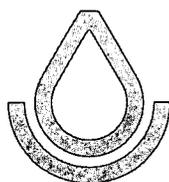


SOIL SURVEY OF

Mescalero - Apache Area, New Mexico

Northeastern Otero County



United States Department of Agriculture
Soil Conservation Service
and the
United States Department of the Interior
Bureau of Indian Affairs
in cooperation with
New Mexico Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1962-66. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1969. This survey was made cooperatively by the Soil Conservation Service, the Bureau of Indian Affairs, and the New Mexico Agricultural Experiment Station. It is part of the technical assistance furnished to the Mescalero Indian Agency and the Otero Soil and Water Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of the Mescalero-Apache Area contains information that can be applied in managing woodland and range; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of lands for industry or recreation.

Locating Soils

All the soils of the Mescalero-Apache Area are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

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

Finding and Using Information

The Guide to Mapping Units can be used to find information in the survey. This guide lists all the soils of the Area in alphabetic order by map symbol. It shows the page where each soil is described and, also, the page for the range site.

Individual colored maps that show the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to

show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those that have a moderate limitation can be colored yellow, and those that have a severe limitation can be colored red.

Foresters and others can refer to the section "Timber Management," where the soils of the Area are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Management for Wildlife."

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

Community planners and others can read about soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas in the section "Soils and Recreation."

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

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

Newcomers in the Mescalero-Apache Area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Area," which gives additional information about the Area.

Cover: Eagle Lake in Hesperus-Tularosa association, strongly sloping. Camping and fishing are important sources of income in the Mescalero-Apache Area.

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Issued January 1976

SOIL SURVEY OF MESCALERO-APACHE AREA, NEW MEXICO

NORTHEASTERN OTERO COUNTY

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SOILS SURVEYED BY DONALD G. MOON, RALPH SMITH, AND ROBERT M. GUTHRIE,
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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, AND
THE UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF INDIAN AFFAIRS, IN
COOPERATION WITH NEW MEXICO AGRICULTURAL EXPERIMENT STATION

THE MESCALERO-APACHE AREA is in the northeastern part of Otero County in south-central New Mexico (fig. 1). The total land area is 460,662

acres, or about 720 square miles. Of this, 460,384 acres, or more than 99 percent, is owned by the Mescalero-Apache Indian tribe. Less than 1 percent of the total acreage is farmed. Most of the acreage is range and woodland.

The Mescalero-Apache Indian Reservation was established by Executive Order of President Ulysses S. Grant on May 27, 1873. Subsequent executive orders altered the Area slightly and defined the boundaries. The population of the reservation is approximately 1,400 enrolled Apache Indians. Mescalero, the only village within the Area, is the seat of the tribal headquarters.

Most of the Area is mountainous. The crest of the Sacramento Mountains and Sierra Blanca (White Mountains) extend through the Area. The east slope drains into the Pecos River, and the west slope drains into the Tularosa Basin, where the water sinks into the white sands and basin floor. About two-thirds of the Area is wooded. Open grassland is along the eastern and western foot slopes and high mountain valleys. The highest point is the 12,003-foot peak of Sierra Blanca. The lowest point is approximately 5,450 feet elevation, about 12 miles southwest of Sierra Blanca.

The main sources of income in the Area are timber, cattle, and recreational enterprises. Income from recreation includes skiing, permits for hunting, picnicking, camping, hiking, and fishing.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the Mescalero-Apache Area, where they are located, and how they can be used. The soil scientists went into the Area knowing they likely would find soils they had already seen and some they had not. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants; the kinds of rock; and many facts about the soils. They dug 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 into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles

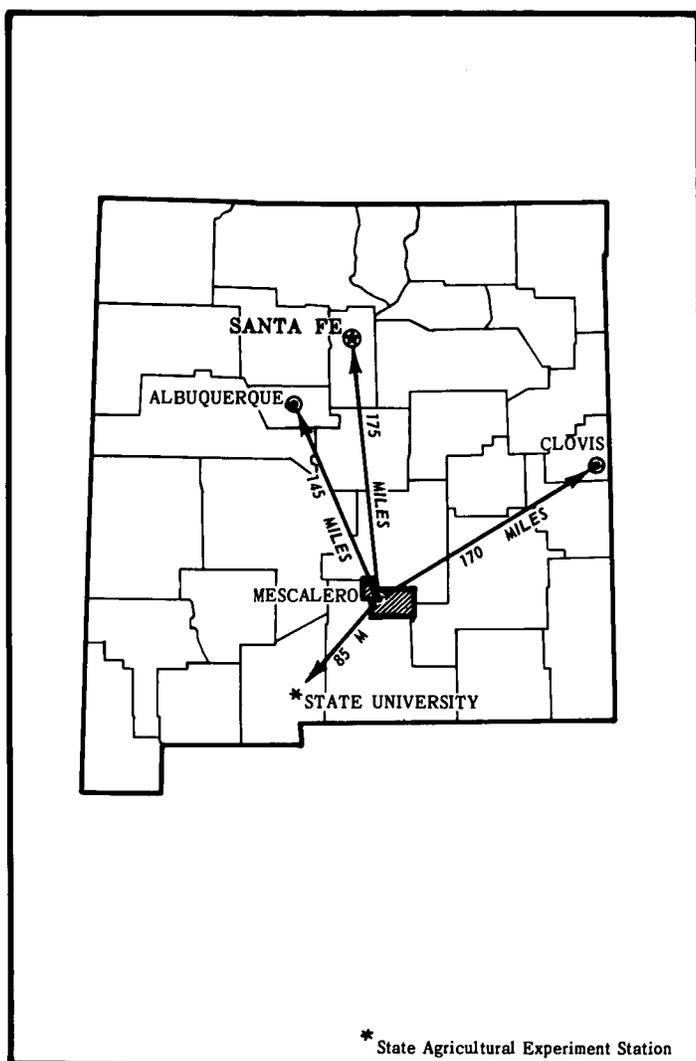


Figure 1.—Location of Mescalero-Apache Area in New Mexico.

with those in areas nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories most used in a local survey (7).¹

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. Telefono and Ruidoso, for example, are the names of two soil series. All the soils in the United States that have the same series name are essentially alike in those characteristics that affect their behavior in the natural landscape.

Soils of one series can differ somewhat in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Telefono clay loam, 3 to 8 percent slopes, is one of several phases within the Telefono series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodland, buildings, field borders, trees, and other details that greatly help in drawing soil boundaries accurately. The soil map in the back of this survey was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in detailed planning management, a mapping unit is nearly equivalent to a soil phase. 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 phase.

Some mapping units are made up of soils of different series or of different phases within one series. Two such kinds of mapping units are shown on the soil map of the Mescalero-Apache Area: soil complexes and associations.

A soil complex consists of two or more soils or land types so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils or land types, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils or land types, joined by a hyphen. Firo-Stony land complex, 12 to 55 percent slopes, is an example.

A soil association is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the survey, there is little value in separating them. The pattern and proportion of the soils are relatively uniform. The name of a soil association consists of the names of the dominant soils, joined by a hyphen. Hesperus-Tularosa association, strongly sloping, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Rock land is a land type in the Mescalero-Apache Area.

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on range yields are gathered. Average yields during favorable and unfavorable years when the range site is in excellent condition are estimated for all soils that apply to range management.

Only part of a soil survey is done when the soils have been named, described, and delineated on the map and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of readers, among them ranchers, managers of woodland, planners for recreational facilities, and others. Grouping soils that are similar in suitability for each specific use is the method of organization commonly used in soil surveys.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups and test these groups by further study and by consultation with foresters, ranchers, engineers, and others. They then adjust the groups according to the results of their studies and consultation. The groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this soil survey shows, in color, the soil associations in the Mescalero-Apache Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils, at least one minor soil, and generally one or more land types, and it is named for the major soils or land types. The soils in one association may occur in another, but in a different pattern.

A soil map that shows soil associations is useful to people who want a general idea of the soils in the Area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is not suitable for detailed planning management because the soils within any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The six soil associations in the Mescalero-Apache Area are described on the following pages.

1. Deama association

Undulating to steep, very shallow to shallow very stony loams on low hills

This association occupies broad, undulating to rolling ridgetops and moderately steep to steep slopes on

¹ Italic numbers in parentheses refer to Literature Cited, p. 78.

limestone hills in the eastern and west-central parts of the Area. The soils formed in material weathered from limestone bedrock. The vegetation is short and mid grasses, forbs, and shrubs, some cactus, and scattered pinyon and juniper trees. Elevation ranges from 5,700 to 6,900 feet. The mean annual precipitation is 12 to 17 inches, mean annual air temperature is 45° to 57° F., and the frost-free season is 140 to 160 days.

This association makes up about 30 percent of the Area. It is about 85 percent Deama soils (fig. 2), 5 percent Limestone rock land, and 10 percent Remunda, Pena, Irock, Ruidoso, and Jarita soils.

Deama soils are on ridgetops, in saddles, and between benches of rock outcrop. They are very stony, cobbly, and gravelly loams 7 to 20 inches deep over limestone bedrock. Limestone rock land consists of rock ledges and rock outcrop on ridges and extremely stony land along colluvial slopes. The other soils are on narrow valley sides.

This association is used mainly for livestock grazing, wildlife, and watershed. The vegetation for livestock responds to good management.

2. Rock land-Oro Grande association

Steep to very steep rock land and moderately steep to very steep, shallow and very shallow stony loams on mountain foot slopes and hills

This association occupies moderately steep to very steep slopes on hills and mountain foot slopes and very steep rock land mostly in the northwestern part of the Area. The soils formed mostly in material weathered from acid igneous rocks. The vegetation is short and mid grasses, forbs, and shrubs, some cactus, and scattered pinyon and juniper trees. Elevation ranges from 5,700 to 7,000 feet. The mean annual precipitation is 11 to 17 inches, mean annual air temperature is 45° to 57° F., and the frost-free season is 140 to 160 days.

This association makes up about 9 percent of the Area. It is about 60 percent Rock land, 10 percent Oro Grande soils (fig. 3), and 30 percent Pinkel, Deama, Gabaldon, Kuma, and Shanta soils.

Rock land is on the steep and very steep slopes. It consists of areas of rock outcrop, areas near vertical rock cliffs, rockslides, and very stony colluvial land

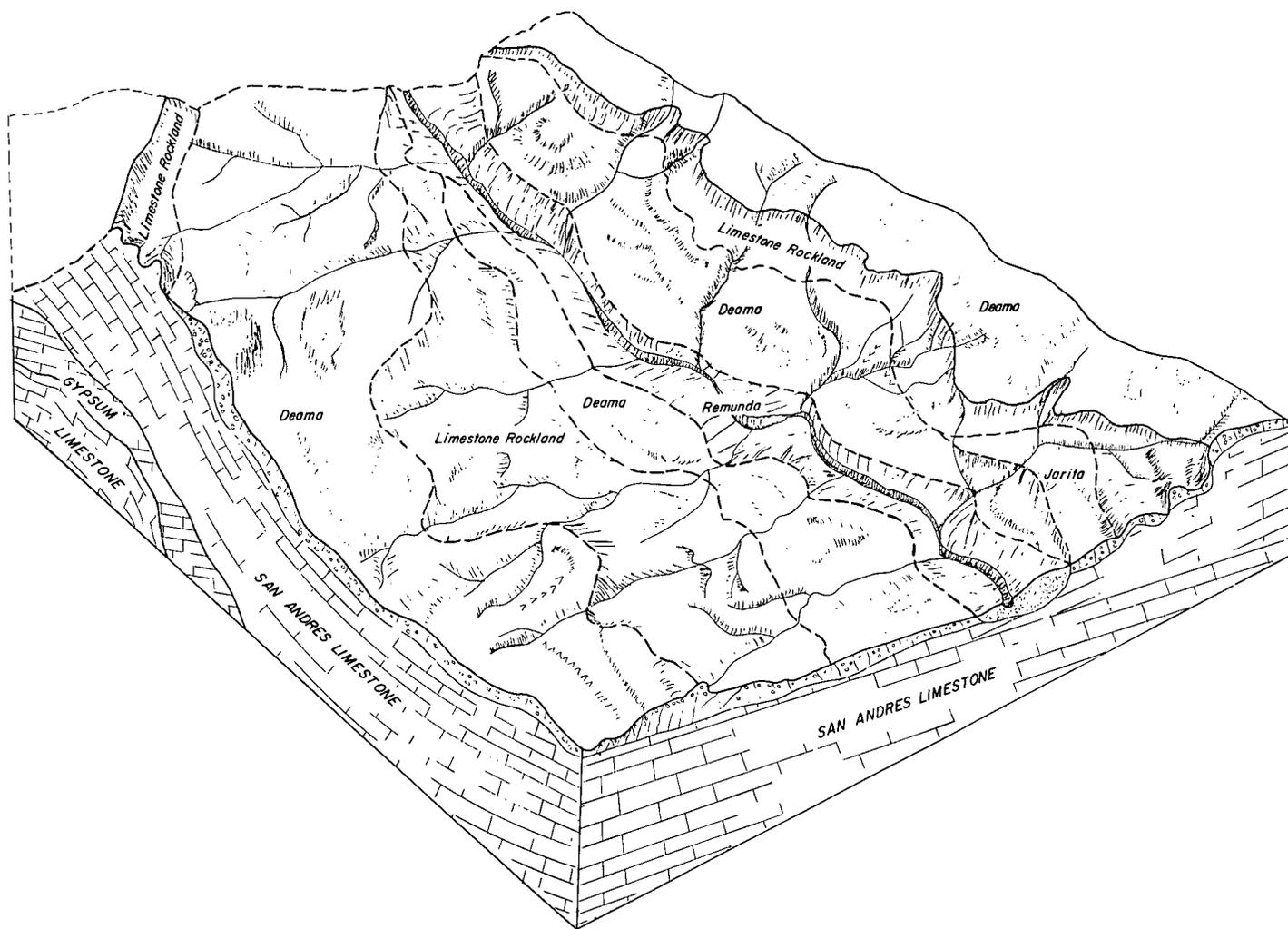


Figure 2.—Pattern of soils and underlying material in association 1.

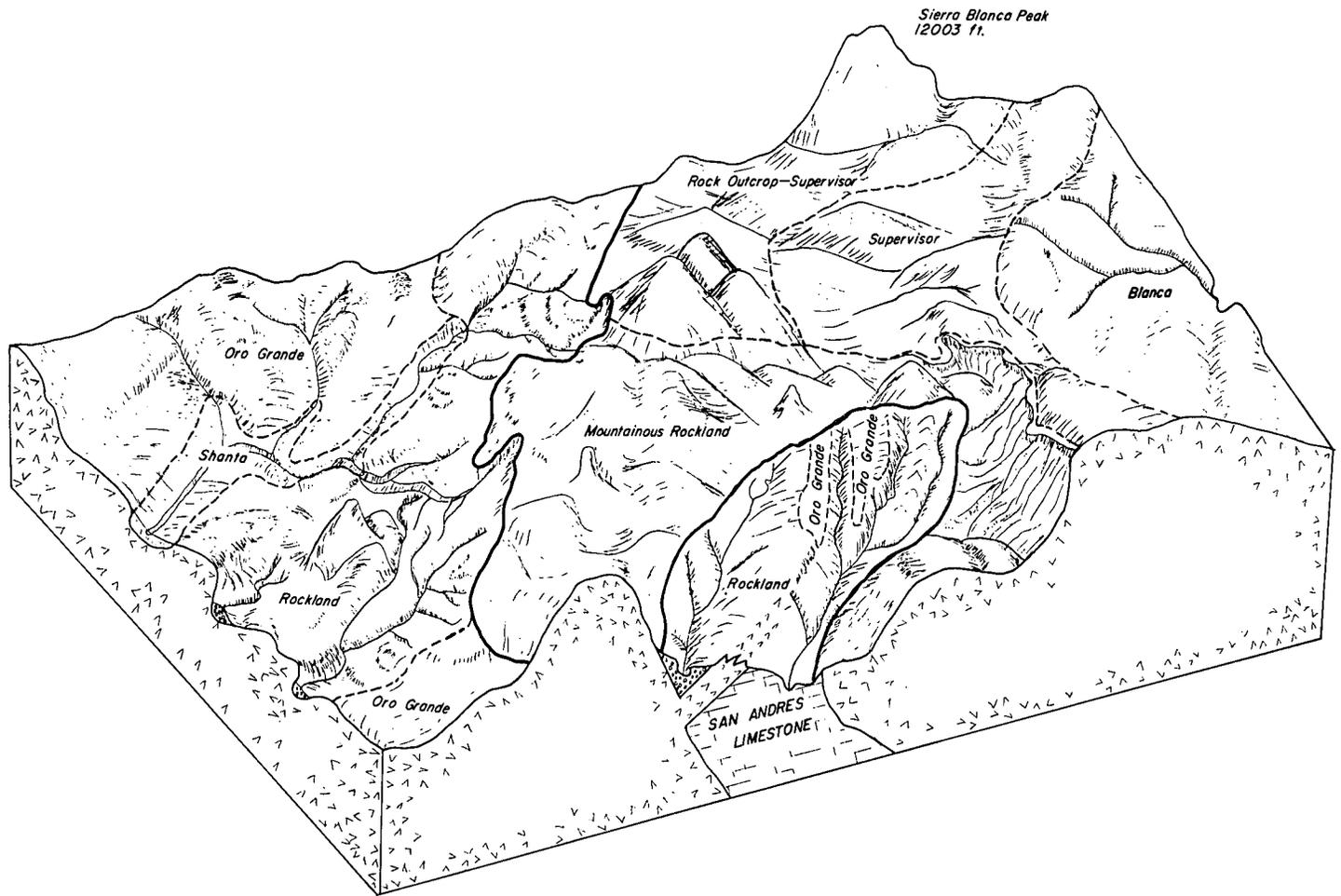


Figure 3.—Pattern of soils and underlying material in association 2.

derived from limestone, acid igneous rock, and sandstone. Oro Grande soils are on ridgetops, in saddles, and on moderately steep hillsides. They have a surface layer of stony loam and a substratum of very stony clay loam. They are 7 to 20 inches deep over acid igneous rock. Most of the other soils are moderately deep and deep loams and clay loams on narrow valley sides.

This association is used mainly for watershed and wildlife. In addition, the Oro Grande soils are used for livestock grazing. The vegetation for livestock use responds to good management.

3. Caballo-Peso-Firo association

Moderately steep to steep, shallow to deep nonstony to very cobbly and very stony clay loams and loams on high mountains

This association occupies the sides of high mountains in the southwestern and northwestern parts of the Area. The soils formed in material weathered from limestone in the southwestern part of the Area and from acid igneous rocks in the northwestern part. The vegetation is mid and tall grasses, forbs, and shrubs and an overstory of ponderosa pine, mixed conifers, and aspen

trees. Elevation ranges from 6,800 to 10,000 feet. The mean annual precipitation is 17 to 25 inches, mean annual air temperature is 37° to 45° F., and the frost-free season is 70 to 110 days.

This association makes up about 11 percent of the Area. It is about 40 percent Caballo soils, 25 percent Peso soils, 25 percent Firo soils, and 25 percent Rockland, cool, and Supervisor, Blanca, Tularosa, and Telefonos soils.

Caballo soils are on ridgetops, in saddles, and on the more northern exposures. They are deep soils that have a surface layer of loam or clay loam and a subsoil of cobbly and very cobbly loam and clay loam. Peso soils are on the more southern exposures in the southwestern part of the Area. They are very cobbly clay loams 20 to 40 inches deep over limestone. Firo soils are on the more southern exposures in the northwestern part of the Area. They are very stony and cobbly loams 7 to 20 inches deep over acid igneous rock.

This association is used mainly for timber, recreation, wildlife, watershed, and limited livestock grazing. The timber responds to selective cutting and good woodland management.

4. *Peso-Mescalero association*

Gently sloping to steep, moderately deep stony and very cobbly silty clay loams and clay loams on intermediate mountains

This association occupies broad mountainous terrain that extends north and south through the entire Area. The soils formed mainly in material weathered from limestone. The vegetation is mid and tall grasses, forbs, and shrubs and a canopy cover dominated by ponderosa pine and some mixed conifer trees on northern exposures. Elevation ranges from 7,200 to 9,000 feet. The mean annual precipitation is 18 to 23 inches, mean annual air temperature is 38° to 45° F., and the frost-free season is 80 to 110 days.

This association makes up about 39 percent of the Area. It is about 70 percent Peso soils, 8 percent Mescalero soils, and 22 percent Rock land, cool, and Gaines, Brycan, Blamer, Hesperus, Firo, and Tularosa soils.

Peso soils are moderately steep to steep on side slopes. They are very cobbly clay loams 20 to 40 inches deep over limestone. Mescalero soils are mainly on ridgetops. They have a surface layer of stony silty clay loam and a subsoil of cobbly and very cobbly clay loam and silty clay loam. They are 20 to 40 inches deep over limestone.

This association is used mainly for timber, recreation, wildlife, watershed, and livestock grazing. The timber responds to selective cutting and good woodland management.

5. *Remunda-Ruidoso association*

Gently sloping to strongly sloping, deep silty clay loams and clay loams in broad valleys

This association occupies gently sloping valley bottoms and strongly sloping valley sides associated with limestone hills in the eastern part of the Area and mixed sedimentary and igneous hills in the northwestern part. The soils formed in alluvium that was derived from mixed igneous and sedimentary rocks. The vegetation is short and mid grasses, cholla, and yucca. Elevation ranges from 5,600 to 6,900 feet. The mean annual precipitation is 11 to 16 inches, mean annual air temperature is 52° to 57° F., and the frost-free season is 140 to 160 days.

This association makes up about 6 percent of the Area. It is about 45 percent Remunda soils, 25 percent Ruidoso soils, and 30 percent Shanta, Gabaldon, and Jarita soils.

Remunda soils are along the extreme east-central part of the Area. They are deep soils that have a surface layer of silty clay loam and clay loam and a subsoil of heavy clay loam.

Ruidoso soils are mainly in the east-central part of the Area. They are deep soils that have a surface layer of silty clay loam and clay loam and a subsoil of heavy clay loam.

This association is used mainly for livestock grazing and wildlife. Maintaining maximum cover minimizes the loss of soil through erosion. The vegetation for livestock responds to good management.

6. *Arosa-Brycan association*

Gently sloping to moderately steep, deep loams and silty clay loams in narrow mountain valleys

This association occupies narrow mountain valley floors in the central part of the Area. The soils formed in alluvium that was derived mostly from mixed acid igneous and sedimentary rocks. The vegetation is mid and tall grasses, forbs, and shrubs and some scattered ponderosa pine. The mean annual precipitation is 18 to 22 inches, mean annual air temperature is 41° to 45° F., and the frost-free season is 80 to 110 days.

This association makes up about 5 percent of the Area. It is about 65 percent Arosa soils, 10 percent Brycan soils, and 25 percent Hesperus, Tularosa, Telefono, and Blamer soils.

All these soils are on narrow valley floors. Arosa soils are deep soils that have a surface layer of silty clay loam and a subsoil of silty clay, clay, and heavy clay loam. Brycan soils are deep soils that have a surface layer of silty clay loam and heavy loam and a subsoil of light clay loam. The Hesperus and Tularosa soils are deep alluvial soils. The Telefono and Blamer soils are clay loams and very stony loams underlain by bedrock at a depth of less than 40 inches.

This association is used mainly for livestock grazing, recreation, wildlife, and some timber in the northern part. The vegetation for wildlife responds to good management.

Descriptions of the Soils

In this section the soil series and mapping units in the series are described. The acreage and proportionate extent of each mapping unit are shown in table 1.

The procedure in this section is first to describe the soil series and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read both the description of that unit and the description of the soil series to which it belongs. The description of a soil series mentions features that apply to all the soils in the series. Differences among the soils of one series are pointed out in the description of the individual soils or are indicated in the soil name. Unless otherwise stated, terms for color and consistence are those of a dry soil. The pH value is determined by using a soil-water dilution of 1 to 5.

As mentioned in the section "How This Survey was Made," not all mapping units are members of a soil series. Rock land, Rock outcrop, and Terrace escarpments, for example, do not belong to a soil series but, nevertheless, are listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the range site and the wildlife habitat group to which the soil has been assigned and where applicable, the timber group. The page for the description of each range site can be found by referring to the Guide to Mapping Units at the back of this survey.

Soil scientists, engineers, students, and others interested in more information about soil series should turn to the section "Formation and Classification of the Soils." Many terms used in the soil descriptions are defined in the Glossary at the back of this soil survey.

TABLE 1.—Approximate acreage and proportionate extent of soils

Mapping unit	Area	Extent	Mapping Unit	Area	Extent
	Acres	Percent			
Arosa silty clay loam, 1 to 12 percent slopes	15,786	3.4	Oro Grande-Rock land complex, 12 to 55 percent slopes	2,805	0.6
Blamer very stony loam, 12 to 55 percent slopes	5,108	1.1	Pena-Irock association, strongly sloping	5,532	1.2
Blanca stony sandy loam, 25 to 55 percent slopes	1,531	.3	Peso very cobbly clay loam, 12 to 55 percent slopes	122,812	26.7
Bryan loam, 3 to 25 percent slopes	633	.1	Peso-Caballo association, steep	34,811	7.6
Bryan silty clay loam, 3 to 25 percent slopes	2,695	.6	Pinkel very cobbly loam, 12 to 55 percent slopes	2,443	.5
Caballo clay loam, 25 to 55 percent slopes	15,345	3.3	Remunda silty clay loam, 1 to 12 percent slopes	16,701	3.6
Caballo loam, 3 to 25 percent slopes	467	.1	Rock land	23,934	5.2
Caballo loam, 25 to 55 percent slopes	3,139	.7	Rock land, cool	24,817	5.4
Deama very stony loam, 1 to 12 percent slopes	39,347	8.5	Rock outcrop-Oro Grande complex, very steep	1,496	.3
Deama very stony loam, 12 to 55 percent slopes	76,013	16.5	Rock outcrop-Supervisor complex, very steep	1,884	.4
Firo very stony loam, 12 to 55 percent slopes	3,894	.9	Ruidoso clay loam, 1 to 8 percent slopes	7,083	1.5
Firo-Stony land complex, 12 to 55 percent slopes	8,564	1.9	Shanta loam, 1 to 8 percent slopes	4,064	.9
Gabaldon loam, 1 to 8 percent slopes	2,497	.5	Supervisor very stony sandy loam, 12 to 55 percent slopes	956	.2
Gaines silty clay loam, 1 to 25 percent slopes	1,898	.4	Telefono clay loam, 3 to 8 percent slopes	301	.1
Gaines clay loam, thin surface variant, 12 to 55 percent slopes	1,175	.3	Telefono clay loam, 8 to 25 percent slopes	418	.1
Hesperus-Tularosa association, strongly sloping	1,403	.3	Terrace escarpments	958	.2
Jarita-Remunda association, gently sloping	3,794	.8	Tularosa silty clay loam, 1 to 12 percent slopes	4,210	.9
Kuma loam, 1 to 8 percent slopes	4,408	1.0			
Limestone rock land	3,972	.9	Total	460,662	100.0
Mescalero stony silty clay loam, 3 to 12 percent slopes	13,768	3.0			

Arosa Series

The Arosa series consists of deep, well-drained soils on narrow mountain valley floors. These soils formed in alluvium derived from mixed igneous and sedimentary rocks. Slopes are 1 to 12 percent. The elevation is 6,800 to 7,900 feet. The vegetation is mainly mid and tall grasses, forbs, shrubs, and scattered ponderosa pine. The mean annual precipitation is 18 to 22 inches, mean annual air temperature is 41° to 45° F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is very dark gray silty clay loam about 10 inches thick. The subsoil is very dark grayish-brown and dark-brown silty clay, clay, and heavy clay loam that extends to a depth of about 52 inches. The substratum is brown clay loam that extends to a depth of 62 inches. The soil is neutral in the subsoil and mildly alkaline in the substratum. The substratum contains a few, fine, soft masses of carbonates.

Arosa soils are slowly permeable. Available water holding capacity is 9.5 to 11 inches to a depth of 60 inches. Roots can penetrate to a depth of 60 inches or more.

These soils are used for livestock grazing, recreation, and wildlife.

Representative profile of Arosa silty clay loam, 1 to 12 percent slopes, in Otero County; about 1 mile southwest of Salt Well in headcut, near south quarter corner of sec. 24, T. 12 S., R. 12 E.

A1—0 to 10 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate, medium, platy structure in upper 2 inches and moderate, very fine, granular below; slightly hard, friable

moist, sticky and slightly plastic wet; common fine roots; many fine interstitial pores; neutral; clear, smooth boundary.

B1—10 to 15 inches, very dark grayish-brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; strong, fine, subangular blocky structure; very hard, firm moist, sticky and plastic wet; common fine and few coarse roots; common fine interstitial pores; neutral; clear, smooth boundary.

B21—15 to 28 inches, very dark grayish-brown (10YR 3/2) clay, very dark brown (10YR 2/2) moist; strong, medium, prismatic structure parting to moderate, fine and medium, angular and subangular blocky; very hard, firm moist, sticky and plastic wet; common fine and few coarse roots; common fine interstitial pores; neutral; clear, smooth boundary.

B22—28 to 39 inches, very dark grayish-brown (10YR 3/2) clay, very dark brown (10YR 2/2) moist; moderate, medium and fine, angular and subangular blocky structure; very hard, firm moist, very sticky and very plastic wet; few medium and coarse roots; few fine interstitial pores; neutral; clear, smooth boundary.

B3—39 to 52 inches, dark-brown (10YR 4/3) heavy clay loam, dark brown (10YR 3/3) moist; moderate, coarse, subangular blocky structure; very hard, firm moist, sticky and plastic wet; few coarse roots; few fine interstitial pores; neutral; clear, smooth boundary.

C—52 to 62 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak, coarse, subangular blocky structure; hard, firm moist, sticky and plastic wet; few coarse roots; few fine interstitial pores; few fine masses of carbonates; mildly alkaline.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 dry and 2 or 3 moist, and chroma of 1 or 2 dry or moist. It is 5 to 10 percent organic matter. The B2 horizon has hue of 7.5YR or 10YR, value of 3 or 4 dry and 2 or 3 moist, and chroma of 1 to 3 dry or moist. It is heavy clay loam to clay. The B3 and C horizons have hue of 5YR

to 10YR, value of 4 to 7 dry and 3 to 5 moist, and chroma of 2 to 4 dry or moist. They are clay loam or clay.

Arosa soils are similar to Brycan and Hesperus soils, but have a finer textured B horizon.

Arosa silty clay loam, 1 to 12 percent slopes (AR).—

This soil is on narrow valley floors in the intermediate mountains throughout the central part of the Area. Included in mapping are small areas of Hesperus, Telefono, and Blamer soils on small ridges and the steeper slopes. Included soils make up less than 15 percent of the mapping unit. Also included are numerous small springs, bogs, and seeps, which are most numerous along the south side of the Area.

Runoff is medium. The hazard of sheet and gully erosion is moderate. The soil is used mainly for livestock grazing, recreation, and wildlife. Clayey range site 3Cy, 3cCy; wildlife habitat group B.

Blamer Series

The Blamer series consists of very shallow to moderately deep, well-drained soils. These soils formed in alluvium and colluvium derived from sandstone and shale. Slopes are 12 to 55 percent. The elevation is 6,900 to 8,200 feet. The vegetation is mainly mid and tall grasses, forbs, shrubs, and a canopy of ponderosa pine. The mean annual precipitation is 18 to 22 inches, mean annual air temperature is 41° to 45° F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is dark grayish-brown very stony loam about 5 inches thick. The surface is covered with 1 inch to 3 inches of undecomposed to partly decomposed leaves, needles, and woody twigs. The subsoil is dark-brown very stony heavy loam about 10 inches thick. The substratum extends to a depth of about 30 inches. It is highly fractured sandstone and hard, fine-textured shale mixed with a small amount of soil material similar to that of the subsoil. Hard sandstone bedrock is at a depth of 30 inches. The soil is neutral throughout.

Blamer soils are moderately permeable. Available water holding capacity is 1 inch to 2 inches. Roots can penetrate as far down as solid bedrock.

These soils are used for livestock grazing, timber, recreation, wildlife, and watershed.

Representative profile of Blamer very stony loam, 12 to 55 percent slopes, in Otero County; about 1¼ miles southwest of Blake Well on north side of road near west quarter corner of NW¼, SE¼, sec. 23, T. 12 S., R. 12 E.

O1—1 inch to 0, undecomposed to partly decomposed leaves, needles, and woody twigs.

A1—0 to 5 inches, dark grayish-brown (10YR 4/2) very stony loam, very dark brown (10YR 2/2) moist; weak, very fine, granular structure; slightly hard, very friable moist, slightly sticky and slightly plastic wet; many fine and medium roots; common fine interstitial pores; 10 percent angular sandstone gravel, 15 percent angular cobbles, 10 percent stones; neutral; clear, smooth boundary.

B2—5 to 15 inches, dark-brown (10YR 3/3) very stony heavy loam, very dark brown (10YR 2/2) moist; weak, fine, subangular blocky structure; hard, friable moist, slightly sticky and slightly plastic wet; common fine to medium roots; common fine interstitial pores; 10 percent angular sandstone gravel, 20 percent angular cobbles, 25 percent stones; neutral; abrupt, irregular boundary.

C—15 to 30 inches, highly fractured sandstone and hard, fine-textured shale; soil material similar to that of the B2 horizon in fractures in the upper part, but amount decreases with increasing depth.

R—30 inches, hard sandstone bedrock.

