn, grain sorghum, and pinto beans are the cultivated crops; oats or winter wheat are the small grains. Sod-forming crops are too difficult and time consuming to establish and are not included in the prevailing system of cropping.

Organic matter

Most of the soils in the Holbrook-Show Low Area, especially those in the semiarid part, are low in organic matter. This is caused by the fact that most of the soils did not originally support vegetation that was conducive to the accumulation of organic matter.

Organic matter improves the chemical and physical properties of the soil. Decaying organic matter releases nitrogen and appreciable amounts of phosphorous to enrich the soil with compounds containing these elements. The physical benefits of organic matter are many. Soil structure, permeability to air and water, and density or looseness are improved by the presence of organic matter. In addition, organic matter acts as a buffer in maintaining soil tilth by preventing damage through land leveling, tilling and harvesting with heavy machines, and trampling by livestock. Damage to soil structure, formation of tillage pans, and compaction of surface soil are less severe when organic matter is increased above its original level. Organic matter can be increased in irrigated soils by growing pasture and hay crops and by returning plant residue and barnyard manure to the soil.

The management of organic matter on dry-farmed soils is different from that on irrigated soils. On the dry-farmed soils, organic matter is obtained from crop residue and is partly incorporated in the soil as stubble mulch. This increases the infiltration of water into the soil. Available moisture and crop yields are closely related in dryfarming. Consequently, it is essential that the soil absorb most of the annual precipitation, particularly that of the summer rains.

Tillage

The main purposes of tillage are to control weeds, break surface crusts, fracture tillage pans, and prepare suitable seedbeds. The time, frequency, and type of cultivation vary with different crops on different soils.

Proper tillage is one of the most important practices in the management of crops and soils. Too much tillage can be detrimental because many soils in the Area are unstable and will break down into a powdery mulch. The result of excessive tillage is a decrease in the permeability of the soil, caused through either the dispersion of the surface soil or the formation of a compacted layer (tillage pan) immediately below the plowed layer. The minimum amount of cultivation that will leave the surface rough and cloddy will control these conditions. This is

called rough tillage. Neither dry-farmed nor irrigated soils should be cultivated excessively.

Fertilizer

The soils in the Area are relatively high in mineral fertility. Consequently, the use of commercial fertilizer in crop production is not so advanced as in other parts of the country. A high mineral fertility is normal for soils that have formed under semiarid and subhumid climate and from a varied mixture of rocks. Under these conditions, plant nutrients do not leach below the root zone of most crops. The use of fertilizer is still on a field-trial basis on the dry-farmed soils. On the irrigated soils, the use of fertilizer has been a common practice in the past 15 years.

Nitrogen is the most deficient element in the Area. Many soils are low in phosphorus, but there is enough of this element in some soils to produce fairly good crops. For high yields, however, many soils should receive phosphate.

The delay in using fertilizer in this Area may be attributed to the large amount of alfalfa that is grown. This crop has maintained a fair nitrogen level in the soils through the fixation of nitrogen and has been credited with maintaining the yields of corn and small grains. In trying to increase production, operators have discovered that applications of phosphate increased yields. The use of nitrogen fertilizer followed that of phosphate. At present, commercial fertilizers that contain phosphorus and nitrogen are the only ones that benefit crops.

Potassium and the minor elements are abundant in most of the soils. Limited field trials with potassium fertilizer have not increased crop yields. These trials, however, were not conducted on irrigated soils in the coniferous forest area that may respond to potash.

Land leveling

Land leveling is an important practice in preparing land for irrigation by methods in which water is distributed by gravity through ditches, furrows, or borders. Through this reclamation practice, soil is moved from the high parts to the low parts of a field to establish a uniform, safe gradient on the surface that allows irrigation water to be distributed evenly over a field.

The first crop in a newly leveled field is likely to show extreme variations in plant growth and yield. This is to be expected because, in moving soil from the high spots to the low spots, subsoil is exposed. Compaction by heavy machinery in different parts of the field may also cause variation in growth and yield. If the field to be leveled is deep, uniformly textured alluvium without toxic salts, growth and yield of crops on the nearly leveled field can be expected to improve rapidly. If leveling exposes sand, gravel, lime (caliche) or toxic salts, different problems arise. Each problem has to be treated through soil, crop, and irrigation management.

A thorough investigation should be made of the soil before land is leveled. Proper design of irrigation systems and field layouts can prevent many difficulties.

Supporting practices

Erosion is a minor problem on irrigated soils in the Holbrook- Show Low Area. Irrigation water causes little erosion because it is usually controlled by competent persons during the period of irrigation. Wind may drift the coarse-textured soils if they are dry and allowed to stay bare during winter and spring. A cover crop protects the soils from wind and prevents drifting.

The dry-farmed soils are not affected seriously by wind erosion. These soils occur in small areas that are partly protected by forest, and they have a moderately durable structure that resists wind movement. However, the dry-farmed soils need protection from water erosion. One torrential summer rain has been known to wash the plow layer from cornfields. Head cutting in gullies is severe if protective measures are not taken. Many areas have prominent central gullies, 5 to 15 feet deep. Few gullies on dryland farms are of the branching type.

Erosion control measures, such as grassed waterways, contour cultivation, contour stripcropping, terracing, and gully control, are not widely used in the Area.

The lack of easily established, sod-forming grasses makes grassed waterways unfeasible. Waterways need to be installed where prominent gullies now exist, but this operation is usually expensive.

Contouring (contour cultivation) is the practice of plowing, planting, and cultivating around the slope on the same level. It is used on a few farms. The practice is difficult to apply when modern farm implements are used, because of the small size and the irregular shape and slope of the fields.

Contour stripcropping presents the same difficulties as contouring. There is the additional problem of establishing a sod crop (if one is desired) to control sheet erosion. The only crops feasible for use in stripcropping are row crops and small grains. These are planted in alternating strips, but if lack of moisture prevents the seeding of either of these crops, the hazard of erosion is serious.

Broad-base terraces are built to control erosion and to hold water on the field. Terraces of this type are particularly well adapted to dryland farming on smooth slopes of less than 1 percent. They are designed to hold large quantities of water and to allow as little water as possible to run off. They are efficient in retaining precipitation. Perhaps their one disadvantage is the high initial cost of construction.

Gully control has been partly achieved by constructing retention dams at favorable locations in large gullies to take advantage of as much storage area as possible. The small gullies, too often, receive little attention. Satisfactory vegetative control measures have not been devised. This is partially attributed to the adverse weather conditions, which discourage establishing the vegetation.

Capability Groups of Soils

The capability classification is a grouping of soils that shows, in a general way, how suitable they are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the

soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes, there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony, and *c* indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no susceptibility to erosion but have other limitations that limit their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally identified by numbers assigned locally, for example, IIe–1 or IIIe–2.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil, and without consideration of possible, but unlikely, major reclamation projects.

Soils in the Holbrook-Show Low Area are classified in capability units according to their use for dryfarming, irrigated farming, woodland, or range. If the capability designation is followed by the letters "Ir" (in parentheses), the soil is in the stated capability unit for irrigated farming. The number of soils that can be irrigated are limited by the availability of irrigation water. If the designation is followed by the letter "D" (in parentheses), the soil is suitable for dryfarming and is in the stated capability unit for that use. If the designation is not followed by a capital letter or letters, the soil is generally not suitable for cultivation, and unless otherwise stated, is suitable for range or woodland.

The eight classes in the capability system, and the subclasses and units in this Area, are described in the list that follows. After the list there is a description of each capability unit and the suggested management for each unit.

Class I. Soils that have few limitations that restrict their use.

(No subclasses.)

Capability unit I–1(Ir): Deep, medium-textured to moderately fine textured, moderately permeable, nearly level soils of high water-holding capacity; well suited to irrigation.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

Subclass IIe. Soils subject to moderate erosion if they are not protected.

Capability unit IIe–1(Ir): Deep, moderately fine textured, moderately to slowly permeable, gently sloping soils of high water-holding capacity; moderately well suited to irrigation.

Capability unit IIe–2(Ir): Deep, medium-textured, moderately permeable, gently sloping soils of good water-holding capacity; moderately well suited to irrigation.

Subclass IIw. Soils that have moderate limitations because of water table and the need for water control.

Capability unit IIw–1: Deep, moderately coarse textured, imperfectly drained soil with a fluctuating water table when irrigated; gently sloping, good in water-holding capacity, and moderately well suited to irrigation.

Subclass IIs. Soils that have moderate limitations of water-holding capacity or permeability.

Capability unit IIs–1(Ir): Deep, medium-textured to moderately fine textured, moderately slowly permeable, nearly level to gently sloping soils of high water-holding capacity; moderately well suited to irrigation.

Capability unit IIs–2(Ir): Deep, medium-textured to moderately fine textured, slowly permeable, nearly level to gently sloping soils of low to moderate available water-holding capacity; moderately well suited to irrigation if minor to moderate reclamation measures are applied.

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

Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.

Capability unit IIIe–1(Ir): Deep, moderately fine textured, moderately to slowly permeable, moderately sloping soils of high water-holding capacity; moderately suited to irrigation.

Capability unit IIIe–2(Ir): Deep, medium-textured, moderately permeable, moderately sloping soils of moderately good water-holding capacity; moderately suited to irrigation.

Capability unit IIIe–3(Ir): Deep to moderately deep, medium-textured, moderately slowly permeable, gently sloping soils of low water-holding capacity; fairly well suited to irrigation.

Capability unit IIIe–4(Ir): Deep to moderately deep, fine-textured, slowly to very slowly permeable, gently sloping soils of good to high water-holding capacity; slight hazard of erosion, slightly affected by alkali that can be corrected, and fairly well suited to irrigation.

Capability unit IIIe–5(Ir): Deep, medium to moderately fine textured, slowly to very slowly permeable, gently sloping soils of high water-holding capacity, fairly well suited to irrigation; fine-textured subsoil.

Capability unit IIIe–6(Ir): Deep, moderately coarse, slowly to very slowly permeable, gently sloping soils of moderately high water-holding capacity, fairly well suited to irrigation; fine-textured subsoil.

Subclass IIIs. Soils that have severe limitations of unfavorable texture, permeability, water-holding capacity, or saline-alkali properties.

Capability unit IIIs–1(Ir): Moderately deep to deep, fine-textured, slowly permeable, nearly level soils of good water-holding capacity, fairly well suited to irrigation.

Capability unit IIIs–2(Ir): Deep, fine-textured, slowly permeable, nearly level soils of high water-holding capacity and affected with saline-alkali properties in the subsoil; fairly well suited to irrigation.

Capability unit IIIs–3(Ir): Deep, moderately coarse textured, moderately rapidly to rapidly permeable soils of moderately low to low water-holding capacity; fairly well suited to irrigation.

Capability unit IIIs–4(Ir): Deep, fine-textured, slowly to very slowly permeable, nearly level to gently sloping soils of low to moderate available water-holding capacity; fairly well suited to irrigation if moderate reclamation practices are applied.

Capability unit IIIs–5(Ir): Moderately deep to deep, slowly permeable, nearly level to gently sloping soils with moderately coarse to moderately fine textured surface soil and fine textured subsoil; fairly well suited to irrigation.

Capability unit IIIs–6(Ir): Deep, medium-textured, moderately slowly permeable, well-drained, nearly level soils of low water-holding capacity; cobbly, moderately fine subsoil.

Capability unit IIIs–7(D): Deep, moderately coarse, well-drained, gently sloping, moderately fertile soils of moderately high water-holding capacity, fairly well suited to dryland farming; clayey subsoil.

Subclass IIIc. Soils that have severe limitations because of adverse climate.

Capability unit IIIc–1(D): Deep, nearly level to gently sloping soils with medium-textured to moderately coarse textured surface soil and moderately permeable subsoil of good water-holding capacity; fairly well suited to dryland farming.

Capability unit IIIc–2(D): Deep, nearly level to gently sloping soils with medium-textured to moderately fine textured surface soil and moderately permeable subsoil of high water-holding capacity; fairly well suited to dryland farming.

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

Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.

Capability unit IVe–1(Ir): Moderately deep to deep, slowly permeable, moderately sloping soils of high water-holding capacity.

Capability unit IVe–2(Ir): Moderately deep, medium-textured, moderately slowly permeable, strongly sloping soil of low water-holding capacity.

Capability unit IVe–3(D): Deep, medium-textured to moderately fine textured soils of high water-holding capacity and on moderate slopes; poorly suited to dryland farming.

Capability unit IVe–4(Ir): Deep, moderately coarse textured, rapidly permeable soil of low water-holding capacity and on moderate slopes; poorly suited to irrigation.

Capability unit IVe–5(Ir): Deep, fine-textured, very slowly permeable soil occurring on moderate slopes and affected by exchangeable sodium; poorly suited to irrigation.

Capability unit IVe–6(D): Deep, moderately sloping soils of high water-holding capacity; poorly suited to dryland farming.

Capability unit IVe–7(Ir): Shallow, medium-textured, well-drained, moderately to moderately rapidly permeable, gently sloping soil low in fertility and water-holding capacity; poorly suited to irrigation.

Subclass IVs. Soils that have very severe limitations of low water-holding capacity, shallowness to bedrock, or high salt content.

Capability unit IVs–1(D): Moderately deep, gently sloping soils with low water-holding capacity; poorly suited to dryland farming.

Capability unit IVs–2(D): Deep, moderately coarse textured, rapidly permeable soils with low water-holding capacity; poorly suited to dryland farming.

Capability unit IVs–3(Ir): Shallow, medium-textured soils over gravel and sand or bedrock and on nearly level to gentle slopes; poorly suited to irrigation.

Capability unit IVs–4(D): Deep, nearly level to gently sloping soils with fine-textured surface soil and slowly permeable subsoil; poorly suited to dryland farming.

Capability unit IVs–5(D): Deep, nearly level to gently sloping, moderately coarse to moderately fine textured soils; poorly suited to dryland farming.

Capability unit IVs–6(D): Deep to moderately deep, medium-textured, moderately permeable, nearly level to gently sloping soils of low water-holding capacity; poorly suited to dryland farming.

Class V. Soils subject to little or no erosion but having other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Subclass Vw. Soils too wet for cultivation.

Capability unit Vw–1: Level soils that have a permanent water table at or near the surface or are flooded for long periods.

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.
- Subclass VIe. Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.
  - Capability unit VIe–1: Deep, gently sloping to steep soils.
  - Capability unit VIe–2: Deep to moderately deep, strongly sloping soils.
- Subclass VIs. Soils generally unsuitable for cultivation and limited to other uses by their moisture capacity, stones, or other features.
  - Capability unit VIs–1: Moderately deep to deep, gently sloping to steep soils that are low in fertility.
  - Capability unit VIs–2: Fine-textured soils.
- Subclass VIc. Soils with a moderately adverse climate.
  - Capability unit VIc–1: Moderately fine to moderately coarse textured soils.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to grazing, woodland, or wildlife.
- Subclass VIIe. Soils very severely limited, chiefly by risk of erosion if protective cover is not maintained.
  - Capability unit VIIe–1: Clay soils on strong to steep slopes.
  - Capability unit VIIe–2: Moderately deep, gravelly, coarse-textured soils on steep slopes.
  - Capability unit VIIe–3: Deep, excessively drained, coarse-textured soils on moderate slopes.
- Subclass VIIs. Soils very severely limited by moisture capacity, stones, or other soil features.
  - Capability unit VIIs–1: Very shallow to shallow soils of medium texture.
  - Capability unit VIIs–2: Very shallow to deep, stony soils.
  - Capability unit VIIs–3: Moderately coarse textured soils.
  - Capability unit VIIs–4: Fine-textured to moderately coarse textured soils with saline-alkali properties.
  - Capability unit VIIs–5: Coarse-textured gravelly and sandy soils.
- Subclass VIIc. Soils very severely limited because of climate.
  - Capability unit VIIc–1: Medium-textured to moderately fine textured soils.

Class VIII. Soils and landforms that have limitations that preclude their use for commercial production of plants and restrict their use to recreation, wildlife, water supply, or esthetic purposes.
- Subclass VIIIe. Sand subject to erosion.
  - Capability unit VIIIe–1: Sand dunes.
- Subclass VIIIw. Soils subject to overflow.
  - Capability unit VIIIw–1: Miscellaneous soils adjacent to streams and subject to intermittent overflow.
- Subclass VIIIs. Soils with severe limitations of depth and texture.
  - Capability unit VIIIs–1: Rock land and terrace escarpments.

The discussion of the capability units shown in the foregoing list is divided into four parts, as follows: (a) Irrigated soils of the semiarid section, (b) irrigated soils of the subhumid section, (c) soils suitable for dryfarming, (d) soils not suited to dryfarming.

Irrigated soils of the semiarid section

These soils occur at elevations of 4,850 to 6,300 feet. The frost-free period is 130 to 174 days, and the precipitation is 7 to 14 inches a year.

CAPABILITY UNIT I–1(Ir)

This capability unit consists of deep, medium-textured to moderately fine textured soils that are moderately permeable and have a high water-holding capacity. The soils occur on nearly level areas of flood plains and alluvial fans. The Bagley and Mogollon soils have stable aggregates. They are slightly finer in texture but more permeable than the Redfield soils. The soils in this unit are—

Bagley clay loam, 0 to 1 percent slopes.
Bagley sandy clay loam, 0 to 1 percent slopes.
Clovis sandy loam, 0 to 1 percent slopes.
Mogollon fine sandy loam, 0 to 1 percent slopes.
Redfield very fine sandy loam, 0 to 1 percent slopes.

These soils are well suited to irrigation and are highly productive of nearly all climatically adapted crops, including alfalfa, corn, oats, wheat, barley, cucumbers, and sweet corn. Suitable rotations range in length from 4 to 6 years. They consist of row crops for 1 to 2 years; small grains, 1 year; and alfalfa, 3 or 4 years.

Alfalfa responds to phosphate, and all other crops respond to nitrogen and phosphate. The soils usually require little leveling, but deep cuts can be made if necessary. These soils are easy to irrigate. Irrigation runs of about 660 feet are the most desirable, and few of them should exceed 1,320 feet. Row crops are best adapted to furrow irrigation; all other crops, to the border system.

CAPABILITY UNIT IIe–1(Ir)

This capability unit consists of deep, moderately fine textured soils that are moderately to slowly permeable and have a high water-holding capacity. The soils occur on gentle slopes and are subject to slight erosion. The Bagley soils have stable aggregates. The Tours and Clovis soils are less stable than the Bagley soils and are subject to a higher rate of erosion. The soils in this unit are—

Bagley clay loam, 1 to 3 percent slopes.
Bagley sandy clay loam, 1 to 3 percent slopes.
Clovis sandy loam, 1 to 3 percent slopes.
Ives fine sandy loam, slightly alkali, 1 to 3 percent slopes.
Jacques clay loam, 1 to 3 percent slopes.
Jocity sandy clay loam, slightly alkali, 1 to 3 percent slopes.
Tours clay loam, 1 to 3 percent slopes.

These soils are moderately well suited to irrigation and are moderately to highly productive of nearly all adapted crops. Alfalfa, corn, oats, wheat, barley, and pasture are the principal crops. Rotations lasting 5 to 7 years are suitable. They consist of row crops for 1 or 2 years; small grains, 1 year; and alfalfa, 3 to 5 years.

Alfalfa responds to phosphate, and all other crops respond to both nitrogen and phosphate. Most leveling requires moderate cuts, but deep cuts can be made if neces-

sary in all soils except the Clovis. In leveling the Clovis soil, it is desirable not to uncover the lime zone in the subsoil. Row crops are best adapted to furrow irrigation; all other crops, to the border system. Irrigation is not particularly difficult, because the soils have gentle slopes. Irrigation runs should seldom exceed 660 feet. Adequate control of irrigation water is needed to prevent soil washing and large losses of tail water.

CAPABILITY UNIT IIe–2(Ir)

This capability unit consists of deep, medium-textured soils on gentle slopes. The soils are moderately permeable and have a good water-holding capacity. The Moffat soil and Redfield sandy loam, 1 to 3 percent slopes, are somewhat coarser in texture than the Mogollon soil but are not so permeable, because they are massive and disperse more readily under irrigation. The soils in this capability unit are—

Moffat sandy loam, 1 to 3 percent slopes.
Mogollon fine sandy loam, 1 to 3 percent slopes.
Redfield sandy loam, 1 to 3 percent slopes.
Redfield very fine sandy loam, 1 to 3 percent slopes.

These soils are moderately well suited to irrigation and are moderately to highly productive of all adapted crops. They are well suited to alfalfa, corn, wheat, barley, and pasture. Cucumbers and sweet corn are suited if grown under intensive management. Rotations lasting 5 to 7 years are suitable. They consist of row crops, 1 or 2 years; small grains, 1 year; and alfalfa or pasture, 3 or 4 years.

Pasture responds to nitrogen, alfalfa to phosphate, and all other crops respond to both nitrogen and phosphate. Moderate cuts are required in most places if these soils are leveled, but deep cuts can be made, if necessary, in all soils except the Moffat. In leveling the Moffat soil, it is desirable not to uncover the lime zone in the subsoil.

Row crops are best adapted to furrow irrigation; all other crops, to the border system. Irrigation is not particularly difficult, because the soils have gentle slopes. Irrigation runs should seldom exceed 660 feet. Periods between irrigations should be shorter on these soils than on those in capability unit IIe–1(Ir) because the water-holding capacity is lower.

CAPABILITY UNIT IIw–1(Ir)

This capability unit consists of a deep, moderately coarse textured, imperfectly drained soil that has good water-holding capacity. The soil is gently sloping, moderately fertile, moderately rapidly permeable, and the water table fluctuates as much as 1 to 4 feet following irrigation. The soil in this unit is—

Pinetop fine sandy loam, 1 to 3 percent slopes.

This soil is moderately well suited to irrigation and is moderately productive of nearly all climatically adapted crops. It is best suited to pasture. It is next best suited to oats, alfalfa-grass mixtures for hay, and corn for silage. Several different rotations lasting from 3 to 6 years can be used, and they all include row crops, small grains, and hay or pasture. Row crops are grown for 1 or 2 years; small grains, for 1 or 2 years; and hay or pasture, for 1 to 4 years.

All crops respond to nitrogen and phosphate. The response to potash fertilizer is not known but should be investigated in field tests. The soils require only moderate leveling; deep cuts can be made, if necessary. The soils are easy to irrigate. Runs of 440 and 660 feet are suitable. Furrow irrigation is best suited to row crops; the border system, to all other crops.

CAPABILITY UNIT IIs–1(Ir)

This capability unit consists of deep, medium-textured to moderately fine textured soils that are nearly level to gently sloping. The soils are slowly permeable and have a high water-holding capacity. The Tours soils and Loamy alluvial land disperse readily during irrigation. The soils in this unit are—

Loamy alluvial land.
Tours clay loam, 0 to 1 percent slopes.
Tours clay loam, deep over clay, 0 to 1 percent slopes.

These soils are moderately well suited to irrigation and are moderately productive of adapted crops. Alfalfa-grass mixtures for hay; wheat, barley, oats; and pasture are the principal crops. Truck crops are poorly suited unless large amounts of organic matter are used and puddling by tillage is prevented. Because these soils disperse readily when wetted, it is desirable to grow few row crops. Close-growing crops should be on the soils for fairly long periods in the crop rotation. Suitable rotations range in length from 5 to 6 years. They consist of irrigated alfafa-grass meadow or pasture for 3 or 4 years; row crops, 1 year; and small grain, 1 year.

All crops respond to nitrogen and phosphate. The soils usually do not require excessive leveling. Exceptions are those having slopes of 1 to 3 percent. Deep cuts can be made, if necessary. Wind erosion is moderately active on the Tours soil and on Loamy alluvial land if these soils are allowed to remain bare and dry during winter and spring. Row crops are best adapted to furrow irrigation; all other crops, to the border irrigation. Moderate irrigation runs of about 660 feet are best, but they should not exceed 1,320 feet. Irrigation grades should be less than 0.5 percent.

CAPABILITY UNIT IIs–2(Ir)

This capability unit consists of deep, medium-textured to moderately fine textured soils on nearly level to gentle slopes. The soils are moderately slowly permeable and have a low to good available water-holding capacity. The soils contain toxic salts, alkali, or both. The soils in this unit are—

Loamy alluvial land, moderately saline-alkali.
Tours clay loam, moderately saline-alkali, 0 to 1 percent slopes.
Tours clay loam, deep over loam, moderately saline-alkali, 0 to 1 percent slopes.

These soils are poorly suited to irrigation in their present condition but are moderately well suited if reclamation is applied. They require a moderate amount of reclamation before general field crops can be grown. In their present condition, they can produce wheatgrasses and fescues that are tolerant of salts and alkali.

Reclamation includes land leveling so that water can be applied evenly on the soils. After leveling, the soil should be leached with irrigation water to remove most of the soluble salts from the root zone. Leaching and the growing of tolerant grasses improve the soils so that small grains, especially barley, can be grown satisfactorily. The

growing of small grains can be followed by seeding of a mixture of alfalfa and grasses. If reclamation progresses satisfactorily, a regular rotation of row crops, small grains, and close-growing crops can be used. Management is similar to that described for capability unit IIs–1(Ir).

CAPABILITY UNIT IIIe–1(Ir)

This capability unit consists of deep, moderately fine textured soils on moderate slopes. The soils have moderate to slow permeability and a high water-holding capacity. The Jocity and Tours soils disperse more readily under irrigation than the Clovis soil. The slight amount of alkali in the Jocity soil is a disadvantage easily offset by management. The soils in this unit are—

Clovis sandy loam, 3 to 5 percent slopes.
Jocity sandy clay loam, slightly alkali, 3 to 5 percent slopes.
Tours clay loam, 3 to 5 percent slopes.

These soils are fairly well suited to irrigation. The steepness of slopes requires the construction of an intricate irrigation system that can properly control water, and need for this system discourages the growing of row crops. Less intricate irrigation systems are needed for sod crops. Such crops improve infiltration and reduce soil washing. Alfalfa, wheat, barley, oats, and pasture are the most suitable crops.

Alfalfa responds to phosphate, and all other crops respond to both nitrogen and phosphate. The soils require much leveling if row crops are to be grown. Deep cuts can be made in the Jocity and Tours soils, but the Clovis soil has a layer of lime in the subsoil that is exposed if deep cuts are made. In deeply cut areas, large amounts of barnyard manure are needed to help counteract the concentration of lime.

The soils are difficult to irrigate. Short irrigation runs, usually less than 440 feet, and small heads of water are necessary. Row crops are best adapted to furrow irrigation, and all other crops to a border system with corrugations.

CAPABILITY UNIT IIIe–2(Ir)

This capability unit consists of deep, medium-textured soils on moderate slopes. The soils are moderately permeable and have a good water-holding capacity. They disperse readily if irrigated where the surface is bare. This dispersion greatly reduces infiltration of water. The soils in this unit are—

Moffat sandy loam, 3 to 5 percent slopes.
Redfield sandy loam, 3 to 5 percent slopes.
Redfield very fine sandy loam, 3 to 5 percent slopes.

These soils are fairly well suited to irrigation. Because they are steep, they are poorly suited to many row crops. Alfalfa, wheat, barley, and pasture are the adapted crops. Rotations lasting 5 to 7 years are suitable. Alfalfa or pasture is grown for 4 to 5 years, and small grains for 2 or 3 years.

Alfalfa responds to phosphate, and all other crops respond to both nitrogen and phosphate. The soils require much land leveling if crops are to be grown. Deep cuts in the Moffat soil should be avoided, if possible, as they will expose lime in the subsoil. The soils are difficult to irrigate because short runs are necessary and fields are irregular in shape. The border irrigation system, with corrugations, is best suited to crops grown on these soils.

CAPABILITY UNIT IIIs–2(Ir)

This capability unit consists of deep, fine-textured soils that are slow in permeability and high in water-holding capacity. These soils are on nearly level parts of flood plains and on alluvial fans. Before they were irrigated, they contained salts or alkali in amounts harmful to most plants. The use of good-quality irrigation water and many years of cropping have leached the salts and alkali from the root zone of most crops. The soils in this unit are—

Jocity silty clay, 0 to 1 percent slopes.
Navajo clay, 0 to 1 percent slopes.

These soils are fairly well suited to irrigation. Their fine texture influences the suitability of crops and the type of management needed. The soils are better suited to small grains and grasses than to row crops. Sorghum is better adapted than corn. Rotations lasting 5 to 7 years are suitable. They consist of row crops for 1 year; small grains, 1 to 3 years; and alfalfa and pasture, 3 to 5 years.

Alfalfa responds to phosphate, and all other crops respond to nitrogen and phosphate. The soils usually do not require excessive leveling, but deep cuts can be made if necessary. The soils puddle and compact if tilled when too moist. In most places the grades for irrigation need to be less than 0.5 percent. Irrigation runs of 1,320 feet are suitable if the grades are nearly level.

CAPABILITY UNIT IIIs–3(Ir)

This capability unit consists of deep, moderately coarse textured soils that are nearly level to gently sloping. The soils are moderately rapidly to rapidly permeable and moderately low to low in water-holding capacity. They are massive, but friable, and they take water readily. They have a low nutrient level and need to be protected from wind erosion. The soils in this unit are—

Sandy alluvial land.
Sandy alluvial land, moderately saline.
Trail fine sandy loam, 0 to 1 percent slopes.
Trail fine sandy loam, 1 to 3 percent slopes.
Trail loamy fine sand, 0 to 1 percent slopes.
Trail loamy fine sand, 1 to 3 percent slopes.

These soils are fairly well suited to irrigation. They are particularly suited to the deep-rooted crops that readily draw moisture from soils with a moderately low to low water-holding capacity. Alfalfa is the most desirable crop; corn, barley, and wheat are next in importance and in adaptability. Rotations lasting 4 to 6 years are suitable. They consist of row crops for 1 or 2 years; small grains, 1 to 2 years; and alfalfa, 3 to 6 years.

All crops respond to applications of commercial fertilizer. Alfalfa needs phosphate, and all other crops need both nitrogen and phosphate. The soils usually require a slight to a moderate amount of leveling, but deep cuts can be made if necessary. Grades of 0.5 to 1 percent are suitable for irrigation. Irrigation runs need to be relatively short, or from 440 to 660 feet in length. Irrigation water should be applied frequently and in small amounts. Large applications cause loss of water through penetration below the root zone. Wind erosion is a hazard if the soils are left bare and unprotected during winter and spring.

CAPABILITY UNIT IIIs–4(Ir)

This capability unit consists of deep, fine-textured soils on nearly level to gentle slopes. The soils are slow to very slow in permeability and low to moderate in available water-holding capacity. Most of the soils contain soluble salts or alkali, or both, that are toxic to plants. The soils in this unit are—

Jocity silty clay, slightly alkali, 0 to 1 percent slopes.
Navajo clay, moderately saline-alkali, 0 to 1 percent slopes.
Navajo clay, moderately saline-alkali, 1 to 3 percent slopes.
Navajo clay, shallow over loam, moderately saline, 0 to 1 percent slopes.
Navajo loam, moderately saline, 0 to 1 percent slopes.

These soils are poorly suited to irrigation in their present condition. However, they can produce wheatgrasses, fescues, and similar plants tolerant of salts and alkali. Moderate to intensive reclamation is required before general field crops can be grown on these soils. This includes precise land leveling so that irrigation water can be applied evenly on the soils. After the soils are leveled, leaching and the growing of grasses tolerant of salts and alkali improve the soils. After this has been done for 2 years or more, depending on the particular soil, it may be feasible to grow barley or grain sorghum for a short time. If yields of these crops are satisfactory, a rotation consisting of row crops, small grains, and sod-forming crops can be started. If the barley and grain sorghum produce poor yields, the soil must be leached until satisfactory production of these trial crops is obtained. It is difficult to improve these soils enough in a short time to produce general field crops.

After a high degree of reclamation has been obtained, these soils need management comparable to that for soils in capability unit IIIs–2(Ir).

CAPABILITY UNIT IVe–4(Ir)

This capability unit consists of a deep, moderately coarse textured soil that has rapid permeability and a low water-holding capacity. The soil occurs on alluvial fans with moderate slopes. This soil is—

Trail loamy fine sand, 3 to 5 percent slopes.

This soil is poorly suited to irrigation because of the steepness of slopes. It requires excessive leveling. Irrigation water needs to be well controlled to prevent erosion and to prevent water from penetrating too deeply. If the slopes are reduced through extensive leveling, this soil is highly productive of the climatically adapted crops, such as corn, sorghum, wheat, barley, alfalfa, pasture forage, and truck crops. If the slopes are made nearly level, this soil can be managed like those in capability unit IIIs–3(Ir). If it is irrigated according to its natural slope, hay and pasture are the best-adapted crops.

CAPABILITY UNIT IVe–5(Ir)

This capability unit consists of a deep, fine-textured soil that has very slow permeability and a good water-holding capacity. The soil occurs on high valley plains and has spotted areas that are affected by exchangeable sodium. The soil in this unit is—

Silver clay, 3 to 5 percent slopes.

This soil is suited to the growing of irrigated pasture or hay. The steepness of slopes, the fine texture of the soil, and the excess sodium make this soil poorly suited to cropping systems that require intensive irrigation and considerable land leveling. The wheatgrasses and fescues are the best-adapted plants for this soil.

The chemical properties of this soil interfere with the response to commercial fertilizer. Nitrogen needs to be used in field trials to determine whether crops will respond. Land leveling has to be restricted to moving only small amounts of soil because it is undesirable to expose the sodium in the subsoil. Irrigation runs need to be short because slopes are steep. Pasture or hay should be irrigated by use of the border system.

CAPABILITY UNIT IVe–7(Ir)

This capability unit consists of a shallow, medium-textured, well-drained soil that is moderate to moderately rapid in permeability. The soil is low in fertility and water-holding capacity. The soil in this unit is—

Moenkopie fine sandy loam, 1 to 3 percent slopes.

This soil is poorly suited to irrigation. Intensive management is required to keep it productive. Adapted crops are alfalfa-grass mixtures for hay, legume-grass mixtures for pasture, and barley. Barley is best suited as a companion crop for reestablishing pasture or hay.

When leveling, only shallow cuts can be made. Because the soil is shallow, better results are obtained through planing the surface and irrigating on the existing grade. The soil is difficult to irrigate. Water should be applied frequently and in small amounts. Large amounts of water can be lost in runoff. Irrigation runs should range from 330 to 660 feet in length. The border system of irrigation is best suited.

CAPABILITY UNIT IVs–3(Ir)

This capability unit consists of a shallow, medium-textured soil over gravel and sand. The soil has a very low water-holding capacity. It occupies gently sloping uplands and nearly level flood plains. It is moderately permeable above the substratum. The soil in this unit is—

Trail fine sandy loam, shallow over gravel, 0 to 1 percent slopes.

This soil is poorly suited to irrigation because intensive management is needed to keep it moderately productive. The adapted crops are alfalfa and grasses for hay, other legumes and grasses for pasture, and barley. Barley is best used as a companion crop for reestablishing pasture or hay.

Crops respond to nitrogen and phosphate. The soil is shallow, and only slight cuts can be made when leveling. Consequently, it is best to plane the surface of these soils and to irrigate on the existing grade. This soil is difficult to irrigate. Water should be applied frequently and in small amounts. Large amounts of water can be lost through deep penetration into the gravel beds. The length of runs needs to be in the range of 330 to 660 feet. The border system of irrigation is best suited.

Irrigated soils of the subhumid section

Irrigated soils in the subhumid part of the Area occur at elevations of 6,300 to 7,500 feet. The frost-free period is 110 to 130 days, and the precipitation is 14 to 22 inches per year.

CAPABILITY UNIT IIIe-3 (Ir)

This capability unit consists of deep to moderately deep, medium-textured, gently sloping soils. Stones and cobbles that occasionally occur on the surface increase in number with depth and cause the soils to be low in water-holding capacity. The soils are moderately fertile and moderately slowly permeable. Soils in this unit are—

Sponseller silt loam, 1 to 3 percent slopes.
Sponseller gravelly loam, 1 to 3 percent slopes.

These soils are fairly well suited to irrigation and are moderately productive of nearly all climatically adapted crops. Wheat, oats, pasture, and hay are the principal crops. Apples and truck crops are also suited. Rotations are flexible because the principal crops are small grains, and hay or pasture. A suitable rotation consists of small grains for 3 or 4 years followed by hay or pasture for 3 or 4 years.

Deep cuts should be avoided in leveling because the amount of stones in the subsoil increases with depth. The stones need to be removed from the surface after leveling. Because of stones, border irrigation is best suited to these soils. Irrigation runs should generally be less than 660 feet in length. The response of crops to commercial fertilizer has not yet been established.

CAPABILITY UNIT IIIe-4 (Ir)

This capability unit consists of moderately deep to deep, fine-textured, moderately slowly to very slowly permeable soils on gentle slopes. These soils are good to high in water-holding capacity. The hazard of erosion is slight. Soils in this unit are—

Jocity silty clay, slightly alkali, 1 to 3 percent slopes.
Silver clay, 1 to 3 percent slopes.
Springerville clay, 1 to 3 percent slopes.

These soils are fairly well suited to irrigation and are moderately productive of adapted crops. Small grains and pasture are best suited because of the fine soil texture, short growing season, and cool climate. Row crops, except truck crops, are poorly suited. Suitable rotations are variable and may consist of small grains for 2 to 4 years followed by pasture for 3 to 5 years. An occasional row crop can be grown.

The soils must be irrigated carefully to prevent water and soil losses.

CAPABILITY UNIT IIIe-5 (Ir)

This capability unit consists of deep, medium to moderately fine textured soils with clay subsoil. The soils are slowly to very slowly permeable, gently sloping, and high in water-holding capacity. Soils in this unit are—

Disterheff clay loam, 1 to 3 percent slopes.
Showlow loam, 1 to 3 percent slopes.
Showlow clay loam, 1 to 3 percent slopes.

These soils are fairly well suited to irrigation. They should be irrigated carefully to prevent loss of water and damage to soil.