Depth to bedrock ranges from 9 to 40 inches, but is generally 20 to 40 inches. The content of coarse fragments between a depth of 10 inches and bedrock ranges from 35 to 85 percent. The profile is typically noncalcareous, but in places is slightly calcareous in the lower part. The solum ranges from mildly alkaline to slightly acid.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3 dry or moist. The organic-matter content ranges from 2 to 10 percent, but decreases from the surface downward. This horizon is loam or clay loam that is 18 to 35 percent clay modified with stones, gravel, and cobbles. The B2 horizon has hue of 5YR, 7.5YR, or 10YR and value of 3, 4, or 5 dry and 2 or 3 moist. It is 15 to 35 percent stones. The C horizon is 35 to 65 percent stones.

Blamer soils are similar to the Gaines thin surface variant, but have a coarser textured B horizon and a higher content of coarse fragments throughout than those soils.

Blamer very stony loam, 12 to 55 percent slopes (BM).—

This soil is on sandstone or sandstone and shale mountainsides in the northwestern part of the Area. Included with it in mapping are small areas of the Gaines thin surface variant and Arosa soils and areas of stony land along toe slopes and of Rock land. Included areas make up less than 15 percent of the mapping unit.

Runoff is medium. The hazard of sheet erosion is slight. The soil is used mainly for livestock grazing, timber, recreation, wildlife, and watershed. Steep Shallow range site 3cSSw, 3dSSw; timber group 3; wildlife habitat group F.

Blanca Series

The Blanca series consists of deep, well-drained soils on high mountain slopes. These soils formed in a mixture of alluvial, glacial, and wind-laid deposits derived from acid igneous rocks. Slopes are 25 to 55 percent. The elevation is 10,000 to 11,500 feet. The vegetation is dominantly mid and tall grasses, forbs, shrubs, and a few scattered stunted spruce trees. The mean annual precipitation is 24 to 28 inches, mean annual air temperature is 36° to 40° F., and the frost-free season is 50 to 90 days.

In a representative profile the surface layer is very dark grayish-brown stony sandy loam and dark grayish-brown sandy loam about 16 inches thick. The next layer is dark grayish-brown very cobbly sandy loam about 9 inches thick. The substratum is brown and light yellowish-brown very cobbly sandy loam and very cobbly loamy sand that extends to a depth of 60 inches. The soil is slightly acid throughout.

Blanca soils are moderately rapidly permeable. Available water holding capacity is 3 to 4 inches to a depth of 60 inches. Roots can penetrate to a depth of 60 inches.

These soils are used for recreation, wildlife, and watershed.

Representative profile of Blanca stony sandy loam, 25 to 55 percent slopes, in Otero County; on eastern slope about 300 feet from the ridgetop in the saddle between Sierra Blanca Peak and Ski Lookout Vista, 850 feet south of the north boundary of the Mescalero-

Apache Indian Reservation, about 850 feet south of the north quarter corner of sec. 4, T. 11 S., R. 11 E.

- A11—0 to 7 inches, very dark grayish-brown (10YR 3/2) stony sandy loam, very dark brown (10YR 2/2) moist; moderate, very fine and fine, granular structure; soft, very friable moist; many fine and medium roots; many fine interstitial pores and common tubular pores; 5 percent gravel, 3 percent cobbles, 3 percent stones; slightly acid; clear, smooth boundary.
- A12—7 to 16 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; slightly hard, very friable moist, slightly sticky wet; many fine roots; many fine and very fine interstitial and tubular pores; 5 percent angular acid igneous gravel, 5 percent cobbles, 2 percent stones; slightly acid; clear, smooth boundary.
- AC—16 to 25 inches, dark grayish-brown (10YR 4/2) very cobbly sandy loam, very dark grayish brown (10YR 3/2) moist; moderate, very fine and fine, granular structure; slightly hard, very friable moist, slightly sticky wet; many fine roots; many fine and very fine interstitial pores; 20 percent coarse angular acid igneous gravel, 20 percent cobbles, 20 percent stones; slightly acid; gradual, wavy boundary.
- C1—25 to 40 inches, light yellowish-brown (10YR 6/4) very cobbly sandy loam, dark yellowish brown (10YR 4/4) moist; weak, very fine, granular structure; slightly hard, very friable moist; few fine roots; common fine interstitial pores; 15 percent gravel, 30 percent cobbles, 30 percent stones; slightly acid; gradual, irregular boundary.
- C2—40 to 60 inches, brown (7.5YR 5/4) very cobbly loamy sand, brown (7.5YR 4/4) moist; massive; soft, very friable moist; few fine and medium interstitial pores; 10 percent angular acid igneous gravel, 35 percent cobbles, 35 percent stones; slightly acid.

The content of coarse fragments typically is about 60 percent, but ranges from 35 to 85 percent. Stones are predominant. The soil ranges from medium acid to slightly acid.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3. The organic-matter content ranges from about 3 to 6 percent in the A horizon and decreases with increasing depth. The AC horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 to 4 moist, and chroma of 2 or 3 dry or moist. It is light loam to sandy loam that is less than 18 percent clay modified by cobbles. The C horizon has hue of 5YR to 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 3 to 5 dry or moist. It ranges from sandy loam to loamy sand. The content of gravel, cobbles, and stones increases with increasing depth.

Blanca soils are similar to Caballo and Supervisor soils. In contrast with Caballo soils, they do not have a B horizon. They are deeper over bedrock than Supervisor soils.

Blanca stony sandy loam, 25 to 55 percent slopes (BN).

—This soil occurs on high mountainsides in the extreme northwestern part of the Area. Included in mapping are small areas of Caballo and Supervisor soils, Rock outcrop, rock ledges, stony land, and Rock land. Included soils make up about 15 percent of the mapping unit.

Runoff is rapid. The hazard of sheet and gully erosion is moderate. The soil is used mainly for recreation, wildlife, and watershed. Steep range site 5St; timber group 6; wildlife habitat group F.

Brycan Series

The Brycan series consists of deep, well-drained soils on narrow mountain valley floors. These soils formed in alluvium derived from mixed acid igneous and sedimentary rocks. Slopes are 3 to 25 percent. The eleva-

tion is 6,900 to 8,200 feet. The vegetation is mainly mid and tall grasses, forbs, shrubs, and scattered ponderosa pine. The mean annual precipitation is 18 to 22 inches, the mean annual air temperature is 41° to 45° F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is very dark grayish-brown silty clay loam and heavy loam about 16 inches thick. The subsoil is dark-brown and brown light clay loam about 24 inches thick. The substratum is yellowish-brown heavy loam that extends to a depth of 60 inches or more. The soil is neutral throughout.

Brycan soils are moderately slowly permeable. Available water holding capacity is 10 to 11 inches to a depth of 60 inches. Roots can effectively penetrate to a depth of 60 inches.

These soils are used for livestock grazing, recreation, wildlife, and some timber in the northern part of the Area.

Representative profile of Brycan silty clay loam, 3 to 25 percent slopes, in Otero County; one-fourth mile north of Salt Well on the west side of road, in SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 19, T. 12 S., R. 13 E.

- A11—0 to 4 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine granular structure; slightly hard, friable moist, sticky and plastic wet; many fine and medium roots; common fine interstitial pores; neutral; abrupt, smooth boundary.
- A12—4 to 16 inches, very dark grayish-brown (10YR 3/2) heavy loam, very dark brown (10YR 2/2) moist; moderate, fine, subangular blocky structure; hard, friable moist, very sticky and plastic wet; many fine and medium roots; common fine interstitial pores; neutral; clear, wavy boundary.
- B2—16 to 25 inches, dark-brown (10YR 3/3) light clay loam, very dark brown (10YR 2/3) moist; moderate, medium, angular and subangular blocky structure; very hard, firm moist, very sticky and very plastic wet; common fine and medium roots; common fine tubular pores and common fine interstitial pores; few worm casts; neutral; clear, wavy boundary.
- B3—25 to 40 inches, brown (10YR 4/3) light clay loam, dark brown (10YR 3/3) moist; weak, medium and coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, firm moist, very sticky and plastic wet; few medium roots; few fine interstitial pores; neutral; clear, wavy boundary.
- C—40 to 60 inches, yellowish-brown (10YR 5/4) heavy loam, dark yellowish brown (10YR 4/4) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; hard, firm moist, sticky and plastic wet; no roots; few fine interstitial pores; neutral.

Reaction ranges from slightly acid to mildly alkaline in the solum. The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 dry and 2 or 3 moist, and chroma of 2 or 3. It is 1 to 5 percent organic matter. The B horizon ranges from heavy loam to silty clay loam or light clay loam. It has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3. The C horizon has hue of 5YR to 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 3 to 5. It ranges from noncalcareous to moderately calcareous and contains disseminated carbonates to soft concretions and mycelia.

Brycan soils are similar to Arosa soils, but have a coarser textured B horizon.

Brycan loam, 3 to 25 percent slopes (BR).—This soil is on narrow valley floors and valley slopes associated with intermediate mountains mainly in the northern part of the Area. It has a profile similar to the one

described as representative of the series, but the surface layer is loam about 8 inches thick. Included in mapping are small areas of Arosa and Hesperus soils, small outcrops of sandstone, and common small springs, bogs, and seeps. These included areas make up less than 15 percent of the mapping unit.

Runoff is medium. The hazard of sheet and gully erosion is moderate. The soil is used mainly for live-stock grazing, recreation, wildlife, and some timber. Loamy range site 3Lo, 3cLo; timber group 2; wildlife habitat group B.

Bryan silty clay loam, 3 to 25 percent slopes (BS).—This soil is on narrow valley floors in the intermediate mountains mainly in the north-central part of the Area. It has the profile described as representative of the series. Included in mapping are small areas of Arosa and Hesperus soils. Included soils make up less than 15 percent of the mapping unit. Also included are a few small springs, bogs, and seeps.

Runoff is medium. The hazard of sheet and gully erosion is moderate. The soil is used mainly for live-stock grazing, recreation, wildlife, and some timber. Clayey range site 3Cy, 3cCy, 3dCy; timber group 2; wildlife habitat group B.

Caballo Series

The Caballo series consists of deep, well-drained soils on high mountainsides. These soils formed in alluvial and colluvial material that was derived from mixed acid igneous and limestone rocks. Slopes are 3 to 55 percent. The elevation is 7,900 to 10,000 feet. The vegetation is mid and tall grasses, forbs, shrubs, and an overstory of mixed conifers and aspen. The mean annual precipitation is 20 to 25 inches, mean annual air temperature is 37° to 42° F., and the frost-free season is 70 to 90 days.

In a representative profile the surface layer is very dark grayish-brown clay loam about 10 inches thick that is covered with 1 inch undecomposed to partly decomposed leaves, needles, and woody twigs. The subsoil is very dark grayish-brown and brown cobbly and very cobbly loam and cobbly clay loam about 44 inches thick. The substratum is highly fractured limestone bedrock. The soil is neutral in the upper part of the subsoil and mildly alkaline below. Thin patchy lime coatings occur on the bottom sides of coarse fragments below a depth of 28 inches.

Caballo soils are moderately permeable. Available water holding capacity is 5 to 6.5 inches. Roots can penetrate to a depth of 54 inches, and tree roots penetrate rock fissures.

These soils are used mainly for timber, recreation, wildlife, and watershed. The less wooded areas are grazed to a limited extent.

Representative profile of Caballo clay loam, 25 to 55 percent slopes, in Otero County; about 1,800 feet west of Horse Springs up Water Canyon on north-facing slopes, near center of NE¼ sec. 1, T. 15 S., R. 12 E.

O1—1 inch to 0, partly decomposed leaves, needles, and woody plant twigs.

A11—0 to 4 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; weak, very fine, granular structure; slightly hard,

friable moist, slightly sticky and slightly plastic wet; many fine and medium roots; many fine interstitial pores; about 10 percent gravel and cobbles; neutral; clear, smooth boundary.

A12—4 to 10 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; strong, very fine, granular structure; hard, friable moist, slightly sticky and slightly plastic wet; many fine and medium roots; many fine interstitial pores; 5 percent gravel, 5 percent cobbles and stones; neutral; clear, wavy boundary.

B21—10 to 28 inches, very dark grayish-brown (10YR 3/2) cobbly clay loam, very dark brown (10YR 2/2) moist; moderate, fine, granular and weak, fine, sub-angular blocky structure; hard, friable moist, slightly sticky and slightly plastic wet; common fine, medium, and coarse roots; common fine interstitial pores; 15 percent gravel, 30 percent cobbles, 15 percent stones; neutral; clear, wavy boundary.

B22—28 to 36 inches, 60 percent brown (7.5YR 5/4) mixed with 40 percent grayish-brown (10YR 5/2) cobbly clay loam, dark brown (7.5YR 4/4) and very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure; hard, firm moist, slightly sticky and slightly plastic wet; few medium and coarse roots; few fine and medium interstitial pores and few tubular pores; about 10 percent angular limestone gravel, 35 percent cobbles, and 20 percent stones; thin, patchy, hard calcium carbonate coatings on bottom sides of cobbles; slightly calcareous to moderately calcareous; mildly alkaline; gradual, wavy boundary.

B23—36 to 42 inches, brown (7.5YR 5/4) very cobbly loam, dark brown (7.5YR 4/4) moist; weak, fine, granular structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; few medium and coarse roots; many very fine and fine interstitial and tubular pores; 10 percent gravel, 50 percent cobbles, 20 percent stones; thin, discontinuous, hard calcium carbonate coatings on bottom sides of coarse fragments; moderately calcareous; mildly alkaline; gradual, wavy boundary.

B3—42 to 54 inches, brown (7.5YR 5/3) cobbly clay loam, dark brown (7.5YR 4/3) moist; weak, medium, subangular blocky structure; hard, friable moist, slightly sticky and slightly plastic wet; few coarse roots; common very fine and fine interstitial pores; 5 percent gravel, 20 percent cobbles, 5 percent stones; thin, discontinuous, hard calcium carbonate coatings on bottom sides of coarse fragments; lime disseminated and few faint lime mycelia; moderately calcareous; mildly alkaline; gradual, wavy boundary.

C—54 to 60 inches, highly fractured limestone bedrock mixed with colluvial boulders and flagstones; 90 percent coarse fragments; small amount of soil material between coarse fragments, roots in fractures and between rock fragments; grades gradually to slightly fractured limestone bedrock.

The solum ranges from 40 to 80 inches in thickness. It ranges from neutral in the A horizon and the upper part of the B horizon to moderately alkaline in the lower part of the B horizon. The content of coarse fragments ranges from 35 to 85 percent.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 dry and 2 or 3 moist, and chroma of 1.5 to 3 dry or moist. The organic-matter content is 4 to 14 percent at the surface and decreases with increasing depth. The B21 horizon has hue of 5YR to 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 1.5 to 4 dry or moist. It ranges from cobbly heavy loam to very cobbly light clay loam. The B22 and B3 horizons have hue of 5YR to 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 2 to 5 dry or moist. The C horizon is about 75 to 95 percent coarse fragments.

Caballo soils are similar to Mescalero, Blanca, and Peso soils. They are deeper than Mescalero and Peso soils, which are on the more southerly exposures and are only 20 to 40 inches deep over bedrock. They have a B horizon, which Blanca soils lack.

Caballo clay loam, 25 to 55 percent slopes (CA).—This soil is on high mountainsides in the southwestern part of the Area. It formed mainly in material derived from limestone. It has the profile described as representative of the series. Included in mapping are small areas of Blanca, Mescalero, and Peso soils, stony land, and Rock outcrop. Included soils make up about 15 percent of the mapping unit.

Runoff is rapid. The hazard of sheet and gully erosion is severe. The soil is used mainly for timber, recreation, wildlife, and watershed. Less wooded areas are grazed to a limited extent. Steep range site 4cSt, 4dSt; timber group 5; wildlife habitat group F.

Caballo loam, 3 to 25 percent slopes (CB).—This soil is on high mountainsides in the northwestern part of the Area. It formed mainly in material derived from acid igneous rock. It has a profile similar to the one described as representative of the series, but the surface layer is loam, the soil is neutral throughout, and most of the coarse fragments are fine-grained, acid igneous rock. Included in mapping are small areas of Blanca soils, stony land, and Rock outcrop. Included soils make up about 15 percent of the mapping unit.

Runoff is medium. The hazard of sheet and gully erosion is moderate. The soil is used mainly for recreation, wildlife, and watershed. Less wooded areas are grazed to a limited extent. Loamy range site 4Lo; wildlife habitat group F.

Caballo loam, 25 to 55 percent slopes (CD).—This soil is on high mountainsides in the northwestern part of the Area. It formed mainly in material derived from acid igneous rocks. It has a profile similar to the one described as representative of the series, but the surface layer is loam, the soil is neutral throughout, and most of the coarse fragments are fine-grained, acid igneous rock. Included in mapping are small areas of Blanca and Supervisor soils, stony land, and Rock outcrop. Included soils make up about 15 percent of the mapping unit.

Runoff is rapid. The hazard of sheet and gully erosion is severe. The soil is used mainly for recreation, wildlife, and watershed. Less wooded areas are grazed to a limited extent. Steep range site 4St; wildlife habitat group F.

Deama Series

The Deama series consists of very shallow and shallow, well-drained soils on low, rolling to steep hills. These soils formed in material weathered from limestone. Slopes are 1 to 55 percent. The elevation is 5,700 to 6,900 feet. The vegetation is mainly short and mid grasses, forbs, shrubs, cactus, yucca, and scattered pinyon and juniper. The mean annual precipitation is 12 to 17 inches, the mean annual air temperature is 45° to 57° F., and the frost-free season is 140 to 160 days.

In a representative profile the surface layer is dark grayish-brown very stony loam and cobbly loam about 8 inches thick. The substratum is brown gravelly loam about 5 inches thick. Limestone bedrock is at a depth of 13 inches. The soil is moderately alkaline throughout. Hard lime coats the surface of the bedrock and the limestone coarse fragments (fig. 4).

Deama soils are moderately permeable. Available water holding capacity is 0.5 inch to 2.5 inches. Roots

easily penetrate as far down as bedrock.

These soils are used mainly for livestock grazing, wildlife, and watershed.

Representative profile of Deama very stony loam, 1 to 12 percent slopes, in Otero County; approximately 1.1 miles northwest of Red Lake and 350 feet west of Red Lake-Augustine Tank road, near the center of NW $\frac{1}{4}$ sec. 4, T. 13 S., R. 16 E.

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) very stony loam, very dark grayish brown (10YR 3/2) moist; weak, fine and very fine, granular structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; many fine roots; common fine interstitial pores; 15 percent angular limestone gravel, 15 percent cobbles, 15 percent stones; slightly calcareous; moderately alkaline; gradual, wavy boundary.

A12ca—4 to 8 inches, dark grayish-brown (10YR 4/2) cobbly loam, very dark grayish brown (10YR 3/2) moist; weak, fine and very fine, subangular blocky structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; common fine roots; common fine interstitial pores; 20 percent angular limestone and hard caliche gravel, 10 percent cobbles, 10 percent stones; discontinuous hard lime coatings on coarse fragments; strongly calcareous; moderately alkaline; clear, wavy boundary.

Cca—8 to 13 inches, brown (10YR 4/3) gravelly loam, dark brown (10YR 3/3) moist; weak, fine and very fine, subangular blocky structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; common fine roots; common fine interstitial pores; 25 percent angular limestone and caliche gravel, 15 percent cobbles, 20 percent stones; many, moderately thick, hard lime coatings on coarse fragments, most numerous on the bottom sides; strongly calcareous; moderately alkaline; clear, abrupt boundary.

R—13 inches, limestone bedrock; upper surface coated with hard lime about 1/8 inch thick.

Depth to bedrock is highly variable and ranges from 7 to 20 inches. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 dry and 2 or 3 moist, and chroma of 2 or 3. The organic-matter content is 1 to 5 percent. This horizon ranges from slightly calcareous to strongly calcareous. The Cca horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 to 4 moist in most places but ranges to 8 dry and 6 moist in some areas of deeper soils, and chroma of 2 or 3. It is loam to light clay loam that is 18 to 35 percent clay and 50 to 85 percent coarse fragments. The carbonate content ranges from 40 to 60 percent.

Deama soils are closely associated with Jarita soils. In contrast with those soils, they do not have a Bt horizon and are not so deep over bedrock.

Deama very stony loam, 1 to 12 percent slopes (DA).

—This undulating to strongly sloping soil is on ridgetops and limestone hills along the eastern side and in the west-central part of the Area. It has the profile described as representative of the series. Included in mapping are small areas of Jarita soils in saddles and on foot slopes and areas of Limestone rock land. Included soils make up about 15 percent of the mapping unit.

Runoff is medium. The hazard of sheet erosion is slight. The soil is used mainly for livestock grazing, wildlife, and watershed. Limestone range site 1Li, 2Li, 2aLi; wildlife habitat group C.

Deama very stony loam, 12 to 55 percent slopes (DE).

—This moderately steep to steep soil is on limestone hillsides along the eastern side and in the west-central part of the Area. Along the western edge the mapped areas are about 15 percent soils that have considerable



Figure 4.—Dcama very stony loam is shallow over limestone.

gypsum at a depth of 6 to 20 inches. This soil has a profile similar to the one described as representative of the series, but slopes are 12 to 55 percent. Included in mapping are small areas of Rock land.

Runoff is rapid. The hazard of water erosion is moderate. The soil is used mainly for livestock grazing, wildlife, and watershed. Steep Shallow range site 2SSw, 2aSSw; wildlife habitat group C.

Firo Series

The Firo series consists of very shallow and shallow, well-drained soils on high mountainsides. These soils formed in alluvium and colluvium derived from mixed acid igneous rocks. Slopes are 12 to 55 percent. The elevation is 6,800 to 9,000 feet. The vegetation is mid and tall grasses, forbs, shrubs, and an overstory of ponderosa pine, oak brush, and mixed conifers on some of the more northern slopes and at higher elevations. The mean annual precipitation is 17 to 23 inches, the mean annual air temperature is 38° to 45° F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is very dark grayish-brown very stony loam about 3 inches thick; 1 inch of undecomposed to partly decomposed

leaves, needles, and woody twigs is on the surface. The subsoil is dark grayish-brown cobbly heavy loam about 12 inches thick. Acid igneous bedrock is at a depth of 15 inches. The soil is neutral throughout.

Firo soils are moderately permeable. Available water holding capacity is 0.5 to 2.0 inches. Roots effectively penetrate as far down as bedrock.

These soils are used mainly for timber, recreation, wildlife, watershed, and limited grazing.

Representative profile of Firo very stony loam, 12 to 55 percent slopes, in Otero County; about 0.6 mile up Cienegita Canyon from Maple Dam on south-facing slope, about 600 feet north of the road in northeast corner of SW $\frac{1}{4}$, NE $\frac{1}{4}$, sec. 35, T. 11 S., R. 11 E.

- O1—1 inch to 0, undecomposed to partly decomposed leaves, needles, and woody twigs.
- A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) very stony loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, very friable moist, slightly sticky and slightly plastic wet; many fine roots; common fine interstitial pores; 5 percent gravel, 10 percent cobbles, 10 percent stones; neutral; clear, smooth boundary.
- B2—3 to 15 inches, dark grayish-brown (10YR 4/2) cobbly heavy loam, very dark brown (10YR 2/2) moist; weak, fine, subangular blocky structure parting

to weak, fine, granular; slightly hard, friable moist, slightly sticky and slightly plastic wet; common fine and medium roots; common fine interstitial pores; 5 percent gravel, 25 percent cobbles, 15 percent stones; neutral; abrupt, irregular boundary.

R—15 inches, acid igneous bedrock; somewhat weathered in upper 2 inches.

Depth to acid igneous bedrock ranges from 7 to 20 inches. The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 1.5 to 3 dry or moist. The organic matter content ranges from 4 to 10 percent. The B2 horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 1 to 3 dry or moist. It is loam or clay loam that is 18 to 35 percent clay and 35 to 85 percent coarse fragments. The lower part of the B2 horizon in some places is slightly calcareous.

Firo soils are closely associated with Caballo soils. In contrast with those soils, which are on the more northerly exposures, they are much shallower over bedrock.

Firo very stony loam, 12 to 55 percent slopes (FR).—

This soil is on high mountainsides in the northwestern part of the Area. The soil formed mainly in material derived from acid igneous rocks. It has the profile described as representative of the series. Included in mapping are small areas of Caballo soils, stony land, rockslides, and Rock outcrop. Included soils make up about 15 percent of the mapping unit.

Runoff is rapid. The hazard of water erosion is slight. The soil is used mainly for timber, recreation, wildlife, and watershed. Less wooded areas are grazed to a limited extent. Steep Shallow range site 3cSSw, 3dSSw; timber group 4; wildlife habitat group F.

Firo-Stony land complex, 12 to 55 percent slopes (FS).—

This complex is about 50 percent Firo very stony loam and 35 percent Stony land. The Firo soil is on ridgetops, in saddles, and on benches between areas of Rock outcrop on the more southerly exposures. Stony land is mainly just below rock cliffs and steep mountainsides. Included in mapping are areas of Rock land, Rock outcrop, and colluvial land. Included areas make up about 15 percent of the mapping unit.

Stony land is so stony and bouldery that identifying the soil material is difficult. About 25 to 60 percent of the surface area is exposed stones. The soil material between stones is loam or light clay loam.

Runoff is medium. The hazard of water erosion is slight. The complex is used mainly for timber, recreation, wildlife, and watershed. Less wooded areas are grazed to a limited extent. Steep Shallow range site 4cSSw, 4dSSw; timber group 5; wildlife habitat group F.

Gabaldon Series

The Gabaldon series consists of deep, well-drained soils on fans and valley fills. These soils formed in alluvium that was derived from mixed sedimentary and igneous rocks. Slopes are 1 to 8 percent. The elevation is 5,700 to 7,000 feet. The vegetation is mainly short and mid grasses and scattered pinyon and juniper. The mean annual precipitation is 14 to 17 inches, the mean annual air temperature is 45° to 57° F., and the frost-free season is 140 to 160 days.

In a representative profile the surface layer is very dark grayish-brown and dark-brown loam about 16 inches thick. The subsoil is about 15 inches of dark-

brown heavy loam that contains a few, very fine, irregularly shaped threads of lime. The substratum extends to a depth of 60 inches or more. It is brown loam that contains a few, fine, soft flecks and masses of lime. The soil is mildly alkaline throughout.

Gabaldon soils are moderately permeable. Available water holding capacity is 9 to 11 inches. Roots can effectively penetrate to a depth of 60 inches.

These soils are used for livestock grazing and wildlife.

Representative profile of Gabaldon loam, 1 to 8 percent slopes, in Otero County; 200 feet south of the north quarter corner of sec. 5, T. 13 S., R. 12 E.

A11—0 to 4 inches, very dark grayish-brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; slightly hard, very friable moist, slightly sticky wet; common fine roots; common fine interstitial and tubular pores; lime finely disseminated; calcareous; mildly alkaline; clear, smooth boundary.

A12—4 to 16 inches, dark-brown (10YR 3/3) loam, very dark brown (10YR 2/2) moist; moderate, fine, subangular blocky structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; common fine roots; common fine interstitial and tubular pores; lime finely disseminated; calcareous; mildly alkaline; clear, smooth boundary.

B2—16 to 31 inches, dark-brown (10YR 3/3) heavy loam, very dark brown (10YR 2/2) moist; moderate, medium, prismatic structure parting to weak, medium and coarse, subangular blocky; hard, friable moist, slightly sticky and slightly plastic wet; common fine roots; common fine interstitial pores and few fine tubular pores; lime finely disseminated and few very fine irregularly shaped lime threads; calcareous; mildly alkaline; gradual, smooth boundary.

C—31 to 60 inches, brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; massive; hard, friable moist, sticky and slightly plastic wet; few fine roots to a depth of 48 inches; few fine and medium interstitial pores and few tubular pores; lime disseminated and few fine soft lime flecks; moderately calcareous; mildly alkaline.

The soil ranges from neutral to mildly alkaline. The A and B horizons have hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3 dry or moist. The B2 horizon ranges from clay loam, loam, and light clay loam to silt loam and light silty clay loam that is 18 to 35 percent clay and less than 15 percent sand coarser than very fine sand. The C horizon has hue of 5YR to 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 2 to 4 dry or moist. Igneous gravel, limestone gravel, or both make up 0 to 15 percent of the soil.

Gabaldon soils are similar to Shanta and Ruidoso soils. In contrast to the Shanta soils, the B horizon of Gabaldon soils is less than 15 percent material coarser than very fine sand. Gabaldon soils contain less clay in the B horizon than Ruidoso soils.

Gabaldon loam, 1 to 8 percent slopes (GA).—This soil is in valley fills and on valley sides scattered along the eastern side and in the northwestern part of the Area. Included in mapping are small areas of Pena, Shanta, and Ruidoso soils near valley floors. Included soils make up less than 15 percent of the mapping unit. A few small springs and seeps also are included in areas where these soils are more closely associated with mountains.

Runoff is medium. The hazard of sheet and gully erosion is moderate. The soil is used mainly for livestock grazing and wildlife. Loamy range site 2Lo, 2aLo; wildlife habitat group A.

Gaines Series

The Gaines series consists of deep, well-drained soils on intermediate mountainsides and narrow ridgetops. These soils formed in alluvial and colluvial materials derived mainly from limestone. Slopes are 1 to 25 percent. The elevation is 6,800 to 8,400 feet. The vegetation is mid and tall grasses, forbs, shrubs, and an overstory of ponderosa pine. The mean annual precipitation is 17 to 21 inches, the mean annual air temperature is 39° to 45° F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is dark grayish-brown silty clay loam about 9 inches thick. The subsoil is about 23 inches of dark grayish-brown and brown heavy silty clay loam and clay. The substratum is about 16 inches thick. It is brown clay intermixed with highly fractured limestone fragments. Limestone bedrock is at a depth of about 48 inches (fig. 5). The soil is neutral in the surface layer and upper part of the subsoil and mildly alkaline in the lower part of the subsoil and in the substratum.

These soils are used for livestock grazing, timber, recreation, wildlife, and watershed.

Representative profile of Gaines silty clay loam, 1 to 25 percent slopes, in Otero County; about 0.2 mile

north of Dry Canyon and Rinconada Road in the north-west corner of borrow pit about 300 feet west of the Goat Canyon-Salt Well Road near the west quarter corner of sec. 36, T. 12 S., R. 12 E.

- A1—0 to 9 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak, very fine, granular structure; hard, friable moist, sticky and slightly plastic wet; many fine roots; many fine interstitial pores and few fine tubular pores; neutral; clear, smooth boundary.
- B1—9 to 15 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, very dark brown (10YR 2/2) moist; strong, medium, subangular blocky structure; hard, friable moist, sticky and plastic wet; common fine and medium roots and few coarse roots; common fine interstitial pores; common thin clay films on surfaces of peds and in pores; 5 percent channery fragments; neutral; clear, smooth boundary.
- B21t—15 to 22 inches, brown (10YR 4/3) heavy silty clay loam, very dark brown (10YR 2/3) moist; moderate, medium, prismatic and strong, medium, subangular blocky structure; hard, firm moist, sticky and plastic wet; common, fine, medium, and coarse roots; common fine interstitial pores; common thin clay films on surfaces of peds and in pores; 5 percent channery fragments; neutral; gradual, wavy boundary.
- B22t—22 to 32 inches, brown (10YR 4/3) clay, dark brown (10YR 3/3) moist; moderate, medium, prismatic



Figure 5.—Profile of Gaines silty clay loam, showing limestone bedrock at a depth of 48 inches.

structure parting to moderate, coarse, subangular blocky; very hard, firm moist, very sticky and plastic wet; few fine, medium, and coarse roots; common fine and very fine interstitial pores; few thin clay films on grains of sand and coatings in pores; 10 percent channery limestone fragments, 5 percent flagstones; few fine soft lime masses; mildly alkaline; gradual, irregular boundary.

C—32 to 48 inches, upper 3 to 8 inches has material from B2t horizon intermixed with the coarse fragments; grades into 85 to 95 percent highly fractured weathered limestone intermingled with siltstone and limy shale; averages very cobbly clay; abrupt, smooth boundary.

R—48 inches, limestone bedrock.

The solum ranges from 24 to 48 inches in thickness. Depth to bedrock ranges from 40 to 72 inches. Limestone fragments make up to 5 to 35 percent of the B horizon. The soil ranges from neutral to mildly alkaline. It has a thin O horizon in some areas.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3 dry or moist. The B2t horizon has hue of 5YR to 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3 dry or moist. It is heavy silty clay loam, clay loam, or clay that is 35 to 60 percent clay. Calcium carbonates in the lower part of the B2t horizon and in the C horizon range from nonvisible, finely divided particles to few, medium, soft lime masses and thin lime mycelia.

Gaines soils are similar to Peso soils, but they have a Bt horizon, which Peso soils lack, and they have a lower content of coarse fragments in the B horizon than Peso soils.

Gaines silty clay loam, 1 to 25 percent slopes (GC).—

This gently sloping to moderately steep soil is on narrow ridgetops and mountainsides in the intermediate mountains in the central part of the Area. Included in mapping are small areas of Peso and Mescalero soils and Rock land. Included soils make up less than 15 percent of the mapping unit.

Runoff is medium. The hazard of sheet and gully erosion is moderate to severe. The soil is used mainly for livestock grazing, timber, recreation, wildlife, and watershed. Clayey range site 3cCy, 3dCy; timber group 1; wildlife habitat group B.

Gaines Series, Thin Surface Variant

The Gaines series, thin surface variant, consists of moderately deep, well-drained soils on intermediate mountainsides. These soils formed in alluvial and colluvial material derived mostly from sandstone and shale. Slopes are 12 to 55 percent. The elevation is 6,700 to 8,000 feet. The vegetation is mid and tall grasses, forbs, shrubs, and an overstory of ponderosa pine. The mean annual precipitation is 18 to 21 inches, the mean annual air temperature is 41° to 45° F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is dark-brown clay loam about 3 inches thick. The subsoil is about 17 inches of brown and yellowish-brown clay. The substratum extends to a depth of 60 inches. It is highly weathered and fractured shale and thin beds of sandstone. The soil is neutral throughout.