Corn, wheat, barley, alfalfa, and truck crops are best suited, and the soils are moderately productive of these crops.

CAPABILITY UNIT IIIe-6 (Ir)

This capability unit consists of deep, moderately coarse textured soils with clay subsoil. The soils are slowly to very slowly permeable, gently sloping, and moderately high in water-holding capacity. Soils in this unit are—

Elledge fine sandy loam, 1 to 3 percent slopes.
Elledge fine sandy loam, deep, 1 to 3 percent slopes.
Showlow sandy loam, 1 to 3 percent slopes.

These soils are fairly well suited to irrigation. They are moderately productive of oats, wheat, pasture, and hay and occasionally of corn harvested for silage. Rotations consist mostly of hay or pasture rotated with small grains. A suitable rotation consists of small grains for 2 or 3 years followed by hay and pasture for 2 or 3 years. One year of corn may follow hay or pasture in the above rotation.

The response of crops to commercial fertilizer is not definitely known because of the lack of reliable data. The soil usually requires moderate leveling and the removal of stones where present. Irrigation grades should be in the range of 0.4 to 0.8 percent, and the irrigation runs can be long. In spring, water should be applied frequently and in small amounts; in summer, water applications can be larger and less frequent.

CAPABILITY UNIT IIIs-1 (Ir)

This capability unit consists of moderately deep to deep, fine-textured, slowly permeable, nearly level soils. The soils are good in water-holding capacity and are moderately high in fertility. A few stones or cobbles are on the surface and in the subsoil. The soils in this capability unit are—

McNary clay, 0 to 1 percent slopes.
Springerville clay, 0 to 1 percent slopes.

These soils are fairly well suited to irrigation and are moderately productive of adapted crops. Small grains and pasture are the best suited crops because the soils are fine textured, the growing season is short, and the climate is cool. Row crops, except market vegetables, are poorly suited. Suitable rotations may be quite variable. They consist of small grains for 2 to 4 years, followed by pasture for 3 to 5 years. An occasional row crop can be grown.

CAPABILITY UNIT IIIs-5 (Ir)

This capability unit consists of moderately deep to deep soils that have a moderately coarse to moderately fine textured surface soil and a fine textured subsoil. The soils occupy nearly level to gentle slopes, are slowly permeable, and have a high water-holding capacity. The Showlow soils commonly have quartzite cobbles in the subsoil. The soils in this capability unit are—

Disterheff clay loam, 0 to 1 percent slopes.
Showlow clay loam, 0 to 1 percent slopes.
Showlow loam, 0 to 1 percent slopes.

These soils are fairly well suited to irrigation, and they are moderately productive. Oats, wheat, pasture forage, and hay and corn grown occasionally for silage are the adapted crops. Suitable rotations consist mostly of hay or pasture for 2 or 3 years and small grains for 2 or 3 years. Corn for 1 year can follow hay or pasture in this rotation.

The response of crops to commercial fertilizer is not definitely known because adequate yield data are not available. The soils usually require a moderate amount of leveling and the removal of stones, where present. Irri-

gation grades need to be between 0.4 to 0.8 percent. Long irrigation runs can be used. Irrigation should be light and frequent in spring and heavy and relatively infrequent in summer.

CAPABILITY UNIT IIIs-6(Ir)

This capability unit consists of a deep, well-drained, medium-textured soil with cobbly, moderately fine textured subsoil. Permeability is moderately slow, and the water-holding capacity is low. The soil in this unit is—

Sponseller silt loam, 0 to 1 percent slopes.

This soil is fairly well suited to irrigation, and it is moderately productive of nearly all climatically adapted crops. Wheat, oats, pasture, and hay are the principal field crops. Apples and market vegetables are also suited. Rotations are flexible because the main crops are small grains, and hay or pasture. A suitable rotation consists of small grains for 3 to 4 years and hay or pasture for 3 to 4 years.

Leveling needs to be held to a minimum. Deep cuts should not be made because the amount of stones in the subsoil increases with depth, and the clayey subsoil should not be exposed if it can be avoided. Stones ought to be removed from the surface when leveling is completed.

The design of irrigation systems should require the minimum of leveling. Because of stones, the border system is best suited to these soils. Irrigation runs should generally be less than 660 feet in length.

This soil is moderately difficult to irrigate. Irrigations should be frequent and in small amounts in spring to prevent waterlogging the soil. Those in summer can be in larger amounts and at longer intervals.

Crops respond to nitrogen and phosphate, but the response to potash is not yet fully known.

CAPABILITY UNIT IVe-1(Ir)

This capability unit consists of moderately deep to deep, slowly permeable soils that have a high water-holding capacity. The soils occur on moderate slopes. The Elledge soils have a few stones and cobbles of sandstone throughout the profile. The Showlow soils have a few cobbles of quartzite in the profile. The soils in this capability unit are—

Elledge fine sandy loam, deep, 3 to 5 percent slopes.
Elledge fine sandy loam, 3 to 5 percent slopes.
Showlow clay loam, 3 to 5 percent slopes.
Showlow loam, 3 to 5 percent slopes.
Showlow sandy loam, 3 to 5 percent slopes.

These soils are moderately to poorly suited to irrigation. Small grains, hay, and pasture forage are the adapted crops. The soils are suited to a rotation consisting of hay or pasture for 2 to 4 years and small grains for 1 or 2 years.

The clay subsoil should not be exposed if this can be prevented. Also, it is desirable to keep the coarser textured surface soil in place. Consequently, land leveling needs to be held to a minimum.

These soils are very difficult to irrigate because of the moderate slopes. Irrigation runs need to be short to prevent large losses of soil through erosion and to obtain even penetration of water. The border system, with corrugations, is best for irrigating these soils. Light, frequent irrigations should be applied during spring to prevent waterlogging the subsoil. Heavy irrigations, applied at long intervals, are suitable in summer. All crops respond to nitrogen and phosphate. Potash fertilizer should be given field trials to determine how crops respond to its use.

CAPABILITY UNIT IVe-2(Ir)

This capability unit consists of a moderately deep, strongly sloping, medium-textured soil that is moderately permeable and low in water-holding capacity. A few cobbles and stones are on the surface, and these are more numerous with increase in soil depth. The soil in this capability unit is —

Sponseller gravelly loam, 5 to 10 percent slopes.

This soil is poorly suited to irrigation because the strong slopes are difficult to irrigate. Hay and pasture are the adapted crops. Rotations are of little importance because only a limited number of crops are adapted to this soil.

Pasture and hay plants respond to nitrogen. Land leveling is not practiced, because the slopes are too strong and numerous stones are in the subsoil. The border system, with corrugations, is the most suitable method of irrigating this soil.

Soils suitable for dryfarming

Soils suitable for dryfarming are in the subhumid part of the Area. Precipitation, temperature, and the length of the growing season are enough to obtain fairly dependable yields of crops. The texture of the surface soil and fertility, permeability, and water-holding capacity are favorable to dryfarming.

CAPABILITY UNIT IIIs-7(D)

This capability unit consists of a deep, well-drained, moderately coarse textured soil with clayey, very slowly permeable subsoil. Slopes are gentle. The water-holding capacity is moderately high. Fertility is moderate. The soil in this capability unit is—

Showlow sandy loam, 1 to 3 percent slopes.

This soil is fairly well suited to dryland farming, and it is moderately productive of adapted crops. Wheat, pinto beans, grain sorghum, and corn are the most suitable crops. Rotations lasting 3 to 5 years are suitable. They may consist of row crops for 1 or 2 years, followed by small grains for 2 to 4 years.

This soil is somewhat low in phosphorus and nitrogen, but the response of crops to these fertilizers is not yet definitely known. Field tests are needed.

Suitable supporting conservation practices consist of terracing, contour tillage, rough tillage, and stubble mulching. These practices are needed to control runoff, decrease erosion, and insure high retention of the moisture that falls in torrential summer storms. Terraces are most suitable on slopes of less than 1 percent.

CAPABILITY UNIT IIIc-1(D)

This capability unit consists of deep, moderately permeable soils on nearly level to gentle slopes. The soils have a medium to moderately coarse textured surface layer, and they have a medium-textured subsoil. The

water-holding capacity is good. The soils in this capability unit are—

Chevelon loam, colluvial variant, 1 to 3 percent slopes.
Heber fine sandy loam, 0 to 1 percent slopes.
Heber fine sandy loam, 1 to 3 percent slopes.
Mogollon fine sandy loam, high rainfall, 1 to 3 percent slopes.
Zeniff fine sandy loam, 0 to 1 percent slopes.
Zeniff fine sandy loam, 1 to 3 percent slopes.
Zeniff loam, 0 to 1 percent slopes.
Zeniff loam, 1 to 3 percent slopes.

These soils are fairly well suited to dryfarming, and they are moderately productive of adapted crops. Wheat, pinto beans, grain sorghum, and corn are the most satisfactory crops. Rotations lasting 3 to 5 years are suitable. They consist of row crops for 1 or 2 years and small grains for 2 to 4 years.

These soils are somewhat low in phosphorus and nitrogen. However, fertilizers containing these elements should be tried in the field to determine crop responses to their use.

Terracing, contouring, rough tillage, and stubble mulching decreases erosion, reduces runoff, and helps the soils retain most or all of the moisture that falls during torrential summer storms. Terraces are most feasible on slopes of less than 1 percent.

CAPABILITY UNIT IIIc–2(D)

This capability unit consists of deep, moderately permeable soils on nearly level to gentle slopes. The surface layer and subsoil are medium textured to moderately fine textured. The surface layer of the Bagley soils is massive and disperses readily when wetted. The water-holding capacity of these soils is high. The soils in this capability unit are—

Bagley clay loam, high rainfall, 0 to 1 percent slopes.
Bagley clay loam, high rainfall, 1 to 3 percent slopes.
Bagley loam, 1 to 3 percent slopes.
Jacques clay loam, 1 to 3 percent slopes.

These soils are fairly well suited to dryfarming and are moderately productive. Wheat, pinto beans, grain sorghum, and corn are the adapted crops. Rotations lasting 3 to 5 years are suitable. They consist of row crops for 1 to 2 years and small grains for 2 to 3 years.

Terracing, contouring, rough tillage, and stubble mulching should be practiced to help absorb most or all of the rain that falls during torrential summer storms and to reduce runoff. Terraces are most feasible on slopes of less than 1 percent.

Nitrogen and phosphorus are low in supply in these soils. Commercial fertilizers containing these elements need to be tried in the field to determine how crops respond to their use. Wind erosion is a minor hazard. Tillage pans are more easily formed in these soils than in those of capability unit IIIc–1(D).

CAPABILITY UNIT IVe–3(D)

This capability unit consists of deep, medium-textured to moderately fine textured soils with moderately fine textured subsoil. The soils are moderately slowly permeable to moderately permeable and have a high water-holding capacity. They occupy moderate slopes on narrow flood plains and along the edges of valley plains. The soils in this capability unit are—

Chevelon loam, 3 to 5 percent slopes.
Chevelon loam, colluvial variant, 3 to 5 percent slopes.
Jacques clay loam, 3 to 5 percent slopes.
Zeniff fine sandy loam, 3 to 5 percent slopes.
Zeniff loam, 3 to 5 percent slopes.

These soils are poorly suited to dryfarming, and their productivity is moderately low. Wheat is the most suitable crop. Next in suitability are corn for fodder and small grains, other than wheat. Rotations 3 to 4 years in length are suitable. These should consist of 2 or 3 years of wheat, followed by 1 year of row crops. Hay and pasture are not suited in a crop rotation because establishing them is extremely difficult.

Contouring, rough tillage, and stubble mulching are the supporting practices best suited to these soils. Contour planting is best adapted if row crops are grown.

The soils are moderately low in nitrogen and phosphorus. However, commercial fertilizers containing these elements should be tested in field trials to determine the response of crops to their use. The hazards of wind and water erosion are moderate unless the supporting practices are used.

CAPABILITY UNIT IVe–6(D)

This capability unit consists of deep, medium-textured to moderately fine textured soils that have slowly permeable clay subsoil of very high water-holding capacity. The soils occur on old valley plains and have moderate slopes. A few cobbles of quartzite are on the surface, but they are more numerous in the subsoil. The soils in this capability unit are.

Showlow clay loam, 3 to 5 percent slopes.
Showlow loam, 3 to 5 percent slopes.
Showlow sandy loam, 3 to 5 percent slopes.

These soils are poorly suited to dryfarming, and they are poorly productive of row crops. Wheat is the best suited small grain, but oats can be grown on the Showlow sandy loam. Grain sorghum is moderately suited to these soils, and corn is poorly suited. Rotations lasting 3 to 5 years are suitable. They consist of row crops for 1 year and small grains for 3 or 4 years.

Data on the response of crops to the use of fertilizers are not available. Fertilizers containing nitrogen or phosphorus need to be evaluated in field trials. The supporting practices are mainly rough tillage, stubble mulching, and contouring. The surface soil should be managed so that it will absorb as much water as possible from torrential summer storms. The hazard of water erosion is slight to moderate, and that of wind erosion, slight.

CAPABILITY UNIT IVs–1(D)

This capability unit consists of a moderately deep, medium-textured soil on moderately sloping upland plains. The surface soil is very weakly aggregated and readily disperses under the impact of torrential summer rains. The subsoil is thin, moderately permeable, and of low water-holding capacity. The hazard of erosion is slight. The soil in this capability unit is—

Chevelon loam, 1 to 3 percent slopes.

These soils are poorly suited to dryfarming and are poorly productive of most crops. The lack of adequate water-holding capacity and the loss of water during summer storms cause the soils to be droughty. Wheat, grain sorghum, and corn are the most suitable crops. Rotations lasting 2 to 4 years are satisfactory. They consist of row crops for 1 year and wheat for 2 or 3 years.

The soils need protection that will help to control runoff and to prevent the dispersion that interferes with infiltration of moisture. Contouring, rough tillage, and stubble mulching are the desirable supporting practices that help to conserve soil and moisture.

The response to fertilizer is not known for these soils. Nitrogen and phosphate fertilizers should be given field trials to determine the response of crops to their use. Water erosion can be moderately severe if supporting conservation practices are not used.

CAPABILITY UNIT IVs-2(D)

This capability unit consists of deep, moderately coarse textured soils that are rapidly permeable and low in water-holding capacity. The soils occur in narrow drainages and on alluvial fans having nearly level to gentle slopes. They are droughty and moderately low in fertility. The soils in this capability unit are—

Heber loamy fine sand, 0 to 1 percent slopes.
Heber loamy fine sand, 1 to 3 percent slopes.

These soils are poorly suited to dryfarming, and they are poorly to moderately productive. The most suitable crops are wheat, oats, grain sorghum, and corn. Rotations of these crops in cycles of 3 to 5 years are satisfactory. They should consist of row crops for 1 year and small grains for 2 or 3 years.

Stubble mulching and the minimum amount of tillage ought to be practiced to help control soil blowing. Little moisture is lost through runoff during heavy summer storms because the surface layer of these soils is coarse and does not readily seal or crust. Infiltration is usually rapid enough to absorb most of the rain.

The response of crops to nitrogen and phosphate fertilizers is not known, because reliable data are not available.

CAPABILITY UNIT IVs-4(D)

This capability unit consists of deep clay soils that are slowly permeable and are good in water-holding capacity. The soils occupy upland plains that have nearly level to gentle slopes. There is a slight hazard of water erosion but no hazard of wind erosion. A few basalt stones occur on the surface. Bedrock or basalt boulders are more than 36 inches from the surface. The soils in this capability unit are—

McNary clay, 0 to 1 percent slopes.
Springerville clay, 0 to 1 percent slopes.
Springerville clay, 1 to 3 percent slopes.

These soils are poorly suited to dryfarming, and they are moderately to poorly productive of most crops. Wheat is the most suitable crop. Summer annuals, such as corn, grain sorghum, and oats, are poorly suited. A suitable rotation consists of wheat for 2 or 3 years, followed by fallow for 1 year.

These soils need conservation practices that help to keep their surface soil porous enough to absorb most of the moisture that falls during severe summer storms. Rough tillage and stubble mulching are the most suitable practices. There is not enough reliable information to know how these crops respond to the use of fertilizer.

CAPABILITY UNIT IVs-5(D)

This capability unit consists of deep, moderately coarse to moderately fine textured soils that have a slowly permeable clay subsoil of high water-holding capacity. The soils occupy nearly level to gentle slopes. The Elledge soils are underlain by sandstone at a depth of 24 to 40 inches. There is a moderate hazard of water erosion and only a slight hazard of wind erosion. The Disterheff soils are deep over basalt. The Showlow soils are underlain by old cobbly gravel, and the Overgaard soils are deep over medium-textured alluvium. The soils in this capability unit are—

Disterheff clay loam, 0 to 1 percent slopes.
Disterheff clay loam, 1 to 3 percent slopes.
Elledge fine sandy loam, deep, 1 to 3 percent slopes.
Elledge fine sandy loam, 1 to 3 percent slopes.
Overgaard fine sandy loam, 0 to 1 percent slopes.
Overgaard fine sandy loam, 1 to 3 percent slopes.
Showlow clay loam, 0 to 1 percent slopes.
Showlow clay loam, 1 to 3 percent slopes.
Showlow loam, 0 to 1 percent slopes.
Showlow loam, 1 to 3 percent slopes.

These soils are moderately to poorly suited to dryfarming, and they are moderately to poorly productive of most crops. Wheat, oats, and grain sorghum are the most suitable crops. Rotations lasting 3 to 5 years are suitable. These consist of row crops for 1 year and small grains for 3 or 4 years.

Supporting conservation practices needed on these soils are contouring, rough tillage, and stubble mulching. On slopes of less than 1 percent, terraces, are suitable for holding most of the moisture that falls during summer storms. On steeper slopes, terraces are better for controlling runoff.

Although the soils are somewhat low in phosphorus and nitrogen, the use of fertilizer containing these elements should be tested in field trials to determine crop responses.

CAPABILITY UNIT IVs-6(D)

This capability unit consists of moderately deep to deep, medium-textured soils on nearly level to gentle slopes. A few stones and cobbles are on the surface, and they are more numerous with increasing depth. They cause the soils to have a moderately low water-holding capacity. The soils are permeable and moderately high in fertility. The soils in this capability unit are—

Sponseller silt loam, 0 to 1 percent slopes.
Sponseller silt loam, 1 to 3 percent slopes.
Sponseller gravelly loam, 1 to 3 percent slopes.

These soils are poorly suited to dryfarming. Stones immediately below their thin surface layer severely interfere with tillage. Also, the many stones deeper in the soils reduce the water-holding capacity to that of shallow to moderately deep soils.

Wheat and oats are the most suitable crops. Climatic limitations are too severe for grain sorghum, and corn is poorly suited. Crop rotations are seldom used. Operators usually plant wheat and oats in alternate years.

Rough tillage and stubble mulching are the needed supporting conservation practices. Contouring and terracing are not feasible, as stones interfere with carrying out these practices. The response of crops to fertilizer is not known because reliable yield data are lacking.

Soils not suited to dryfarming

The capability units in this group are made up of soils that have limitations that permit use for range or for-

estry, but not for dryfarming. Some of the soils in this group, however, are suited to irrigated farming where water is available. These soils that can be reached by water have been classified according to their capability for irrigated farming under that heading.

CAPABILITY UNIT Vw-1

This capability unit consists of level soils that have a permanent water table at or near the surface for long periods or that are flooded for long periods. The soils are deep clay or loamy sand with organic layers. The surface layer is slightly to strongly saline. The soils in this capability unit are—

Navajo clay, poorly drained variant, slightly saline, 0 to 1 percent slopes.
Wet alluvial land.

These soils are well suited to pasture. They produce a salt-marsh type of vegetation, which, under good to excellent conditions, is abundant and palatable. Much of the vegetation is in poor condition because overuse has severely depleted the vigor and composition of the most palatable plants. Grazing of pastures should be rotated and should be deferred for different periods during each growing season. This will allow the palatable plants to improve in vigor and to increase in number.

CAPABILITY UNIT VIe-1

This capability unit consists of deep and gently sloping to steep soils. The surface soil is thin and medium textured to moderately fine textured. It is clayey and contains few to many cobbles of quartzite. The soils in this capability unit are—

Elledge fine sandy loam, deep, 3 to 5 percent slopes.
Elledge fine sandy loam, 3 to 5 percent slopes.
Elledge fine sandy loam, 5 to 10 percent slopes.
Showlow clay loam, 5 to 20 percent slopes.
Showlow loam, 5 to 20 percent slopes.
Showlow sandy loam, 5 to 20 percent slopes.

These soils are suited to grazing and forestry. They are moderately productive of natural forage for grazing but do not produce trees of sawtimber size. Juniper has increased in density since grazing began in the 1880's. It is a weed tree of little economic value, and it competes with the forage plants. Economical control of juniper on these soils has not been achieved.

Deferred-rotation grazing during the growing season of the grasses is needed to maintain or improve the vigor and composition of the stand. The number of livestock should be adjusted to the carrying capacity of the range.

CAPABILITY UNIT VIe-2

This capability unit consists of deep to moderately deep, strongly sloping soils underlain by shale or basalt boulders. The surface soil is medium textured, and the subsoil is moderately permeable. The soils in this capability unit are—

Chevelon loam, 5 to 10 percent slopes.
Sponseller gravelly loam, 5 to 10 percent slopes.
Zeniff fine sandy loam, 5 to 10 percent slopes.

These soils are well suited to grazing and are moderately to highly productive of forage. Except for the Sponseller soil, they are moderately to poorly suited to forestry because they are poor producers of sawtimber. Juniper has invaded these soils to a slight to moderate degree but is only a minor problem.

Deferred-rotation grazing during the growing season of grasses is needed to maintain or improve the vigor and composition of the stand. The number of livestock should not exceed the carrying capacity of the range.

CAPABILITY UNIT VIs-1

This capability unit consists of soils deep to moderately deep over sandstone. The soils are infertile and noncalcareous. They occupy gentle to steep slopes. The surface soil is medium textured, and the subsoil is clay or sandy clay. Few to many stones occur in the surface soil and subsoil. The soils in this capability unit are—

Elledge stony fine sandy loam, 3 to 5 percent slopes.
Elledge stony fine sandy loam, 5 to 10 percent slopes.
Millard gravelly sandy loam, 1 to 3 percent slopes.
Millard gravelly sandy loam, 3 to 10 percent slopes.
Showlow cobbly sandy clay loam, 1 to 3 percent slopes.
Showlow cobbly sandy clay loam, 3 to 5 percent slopes.
Showlow cobbly sandy clay loam, 5 to 20 percent slopes.

These soils are well suited to forestry and are moderately to highly productive of ponderosa pine. They are poorly suited to grazing and are poor producers of grass. Areas of these soils in the Sitgreaves National Forest are managed by the U.S. Forest Service. Those in private ownership are too small to be managed for forestry.

CAPABILITY UNIT VIs-2

This capability unit consists of soils that have a very calcareous clay or clay loam surface layer and a calcareous clay subsoil. These soils occupy gentle to moderate slopes. The soils in this capability unit are—

Claysprings clay, 1 to 3 percent slopes.
Claysprings clay, 3 to 5 percent slopes.
Claysprings clay loam, 3 to 5 percent slopes.

These soils are moderately suited to grazing, and if properly managed, are moderately productive of forage. Most of the tree vegetation is juniper, mixed with a small number of pinyon pines.

Most of the soils have been completely invaded by juniper since grazing began in the 1880's. No economic use has been found for the juniper, which should be eradicated to allow greater production of forage. Bulldozing and cabling are suitable methods of eradication.

CAPABILITY UNIT VIc-1

This capability unit consists of deep, friable, moderately fine to moderately coarse textured soils on nearly level to gentle slopes. The subsoil is moderately permeable. All soils, except the Millard, have a high water-holding capacity. The Millard soils have a moderately low water-holding capacity. The soils in this capability unit are—

Bagley clay loam, 0 to 1 percent slopes.
Bagley clay loam, 1 to 3 percent slopes.
Bagley sandy clay loam, 0 to 1 percent slopes.
Bagley sandy clay loam, 1 to 3 percent slopes.
Clovis sandy loam, 0 to 1 percent slopes.
Clovis sandy loam, 1 to 3 percent slopes.
Clovis sandy loam, 3 to 5 percent slopes.
Mogollon fine sandy loam, 0 to 1 percent slopes.
Mogollon fine sandy loam, 1 to 3 percent slopes.

These soils are well suited to grazing and are moderately productive of many kinds of grass. The spread of juniper has been accelerated by overgrazing and is now a moderate

problem. Juniper should be eradicated to increase the production of forage. The most practical methods of eradication are cabling and burning.

Grazing should be managed so that the vigor and composition of the native grasses can improve. Deferred-rotation grazing is a suitable system for this purpose.

CAPABILITY UNIT VIIe–1

The capability unit consists of calcareous clay or clay loam soils on strong to steep slopes. Erosion on these soils is more active than it is on soils of capability unit VIs–2. The soils in this capability unit are—

Claysprings clay, 5 to 20 percent slopes.
Claysprings clay loam, 5 to 20 percent slopes.

These soils are moderately to poorly suited to grazing, and they are moderately to poorly productive of forage. They are mainly covered by juniper, mixed with a small number of pinyon pines. The juniper occurs in moderate to dense stands of mature trees or in sparse to moderately dense stands of young trees that have invaded former grassland.

The main problem is to decrease the density of the juniper and to increase the production of forage. This is a difficult problem to solve because the eradication of juniper is not economically feasible by present-day methods. Burning is a dangerous procedure because the areas in need of treatment are near the Sitgreaves National Forest. No satisfactory herbicides for the eradication of pinyon and juniper have been discovered.

CAPABILITY UNIT VIIe–2

This capability unit consists of a moderately deep to deep, gravelly, coarse-textured, steep, somewhat excessively drained soil. It is low in fertility and water-holding capacity and moderately rapid in permeability. The soil in this unit is—

Millett gravelly loamy sand, 5 to 20 percent slopes.

This soil is suited to grazing. It is moderately to highly productive of forage, considering the rain it gets.

The main problem is to control grazing by limiting the number of livestock on the range. Deferred-rotation grazing is needed to improve the vigor and composition of the grasses. If grass is grazed too closely during the winter, plants are pulled from the soil. Juniper is invading the Millett soils.

CAPABILITY UNIT VIIe–3

This capability unit consists of a deep, coarse-textured, excessively drained, very rapidly permeable soil. The soil is low in fertility and water-holding capacity. The soil in this unit is—

Sheppard fine sand, 3 to 10 percent slopes.

This soil is suited to grazing. It is moderately to highly productive of forage, considering the rain it gets.

The main problem is to control grazing by limiting the number of livestock on the range. Deferred-rotation grazing is needed to improve the vigor and composition of the grasses.

CAPABILITY UNIT VIIs–1

This capability unit consists of calcareous, very shallow to shallow, medium-textured soils that occur in an area that gets 7 to 10 inches of rainfall per year. The soils have a low to very low water-holding capacity. The sparse cover of vegetation leaves much of the surface without protection. The bare soils readily disperse and seal at the surface during torrential rains. This increases runoff and the loss of moisture. The soils in this capability unit are—

Moenkopie fine sandy loam, 1 to 3 percent slopes.
Moenkopie fine sandy loam, 3 to 5 percent slopes.
Moenkopie fine sandy loam, very shallow, 1 to 3 percent slopes.
Moenkopie fine sandy loam, very shallow, 3 to 10 percent slopes.

These soils are suitable for grazing, but they are poor producers of forage. They support a sparse cover of short bunch grass and a few perennial weeds and shrubs.

The main problem is the control of grazing by limiting the number of livestock on the range. Deferred rotation grazing is needed to maintain or improve the vigor and composition of the grasses. Climate does not prevent grazing on these soils in any part of the year.

CAPABILITY UNIT VIIs–2

This capability unit consists of very shallow to deep, stony soils on basalt, limestone, and sandstone. The soils are in an area that gets 15 to 22 inches of rainfall per year. The soils and land types in this capability unit are—

Paiso stony clay loam, shallow, 1 to 3 percent slopes.
Paiso stony clay loam, shallow, 3 to 5 percent slopes.
Paiso stony clay loam, shallow, 5 to 10 percent slopes.
Rock land, basalt.
Rock land, limestone.
Rock land, sandstone.
Springerville stony clay, 0 to 1 percent slopes.
Springerville stony clay, 1 to 3 percent slopes.

These soils are suitable for grazing and forestry, and they are moderately productive. The amount of forage available for grazing varies greatly, according to the amount and composition of the forest cover. In some areas juniper is now so dense that control measures are needed. Most of the areas that have sawtimber are inside the Sitgreaves National Forest and are managed by the U.S. Forest Service.

Deferred-rotation grazing and adjustment of livestock numbers to the carrying capacity of the forage are the main requirements for improving the vigor and composition of the range.

CAPABILITY UNIT VIIs–3

This capability unit consists of moderately coarse textured soils that can absorb all or most of the precipitation from torrential storms. The soils have a moderately low to low water-holding capacity, but it is adequate for the 7 to 13 inches of annual precipitation received by these soils. A high percentage of the moisture in the soil is available to plants. The soils in this capability unit are—

Trail loamy fine sand, 0 to 1 percent slopes.
Trail loamy fine sand, 1 to 3 percent slopes.
Trail loamy fine sand, 3 to 5 percent slopes.
Trail fine sandy loam, 0 to 1 percent slopes.
Trail fine sandy loam, 1 to 3 percent slopes.
Trail fine sandy loam, shallow over gravel, 0 to 1 percent slopes.

These soils are suitable for grazing, and they are moderately to highly productive for the amount of rainfall they receive.

Proper stocking and deferred-rotation grazing are needed to maintain or improve the vigor and composition of the grasses. The forage should be grazed lightly in

winter to prevent livestock from pulling up the plants. Wind erosion is a moderate hazard if the grass cover is depleted too severely.

CAPABILITY UNIT VIIs-4

This capability unit consists of fine to moderately coarse textured soils containing chemicals that are toxic to plants. The saline soils contain harmful salts, and the alkali soils, a high percentage of exchangeable sodium. The saline-alkali soils contain both salts and alkali. The soils of this capability unit have been influenced by the water table in the past, or they now have a water table between 5 and 10 feet from the surface. Rainfall is 7 to 10 inches per year. The soils in this capability unit are—

Ives fine sandy loam, slightly alkali, 1 to 3 percent slopes.
Loamy alluvial land, moderately saline-alkali.
Loamy alluvial land, strongly saline.
Navajo clay, moderately saline-alkali, 0 to 1 percent slopes.
Navajo clay, moderately saline-alkali, 1 to 3 percent slopes.
Navajo clay, shallow over loam, moderately saline, 0 to 1 percent slopes.
Navajo clay, shallow over sand, moderately saline, 0 to 1 percent slopes.
Navajo clay loam, strongly saline-alkali, 0 to 1 percent slopes.
Navajo loam, moderately saline, 0 to 1 percent slopes.
Sandy alluvial land, moderately saline.
Sandy alluvial land, strongly saline.
Silver clay, 1 to 3 percent slopes.
Silver clay, 3 to 5 percent slopes.
Tours clay loam, moderately saline-alkali, 0 to 1 percent slopes.
Tours clay loam, deep over loam, moderately saline-alkali, 0 to 1 percent slopes.

These soils are suitable for grazing, but they are poor producers of forage. The grasses and woody shrubs that are eaten by livestock are those that tolerate the salts, alkali, or both. Most forage is low in palatability.

Management needs are difficult to determine because the forage plants respond slowly to practices that ordinarily improve the range. Livestock numbers need to be adjusted to the available forage to improve the vigor and condition of the range.

CAPABILITY UNIT VIIs-5

This capability unit consists of coarse-textured soils that contain gravel and sand. These soils have a very low water-holding capacity, but it is usually sufficient to hold most of the winter precipitation. The soils receive 7 to 13 inches of rainfall per year. The soils and land type in this capability unit are—

Millett gravelly loamy sand, 1 to 3 percent slopes.
Millett gravelly loamy sand, 3 to 5 percent slopes.
Terrace escarpments, sandy.

These soils are suited to grazing, and they are moderately to highly productive for the amount of rain they get.

The grazing on these soils needs to be managed through a deferred-rotation system and an adjustment of livestock numbers to prevent overuse of the forage. These practices help to maintain and improve the vigor and composition of the grasses. Close grazing may cause livestock to pull plants from the soils in winter. Juniper is invading a small area of the Millett soils.

CAPABILITY UNIT VIIc-1

This capability unit consists of deep, medium-textured to moderately fine textured soils that can hold only a limited amount of precipitation. The rainfall on these soils is 7 to 13 inches per year. A moderate amount of wind erosion occurs.

The soils and land types in this capability unit are—

Dune land, loamy.
Jocity sandy clay loam, slightly alkali, 1 to 3 percent slopes.
Jocity sandy clay loam, slightly alkali, 3 to 5 percent slopes.
Loamy alluvial land.
Moffat sandy loam, 1 to 3 percent slopes.
Moffat sandy loam, 3 to 5 percent slopes.
Redfield sandy loam, 1 to 3 percent slopes.
Redfield sandy loam, 3 to 5 percent slopes.
Redfield very fine sandy loam, 0 to 1 percent slopes.
Redfield very fine sandy loam, 1 to 3 percent slopes.
Redfield very fine sandy loam, 3 to 5 percent slopes.
Sandy alluvial land.
Tours clay loam, 0 to 1 percent slopes.
Tours clay loam, 1 to 3 percent slopes.
Tours clay loam, 3 to 5 percent slopes.

These soils are suitable for grazing, and they are moderately productive. They occur in semiarid areas that have moderately hot summers and moderate winters. Climate does not interfere with grazing during any part of the year.

Stocking that adjusts the number of livestock to the available forage is the main management needed. A deferred-rotation system of grazing ought to be used to maintain or improve forage production.

CAPABILITY UNIT VIIIe-1

This capability unit consists of narrow bands of sand dunes adjacent to the Little Colorado River. The material in the dunes is deep, coarse-textured, excessively drained, rapidly permeable sand that is generally bare of vegetation and subject to wind erosion. The land type in this unit is—

Dune land, sandy.

Dune land, sandy, is mostly suitable for recreation and wildlife. Vegetation should be established and protected to stabilize the sand.

CAPABILITY UNIT VIIIw-1

This capability unit consists of riverwash in the beds of intermittent streams. The land type in this unit is—

Riverwash.

This material is a source of sand and gravel. The areas are suitable mostly for recreation, wildlife, or esthetic purposes.

CAPABILITY UNIT VIIIs-1

This capability unit consists of exposed shale and sandstone rock land and the loamy escarpments of terraces. Rock land supports a few scanty, stunted junipers and woody shrubs. Terrace escarpments are almost bare of vegetation. The land types in this capability unit are—

Rock land, shale and sandstone.
Terrace escarpments, loamy.

The most suitable use of these land types is recreation, wildlife habitat, or esthetic purposes. Coconino sandstone can be quarried in areas of Rock land and sold as flagstone and building material.

Estimated Yields

The estimated yields of important crops grown on soils in the Holbrook-Show Low Area are shown for two levels

of management in table 4. The yields in columns A are those to be expected under the prevailing management; the yields in columns B, those to be expected under improved management. The soils differ widely in productivity and in their response to different methods of management.

Under prevailing management (columns A) on the irrigated soils, little or no nitrogen and phosphate fertilizer is applied to wheat and corn, little or no phosphate is applied to alfalfa, and no fertilizer is applied to barley and oats; excessive tillage is used in preparing seedbeds and in cultivating corn; alfalfa is pastured in winter; and too much time elapses between irrigations, so that crops are short of water in summer.

Under prevailing management, (columns A) on the dry-farmed soils, excessive shallow tillage is used in the preparation of seedbeds and the control of weeds, and in cultivation no provision is made for the prevention of tillage pans. All crop residues, however, are plowed under.

The estimated yields in columns B are mostly based on the yields obtained from soils that are farmed under a fairly high level of management. Although yield data are limited, those available are believed to represent reasonably well the yields than can be expected when the best practices are used. The best practices on irrigated soils include the use of commercial fertlizer, improved varieties of crops, timely and properly managed irrigations to suit the crop, proper methods of tillage, and adequate leveling of fields. In addition, alfalfa is not grazed during winter, and all possible organic matter is returned to the soil. Improved management on the dry-farmed soils includes rough tillage, stubble mulching, chiseling or ripping of compacted soils, terracing on gentle slopes, and using improved varieties of crops.

The data in table 4 are based chiefly on information obtained through field observations and consultations with farmers in the Area. Actual crop yields were used whenever available.