The Gaines thin surface variant is slowly permeable. Available water holding capacity is about 2 to 4 inches. Tree roots penetrate rock fissures to a depth of 48 inches.

These soils are used for livestock grazing, timber, recreation, wildlife, and watershed.

Representative profile of Gaines clay loam, thin sur-

face variant, 12 to 55 percent slopes, in Otero County; one-half mile south-southwest of Sago Dam near the center of the NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 6, T. 12 S., R. 13 E.

A1—0 to 3 inches, dark-brown (10YR 4/3) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, very fine, granular structure; hard, friable moist, slightly sticky and slightly plastic wet; many fine interstitial pores; 5 percent angular sandstone gravel, trace of stones; neutral; clear, smooth boundary.

B2t—3 to 20 inches, 80 percent brown (10YR 5/3) and 20 percent yellowish-brown (10YR 5/4) clay, dark brown (10YR 4/3) and dark yellowish brown (10YR 4/5) moist; moderate, medium, subangular blocky structure; hard, firm moist, sticky and plastic wet; common fine and medium roots; few fine interstitial and tubular pores; few thin clay films on surfaces of peds and lining pores; few slickensides; 5 percent angular sandstone gravel, trace of stones; neutral; abrupt, smooth boundary.

C—20 to 60 inches, highly weathered and fractured, fine-textured, hard and brittle shale and thin beds of sandstone; less weathered below a depth of 30 inches, but can be dug into with a shovel.

The solum ranges from 10 to 25 inches in thickness. It is slightly acid to mildly alkaline. The content of coarse sandstone fragments ranges from 5 to 35 percent.

The A horizon ranges from 2 to 10 percent in organic-matter content. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 dry and 2 or 3 moist, and chroma of 2 or 3 dry or moist. The B2t horizon ranges from heavy clay loam to clay that is 35 to 60 percent clay. The B2t horizon has hue of 7.5YR or 10YR, has value of 4 or 5 dry and 3 or 4 moist, and is mottled with colors that have chroma of 3 to 6. Digging into the underlying beds with a shovel becomes increasingly difficult below a depth of 40 inches.

The Gaines thin surface variant is similar to Blamer soils. It has a finer textured B2 horizon and a lower content of coarse fragments throughout than Blamer soils.

Gaines clay loam, thin surface variant, 12 to 55 percent slopes (GE).—

This soil occurs as small areas on intermediate sandstone and shale mountainsides in the northwestern part of the Area. Included in mapping are small areas of Brycan, Arosa, Firo, and Blamer soils and Rock land. Included soils make up less than 15 percent of the mapping unit.

Runoff is rapid. The hazard of sheet and gully erosion is severe. The soil is used mainly for livestock grazing, timber, recreation, wildlife, and watershed. Steep Shallow range site 3cSSw, 3dSSw; timber group 3; wildlife habitat group F.

Hesperus Series

The Hesperus series consists of deep, well-drained soils on alluvial fans and in narrow valley fills. These soils formed in material derived from mixed sedimentary and acid igneous rocks. Slopes are 1 to 25 percent. The elevation is 6,900 to 8,600 feet. The vegetation is mainly mid and tall grasses and scattered ponderosa pine. The mean annual precipitation is 18 to 22 inches, mean annual air temperature is 38° to 45° F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is very dark gray loam about 20 inches thick. The subsoil is pale-brown light clay loam that extends to a depth of more than 60 inches. The soil is neutral throughout.

Hesperus soils are moderately slowly permeable. Available water holding capacity is 10 to 12 inches. Roots can penetrate to a depth of 60 inches.

These soils are used for livestock grazing, recreation, and wildlife.

Representative profile of Hesperus loam, 1 to 25 percent slopes, in an area of Hesperus-Tularosa association, strongly sloping, in Otero County; about one-eighth mile above Eagle Lake in borrow pit about 50 feet north of road, south side of NE $\frac{1}{4}$ sec. 1, T. 11 S., R. 11 E.

- A11—0 to 6 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) moist; strong, fine, granular structure; slightly hard, very friable moist, slightly sticky and slightly plastic wet; many fine and medium roots; common fine and medium tubular pores and many fine interstitial pores; about 7 percent organic matter; neutral; gradual, smooth boundary.
- A12—6 to 20 inches, very dark gray (10YR 3/1) heavy loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure parting to moderate, fine, granular; hard, friable moist, slightly sticky and slightly plastic wet; many fine and medium roots; common fine and medium tubular pores and many fine interstitial pores; about 4 percent organic matter; neutral; gradual, smooth boundary.
- B21t—20 to 36 inches, pale-brown (10YR 6/3) light clay loam, brown (10YR 4/3) moist; peds coated with nearly continuous organic stains that are very dark gray (10YR 3/1) dry and black (10YR 2/1) moist; moderate, medium and coarse, subangular blocky structure; hard, friable moist, sticky and plastic wet; common fine roots; common fine and medium tubular and interstitial pores; few thin clay films on sand grains; few fine, faint, reddish mottles; neutral; gradual, smooth boundary.
- B22t—36 to 70 inches, pale-brown (10YR 6/3) light clay loam, brown (10YR 4/3) moist; brownish-yellow (10YR 6/6) to yellowish-brown (10YR 5/6) mottles; weak, coarse and medium, subangular blocky structure; hard, friable moist, sticky and plastic wet; few fine roots to a depth of 40 inches; common fine interstitial pores; few thin clay films on sand grains; many insect burrows filled with darker material from the A horizon; 3 percent angular, mixed, acid igneous gravel; common, medium, distinct and prominent, soft iron mottles; neutral.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 1 or 2. It is 3 to 10 percent organic matter in the upper part and 2 to 4 percent in the lower part.

The B21t horizon ranges from sandy clay loam to light clay loam that is 18 to 35 percent clay. The B2t horizon has hue of 7.5YR or 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 3 to 6. It is noncalcareous to slightly calcareous in the lower part. Organic staining on the surfaces of peds in the upper part of the B2t horizon ranges from weak patchy to nearly continuous. The B2t horizon extends to a depth of 40 to 75 inches.

Hesperus soils are similar to Arosa soils, but have a coarser textured B horizon.

Hesperus-Tularosa association, strongly sloping (HT).

—This mapping unit is about 65 percent Hesperus loam, 1 to 25 percent slopes, and 25 percent Tularosa loam, 1 to 12 percent slopes. The Hesperus soil is mainly on the more sloping sides of narrow valleys, and the Tularosa soil is on the less sloping valley floors. The Tularosa soil has a profile similar to the one described as representative of the Tularosa series, but the surface layer is loam.

Included with these soils in mapping are areas of Arosa soils, which make up about 5 percent of the mapping unit; areas of Telefono soils, which make up 3 percent; and areas of Shanta soils, which make up 2 percent.

Runoff is medium. The hazard of sheet and gully erosion is moderate. This unit is used mainly for

livestock grazing, recreation, and wildlife. Loamy range site 3Lo, 3cLo; wildlife habitat group B.

Irock Series

The Irock series consists of deep, well-drained soils on high terraces and fans and in valley fills. These soils formed in old alluvium derived from mixed sedimentary and acid igneous rocks that have since been highly dissected by water erosion. Slopes are 12 to 55 percent. The elevation is 5,700 to 6,900 feet. The vegetation is mainly short and mid grasses, cholla, yucca, cactus, and scattered pinyon and juniper. The mean annual precipitation is 14 to 17 inches, the mean annual air temperature is 45° to 57° F., and the frost-free season is 140 to 160 days.

In a representative profile the surface layer is brown cobbly sandy loam about 7 inches thick. The subsoil is about 13 inches of yellowish-brown and light yellowish-brown cobbly heavy sandy loam. The substratum is yellowish-brown cobbly light sandy clay loam between depths of 20 to 26 inches and mostly highly weathered and fractured, fine-grained igneous rocks and stones below. Fine-grained, acid igneous bedrock is at a depth of 42 inches. The soil is neutral in the surface layer and mildly alkaline in the subsoil and substratum. Thin discontinuous lime coatings are on the bottom sides of coarse fragments in the substratum.

Irock soils are moderately permeable. Available water holding capacity is 2.5 to 3.5 inches to a depth of 42 inches. Roots can effectively penetrate to a depth of 42 inches.

These soils are used for livestock grazing, wildlife, and watershed.

The Irock soils in the Mescalero-Apache Area are mapped only with Pena soils.

Representative profile of Irock cobbly sandy loam, 12 to 55 percent slopes, in an area of Pena-Irock association, strongly sloping, in Otero County; about 100 feet west of Rinconada Arroyo on west side of road cut in northeast corner of SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 14, T. 12 S., R. 11 E.

- A1—0 to 7 inches, brown (10YR 4/3) cobbly sandy loam, dark brown (10YR 3/3) moist; weak, very fine, granular structure; slightly hard, very friable moist, slightly sticky wet; many fine and medium roots; common fine pores and few coarse interstitial pores; 20 percent gravel, 30 percent cobbles, a few stones; neutral; clear, wavy boundary.
- B2t—7 to 20 inches, yellowish-brown (10YR 5/4) and light yellowish-brown (10YR 6/4) cobbly heavy sandy loam, dark yellowish brown (10YR 4/4) moist; weak, fine, subangular blocky structure; hard, friable moist, slightly sticky and slightly plastic wet; common fine and medium roots; few fine and medium interstitial pores; few thin clay films on sand grains and inside pores; 25 percent gravel, 40 percent cobbles, 5 percent stones; slightly calcareous; mildly alkaline; gradual, wavy boundary.
- C1ca—20 to 26 inches, yellowish-brown (10YR 5/4) cobbly light sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; hard, friable moist, slightly sticky and slightly plastic wet; few fine and medium roots; few fine and medium interstitial pores; 25 percent gravel, 45 percent cobbles, 15 percent stones; thin discontinuous lime coatings on bottoms of coarse fragments; strongly calcareous; mildly alkaline; clear, wavy boundary.

IIC2—26 to 42 inches, highly weathered, highly fractured and disintegrated, fine-grained igneous rock and stone; about 5 percent of mass in upper 10 inches is soil material similar to C1ca horizon; gradual, irregular boundary.

R—42 inches, consolidated, fine-grained, acid igneous bedrock.

The solum ranges from 20 to 30 inches in thickness. Depth to consolidated bedrock ranges from 42 to 72 inches. The content of coarse fragments ranges from 35 to 85 percent throughout, increasing with increasing depth. The solum ranges from neutral or mildly alkaline in the upper part to moderately alkaline in the lower part.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3 dry or moist. It is 1 to 4 percent organic matter.

The B2t horizon has hue of 7.5YR or 10YR, value of 4 to 6 dry and 3 or 4 moist, and chroma of 3 to 5 dry or moist. It is heavy sandy loam or sandy clay loam that is 18 to 35 percent clay.

The C1ca horizon has hue of 5YR to 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 3 to 6 dry or moist. Carbonates range from finely divided, nonvisible particles in the B2t horizon to few, medium, soft masses and thin discontinuous lime coatings on the bottom sides of coarse fragments in the C1ca horizon. The C1ca horizon is 5 to 15 percent lime.

Irock soils are closely associated with Pena soils. Irock soils have a Bt horizon, which Pena soils lack. They contain less lime in the C horizon than Pena soils.

Jarita Series

The Jarita series consists of moderately deep, well-drained soils that formed on alluvial fans and in alluvial deposits over limestone bedrock. Slopes are 1 to 12 percent. The elevation is 5,800 to 7,000 feet. The vegetation is mainly short and mid grasses, cholla, and yucca. The mean annual precipitation is 12 to 17 inches, the mean annual air temperature is 45° to 57° F., and the frost-free season is 140 to 160 days.

In a representative profile the surface layer is dark grayish-brown silt loam about 4 inches thick. The subsoil is about 24 inches of brown light clay loam and light silty clay loam that contains a few, fine, soft lime concretions in the lower 3 inches. Slightly fractured limestone bedrock is at a depth of about 28 inches (fig. 6). The soil is neutral in the surface layer and upper part of the subsoil and mildly alkaline in the lower part of the subsoil.

Jarita soils are moderately slowly permeable. Available water holding capacity is 5 to 6 inches. Roots easily penetrate as far down as bedrock.

These soils are used for livestock grazing, wildlife, and watershed.

Representative profile of Jarita silt loam, 1 to 12



Figure 6.—Jarita soil is only 28 inches deep over bedrock.

percent slopes, in an area of Jarita-Remunda association, gently sloping, in Otero County; about 4,000 feet northeast of Washpan Tank in center of NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34, T. 13 S., R. 16 E.

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; hard, friable moist, slightly sticky and slightly plastic wet; common fine roots; many fine interstitial pores, common fine vesicular pores in upper 1 inch; neutral; clear, smooth boundary.

B21t—4 to 9 inches, brown (7.5YR 4/3) light clay loam, dark brown (7.5YR 3/3) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, friable moist, sticky and plastic wet; common fine roots; common fine interstitial pores; few thin clay films on vertical surfaces of peds and sand grains and in pores; neutral; clear, smooth boundary.

B22t—9 to 28 inches, brown (7.5YR 4/3) light silty clay loam, dark reddish brown (5YR 3/3) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, friable moist, slightly sticky and slightly plastic wet; few fine roots; common fine interstitial pores; few thin clay films on sand grains and in pores; 5 percent cobbles, a few stones; generally noncalcareous, but moderately calcareous spots near few fine soft lime concretions in lower 3 inches; mildly alkaline; abrupt, wavy boundary.

R—28 inches, slightly fractured limestone bedrock.

Depth to limestone bedrock ranges from 20 to 40 inches. The content of coarse fragments ranges from 5 to 35 percent and increases with increasing depth.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3. The B2t horizon has hue of 5YR or 7.5YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3 dry or moist. It is 18 to 35 percent clay. Carbonates increase with increasing depth in the lower part of the B2t horizon. They range from nonvisible, finely divided particles to weak soft lime concretions and thin lime mycelia. The carbonate equivalent ranges from 5 to 12 percent.

Jarita soils are closely associated with Deama soils. They have a B2t horizon, which Deama soils lack. They are deeper over bedrock and have a lower content of coarse fragments than Deama soils.

Jarita-Remunda association, gently sloping (JR).—

This mapping unit is about 60 percent Jarita silt loam, 1 to 12 percent slopes, and 30 percent Remunda silty clay loam, 1 to 12 percent slopes. The Jarita soil is on the higher parts of the landscape, and the Remunda soil is in swales and on the lower parts of the landscape. Included in mapping are small areas of Deama and Ruidoso soils. Included soils make up about 5 percent each of the mapping unit.

Runoff is medium. The hazard of sheet and gully erosion is moderate. This unit is used mainly for livestock grazing, wildlife, and watershed. Clayey range site 2Cy; wildlife habitat group D for Jarita soil and group A for Remunda soil.

Kuma Series

The Kuma series consists of deep, well-drained soils on fans and in valley fills. These soils formed in old alluvium derived from mixed sedimentary and igneous rocks. Slopes are 1 to 8 percent. The elevation is 5,900 to 6,900 feet. The vegetation is mainly short and mid grasses, cholla, yucca, and scattered pinyon and juniper. The mean annual precipitation is 14 to 17

inches, the mean annual air temperature is 45° to 57° F., and the frost-free season is 140 to 160 days.

In a representative profile the surface layer is brown loam about 5 inches thick. The subsoil is about 32 inches of brown light clay loam. The soil is mildly alkaline in the surface layer and upper part of the subsoil and moderately alkaline in the lower part of the subsoil. The underlying material to a depth of 60 inches is reddish-brown heavy clay loam. It is an old buried subsoil that contains many fine gypsum crystals.

Kuma soils are moderately slowly permeable. Available water holding capacity is 11 to 12.5 inches to a depth of 60 inches. Roots can easily penetrate to a depth of 60 inches.

These soils are used for livestock grazing and wildlife.

Representative profile of Kuma loam, 1 to 8 percent slopes, in Otero County; about one-fourth mile east of dam to stockwater pond near center of NE $\frac{1}{4}$ sec. 19, T. 12 S., R. 12 E.

A1—0 to 5 inches, brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak, very fine, granular structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; many fine roots; many fine interstitial pores; mildly alkaline; clear, smooth boundary.

B21t—5 to 11 inches, brown (10YR 4/3) light clay loam, dark brown (10YR 3/3) moist; moderate, medium, prismatic and moderate, medium and coarse, subangular blocky structure; hard, friable moist, slightly sticky and slightly plastic wet; many fine roots; common fine interstitial pores and few, fine, medium, tubular pores; few thin clay films on vertical surfaces of peds; slightly calcareous; mildly alkaline; clear, smooth boundary.

B22t—11 to 22 inches, brown (10YR 4/3) light clay loam, dark brown (10YR 3/3) moist; moderate, fine and medium, subangular blocky structure; hard, friable moist, sticky and slightly plastic wet; common fine roots; common fine interstitial pores and few medium tubular pores; few thin clay films on faces of peds and in pores; moderately calcareous; mildly alkaline; clear, smooth boundary.

B23t—22 to 37 inches, brown (10YR 4/3) light clay loam, dark brown (10YR 3/3) moist; moderate, fine and medium, subangular blocky structure; hard, friable moist, slightly sticky and slightly plastic wet; common fine roots in upper 10 inches, few fine roots in lower part; common fine interstitial pores; few thin clay films on vertical surfaces of peds; lime disseminated; moderately calcareous; moderately alkaline; gradual, wavy boundary.

B2tb—37 to 60 inches, reddish-brown (5YR 4/4) heavy clay loam, dark reddish brown (5YR 3/4) moist; weak and moderate, medium, subangular blocky structure; very hard, firm moist, sticky and plastic wet; few fine roots to a depth of 40 inches; few fine interstitial pores; few thin clay films on surfaces of peds; ped interiors noncalcareous, ped surfaces calcareous; many, prominent, fine gypsum crystals; mildly alkaline.

The solum ranges from 20 to 50 inches in thickness. It is neutral to moderately alkaline. Lime in the lower part of the B horizon ranges from disseminated particles to common, fine, soft masses or mycelia. An old buried B horizon is common below a depth of 37 inches.

The A horizon is 7.5YR or 10YR in hue, 3 to 5 in value when dry and 2 or 3 when moist, and 2 or 3 in chroma. The organic-matter content is 1 to 4 percent.

The B2t horizon ranges from heavy loam and light clay loam to heavy silt loam and light silty clay loam that is 18 to 35 percent clay. This horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3 in the upper part and 2 to 4 in the lower part.

Mixed subangular gravel makes up 0 to 5 percent of the soil.

Kuma soils are closely associated with Remunda soils. They have a coarser textured B horizon than Remunda soils.

Kuma loam, 1 to 8 percent slopes (KU).—This soil is in valley fills and on valley sides scattered along the eastern side and in the northwestern part of the Area. Included in mapping are areas of Remunda, Ruidoso, Shanta, and Gabaldon soils. Included soils make up less than 15 percent of the mapping unit.

Runoff is medium. The hazard of sheet and gully erosion is moderate. The soil is used for livestock grazing and wildlife. Loamy range site 2Lo, 2aLo; wildlife habitat group A.

Limestone Rock Land

Limestone rock land (LM) consists of very shallow soils on limestone hillsides and many rock outcrops. It is predominantly along the eastern side of the Area. Slopes are 12 to 55 percent. The elevation is 5,700 to 6,900 feet. The vegetation is mainly a sparse stand of short and mid grasses, forbs, shrubs, and scattered juniper growing mainly in cracks and crevices of bedrock. The mean annual precipitation is 12 to 17 inches, mean annual air temperature is 45° to 57° F., and the frost-free season is 140 to 160 days.

Limestone rock land is about 60 to 70 percent Rock land, in which are areas of loamy soil material less than 4 inches deep over limestone bedrock, and 30 to 40 percent the shallow and very shallow very stony Deama soils. In places along the western edge of the Area, the bedrock is soft gypsum. Included in mapping are areas where the mean annual soil temperature is higher than is typical for the Area and the vegetation is creosotebush.

The Deama soil has a profile similar to the one described as representative of the Deama series, but in most places depth to limestone bedrock is 4 to 12 inches. Rock land is similar to the Rock land described under that heading.

Runoff is rapid. The hazard of water erosion is slight to moderate. Limestone rock land is used mainly for livestock grazing, wildlife, and watershed. During extremely dry years it provides more usable forage for livestock than some nonstony soils. Steep Very Shallow range site 1SVS, 2SVS; wildlife habitat group C.

Mescalero Series

The Mescalero series consists of moderately deep, well-drained soils on intermediate mountain crests and in saddles. These soils formed in material weathered from limestone. Slopes are 3 to 12 percent. The elevation is 7,200 to 9,000 feet. The vegetation is mid and tall grasses, forbs, shrubs, and an overstory of ponderosa pine. The mean annual precipitation is 18 to 23 inches, mean annual air temperature is 38° to 45° F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is very dark grayish-brown stony silty clay loam about 2 inches thick; a 1-inch layer of undecomposed to partly decomposed leaves, needles, and woody twigs is on the surface. The subsoil is about 17 inches of very dark

grayish-brown and brown cobbly and very cobbly silty clay loam and clay loam. The substratum, about 9 inches thick, is about 85 percent limestone coarse fragments mixed with brown clay loam. Limestone bedrock is at a depth of about 28 inches (fig. 7). The soil is neutral in the surface layer, mildly alkaline in the upper part of the subsoil, and moderately alkaline in the lower part of the subsoil and in the substratum.

Mescalero soils are moderately slowly permeable. Available water holding capacity is 2 to 3.5 inches. Roots easily penetrate as far down as bedrock.

These soils are used mainly for timber, recreation, wildlife, watershed, and livestock grazing.

Representative profile of Mescalero stony silty clay loam, 3 to 12 percent slopes, in Otero County; about 1,000 feet north of Harley Mountain Road on top of ridge one-fourth mile west of Harley Well near center of NE $\frac{1}{4}$ sec. 22, T. 13 S., R. 13 E.

- O1—1 inch to 0, undecomposed and partly decomposed leaves, needles, and woody plant twigs.
- A1—0 to 2 inches, very dark grayish-brown (10YR 3/2) stony silty clay loam, very dark brown (10YR 2/2) moist; weak, thick, platy structure parting to moderate, fine, granular; slightly hard, very friable moist, slightly sticky and slightly plastic wet; many fine and medium roots; many fine interstitial pores and few fine tubular pores; 5 percent channery fragments, 10 percent cobbles, 5 percent stones; neutral; clear, wavy boundary.
- B21—2 to 10 inches, very dark grayish-brown (10YR 3/2) cobbly silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine and very fine, subangular blocky structure; hard, friable moist, sticky and plastic wet; many fine and medium roots; common fine and medium interstitial pores; dark organic stainings on surfaces of peds; 10 percent channery fragments, 25 percent cobbles, 5 percent stones; noncalcareous to slightly calcareous in lower part; mildly alkaline; clear, wavy boundary.
- B22—10 to 15 inches, very dark grayish-brown (10YR 3/2) very cobbly silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine, subangular blocky structure; hard, friable moist, very sticky and plastic wet; common medium and few fine roots; common medium and fine interstitial pores; dark organic stainings on surfaces of peds; 20 percent channery fragments, 35 percent cobbles, 5 percent stones; thin discontinuous lime coatings on bottoms of cobbles and stones; moderately calcareous; moderately alkaline; clear, wavy boundary.
- B3—15 to 19 inches, brown (10YR 4/3) very cobbly clay loam, dark brown (10YR 3/3) moist; moderate, fine, subangular blocky structure; hard, friable moist, sticky and plastic wet; few medium and coarse roots; common medium and fine interstitial pores; 5 percent channery fragments, 60 percent cobbles, 20 percent stones; discontinuous lime coatings on bottoms of coarse fragments; moderately calcareous; moderately alkaline; gradual, wavy boundary.
- C—19 to 28 inches, 85 percent coarse fragments of fractured limestone bedrock and 15 percent material similar to B3 horizon in fractures; roots penetrate fractures; gradual, smooth boundary.
- R—28 inches, limestone bedrock.

The solum ranges from 12 to 20 inches in thickness. Depth to bedrock ranges from 20 to 40 inches. The profile is 35 to 85 percent coarse fragments. It ranges from moderately alkaline to neutral.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 dry and 2 or 3 moist, and chroma of 1.5 to 3 dry or moist. It is 3 to 10 percent organic matter.

The B2 horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 1.5 to 3 dry or moist. It is cobbly silty clay loam or clay loam. The B



Figure 7.—Mescalero stony silty clay loam over fractured bedrock.

horizon averages 24 to 35 percent clay. The content of calcium carbonate ranges from 2 to 15 percent, increasing with increasing depth in the B3 and C horizons to the limestone bedrock.

Mescalero soils are closely associated with Caballo, Peso, and Telefono soils. They are dark colored to a greater depth than Peso soils. They have a higher content of coarse fragments than Telefono soils and are not so deep over bedrock as Caballo soils.

Mescalero stony silty clay loam, 3 to 12 percent slopes (ME).—This soil is mainly on mountain ridges and in saddles in the central part of the Area. It formed mainly in material weathered from limestone. Included in mapping are small areas of Peso and Telefono soils, stony land, and Rock outcrop. Included soils make up about 15 percent of the mapping unit.

Runoff is medium. The hazard of sheet erosion is slight. The soil is used for timber, recreation, wildlife, watershed, and livestock grazing. Limestone range site 3Li, 3cLi; timber group 3; wildlife habitat group F.

Oro Grande Series

The Oro Grande series consists of shallow and very shallow, well-drained soils on hillsides and mountain foot slopes. These soils formed in material weathered from fine-grained, mixed, acid igneous rocks. Slopes

are 12 to 55 percent. The elevation is 5,700 to 6,900 feet. The vegetation is mainly short and mid grasses, forbs, shrubs, cactus, yucca, and scattered pinyon pine and juniper. The mean annual precipitation is 12 to 17 inches, mean annual air temperature is 50° to 57° F., and the frost-free season is 140 to 160 days.

In a representative profile the surface layer is brown stony loam about 3 inches thick. Below this is about 13 inches of grayish-brown very stony clay loam. Fine-grained, acid igneous bedrock is at a depth of 16 inches. The soil is neutral in the surface layer and moderately alkaline in the underlying layer. A few thin lime coatings occur on the bottoms of coarse fragments below a depth of 10 inches.

Oro Grande soils are moderately permeable. Available water holding capacity is 1 inch to 2 inches. Roots easily penetrate as far down as bedrock.

These soils are used mainly for livestock grazing, wildlife, and watershed.

Representative profile of Oro Grande stony loam, 12 to 55 percent slopes, in an area of Oro Grande-Rock land complex, 12 to 55 percent slopes, in Otero County; 3 miles north of Campbell Well in Bull Pasture of the Rinconada Basin or one-half mile northwest of Morris Well in east center of NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 12 S., R. 11 E.

- A1—0 to 3 inches, brown (10YR 4/3) stony loam, dark brown (10YR 3/3) moist; weak, very fine, granular structure; soft, friable moist, slightly sticky and slightly plastic wet; common fine roots; common fine interstitial pores; 15 percent angular fine-grained igneous gravel, 15 percent cobbles, 10 percent stones; neutral; clear, smooth boundary.
- C—3 to 16 inches, grayish-brown (10YR 5/2) very stony clay loam, dark brown (10YR 3/3) moist; weak, very fine, granular structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; common fine roots to a depth of 10 inches, few to a depth of 16 inches; few fine interstitial pores; 15 percent angular mixed igneous gravel, 15 percent cobbles, 15 percent stones; noncalcareous in upper part becoming moderately calcareous in lower part; few thin lime coatings on bottoms of rock fragments below a depth of 10 inches; moderately alkaline; abrupt, irregular boundary.
- R—16 inches, highly fractured, fine-grained, acid igneous bedrock consisting of mixed, acid igneous dikes and sills.

The soil material over igneous bedrock ranges from 7 to 20 inches in thickness. The content of mixed igneous fragments ranges from 35 to 85 percent. The upper part of the soil is generally neutral to moderately alkaline, and the lower part is mildly alkaline to moderately alkaline.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 dry and 2 or 3 moist, and chroma of 2 or 3. It is 1 to 5 percent organic matter.

The C horizon is stony loam to light clay loam that is 18 to 35 percent clay. It has hue of 7.5YR or 10YR, value of 4 to 6 dry and 2 to 4 moist, and chroma of 2 or 3.

Carbonates range from nonvisible, finely divided particles in the upper part of the soil to concretions and soft, distinct, fine bodies in the lower part. Coarse fragments in the lower part have thin discontinuous to nearly continuous lime coatings on the surface. The average carbonate content of the profile is less than 15 percent. The Cca horizon is discontinuous.

Oro Grande soils are similar to Deama soils, but have a lower content of carbonates in the C horizon.

Oro Grande-Rock land complex, 12 to 55 percent slopes (OR).—This complex is about 60 percent Oro Grande soil and 40 percent Rock land. The moderately steep Oro Grande soil is on ridges, in saddles, and on hillsides. Rock land is steep and is near vertical cliffs, igneous dikes, stony colluvial land, and Rock outcrop. Small areas of Rock land also occur within areas of Oro Grande soils. This complex is mapped mainly in the northwestern part of the Area.

The Oro Grande soil has the profile described as representative of the series. Rock land is similar to the Rock land described under that heading, but is not so steep.

Runoff is medium. The hazard of erosion is moderate. The complex is used mainly for livestock grazing, wildlife, and watershed. Steep Shallow range site 2SSw, 2aSSw; wildlife habitat group C.

Pena Series

The Pena series consists of deep, well-drained soils on high terraces. These soils formed in old alluvium derived from mixed sedimentary and acid igneous rocks. Slopes are 1 to 25 percent. The elevation is 5,700 to 6,900 feet. The vegetation is mainly short and mid grasses, cholla, yucca, cactus, and scattered pinyon pine and juniper. The mean annual precipitation is 14 to 17 inches, the mean annual air temperature is 45° to 57° F., and the frost-free season is 140 to 180 days.

In a representative profile the surface layer is dark grayish-brown gravelly loam about 8 inches thick. The next 10 inches is dark grayish-brown cobbly loam. The substratum is light-gray, strongly calcareous cobbly sandy clay loam and very cobbly loam that extends to a depth of 60 inches. The soil is mildly alkaline in the surface layer and moderately alkaline below. About 30 percent of the substratum is lime that decreases in amount below a depth of 30 inches.

Pena soils are moderately permeable. Available water holding capacity to a depth of 60 inches is 5 to 6 inches. Grass roots easily penetrate to a depth of 30 inches, and tree roots penetrate to a depth of 48 inches.

These soils are used for livestock, wildlife, and watershed.

Representative profile of Pena gravelly loam, 1 to 25 percent slopes, in an area of Pena-Irock association, strongly sloping, in Otero County; approximately 1 mile west and one-fourth mile south of Campbell Well or near southwest corner of NW¼, sec. 27, T. 12 S., R. 11 E.

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) gravelly loam, dark brown (10YR 3/3) moist; weak, fine and very fine, granular structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; many fine roots; common fine interstitial pores; 20 percent gravel and cobbles and a few stones; slightly calcareous; mildly alkaline; clear, wavy boundary.

AC—8 to 18 inches, dark grayish-brown (10YR 4/2) cobbly loam, dark brown (10YR 3/3) moist; weak, coarse and fine, subangular blocky structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; common fine roots; common fine interstitial pores; 10 percent gravel, 20 percent cobbles, 5 percent stones; thin patchy lime coatings on bottoms of gravel, cobbles, and stones and few thin lime mycelium and finely divided carbonates throughout; strongly calcareous; moderately alkaline; clear, wavy boundary.

C1ca—18 to 30 inches, light-gray (10YR 7/2) cobbly sandy clay loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable moist, slightly sticky and slightly plastic wet; few fine roots; few fine and medium interstitial pores; 15 percent gravel, 30 percent cobbles, 10 percent stones; nearly continuous hard lime coatings on coarse fragments; about 30 percent of fine-earth material is calcium carbonate that is finely divided throughout; moderately alkaline; strongly calcareous; gradual, irregular boundary.

C2ca—30 to 60 inches, light-gray (10YR 7/2) very cobbly loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable moist, slightly sticky and slightly plastic wet; no roots; few fine interstitial pores; 15 percent gravel, 40 percent cobbles, 20 percent stones; thin nearly continuous caliche coatings on coarse fragments, mostly in upper 12 inches; about 20 percent of fine-earth material is calcium carbonate that is finely divided throughout and decreases gradually in amount below a depth of 42 inches; strongly calcareous; moderately alkaline.

Depth to the Cca horizon ranges from 10 to 30 inches. The content of coarse fragments ranges from 35 to 85 percent and increases with increasing depth. The solum ranges from mildly alkaline to moderately alkaline from the surface downward.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3 dry or moist. The AC horizon ranges from cobbly loam to cobbly sandy clay loam that is 7 to 28 percent clay. It has hue of 7.5YR or 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 2 to 4 dry or moist. It is sandy loam to clay loam that is 7 to 28 percent clay modified with gravel,

cobbles, or both. The lime content of the AC horizon ranges from 8 to 15 percent.

The Cca horizon has hue of 7.5YR or 10YR, value of 5 to 8 dry and 4 to 6 moist, and chroma of 2 to 4 dry or moist. The lime content averages more than 15 percent.

Pena soils are closely associated with Irock soils. They lack the Bt horizon of the Irock soils and contain more lime in the C horizon than those soils.