TABLE 4.—*Estimated average acre yields of the main crops from the soils suited to cultivation*

[Yields in columns A are those expected over a period of years under the prevailing management practices; those in columns B, under improved management practices. Absence of a yield figure indicates crop is seldom, if ever, grown on the specified soil]

Soil	Barley		Wheat		Oats		Corn for silage		Alfalfa	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*
Bagley clay loam, 0 to 1 percent slopes	50	65	45	55	50	62	17	19	6. 5	7
Bagley clay loam, 1 to 3 percent slopes	50	65	45	55	50	62	16	18	6. 5	7
Bagley clay loam, high rainfall, 0 to 1 percent slopes			15	20			4	6		
Bagley clay loam, high rainfall, 1 to 3 percent slopes			15	20			4	5		
Bagley sandy clay loam, 0 to 1 percent slopes	50	65	45	58	50	65	16	18	6. 5	7
Bagley sandy clay loam, 1 to 3 percent slopes	50	65	45	58	50	65	16	18	6. 5	7
Bagley loam, 1 to 3 percent slopes			14	19			4	5		
Chevelon loam, 3 to 5 percent slopes			11	17			3	5		
Chevelon loam, 1 to 3 percent slopes			12	18			3	5		
Chevelon loam, colluvial variant, 1 to 3 percent slopes			15	21			4	6		
Chevelon loam, colluvial variant, 3 to 5 percent slopes			13	19			3. 5	5. 5		
Claysprings clay loam, 3 to 5 percent slopes			16	19			4	5		
Clovis sandy loam, 1 to 3 percent slopes							10	12	4	5
Clovis sandy loam, 0 to 1 percent slopes							12	14	5	6
Disterheff clay loam, 0 to 1 percent slopes			35	40	55	65			3	3. 5
Disterheff clay loam, 1 to 3 percent slopes			30	36	50	60				
Elledge fine sandy loam, deep, 1 to 3 percent slopes			20	28	40	50	7	8. 5		
Elledge fine sandy loam, deep, 3 to 5 percent slopes			18	26	35	45	6	7. 5		
Elledge fine sandy loam, 1 to 3 percent slopes			17	24	30	40	5	7		
Elledge fine sandy loam, 3 to 5 percent slopes			17	24	30	38	5	7		
Elledge stony fine sandy loam, 3 to 5 percent slopes			15	20	25	35	4	6		
Heber fine sandy loam, 0 to 1 percent slopes			15	19	18	24				
Heber fine sandy loam, 1 to 3 percent slopes			13	18	16	23				
Heber loamy fine sand, 0 to 1 percent slopes			13	19	16	20			1. 2	2
Heber loamy fine sand, 1 to 3 percent slopes			12	18	15	19				
Ives fine sandy loam, slightly alkali, 1 to 3 percent slopes	40	55					10	12	4. 5	5. 5
Jacques clay loam, 1 to 3 percent slopes			16	22	18	26				
Jocity silty clay, 0 to 1 percent slopes	45	60					11	13	5	7
Jocity silty clay, slightly alkali, 0 to 1 percent slopes	40	55					10	12	4. 5	6
Jocity silty clay, slightly alkali, 1 to 3 percent slopes							9	11	4	5
Loamy alluvial land	40	50					11	13	3. 5	5
Loamy alluvial land, moderately saline-alkali	40	48			40	50			4. 5	8
Mogollon fine sandy loam, 0 to 1 percent slopes	45	52					18	20	7	7. 5
Mogollon fine sandy loam, 1 to 3 percent slopes	45	52					18	20	7	7. 5
Mogollon fine sandy loam, high rainfall, 1 to 3 percent slopes			18	24			7	8. 5		
Navajo clay, moderately saline-alkali, 0 to 1 percent slopes							8	10	2. 5	3
Navajo clay, 0 to 1 percent slopes							10	12	4	4. 5
Navajo loam, moderately saline, 0 to 1 percent slopes							8	10	3. 5	4. 25
Overgaard fine sandy loam, 0 to 1 percent slopes							5	6. 5		
Overgaard fine sandy loam, 1 to 3 percent slopes							4. 5	6		

TABLE 4.—*Estimated average acre yields of the main crops from the soils suited to cultivation*—Continued

Soil	Barley		Wheat		Oats		Corn for silage		Alfalfa	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*
Pinetop fine sandy loam, 1 to 3 percent slopes	------	------	------	------	60	65	10	11	3. 5	4
Redfield very fine sandy loam, 0 to 1 percent slopes	40	55	------	------	------	------	12	14	4. 5	5. 5
Redfield very fine sandy loam, 1 to 3 percent slopes	35	48	------	------	------	------	11	13	4	5
Sandy alluvial land	------	------	------	------	------	------	10	12	4	5. 5
Showlow clay loam, 0 to 1 percent slopes	------	------	------	------	45	52	8. 5	10	3	3. 5
Showlow clay loam, 1 to 3 percent slopes:										
Dryland	------	------	15	20	------	------	5	6	------	------
Irrigated	------	------	------	------	------	------	8	9. 5	------	------
Showlow clay loam, 3 to 5 percent slopes	------	------	14	19	------	------	4. 5	5. 5	------	------
Showlow sandy loam, 1 to 3 percent slopes:										
Dryland	------	------	20	26	------	------	5. 5	6. 5	------	------
Irrigated	------	------	------	------	50	65	10	12	3. 5	4
Showlow sandy loam, 3 to 5 percent slopes	------	------	22	28	------	------	5	6	------	------
Springerville clay, 0 to 1 percent slopes	45	55	30	36	50	60	------	------	------	------
Springerville clay, 1 to 3 percent slopes	40	50	28	34	45	55	------	------	------	------
Tours clay loam, 0 to 1 percent slopes	40	50	------	------	------	------	12	14	1. 5	5. 5
Tours clay loam, deep over clay, 0 to 1 percent slopes	50	60	------	------	------	------	12	14	4. 5	5. 5
Tours clay loam, deep over loam, moderately saline-alkali, 0 to 1 percent slopes	35	42	------	------	------	------	------	------	3	4
Trail loamy fine sand, 0 to 1 percent slopes	------	------	------	------	------	------	10	12	4. 5	5. 5
Trail loamy fine sand, 1 to 3 percent slopes	35	45	------	------	------	------	10	12	4. 5	5. 5
Trail fine sandy loam, 0 to 1 percent slopes	45	55	40	48	50	60	15	17	6	7. 5
Trail fine sandy loam, 1 to 3 percent slopes	45	55	40	48	50	60	15	17	6	7. 5
Zeniff fine sandy loam, 0 to 1 percent slopes	------	------	20	29	------	------	6. 5	7. 5	------	------
Zeniff fine sandy loam, 1 to 3 percent slopes	------	------	18	25	------	------	6. 0	7. 0	------	------
Zeniff fine sandy loam, 3 to 5 percent slopes	------	------	15	20	------	------	------	------	------	------
Zeniff loam, 0 to 1 percent slopes	------	------	15	23	------	------	5	7	------	------
Zeniff loam, 1 to 3 percent slopes	------	------	14	22	------	------	5	6. 5	------	------

Engineering Applications of the Soils

Many individual engineering functions require a survey of the soil for the proper application of engineering data. The information in this soil survey report of the Holbrook-Show Low Area, Ariz., contains much information engineers can use, but it is not intended to eliminate the need of sampling and testing soils in preparation of designs for the construction of specific engineering work. The information in this report can be used to—

(1) Make preliminary estimates of the engineering properties of soil in the planning of agricultural drainage systems, farm ponds, irrigation systems, and diversion terraces.

(2) Correlate performance of engineering structures with soil mapping units and thus develop information that will be useful in designing and maintaining structures.

(3) Locate probable sources of gravel and other construction material.

(4) Make preliminary evaluation of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and communication cables and in planning detailed investigations of the selected locations.

(5) Determine the suitability of soil units for cross-country movement of vehicles and construction equipment.

(6) Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreational sites.

(7) Supplement the information obtained from other published maps and reports and aerial photographs to make maps and reports that can be used readily by engineers.

(8) Develop other preliminary estimates for construction purposes pertaining to the particular area.

The mapping and the descriptive reports are somewhat generalized and should be used only in planning more detailed field surveys to determine the in-place condition of the soil and the site of the proposed engineering construction.

Some of the terms used by the agricultural soil scientist may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, sand, aggregate, and granular structure—may have special meaning in soil science. These terms are defined as follows:

Soil: The natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over periods of time.

Clay: As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil

textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Silt: As a soil separate, individual mineral particles of soil that range in diameter between the upper size of clay, 0.002 millimeter, and the lower size of very fine sand, 0.05 millimeter. As a textural class, silt contains 80 percent or more of silt and less than 12 percent of clay.

Sand: As a soil separate, individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. They may be of any mineral composition. As a textural class, the name of any soil that contains 85 percent or more of sand and not more than 10 percent of clay.

Aggregate: Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism. Many properties of the aggregate differ from those of an equal mass of unaggregated soil. Water-stable aggregates, those that do not disintegrate easily, are of special importance to soil structure.

Granular structure: Individual grains grouped into spherical aggregates with indistinct sides. Highly porous granules are commonly called crumbs.

Soil test data

To be able to make the best use of the soil maps and the soil survey reports, the engineer should know the physical properties of the soil materials and the in-place condition of the soil. After testing soil materials and observing their behavior in engineering structures and foundations, the engineer can develop design recommendations for the soil units delineated on the map.

Samples from the principal soil type of two extensive soil series were tested in accordance with standard procedure (*1*) to help evaluate the soils for engineering purposes (table 5).

The engineering soil classifications in table 5 are based on data obtained by mechanical analyses and by tests to determine the liquid limits and plastic limits. Mechanical analyses were made by combined sieve and hydrometer methods. Percentage of clay obtained by the hydrometer method should not be used in determining the soil textural class.

The liquid-limit and plastic-limit tests measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a solid to a semisolid, then to a plastic state. As the moisture content is further increased, the material changes from the plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

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Table 5 also gives compaction (moisture-density) data for the tested soils. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material will increase until the "optimum moisture" content is reached. After that, the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is termed "maximum dry density." Moisture-density data are important in earthwork, for, as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density, when it is at approximately the optimum moisture content.

Engineering soil classification systems

Most highway engineers classify soil materials according to the system approved by the American Association of State Highway Officials (*1*, *4*). In this system, soil materials are classified in seven principal groups. The groups range from A-1, gravelly soil of high bearing capacity, to A–7, clay soils having low strength when wet. In each group the relative engineering value of the material is indicated by a group index number. Group index numbers range from 0, for the best materials, to 20, for the poorest. The group index number is shown in parentheses, following the soil group symbol, in the next to last column in table 5.

Some engineers prefer to use the Unified soil classification system (*8*, *4*). In this system, soil materials are identified as coarse grained, 8 classes; fine grained, 6 classes; and highly organic. An approximate classification can be made in the field. The last column in table 5 shows the classification of the tested soils according to the Unified system.

Suitability of soils for engineering uses

Table 6 shows the features, the estimated classification, and the quality of the soils in the Holbrook-Show Low Area for stated kinds of engineering construction. Additional data on soil characteristics can be obtained by referring to the sections "Descriptions of the Soils" and "Genesis, Classification, and Morphology of the Soils." The data in these sections, together with those in table 5 and the experiences with soils in the Area, are the basis for the information given in table 6. Table 6 is explained in the following paragraphs.

Poorly drained or wet soils have important engineering problems in this area. Only the soils on flood plains have a water table high enough to cause construction problems. Wet alluvial land has water at or near the surface most of the year. It has clay and organic layers. The Pinetop soils have a permanent water table 1 to 4 feet from the surface. Some of the soils mapped as Sandy alluvial land and Loamy alluvial land and those mapped in the Navajo series are affected by a high water table. Special surveys are needed in these places to see if more suitable locations can be found for highways. The suitability of the soil material for road subgrade is based on the texture of the soil material. Soils with plastic clay layers impede internal drainage and have low stability when wet, hence are rated "poor."

TABLE 5.—*Engineering*

Soil name and location	Parent material	Bureau of Public Roads report number	Depth from surface	Horizon	Moisture-density	
					Maximum dry density	Optimum moisture
			Inches		*Lb. per cu. ft.*	*Percent*
Showlow loam:						
Near center of sec. 12, T. 11 N., R. 18 E. (Modal profile).	Tertiary or quaternary alluvium.	S 31799	1–3	A12	112	14
		S 31800	12–24	B21	98	24
		S 31801	44–52+	C1	116	12
Near N. ¼ corner of sec. 7, T. 11 N., R. 19 E.	Tertiary or quaternary alluvium.	S 31802	0–2	A1	110	15
		S 31803	14–20	B23	106	20
		S 31804	46–55+	C1	110	15
Springerville clay:						
NE. corner of NW¼SW¼ sec. 13, T. 9 N., R. 22 E. (Modal profile).	Basalt (cinder influence)	S 31805	0–2	A11	93	24
		S 31806	14–28	A13	93	25
		S 31807	28–46	Cca	90	29
NE. corner of NW¼ SW¼ sec. 24, T. 9 N., R. 22 E.	Basalt (cinder influence)	S 31808	0–2	A11	92	24
		S 31809	17–30	A13	93	27
		S 31810	30–43	Cca	92	28

[1] Tests performed by Bureau of Public Roads in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*).

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

Gravel taken from pits in Millett gravelly loamy sand, near Snowflake, and from Millard gravelly sandy loam, east of Linden, has been used in the base course of county roads. The State Highway Department takes sand and gravel from the beds of local, intermittent streams for use in the construction of State roads. These streambeds also supply the sand and gravel used in concrete for industrial construction.

Soil engineering can be applied in numerous ways to farming and ranching. Ponds on rangeland are used to store water for livestock and to help distribute the grazing. Most ponds are not permanent sources of livestock water, however.

Dams require material that is satisfactory for impervious cores, as well as for stable faces and back slopes. Ponds must be located on very slowly permeable soils so that large amounts of water will not leak into the substratum.

Consideration of the erodibility of the soil is essential when earth structures, such as diversion terraces or dikes, waterways, and irrigation canals, are used for conveying or diverting water. Information on erodibility helps engineers to determine gradients of structures and the kind of protection that is needed to safeguard the structures. The Tours soils are very erodible and unstable; unprotected irrigation canals with grades of 0.4 percent erode rapidly. In addition, the sides slough. Erodibility, gradient, and stability of the sides must be considered when building an elevated canal. Stable soils, such as the Mogollon, tolerate more slope, slough very little, and can support an elevated canal with less hazard than the Tours soils.

In the Holbrook-Show Low Area, most of the water for irrigation flows in unlined ditches. A large amount of water is generally lost through seepage from these canals. The more sandy soils usually, but not always, have a higher rate of loss than the fine-textured soils. The Bagley soils have texture comparable to that of the Tours soils, but they lose considerably more water because of physical properties that make them more rapidly permeable.

Engineering problems in the field require on-site investigations to develop the proper design of earth structures.

Genesis, Classification, and Morphology of the Soils

This section discusses the factors of soil formation and classifies the soils in the Holbrook-Show Low Area into orders and great soil groups. In addition, laboratory data are given for representative soils. The layers of soil analyzed in the laboratory may not agree in depth with those in the technical descriptions of the profile.

test data[1]

Mechanical analyses[2]—												Liquid limit	Plasticity index	Classification	
Percentage passing sieve[3]—								Percentage smaller than[3]—							
1½ inch	1 inch	¾ inch	⅜ inch	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO[4]	Unified[5]
100	99	97	94	92	90	80	61	57	37	22	15	26	7	A-4(5)	ML–CL.
	100	99	98	96	94	88	75	71	59	51	45	50	25	A-7-6(16)	CL.
100	99	93	79	68	57	39	18	17	15	13	12	38	19	A-2-6(0)	SC.
100	97	91	79	74	68	52	30	27	22	16	13	30	11	A-2-6(0)	SC.
100	99	97	90	80	64	47	31	29	27	25	23	57	34	A-2-7(3)	SC.
		100	99	97	89	66	30	28	25	22	20	50	28	A-2-7(3)	SC.
[6] 99	98	98	98	98	98	97	93	91	75	60	54	51	25	A-7-6(16)	CH.
						100	97	95	80	63	55	58	30	A-7-6(20)	CH.
[7] 76	73	70	67	62	58	57	54	53	46	37	32	65	33	A-7-5(18)	MH–CH.
100	99	99	99	99	99	98	92	89	74	58	52	50	26	A-7-6(16)	CL.
						100	94	91	77	62	55	58	32	A-7-6(20)	CH.
[8] 96	89	84	74	65	55	52	48	47	43	34	30	66	37	A-7-6(10)	GC.

[3] Based on total material. Laboratory test data corrected for amount discarded in field sampling.

[4] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1, Ed. 8): The Classification of Soils and Soil-Aggregate Mixtures for Highway Purposes, AASHO Designation: M 145–49.

[5] Based on the Unified Soil Classification System, Tech. Memo. No. 3–357, v. 1, Waterways Expt. Sta., Corps of Engin., March 1953 (*8, 4*).

[6] 100-percent of material passed the 3-inch sieve.

[7] Separates larger than 3 inches, amounting to 20 percent of sample, were discarded in the field.

[8] 100 percent of material passed the 2-inch sieve.

Factors of Soil Formation

Soil is the product of the interaction of climate, native vegetation, parent material, topography, and time. All five factors have a part in the genesis of every soil, but the relative importance of each factor differs from place to place. In extreme cases one factor may dominate the formation of the soil and fix most of its properties, as is common when the parent material consists of pure quartz sand. Little change occurs in quartz sand, and the soils derived from it usually have faint horizons. Even in quartz sand, however, distinct profiles can be formed under certain types of vegetation and on a low, flat topographic position where the water table is high. The effects of any one factor are not always readily distinguished from those of the other factors.

Climate

The Holbrook-Show Low Area has a subhumid and semiarid, temperate, continental climate that is characteristic of the Colorado Plateau in the Southwestern United States. Climatic data for seven stations in the Area are shown in table 1 (p. —). Climate has had a significant influence on soil development in the Area. This is shown in normal soils that have formed in alluvium.

In the semiarid part of the Area, low rainfall has influenced greatly the soil-forming processes. The present moisture regime is adequate for weathering of minerals and formation of silicate clay. But there is little evidence of clay in the subsoil, because (a) the soils are high in lime, which inhibits the weathering of silicates, and (b) geologic erosion removes leached or weathered materials about as rapidly as they are formed. There is not enough precipitation to move carbonates and clay into the subsoil as rapidly as they are liberated. Consequently, with only a few exceptions, the soils are moderately to strongly calcareous throughout the profile. Weathering of the sedimentary rocks has produced soils that are shallow to very shallow and that are in equilibrium with the processes of weathering and erosion under the present climate. Soils in medium to gravelly alluvium are shallow to moderately deep over the parent material.

In the subhumid part of the Area, rainfall has been heavy enough to leach carbonates from the surface soil and upper subsoil as rapidly as they are liberated in most soils. The greater supply of moisture has also influenced chemical weathering to such degree that many soils have clay in the subsoil. All the soils in the semiarid part are alkaline, but many of those in the subhumid part are neutral to slightly acid in the surface soil and upper subsoil.