Pena-Irock association, strongly sloping (PA).—This mapping unit is about 55 percent Pena soil and 30 percent Irock soil. The Pena soil is on rolling ridgetops and gently sloping terraces, and the Irock soil is moderately steep to steep on side slopes along arroyos and breaks of old alluvial deposits. These soils are in the northwestern part of the area. They have the profiles described as representative of the Pena and Irock series.

Included with this unit in mapping are small areas of Rock land, Deama and Pinkel soils, and Terrace escarpments. Included areas make up about 15 percent of the mapping unit. Along the western edge of the mapping unit the precipitation is less than is typical for the Area and the soils have a lighter colored, thinner surface layer.

Runoff is medium to rapid. The hazard of sheet and gully erosion is moderate.

This unit is used mainly for livestock grazing, wildlife, and watershed. Loamy range site 2Lo for Pena soil and Steep Gravelly 2aSGr, 2SGr for Irock soil; wildlife habitat group C for Irock soil and group D for Pena soil.

Peso Series

The Peso series consists of moderately deep, well-drained soils on intermediate mountainsides. These soils formed in alluvial and colluvial material derived from limestone. Slopes are 12 to 55 percent. The elevation is 7,200 to 9,000 feet. The vegetation is mid and tall grasses, forbs, shrubs, and an overstory of ponderosa pine. Also, mixed conifers are at some of the higher elevations and more northern slopes. The mean average precipitation is 18 to 22 inches, the mean annual air temperature is 38° to 45° F., and the frost-free season is 80 to 110 days.

In a representative profile the surface layer is very dark grayish-brown very cobbly clay loam about 4 inches thick; 1 inch of undecomposed to partly decomposed leaves, needles, and woody twigs is on the surface. The subsoil is about 12 inches of dark grayish-brown very cobbly clay loam. The substratum is brown very cobbly clay loam. Limestone bedrock is at a depth of about 32 inches. The soil is mildly alkaline in the surface layer and subsoil and moderately alkaline in the substratum.

Peso soils are moderately slowly permeable. Available water holding capacity is 1.5 to 4 inches to bedrock. Roots easily penetrate as far down as bedrock, and tree roots penetrate cracks in the bedrock to a greater depth.

These soils are used mainly for timber, recreation, wildlife, and watershed. The less wooded areas are grazed to a limited extent.

Representative profile of Peso very cobbly clay loam, 12 to 55 percent slopes, in Otero County; about one-fourth mile up Five Canyon on south-facing slope and

500 feet north of road, near southwest corner of sec. 13, T. 14 S., R. 12 E.

O1—1 inch to 0, undecomposed to partly decomposed leaves, needles, and woody twigs.

A1—0 to 4 inches, very dark grayish-brown (10YR 3/2) very cobbly clay loam, very dark brown (10YR 2/2) moist; soft, very friable moist, slightly sticky and slightly plastic wet; many fine roots; many fine interstitial pores; about 10 percent channery fragments, 35 percent cobbles, and 10 percent stones; mildly alkaline; clear, wavy boundary.

B2—4 to 16 inches, dark grayish-brown (10YR 4/2) very cobbly clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, subangular blocky structure; hard, friable moist, sticky and plastic wet; common fine and medium roots; common fine and medium interstitial pores; about 10 percent channery fragments, 35 percent cobbles, and 10 percent stones; slightly calcareous; mildly alkaline; clear, wavy boundary.

Cca—16 to 32 inches, brown (7.5YR 5/3) very cobbly clay loam, brown (7.5YR 4/3) moist; massive; hard, friable moist, sticky and slightly plastic wet; few medium and coarse roots; few fine interstitial pores and medium tubular pores; 10 percent gravel, 55 percent cobbles, 20 percent stones; few, thin, hard carbonate coatings on bottom sides of coarse fragments; common fine flecks of soft lime in soil mass; moderately calcareous; moderately alkaline; gradual, wavy boundary.

R—32 inches, limestone bedrock; upper 6 inches highly fractured.

Depth to bedrock ranges from 20 to 40 inches. The upper 2 to 16 inches of bedrock is highly fractured. Limestone fragments make up 35 to 85 percent of the soil and increase in number with increasing depth. The A and B horizons range from neutral to mildly alkaline.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 dry and 2 or 3 moist, and chroma of 1.5 to 3 dry or moist. The organic-matter content is 2 to 14 percent. The A horizon ranges from noncalcareous to moderately calcareous.

The B2 horizon is very cobbly and ranges from light clay loam, silty clay loam, and silt loam to loam that is 18 to 35 percent clay. It has hue of 5YR, 7.5YR, or 10YR; value of 4 or 5 dry and 2 or 3 moist; and chroma of 2 or 3 dry or moist. Calcium carbonate ranges from finely divided, nonvisible particles to a few, medium, soft mottles or mycelia in the upper part of the B2 horizon where a few, thin, patchy coatings are on the bottoms of coarse fragments.

The Cca horizon is 70 to 95 percent limestone fragments. The C horizon has hue of 7.5YR or 10YR, value of 4 to 7 dry and 3 to 5 moist, and chroma of 3 to 5 dry or moist. Lime ranges from finely divided, nonvisible bodies to common soft mottles, soft concretions and mycelia, and thin patchy caliche on coarse fragments. Calcium carbonate content ranges from 6 to 15 percent in the Cca horizon.

Peso soils are similar to the associated Caballo and Gaines soils. They are warmer than Caballo soils, which are on the more northern slopes at higher elevations. They contain more coarse fragments in the B horizon than Gaines soils, and they lack the Bt horizon of those soils.

Peso very cobbly clay loam, 12 to 55 percent slopes (PB).—This soil is on intermediate limestone mountainsides throughout the central part of the Area. It has the profile described as representative of the series. Included in mapping are small areas of Caballo, Mescalero, and Gaines soils, stony land, and Rock outcrop. Included soils make up about 15 percent of the mapping unit.

Runoff is rapid. The hazard of sheet and gully erosion is moderate. The soil is used mainly for timber, recreation, wildlife, and watershed. Less wooded areas are grazed to a limited extent. Steep Shallow range

site 3cSSw, 3dSSw; timber group 3; wildlife habitat group F.

Peso-Caballo association, steep (PC).—This mapping unit is about 55 percent Peso very cobbly clay loam, 12 to 55 percent slopes, and 35 percent Caballo clay loam, 25 to 55 percent slopes. The Peso soil is on the more southern exposures, and the Caballo soil is on the more northern exposures and the high-elevation southern exposures. Included in mapping are small areas of Gaines, Telefono, and Mescalero soils. Included soils make up about 10 percent of the mapping unit.

Runoff is medium. The hazard of sheet and gully erosion is moderate. This unit is used mainly for timber, recreation, wildlife, and watershed. Less wooded areas are grazed to a limited extent. Steep Shallow range site 4cSSw, 4dSSw; timber group 5; wildlife habitat group F.

Pinkel Series

The Pinkel series consists of moderately deep to very shallow, well-drained soils on hillsides and mountain foot slopes. These soils formed in alluvial and colluvial material that was derived from mixed sources, mostly sandstone and shale. Slopes are 12 to 55 percent. The elevation is 5,800 to 6,900 feet. The vegetation is mainly short and mid grasses, forbs, shrubs, cactus, yucca, oak, pinyon pine, and juniper. The mean annual precipitation is 12 to 17 inches, the mean annual air temperature is 45° to 57° F., and the frost-free season is 140 to 160 days.

In a representative profile the surface layer is brown very cobbly loam about 4 inches thick. The subsoil is brown very cobbly sandy clay loam about 9 inches thick. The substratum extends to a depth of 30 inches. It is 85 to 90 percent sandstone fragments and 10 to 15 percent voids filled with brown sandy loam and sandy clay loam. Sandstone bedrock is at a depth of about 30 inches.

Pinkel soils are moderately permeable. Available water holding capacity is 1 to 2 inches. Roots easily penetrate as far down as bedrock and extend into cracks in the sandstone.

These soils are used mainly for livestock grazing, wildlife, and watershed.

Representative profile of Pinkel very cobbly loam, 12 to 55 percent slopes, in Otero County; about 150 feet north of Water Spreader Dam in Pinkey Canyon in southeast corner of NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 19, T. 12 S., R. 12 E.

A1—0 to 4 inches, brown (10YR 4/3) very cobbly loam, dark brown (10YR 3/3) moist; moderate, medium, platy structure parting to weak, very fine, granular; slightly hard, friable moist, slightly sticky and slightly plastic wet; many fine roots; common fine interstitial pores; 15 percent gravel, 30 percent cobbles, 15 percent stones; neutral; clear, smooth boundary.

B2—4 to 13 inches, brown (7.5YR 4/2) very cobbly sandy clay loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; common fine and medium roots; few fine interstitial pores; 10 percent gravel, 35 percent cobbles, 35 percent stones; thin discontinuous lime coatings on undersides of rock fragments; mildly alkaline; abrupt, irregular boundary.

C—13 to 30 inches, 85 to 90 percent sandstone fragments;

some voids filled with brown (7.5YR 4/4) sandy loam and sandy clay loam, dark brown (7.5YR 3/4) moist; slightly calcareous; sandstone fractures open into grayish shales in the lower part; tree roots penetrate fractures; abrupt, irregular boundary.

R—30 inches, sandstone bedrock.

Depth to bedrock ranges from 8 to 40 inches, but is generally 20 to 40 inches. Sandstone beds are tilted and highly fractured in the upper part. The content of coarse fragments in the B and C horizons ranges from 35 to 85 percent. The soil is neutral to mildly alkaline.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3. The organic-matter content ranges from 1 to 4 percent and decreases with increasing depth.

The B2 horizon has hue of 5YR or 7.5YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3 dry or moist. It is loam, sandy clay loam, or light clay loam that is 18 to 35 percent clay.

The C horizon has hue of 5YR to 10YR, value of 3 to 5 dry and 2 to 4 moist, and chroma of 2 to 4 dry or moist. The soil ranges from noncalcareous to moderately calcareous. Lime ranges from nonvisible, finely divided particles to common, fine to medium, soft lime concretions and mycelia and a few thin coatings on the undersides of fragments in the lower part. The amount of lime increases with increasing depth, but is less than 15 percent.

Pinkel soils are similar to the Oro Grande soils but are typically deeper over bedrock than those soils. They are underlain by sandstone, whereas Oro Grande soils are underlain by acid igneous rock.

Pinkel very cobbly loam, 12 to 55 percent slopes (PK).—This soil is mainly on sandstone hillsides and mountain foot slopes in the northwestern part of the Area. Included in mapping are small areas of the Gaines thin surface variant, Kuma and Pena soils, and Rock land. Included soils make up less than 15 percent of the mapping unit.

Runoff is rapid. The hazard of sheet erosion is moderate. The soil is used mainly for livestock grazing, wildlife, and watershed. Steep Shallow range site 2SSw, 2aSSw; wildlife habitat group C.

Remunda Series

The Remunda series consists of deep, well-drained soils on fans and valley fills. These soils formed in old alluvium derived from mixed sedimentary and igneous rocks. Slopes are 1 to 12 percent. The elevation is 5,600 to 6,900 feet. The vegetation is mainly short and mid grasses, cholla, and yucca. The mean annual precipitation is 12 to 16 inches, the mean annual air temperature is 52° to 57° F., and the frost-free season is 140 to 160 days.

In a representative profile the surface layer is brown silty clay loam about 14 inches thick. The subsoil is about 34 inches of brown and reddish-brown heavy clay loam and clay. The substratum is reddish-brown clay loam that extends to a depth of 64 inches. It contains common, medium-sized, soft calcium carbonate nodules. The soil is neutral in the surface layer and the upper part of the subsoil and mildly alkaline in the lower part of the subsoil and in the substratum.

Remunda soils are slowly permeable. Available water holding capacity is 10 to 12 inches. Roots can easily penetrate to a depth of 60 inches.

These soils are used for livestock grazing and wildlife.

Representative profile of Remunda silty clay loam, 1

to 12 percent slopes, in Otero County; about 200 yards northwest of Lower Indian Well and on east side of road in headcut west of arroyo, in SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 15, T. 14 S., R. 16 E.

- A1—0 to 14 inches, brown (10YR 4/3) silty clay loam, very dark brown (10YR 2/2) moist; weak, fine, subangular blocky structure; hard, friable moist, sticky and plastic wet; common fine roots; common fine interstitial pores; neutral; abrupt, smooth boundary.
- B1—14 to 19 inches, brown (7.5YR 4/2) heavy clay loam, dark brown (10YR 3/2) moist; moderate, medium, subangular blocky structure; hard, firm moist, sticky and plastic wet; common fine and medium roots; common fine interstitial pores; neutral; clear, smooth boundary.
- B21t—19 to 38 inches, reddish-brown (5YR 5/4) clay, dark reddish brown (5YR 3/4) moist; moderate, coarse, prismatic structure parting to strong, coarse, angular and subangular blocky; hard, firm moist, very sticky and very plastic wet; few fine roots; few medium tubular pores and common fine interstitial pores; many thin clay films on vertical surfaces of peds and in fine old root channels; neutral; gradual, smooth boundary.
- B22t—38 to 48 inches, brown (7.5YR 5/4) heavy clay loam, dark reddish brown (5YR 3/4) moist; moderate, coarse, subangular blocky structure; hard, firm moist, sticky and plastic wet; few fine roots; few fine and medium interstitial pores; few thin clay films on vertical surfaces of peds; noncalcareous between few, fine, soft carbonate nodules; mildly alkaline; clear, wavy boundary.
- C—48 to 64 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; weak, medium and coarse, subangular blocky structure; hard, friable moist, sticky and plastic wet; few fine and medium interstitial pores; noncalcareous to strongly calcareous in immediate vicinity of common, medium, soft carbonate nodules; mildly alkaline.

The A horizon has hue of 7.5YR to 10YR and value of 3 to 5 dry and 2 or 3 moist. It ranges from silty clay loam to clay loam. The B horizon has hue of 5YR to 10YR, value of 3 to 5 dry and 2 to 3 moist, and chroma of 2 to 5. The B21t and B22t horizons range from heavy clay loam to light clay. The C horizon ranges from loam to clay loam.

Remunda soils are closely associated with Kuma and Ruidoso soils. They have a finer textured B horizon than Kuma soils. They are dark colored to a lesser depth than Ruidoso soils.

Remunda silty clay loam, 1 to 12 percent slopes (RC).

—This soil is mainly on the floors of narrow valleys and the sides of broad valleys between limestone hills in the eastern part of the Area. Included in mapping are small areas of Ruidoso, Kuma, and Jarita soils. Included soils make up less than 15 percent of the mapping unit.

Runoff is medium. The hazard of sheet and gully erosion is moderate. The soil is used for livestock grazing and wildlife. Clayey range site 2Cy; wildlife habitat group A.

Rock Land

Rock land (RD) consists of very shallow, slightly eroded, steep and very steep soils on hillsides, many rock outcrops, areas that are so stony and bouldery that the soil material cannot be identified, and areas of rubble land that are mostly stones and boulders. The rock is fine-grained igneous rock, limestone, and sandstone. Along the western edge is interbedded soft gypsum. Slopes are 55 to 75 percent. The elevation is 5,700 to 7,000 feet. The vegetation is a sparse stand of short

and mid grasses, forbs, shrubs, and scattered pinyon pine and juniper. The mean annual precipitation is 11 to 17 inches, mean annual air temperature is 45° to 57° F., and the frost-free season is 140 to 160 days.

Included with Rock land in mapping are small areas of Deama, Oro Grande, and Pinkel soils. These included soils make up about 15 percent of the mapping unit.

Runoff is rapid, and the erosion hazard is slight. Rock land is used for watershed, wildlife, and recreation and for limited grazing along bordering areas. Rough Broken range site 1RB, 2RB; wildlife habitat group E.

Rock Land, Cool

Rock land, cool (RE) consists of very shallow, slightly eroded, steep and very steep soils on mountainsides, many rock outcrops, areas that are so stony and bouldery that the soil material cannot be identified, and areas of rubble land that are mostly stones and boulders. The rock is fine-grained, acid igneous rock, limestone, and sandstone. Slopes are 55 to 75 percent. The elevation is 6,700 to 10,000 feet. The vegetation is a sparse stand of mid and tall grasses, forbs, shrubs, and scattered ponderosa pine, mixed conifers, and aspen. The mean annual precipitation is 17 to 24 inches, mean annual air temperature is 38° to 45° F., and the frost-free season is 80 to 110 days.

Included with Rock land, cool, in mapping are small areas of Firo, Peso, Caballo, Mescalero, and Gaines soils. These included soils make up about 15 percent of the mapping unit. Small springs and mountain streams are common.

Runoff is rapid, and the erosion hazard is slight. Rock land, cool, is used for watershed, wildlife, and recreation and for limited grazing along bordering areas. It also has esthetic value. Rough Broken range site 3RB, 4RB; wildlife habitat group G.

Rock Outcrop

Rock outcrop consists of exposures of bare bedrock or areas where less than 4 inches of soil material is over bedrock. It occurs on steep and very steep ridgetops, side slopes, and breaks on hills and mountains. Slopes are 12 to 75 percent, and nearly vertical cliffs are common. The elevation is 5,900 to 6,900 feet where Rock outcrop occurs with Oro Grande soils and 11,000 to 12,000 feet where it occurs with Supervisor soils. The vegetation is sparse. The mean annual temperature and frost-free season are comparable to those of the Oro Grande and Supervisor series.

Rock outcrop is more than 90 percent fine-grained, acid igneous bare bedrock or less than 4 inches of soil material over the bedrock. Fissures and cracks in the bedrock are filled with soil material and support some vegetation. Roots effectively penetrate these cracks where soil and moisture conditions are favorable.

Rock outcrop is used for watershed, wildlife, and recreation at higher elevations, and for limited grazing in areas accessible to livestock. It also has esthetic value.

Rock outcrop-Oro Grande complex, very steep (RG).—This complex is about 40 percent Rock outcrop and 40 percent Oro Grande soil. Rock outcrop is on narrow ridgetops and very steep side slopes, along breaks,

and near vertical cliffs. The moderately steep to steep Oro Grande soil is in saddles and on side slopes.

Included with this unit in mapping are areas of stony rock land and stony colluvial land. Included areas make up about 10 percent each of the mapping unit.

Runoff is rapid. The hazard of sheet erosion is slight where soil material occurs. This unit is used mainly for watershed, wildlife, and limited grazing of livestock. It also has esthetic value. Steep Very Shallow range site 1SVS; wildlife habitat group C.

Rock outcrop-Supervisor complex, very steep (RK).—This complex is about 60 percent Rock outcrop and 25 percent Supervisor very stony sandy loam. Rock outcrop is on narrow ridges, mountain peaks, and very steep side slopes and near vertical cliffs. The moderately steep to steep Supervisor soil is in saddles and on side slopes. Rock outcrop is similar to the Rock outcrop described under that heading, but is steeper.

Included with this unit in mapping are areas of rubble land and rockslides that make up about 10 percent of the mapping unit. Also included are areas of Blanca soils that make up about 5 percent.

Runoff is rapid. The hazard of water erosion is moderate. This unit is used mainly for watershed, wildlife, and recreation, chiefly skiing. It also has esthetic value. Rough Broken range site 5RB; wildlife habitat group G.

Ruidoso Series

The Ruidoso series consists of deep, well-drained soils on fans and valley fills. These soils formed in old alluvium derived from mixed sedimentary and igneous rocks. Slopes are 1 to 8 percent. The elevation is 5,600 to 6,900 feet. The vegetation is mainly short and mid grasses, cholla, and yucca. The mean annual precipitation is 11 to 15 inches, mean annual air temperature is 52° to 57° F., and the frost-free season is 140 to 160 days.

In a representative profile the surface layer is dark grayish-brown silty clay loam and clay loam about 15 inches thick. The subsoil is dark grayish-brown, brown, and reddish-brown heavy clay loam that extends to a depth of 64 inches. The soil is neutral in the surface layer and upper part of the subsoil and mildly alkaline in the lower part of the subsoil. Few, fine, irregularly shaped, soft masses of lime occur in seams below a depth of about 48 inches.

Ruidoso soils are slowly permeable. Available water holding capacity is 10 to 12 inches. Roots can easily penetrate to a depth of 60 inches.

These soils are used for livestock grazing and wildlife.

Representative profile of Ruidoso clay loam, 1 to 8 percent slopes, in Otero County; about one-fourth mile south of west side of Red Lake on east side of large gully that runs north and south in sec. 9, T. 13 S., R. 16 E.

A11—0 to 3 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine, granular structure; slightly hard, friable moist, sticky and slightly plastic wet; many fine roots; common fine interstitial and tubular pores; neutral; clear, smooth boundary.

A12—3 to 15 inches, dark grayish-brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; mod-

erate, fine, subangular blocky structure; slightly hard, friable moist, sticky and plastic wet; common fine roots; common fine interstitial and tubular pores; neutral; clear, smooth boundary.

B21t—15 to 28 inches, dark grayish-brown (10YR 4/2) heavy clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, friable moist, sticky and plastic wet; common fine roots; common fine interstitial pores and few fine tubular pores; very thin clay films on faces of peds and in pores and old root channels; neutral; clear, smooth boundary.

B22t—28 to 48 inches, brown (7.5YR 4/2) heavy clay loam, dark brown (7.5YR 3/2) moist; moderate, medium, prismatic structure parting to strong, medium, angular and subangular blocky; hard, friable moist, sticky and plastic wet; few fine roots; common fine interstitial pores and few fine tubular pores; common thin clay films on faces of peds and in old root channels; mildly alkaline; clear, smooth boundary.

B3ca—48 to 64 inches, reddish-brown (5YR 4/3) heavy clay loam, dark reddish brown (5YR 3/3) moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, friable moist, sticky and plastic wet; few roots in upper 10 inches; few fine interstitial and tubular pores; few, fine, irregularly shaped, soft masses of lime in seams; moderately calcareous; mildly alkaline.

The solum is more than 40 inches thick. The dark-colored upper part of the profile, which is more than 1 percent organic matter, ranges from 20 to 40 inches in thickness. The A and B2t horizons range from neutral to mildly alkaline.

The A and B21t horizons have hue of 7.5YR or 10YR, value of 3 or 4 dry and 2 or 3 moist, and chroma of 2 or 3 dry or moist. The B22t horizon has hue of 5YR to 10YR, value of 3 to 5 dry and 2 to 4 moist, and chroma of 2 to 4 dry or moist. The B horizon is clay loam to clay that is 35 to 50 percent clay. The B3ca horizon has hue of 5YR to 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 3 or 4 dry or moist.

Ruidoso soils are closely associated with Gabaldon, Kuma, and Remunda soils. They contain more clay in the B horizon than Kuma or Gabaldon soils. They are dark colored to a greater depth than Remunda soils.

Ruidoso clay loam, 1 to 8 percent slopes (RU).—This soil is mainly on the floors of narrow valleys and on the sides of broad valleys between limestone hills in the eastern part of the Area. Included in mapping are small areas of Remunda, Kuma, and Jarita soils. Also included, on the lower valley floor in the northwestern part of the Area, are small areas of soil that have less clay in the subsoil than is typical for the series. Included soils make up less than 15 percent of the mapping unit.

Runoff is medium. The hazard of sheet and gully erosion is moderate. The soil is used for livestock grazing and wildlife. Clayey range site 1Cy; wildlife habitat group A.

Shanta Series

The Shanta series consists of deep, well-drained soils on fans and valley fills. These soils formed in recent alluvium derived from mixed sedimentary and igneous rocks. Slopes are 1 to 8 percent. The elevation is 5,400 to 6,500 feet. The vegetation is mainly short and mid grasses, cholla, mesquite, yucca, cactus, and scattered pinyon pine and juniper. The mean annual precipitation is 12 to 15 inches, mean annual air temperature

is 45° to 57° F., and the frost-free season is 140 to 160 days.

In a representative profile the surface layer is brown loam about 23 inches thick. The substratum is brown light sandy clay loam to a depth of about 50 inches. Below this, to a depth of 60 inches, it is stratified coarse sand and gravel. The surface layer is mildly alkaline, and the substratum is moderately alkaline. The substratum has a few, fine, faint, soft blotches of lime.

Shanta soils are moderately permeable. Available water holding capacity is 7.5 to 9 inches. Roots can easily penetrate to a depth of 50 inches.

These soils are used mainly for livestock grazing and wildlife.

Representative profile of Shanta loam, 1 to 8 percent slopes, in Otero County; about 1,000 feet east of west boundary of Mescalero-Apache Indian Reservation and 800 feet south of entrance road, about 1,000 feet east of northwest corner of SW $\frac{1}{4}$ sec. 8, T. 11 S., R. 10 E.

A11—0 to 9 inches, brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak, fine, granular structure; soft, very friable moist; common fine and medium roots; common fine interstitial and tubular pores; 5 percent gravel; calcareous; mildly alkaline; gradual, smooth boundary.

A12—9 to 23 inches, brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak, moderate and coarse, subangular blocky structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; common fine and medium roots; few medium and fine interstitial pores and few fine tubular pores; 10 percent gravel and cobbles; slightly calcareous; mildly alkaline; gradual, smooth boundary.

C1—23 to 50 inches, brown (10YR 5/3) light sandy clay loam that has thin layers of silt loam and sand and gravel, dark brown (10YR 3/3) moist; massive; slightly hard, friable moist, slightly sticky and slightly plastic wet; few fine and medium roots to a depth of 36 inches, few coarse roots below; few fine and medium interstitial pores; 10 percent gravel and cobbles; lime disseminated and segregated as few, fine, faint blotches; moderately calcareous; moderately alkaline; diffuse, irregular boundary.

IIC2—50 to 60 inches, coarse sand and gravel.

The soil ranges from mildly alkaline to moderately alkaline. Lime ranges from disseminated throughout to common soft concretions, mottles, and mycelia in the lower part of the profile.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 dry and 2 or 3 moist, and chroma of 2 or 3 dry or moist. The organic-matter content ranges from 1 to 3 percent in this horizon. It decreases irregularly with increasing depth. The C horizon has hue of 7.5YR or 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 3 to 5 dry or moist. The entire profile is stratified loam, clay loam, sandy clay loam, sandy loam, and gravelly sandy loam that is 18 to 35 percent clay. The content of coarse fragments ranges from 5 to 20 percent.

Shanta soils are similar to Gabaldon soils. In contrast with those soils, they are more than 15 percent material coarser than very fine sand in the B horizon.

Shanta loam, 1 to 8 percent slopes (SH).—This soil is in recent valley fills, mainly in the northwestern part of the Area. Included in mapping are small areas of Gabaldon, Kuma, and Ruidoso soils. Also included are areas of a soil that is as much as 30 percent gypsum. Included soils make up less than 45 percent of the mapping unit.

Runoff is medium. The hazard of sheet and gully erosion is moderate. The soil is used mainly for live-

stock grazing and wildlife. Loamy range site 1Lo; wildlife habitat group A.

Supervisor Series

The Supervisor series consists of moderately deep, well-drained soils on high mountainsides. These soils formed in highly weathered and shattered, fine-grained, acid igneous rocks. Slopes are 12 to 65 percent. The elevation is 11,000 to 12,000 feet. The vegetation is mainly mid and tall grasses, forbs, shrubs, and scattered dwarfed spruce trees. The mean annual precipitation is 26 to 30 inches, mean annual air temperature is 36° to 40° F., and the frost-free season is 50 to 70 days.

In a representative profile the surface layer is brown very stony sandy loam about 6 inches thick. The next layer is about 10 inches of brown very cobbly sandy loam. The substratum is yellowish-brown very cobbly sandy loam about 8 inches thick. Acid igneous bedrock is at a depth of about 24 inches. The soil is slightly acid throughout.

Supervisor soils are moderately rapidly permeable. Available water holding capacity is 1 inch to 3 inches. Roots easily penetrate as far down as bedrock.

These soils are used for recreation, chiefly skiing, and for wildlife and watershed. Areas of Supervisor soil also have esthetic value.

Representative profile of Supervisor very stony sandy loam, 12 to 55 percent slopes, in Otero County; about 1.2 miles north and 800 feet west of Sierra Blanca Peak on a west-facing slope, about 100 feet west of saddle ridge and 0.28 mile southeast of Ski Lookout Vista, near northeast corner of NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 11 S., R. 11 E.

A1—0 to 6 inches, brown (10YR 4/3) very stony sandy loam, dark brown (10YR 3/3) moist; weak, very fine and fine, granular structure; slightly hard, very friable moist, slightly sticky wet; many fine roots; many fine and very fine interstitial pores; common fine tubular insect burrows; 15 percent angular acid igneous gravel, 25 percent angular cobbles, 15 percent angular stones; slightly acid; clear, wavy boundary.

AC—6 to 16 inches, brown (10YR 5/3) very cobbly sandy loam, dark brown (10YR 3/3) moist; weak, very fine and fine, granular structure; hard, very friable moist, slightly sticky wet; many fine roots; many fine interstitial pores; 15 percent angular acid igneous gravel, 35 percent angular cobbles, 30 percent angular stones; slightly acid; abrupt, wavy boundary.

C—16 to 24 inches, yellowish-brown (10YR 5/4) very cobbly sandy loam, dark yellowish brown (10YR 3/4) moist; few fine roots; 85 to 95 percent highly fractured and weathered bedrock and partly decomposed rock fragments; slightly acid; gradual, wavy boundary.

R—24 inches, acid igneous bedrock; upper 8 inches highly fractured.

The depth to weathered and fractured, fine-grained, acid igneous bedrock ranges from 12 to 30 inches. The depth to solid bedrock ranges from 20 to 40 inches. The soil ranges from neutral to medium acid.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 2 or 3. It is 3 to 10 percent organic matter. The AC horizon is very cobbly and ranges from sandy loam to light sandy clay loam that is 7 to 28 percent clay. The AC and C horizons have hue of 5YR to 10YR, value of 4 or 5 dry and 3 or 4 moist, and chroma of 3 to 5.

Supervisor soils are similar to Blanca soils. They are shallower over bedrock than those soils.

Supervisor very stony sandy loam, 12 to 55 percent slopes (SU).—This soil is on high mountainsides in the northwestern part of the Area. Included in mapping are small areas of Rock land, which make up about 15 percent of the mapping unit. Also included are areas of Blanca soils, which make up about 5 percent.

Runoff is rapid. The hazard of water erosion is moderate. The soil is used mainly for recreation (fig. 8), wildlife, and watershed. Steep Shallow range site 5SSw, 5cSSw; timber group 6; wildlife habitat group F.

Telefono Series

The Telefono series consists of moderately deep, well-drained soils on mountain crests and in saddles. These soils formed in material derived from limestone. Slopes are 3 to 25 percent. The elevation is 7,700 to 10,000 feet. The vegetation is mid and tall grasses, forbs, shrubs, and an overstory of mixed conifers. The mean annual precipitation is 20 to 24 inches, mean annual air tem-

perature is 36° to 41° F., and the frost-free season is 60 to 80 days.

In a representative profile the surface layer is very dark grayish-brown clay loam about 2 inches thick; about 1 inch of partly decomposed leaves, needles, and woody twigs is on the surface. The upper part of the subsoil is about 4 inches of very dark grayish-brown and brown heavy silty clay loam. The lower part of the subsoil is very dark grayish-brown and dark reddish-brown clay between depths of 6 and 14 inches and dark-brown cobbly clay to a depth of 26 inches. The substratum is reddish-brown very cobbly heavy clay loam that contains a few, fine, soft masses of lime. Limestone bedrock is at a depth of 36 inches. The soil is neutral in the surface layer and subsoil and mildly alkaline in the substratum.

Telefono soils are slowly permeable. Available water holding capacity is 4 to 5 inches. Roots effectively penetrate to a depth of 20 to 40 inches.

These soils are used mainly for timber, recreation, wildlife, and watershed. The less wooded areas are grazed to a limited extent.



Figure 8.—Supervisor soils at an elevation of about 11,000 feet. This is an excellent feeding area for elk. Commercial hiking, back-packing, and hunting are sources of income for the Mescalero Agency.

Representative profile of Telefono clay loam, 3 to 8 percent slopes, in Otero County; about one-half mile west-southwest of Telephone Tank on north-facing slope of east Telefono Canyon, near east quarter corner of sec. 5, T. 14 S., R. 13 E.

- O1—1 inch to 0, partly decomposed leaves, needles, and twigs.
- A1—0 to 2 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; many fine roots; many fine interstitial pores and few fine tubular pores; neutral; clear, smooth boundary.
- B21t—2 to 6 inches, very dark grayish-brown (10YR 3/2) and brown (7.5YR 4/2) heavy silty clay loam, very dark brown (10YR 2/2) and dark brown (7.5YR 3/2) moist; moderate, very fine, subangular and angular blocky structure; hard, firm moist, sticky and plastic wet; common fine and medium roots; common fine interstitial pores and few fine tubular pores; common thin clay films on sand grains and in pores; neutral; clear, smooth boundary.
- B22t—6 to 14 inches, very dark grayish-brown (10YR 3/2) and dark reddish-brown (5YR 3/2) clay, very dark brown (10YR 2/2) and dark reddish brown (5YR 2/2) moist; strong, fine, angular and subangular blocky structure; hard, firm moist, sticky and plastic wet; few fine, medium, and coarse roots; few fine interstitial pores; common thin clay films on faces of peds; about 5 percent gravel and cobbles; neutral; clear, wavy boundary.
- B3—14 to 26 inches, dark-brown (7.5YR 3/2) cobbly clay, very dark brown (7.5YR 2/2) moist; moderate, fine, angular and subangular blocky structure; hard, firm moist, slightly sticky and plastic wet; few coarse roots; few fine interstitial pores and medium tubular pores; about 7 percent gravel, 15 percent cobbles, and 7 percent stones; slightly calcareous near limestone fragments; neutral; gradual, wavy boundary.
- C1—26 to 36 inches, reddish-brown (5YR 5/4) very cobbly heavy clay loam, reddish brown (5YR 4/4) moist; moderate, very fine, subangular blocky structure; hard, firm moist, sticky and plastic wet; few coarse roots; common very fine interstitial pores; 85 percent gravel, stones, and cobbles; few fine soft masses of carbonate; slightly calcareous; mildly alkaline; grades into consolidated bedrock.
- R—36 inches, limestone bedrock.

The solum ranges from 16 to 36 inches in thickness. Bedrock is at a depth of 20 to 40 inches. The content of coarse fragments ranges from 5 to 35 percent and increases with increasing depth. The soil ranges from slightly acid in the A and B21t horizons to mildly alkaline in the B22t horizon.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 dry and 2 or 3 moist, and chroma of 1.5 to 3.5 dry or moist. It is 2 to 10 percent organic matter. The B2 horizon has hue of 5YR to 10YR, value of 3 or 4 dry and 2 or 3 moist, and chroma of 1.5 to 3.5. It is heavy silty clay loam, heavy clay loam, or clay that is 35 to 60 percent clay. No carbonates are evident in some places.

Telefono soils are closely associated with Caballo, Peso, and Mescalero soils. They are not so deep over bedrock as Caballo soils. They have cooler summer soil temperatures than Peso and Mescalero soils, and they contain fewer coarse fragments than those soils.

Telefono clay loam, 3 to 8 percent slopes (TC).—This soil is mainly on mountain ridges and in saddles in the south-central part of the Area. It formed mainly in material weathered from limestone. It has the profile described as representative of the series.

Included in mapping are small areas of Mescalero, Peso, and Caballo soils and stony rock land. Included areas make up about 15 percent of the mapping unit.

Runoff is medium. The hazard of sheet and gully

erosion is moderate. The soil is used mainly for timber, recreation, wildlife, and watershed. Less wooded areas are grazed to a limited extent. Clayey range site 4dCy; timber group 5; wildlife habitat group F.

Telefono clay loam, 8 to 25 percent slopes (TE).—This soil is mainly on mountain ridges, in saddles, and on upper sides in the south-central part of the Area. It formed mainly in material weathered from limestone. Included in mapping are areas of Caballo, Peso, and Mescalero soils and Rock outcrop. Included areas make about 15 percent of the mapping unit.

Runoff is medium. The hazard of sheet and gully erosion is severe. The soil is used for timber, recreation, wildlife, and watershed. Less wooded areas are grazed to a limited extent. Clayey range site 4cCy, 4dCy; timber group 5; wildlife habitat group F.

Terrace Escarpments

Terrace escarpments (TR) are along breaks and terrace fronts, principally in the extreme northwestern part of the Area. The terrace face is broken by numerous intermittent drainage channels. Differences in elevation are mainly 50 to 200 feet. In many places fine- to coarse-textured stratified alluvium is exposed. In some it is capped by a thin mantle of colluvial material. About 20 percent of the exposed areas are cobbles and stones. Slopes are 12 to 55 percent. The elevation is 5,600 to 6,900 feet. The vegetation is short and mid grasses, yucca, mesquite, cholla, and scattered oak brush, pinyon pine, and juniper. Numerous areas are barren. The mean annual precipitation is 11 to 15 inches, mean annual air temperature is 50° to 70° F., and the frost-free season is 140 to 160 days.

Terrace escarpments is about 15 percent Rock land, 5 percent gullied land, and 10 percent soils that are shallow over interbedded gypsum.

Runoff is rapid, and the hazard of water erosion is severe. Terrace escarpments is used mainly for livestock grazing, wildlife, and watershed. Steep Very Shallow range site 1SVS; wildlife habitat group C.

Tularosa Series

The Tularosa series consists of deep, well-drained soils in narrow, high mountain valleys. These soils formed in alluvium that was derived from mixed acid igneous and sedimentary rocks, mainly limestone. Slopes are 1 to 12 percent. The elevation is 7,700 to 9,500 feet. The vegetation is mainly mid and tall grasses, forbs, shrubs, and scattered mixed conifers. The mean annual precipitation is 20 to 24 inches, mean annual air temperature is 37° to 45° F., and the frost-free season is 70 to 90 days.

In a representative profile the surface layer is dark-gray silty clay loam about 9 inches thick. The subsoil is about 22 inches of dark-gray light clay loam. The substratum is dark-gray, stratified clay and clay loam that extends to a depth of 60 inches. The soil is mildly alkaline throughout.

Tularosa soils are moderately slowly permeable. Available water holding capacity is 10 to 12 inches. Roots can easily penetrate to a depth of 60 inches.

These soils are used for livestock grazing, recreation, and wildlife.

Representative profile of Tularosa silty clay loam, 1 to 12 percent slopes, in Otero County; in southwest corner of NE $\frac{1}{4}$ sec. 16, T. 15 S., R. 13 E.

A1—0 to 9 inches, dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist, very dark brown (10YR 2/2) rubbed and moist; moderate, fine and very fine, granular structure; slightly hard, friable moist, slightly sticky and slightly plastic wet; many fine roots; many fine interstitial pores; mildly alkaline; clear, wavy boundary.

B2—9 to 31 inches, dark-gray (10YR 4/1) light clay loam, very dark brown (10YR 2/2) moist, very dark grayish brown (10YR 3/2) rubbed and moist; moderate, medium and fine, subangular blocky structure; hard, friable moist, sticky and plastic wet; common fine roots; common fine interstitial pores; 5 percent gravel; mildly alkaline; clear, wavy boundary.

C—31 to 60 inches, dark-gray (10YR 4/1) stratified clay and clay loam, very dark brown (10YR 2/2) moist; weak, coarse and medium, subangular blocky structure; hard, firm moist, sticky and plastic wet; few fine and very fine interstitial pores; 5 percent gravel; slightly calcareous in spots; mildly alkaline.

The solum ranges from 16 to 50 inches in thickness. It is slightly acid to mildly alkaline. The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 dry and 2 or 3 moist, and chroma of 1 or 2. It is 3 to 10 percent organic matter. The B2 horizon has hue of 7.5YR or 10YR, value of 3 or 4 dry and 2 or 3 moist, and chroma of 1 or 2. It ranges from heavy loam to silty clay loam or light clay loam that is 18 to 35 percent clay. The C horizon has hue of 5YR to 10YR, value of 3 to 5 dry and 2 to 4 moist, and chroma of 1 to 3 dry or moist.

Tularosa soils are similar to Hesperus and Brycan soils. In contrast with Hesperus soils, they lack a Bt horizon. The soil temperature is cooler in summer than in Brycan and Hesperus soils.

Tularosa silty clay loam, 1 to 12 percent slopes (TU).

—This soil is in valleys in high mountainous areas, mainly in the south-central part of the Area. Included in mapping are small bogs, springs, and seeps.

Runoff is medium. The hazard of sheet and gully erosion is moderate. The soil is used mainly for livestock grazing, recreation, and wildlife. Clayey range site 4Cy, 4cCy; wildlife habitat group B.

Use and Management of the Soils

Income in the Mescalero-Apache Area is mainly derived from livestock grazing, timber harvesting, and the sale of recreation privileges. The pages that follow describe the management of range of the Area by range sites within vegetative belts, the management of timber by timber groups, and the management for wildlife by wildlife habitat groups.

This part of the survey also explains the system of capability classification and provides information on the suitability of the soils for highways and other engineering structures.

Range Management²

Range sites are distinctive kinds of range that differ in potential for producing native plants. Knowing the plants that are likely to grow best on each site and the

² ELLIS KLETT, range conservationist, helped prepare this section.

kinds and amount of herbage produced is essential to managers of range. The combined effect of soil and climate determines the potential forage production on each site. Management determines how much of the potential is actually produced.

The Mescalero-Apache Area is divided into vegetative belts, each of which has two or more range sites. Belt 1, the warmest and at the lowest elevation, receives the least precipitation. Belt 5, the coldest and at the highest elevation, receives the most precipitation. Differences in climate are enough to influence the kind and amount of vegetation.

Figure 9 is a map of the Area that shows the general pattern of the five vegetative belts. The belts are defined as follows:

Belt 1. Open grassland: Elevation less than 6,000 feet; average annual precipitation 8 to 12 inches.

Belt 2. Grassland and scattered pinyon pine and juniper: Elevation 6,000 to 6,800 feet; average annual precipitation 12 to 16 inches.

Belt 3. Grazed woodland of ponderosa pine: Elevation 6,800 to 8,000 feet; average annual precipitation 16 to 20 inches.

Belt 4. Grazed woodland of mixed conifers: Elevation 8,000 to 11,000 feet; average annual precipitation 20 to 24 inches.

Belt 5. Open grassland and scattered spruce trees: Elevation 11,000 feet and higher; average annual precipitation 14 inches or more.

Range sites and range condition

Soils and climate differ widely in the Mescalero-Apache Area. For this reason there are several different kinds of range, or range sites, in the Area.

Over the centuries, a mixture of plants best suited to growing on each range site has developed. This group of plants is called the potential, or climax, plant community for the site. The climax plant community for a site varies slightly from year to year, but the kinds and amount of plants remain about the same if undisturbed. Range conservationists and soil scientists, working together, group the kinds of soil that naturally grow the same climax plant community into range sites.

The original mixture of plants was so well adapted to the soil and climate of the range site that other kinds of plants could not move in unless an area was disturbed. So consistent is the relation between plants, climate, and soils that the climax plant community can be accurately predicted even on severely disturbed sites if the soil is identified.

Repeated overuse by grazing animals, excessive burning, or plowing results in changes in the kinds, proportions, or amount of climax plants in the plant community. Depending on the kind and degree of disturbance, some kinds of plants increase and others decrease. If disturbance is severe, plants that do not belong in the climax plant community may invade. Plant response to grazing use depends on the kind of grazing animal, the season of use, and how closely the plant is grazed. If good management follows disturbance, however, the climax plant community is gradually reestablished unless the soil has been severely eroded.

The plants on a given site are grouped, according

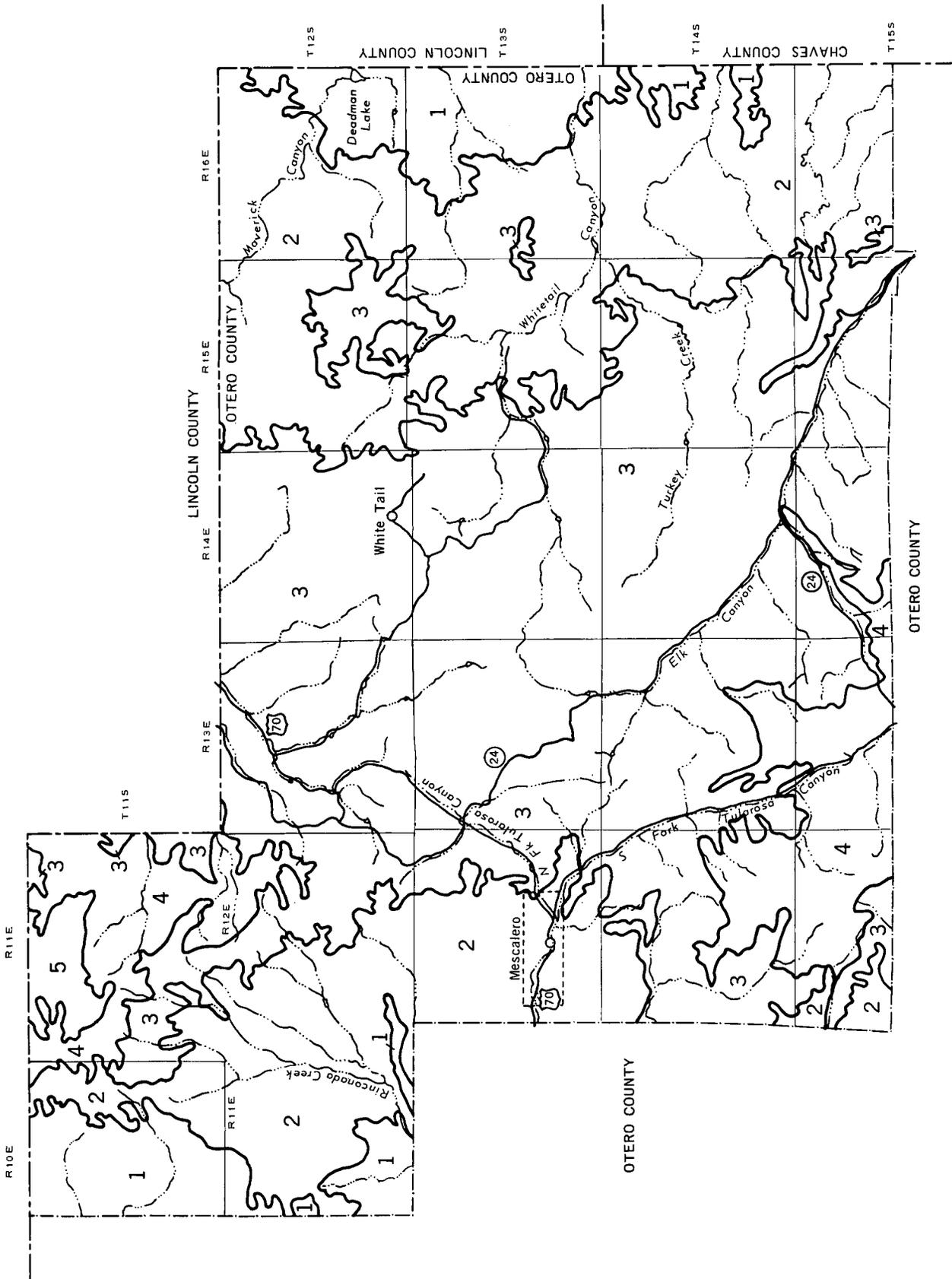


Figure 9.—Vegetative belts in the survey area. They are defined in the text.

to their response to grazing, as decreaseers, increaseers, and invaders. Decreaseers are plants in the potential plant community that tend to die out if they are heavily grazed. They are generally the most palatable and productive perennials. Increaseers are plants that become more abundant as the decreaseers decline. They are generally the shorter, less productive, and less palatable plants. Invaders are plants that become established if both decreaseers and increaseers decline.

Range condition is an expression of how the present plant community compares with the climax plant community for the range site. The more nearly the present kinds and amount of plants are like the climax plant mixture, the higher the range condition.

The present range condition provides an index to changes that have taken place in the plant community. More important, however, range condition is a basis for predicting the kinds and amount of changes in the present plant community that can be expected from management and treatment. Thus, the range condition rating indicates the nature of the present plant community, and the climax cover for the range sites represents a goal toward which range management may be directed.

Knowledge of the climax plant communities of range sites and the nature of present communities as compared with the potential is important in planning and applying conservation on rangeland. Such information is the basis for selecting management objectives, designing grazing systems, managing for wildlife, determining potential for recreation, and rating watershed conditions.

Any management objective on range must provide for a plant cover that adequately protects or improves the soil and water resources and meets the needs of the operator. This usually involves increasing desirable plants and restoring the plant community to near-climax condition. Sometimes, however, a plant cover somewhat below climax is better suited to specific grazing needs, provides better wildlife habitat, or furnishes other benefits while still protecting the soil and water resources.

Most of the Mescalero-Apache Area is range or grazed woodland. The areas within vegetative belts 1 and 2 can be grazed mostly throughout the year, because winter is generally mild and accumulated snow remains on the ground for only a short period.

Livestock are mainly cows, calves, and yearlings. The size of pastures ranges from a few to several sections.

For effective planning of range management, it is necessary to know both the present condition and the trend, that is, whether the condition is improving or deteriorating.

The total suggested stocking rate for the Area at current range condition and under present development is 77,313 animal-unit-months (12).

Grazing management

Good range management increases production of the best native forage plants and conserves soil and water.

Proper grazing use is of primary importance. Without it, all other practices are ineffective. Most of the nutrients that plants need in order to grow, flower, and reproduce are manufactured in the foliage. Live-

stock seek out the most palatable plants first. If they eat more than half the yearly growth, the plants cannot compete successfully with the less desirable plants, and the range deteriorates. The amount of vegetation left on the surface and the amount of live roots in the soil are comparable. In addition, more vegetation left on the surface increases the water-intake rate, improves the available water holding capacity, and helps control erosion.

Deferred grazing, or excluding livestock from native grassland during all or part of the growing season, gives desirable plants a chance to grow, seed, and reproduce. The vegetation on some sites responds to this practice more quickly than others. Gravelly and stony soils show more improvement with deferment than loamy and clayey soils.

A planned grazing system, or alternately resting and grazing parts of a range throughout a growing season, gives the vegetation in all parts a chance to renew plant vigor, build plant food reserves in the roots, and reproduce.

Fencing the range into effective management units makes it easier to keep livestock evenly distributed. Fences should follow range site or vegetative type boundaries as much as possible, so that areas of different potential are separated for better range management.

Water development is essential. An ample supply of good-quality water at suitable locations helps keep livestock evenly distributed over the range. In many parts of the Area the supply of water from existing wells, springs, or ponds is not adequate. Pipelines to additional areas have been effective. Seeps and springs in mountainous areas have some potential for further development.

Water spreading diverts runoff from natural channels or gullies and spreads it over nearly level areas. Earthen diversions, net wire diversions, and rock and brush dams have been used. Water spreading is most effective where the soil is deep enough to hold a large amount of water where the surface layer absorbs water quickly.

Contour furrowing and pitting help control runoff and floodwater and thereby control erosion and increase infiltration. These practices are most effective on deep, fine-textured soils. If competing perennials are not present, seeding to adapted species in conjunction with pitting may help establish desirable vegetation and hasten improvement of the range.

Range seeding with native or adapted introduced species increases the yield of herbage and helps control erosion and conserve moisture on areas that are depleted or in poor condition. Seeding is difficult at the lower elevations because of the dry climate, and seeding failure is common. Stands are more easily established on the medium-textured and coarse-textured soils.

Brush management, or controlling or suppressing cholla, pinyon pine, juniper, and other nonforage-producing shrubs, increases the amount of moisture available to forage plants. Brush management is more practical where the soils are deep or moderately deep and nearly level or gently sloping. Steep soils are more susceptible to erosion if cleared.

Descriptions of range sites

The soils of the Mescalero-Apache Area have been grouped by vegetative belts into eight range sites. In addition, some sites within vegetative belts 2 to 5 are also grouped according to canopy cover.

In the range site symbols used by the Bureau of Indian Affairs, the Arabic number indicates the vegetative belt. The lowercase letter *a*, *b*, *c*, or *d*, which sometimes follows numbers 2 to 5, pertains to the woodland canopy cover: *a* means 10 to 39 percent pinyon pine and juniper; *b* means 40 to 69 percent pinyon pine and juniper; *c* means 10 to 39 percent ponderosa pine, mixed conifers, or both; and *d* means 40 to 69 percent ponderosa pine, mixed conifers, or both. The remaining letters in the symbol indicate the name of the range site, such as CI for Clayey or RB for Rough Broken.

Each description mentions important soil characteristics, principal plants, and estimated yields and suggests management. The estimated yields represent grasses, forbs, and browse. See table 2 for estimated yields of usable herbage grown on each soil, by range site.

To find the range site to which each soil has been assigned and the page on which it is described, turn to the Guide to Mapping Units near the back of this publication.

CLAYEY RANGE SITE

This range site consists of moderately deep to deep, well-drained soils. These soils have a surface of silt loam, silty clay loam, or clay loam and are underlain by silty clay loam, clay loam, silty clay, or clay. Slope ranges from 1 to 25 percent. Permeability is moderately slow to slow, and the available water holding capacity is 4 to 12 inches.

CLAYEY RANGE SITE 1Cy receives 11 to 15 inches of precipitation and is at elevations of 5,600 to 6,900 feet. Southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is mid and short grasses. The most abundant decreaseers are side-oats grama, black grama, bluestem, vine-mesquite, and western wheatgrass. The most abundant increaseers are blue grama, wolftail, ring muhly, and galleta. If the range is in poor condition, it is dominated by ring muhly, broom snakeweed, mesquite, yucca, cholla, cactus, junipers, and annuals.

In order of importance, the grazing management practices on this site are fencing, planning grazing systems, proper grazing use, range seeding, water spreading, brush management, contour furrowing and pitting, deferred grazing, and water development. One or more is needed.

If the range is in excellent condition, the air-dry weight of annual growth is about 1,520 pounds per acre in favorable years and 550 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

CLAYEY RANGE SITE 2Cy receives 12 to 17 inches of precipitation and is at elevations of 5,600 to 7,000 feet. Only southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is mid and short grasses. The most abundant decreaseers are side-oats grama, black grama, bluestem, vine-mesquite, plains bristlegrass, Indian ricegrass, winter-

fat, and western wheatgrass. The most abundant increaseers are blue grama, galleta, wolftail, ring muhly, and dropseed. If the range is in poor condition, it is dominated by cholla, cactus, yucca, pinyon pine, and juniper.

In order of importance, the grazing management practices on this site are brush management, fencing, proper grazing use, range seeding, water spreading, contour furrowing and pitting, deferred grazing, planned grazing systems, and water development. One or more is needed.

If the range is in excellent condition, the air-dry weight of annual growth is about 1,600 pounds per acre in favorable years and 600 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

CLAYEY RANGE SITE 3Cy receives 18 to 22 inches of precipitation and is at elevations of 6,800 to 8,200 feet. Northern exposures are at the lower elevations, and southern exposures are on ridgetops at the higher elevations.

If the range is in excellent condition, the plant cover is mid and tall grasses. The most abundant decreaseers are Arizona fescue, bluestem, mountain muhly, and western wheatgrass. The most abundant increaseers are blue grama, bottlebrush squirreltail, perezia, and ring muhly. Where the range is in poor condition, it is invaded by Kentucky bluegrass, sleepygrass, broom snakeweed, oak brush, and annuals.

Practical range management includes one or more of the following: brush management, deferred grazing, planned grazing systems, range seeding, water spreading, contour furrowing and pitting, fencing, proper grazing use, and water development.

If the range is in excellent condition, the air-dry weight of annual growth is about 1,840 pounds per acre in favorable years and 600 pounds in unfavorable years (fig. 10). Approximately 90 percent of this is forage for cattle.

CLAYEY RANGE SITE 3cCy receives 17 to 22 inches of precipitation and is at elevations of 6,800 to 8,400 feet. Northern exposures are at the lower elevations, and southern exposures are on ridgetops at the higher elevations.

If the range is in excellent condition, the plant cover is a 10- to 39-percent canopy cover of ponderosa pine and mid and tall grasses. The most abundant decreaseers are Arizona fescue, little bluestem, big bluestem, mountain muhly, pine dropseed, and western wheatgrass. The most abundant increaseers are blue grama, bottlebrush squirreltail, ring muhly, and oak brush. Where the range is in poor condition, it is invaded by Kentucky bluegrass, sleepygrass, broom snakeweed, oak brush, and annuals.

Practical range management includes one or more of the following: brush management, deferred grazing, planned grazing systems, water development, proper grazing use, contour furrowing and pitting, fencing, range seeding, and water spreading.

If the range is in excellent condition, the air-dry weight of annual growth is about 650 pounds per acre in favorable years and 200 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

CLAYEY RANGE SITE 3dCy receives 17 to 22 inches of

TABLE 2.—Estimated annual yields of grasses, forbs, and browse on range in excellent condition

[Data on range sites, yields, and vegetative types supplied by Bureau of Indian Affairs, Mescalero. The symbol < means less than]

Symbol	Soil	Range site		Yields per acre ¹	
		Name	Symbol	Favorable years	Unfavorable years
				Lb	Lb
AR	Arosa silty clay loam, 1 to 12 percent slopes -----	Clayey.	3Cy	1,840	600
			3cCy	650	200
BM	Blamer very stony loam, 12 to 55 percent slopes -----	Steep Shallow.	3cSSw	580	190
			3dSSw	170	<75
BN	Blanca stony sandy loam, 25 to 55 percent slopes -----	Steep.	5St	1,530	650
BR	Brycan loam, 3 to 25 percent slopes -----	Loamy.	3Lo	1,920	630
			3cLo	640	200
BS	Brycan silty clay loam, 3 to 25 percent slopes -----	Clayey.	3Cy	1,840	600
			3cCy	650	200
			3dCy	360	125
CA	Caballo clay loam, 25 to 55 percent slopes -----	Steep.	4cSt	530	185
			4dSt	310	110
CB	Caballo loam, 3 to 25 percent slopes -----	Loamy.	4Lo	1,880	600
CD	Caballo loam, 25 to 55 percent slopes -----	Steep.	4St	1,510	500
DA	Deama very stony loam, 1 to 12 percent slopes -----	Limestone.	1Li	875	175
			2Li	875	175
			2aLi	410	90
DE	Deama very stony loam, 12 to 55 percent slopes -----	Steep Shallow.	2SSw	620	210
			2aSSw	410	90
FR	Firo very stony loam, 12 to 55 percent slopes -----	Steep Shallow.	3cSSw	580	190
			3dSSw	170	<75
FS	Firo-Stony land complex, 12 to 55 percent slopes -----	Steep Shallow.	4cSSw	450	180
			4dSSw	150	75
GA	Gabaldon loam, 1 to 8 percent slopes -----	Loamy.	2Lo	1,660	600
			2aLo	600	200
GC	Gaines silty clay loam, 1 to 25 percent slopes -----	Clayey.	3cCy	650	200
			3dCy	360	125
GE	Gaines clay loam, thin surface variant, 12 to 55 percent slopes.	Steep Shallow.	3cSSw	580	190
			3dSSw	170	<75
HT	Hesperus-Tularosa association, strongly sloping -----	Loamy.	3Lo	1,920	630
			3cLo	640	200
JR	Jarita-Remunda association, gently sloping -----	Clayey.	2Cy	1,660	600
KU	Kuma loam, 1 to 8 percent slopes -----	Loamy.	2Lo	1,660	600
			2aLo	600	200
LM	Limestone rock land -----	Steep Very Shallow.	1SVS	440	100
			2SVS	530	150
ME	Mescalero stony silty clay loam, 3 to 12 percent slopes.	Limestone.	3Li	1,000	400
			3cLi	450	200
OR	Oro Grande-Rock land complex, 12 to 55 percent slopes.	Steep Shallow.	2SSw	620	210
			2aSSw	410	90
PA	Pena-Irock association, strongly sloping: Pena part -----	Loamy.	2Lo	1,660	600
	Irock part -----	Steep Gravelly.	2SGr	710	230
			2aSGr	430	150
PB	Peso very cobbly clay loam, 12 to 55 percent slopes --	Steep Shallow.	3cSSw	580	190
			3dSSw	170	<75
PC	Peso-Caballo association, steep -----	Steep Shallow.	4cSSw	450	180
			4dSSw	150	75
PK	Pinkel very cobbly loam, 12 to 55 percent slopes -----	Steep Shallow.	2SSw	620	210
			2aSSw	410	90
RC	Remunda silty clay loam, 1 to 12 percent slopes -----	Clayey.	2Cy	1,660	600
RD	Rock land -----	Rough Broken.	1RB	² 150-250	² 50-100
			2RB	² 150-250	² 50-100
			3RB	² 250-500	² 100-200
RE	Rock land, cool -----	Rough Broken.	4RB	² 250-500	² 100-200
RG	Rock outcrop-Oro Grande complex, very steep -----	Steep Very Shallow.	1SVS	440	100
RK	Rock outcrop-Supervisor complex, very steep -----	Rough Broken.	5RB	² 700	² 225
RU	Ruidoso clay loam, 1 to 8 percent slopes -----	Clayey.	1Cy	1,520	550
SH	Shanta loam, 1 to 8 percent slopes -----	Loamy.	1Lo	1,470	530
SU	Supervisor very stony sandy loam, 12 to 55 percent slopes.	Steep Shallow.	5SSw	800	275
			5cSSw	480	150
TC	Telefono clay loam, 3 to 8 percent slopes -----	Clayey.	4cCy	650	200
			4dCy	200	<75
TE	Telefono clay loam, 8 to 25 percent slopes -----	Clayey.	4dCy	200	<75
TR	Terrace escarpments -----	Steep Very Shallow.	1SVS	440	100
TU	Tularosa silty clay loam, 1 to 12 percent slopes -----	Clayey.	4Cy	1,880	620
			4cCy	650	200

¹ Yields are amounts of forage for grazing livestock, excluding trees and nonusable species.² Yields are usable only by wildlife. Areas are too steep for domestic livestock.



Figure 10.—Arosa silty clay loam, 1 to 12 percent slopes, frequently produces more than 1,800 pounds of usable forage in a year.

precipitation and is at elevations of 6,800 to 8,400 feet. Northern exposures are at the lower elevations, and southern exposures are on ridgetops at the higher elevations.

If the range is in excellent condition, the plant cover consists of a 40- to 69-percent canopy cover of ponderosa pine and mid and tall grasses. The most abundant decreases are fescue, bluestem, mountain muhly, pine dropseed, nodding brome, and western wheatgrass. The most abundant increasers are blue grama, bottlebrush squirreltail, and oak brush. If the range is in poor condition, it is dominated by Kentucky bluegrass, sleepygrass, broom snakeweed, oak brush, undesirable forbs, and annuals.

In order of importance, the grazing management practices on this site are brush management, deferred grazing, planned grazing systems, range seeding, water spreading, contour furrowing and pitting, fencing, proper grazing use, and water development. One or more is needed.

Where the range is in excellent condition, the air-dry weight of annual growth is about 360 pounds per acre in favorable years and 125 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

CLAYEY RANGE SITE 4Cy receives 20 to 24 inches of precipitation and is at elevations of 7,700 to 9,500 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is mid and tall grasses. The most abundant decreases are mountain muhly, fescue, mountain brome, needlegrass, big bluestem, and little bluestem. The most abundant increasers are western wheatgrass, blue grama, snowberry, forbs, and shrubs. Where the range is in poor condition, it was invaded by Kentucky bluegrass, sleepygrass, redtop, oak brush, woody shrubs, and annuals.

In order of importance, the grazing management practices on this site are brush management, deferred grazing, planned grazing systems, range seeding, water spreading, contour furrowing and pitting, fencing, proper grazing use, and water development. One or more is needed.

Where the range is in excellent condition, the air-dry weight of annual growth is about 1,880 pounds per acre in favorable years and 620 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

CLAYEY RANGE SITE 4cCy receives 20 to 24 inches of

precipitation and is at elevations of 7,700 to 10,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

Where the range is in excellent condition, the plant cover is a 10- to 30-percent canopy cover of mixed conifers and mid and tall grasses. The most abundant decreaseers are mountain muhly, fescue, mountain brome, needlegrass, and bluestem. The most abundant increaseers are western wheatgrass, pine dropseed, blue grama, snowberry, forbs, and shrubs. If the range is in poor condition, it is dominated by Kentucky bluegrass, sleepygrass, redbtop, oak brush, woody shrubs, and annuals.

Practical range management includes one or more of the following: brush management, deferred grazing, planned grazing systems, range seeding, water spreading, contour furrowing and pitting, fencing, proper grazing use, and water development.

If range is in excellent condition, the air-dry weight of annual growth is about 650 pounds per acre in favorable years and 200 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

CLAYEY RANGE SITE 4dCy receives 20 to 24 inches of precipitation and is at elevations of 7,700 to 10,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is a 40- to 69-percent canopy cover of mixed conifers and mid and tall grasses. The most abundant decreaseers are mountain muhly, fescue, mountain brome, needlegrass, and bluestem. The most abundant increaseers are western wheatgrass, pine dropseed, blue grama, snowberry, forbs, and shrubs. Where the range is in poor condition, it is invaded by Kentucky bluegrass, sleepygrass, blue grama, redbtop, oak brush, woody shrubs, and annuals.

Practical range management includes one or more of the following: brush management, fencing, planned grazing systems, water development, deferred grazing, proper grazing use, and range seeding after forest fires.

Where the range is in excellent condition, the air-dry weight of annual growth is about 200 pounds per acre in favorable years and less than 75 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

LIMESTONE RANGE SITE

This range site consists of very shallow to moderately deep, well-drained soils. These soils have a surface layer of very stony loam to stony silty clay loam and are underlain by cobbly silty clay loam, very cobbly clay loam, or gravelly loam over limestone. Slope ranges from 1 to 12 percent. Permeability is moderate to moderately slow, and the available water holding capacity is 0.5 to 3.5 inches.

LIMESTONE RANGE SITE 1Li, 2Li receives 12 to 17 inches of precipitation and is at elevations of 5,700 to 6,900 feet. Southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is mid and short grasses. The most abundant decreaseers are side-oats grama, black grama, little bluestem, bush muhly, plains lovegrass, and deergrass. The most abun-

dant increaseers are blue grama, hairy grama, wolftail, mesa dropseed, and galleta. Where the range is in poor condition, it is dominated by yucca, cholla, broom snakeweed, ring muhly, juniper, and annuals.

In order of importance, the grazing management practices on this site are planned grazing systems, water development, deferred grazing, and proper grazing use. One or more is needed.

If the range is in excellent condition, the air-dry weight of annual growth is about 875 pounds per acre in favorable years and 175 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

LIMESTONE RANGE SITE 2aLi receives 15 to 17 inches of precipitation and is at elevations of 5,700 to 6,900 feet. Southern exposures are at the higher elevations.

Where the range is in excellent condition, the plant cover is a 10- to 39-percent canopy cover of pinyon pine and juniper and mid and short grasses. The most abundant decreaseers are side-oats grama, black grama, little bluestem, bush muhly, plains lovegrass, and deergrass. The most abundant increaseers are blue grama, hairy grama, wolftail, pinyon pine, and juniper. Where the range is in poor condition, yucca, cholla, broom snake-weed, ring muhly, pinyon pine, juniper, and annuals are dominant.