Native vegetation

Native vegetation that is active in soil formation has changed only slightly on the uncultivated soils, but it has changed drastically on cultivated soils. The first settlers found open stands of ponderosa pine on the Mogollon

TABLE 6.—*Features and estimated quality*

Soil series and land types	Brief description of soil profile [1]	Dominant slope	Parent material
		Percent	
Bagley	36 to 40 inches of clay loam and clay over loam	0–1	Medium- to fine-textured alluvium
Chevelon	22 to 28 inches of loam and clay loam over bedrock.	3–5	Shale and shaly sandstone
Claysprings	Deep clay	3–10	Calcareous lakebed clay
Clovis	50 to 58 inches of sandy clay loam over sandy loam.	1–3	Loamy alluvium with gravel
Disterheff	5 to 10 inches of clay loam over clay	0–3	Volcanic cinders and basalt
Elledge	10 to 15 inches of loamy sand over 15 to 24 inches of sandy clay over bedrock.	1–5	Soft, shaly sandstone
Heber	Deep fine sandy loam	0–3	Medium-textured alluvium
Ives	Deep, stratified clay loam, loam, and fine sandy loam.	0–1	Stratified alluvium
Jacques	Deep clay loam	0–1	Moderately fine textured alluvium
Jocity	Deep sandy clay loam	1–3	Moderately fine textured alluvium
McNary	Deep clay containing few stones and cobbles of basalt.	0–1	Volcanic cinders and basalt
Millard	12 to 16 inches of gravelly sandy loam over loamy gravel and gravel.	3–10	Gravelly alluvium
Millett	20 to 26 inches of loamy gravel over gravel	5–20	Gravelly alluvium
Moenkopie	10 to 22 inches of fine sandy loam over bedrock	1–5	Interbedded sandstone and sandy shale
Moffat	12 to 16 inches of sandy loam over loam and loamy sand.	1–3	Mixed stratified alluvium
Mogollon	10 to 14 inches of fine sandy loam over 22 to 26 inches of sandy clay loam over loam.	0–1	Loamy alluvium
Navajo	Deep, saline-alkali clay	0–1	Clayey alluvium
Overgaard	8 to 11 inches of sandy loam over sandy clay loam	0–3	Alluvium
Pinetop	Deep fine sandy loam	1–3	Loamy alluvium
Redfield	Deep very fine sandy loam or loam	1–3	Sandy alluvium
Rock land	2 to 6 inches of soil over bedrock; many bedrock exposures.	5–100	Sandstone, limestone, and sandy shale
Sandy and Loamy alluvial land	Stratified clay, silt, loam, sandy loam, and loamy sand.	0–1	Stratified alluvium
Sheppard	Deep sand	3–10	Sandy alluvium
Showlow	28 to 36 inches of clay with a few cobbles over gravelly clay loam.	3–20	Tertiary cobbly alluvium
Silver	44 to 48 inches of clay over sandy clay loam	1–3	Gravelly loamy alluvium
Sponseller	40 to 46 inches of cobbly and stony clay loam over basalt boulders, stones, and cinders.	1–3	Basalt and volcanic cinders
Springerville	3 to 4½ feet of stony clay over bedrock	0–3	Basalt and volcanic cinders
Terrace escarpments	Deep clay loam and loam	5–100	Alluvium consisting of gravel to clay loam.
Tours	Deep clay loam	0–3	Alluvium
Trail	Deep sandy loam and loamy sand	0–3	Alluvium
Wet alluvial land	Stratified clay, clay loam, fine sandy loam, and muck.	0–1	Mixed alluvium
Zeniff	12 to 16 inches of loam over 22 to 32 inches of clay loam over loam or silt loam.	0–3	Medium-textured alluvium

[1] To a depth of 5 feet or less from surface. On-site examination is needed to determine characteristics at greater depths.

[2] To a depth of 5 feet from surface.

[3] Soil is not irrigated.

of soils for engineering construction

Estimated soil classification		Quality as source of—			Quality for pond sites without application of [2] sealing material	Erodibility in confined channels	Loss of water when used in unlined irrigation canals
AASHO	Unified	Material for subgrade	Material for dams				
			Core	Face and back slopes			
A–6 over A–2	CL over Sm	Fair	Fair	Good	Good	Low	Moderate to high.
A–6 with A–1 substrata	CL with GP–SM substrata.	Fair	Good	Good	Fair	High	[3].
A–6 over A–7	CL over CH	Poor	Good	Poor	Excellent	High	[3].
A–4 over A–2	CL over SM	Good	Fair	Good	Fair	Moderate	Moderate.
A–7	CH	Poor	Good	Fair	Good	Moderate	Low.
A–3 over A–6 with A–1 substrata.	SP or SM over CL with GM substrata.	Good	Good	Good	Fair	Moderate	Low.
A–2	SM	Good	Poor	Fair	Poor	High	[3].
A–2 or A–4	SM	Fair	Fair	Poor	Fair	High	Moderate.
A–4	CL	Fair	Good	Good	Good	Low	Moderate to low.
A–2	SC	Good	Good	Fair	Good	High	Low.
A–7	CH	Poor	Good	Poor	Excellent	Moderate	Low.
A–2 over A–1	SC over GW or GM	Good	Not suitable.	Good	Not suitable.	Low	[3].
A–1	GW	Good	Not suitable	Good	Not suitable	Low	High.
A–2 with A–1 substrata	SM with GP substrata	Good	Poor	Good	Fair	High	Moderate.
A–2 over A–3	SC over SP or SM	Good	Good	Fair	Fair	High	Moderate to high.
A–2 over A–4 over A–2	SM over CL over SM	Good	Good	Good	Good	Moderate	Moderate to high.
A–7	CH	Poor	Good	Poor	Excellent	High	Low.
A–2 over A–6 over A–2	SM over CL over SM	Fair	Fair	Fair	Good	Moderate	[3].
A–2	SM	Good	Poor	Fair	Fair	Moderate	High.
A–2 or A–4	SM or CL	Fair	Poor	Poor	Fair	High	Moderate.
A–1	GP or GM	Fair, shallow.	Not suitable.	Good	Not suitable.	Low	[3].
A–2, A–3, and A–7	SM, SP, and CH	Fair	Fair	Fair	Good	High	Moderate to low.
A–3	SP	Good	Poor	Poor	Not suitable	Low	High.
A–4 over A–7–6 over A–2–6.[4]	CL over SC [4]	Fair	Good	Good	Good	Moderate	Low.
A–6 over A–2	CL over GC	Fair	Good	Fair	Good	High	Low
A–2 over A–1	GC over GW or GM	Good	Poor	Good	Poor	Moderate to low.	Moderate.
A–7–6 [4]	SC [4]	Poor	Good	Poor	Excellent	Moderate	Low.
A–2 and A–6	CL and SM	Fair to good	Good and fair.	Good	Not suitable.	High	[3].
A–6 or A–7	CL and MH	Fair	Fair	Fair	Good	High	Low.
A–2	SC	Good	Fair	Fair	Poor	Moderate to low.	High.
A–6 and A–7	CL and CH	Poor	Good	Poor	Good	Moderate	[3].
A–2 over A–4 over A–2	SM over CL over SM	Good	Good	Fair	Good	Moderate	[3].

[4] The AASHO (*1*, *4*) and Unified (*8*, *4*) classifications were determined by the Bureau of Public Roads. See table 5 for analytical data on the Showlow and Springerville soils.

Plateau. The area between the grassland and the pine forest was a fairly open stand of pinyon pine and juniper with a moderately dense understory of grasses. Short bunch grasses were the dominant grassland plants.

Grasses have been the dominant kind of native vegetation that influenced soil formation. They were heavily grazed, with the result that plants undesirable for grazing became established. Woody shrubs and weeds replaced many of the grasses.

In the pinyon-juniper woodland, grazing and overuse of the land caused juniper to increase in density and to invade grassland. Consequently, the bunch grasses diminished in density. Much the same kind of a change took place in the ponderosa pine forests. Trees increased in number at the expense of the grass. However, this change in vegetation has had little effect on the soils.

The farming of small tracts of land in the Holbrook-Show Low Area has influenced the rate of soil development. The clearing of forest, the plowing of grassland, the leveling and cultivating of soil, the growing of new species of plants, and the influence of sheet and gully erosion will determine the direction and the rate of soil genesis in the future. Few changes can yet be seen, except where plowing and land leveling have changed the uppermost part of the soil profile.

Parent material

The kind, source, and nature of parent material are greatly variable. Some soils in the Area have formed in weathered limestone, sandstone, and shale of Permian, Triassic, and Upper Cretaceous ages and in Tertiary basalt and volcanic cinders. Other parent materials consist of Tertiary and Quaternary gravelly alluvium, of highly mixed lithology, that caps the sedimentary rocks. Small areas of Tertiary lacustrine clay are exposed to weathering on the northern edge of the Mogollon Plateau. A large body of Rocky Mountain outwash of Tertiary age caps the Chinle shale or claystone north of the Little Colorado and Puerco Rivers. These old sediments are stratified with lenses of fine gravel, sand, and loamy material. Areas from which erosion has removed the cap and exposed the Chinle shale or claystone are now badlands known as the Painted Desert. Remnants of gravel terraces of mixed lithology occur near drainageways leading to the Little Colorado River and Silver Creek.

The recent sediment in which alluvial soils are forming washed from soils that formed in weathered Chinle shale and claystone and from material that washed from these rocks after they were exposed. Some alluvial soils are forming in sediment that washed from only one kind of rock. Some are forming in a mixture of material from three or four kinds of parent rock. Other soils have an even more complex lithology.

Most of the material in the Tertiary or Quaternary alluvium is foreign to the Area. This is most evident in the cobbly, gravelly alluvium. Much of this alluvium originated from quartzite, granite, marble, and limestone rocks that do not occur locally. It is difficult to trace the origin of many of these foreign materials.

Topography

The Holbrook-Show Low Area is a small part of the south end of the immense Colorado Plateau. Slopes strongly influence the depth of the soils in the Area. There is a significant correlation between gradient and depth, where soils originated in similar parent material and under the same climate.

In the semiarid part of the Area, the maximum thickness of soils that formed from weathered shale, sandy shale, and earthy limestone on nearly level slopes ranges from 18 to 20 inches. Soils on moderate slopes are very shallow, usually less than 12 inches thick. Soils on strong slopes are very thin. Bedrock is exposed over large areas. The exposure of bedrock on strong slopes is attributed to the relatively high rate of erosion, which removes soil as rapidly as it is formed. These characteristics are typical of soils that have formed in a semiarid climate that has low rainfall, high-velocity wind, sparse vegetation, and torrential summer rainstorms. Runoff is rapid during the rainstorms, and erosion is severe in relation to the rate of soil formation.

Medium to moderately coarse textured alluvium in level areas or on moderate slopes in the semiarid zone develops into deep to moderately deep soils. This kind of parent material, however, weathers too slowly and erodes too rapidly to form soils on strong to steep slopes. Under this condition, genetic soil profiles are not formed, and terrace escarpments and other miscellaneous land types are common.

In the subhumid climatic zone, a higher moisture regime affects soil formation and the rate of weathering, especially of chemical weathering, is more rapid than in the semiarid zone. The rate of erosion is also lower than in the semiarid zone because vegetation protects the soil. These conditions are better for weathering and soil formation than those in the semiarid climatic zone. Consequently, the soils that have formed from similar parent material and on similar slopes are deeper in the subhumid part than in the semiarid part of the Area. Bedrock exposures are common on strong slopes in the semiarid zone, but shallow to moderately deep soils form on comparable parent material in the subhumid zone. Soils formed from cobbly gravelly alluvium have a developed profile on steep slopes. Those formed from medium-textured alluvium have a developed profile on strong slopes. Under similar conditions of slope and parent material, soil profiles are not developed in the semiarid zone.

The slope and thickness of soils cannot be correlated in soils that have formed on basalt and cinders. The basalt and volcanic cinders in the Area vary in age, and the forces of weathering are not in equilibrium with the other existing factors of soil formation.

Silty and clayey sediments carried in floodwater are readily dropped on fairly steep flood plains if vegetation slows the current. Shifting currents in flooding streams cause the deposition of sediment of variable particle size at a given point. As a result, the sediment accumulated on the flood plains of the Little Colorado River is a complex of stratified material. The moderately coarse textured soils generally occur on flood plains that have gradients of more than 1 percent.

Time

Soils in the Area range in age from very young to old. The very young soils are forming in the clayey sediment

deposited in man-made reservoirs. When sediment accumulated in large amounts, the reservoirs were drained, and the soils in them were cultivated. These soils have been forming for less than 70 years.

Where aggradation is active, many flood-plain soils receive fresh sediment at frequent intervals. Soils in these positions are the young soils in the Area. Some soils that are high on the flood plain show the first stages of horizon formation. They have weak to moderate structure, slight accumulation of clay, and faint lime mycelia in the subsoil. These soils are occasionally flooded. It is possible, however, that flood crests are higher now because the density of grass has been reduced through settlement and grazing. If this is true, the soils on flood plains that appear to be in their first stage of development may actually be in a period of retrogression, since the rate of deposition may be more rapid than the rate of soil development.

The old soils in the Area are on the Mogollon Plateau. They occur on cobbly, gravelly alluvium of Tertiary age and on upper Cretaceous sandstone. These old soils have weathered for a very long time and show a strong degree of development. The cobbly and gravelly alluviums have weathered until a thick, clay subsoil and a thin, medium-textured surface soil have formed. Some sandstone has weathered to form a loamy sand and sandy loam surface soil and a sandy clay subsoil.

Soils with medial development commonly occur on sediment that forms the terraces and valley plains. These geomorphic surfaces have not been exposed to weathering so long as those on top of the Mogollon Plateau. Moderately fine textured subsoil has formed from gravelly to medium-textured alluvium. Carbonates have been leached to a depth of 12 to 48 inches below the surface and have accumulated in weak to moderate concentrations.

Some of the soils that are subject to a long period of weathering do not express the influence of time in their formation because the dominating influence has been parent material.

Classification and Morphology of the Soils

The system of soil classification now being used in the United States has six categories, one above the other (7). Each successively higher category has a smaller total number of classes, and each of those classes has a broader range of characteristics. Thus, there are thousands of classes in the lowest category and no more than three in the highest category. Beginning at the top, the six categories in the system of soil classification are the order, suborder, great soil group, family, series, and type. Of these, only four have been widely used. They are the order, great soil group, series, and type.

The categories of the soil order and the great soil group are described briefly in the following paragraphs. The soil series and soil type are discussed in the section "How soils are Named, Mapped, and Classified." The highest category in the present system of soil classification consists of three classes, known as the zonal, intrazonal, and azonal orders.

Zonal soils have characteristics that reflect the influence of the active factors of soil genesis—climate and living organisms. Their profiles have well-differentiated horizons. Zonal soils have formed on undulating, well-drained uplands in materials that have been in place a long time. They are intermediate in physical and chemical composition and are not subject to extremes in drainage or topography.

Intrazonal soils have genetically related horizons, which have developed through the dominant influences of topography or parent material over those of climate and living organisms. Like the zonal soils, these soils have formed from materials that have been in place a long time. The materials, however, may be extreme in nature, as, for example, very fine textured or highly calcareous. Or the soils may develop where parent materials are not extreme but drainage is restricted by level topography.

The azonal order consists of soils that lack discernible, genetically related horizons because of youth, resistant parent material, or steep topography. Soils in this order may be forming in flood-plain material or other recently deposited sediment, which have been in place for too short a time to allow differentiation of horizons other than the accumulation of some organic material in the surface layer. The lack of genetically related horizons may also be caused by parent materials that are resistant to change, or on steep slopes, by erosion that removes soil material from the surface as fast as it forms in the parent material.

The very shallow to shallow, gently to moderately sloping soils on weakly consolidated shale and sandy shale, the very young soils on alluvial bottom lands, and the very weakly developed soils on sand or on clay are examples of azonal soils.

The great soil group, the next lower category beneath the order, has been widely used in this country. Classes in this category have been used to great extent because they indicate a number of relationships in the genesis of soil and also indicate something of the fertility status, adaptability for crops or trees, and the like.

Each great soil group consists of a large number of soil series having many internal features in common. Thus, all members of a single great soil group in either the zonal or intrazonal order have the same number and kind of definitive horizons in their profiles. These definitive horizons need not be expressed in the same degree, nor do they need to be of the same thickness in all soils within one great soil group. Specific horizons must be recognizable, however, in every soil profile of a soil series representing a given great soil group.

Great soil groups in the azonal order are defined in part on the nature of the profile and in part on the history or origin of the soil. All members of a single great soil group have a number of internal features in common, but none of the great soil groups in the azonal order has distinct horizonation. Consequently, all of them still bear a strong imprint of the materials from which they are being formed. Definitions of the great soil groups in the azonal order are centered on the portion of the profile approximately comparable in thickness to the solum of associated great soil groups of the zonal and intrazonal orders.

The soil series identified in the Holbrook-Show Low Area have been placed in great soil groups and orders as follows:

Order and great soil group	*Series*
Zonal order:	
Brown soils	Millard
Reddish Brown soils	Clovis Millett Silver
Reddish Chestnut soils	Chevelon Disterheff Showlow Zeniff
Reddish Prairie soils	Paiso
Gray Wooded soils	Overgaard
Intrazonal order:	
Brown Forest soils	Sponseller
Calcisols	Moffat
Grumusols	McNary Springerville
Planosols	Elledge
Azonal order:	
Alluvial soils	Bagley Heber Ives Jacques Jocity Mogollon Navajo Pinetop Redfield Tours Trail
Regosols	Claysprings Moenkopie Sheppard

Analytical data for a representative soil of most of the series in the Holbrook-Show Low Area are given in tables 7 and 8 at the end of this section.

Zonal soils

In the Holbrook-Show Low Area the zonal order is represented by the Brown, Reddish Brown, Reddish Chestnut, Reddish Prairie, and Gray Wooded soils. A discussion of these great soil groups and the soil series in each follows.

BROWN SOILS

The Brown soils have developed in a temperate or cool, semiarid climate and under native vegetation consisting of short bunch grasses and shrubs. The surface soil is brown, and the subsoil grades, at a depth ranging from 1 to 2 feet, into material containing mottles of segregated lime or into light-gray or white calcareous layers. Brown soils are neutral to mildly alkaline. Content of organic matter is moderately low in the surface soil and very low in the subsoil. The surface soil and subsoil have moderate to strong, granular structure. The Millard soils are the only Brown soils in the Area.

The following profile of Millard gravelly sandy loam was observed near the southwest corner of sec. 10, T. 12 N., R. 18 E.:

A11—0 to 3 inches, brown (7.5YR 4/3; 7.5YR 3/2, when moist) gravelly sandy loam; moderate, medium to fine, granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; neutral (pH 6.8); noncalcareous; abrupt boundary.

A12—3 to 9 inches, reddish-brown (5YR 4/3; 5YR 3/3, when moist) gravelly sandy clay loam; moderate, very fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.9); noncalcareous; clear boundary.

B2—9 to 14 inches, reddish-brown (5YR 4/4; 5YR 3/4, when moist) very gravelly sandy clay loam; moderate, medium to fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.9); noncalcareous; clear boundary.

B2ca—14 to 42 inches, dark-red (2.5YR 3/6, dry and moist) clayey gravel; moderate, fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; mildly alkaline (pH 7.4); calcareous; many prominent lime mottles; gradual boundary.

C—42 to 60 inches +, reddish-brown (2.5YR 4/4; 5YR 4/3, when moist) very gravelly loamy sand; massive; hard when dry, very friable to loose when moist, nonsticky and nonplastic when wet; neutral (pH 6.8); noncalcareous, except in a few places on bottom of pebbles.

This profile is in an area that has a slope of 1 percent and has somewhat excessive drainage. At one time the native vegetation was short bunch grasses and a few juniper trees. The trees have increased in number, and they now cover one-third to one-half of the surface. The cover of grass is sparse. The laboratory analysis of Millard gravelly sandy loam is shown in table 7.

REDDISH BROWN SOILS

The Reddish Brown soils developed in a warm, temperate, semiarid climate that has hot to warm summers and supports a rather thick cover of short grasses or bunch grasses and scattered shrubs and small trees. The surface soil is typically reddish brown and has granular structure. The upper subsoil is reddish brown to red. The lower subsoil may be light brown to pink or nearly white and very limy. The soils are high in fertility, but the climate makes them largely unsuited to dryfarming. Reddish Brown soils in the Area belong to the Clovis, Millett, and Silver series.