Practical range management includes one or more of the following: fencing, proper grazing use, water development, deferred grazing, and planned grazing systems.

If the range is in excellent condition, the air-dry weight of annual growth is about 410 pounds per acre in favorable years and 90 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

LIMESTONE RANGE SITE 3Li receives 18 to 23 inches of precipitation and is at elevations of 7,200 to 9,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations on ridgetops.

If the range is in excellent condition, the plant cover is mid and tall grasses. The most abundant decreaseers are Arizona fescue, mountain muhly, side-oats grama, mountain brome, little bluestem, big bluestem, and pine dropseed. The most abundant increaseers are blue grama, bottlebrush squirreltail, mountain-mahogany, oak brush, and ponderosa pine. If the range is in poor condition, it is dominated by Kentucky bluegrass, sleepygrass, broom snakeweed, and annuals.

Practical range management includes one or more of the following: fencing, proper grazing use, water development, deferred grazing, and planned grazing systems.

If the range is in excellent condition, the air-dry weight of annual growth is about 1,000 pounds per acre in favorable years and 400 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

LIMESTONE RANGE SITE 3cLi receives 18 to 23 inches of precipitation and is at elevations of 7,200 to 9,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations on ridgetops.

If the range is in excellent condition, the plant cover is a 10- to 39-percent canopy cover of ponderosa pine

and mid and tall grasses. The most abundant decreaseers are Arizona fescue, mountain muhly, side-oats grama, mountain brome, little bluestem, big bluestem, and pine dropseed. The most abundant increaseers are blue grama, bottlebrush squirreltail, mountain-mahogany, and oak brush. Where the range is in poor condition, it is invaded by Kentucky bluegrass, sleepygrass, broom snakeweed, and annuals.

In order of importance, the range management on this site includes fencing, proper grazing use, water development, deferred grazing, and planned grazing systems. One or more is needed.

If the range is in excellent condition, the air-dry weight of annual growth is about 450 pounds per acre in favorable years and 200 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

LOAMY RANGE SITE

This range site consists of deep, well-drained soils. These soils have a surface layer of loam, very fine sandy loam, or gravelly loam and are underlain by loam, light clay loam, sandy clay loam, cobbly loam, or very cobbly loam. Slope ranges from 1 to 25 percent. Permeability is moderate to moderately slow, and the available holding capacity is 5 to 12 inches.

LOAMY RANGE SITE 1Lo receives 12 to 15 inches of precipitation and is at elevations of 5,400 to 6,500 feet. Southern exposures are at the higher elevations.

Where the range is in excellent condition, the plant cover is mid and short grasses. The most abundant decreaseers are black grama, side-oats grama, Arizona cottontop, bush muhly, little bluestem, and winterfat. The most abundant increaseers are blue grama, galleta, three-awn, and dropseed. If the site is in poor condition, it is invaded by ring muhly, broom snakeweed, burrograss, cactus, cholla, and annuals.

Practical range management includes one or more of the following: brush management, contour furrowing and pitting, deferred grazing, fencing, planned grazing systems, proper grazing use, range seeding, water development, and water spreading.

If the range is in excellent condition, the air-dry weight of annual growth is about 1,470 pounds per acre in favorable years and 530 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

LOAMY RANGE SITE 2Lo receives 14 to 17 inches of precipitation and is at elevations of 5,700 to 7,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

If this range is in excellent condition, the plant cover is mid and short grasses. The most abundant decreaseers are side-oats grama, silver beardgrass, big bluestem, little bluestem, bush muhly, black grama, and winterfat. The most abundant increaseers are blue grama, galleta, wolftail, three-awn, dropseed, pinyon pine, and juniper. If the site is in poor condition, it is dominated by ring muhly, broom snakeweed, burrograss, cholla, cactus, and annuals.

Practical range management includes one or more of the following: brush management, contour furrowing and pitting, deferred grazing, fencing, planned grazing systems, proper grazing use, range seeding, water development, and water spreading.

If the range is in excellent condition, the air-dry weight of annual growth is about 1,660 pounds per acre in favorable years and 600 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

LOAMY RANGE SITE 2aLo receives 14 to 17 inches of precipitation and is at elevations of 5,700 to 7,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

Where the range is in excellent condition, the plant cover is a 10- to 39-percent canopy cover of pinyon pine and juniper and mid and short grasses. The most abundant decreaseers are side-oats grama, black grama, needle-and-thread, vine-mesquite, Indian ricegrass, and winterfat. The most abundant increaseers are blue grama, galleta, wolftail, three-awn, and dropseed. Some ponderosa pines are at the higher elevations. If the range is in poor condition, it is invaded by ring muhly, broom snakeweed, burrograss, oak brush, cholla, yucca, cactus, and annuals.

Practical range management includes one or more of the following: brush management, contour furrowing and pitting, deferred grazing, fencing, planned grazing systems, proper grazing use, range seeding, water development, and water spreading.

If the range is in excellent condition, the air-dry weight of annual growth is about 600 pounds per acre in favorable years and 200 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

LOAMY RANGE SITE 3Lo receives 18 to 24 inches of precipitation and is at elevations of 6,800 to 9,500 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

Where the range is in excellent condition, the plant cover is mid and tall grasses. The most abundant decreaseers are Arizona fescue, mountain muhly, big bluestem, little bluestem, side-oats grama, and needle-and-thread. The most abundant increaseers are western wheatgrass, blue grama, mat muhly, wolftail, and bottlebrush squirreltail. Where the range is in poor condition, it is dominated by Kentucky bluegrass, sleepygrass, broom snakeweed, oak brush, and annuals.

Practical range management includes one or more of the following: brush management, contour furrowing and pitting, deferred grazing, fencing, planned grazing systems, proper grazing use, range seeding, water development, and water spreading.

If the range is in excellent condition, the air-dry weight of annual growth is about 1,920 pounds per acre in favorable years and 630 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

LOAMY RANGE SITE 3cLo receives 18 to 24 inches of precipitation and is at elevations of 6,800 to 9,500 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is a 10- to 39-percent canopy cover of ponderosa pine and mid and tall grasses. The most abundant decreaseers are Arizona fescue, mountain muhly, big bluestem, little bluestem, side-oats grama, and needle-and-thread. The most abundant increaseers are blue grama, bottlebrush squirreltail, mat muhly, and oak brush. If the range is in poor condition, it is invaded by Kentucky bluegrass,

sleepygrass, broom snakeweed, rabbitbrush, oak brush, pinyon pine, juniper, and annuals.

In order of importance, the grazing management practices on this site are brush management, contour furrowing and pitting, deferred grazing, fencing, planned grazing systems, proper grazing use, range seeding, water development, and water spreading. One or more is needed.

If the range is in excellent condition, the air-dry weight of annual growth is about 640 pounds per acre in favorable years and 200 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

LOAMY RANGE SITE 4Lo receives 20 to 25 inches of precipitation and is at elevations of 7,900 to 10,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

Where the range is in excellent condition, the plant cover is mid and tall grasses. The most abundant decreaseers are mountain muhly, mountain brome, needlegrass, Arizona fescue, and Thurber fescue. The most abundant increaseers are perennial forbs, bottlebrush squirreltail, western wheatgrass, iris, aspen, and some mixed conifers. If the range is in poor condition, it is dominated by Kentucky bluegrass, sleepygrass, redbud, oak brush, woody shrubs, and annuals.

Practical range management includes one or more of the following: brush management, contour furrowing and pitting, deferred grazing, fencing, planned grazing systems, proper grazing use, range seeding, water development, and water spreading.

If the range is in excellent condition, the air-dry weight of annual growth is about 1,880 pounds per acre in favorable years and 600 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

STEEP RANGE SITE

This range site consists of deep, well-drained soils. These soils have a surface layer of clay, loam, or stony sandy loam and a subsoil or underlying horizons of very cobbly loam, cobbly clay loam, or very cobbly sandy loam. Slope ranges from 25 to 55 percent. Permeability is moderate to moderately rapid, and the available water holding capacity is 3 to 6.5 inches.

STEEP RANGE SITE 4St receives 20 to 25 inches of precipitation and is at elevations of 7,900 to 10,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is mid and tall grasses. The most abundant decreaseers are mountain muhly, mountain brome, needlegrass, Arizona fescue, and Thurber fescue. The most abundant increaseers are perennial forbs, shrubs, iris, sedges, aspen, and some mixed conifers. If the range is in poor condition, it is invaded by Kentucky bluegrass, sleepygrass, woody shrubs, and annuals.

Practical range management includes one or more of the following: chemical brush management, deferred grazing, fencing, planned grazing systems, proper grazing use, aerial range seeding, and water development.

If the range is in excellent condition, the air-dry weight of annual growth is about 1,510 pounds per acre in favorable years and 500 pounds in unfavorable

years. Approximately 90 percent of this is forage for cattle.

STEEP RANGE SITE 4cSt receives 20 to 25 inches of precipitation and is at elevations of 7,900 to 10,000 feet. Southern exposures are at the lower elevations.

Where the range is in excellent condition, the plant cover is a 10- to 39-percent canopy cover of aspen and mixed conifers and mid and tall grasses. The most abundant decreaseers are mountain muhly, mountain brome, needlegrass, Arizona fescue, Thurber fescue, and pine dropseed. The most abundant increaseers are perennial forbs, shrubs, iris, sedges, aspen, and mixed conifers. If the range is in poor condition, it is dominated by Kentucky bluegrass, sleepygrass, three-awn, woody shrubs, and annuals.

Practical range management includes one or more of the following: chemical brush management, deferred grazing, fencing, planned grazing systems, proper grazing use, aerial range seeding, and water development.

If the range is in excellent condition, the air-dry weight of annual growth is about 530 pounds per acre in favorable years and 185 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

STEEP RANGE SITE 4dSt receives 20 to 25 inches of precipitation and is at elevations of 7,900 to 10,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is a 40- to 69-percent canopy cover of aspen and mixed conifers and mid and tall grasses. The most abundant decreaseers are mountain muhly, mountain brome, needlegrass, Arizona fescue, Thurber fescue, and pine dropseed. The most abundant increaseers are perennial forbs, shrubs, iris, sedges, aspen, and mixed conifers. If the range is in poor condition, it is invaded by Kentucky bluegrass, sleepygrass, woody shrubs, and annuals.

Practical range management includes one or more of the following: chemical brush management, deferred grazing, fencing, planned grazing systems, proper grazing use, aerial range seeding, and water development.

If the range is in excellent condition, the air-dry weight of annual growth is about 310 pounds per acre in favorable years and 110 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

STEEP RANGE SITE 5St receives 24 to 28 inches of precipitation and is at elevations of 10,000 to 11,500 feet, on both northern and southern exposures.

Where the range is in excellent condition, the plant cover is mostly mid grasses. The most abundant decreaseers are Arizona fescue, Thurber fescue, Alpine fescue, mountain dandelion, and clover. The most abundant increaseers are bluegrass, sedges, Indian paintbrush, perennial shrubs, and spruce trees. If the range is in poor condition, it is dominated by Kentucky bluegrass, woody shrubs, and annuals.

Practical range management includes one or more of the following: chemical brush management, deferred grazing, fencing, planned grazing systems, proper grazing use, aerial range seeding, and water development, mostly the development of springs.

If the range is in excellent condition, the air-dry weight of annual growth is about 1,530 pounds per acre in favorable years and 650 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

STEEP GRAVELLY RANGE SITE

This range site consists of deep, well-drained soils. These soils have a surface layer and subsoil of cobbly sandy loam. Slope ranges from 12 to 55 percent. Permeability is moderate, and the available water holding capacity is 2.5 to 3.5 inches.

STEEP GRAVELLY RANGE SITE 2SGr receives 14 to 17 inches of precipitation and is at elevations of 5,700 to 6,900 feet. Southern exposures are at the higher elevations.

Where the range is in excellent condition, the plant cover is mid and short grasses. The most abundant decreaseers are side-oats grama, black grama, Texas bluestem, plains lovegrass, and bush muhly. The most abundant increaseers are blue grama, galleta, wolftail, ring muhly, sand dropseed, perennial forbs, pinyon pine, and juniper. Where the range is in poor condition, it is invaded by mesquite, cholla, yucca, and annuals.

In order of importance, the grazing management practices for this site are chemical brush management, deferred grazing, fencing, planned grazing systems, proper grazing use, aerial range seeding, and water development. One or more is needed.

If the range is in excellent condition, the air-dry weight of annual growth is about 710 pounds per acre in favorable years and 230 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

STEEP GRAVELLY RANGE SITE 2aSGr receives 14 to 17 inches of precipitation and is at elevations of 5,700 to 6,900 feet. Southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is a 10- to 39-percent canopy cover of pinyon pine and juniper and mid and short grasses. The most abundant decreaseers are side-oats grama, black grama, Texas bluestem, plains lovegrass, bush muhly, bottlebrush squirreltail, needle-and-thread, and pinyon ricegrass. The most abundant increaseers are blue grama, galleta, wolftail, ring muhly, sand dropseed, pinyon pine, and juniper. If the range is in poor condition, it is invaded by mesquite, cholla, yucca, and annuals.

Practical range management includes one or more of the following: chemical brush management, deferred grazing, fencing, planned grazing systems, proper grazing use, aerial range seeding, and water development.

If the range is in excellent condition, the air-dry weight of annual growth is about 430 pounds per acre in favorable years and 150 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

STEEP SHALLOW RANGE SITE

This range site consists of shallow, well-drained soils that are stony loam or very stony loam over bedrock or moderately deep to deep soils that have a surface layer of stony loam, very stony loam, very cobbly loam, very cobbly clay loam, or clay loam and a subsoil or underlying material of very stony loam, very cobbly clay

loam, or very cobbly sandy loam to clay. Slope ranges from 12 to 55 percent. Permeability is moderately rapid to slow, and the available water holding capacity is 0.5 to 6.5 inches.

STEEP SHALLOW RANGE SITE 2SSw receives 12 to 17 inches of precipitation and is at elevations of 5,700 to 6,900 feet. Southern exposures are at the higher elevations.

Where the range is in excellent condition, the plant cover is mid and short grasses. The most abundant decreaseers are side-oats grama, black grama, little bluestem, needle-and-thread, plains lovegrass, and green sprangletop. The most abundant increaseers are blue grama, galleta, wolftail, dropseed, skunkbush sumac, oak brush, perennial forbs, pinyon pine, and juniper. If the range is in poor condition, it is invaded by yucca, cholla, sotol, cactus, ocotillo, broom snakeweed, and shrubs.

Practical range management includes one or more of the following: chemical brush management, deferred grazing, fencing, planned grazing systems, proper grazing use, and water development.

If the range is in excellent condition, the air-dry weight of annual growth is about 620 pounds per acre in favorable years and 210 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

STEEP SHALLOW RANGE SITE 2aSSw receives 12 to 17 inches of precipitation and is at elevations of 5,700 to 6,900 feet. Southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is a 10- to 39-percent canopy cover of pinyon pine and juniper and mid and short grasses. The most abundant decreaseers are side-oats grama, black grama, little bluestem, big bluestem, bush muhly, plains lovegrass, deergrass, and pinyon ricegrass. The most abundant increaseers are blue grama, galleta, wolftail, dropseed, skunkbush sumac, oak brush, perennial forbs, pinyon pine, and juniper. If the range is in poor condition, it is invaded by yucca, cholla, sotol, cactus, ocotillo, broom snakeweed, and shrubs.

Practical range management includes one or more of the following: chemical brush management, deferred grazing, fencing, planned grazing systems, proper grazing use, and water development.

If the range is in excellent condition, the air-dry weight of annual growth is about 410 pounds per acre in favorable years and 90 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

STEEP SHALLOW RANGE SITE 3cSSw receives 17 to 23 inches of precipitation and is at elevations of 6,700 to 9,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is a 10- to 39-percent canopy cover of ponderosa pine and mid and tall grasses. The most abundant decreaseers are side-oats grama, little bluestem, Arizona fescue, mountain muhly, big bluestem, muttongrass, needlegrass, and pine dropseed. The most abundant increaseers are blue grama, bottlebrush squirreltail, oak brush, snowberry, ponderosa pine, pinyon pine, and juniper. Where the range is in poor condition, it is dominated by

Kentucky bluegrass, rabbitbrush, sleepygrass, and annuals.

Practical range management includes one or more of the following: chemical brush management, deferred grazing, fencing, planned grazing systems, proper grazing use, aerial range seeding, and water development.

If the range is in excellent condition, the air-dry weight of annual growth is about 580 pounds per acre in favorable years and 190 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

STEEP SHALLOW RANGE SITE 3dSSw receives 17 to 23 inches of precipitation and is at elevations of 6,700 to 9,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

Where the range is in excellent condition, the plant cover is a 40- to 69-percent canopy cover of ponderosa pine and mid and tall grasses. The most abundant decreaseers are side-oats grama, little bluestem, mountain muhly, muttongrass, pine dropseed, and needlegrass. The most abundant increaseers are blue grama, snowberry, bottlebrush squirreltail, oak brush, wild rose, pinyon pine, juniper, and ponderosa pine. Where the range is in poor condition, it is invaded by Kentucky bluegrass, rabbitbrush, sleepygrass, and annuals.

Practical range management includes one or more of the following: chemical brush management, deferred grazing, fencing, planned grazing systems, proper grazing use, aerial range seeding, and water development.

If the range is in excellent condition, the air-dry weight of annual growth is about 170 pounds per acre in favorable years and less than 75 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

STEEP SHALLOW RANGE SITE 4cSSw receives 17 to 25 inches of precipitation and is at elevations of 6,800 to 10,000 feet. Northern exposures are at the lower elevations, and southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is a 10- to 39-percent canopy cover of mixed conifers and mid and tall grasses. The most abundant decreaseers are Arizona fescue, Thurber fescue, mountain muhly, mountain brome, side-oats grama, Canadian wildrye, and little bluestem. The most abundant increaseers are muttongrass, blue grama, bottlebrush squirreltail, mountain-mahogany, sedges, oak brush, aspens, perennial forbs, and mixed conifers. If the range is in poor condition, it is dominated by Kentucky bluegrass, sleepygrass, brush, and annuals.

Practical range management includes one or more of the following: deferred grazing, fencing, planned grazing systems, proper grazing use, and development of springs.

If the range is in excellent condition, the air-dry weight of annual growth is about 450 pounds per acre in favorable years and 180 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

STEEP SHALLOW RANGE SITE 4dSSw receives 17 to 25 inches of precipitation and is at elevations of 6,800 to 10,000 feet. Northern exposures are at the lower elevations,

and southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is a 40- to 69-percent canopy cover of mixed conifers and mid and tall grasses. The most abundant decreaseers are Arizona fescue, Thurber fescue, mountain muhly, mountain brome, Canadian wildrye, little bluestem, big bluestem, and side-oats grama. The most abundant increaseers are muttongrass, blue grama, bottlebrush squirreltail, mountain-mahogany, sedges, oak brush, aspens, perennial forbs, and mixed conifers. Where the range is in poor condition, it is invaded by Kentucky bluegrass, sleepygrass, brush, and annuals.

In order of importance, the grazing management practices on this site are deferred grazing, fencing, planned grazing systems, proper grazing use, and development of springs. One or more is needed.

If the range is in excellent condition, the air-dry weight of annual growth is about 150 pounds per acre in favorable years and 75 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

STEEP SHALLOW RANGE SITE 5SSw receives 26 to 30 inches of precipitation and is at elevations of 11,000 to 12,000 feet. Northern exposures are at the lower elevations.

Where the range is in excellent condition, the plant cover is mid and short grasses. The most abundant decreaseers are muhly, fescue, needlegrass, tufted hairgrass, mountain brome, and clovers. The most abundant increaseers are native forbs, native shrubs, bluegrasses, blue grama, sedges, and spruce. Where the range is in poor condition, it is invaded by Kentucky bluegrass, timothy, redtop, native shrubs, brush, and annuals.

Practical range management includes one or more of the following: deferred grazing, planned grazing systems, proper grazing use, and water development, mostly the development of springs.

If the range is in excellent condition, the air-dry weight of annual growth is about 800 pounds per acre in favorable years and 275 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

STEEP SHALLOW RANGE SITE 5cSSw receives 26 to 30 inches of precipitation and is at elevations of 11,000 to 12,000 feet. Northern exposures are at the lower elevations.

If the range is in excellent condition, the plant cover is a 10- to 39-percent canopy cover of spruce and mid and short grasses. The most abundant decreaseers are muhly, fescue, needlegrass, tufted hairgrass, mountain brome, and clovers. The most abundant increaseers are native forbs, native shrubs, bluegrasses, blue grama, sedges, and spruce. Where the range is in poor condition, it is dominated by Kentucky bluegrass, timothy, redtop, native shrubs, and annuals.

Practical range management includes one or more of the following: deferred grazing, planned grazing systems, proper grazing use, and water development, mostly the development of springs.

If the range is in excellent condition, the air-dry weight of annual growth is about 480 pounds per acre in favorable years and 150 pounds in unfavorable years. Approximately 90 percent of this, excluding trees, is forage for cattle.

STEEP VERY SHALLOW RANGE SITE

This range site consists of very shallow, well-drained soils over bedrock. These soils have a surface layer of stony loam and a subsoil of very stony clay loam. Slope ranges from 12 to 55 percent. Permeability is moderate, and the available water holding capacity is 1.0 to 2.0 inches.

STEEP VERY SHALLOW RANGE SITE 1SVS receives 11 to 17 inches of precipitation and is at elevations of 5,600 to 6,900 feet. Southern exposures are at the higher elevations.

If the range is in excellent condition, the plant cover is mid and short grasses. The most abundant decreases are side-oats grama, black grama, winterfat, little bluestem, needle-and-thread, western wheatgrass, love-grasses, and fourwing saltbush. The most abundant increasers are blue grama, galleta, wolftail, dropseed, ring muhly, skunkbush sumac, and perennial forbs. If the range is in poor condition, it is invaded by mesquite, yucca, cholla, cactus, ocotillo, oak brush, pinyon pine, and juniper.

Practical range management includes one or more of the following: deferred grazing, fencing, planned grazing systems, proper grazing use, and water development.

If the range is in excellent condition, the air-dry weight of annual growth is about 440 pounds per acre in favorable years and 100 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

STEEP VERY SHALLOW RANGE SITE 2SVS receives 12 to 17 inches of precipitation and is at elevations of 5,700 to 6,900 feet. Southern exposures are at the higher elevations.

The most abundant decreases are side-oats grama, black grama, little bluestem, needle-and-thread, plains lovegrass, and green sprangletop. The most abundant increasers are blue grama, galleta, wolftail, dropseed, ring muhly, skunkbush sumac, perennial forbs, pinyon pine, and juniper. If the range is in poor condition, it is invaded by mesquite, yucca, cholla, cactus, oak brush, ocotillo, and annual weeds.

Practical range management includes one or more of the following: deferred grazing, fencing, planned grazing systems, and proper grazing use.

If the range is in excellent condition, the air-dry weight of annual growth is about 530 pounds per acre in favorable years and 150 pounds in unfavorable years. Approximately 90 percent of this is forage for cattle.

ROUGH BROKEN RANGE SITE

This range site consists of steep to very steep hillsides and mountainsides of Rock outcrop, Stony land, stony colluvial land, rockslides, and small pockets of shallow to deep stony loamy soils. Slope ranges from 25 to 75 percent. Permeability generally is moderate above the bedrock.

ROUGH BROKEN RANGE SITE 1RB, 2RB receives 11 to 17 inches of precipitation and is at elevations of 5,700 to 7,000 feet. Southern exposures are at the higher elevations.

This type of land has vegetation that is used by livestock but also has steep slopes and is inaccessible. The vegetation is forage for wildlife.

The dominant vegetation present for wildlife use includes silver sagebrush, dogwood, Apache plume, wild

rose, mountain-mahogany, squawbush, Wright silk-tassel, desert ceanothus, winterfat, chamiza, oak brush, and many forbs. If the area is abused, it is invaded by such plants as Spanish dagger, cactus, sotol, sacahuista, pinyon pine, and juniper.

Water development, mainly the development of springs, is necessary for practical range management on this site.

If the range is in excellent condition, the air-dry weight of annual growth that is usable by wildlife is about 150 to 250 pounds per acre in favorable years and 50 to 100 pounds in unfavorable years.

ROUGH BROKEN RANGE SITE 3RB, 4RB receives 17 to 24 inches of precipitation and is at elevations of 6,700 to 10,000 feet. Northern exposures are at the lower elevations.

This type of land has vegetation that is used by livestock but also has steep slopes and is inaccessible. The vegetation is forage for wildlife.

The dominant vegetation present for wildlife use includes mountain-mahogany, Gambel oak, snowberry, skunkbush sumac, blueberry elder, chokecherry, currant, gooseberry, serviceberry, bitterbrush, gentian, sedges, perennial forbs, mountain brome, Arizona fescue, pinyon pine, and alligator juniper. If the area is abused, it is invaded by undesirable shrubs, forbs, and annuals.

Water development, mainly the development of springs, is needed for practical range management of this site.

If the range is in excellent condition, the air-dry weight of annual growth that is usable by wildlife is about 250 to 500 pounds per acre in favorable years and 100 to 200 pounds in unfavorable years.

ROUGH BROKEN RANGE SITE 5RB receives 24 to 30 inches of precipitation and is at elevations of 10,000 to 12,000 feet. Northern exposures are at the lower elevations.

This type of land has vegetation that is used by livestock but also has steep slopes, is at high elevations, and is inaccessible. The vegetation is forage for wildlife.

The dominant vegetation present for wildlife use includes mountain-mahogany, skunkbush sumac, snowberry, Gambel oak, serviceberry, chamiza, filaree, true cercocarpus, sedges, vetch, peavines, clovers, mountain muhly, mountain brome, Thurber fescue, and Arizona fescue. If the area is abused, it is dominated by undesirable shrubs, forbs, and annuals.

Water development, mainly the development of springs, is necessary for practical range management on this site.

If the range is in excellent condition, the air-dry weight of annual growth that is usable by wildlife is about 700 pounds per acre in favorable years and 225 pounds in unfavorable years.

Timber Management

About 40 percent of the Mescalero-Apache Area, or about 214,000 acres, is commercial forest. In addition, about 10 percent of the Area is covered by pinyon pine and juniper (fig. 11), which could have commercial use as fenceposts, firewood, or pulpwood.

The soils that support commercial timber and woodland are mainly those at the higher elevations, where



Figure 11.—Pinyon pine and juniper trees on Deama very stony loam, 1 to 12 percent slopes. The juniper trees provide fenceposts.

the environment is favorable for trees. Only those soils within forested areas are described in this section of the survey.

Most forested areas have been partly cut over for sawtimber. Some were harvested as long ago as 30 years. Since that time, selective harvesting has again produced commercial sawtimber.

Ponderosa pine, the principal timber species, is the most important commercially. Douglas-fir, white fir, corkbark fir, limber pine, Mexican white pine, and Engelmann spruce are interspersed at higher elevations and on north-facing slopes. In this Area ponderosa pine grows best at elevations of 7,000 to 8,500 feet. It grows well on the Peso, Caballo, Gaines, and Mescalero soils.

At elevations of about 7,000 feet on north-facing slopes and 8,500 feet on south-facing slopes the tree cover generally changes to a mixed stand of Douglas-fir, white fir, and ponderosa pine. In places, however, are nearly pure stands of Douglas-fir and white fir. The upper elevation range for fir trees appears to be 8,800 feet on the north-facing slopes to 10,000 feet on ridgetops and south-facing slopes.

At elevations of 5,700 to 7,000 feet the tree cover is mostly pinyon pine and juniper. These species are also

common on south-facing slopes at elevations as high as 8,000 feet. Pinyon pine and juniper grow best on the Deama, Oro Grande, Pena, and Irock soils. Engelmann spruce generally occurs at elevations of more than 10,000 feet. Engelmann spruce and corkbark fir are the main species on the Blanca and Supervisor soils.

The soils of the Mescalero-Apache Area have been assigned to timber groups to assist owners in planning the use of their soils for wood crops. Each group is made up of soils that are suited to the same kinds of trees, need about the same management where the vegetation on them is similar, and have the same potential production (5). Table 3 shows the acreage and extent of each group.

Each timber group listed in table 3 is identified by a symbol based on field determination of average site index. Site index of a given soil is the height, in feet, that the taller trees of a given species reach in a natural, essentially unmanaged stand in a stated number of years. Site index can be converted into approximate expected growth and yield per acre in cords and board feet.

The site index values for ponderosa pine and Douglas-fir were determined from curves developed by

TABLE 3.—*Timber groups and management*

Woodland group and soil symbol	Dominant species	Site index ¹	Ratings of hazards and limitations				Acres ²	Percent of timberland
			Woody species competition	Equipment limitations	Windthrow hazard	Erosion hazard		
Group 1: GC	Ponderosa pine	90+	Slight	Slight	Slight	Moderate	1,898	0.9
Group 2: BR, BS	Ponderosa pine	75-89	Slight	Slight	Slight	Moderate	3,328	1.6
Group 3: BM, GE, ME, PB	Ponderosa pine	60-74	Moderate to severe.	Moderate	Slight	Slight to moderate.	142,863	66.8
Group 4: FR	Ponderosa pine	45-59	Moderate	Moderate	Moderate	Slight	3,894	1.8
Group 5: CA, FS, PC, TC, TE	Douglas-fir, white fir, Mexican white pine.	60-90	Moderate	Moderate; slight on TC.	Slight to moderate.	Slight to severe.	59,439	27.8
Group 6: BN, SU	Engelmann spruce, cork-bark fir.	30-50	Moderate	Moderate	Slight to moderate.	Slight to moderate.	2,487	1.1

¹ The average height of the dominant and codominant trees at 100 years of age. Based on the site index values for ponderosa pine from Meyer's Curve (6).

² Total acreage actually covered with trees. Most of the ponderosa pine is in vegetative belt 3. White fir and Douglas-fir are in vegetative belt 4. Spruce and corkbark fir are in vegetative belt 5.

Meyer (6). The site index values for Engelmann spruce were determined from curves developed by Brickell (2). The site index values for white fir were determined from curves developed by Haig (4).

Among the factors to be considered in forest management are protection against fire, insects, and disease; thinning and pruning to improve quality of the stands; reforestation; cutting to improve the stocking level and age class distribution of the stands; and management of the watershed. The paragraphs that follow explain the hazards and limitations in timber management.

Woody species competition.—Sites that have been disturbed by fire, cutting, or other factors are apt to be invaded by brush, undesirable trees, and other plants. Such competition hinders the establishment and growth of desirable species. A rating of *slight* indicates that invasion by undesirable species will have little effect on growth of desirable species. A rating of *moderate* indicates that competition will not seriously affect establishment of adequate stands of commercial-quality timber. A rating of *severe* indicates that competition is strong and prevents natural regeneration. Oak brush and alligator juniper are the chief competing species. If seedlings are planted, the competing species must be controlled.

Equipment limitation.—Management of forest may be hampered by soil characteristics and topographic features that restrict or prevent the use of equipment. The chief factors that affect the use of equipment on most of the soils in the Area are slope, susceptibility to erosion, and stoniness.

The equipment limitation rating of *slight* indicates no special problem in use of equipment. A rating of *moderate* indicates that not all types of equipment can be used. For a short period after the frost leaves the soil in spring and occasionally after summer rainfall, all the forested soils of the Area are too wet and soft to support equipment.

Windthrow hazard.—Soil characteristics affect the development of tree roots and, consequently, the resis-

tance of trees to the force of the wind. A rating of *slight* indicates that the soil depth is more than 20 inches; roots hold the tree firmly against a normal wind, and windthrow is not common. A rating of *moderate* indicates that soil depth is 10 to 20 inches; root development is not adequate for stability, and windthrow may occur when wind velocity is high. A *severe* rating indicates that soil depth is less than 10 inches; windthrow is common during high wind velocity.

Erosion hazard.—The erosion hazard is rated according to inherent soil characteristics, such as slope, surface cover of stones and cobbles, and aspect. Ratings of slight, moderate, and severe are used to indicate susceptibility to erosion if the soil is disturbed or if it lacks a protective cover of vegetation. A rating of *slight* indicates that only a small loss of soil occurs where there has been disturbance or depletion of plant cover. A rating of *moderate* indicates that disturbance of the surface layer and loss of protective vegetation result in conditions conducive to erosion. Careful planning and construction of roads, skid trails, and landings are necessary to prevent soil loss. A *severe* rating indicates that the soils are susceptible to serious erosion and soil loss. Harvesting must be done carefully, and special logging methods that minimize soil disturbance are advisable. All roads and skid trails must be carefully located and constructed. They must be adequately drained to control excessive runoff. After logging has been completed, the roads must be seeded to reduce runoff and curb erosion.

Timber suitability groups

All forest soils of the Mescalero-Apache Area are under the administration of the Mescalero-Apache Indian Agency (12). They have been assigned to six timber suitability groups in order of their estimated relative potential productivity (fig. 12). Groups 1 to 4 are numbered in decreasing order of productivity for ponderosa pine, and groups 5 and 6 for mixed conifers, mainly Douglas-fir, white fir, and Engelmann spruce. The Guide to Mapping Units at the back of this soil



Figure 12.—Trees are carefully selected for cutting of sawtimber. Timber group 1.

survey shows the timber groups to which the timber soils have been assigned. The names of the soil series represented are mentioned in each timber suitability group, but the listing of the series name does not necessarily indicate that all the soils of a series are in the same timber suitability group.