The Clovis soils are representative of the Reddish Brown great soil group. The following profile of Clovis sandy loam was observed one-fourth mile west of the post office in Taylor, Ariz.:

A11—0 to 1 inch, reddish-brown (5YR 5/3; 5YR 3/3, when moist) sandy loam; moderate, very fine, granular structure; soft when dry, loose when moist, slightly sticky and nonplastic when wet; mildly alkaline (pH 7.8); noncalcareous; abrupt boundary.

A12—1 to 3 inches, reddish-brown (5YR 5/3; 5YR 3/3, when moist) sandy loam; moderate, thin to medium, platy structure; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; moderately alkaline (pH 8.0); noncalcareous; abrupt boundary.

A13—3 to 6 inches, reddish-brown (5YR 5/3; 5YR 3/3, when moist) sandy loam; very weak, very thick, platy structure; slightly hard when dry, very friable when

moist, slightly sticky and nonplastic when wet; moderately alkaline (pH 8.1); noncalcareous; clear boundary.

B1—6 to 10 inches, reddish-brown (5YR 4/3; 5YR 3/3, when moist) sandy clay loam; weak, coarse, prismatic structure breaking to moderate, medium, subangular blocky; hard when dry, friable when moist, sticky and plastic when wet; moderately alkaline (pH 8.0); noncalcareous; thin continuous clay films on all ped faces; abrupt boundary.

B2—10 to 23 inches, reddish-brown (2.5YR 4/4; 2.5YR 3/4, when moist) sandy clay loam; strong, coarse to medium, prismatic structure breaking to moderate to coarse, subangular blocky; very hard when dry, slightly firm when moist, sticky and plastic when wet; mildly alkaline (pH 7.8); noncalcareous; moderately thick clay films on all ped faces; clear, smooth boundary.

B2ca—23 to 31 inches, reddish-brown (5YR 5/3; 5YR 4/3, when moist) sandy clay loam; moderate, medium, prismatic structure breaking to moderate, coarse to medium, subangular blocky; hard when dry, friable when moist, slightly sticky and plastic when wet; moderately alkaline (pH 8.3); mildly calcareous; clear boundary.

B3ca—31 to 54 inches, light-brown (7.5YR 6/3; 7.5YR 5/3, when moist) sandy clay loam; many, coarse, distinct lime mottles; moderate, medium, subangular blocky structure; very hard when dry, friable when moist, sticky and slightly plastic when wet; moderately alkaline (pH 8.3); strongly calcareous; clear boundary.

C—54 to 60 inches +, reddish-brown (5YR 5/3; 5YR 4/3, when moist) loam; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 8.2); calcareous.

The profile described is in a pasture that has a slope of 1 percent and that had been moderately trampled. The vegetation consisted of a moderate stand of short bunch grasses and a few woody shrubs. The laboratory analysis of samples from the horizons of Clovis sandy loam is given in table 8.

The Millett and Silver soils are similar to the Clovis soils in kind and arrangement of horizons. They differ markedly in depth of weathering, in degree of development, or in nature of the parent material.

The Millett soils developed in sand and gravel, are shallow to moderately deep over the parent material, and have a thin, moderately coarse textured subsoil. The typical Millett soils occur on strong to steep slopes on rolling topography, but the typical Clovis soils occur on gentle, smooth slopes.

The Silver soils developed in medium-textured, mixed alluvium containing gravel. The surface soil and subsoil are grayer or paler in color and finer in texture than those of the Clovis soils. They are also more alkaline, and in spots the subsoil is high in exchangeable sodium. The lack of leaching in the Silver soils is attributed to highly dispersed clay.

REDDISH CHESTNUT SOILS

The Reddish Chestnut soils have developed in warm, temperate, semiarid or subhumid climate. The vegetation is mainly grasses, but in places brush and small trees are scattered over the area. The surface soil is typically brown to reddish brown in the upper part and lighter colored, or grayer, and highly calcareous in the lower part. Reddish Chestnut soils are fairly high in fertility, but the small amount of rainfall and high rate of evaporation tend to limit the growth of crops. Soils of the Chevelon, Disterheff, Showlow, and Zeniff series have been classified as Reddish Chestnut soils.

The Showlow soils are representative of the Reddish Chestnut great soil group. The following profile of Showlow loam was observed 2.1 miles east of the post office in Aripine, Ariz.:

A11—0 to 1 inch, brown (7.5YR 5/2; 7.5YR 3/2, when moist) loam; weak, thick, platy structure; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; neutral (pH 6.8); noncalcareous; abrupt boundary.

A12—1 to 3 inches, dark grayish-brown (10YR 4/2; 10YR 2/2, when moist) loam; moderate, thin, platy structure; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; neutral (pH 6.9); noncalcareous; abrupt boundary.

B1—3 to 12 inches, reddish-brown (5YR 4/3; 5YR 3/3, when moist) clay loam; moderate, medium to fine, subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; neutral (pH 6.9); noncalcareous; gradual boundary.

B21—12 to 24 inches, clay that is the same color as the soil material in the B1 horizon but has slightly redder hue; moderate, coarse, prismatic structure breaking to moderate, very coarse to coarse, angular blocky; extremely hard when dry, extremely firm when moist, very sticky and very plastic when wet; neutral (pH 7.1); noncalcareous; thick continuous clay films on all peds; clear, smooth boundary.

B22—24 to 31 inches, reddish-brown (2.5YR 4/4, dry and moist) clay; strong, coarse to medium, angular blocky structure; extremely hard when dry, extremely firm when moist, very sticky and very plastic when wet; mildly alkaline (pH 7.5); thick continuous clay films on all peds; clear boundary.

BCca—31 to 44 inches, reddish-brown (5YR 5/4; 5YR 4/4, when moist) gravelly sandy clay loam; massive; very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.6); calcareous; common, medium, faint lime mottles; clear boundary.

C1—44 to 52 inches, very gravelly sandy clay loam that has the same color as the soil material in the BCca horizon; massive; very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; mildly alkaline (pH 7.7); calcareous.

This profile is in an area of about 1 percent slope that has good drainage. The vegetation consists of an understory of bunch grasses and a moderate overstory of junipers and a few pinyon pines and Gambel oaks. Analytical data for Showlow loam are given in table 8.

The Chevelon soils have horizons that are similar to those of the Showlow soils. In addition, they occur in close geographic association with the Showlow soils. However, the Chevelon soils are moderately deep and have formed from weathered calcareous shale and sandy shale. They show medial development and have a clay loam subsoil, whereas the Showlow soils show maximum development and have a clay subsoil. The Chevelon soils differ greatly from the Showlow soils in the degree of calcareousness. They are moderately to strongly calcareous throughout, even though the texture and structure of their horizons show strong characteristics of weathering.

The Disterheff soils are quite similar to the Showlow soils in depth of weathering, color, and texture of the horizons, but they differ in parent material. The Disterheff soils have formed in alluvium derived mainly from basalt and volcanic cinders. The C horizon of the Disterheff soils has some characteristics of stratification but does not contain gravel as does that of the Showlow soils.

The Zeniff soils are not so strongly developed as the Showlow soils, and they are dominantly brown throughout, although some of them are reddish brown. The Zeniff soils have clay loam and sandy clay loam subsoil and a very faint expression of lime, usually at a depth of more than 4 feet from the surface. They are much younger than the Showlow soils and usually have a thicker A horizon. The Zeniff soils have formed in medium-textured, mildly calcareous alluvium. They do not have cobbles of quartzite, nor the strong structure that is characteristic of the Showlow soils.

REDDISH PRAIRIE SOILS

The Reddish Prairie soils are redder in color than the Prairie soils. In the Holbrook-Show Low Area, this reddish color is attributed to the warm climate. The Reddish Prairie soils are usually saturated with bases and have no horizons of lime accumulation. They occur in a warm, subhumid to moderately humid climate and have developed under grass. The Paiso soils have been classified as Reddish Prairie soils.

The following profile of Paiso stony clay loam, shallow, was observed 1 mile north of Show Low, Ariz.:

A11—0 to 2 inches, reddish-brown (5YR 5/3; 5YR 3/3, when moist) stony clay loam; moderate, very fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.8); noncalcareous; abrupt boundary.

A12—2 to 8 inches, dark grayish-brown (5YR 4/2; 5YR 3/2, when moist) stony clay loam; moderate, prismatic structure breaking to moderate, fine, subangular blocky; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.8); noncalcareous; abrupt boundary.

B2—8 to 18 inches, dark reddish-brown (5YR 3/3, dry and moist) stony clay; weak, fine to moderate, prismatic structure breaking to strong, fine, angular blocky; very hard when dry, very firm when moist, sticky and plastic when wet; neutral (pH 6.9); noncalcareous; very abrupt, irregular boundary.

Dr—18 inches +, basalt rock that is slightly weathered in the upper part.

This profile is in an area that has a slope of 2 percent and that has been severely grazed. The cover is mainly a weak sod of blue grama, rather than the bunchy growth of blue grama that is characteristic of this species when grazed conservatively. The depth to bedrock ranges from 8 to 20 inches within short distances.

GRAY WOODED SOILS

The Gray Wooded soils have a well-developed, well-drained profile with a moderately thin duff (A0) horizon and a thin organic-mineral (A1) horizon over a light-colored, bleached A2 horizon. These horizons are underlain by a brown B2 horizon that is more clayey than the upper horizons and is blocky or subangular blocky. The lower part of the B2 grades into lighter colored, more friable B3 and C horizons. Gray Wooded soils occur in cool, subhumid to semiarid, mesothermal to microthermal climatic regions and are under coniferous, deciduous, or mixed forest cover. Overgaard fine sandy loam is the only Gray Wooded soil in the Area. It occurs under a cover of ponderosa pine and Gambel oak.

The following profile of Overgaard fine sandy loam was observed three-fourths of a mile west of Pinedale, Ariz.:

A00—1 inch to 0, dry pine needles.

A1—0 to 3 inches, dark grayish-brown (10YR 4/2; 10YR 2/2, when moist) loamy fine sand; weak, thin, platy structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; medium acid (pH 5.9); noncalcareous; abrupt boundary.

A2—3 to 9 inches, grayish-brown (10YR 5/2; 10YR 4/3, when moist) fine sandy loam; weak, medium, subangular blocky structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; neutral (pH 6.6); noncalcareous; abrupt boundary.

B21—9 to 13 inches, dark-brown (7.5YR 4/2; 7.5YR 3/2, when moist) sandy clay loam; weak, medium, prismatic structure breaking to strong, fine, angular blocky; extremely hard when dry, very firm when moist, sticky and plastic when wet; neutral (pH 6.9); noncalcareous; thick continuous clay films or ped faces; clear boundary.

B22—13 to 27 inches, dark-brown (7.5YR 4/2; 7.5YR 3/2, when moist) clay loam; strong, medium to coarse, prismatic structure breaking to moderate, coarse, angular blocky; very hard when dry, firm when moist, slightly sticky and plastic when wet; neutral (pH 7.0); noncalcareous; many thin clay films; gradual boundary.

B23—27 to 45 inches, brown (7.5YR 4/2; 7.5YR 3/2, when moist) sandy clay loam; strong, medium to coarse, prismatic structure breaking to moderate, coarse, angular blocky; very hard when dry, firm when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.8); many patchy clay films; gradual boundary.

B3—45 to 68 inches, light sandy clay loam having the same color as the material in the B23 horizon; weak, very coarse, prismatic structure to massive; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 7.0); noncalcareous; fine, thin, patchy clay films; gradual boundary.

C—68 to 80 inches +, reddish-brown (5YR 5/4; 5YR 4/4, when moist) sandy loam; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; neutral (pH. 7.3); noncalcareous.

This profile is in an area that has a slope of less than 1 percent and has good drainage. The vegetation is an almost pure stand of ponderosa pine. The laboratory analysis of Overgaard fine sandy loam is given in table 7.

Intrazonal soils

In the Holbrook-Show Low Area, the intrazonal order is represented by the Brown Forest soils, the Calcisols, the Grumusols, and the Planosols.

BROWN FOREST SOILS

The Brown Forest soils have a very dark brown surface horizon and are relatively high in organic matter. Below the surface horizon, the profile grades through lighter colored soil into the parent material. Brown Forest soils are slightly acid, contain little or no accumulation of iron and alumina, and are moderately high in exchangeable calcium. They have developed in parent material that was relatively rich in bases. They occur in a humid, temperate climate and are under forest vegetation. The Sponseller soils have been classified as Brown Forest soils.

A profile of Sponseller silt loam, observed under ponderosa pine 1 mile southwest of Lakeside, Ariz., in the SE¼ of sec. 25, T. 9 N., R. 22 E., is described as follows:

A0—1 inch to 0, partially decomposed pine needles.

A1—0 to 4 inches, reddish-brown (5YR 5/2; 5YR 3/3, when moist) silt loam; moderate, thick, platy structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; neutral (pH 6.8); clear boundary.

B21—4 to 11 inches, reddish-brown (5YR 4/4; 5YR 3/4, when moist) cobbly clay loam; weak, medium to coarse,

angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly acid (pH 6.2); few, thin, patchy clay films; clear boundary.

B22—11 to 20 inches, reddish-brown (5 YR 4/4; 5YR 3/4, when moist) very cobbly clay loam containing angular cobbles of basalt; weak, fine to medium, subangular blocky to granular structure; slightly hard when dry, friable when moist, slightly plastic and slightly sticky when wet; slightly acid (pH 6.3); few, thin, patchy clay films; clear boundary.

C1—20 to 42 inches, reddish-brown (5YR 4/3; 5YR 3/3, when moist) very stony clay loam; weak, medium, angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; neutral (pH 6.7); abrupt, irregular boundary.

Dr—42 inches +, partially weathered basalt stones and bedrock.

This profile is under a pure stand of ponderosa pine and on a slope of 1 percent. The soil is moderately slowly permeable and has very slow runoff. The laboratory analysis of Sponseller silt loam is given in table 7.

CALCISOLS

Calcisols are a group of soils that have formed in highly calcareous parent material in arid and semiarid regions. These soils have developed where leaching is limited and are mainly under a sparse stand of short grasses and shrubs. They usually have prominent horizons of calcium carbonate accumulation. The Moffat soils are classified as Calcisols.

A profile of Moffat sandy loam, observed 2 miles west of Holbrook, Ariz., in a range area near the SW. corner of sec. 34, T. 17 N., R. 20 E., is described as follows:

A1—0 to 6 inches, reddish-brown (5YR 5/3; 5YR 3/3, when moist) sandy loam; weak, thick, platy to weak, very fine, granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.8); calcareous; clear boundary.

Cca1—6 to 15 inches, reddish-brown (5YR 4/3; 5YR 3/3, when moist) heavy sandy loam; weak, fine to medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately alkaline (pH 7.9); calcareous; clear boundary.

Cca2—15 to 34 inches, light reddish-brown (5YR 6/3; 5YR 5/4, when moist) sandy clay loam; massive; hard to slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; moderately alkaline (pH 8.0); strongly calcareous; gradual boundary.

C—34 to 58 inches +, reddish-brown (5YR 5/3; 5YR 4/4, when moist) loamy sand; massive; loose when dry and moist, nonsticky and nonplastic when wet; mildly alkaline (pH 7.7); calcareous.

This profile occurs in an area that has a slope of 3 percent; it is on the side of a low, rolling ridge. Short bunch grasses are the dominant vegetation. The soil is moderately permeable and has slow runoff. The laboratory analysis of Moffat sandy loam is given in table 7.

GRUMUSOLS

The Grumusols are fine-textured soils, mainly clays, that occur in a climate that has wet and dry seasons. Soil moisture may accumulate from rain or floods and in quantities that saturate the soil. In dry seasons, deep cracks form in the soil. The surface of the Grumusols, under natural conditions, is generally irregular as the result of the shrinking, cracking, and sloughing when the soils dry and the swelling and churning of the soils when they are wet. The McNary and Springerville soils have been classified as Grumusols.

A profile of Springerville clay, observed 2 miles north of Lakeside, Ariz., in the NW¼SW¼ sec. 13, T. 9 N., R. 22 E., is described as follows:

A11—0 to 2 inches, dark-brown (7.5YR 3/2, dry and moist) stony clay; moderate, fine, granular structure; hard when dry, very friable when moist, very sticky and very plastic when wet; slightly acid (pH 6.4); noncalcareous, except immediately adjacent to the few, small nodules of lime; abrupt, wavy boundary.

A12—2 to 14 inches, dark reddish-brown (5YR 3/2, dry and moist) stony clay; moderate, medium to coarse, subangular blocky and angular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; slightly acid (pH 6.2); noncalcareous, except immediately adjacent to the few, small lime concretions; a few slickensides; gradual, wavy boundary.

A13—14 to 28 inches, stony clay that has the same color as the material in the A12 horizon; strong, medium to coarse, angular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; neutral (pH 6.7); noncalcareous, except for soil immediately adjacent to lime nodules; many slickensides; gradual, wavy boundary.

Cca—28 to 46 inches, dark-brown (7.5YR 4/2; 7.5YR 3/2, when moist) stony clay; weak, coarse, angular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; mildly alkaline (pH 7.6); strongly calcareous; few, coarse, prominent, pinkish-white mottles of lime; abrupt, irregular boundary.

Dr—46 inches +, hard, weathered basalt.

The profile of this soil was observed in an area that has slopes of less than 1 percent. Cobbles and stones of basalt commonly occur more than 14 inches from the surface, and they are more numerous as depth to bedrock increases. The soil is very slowly permeable when it is filled with moisture to field capacity. Analytical data for Springerville clay are given in table 8.

The McNary soils are similar in texture and in shrinking-swelling characteristics to the Springerville soils. Both kinds of soils formed from similar parent material. They differ mainly in color. The McNary soils are black to a depth of 15 to 22 inches and below this are reddish brown to reddish gray to a depth of 52 to 60 inches. The A11 and A12 horizons of the McNary soils are much higher in organic matter than those of the Springerville soils. The McNary soils are deeper to bedrock.

PLANOSOLS

The Planosols are intrazonal soils that have one or more horizons that contrast sharply with a horizon above or below, because of cementation and high clay content, and are separated by an abrupt boundary. Planosols are found under forest or grass vegetation in mesothermal to tropical, perhumid to semiarid climates, and they usually, but not always, have a fluctuating water table.

Soils of the Elledge series are the only Planosols in the Area. The profile of the Elledge soils changes abruptly between the gravelly loamy fine sand A2 horizon and the sandy clay B2 horizon. The following profile was observed on the west edge of the town of Show Low in sec. 19, T. 10 N., R. 22 E.:

A1—0 to 6 inches, dark-gray (10YR 4/1; 10YR 2/2, when moist) loamy fine sand; moderate, thick, platy structure; very friable when moist, nonsticky and nonplastic when wet; neutral (pH 7.0); noncalcareous; clear, wavy boundary.

A2—6 to 13 inches, light brownish-gray (10YR 6/2; 10YR 4/3, when moist) gravelly loamy fine sand; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; neutral (pH 6.7); noncalcareous; abrupt, wavy boundary.