TIMBER GROUP 1

The only soil in this group, Gaines silty clay loam, 1

to 25 percent slopes, is well drained. It has a surface layer of silty clay loam, a subsoil of silty clay loam or clay, and a substratum of clay intermixed with coarse fragments of highly fractured limestone. Fractured bedrock is at a depth of 48 inches. Elevation is 6,800 to 8,400 feet, precipitation is 17 to 22 inches, mean annual air temperature is 39° to 45° F., and the frost-free season is 80 to 110 days. Permeability is slow. Runoff from the bare soil is medium, and the erosion hazard is moderate. Available water holding capacity is 6 to 7 inches. Effective rooting depth is 48 inches.

This is the most productive soil in the Area. The dominant woodland species, ponderosa pine, has a site index of more than 90.

Competition from woody species ordinarily does not prevent establishment of a good stand of ponderosa pine. The normal use of equipment is not limited. Disturbance of the plant cover increases the erosion hazard.

TIMBER GROUP 2

The soils of this group are in the Brycan series. They are well drained and have a surface layer of clay loam. The substratum is heavy loam to a depth of 60 inches or more. Slopes are 3 to 25 percent. Elevation is 6,900 to 8,200 feet, precipitation is 18 to 22 inches, average annual air temperature is 41° to 45° F., and the frost-free season is 80 to 110 days. Permeability is moderately slow. Runoff from the bare soil is medium, and the erosion hazard is moderate. Available water holding capacity is 10 to 11 inches. Effective rooting depth is 60 inches or more.

The dominant woodland species, ponderosa pine, has a site index of 75 to 89.

Competition from woody species ordinarily does not prevent establishment of a good stand of ponderosa pine. The normal use of equipment is not limited. Disturbance of the plant cover increases the erosion hazard.

TIMBER GROUP 3

The soils of this group are in the Blamer, Gaines (variant), Mescalero, and Peso series. They are well drained and have a surface layer of very stony loam, clay loam, stony silty clay loam, or very cobbly clay loam. The subsoil is loam to clay that is commonly very cobbly or very stony. The substratum is very cobbly and stony to extremely cobbly and stony or shaly material over fractured limestone, sandstone, or shale. The depth to bedrock is 20 to 40 inches. Slopes are 3 to 55 percent. Elevation is 6,700 to 9,000 feet, precipitation is 18 to 23 inches, mean annual air temperature is 38° to 45° F., and the frost-free season is 80 to 110 days. Permeability is moderate to slow. Runoff from the bare soil is medium to rapid, and the erosion hazard is slight to moderate. Available water holding capacity is 1 to 4 inches. Effective rooting depth is mainly 20 to 40 inches, but a few roots extend through fractures in the bedrock to a depth of 72 inches.

The dominant woodland species, ponderosa pine, has a site index of 60 to 74.

Moderate to severe competition from woody species prevents the reestablishment of a good stand of ponderosa pine. Oak brush is the dominant competitor.

The steep slopes and stoniness create a moderate limitation for the normal use of equipment. The windthrow hazard is mainly slight. Because of stoniness, the erosion hazard is only slight to moderate.

TIMBER GROUP 4

The only soil in this group, Firo very stony loam, 12 to 55 percent slopes, is well drained. It has a surface layer of very stony loam, a subsoil of cobbly heavy loam, and acid igneous bedrock within a depth of 20 inches. The upper part of the bedrock is fractured in a few places. Slopes are 12 to 55 percent. Elevation is 6,800 to 9,000 feet, precipitation is 17 to 23 inches, mean annual air temperature is 38° to 45° F., and the frost-free season is 80 to 110 days. Permeability is moderate. Runoff from the bare soil is rapid, and the erosion hazard is slight. Available water holding capacity is 0.5 to 2.0 inches. Effective rooting depth is 7 to 20 inches.

The dominant woodland species, ponderosa pine, has a site index of 45 to 59.

Moderate competition from woody species restricts the reestablishment of a good stand of ponderosa pine. Oak brush is the dominant competitor. The steep slopes and stoniness create a moderate limitation for the normal use of equipment. The windthrow hazard is moderate.

TIMBER GROUP 5

The soils of this group are in the Caballo, Firo, Peso, and Telefono series. They are well drained and have a surface layer of clay loam, loam, very stony loam, or very cobbly clay loam and a subsoil of clay loam, cobbly loam, and cobbly or very cobbly clay loam. Limestone or acid igneous bedrock is generally between depths of 20 and 72 inches, but in the Firo soils it is within a depth of 10 to 20 inches. Slopes are 3 to 55 percent. Elevation is 6,800 to 10,000 feet, precipitation is 17 to 25 inches, mean annual air temperature is 36° to 45° F., and the frost-free season is 60 to 110 days. Permeability is moderate to slow. Runoff from the bare soil is medium to rapid, and the erosion hazard is slight to moderate. Available water holding capacity is 0.5 to 2.0 inches in the Firo soils and 1.5 to 6.5 inches in the others. Effective rooting depth is mainly 20 to 72 inches.

The dominant woodland species, Douglas-fir, has a site index of 60 to 90.

Moderate competition from woody species prevents the reestablishment of a good stand of desirable timber. Oak brush is the dominant competitor. Where slopes are less than 25 percent the equipment limitation is only slight, and where slopes are 25 to 55 percent it is moderate. The windthrow hazard is moderate on the Firo soils and slight on the others.

TIMBER GROUP 6

The soils of this group are in the Blanca and Supervisor series. They are well drained and have a surface layer of stony or very stony sandy loam. The underlying material is brown to dark grayish-brown very cobbly sandy loam. Slopes are 12 to 55 percent. Elevation is 10,000 to 12,000 feet, precipitation is 24 to 30 inches, mean annual air temperature is 36° to 40° F., and the frost-free season is 50 to 90 days. Permeability

is moderately rapid. Runoff from the bare soil is rapid. The erosion hazard is slight on the Supervisor soils and moderate on the Blanca soils. Available water holding capacity is 1 to 4 inches. Effective rooting depth is about 20 to 40 inches in the Supervisor soils and 60 inches or more in the Blanca soils.

The dominant woodland species, Engelmann spruce, has a site index of 30 to 50.

Moderate competition from woody species prevents the reestablishment of a good stand of desirable timber. Oak brush and various high mountain shrubby brush are the dominant competitors. The steep slopes and stoniness create a moderate limitation for the normal use of equipment. The windthrow hazard is slight on the Blanca soils and moderate on the Supervisor soils. The erosion hazard is slight to moderate.

Management for Wildlife

The Mescalero-Apache Area provides many areas of high quality, well-suited wildlife habitat. It ranges from the semiarid grasslands on piedmont fans and valley slopes to the low rolling limestone hills dotted with shrubs and pinyon and juniper trees and to the tree- and shrub-dotted slopes of the Sacramento Mountains and the Sierra Blanca. Wildlife is an important natural and commercial resource of the Area (fig. 13). Antelope, quail, and mourning dove are the most abundant within the semiarid grasslands. Deer, turkey, bear, and elk are associated with the mountain soils and vegetation. Occasionally, wild horses are seen in the Sierra Blanca.

The kinds and number of wildlife in an area depend on the amount, quality, and distribution of food, shelter, and water. Habitat is directly related to the kinds of soil, the climate, and the vegetation. The kind, quality, and abundance of habitat are directly affected by the land use, the kinds and patterns of vegetation, and the supply and distribution of water.

Research is being carried on to introduce special species, such as chukars (see figure 13), Barbary sheep, and bighorn sheep. The Mescalero Indian Agency hopes some of these species will increase and eventually be an additional source of income through the sale of special hunting permits.

The soils in the Area are grouped according to their suitability for providing different types of wildlife habitat and on the quality of habitat for wildlife significant in the Mescalero-Apache Area. The groups are listed in table 4. The ratings in the table show only the potential. They do not necessarily reflect existing habitat. An onsite determination of existing conditions is needed before actual planning is done.

The information in table 4 can be used in—

1. Planning the broad use of parks, refuges, and nature-study areas.
2. Selecting the better soils for creating, improving, or maintaining specific kinds of wildlife habitat.
3. Determining the relative intensity of management needed for individual habitat.
4. Making special interpretations for local wildlife in publications.



Figure 13.—Chukars, an introduced species. Wildlife habitat group C.

Types of habitat

Table 4 shows the suitability of soils, by groups, for nine different types of wildlife habitat. Suitability is expressed as good, moderate, or poor. Soils suitable for vigorous growth of a wide variety of the key plants are rated *good*. Soils suitable for the growth of several key species are rated *moderate*. Soils that support no wildlife or only a very few species are rated *poor*.

Mountain forests and grasslands are areas of large trees and associated grasses, forbs, and shrubs and meadows or open parks. The key plants are fir, spruce, aspen, ponderosa pine, snowberry, buffaloberry, mountain-mahogany, sedges, skunkbush sumac, serviceberry, cliffrose, bluegrass, and fescue.

Foothill trees and shrubs are areas of mountainsides and foothills where there are small native trees, shrubs, associated grasses, and forbs. The key plants are pinyon, one-seed juniper, blue grama, side-oats grama, mountain-mahogany, Gambel oak, and shrub live oak.

Tall or short grass prairies are areas of rolling plains and lower mountainsides where native grasses, shrubs, and forbs grow. The key plants are blue grama, bluestem, vine-mesquite, western wheatgrass, galleta, tobosa, cliffrose, serviceberry, and skunkbush sumac. Sunflowers, crotons, and pigweed grow in disturbed areas or ponded depressions.

Semidesert shrubs and grasses are areas where there are native grasses and shrubs. Key plants are alkali sacaton, three-awn, sand sagebrush, fourwing saltbush, winterfat, Apache plume, and cactus.

Domestic seed and grainfields are planted cultivated fields of domestic grain and seeds that produce annual herbaceous plants. Key plants are barley, corn, oats, grain sorghum, wheat, and millet. The group is rated for both irrigated and nonirrigated areas.

Domestic pastures and haylands are planted domestic perennial grasses and herbaceous legumes. Key plants are alfalfa, tall wheatgrass, tall fescue, smooth brome, orchardgrass, and weeping lovegrass. Few fields are presently being formed. The group is rated for both irrigated and nonirrigated uses.

Bosque bottoms are areas next to major streams and rivers where native trees, grasses, and shrubs grow. They receive extra water from flooding or have a high water table, but are not excessively wet. Key plants are cottonwood, willow, and tamarisk.

Wetland plants are found in naturally moist to wet sites. The key plants are saltmarsh bulrush, inland saltgrass, reeds, sedges, and cattail.

Shallow water impoundments are impoundments of water generally no more than 3 feet deep. Soils are rated on their suitability for shallow ponds and reser-

voirs. Submerged and floating aquatic plants are common. Shallow water impoundments are constructed by impoundment or shallow excavation. Soils are rated as to their suitability for retaining water as well as their limitations for the production of plants that provide food for waterfowl.

Deep water impoundments are not rated in this section. Persons interested in the soil use for this type of impoundment should look at the soil rating for ponds and reservoirs in the engineering section.

Desirable habitat

The suitability by soil groups is expressed as *poor* in table 4 if creating, improving, or maintaining the desired habitat is very expensive or impractical. Overcoming the severe soil limitations would require a high degree of intensive management or would be impossible or impractical.

Suitability is expressed as *moderate* if the needed habitat can be created, improved, or maintained. Moderate soil limitations affect the maintenance, establishment, or improvement of the habitat, but under a moderate intensity of management and frequent attention, satisfactory results can be obtained.

Suitability is *good* if the needed habitat can generally be easily created, improved, or maintained. There are only slight limitations or no limitations that affect the maintenance, establishment, or improvement of the habitat.

Wildlife habitat groups

Each wildlife habitat group in the Mescalero-Apache Area is briefly described on the following pages. In each description are the wildlife habitat group name, the soil characteristics that influence the land use and the kinds and patterns of vegetation, the present land use and vegetation, and the suitability for local wildlife.

The names of the soil series represented are mentioned in the description of each wildlife habitat group. The listing of the series name, however, does not necessarily indicate that all the soils of a series are in the same wildlife habitat group.

WILDLIFE HABITAT GROUP A

This group consists of soils in the Gabaldon, Kuma, Remunda, Ruidoso, and Shanta series. These are deep soils that have a surface layer of loam, silty clay loam, or clay loam and are underlain by loam, sandy clay loam, clay loam, or clay. The soils are well drained. Slopes are 1 to 12 percent. Elevations range from 5,400 to 7,000 feet. Permeability is moderate to slow. Runoff is medium. Available water holding capacity is 7.5 to 12.5 inches. These soils are on fans and in valley fill surrounded by low hills along the eastern border and in the northwestern corner of the Area.

The native vegetation is blue grama, side-oats grama, galleta, black grama, winterfat, cholla, cactus, and yucca. Only a few acres in scattered small fields can be irrigated for small grain, hay, pasture, or orchards.

Habitat is excellent for antelope; fair to good for dove, waterfowl, and fish; and poor for pheasant, turkey, deer, elk, and bear. Irrigated areas are excellent for pheasant and quail.

WILDLIFE HABITAT GROUP B

This group consists of soils in the Arosa, Brycan, Gaines, Hesperus, and Tularosa series. These are deep soils that have a surface layer of loam or silty clay loam and are underlain by clay loam, silty clay loam, clay, or silty clay. The soils are well drained except for a few isolated scattered springs, seeps, or high water tables. Slopes are 1 to 25 percent. Elevations range from 6,800 to 9,500 feet. Permeability is moderately slow to slow. Runoff is medium. Available water holding capacity is 6 to 12 inches. These soils occur on the floors of narrow mountain valleys.

The native vegetation is western wheatgrass, Arizona fescue, bluestem, sleepygrass, blue grama, scattered snowberry, mountain-mahogany, cliffrose, oak brush, pinyon pine, juniper, and ponderosa pine. Mixed conifers grow at the higher elevations.

Habitat is excellent for antelope and fair to good for dove, quail, bear, fish, pheasant, waterfowl, deer, and elk. Irrigated areas are excellent for pheasant.

WILDLIFE HABITAT GROUP C

This group consists of soils in the Deama, Irock, Oro Grande, and Pintel series and Rock land, Rock outcrop, and Terrace escarpments. These are very shallow to deep soils that have a surface layer of very stony, stony, cobbly, or very cobbly sandy loam and loam and are underlain by very cobbly sandy clay loam, very stony clay loam, gravelly loam, or cobbly sandy loam. The soils are well drained. Slopes are 1 to 55 percent. Elevations range from 5,700 to 6,900 feet. Permeability is moderate. Runoff is medium to rapid. Available water holding capacity is 0.5 to 3.5 inches. These soils are on low rolling foothills and adjoining slopes, mostly along the eastern border and in the northwestern part of the Area.

The native vegetation is black grama, side-oats grama, galleta, blue grama, winterfat, fourwing saltbush, skunkbush sumac, juniper, pinyon pine, cholla, cactus, and yucca.

Habitat is excellent for deer (fig. 14), fair to good for antelope, and poor for turkey, fish, elk, bear, pheasant, quail, dove, and waterfowl.

WILDLIFE HABITAT GROUP D

This group consists of soils in the Jarita and Pena series. These are moderately deep to deep soils that have a surface layer of silt loam or gravelly loam and are underlain by silty clay loam, clay loam, or cobbly loam. The soils are well drained. Slopes are 1 to 25 percent. Elevations range from 5,700 to 7,000 feet. Permeability is moderate to moderately slow. Runoff is medium to rapid. Available water holding capacity is 5 to 6 inches. These soils are on rolling dissected old terraces and toe slopes around limestone hills.

The native vegetation is blue grama, side-oats grama, black grama, galleta, ring muhly, winterfat, fourwing saltbush, cactus, and scattered oak brush, pinyon pine, and juniper.

Habitat is excellent for antelope, fair to good for deer, and poor for turkey, fish, elk, bear, dove, quail, pheasant, and waterfowl. Small scattered irrigated fields are excellent for pheasants.

TABLE 4.—*Suitability by soil groups for*
[Absence of an entry indicates type of

Soil groups	Types of habitat							
	Mountain forests and grassland	Foothill trees and shrubs	Tall or short grass prairies	Semidesert shrubs and grasses	Domestic seed and grainfields		Domestic pastures and haylands	
					Irrigated	Nonirrigated	Irrigated	Nonirrigated
A	Poor -----	Poor -----	Good -----	Moderate ---	Moderate ---	Poor -----	Good -----	Poor -----
B	Moderate ---	Moderate ---	Good -----	Poor -----	Moderate ---	Moderate ---	Good -----	Moderate ---
C	Poor -----	Good -----	Moderate ---	Poor -----	-----	-----	-----	-----
D	Poor -----	Moderate ---	Good -----	Poor -----	Poor -----	Poor -----	Moderate ---	Poor -----
E	Poor -----	Moderate ---	Poor -----	Poor -----	-----	-----	-----	-----
F	Good -----	Moderate ---	Poor -----	Poor -----	-----	-----	-----	-----
G	Moderate ---	Poor -----	Poor -----	Poor -----	-----	-----	-----	-----

¹ Introduced species, such as Chukars, grouse, Barbary sheep, bighorn sheep, may prove successful. Special study is needed.

² Suitability is poor if slope is more than 3 percent.

³ Excellent where irrigated or where dryland domestic seed and grain crops are grown.

WILDLIFE HABITAT GROUP E

This group consists only of Rock land, the many areas of very shallow, steep and very steep Rock outcrop, stony land, colluvial land, and rubble land. Stones and boulders submerge soil characteristics. Slopes are 55 to 75 percent on side slopes in the foothills. Elevations range from 5,700 to 7,000 feet. Runoff is rapid. Available water holding capacity is very low.

The native vegetation consists of Apache plume, mountain-mahogany, squawbush, blue grama, side-oats grama, galleta, winterfat, fourwing saltbush, oak brush, pinyon pine, juniper, cholla, cactus, and yucca.

Rock land is fair to good habitat for deer and poor for turkey, fish, elk, bear, dove, quail, pheasant, waterfowl, and antelope.

WILDLIFE HABITAT GROUP F

This group consists of soils in the Blamer, Blanca, Caballo, Firo, Gaines (variant), Mescalero, Peso, Supervisor, and Telefono series. These are shallow to deep soils that have a surface layer of very stony, stony, and cobbly loam, sandy loam, and clay loam and in some places nonstony silty clay loam, loam, and clay loam. They are underlain by clay, silty clay loam, and cobbly or very cobbly sandy loam, loam, clay loam, and silty clay loam. They are well drained. Slopes are 3 to 55 percent. Elevations range from 6,700 to 12,000 feet. Permeability is moderately rapid to slow. Runoff is medium to rapid. Available water holding capacity is 0.5 to 6.5 inches. These soils are on low mountainsides.

The native vegetation is ponderosa pine, fir, aspen, spruce, blue grama, side-oats grama, mountain brome, mountain muhly, needlegrass, fescue, mountain-

mahogany, oak brush, serviceberry, cliffrose, sedge, pinyon pine, and juniper.

Habitat is excellent for elk, bear, and turkey (fig. 15); fair to good for deer; and poor for fish, pheasant, dove, quail, waterfowl, and antelope.

WILDLIFE HABITAT GROUP G

This group consists of soils in the Supervisor series, Rock outcrop, and Rock land, cool. These are very shallow to moderately deep, very steep very stony sandy loam soils and many areas of Rock outcrop, stony land, colluvial land, and rubble land. Slopes are 55 to 75 percent on high mountainsides. Elevations range from 6,700 to 12,000 feet. Permeability is moderately rapid. Runoff is rapid. Available water holding capacity is very low to low.

The native vegetation is ponderosa pine, fir, aspen, mountain brome, mountain muhly, bluestems, needlegrass, fescue, mountain-mahogany, oak brush, serviceberry, cliffrose, and sedges.

Habitat is fair to good for elk, bear, and turkey; and poor for antelope, dove, fish, deer, waterfowl, pheasant, and quail.

Fishing and hunting

The Mescalero Agency sells special permits for fishing and hunting, along with overnight camping and picnicking.

Game animals, like livestock, depend for a food supply on plants produced by the land. The land must also produce the water and cover needed by the animals. Proper stocking is maintained by regulating the number of permits sold and the area to be hunted. Good

types of habitat and kinds of wildlife

habitat not applicable for soil group listed]

Types of habitat—Continued			Kinds of wildlife ¹		
Bosque bottoms	Wetland plants	Shallow water impoundments ²	Poor	Fair to good	Excellent
Poor -----	Poor -----	Moderate ---	Turkey, deer, elk, bear -----	Dove, waterfowl, fish ---	Antelope, ³ pheasant, quail.
Poor ⁴ -----	Poor ⁵ -----	Moderate ---	-----	Turkey, quail, dove, waterfowl, bear, deer, elk, fish.	Antelope, pheasant. ³
-----	-----	-----	Turkey, dove, quail, pheasant, waterfowl, fish, elk, bear.	Antelope -----	Deer.
-----	-----	Poor -----	Turkey, dove, quail, pheasant, fish, elk, bear.	Deer -----	Antelope.
-----	-----	-----	Turkey, dove, quail, pheasant, waterfowl, fish, elk, bear, antelope.	Deer -----	-----
-----	-----	-----	Antelope, fish, dove, quail, waterfowl, pheasant.	Deer -----	Elk, bear, turkey.
-----	-----	-----	Antelope, deer, fish, dove, waterfowl, pheasant, quail.	Turkey, elk, bear -----	-----

⁴ Good near springs and along perennial streams.

⁵ Good if water table is high. Also good near springs.

hunting areas are a major part of the Area. The Mescalero Agency continues to research new species for future growth in this industry.

Five creeks provide 27 miles of streams capable of supporting game fish. There are now 25 surface acres of artificial lakes in 18 impoundments that produce game fish. Rainbow trout is the principal species, although brown trout and a rare variety of cutthroat trout also occur. One small pond has a population of largemouth bass and bluegill. Suitable waters are stocked by the Mescalero National Fish Hatchery. These areas possess an importance greater than might be expected because of the large number of people who live in the low, dry, warm country that surrounds the Reservation.

Ruidoso Creek, Eagle Lake, and Cienegita Lake provide the best fishing within the Area. These waters are a short distance west and northwest of Ruidoso. Overnight camping and picnicking facilities are available within some of these areas.

Capability Grouping

Both dryfarming and irrigation farming have been practiced in the Mescalero-Apache Area, but only about 1,200 acres, or 0.3 percent, of the acreage is now being farmed. Of this acreage, about 50 percent is dryfarmed and 50 percent irrigated. More has been farmed in the past, but has since reverted to grass.

The Mescalero Agency grows corn, truck crops, orchards, small grain, and pasture in very small scattered areas within the valleys that fall within vegeta-

tive belts 2, 3, and 4.³ Some of these areas are private holdings not owned by the Mescalero Agency. Farm crops have a very low potential within the Area and are being phased out in preference to pasture or native grassland.

Management of the entire Area is by range sites and timber groups. Capability units are not used as a management unit in this Area and will not be used in the foreseeable future. Nevertheless, the capability system is described in the following paragraphs and can be used as a reference in comparing the soils of this Area with those in adjoining areas.

The capability classification is a grouping of soils that shows, in a general way, their suitability 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. The soils are grouped according to degree and kind of limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils and without consideration of possible but unlikely major reclamation projects.

In the capability system, all soils are grouped at three levels: the capability class, the subclass, and the unit. These are described in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I to VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

³ See explanation of vegetative belts under "Range Management."



Figure 14.—Deer in wildlife habitat group C.

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, water supply, or esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral; for example, VI_e. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes 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*, used in only some parts of the United States, shows 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 limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, although they have other limitations that restrict their use.



Figure 15.—Elk in wildlife habitat group F.

CAPABILITY UNITS are soil groups within the subclasses. All soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to be similar in productivity and other responses to management. Thus, the capability unit is a convenient grouping for making statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol; for example, VIe-1 or VIIs-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation; and the Arabic numeral specifically identifies the capability unit within each subclass.

Engineering Uses of the Soils

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engi-

neering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.

6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 5, 6, and 7, which show, respectively, results of engineering laboratory tests on soil samples, estimates of soil properties significant in engineering, and interpretations for various engineering uses.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 6 and 7, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or require excavations to depths greater than those shown in the tables, generally depths of more than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning in soil science that may not be familiar to engineers. Many of these terms are defined in the Glossary.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system used by the Soil Conservation Service, Department of Defense (11), and other agencies, and the AASHO system (1) adopted by the American Association of State Highway Officials.

The Unified system classifies soils according to those properties that affect use as construction material for purposes other than highway construction and maintenance and as foundation material. In the Unified system, soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content and are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHO system classifies soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is assigned to one of seven basic groups, which range from A-1 to A-7, on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils, which have high bearing strength and are the best soils for subgrade, or foundation. At the other extreme, in group A-7, are clay soils, which have low strength when wet and are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b; A-2-4, A-2-5, A-2-6, A-2-7; and

A-7-5 and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHO classification for tested soils, with group index numbers in parentheses, is shown in table 5; the estimated classification, without group index numbers, is shown in table 6 for all soils mapped in the Area.

Engineering test data

Table 5 contains engineering test data for some of the major soils in the Mescalero-Apache Area. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications shown are based on data obtained by mechanical analyses and by tests to determine liquid limit and plastic limit. The mechanical analyses were made by the combined sieve and hydrometer method.

Compaction, or moisture-density, data are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases as the moisture content increases. The highest dry density obtained in the compactive test is termed the *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material. As the moisture content of a dry clayey soil increases, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a 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 the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

Soil properties significant in engineering

Estimates of soil properties significant in engineering are shown in table 6. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other survey areas. Following are explanations of some of the columns in table 6.

Depth to bedrock is distance from the surface of the soil to the upper surface of the rock layer.

Depth to a seasonal high water table is not shown in table 6 because a water table occurs in only a few areas within recent alluvial deposits. Local inclusions of peat or muck may occur where there is a seasonal water table. These inclusions are mainly in Arosa silty clay loam, 1 to 12 percent slopes (AR); Brycan loam, 3 to 25 percent slopes (BR); and Brycan silty clay loam, 3 to 25 percent slopes (BS).

Soil texture is described in table 6 in the standard

terms used by the Department of Agriculture. These terms take into account the relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand."

Permeability is the quality that enables a soil to transmit water or air. It is estimated on the basis of soil characteristics observed in the field, particularly structure and texture. The estimates in table 6 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and terms used to describe soil reaction are explained in the Glossary.

Salinity refers to the amount of soluble salts in the soil. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25° C. Salinity affects the suitability of a soil for the production of crops, its stability when used as construction material, and its corrosiveness to metals and concrete.

Shrink-swell potential is the relative change in volume to be expected of soil material as the moisture content changes, that is, the extent to which the soil shrinks when dry or swells when wet. Extent of shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material that has this rating.

Corrosivity, as used in table 6, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel. The rate of corrosion of uncoated steel is related to such soil properties as drainage, texture, total acidity, and electrical conductivity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations made entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means there is a low probability of soil-induced corrosion damage. A rating of *high* means there is a high probability of damage, so that protective measures for steel should be used to avoid or minimize damage.

Engineering interpretations

The engineering interpretations in table 7 are based on the properties of soils shown in table 6, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of the Mescalero-Apache Area. The table shows the suitability of each soil as a source of topsoil, sand and gravel, and road fill; lists those soil features not to be overlooked in planning, installation, and maintenance; and indicates the degree and

kind of limitations that affect specified engineering projects. The degree of limitation is expressed as slight, moderate, and severe. *Slight* means that soil properties are generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* indicates soil properties are so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required.

Table 7 also classifies each soil according to hydrologic group, or runoff potential.

Following are explanations of some of the columns in table 7.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that results at the area from which topsoil is taken.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials. Neither do they indicate the quality of the deposit.

Road fill is soil material in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and the relative ease of excavating the material at borrow areas.

Features under "Winter grading" reflect the predicted performance or behavior of the soil. A fine-textured soil is plastic when wet and when frozen, and breaking clods is more difficult than in a coarse-textured soil.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope, depth to bedrock or other unfavorable material, presence of stones, permeability, and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments require soil material that is resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compact-

TABLE 5.—*Engineering*

[Tests performed by New Mexico Highway Department, Materials and Testing Division, in accordance

Soil name and location	New Mexico report number	Depth	Mechanical analysis ¹	
			Percentage passing sieve—	
			3 inches	2 inches
		<i>Inches</i>		
Arosa silty clay loam: 1 mile southwest of Salt Well in headcut S $\frac{1}{4}$ corner sec. 24, T. 12 S., R. 12 E. (Modal).	66-1600 66-1601	0-10 15-28	-----	-----
Deama very stony loam: 1.1 miles northwest of Red Lake, 350 feet west of road near center NW $\frac{1}{4}$ sec. 4, T. 13 S., R. 16 E. (Modal).	66-1567 66-1568	0-4 4-8	100 100	94 86
Firo very stony loam: Northeast corner of SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 35, T. 11 S., R. 11 E. (Modal)	66-1584	3-15	100	93
Kuma loam: One-fourth mile east of stock water pond dam near center of NE $\frac{1}{4}$ sec. 19, T. 12 S., R. 12 E. (Modal).	66-1575 66-1570	0-5 11-22	-----	-----
Mescalero stony silty clay loam: One-fourth mile west of Harley Well near center of NE $\frac{1}{4}$ sec. 22, T. 13 S., R. 13 E. (Modal).	66-1578 66-1579 66-1580	0-2 2-10 15-19	100 100 100	80 87 84
Shanta loam: 1,000 feet east of west boundary of the Mescalero-Apache Indian Reservation, and 800 feet south of road, 1,000 feet east of northwest corner SW $\frac{1}{4}$ sec. 8, T. 11 S., R. 10 E. (Modal).	66-1569 66-1570 66-1571	0-9 9-23 23-50	-----	-----
Telefono clay loam: E $\frac{1}{4}$ corner sec. 5, T. 14 S., R. 13 (Modal).	66-1588 66-1589 66-1590	0-2 2-6 6-14	-----	-----

¹ Mechanical analyses according to AASHO Designation T 88-57 (1). Results by this procedure frequently may differ somewhat material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The

bility. Stones and organic material in a soil are among the factors that are unfavorable.

Local roads and streets, as rated in table 7, have an all-weather surface that is expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity of the subgrade and the workability and quantity of cut and fill material available. The AASHO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness or flooding affects stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Dwellings without basements, as rated in table 7, are no more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 7 apply only to a depth of about 6 feet. Therefore, limitation ratings of *slight* or

test data

with standard procedures of the American Association of State Highway Officials (AASHO)]

Mechanical analysis ¹ —Continued							Liquid limit	Plasticity index	Classification		
Percentage passing sieve—Continued									AASHO	Unified	
1 inch	3/4 inch	3/8 inch	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)					
							<i>Percent</i>				
				100	95	71	39	12	A-6 (8)	ML	
				100	99	93	44	19	A-7-6 (12)	CL	
89	87	83	78	75	72	60	29	7	A-4 (5)	CL-ML	
73	68	63	60	57	53	43	39	10	A-4 (2)	GM	
77	70	65	58	54	51	44	37	11	A-6 (2)	GM	
				100	99	94	30	7	A-4 (8)	ML-CL	
				100	96	87	32	11	A-6 (8)	CL	
74	69	64	62	60	58	44	53	14	A-7-5 (4)	GM	
69	66	60	58	57	54	37	52	20	A-7-5 (3)	GM	
54	48	37	29	22	22	21	52	16	A-2-7 (1)	GM	
				100	94	66	24	6	A-4 (6)	CL-ML	
				100	95	64	24	7	A-4 (6)	CL-ML	
				100	92	63	24	7	A-4 (6)	CL-ML	
				100	96	87	49	14	A-7-5 (12)	ML	
				100	98	86	49	18	A-7-5 (13)	ML	
				100	99	93	62	27	A-7-5 (18)	MH	

from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the mechanical analyses data used in this table are not suitable for naming textural classes for soils.

moderate may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet. Each site, however, should be investigated before it is selected. This interpretation can also be used for the construction of temporary comfort stations in recreational areas.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewerlines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material between depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are per-

meability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor, and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic matter, and slope. If the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classification and the amount of stones, if any, that influence the ease of excavation and compaction of the embankment material.