B2—13 to 19 inches, mottled brown, reddish-yellow, and reddish-brown (7.5YR 5/2; 5YR 6/6; 2.5YR 4/4; 7.5YR 4/4 and 5/6; 5YR 4/3; 2.5YR 3/6, when moist) sandy clay; very weak, medium, prismatic breaking to strong, coarse to medium, subangular blocky and angular blocky structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; medium acid (pH 5.9); gradual, wavy boundary.

B3—19 to 28 inches, sandy clay having approximately the same color as the material in the B2 horizon, except for less mottles of red and more of brown and reddish yellow; moderate, coarse to medium, subangular blocky and angular blocky structure; extremely hard when dry, firm when moist, sticky and plastic when wet; medium acid (pH 5.8); abrupt, irregular boundary.

Dr—28 inches +, decomposed sandstone.

The profile of this soil was observed on a slope of 3 percent. The subsoil contains stones and cobbles of sandstone and is very slowly permeable. Elledge fine sandy loam and Elledge stony fine sandy loam occur in the same area as this profile of Elledge loamy fine sand. The laboratory analysis of Elledge fine sandy loam is given in table 8.

Azonal soils

The azonal soils in the Holbrook-Show Low Area are members of the Alluvial and Regosol great soil groups.

ALLUVIAL SOILS

Alluvial soils in the Holbrook-Show Low Area are variable from place to place because of local variations in the sediment that makes up their parent material. They vary greatly in color, texture, and arrangement of layers. There is also a considerable difference in the age of the sediment, although no appreciable weathering has occurred. Some of the Alluvial soils contain harmful salts and alkali, either because of the nature of the parent material or the influence of a water table. A few soils are wet most of the year. Other Alluvial soils are highly stratified with material that varies widely in texture. Alluvial soils in the subhumid part of the Area contain much more organic matter than those in the semiarid part. Most of the Alluvial soils are alkaline and calcareous, but some are neutral and noncalcareous.

Alluvial soils in the Holbrook-Show Low Area belong to the Bagley, Heber, Ives, Jacques, Jocity, Mogollon, Navajo, Pinetop, Redfield, Tours, and Trail series. None of these series is more representative of the group than the other. The laboratory analyses of several of these soils are given in table 7.

REGOSOLS

Regosols consist of deep, unconsolidated rock (soft mineral deposits) in which few or no clearly expressed soil characteristics have developed. They are largely confined to recent sand dunes, to slightly weathered clay deposits, and to areas of steeply sloping loess and glacial drift. The Claysprings, Moenkopie, and Sheppard soils are classified as Regosols.

The Claysprings soils are representative of the Regosol great soil group. They are in Tertiary clay beds in a subhumid climate, and they have horizons that are weakly defined, mainly on the basis of small differences in structure. They occur on gently to steeply sloping areas, mostly under juniper but also under a sparse ground cover of bunch grasses.

The following profile of Claysprings clay was observed near the east quarter corner of sec. 14, T. 11 N., R. 19 E., 1½ miles south of Clay Springs, Ariz.:

A1—0 to 2 inches, reddish-brown (5YR 4/3; 5YR 3/4, when moist) clay; moderate, very fine, granular structure; hard when dry, firm when moist, sticky and very plastic when wet; mildly alkaline (pH 7.8); strongly calcareous; abrupt, smooth boundary.

C1—2 to 9 inches, reddish-brown (5YR 4/3, dry and moist) clay; moderate, medium to coarse, prismatic breaking to strong, medium to coarse, angular blocky structure; extremely hard when dry, extremely firm when moist, sticky and very plastic when wet; moderately alkaline (pH 7.9); strongly calcareous; clear, smooth boundary.

C2—9 to 60 inches +, color, texture, and consistency same as in C1 horizon; strong, medium to coarse, angular blocky structure; very few, fine to medium, faint mottles of lime; many slickensides, mildly alkaline (pH 7.7) strongly calcareous.

The profile of this soil is in an area that has a slope of 6 percent. Runoff is medium to rapid. The vegetation consisted of western wheatgrass and juniper. The laboratory analysis of Claysprings clay is given in table 7.

The Sheppard soils differ markedly from the Claysprings in parent material. The Sheppard soils occur in sand and have many of the properties associated with sandy soils, such as very low water-holding capacity, very rapid permeability, and low fertility. They are also subject to wind erosion. The Claysprings soils, on the other hand, have high water-holding capacity and very slow permeability.

The Moenkopie soils differ from the Claysprings soils in parent material. They consist of weathered shale and sandy shale and are very shallow to shallow over bedrock. They are medium to moderately coarse textured and are low to very low in water-holding capacity. The laboratory analysis of Moenkopie fine sandy loam is given in table 7.

Laboratory Data

Laboratory data for representative soils of most of the series in the Holbrook-Show Low Area are given in tables 7 and 8.

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TABLE 7.—*Analyses of soil samples,*

Name	Soil sample No.	Depth from surface	pH		Conductivity [2]
			Paste	1:5 suspension	
		Inches			*Mmhos./cm.*
Bagley clay loam	1251	0–9	7. 5	8. 1	0. 5
	1252	9–24	7. 7	8. 4	. 3
	1253	24–39	7. 8	8. 4	. 5
	1254	39–64	7. 8	8. 3	. 5
Chevelon loam	1259	0–3	7. 8	8. 1	. 65
	1260	3–10	7. 9	8. 3	. 35
	1261	10–15	7. 8	8. 2	. 4
	1262	12–25	7. 8	8. 4	. 35
Claysprings clay	1263	0–2	7. 8	8. 1	. 55
	1264	2–9	7. 9	8. 0	. 40
	1265	9–60	7. 7	8. 3	. 52
Disterheff clay loam	1363	0–3	6. 8	7. 0	. 75
	1364	3–7	6. 3	6. 8	. 45
	1365	7–26	6. 1	6. 8	. 2
	1366	26–44	7. 5	8. 4	. 4
	1367	44–57	7. 3	8. 5	. 3
Heber fine sandy loam	1269	0–5	7. 4	7. 7	. 60
	1270	5–38	7. 3	7. 5	. 36
	1271	38–49	7. 6	7. 9	. 5
Heber loamy fine sand	1276	0–6	8. 0	8. 2	. 75
	1277	6–14	7. 95	8. 4	. 85
	1278	14–60	8. 0	8. 5	. 45
Ives fine sandy loam, slightly alkali	1272	0–60	8. 1	9. 4	. 9
Jacques clay loam	1255	0–3	7. 4	7. 9	. 3
	1256	3–10	7. 4	7. 9	. 4
	1257	10–31	7. 4	8. 0	. 3
	1258	31–44	7. 6	8. 2	. 3
Jocity sandy clay loam, slightly alkali	1273	0–9	8. 1	9. 4	. 5
	1274	9–41	7. 9	9. 1	7. 0
	1275	41–60	7. 9	9. 1	5. 0
McNary clay	1418	0–4	7. 6	7. 6	. 6
	1419	4–18	7. 7	7. 7	. 35
	1420	18–32	7. 6	8. 0	. 45
	1421	32–56	7. 6	8. 1	. 6
Millard gravelly sandy loam	1284	0–4	6. 8	7. 3	. 45
	1285	4–9	6. 9	7. 3	. 45
	1286	9–18	6. 9	7. 3	. 50
	1287	18–42	7. 35	7. 8	. 25
	1288	42–60	6. 85	7. 2	. 35
Millett gravelly sandy loam	1289	0–3	7. 1	7. 4	. 5
	1290	3–9	7. 2	7. 6	. 4
	1291	9–24	7. 8	8. 2	. 6
	1292	24–56	8. 1	8. 7	. 6
Moenkopie fine sandy loam	1293	0–8	8. 2	8. 9	. 5
	1294	8–21	8. 0	8. 8	. 5
Moffat sandy loam	1422	0–4	7. 75	8. 15	. 5
	1423	4–15	7. 9	8. 1	. 65
	1424	15–34	8. 0	8. 4	. 5
	1425	34–58	7. 7	8. 25	8. 5
Mogollon fine sandy loam	1325	0–13	7. 75	8. 0	. 9
	1326	13–29	7. 9	8. 3	. 6
	1327	29–60	8. 15	8. 8	1. 0
Navajo clay	1430	0–8	7. 5	8. 1	1. 5
	1431	8–60	7. 5	8. 1	3. 0
Navajo clay, moderately saline-alkali	1301	0–10	7. 6	8. 1	7. 2
	1302	10–60	7. 5	8. 1	12. 2

See footnotes at end of table.

Holbrook-Show Low Area, Ariz.[1]

Sand	Silt	Clay	$CaCO_3$	Organic carbon [3]	NO_3	PO_4 [4]	K [5]	Moisture equivalent	Cation exchange capacity	Exchangeable potassium	Exchangeable sodium
Percent	*Percent*	*Percent*	*Percent*	*Percent*	*P.p.m.*	*P.p.m.*	*P.p.m.*	*Percent*	*Meq./100 gm. soil*	*Percent*	*Percent*
25	36	39	2.3	0.8	26.0	7.0	92.5	32.4	29.0	3.8	2.4
21	34	45	2.6	.5	11.5	23.0	100.7	31.5			
21	35	44	4.0	.4	7.0	1.7	81.5	30.3			
45	31	24	2.8	.35	3.6	9.7	64.0	24.1			
45	40	15	9.5	.85	11.5	7.3	70.5	18.4	15.0	2.3	1.3
39	37	24	12.5	.6	13.0	13.3	32.5	18.5			
33	38	29	12.5	.5	21.5	.9	29.5	20.0			
30	41	29	10.0	.2	4.0	.9	17.5	20.5			
38	22	40	12.8	1.0	22.0	2.0	103.0	35.7	37.4	2.6	1.6
18	18	64	13.8	.4	5.8	1.9	47.5	42.0			
18	20	62	14.2	.2	3.3	1.7	32.5	44.1			
64	27	9	0	2.70	70.5	3.8	64.0	19.2	20.4	2.0	1.3
54	26	20	0	.82	9.8	2.6	22.5	18.8			
33	17	50	0	.57	7.5	1.3	19.5	44.5			
38	26	36	11.25	.27	5.0	2.0	17.5	32.2			
46	24	30	9.0	.13	5.8	1.2	17.5	26.0			
66	22	12	0	.9	7.5	9.4	89.0	14.0	18.4	1.8	1.4
77	14	9	0	.75	14.5	3.4	15.0	13.2			
80	15	5	0	.9	3.8	8.2	17.5	10.0			
84	13	3	5.0	.96	6.8	26.5	35.0	7.3	9.0	1.0	2.8
79	18	3	7.6	.7	6.0	7.0	16.5	6.5			
76	19	5	4.0	.5	2.5	3.9	12.5	9.0			
84	10	6	2.0	.02	3.8	2.2	17.5	10.8	27.4	2.3	8.3
35	35	30	.6	.4	2.0	2.9	97.5	30.0	31.6	1.5	4.4
37	27	36	.5	.75	3.3	6.3	52.5	31.9			
39	23	38	.4	.6	2.5	2.2	45.0	34.7			
37	23	40	5.3	.5	2.5	5.9	55.0	30.7			
66	14	20	3.0	.06	9.8	3.8	20.0	62.0	30.6	1.0	6.5
56	17	27	3.0	.06	3.8	2.7	43.0	22.8			
81	10	9	3.0	.005	6.0	2.8	10.0	11.5			
30	34	36	1.0	2.4	3.75	8.0	55.0	39.5	47.0	2.7	1.2
32	33	35	1.0	1.5	1.3	4.8	25.0	39.2			
24	24	52	11.6	.53	1.9	3.8	17.5	59.0			
26	21	52	14.0	.33	.7	2.0	12.5	59.0			
66	27	7	0	.75	2.8	7.2	42.5	11.5	12.6	1.2	2.2
64	26	10	0	1.0	7.0	3.2	52.5	13.4			
66	18	16	0	.75	4.5	2.0	15.0	11.6			
80	4	16	.3	.35	1.8	1.5	17.5	12.0			
84	1	15	0	.06	7.0	1.3	17.5	10.2			
84	12	4	0	.5	4.5	10.3	17.5	10.5	10.0	1.3	1.2
74	17	9	0	.7	4.0	1.4	17.5	10.5			
80	11	9	15.0	.35	9.5	.6	15.0	10.1			
95	4	1	5.0	.06	3.3	3.4	27.5	4.4			
76	20	4	9.0	.35	13.0	3.4	75.5	8.3	6.3	2.6	6.0
64	28	8	11.0	.35	3.8	2.9	66.0	8.0			
74	12	14	6.8	.27	4.6	3.8	45.0	9.8	28.8	1.4	1.8
68	15	17	9.5	.33	2.4	7.0	25.0	12.8			
65	13	22	21.5	.21	.7	3.8	12.5	12.6			
82	10	8	6.8	.03	3.3	6.5	10.0	7.1			
66	17	17	.4	.4	12.5	7.8	68.0	17.9	24.3	2.5	2.0
53	26	21	1.5	.5	12.0	7.8	64.0	18.2			
62	22	16	3.0	.35	12.5	6.1	25.0	16.4			
8	30	62	9.8	.66	10.5	9.8	97.5	32.3	20.0	5.8	2.4
10	26	64	9.8	.69	195.0	4.3	6.2	30.0			
14	26	60	7.1	.5	67.5	3.8	52.5	31.4	41.0	1.9	5.0
14	19	67	6.2	.35	8.0	3.5	37.5	36.8			

TABLE 7.—*Analyses of soil samples,*

Name	Soil sample No.	Depth from surface	pH		Conductivity [2]
			Paste	1:5 suspension	
		Inches			*Mmhos./cm.*
Overgaard fine sandy loam	1339	0–3	5.9	6.2	.3
	1340	3–9	6.6	7.0	.4
	1341	9–13	6.1	6.95	.3
	1342	13–27	6.5	7.0	.3
	1343	27–45	6.8	7.2	.3
	1344	45–68	7.0	7.4	.5
	1345	68–80	7.3	7.6	.4
Pinetop fine sandy loam	1359	0–12	7.5	7.7	1.1
	1360	12–22	7.1	7.35	.55
	1361	22–37	6.5	7.3	.35
	1362	37–56	6.5	7.2	.3
Sandy alluvial land, moderately saline	1312	0–16	8.1	8.6	2.6
	1313	16–29	8.1	8.9	4.7
	1314	29–51	7.85	8.8	8.0
	1315	51–56	7.7	9.1	12.0
	1316	56–66	7.6	8.5	12.0
Sheppard fine sand	1318	0–8	8.0	8.4	.9
	1319	8–60	8.1	8.5	1.0
Silver clay	1320	0–4	7.6	8.1	2.2
	1321	4–29	7.75	8.3	1.0
	1322	29–46	7.5	7.9	6.0
	1323	46–60	7.5	7.8	6.5
Sponseller silt loam	1426	0–4	6.8	7.0	.45
	1427	4–11	6.2	6.5	.3
	1428	11–20	6.3	6.8	.5
	1429	20–42	6.65	6.7	.55
Wet alluvial land	1303	0–7	7.8	8.7	15+
	1304	7–12	7.9	8.8	7.0
	1305	12–15	7.8	8.1	5.0
	1306	15–30	7.7	8.4	2.9
	1307	30–48	8.0	9.0	2.9
Zeniff fine sandy loam	1279	0–6	7.2	7.75	1.2
	1280	6–14	7.2	7.6	.5
	1281	14–28	7.1	7.8	.25
	1282	28–47	7.3	8.1	.2
	1283	47–60	7.4	8.0	.2

[1] Analyses by H. V. Smith, professor, University of Arizona.
[2] Electrical conductivity—E.C. x 10^3. Commonly used for expressing the salinity of soil extracts, because it can be directly related to salt content.
[3] Multiply by 1.724 to obtain percentage of organic matter.

Holbrook-Show Low Area, Ariz.[1]—Continued

Sand	Silt	Clay	$CaCO_3$	Organic carbon [3]	NO_3	PO_4 [4]	K [5]	Moisture equivalent	Cation exchange capacity	Exchangeable potassium	Exchangeable sodium
Percent	*Percent*	*Percent*	*Percent*	*Percent*	*P.p.m.*	*P.p.m.*	*P.p.m.*	*Percent*	*Meq./100 gm. soil*	*Percent*	*Percent*
78	19	3	0	1.2	13.0	5.3	25.0	15.3	18.8	6	1.0
74	15	11	.25	.48	5.8	4.5	25.0	11.0			
47	21	32	0	.53	1.8	16.0	43.0	28.5			
44	17	39	0	.60	2.5	30.5	45.0	25.2			
56	19	25	.25	.43	4.0	36.3	45.0	21.4			
48	25	27	.25	.15	4.5	40.7	47.5	22.6			
78	9	13	.3	.12	3.8	37.5	30.0	11.9			
73	15	12	1.0	1.1	8.0	3.9	22.5	16.5	25.5	1.0	1.3
79	11	10	0	.42	3.3	2.9	15.0	11.0			
80	10	10	.5	.27	1.8	2.8	12.5	10.9			
66	16	18	0	.35	.5	3.8	12.5	19.8			
78	20	2	4.0	.2	12.5	7.0	52.5	7.0	12.7	2.1	3.0
90	8	2	3.0	.06	11.0	2.9	12.5	6.3			
52	39	9	5.4	.3	12.5	4.4	29.5	15.4			
14	26	60	7.5	.6	14.0	2.8	57.0	44.4			
26	55	19	8.2	.75	12.0	2.3	42.5	25.1			
92	4	4	3.0	.2	10.5	3.9	17.5	3.6	9.2	1.1	2.4
96	1	3	3.2	.1	14.0	1.9	10.5	3.8			
26	26	48	4.0	.8	24.0	2.4	64.0	31.9	43.6	3.3	2.5
24	20	56	0	.4	12.0	4.6	15.0	38.9			
33	20	47	14.0	.2	14.0	2.7	15.0	28.5			
53	20	27	12.0	.15	14.0	3.2	17.5	21.9			
28	53	19	0	1.26	2.8	3.3	47.5	23.0	11.2	3.9	4.4
24	45	31	1.0	.77	.4	3.3	17.5	22.5			
26	38	36	(6)	.72	3.8	.8	10.0	22.4			
30	34	36	0	.69	2.8	2.3	15.0	27.6			
32	37	31	27.0	3.5	37.0	6.1	160.0	44.0	27.5	8.7	34.0
13	23	64	35.5	.9	9.0	3.9	100.0	42.0	43.1	2.8	12.0
28	34	38	31.9	2.1	9.0	1.0	57.0	62.0	27.2	2.9	11.3
28	28	44	29.0	1.5	6.8	1.2	52.5	38.0	23.2	3.2	4.8
58	26	16	15.0	.2	3.8	.9	32.5	16.2	19.0	4.2	6.0
64	25	11	0	.8	4.0	29.2	64.0	12.9	16.8	1.5	2.2
46	39	15	0	.9	5.0	7.2	35.0	15.3			
35	43	22	0	.8	7.0	4.5	22.0	20.6			
40	36	24	0	.7	2.0	4.9	22.0	21.5			
22	51	27	0	.75	4.8	6.3	22.0	25.3			

[4] CO_2 soluble phosphorus.
[5] CO_2 soluble potassium.
[6] Trace.

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