TABLE 6.—*Estimates of soil*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. fully the instructions for referring to other series that appear

Soil series and map symbols	Depth—		Dominant USDA texture	Classification		Coarse fragments greater than 3 inches
	To bedrock	From surface		Unified	AASHO	
	<i>Feet</i>	<i>Inches</i>				<i>Percent</i>
Arosa: AR -----	>5	0-10 10-60	Silty clay loam ----- Silty clay, clay, and heavy clay loam.	ML CL or CH	A-6 A-7	-----
Blamer: BM -----	0.7-3.5	0-15 15-30 30	Very stony loam ----- Highly fractured sandstone ----- Sandstone bedrock.	ML or SM ML or SM	A-4 A-4	20-45 50-80
Blanca: BN -----	>5	0-16 16-25 25-60	Sandy loam and stony sandy loam ----- Very cobbly sandy loam ----- Very cobbly sandy loam to very cobbly loamy sand.	SM GM GM or GP-GM	A-2 A-1 A-1	5-15 35-50 40-60
Brycan: BR, BS -----	>5	0-16 16-40 40-60	Loam and silty clay loam ----- Light clay loam ----- Loam -----	ML or CL CL ML or CL	A-4 or A-6 A-6 or A-7 A-6	-----
Caballo: CA, CB, CD -----	3.5-5	0-10 10-54 54-60	Clay loam or loam ----- Cobbly clay loam ----- Fractured limestone.	CL GM	A-6 A-2	5-15 45-60
Deama: DA, DE -----	0.5-1.5	0-13 13	Very stony, gravelly, and cobbly loam. Limestone bedrock.	GM or ML	A-4	30-50
Firo: FR, FS ----- No valid estimates can be made for Stony land part of FS.	0.5-1.5	0-15 15	Very stony or cobbly loam ----- Acid igneous bedrock.	GM	A-6	20-40
Gabaldon: GA -----	>5	0-60	Loam -----	ML or CL	A-4 or A-6	-----
Gaines: GC -----	3.5-6	0-22 22-32 32-48 48	Silty clay loam ----- Clay ----- Very cobbly clay ----- Limestone bedrock.	CL CL GM	A-7 A-7 A-2	0-5 5-10 50-75
Gaines thin surface variant: GE.	1.5-3.5	0-20 20-30 30	Clay ----- Highly weathered, fractured brittle shale and sandstone. Unweathered sandstone and shale.	CL	A-7	0-10
*Hesperus: HT ----- For Tularosa part, see Tularosa series.	>5	0-20 20-70	Loam ----- Clay loam -----	CL CL	A-4 A-6	-----
Irock ----- Mapped only with Pena soils.	3.5-6	0-26 26-42 42	Cobbly sandy loam or cobbly sandy clay loam. Highly weathered igneous rock. Igneous bedrock.	GM or GC	A-1 or A-2	30-50
*Jarita: JR ----- For Remunda part, see Remunda series.	1.5-3.5	0-28 28	Silt loam, light clay loam, and silty clay loam. Limestone bedrock.	CL	A-6 or A-7	0-20
Kuma: KU -----	>5	0-37 37-60	Heavy loam and light clay loam ----- Heavy clay loam -----	ML or CL ML or CL	A-6 A-6 or A-7	-----
Limestone rock land: LM. No valid estimates can be made.						

properties significant in engineering

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care- in the first column of this table. The symbol > means more than]

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Probability of corrosion damage to uncoated steel
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				<i>Inches per hour</i>	<i>Inches per inch of soil</i>	<i>pH</i>	<i>Mmhos per cm</i>		
100	100	90-100	70-85	0.20-0.63	0.19-0.21	6.6-7.3	0-1	Low -----	Moderate.
100	100	90-100	85-95	0.06-0.20	0.15-0.17	6.6-7.8	0-1	Moderate to high --	High.
75-90	70-85	60-80	45-65	0.63-2.0	0.08-0.10	6.1-7.8	0-1	Low -----	Moderate.
75-90	70-85	60-80	45-65	0.63-2.0	0.02-0.04	6.1-7.8	0-1	Low -----	Low.
95-100	85-100	55-65	25-35	2.0-6.3	0.10-0.12	5.6-6.5	0-1	Low -----	Moderate.
30-50	20-30	15-20	10-15	2.0-6.3	0.04-0.06	5.6-6.5	0-1	Low -----	Low.
30-50	20-30	10-20	5-15	2.0-6.3	0.03-0.05	5.6-6.5	0-1	Low -----	Low.
100	100	85-95	60-75	0.63-2.0	0.16-0.18	6.1-7.8	0-1	Low -----	Moderate.
100	100	90-100	70-80	0.20-0.63	0.19-0.21	6.1-7.8	0-1	Moderate -----	Moderate.
100	100	85-95	60-75	0.63-2.0	0.16-0.18	6.1-7.8	0-1	Low -----	Moderate.
85-95	80-90	75-85	55-65	0.63-2.0	0.15-0.20	6.6-7.3	0-1	Moderate -----	Moderate.
35-50	30-40	20-30	15-25	0.63-2.0	0.05-0.08	6.8-7.8	0-1	Low -----	Moderate.
60-80	55-75	50-75	40-60	0.63-2.0	0.10-0.12	7.9-8.4	1-4	Low -----	High.
55-70	50-65	50-60	40-50	0.63-2.0	0.07-0.10	6.6-7.3	0-1	Low -----	Moderate.
90-100	85-100	80-95	70-85	0.63-2.0	0.16-0.18	6.6-7.8	1-4	Low to moderate --	High.
90-100	85-100	80-95	75-90	0.20-0.63	0.18-0.20	6.6-7.8	0-1	Moderate -----	Moderate.
85-100	80-100	70-85	65-80	0.06-0.20	0.13-0.15	6.6-7.8	1-4	Moderate -----	High.
30-40	20-35	15-30	10-25	0.06-0.20	0.03-0.05	6.6-7.8	1-4	Low -----	High.
90-100	85-95	80-90	75-85	0.06-0.20	0.13-0.15	6.6-7.3	0-1	Moderate -----	High.
100	100	85-95	60-75	0.63-2.0	0.16-0.18	6.6-7.3	0-1	Moderate -----	Moderate.
95-100	90-100	85-100	65-80	0.20-0.63	0.19-0.21	6.6-7.3	0-1	Moderate -----	Moderate.
30-50	20-35	15-30	10-25	0.63-2.0	0.06-0.09	6.6-7.8	0-1	Low -----	Moderate.
70-100	65-100	60-100	55-90	0.20-0.63	0.15-0.21	6.6-7.8	0-1	Moderate -----	Moderate.
100	95-100	85-100	80-95	0.20-0.63	0.19-0.21	6.6-8.4	1-4	Low to moderate--	High.
100	95-100	90-100	85-95	0.20-0.63	0.19-0.21	6.6-8.4	1-4	Low to moderate--	High.

TABLE 6.—*Estimates of soil properties*

Soil series and map symbols	Depth—		Dominant USDA texture	Classification		Coarse fragments greater than 3 inches
	To bedrock	From surface		Unified	AASHO	
	<i>Feet</i>	<i>Inches</i>				<i>Percent</i>
Mescalero: ME -----	1.5-3.5	0-10 10-28 28	Stony and cobbly silty clay loam --- Very cobbly silty clay loam, clay loam, and highly fractured limestone bedrock. Limestone bedrock.	GM GM	A-7 A-2	15-30 70-85
Oro Grande: OR ----- No valid estimates can be made for Rock land part.	0.5-1.5	0-16 16	Stony loam and very stony clay loam. Acid igneous bedrock.	GM	A-2 or A-4	40-60
*Pena: PA ----- For Irock part, see Irock series.	>5	0-18 18-30 30-60	Gravelly and cobbly loam ----- Cobbly sandy clay loam ----- Very cobbly loam -----	SM or ML SM GM	A-4 A-4 or A-2 A-4	10-40 50-70 55-75
*Peso: PB, PC ----- For Caballo part of PC, see Caballo series.	1.5-3.5	0-32 32	Very cobbly clay loam ----- Limestone bedrock.	CL	A-6	50-65
Pinkel: PK -----	0.5-3.5	0-30 30	Very cobbly loam and very cobbly sandy clay loam. Sandstone bedrock.	SM or SC	A-4 or A-2	60-80
Remunda: RC -----	>5	0-14 14-48 48-60	Silty clay loam ----- Heavy clay loam or clay ----- Clay loam -----	CL CH CL	A-6 A-7 A-6	----- ----- -----
Rock land: RD, RE. No valid estimates can be made.						
*Rock outcrop: RG, RK. No valid estimates can be made. For Oro Grande part of RG and Supervisor part of RK, see those series.						
Ruidoso: RU -----	>5	0-15 15-48 48-64	Silty clay loam and clay loam ----- Heavy clay loam ----- Clay loam -----	CL CH CL	A-6 A-7 A-6	----- ----- -----
Shanta: SH -----	>5	0-50 50-60	Loam or light sandy clay loam ----- Sand and gravel -----	CL or ML SW-SM or SM	A-4 A-1 or A-2	0-10 0-10
Supervisor: SU -----	1.5-3.5	0-24 24	Very stony sandy loam and very cobbly sandy loam. Fractured, fine-grained, acid igneous bedrock.	SM	A-2	50-75
Telefono: TC, TE -----	1.5-3.5	0-6 6-14 14-26 26-36 36	Silty clay loam ----- Clay ----- Cobbly clay ----- Very cobbly heavy clay loam ----- Bedrock.	ML MH CL CL	A-7 A-7 A-7 A-6	0-5 0-5 20-35 40-55
Terrace escarpments: TR. No valid estimates can be made.						
Tularosa: TU -----	>5	0-31 31-60	Silty clay loam or clay loam ----- Stratified clay and clay loam -----	CL CL or CH	A-6 A-6 or A-7	----- -----

significant in engineering—Continued

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Probability of corrosion damage to uncoated steel
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
55-65 25-45	50-60 20-35	50-60 20-35	35-45 15-25	0.20-0.63 0.20-0.63	0.09-0.12 0.04-0.08	6.6-7.8 6.6-8.4	1-4 1-4	Low ----- Low -----	High. High.
55-65	50-65	45-55	30-45	0.63-2.0	0.06-0.09	6.6-8.4	0-1	Low -----	Moderate.
75-85 75-85 65-75	70-80 70-80 60-70	60-70 50-65 50-65	45-55 30-45 35-50	0.63-2.0 0.63-2.0 0.63-2.0	0.11-0.14 0.07-0.09 0.05-0.08	7.4-8.4 7.9-8.4 7.9-8.4	0-1 1-4 1-4	Low ----- Low ----- Low -----	Moderate. High. High.
75-85	70-80	60-75	50-60	0.20-0.63	0.08-0.10	6.6-8.4	0-1	Moderate -----	Moderate.
80-90	75-85	60-75	25-45	0.63-2.0	0.05-0.07	6.6-7.8	0-1	Low -----	Moderate.
100 100 100	100 100 100	90-100 90-100 90-100	80-95 75-95 70-80	0.20-0.63 0.06-0.20 0.20-0.63	0.19-0.21 0.15-0.17 0.19-0.21	6.6-7.3 6.6-7.8 7.4-7.8	0-1 0-1 0-1	Moderate ----- High ----- Moderate -----	Moderate. High. Moderate.
100 100 100	100 100 100	90-100 90-100 90-100	80-90 75-90 80-90	0.20-0.63 0.06-0.20 0.20-0.63	0.19-0.21 0.19-0.21 0.19-0.21	6.6-7.8 6.6-7.8 7.9-8.4	0-1 0-1 1-4	Moderate ----- High ----- Moderate -----	Moderate. Moderate. High.
90-100 75-95	90-100 70-90	85-95 40-60	55-70 5-15	0.63-2.0 6.3-20.0	0.15-0.17 0.03-0.06	7.4-8.4 7.4-8.4	0-2 0-1	Low to moderate-- Low -----	Moderate. Low.
80-90	75-85	45-60	20-35	2.0-6.3	0.05-0.08	5.6-7.3	0-1	Low -----	Low.
90-100 90-100 85-95 65-75	90-100 90-100 75-85 60-70	90-100 90-100 70-80 55-65	80-90 85-95 60-75 50-60	0.20-0.63 0.06-0.20 0.06-0.20 0.20-0.63	0.19-0.21 0.15-0.17 0.10-0.12 0.05-0.09	6.1-7.3 6.1-7.3 6.6-7.8 7.4-7.8	0-1 0-1 0-1 0-1	Low ----- Moderate ----- Moderate ----- Moderate -----	Moderate. High. High. Moderate.
90-100 90-100	90-100 90-100	90-100 90-100	85-95 70-95	0.20-0.63 0.20-0.63	0.18-0.20 0.17-0.20	6.1-7.8 6.1-7.8	0-1 0-1	Moderate ----- Moderate -----	Moderate. High.

TABLE 7.—Engineering

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. fully the instructions for referring to other series

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road fill	Winter grading	Terraces and diversions	Farm ponds	
						Reservoir areas	Embankments
Arosa: AR -----	Fair: silty clay loam.	Unsuited: fine grained.	Poor: ML, CL, or CH material.	Plastic when wet; frozen during winter.	Medium to low shear strength; moderate to high shrink-swell potential; fair stability.	Erodible slopes; slowly permeable.	Medium to low shear strength; low permeability when compacted; medium to low piping hazard.
Blamer: BM -----	Poor: slope; stones.	Unsuited: fine grained; stony.	Poor: bedrock at a depth of 9 to 40 inches.	Difficult to break frozen clods; often snow covered.	Bedrock at a depth of 9 to 40 inches; stony; steep.	Bedrock at a depth of 9 to 40 inches; stony; steep.	Bedrock at a depth of 9 to 40 inches; slope is 12 to 55 percent; stony.
Blanca: BN -----	Poor: slope is 25 to 55 percent.	Poor to fair: very cobbly sandy loam and loamy sand.	Poor: slope is 25 to 55 percent.	Difficult to break frozen clods; often snow covered.	Very cobbly; underlying material; steep.	Moderately rapidly permeable; very cobbly underlying material; steep.	Medium to high shear strength; medium to low permeability when compacted; medium piping hazard; slope is 25 to 55 percent.
Brycan: BR, BS ----	Good for BR if slope is 3 to 8 percent, fair if 8 to 15 percent, poor if 15 to 25 percent.	Unsuited: fine grained.	Fair: slope; ML or CL material.	Plastic when wet; frozen during winter.	Moderate shrink-swell potential; banks erode.	Erodible slopes; moderately permeable substratum.	Medium to low shear strength; low permeability when compacted; medium piping hazard.
Caballo: CA, CB, CD	Good for CB if slope is 3 to 8 percent, fair if 8 to 15 percent, poor if more than 15 percent.	Unsuited: fine grained and cobbly.	Poor if slope is more than 25 percent, fair if 3 to 25 percent.	Difficult to break frozen clods; often snow covered.	Very cobbly subsoil; some steep slopes.	Some steep slopes; very cobbly subsoil; moderately permeable.	High to medium shear strength; medium to low permeability when compacted; slope is 3 to 55 percent.

See footnote at end of table.

interpretations

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care—that appear in the first column of this table]

Degree and kind of limitation affecting—						Hydro- logic group
Local roads and streets	Dwellings without basements	Sanitary landfill (trench type) ¹	Shallow excavations	Septic tank absorption fields	Sewage lagoons	
Severe: plastic; moderate to high shrink-swell potential; cut slopes erode.	Moderate: moderate to high shrink-swell potential; areas adjacent to arroyo beds subject to flooding.	Slight on upper slopes; severe on lower slopes; areas adjacent to arroyos subject to flooding.	Severe: clay	Severe: slowly permeable.	Moderate if slope is 1 to 7 percent, severe if 7 to 12 percent.	C
Severe: slope is 12 to 55 percent; bedrock at a depth of 9 to 40 inches; stony.	Severe: slope is 12 to 55 percent; very stony.	Severe: bedrock at a depth of 9 to 40 inches.	Severe: bedrock at a depth of 9 to 40 inches; very stony.	Severe: bedrock at a depth of 9 to 40 inches; slope is 12 to 55 percent.	Severe: slope is 12 to 55 percent; bedrock at a depth of 9 to 40 inches; stony.	C
Severe: slope is 25 to 55 percent; cut slopes erode; moderate hazard of frost heave; severe hazard of snow drifting.	Severe: slope is 25 to 55 percent; subject to sliding.	Severe: slope is 25 to 55 percent.	Severe: slope is 25 to 55 percent; subject to slumping below a depth of 40 inches.	Severe: slope is 25 to 55 percent.	Severe: slope is 25 to 55 percent; moderately rapidly permeable; very cobbly underlying layers.	B
Moderate if slope is 3 to 15 percent; moderate shrink-swell potential; plastic; cut slopes erode. Severe if slope is 15 to 25 percent.	Moderate to severe: moderate shrink-swell potential; slope is 3 to 25 percent.	Moderate: silty clay loam and clay loam.	Slight -----	Severe: moderately slowly permeable.	Moderate if slope is 3 to 7 percent; moderately permeable in substratum. Severe if slope is more than 7 percent.	B
Moderate if slope is 3 to 15 percent: cut slopes erode; moderate hazard of snow drifting; cobbly and very cobbly substratum. Severe if slope is 15 to 55 percent.	Slight if slope is 3 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 55 percent.	Severe: very cobbly and stony underlying material; bedrock within depth of 40 to 80 inches.	Moderate to severe: very cobbly and stony underlying material; bedrock within depth of 40 to 80 inches.	Severe if slope is 15 to 55 percent, moderate if 3 to 15 percent.	Severe if slope is 7 to 55 percent: moderately permeable. Moderate if slope is 3 to 7 percent.	B

TABLE 7.—Engineering

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road fill	Winter grading	Terraces and diversions	Farm ponds	
						Reservoir areas	Embankments
Deama: DA, DE ----	Poor: bedrock at depth of 0.5 foot to 1.5 feet.	Unsuited: bedrock at depth of 0.5 foot to 1.5 feet.	Poor: bedrock at a depth of 0.5 foot to 1.5 feet.	Winter creates no additional problems.	Bedrock at a depth of 7 to 20 inches; some steep slopes.	Some steep slopes; stony; bedrock at a depth of 7 to 20 inches.	Bedrock at a depth of 7 to 20 inches; stony; slope is 1 to 55 percent.
*Firo: FR, FS ----- For Stony land part of FS, see Stony land.	Poor: bedrock at a depth of 0.5 foot to 1.5 feet.	Unsuited: bedrock at a depth of 0.5 foot to 1.5 feet.	Poor: bedrock at a depth of 0.5 foot to 1.5 feet.	Difficult to break frozen clods; often snow covered.	Bedrock at a depth of 7 to 20 inches; stony; steep slopes.	Bedrock at a depth of 7 to 20 inches; slope is 12 to 55 percent; stony.	Bedrock at a depth of 7 to 20 inches; slope is 12 to 55 percent; stony.
Gabaldon: GA ----	Good -----	Unsuited: fine grained.	Fair: ML or CL material.	Slightly plastic when wet.	Low to moderate shrink-swell potential; banks erode.	Side slopes erode; moderately permeable.	Medium to low shear strength; medium to low permeability when compacted; medium piping hazard.
Gaines: GC -----	Fair: silty clay loam.	Unsuited: fine grained.	Fair: CL material.	Plastic when wet; frozen during winter.	Very cobbly underlying layers; moderate shrink-swell potential; banks erode.	Very cobbly; bedrock at a depth of 40 to 72 inches.	Medium shear strength; low to medium permeability when compacted; medium to low piping hazard.
Gaines thin surface variant: GE.	Poor: slope	Unsuited: fine grained.	Poor: fractured bedrock at a depth of 1.5 to 3.5 feet.	Plastic when wet; difficult to break frozen clods; often snow covered.	Moderate shrink-swell potential; subject to cracking; slopes erode; shale and sandstone at a depth of 20 to 40 inches.	Slope is 12 to 55 percent; fractured shale and sandstone at a depth of 20 to 40 inches.	Medium to low shear strength; low permeability when compacted; low to medium piping hazard; fractured shale and sandstone at a depth of 20 to 40 inches; slope is 12 to 55 percent.

See footnote at end of table.

interpretations—Continued

Degree and kind of limitation affecting—						Hydro-logic group
Local roads and streets	Dwellings without basements	Sanitary landfill (trench type) ¹	Shallow excavations	Septic tank absorption fields	Sewage lagoons	
Severe: bedrock at a depth of 7 to 20 inches; slope is 1 to 55 percent.	Severe: shallow to bedrock; very stony.	Severe: shallow to bedrock; very stony.	Severe: shallow to bedrock; very stony.	Severe: bedrock at a depth of 7 to 20 inches; stony.	Severe: slope is 1 to 55 percent; stony; bedrock at a depth of 7 to 20 inches.	C
Severe: bedrock at a depth of 7 to 20 inches; slope is 12 to 55 percent; stony.	Severe: bedrock at a depth of 0.5 foot to 1.5 feet.	Severe: bedrock at a depth of 0.5 foot to 1.5 feet.	Severe: bedrock at a depth of less than 20 inches; very stony.	Severe: bedrock at a depth of 7 to 20 inches; slope is 12 to 55 percent.	Severe: bedrock at a depth of 7 to 20 inches; slope is 12 to 55 percent; stony.	D
Moderate: low to moderate shrink-swell potential; plastic; cut slopes erode.	Slight to moderate: low to moderate shrink-swell potential.	Slight -----	Slight -----	Slight -----	Moderate: slope is 1 to 8 percent; moderately permeable.	B
Moderate if slope is 1 to 15 percent; moderate shrink-swell potential; plastic; cuts erode; susceptible to frost heave. Severe if slope is 15 to 25 percent.	Moderate: moderate shrink-swell potential. Severe if slope is 15 to 25 percent.	Severe: bedrock at a depth of 3.5 to 6 feet.	Moderate: bedrock at a depth of 3.5 to 6 feet. Severe if slope is 15 to 25 percent.	Severe: slowly permeable.	Severe if slope is 7 to 25 percent, moderate if 1 to 7 percent.	C
Severe: slope is 12 to 55 percent; cuts erode; susceptible to frost heave; plastic.	Severe: slope is 12 to 55 percent; susceptible to sliding.	Severe: slope is 12 to 55 percent; bedrock at a depth of 1.5 to 3.5 feet.	Severe: slope is 12 to 55 percent; fractured bedrock and shale at a depth of 1.5 to 3.5 feet.	Severe: moderately slowly permeable; fractured shale and sandstone at a depth of 20 to 40 inches; slope is 12 to 55 percent.	Severe: slope is 12 to 55 percent; fractured shale and sandstone at a depth of 20 to 40 inches.	C

TABLE 7.—Engineering

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road fill	Winter grading	Terraces and diversions	Farm ponds	
						Reservoir areas	Embankments
*Hesperus: HT ----- For Tularosa part, see Tularosa series.	Good if slope is 1 to 8 percent, fair if 8 to 15 percent, poor if 15 to 25 percent.	Unsuited: fine grained.	Poor: CL material.	Plastic when wet; frozen during winter.	Moderate shrink-swell potential; banks erode.	Side slopes erode; moderately permeable.	Medium to low shear strength; low permeability when compacted; low to medium piping hazard.
Irock ----- Mapped only with Pena soils.	Poor: cobbly material.	Poor: GM or GC material.	Good if slope is 12 to 15 percent, fair if 15 to 25 percent, poor if 25 to 55 percent.	Winter creates no additional problems.	Slope is 12 to 55 percent; cobbly; banks erode.	Slope is 12 to 55 percent; cobbly; moderately permeable.	Medium to high shear strength; medium to low permeability when compacted; medium to low piping hazard.
*Jarita: JR ----- For Remunda part, see Remunda series.	Fair: bedrock at a depth of 1.5 foot to 3.5 feet.	Unsuited: fine grained.	Poor: bedrock at a depth of 20 to 40 inches.	Winter creates no additional problems.	Moderate shrink-swell potential; banks erode.	Side slopes erode; bedrock at a depth of 20 to 40 inches; moderately slowly permeable.	Medium to low shear strength; low permeability when compacted; low to medium piping hazard; bedrock at a depth of 20 to 40 inches.
Kuma: KU -----	Good -----	Unsuited: fine grained.	Fair: ML or CL material.	Winter creates no additional problems.	Low to moderate shrink-swell potential; banks erode.	Side slopes erode; moderately permeable.	Medium to low shear strength; medium to low permeability when compacted; medium piping hazard.
Limestone rock land: LM.	Poor: slope is 12 to 55 percent; rock outcrops.	Unsuited: rock outcrops.	Poor: bedrock at a depth of less than 4 inches.	Winter creates no additional problems.	Slope is 12 to 55 percent; bedrock at a depth of less than 4 inches.	Slope is 12 to 55 percent; bedrock at a depth of less than 4 inches.	Bedrock at a depth of less than 4 inches.

See footnote at end of table.

interpretations—Continued

Degree and kind of limitation affecting—						Hydro- logic group
Local roads and streets	Dwellings without basements	Sanitary landfill (trench type) ¹	Shallow excavations	Septic tank absorption fields	Sewage lagoons	
Moderate if slope is 1 to 15 percent; moderate shrink-swell potential; plastic; cut slopes erode. Severe if slope is 15 to 25 percent.	Moderate if slope is 1 to 15 percent; moderate shrink-swell potential. Severe if slope is 15 to 25 percent.	Moderate: clay loam; slope is 1 to 25 percent.	Slight if slope is 1 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 25 percent.	Severe: moderately slowly permeable.	Moderate if slope is 1 to 7 percent, severe if 7 to 25 percent.	B
Severe: slope is 12 to 55 percent; cobbly.	Severe: slope is 12 to 55 percent.	Severe: bedrock at a depth of 40 to 72 inches.	Severe: slope is 12 to 55 percent.	Severe: slope is 12 to 55 percent.	Severe: slope is 12 to 55 percent.	B
Moderate: moderate shrink-swell potential; plastic; cuts erode; bedrock at a depth of 20 to 40 inches.	Moderate: moderate shrink-swell potential; bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches; moderately slowly permeable.	Severe: bedrock at a depth of 20 to 40 inches.	C
Moderate: low to moderate shrink-swell potential; plastic; cut slopes erode.	Moderate: moderate shrink-swell potential.	Moderate: clay loam.	Slight -----	Severe: moderately slowly permeable.	Moderate: slopes mainly 2 to 7 percent.	B
Severe: slope is 12 to 55 percent; bedrock at a depth of less than 4 inches.	Severe: very shallow; very stony and rocky; slope is 12 to 55 percent.	Severe: very shallow; very stony and rocky; slope is 12 to 55 percent.	Severe: very shallow bedrock.	Severe: slope is 12 to 55 percent; bedrock at a depth of less than 4 inches.	Severe: slope is 12 to 55 percent; bedrock at a depth of less than 4 inches.	D

TABLE 7.—Engineering

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road fill	Winter grading	Terraces and diversions	Farm ponds	
						Reservoir areas	Embankments
Mescalero: ME ----	Poor: stony and cobbly.	Unsuited: fine grained and cobbly.	Poor: bedrock at a depth of 20 to 40 inches.	Difficult to break frozen clods; often snow covered.	Bedrock at a depth of 20 to 40 inches; stony; very cobbly subsoil.	Bedrock at a depth of 20 to 40 inches; stony.	High to medium shear strength; medium to low permeability when compacted; medium to low piping hazard.
*Oro Grande: OR -- For Rock land part, see Rock land.	Poor: bedrock at a depth of 0.5 foot to 1.5 feet.	Unsuited: fine grained and stony.	Poor: bedrock at a depth of 0.5 foot to 1.5 feet.	Winter creates no additional problems.	Slope is 12 to 55 percent; bedrock at a depth of 7 to 20 inches; stony.	Slope is 12 to 55 percent; bedrock at a depth of 7 to 20 inches; stony.	Slope is 12 to 55 percent; bedrock at a depth of 7 to 20 inches; stony.
*Pena: PA ----- For Irock part, see Irock series.	Poor: gravelly and cobbly.	Poor: SM and GM material.	Fair if slope is 15 to 25 percent, good if 1 to 15 percent.	Winter creates no additional problems.	Fair stability; erodible slopes; cobbly underlying layers.	Moderately permeable; cobbly underlying layers.	Medium to high shear strength; medium to low permeability when compacted; medium piping hazard.
*Peso: PB, PC ----- For Caballo part of PC, see Caballo series.	Poor: very cobbly.	Unsuited: fine grained and cobbly.	Poor: bedrock at a depth of 1.5 to 3.5 feet.	Difficult to break frozen clods; often snow covered.	Slope is 12 to 55 percent; bedrock at a depth of 20 to 40 inches; cobbly.	Slope is 12 to 55 percent; bedrock at a depth of 20 to 40 inches; cobbly.	Medium to low shear strength; low permeability when compacted; low to medium piping hazard; slope is 12 to 55 percent; bedrock at a depth of 20 to 40 inches.
Pinkel: PK -----	Poor: very cobbly.	Unsuited: very cobbly SC and SM material.	Poor: bedrock at a depth of 0.5 foot to 3.5 feet.	Winter creates no additional problems.	Slope is 12 to 55 percent; bedrock at a depth of 8 to 40 inches; cobbly.	Slope is 12 to 55 percent; bedrock at a depth of 8 to 40 inches; cobbly.	Slope is 12 to 55 percent; bedrock at a depth of 8 to 40 inches; cobbly.

See footnote at end of table.

interpretations—Continued

Degree and kind of limitation affecting—						Hydro- logic group
Local roads and streets	Dwellings without basements	Sanitary landfill (trench type) ¹	Shallow excavations	Septic tank absorption fields	Sewage lagoons	
Moderate: bedrock at a depth of 20 to 40 inches; stony; very cobbly subsoil.	Moderate to severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches; very cobbly within a depth of 10 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches; stony; very cobbly subsoil.	C
Severe: slope is 12 to 55 percent; bedrock at a depth of 7 to 20 inches.	Severe: slope is 12 to 55 percent; shallow over bedrock; stony.	Severe: slope is 12 to 55 percent; shallow over bedrock.	Severe: shallow over bedrock.	Severe: slope is 12 to 55 percent; bedrock at a depth of 7 to 20 inches; stony.	Severe: slope is 12 to 55 percent; bedrock at a depth of 7 to 20 inches; stony.	D
Slight if slope is 1 to 8 percent. Moderate if slope is 8 to 15 percent; erodible where exposed on embankments. Severe if slope is 15 to 25 percent.	Slight if slope is 1 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 25 percent.	Moderate if slope is 1 to 15 percent; very cobbly below a depth of 30 inches. Severe if slope is 15 to 25 percent.	Moderate if slope is 1 to 15 percent; very cobbly below a depth of 30 inches. Severe if slope is 15 to 25 percent.	Moderate if slope is 1 to 15 percent; moderately permeable. Severe if slope is 15 to 25 percent.	Moderate if slope is 1 to 15 percent; moderately permeable. Severe if slope is 7 to 25 percent.	B
Severe: slope is 12 to 55 percent; bedrock at a depth of 20 to 40 inches; cobbly.	Severe: slope is 12 to 55 percent; bedrock at a depth of 1.5 to 3.5 feet.	Severe: slope is 12 to 55 percent; bedrock at a depth of 1.5 to 3.5 feet.	Severe: bedrock at a depth of less than 40 inches; very cobbly.	Severe: slope is 12 to 55 percent; bedrock at a depth of 20 to 40 inches; stony and cobbly.	Severe: slope is 12 to 55 percent; bedrock at a depth of 20 to 40 inches; stony and cobbly.	C
Severe: slope is 12 to 55 percent; bedrock at a depth of 8 to 40 inches; cobbly.	Severe: slope is 12 to 55 percent; bedrock at a depth of 0.5 foot to 3.5 feet.	Severe: slope is 12 to 55 percent; bedrock at a depth of 0.5 foot to 3.5 feet.	Severe: bedrock at a depth of less than 40 inches; very cobbly.	Severe: slope is 12 to 55 percent; bedrock at a depth of 8 to 40 inches; stony and cobbly.	Severe: slope is 12 to 55 percent; bedrock at a depth of 8 to 40 inches; stony and cobbly.	C

TABLE 7.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road fill	Winter grading	Terraces and diversions	Farm ponds	
						Reservoir areas	Embankments
Remunda: RC ----	Fair: silty clay loam.	Unsuited: fine grained.	Poor: CL and CH material.	Winter creates no additional problems.	Medium to low shear strength; moderate to high shrink-swell potential; fair stability; slopes erode.	Side slopes erode; slowly permeable.	Medium to low shear strength; low permeability when compacted; low to medium piping hazard.
Rock land: RD, RE --	Poor: rock outcrops.	Unsuited: rocky.	Poor: rocky; slope is 55 to 75 percent.	Often covered by deep snow drifts and slides.	Slope is 55 to 75 percent; stony and rocky.	Slope is 55 to 75 percent; stony and rocky.	Slope is 55 to 75 percent; stony and rocky.
*Rock outcrop: RG, RK. For Oro Grande part of RG and Supervisor part of RK, see their respective series.	Poor: rock outcrops.	Unsuited: rocky.	Poor: slope is 12 to 75 percent; rocky.	No additional hazard in RG; often deep snow drifts on RK.	Slope is 12 to 75 percent; rocky.	Slope is 12 to 75 percent; rocky.	Slope is 12 to 75 percent; rocky.
Ruidoso: RU -----	Fair: clay loam.	Unsuited: fine grained.	Poor: CL and CH material.	Winter creates no additional problems.	Medium to low shear strength; moderate to high shrink-swell potential; fair stability; slopes erode.	Side slopes erode; slowly permeable.	Medium to low shear strength; low permeability when compacted; low to medium piping hazard.
Shanta: SH -----	Good -----	Unsuited: mainly fine grained; SW-SM substratum is thin and discontinuous.	Fair: ML or CL material.	Winter creates no additional problems.	Fair stability; banks erode.	Pervious substratum; moderately permeable to a depth of 50 inches.	Medium to low shear strength; medium to low permeability when compacted.
Stony land ----- Mapped only with Firo soils.	Poor: stony.	Unsuited: stony and fine grained.	Poor: slope is 12 to 55 percent; stony.	Often snow covered.	Slope is 12 to 55 percent; stony.	Slope is 12 to 55 percent; stony.	Slope is 12 to 55 percent; stony intermingled with shallow soils.

See footnote at end of table.

interpretations—Continued

Degree and kind of limitation affecting—						Hydro-logic group
Local roads and streets	Dwellings without basements	Sanitary landfill (trench type) ¹	Shallow excavations	Septic tank absorption fields	Sewage lagoons	
Severe: moderate to high shrink-swell potential; fair stability; slopes erode.	Moderate to severe: moderate to high shrink-swell potential; some areas subject to flooding from higher side slopes.	Moderate on upper slopes: silty clay loam. Severe on lower slopes; small areas immediately along arroyos subject to flooding.	Slight -----	Severe: slowly permeable.	Slight if slope is 1 to 2 percent, moderate if 2 to 7 percent, severe if 7 to 12 percent.	C
Severe: slope is 55 to 75 percent; stony and rocky.	Severe: steep and very steep; stony and rocky.	Severe: steep and very steep; stony and rocky.	Severe: steep and very steep; stony and rocky.	Severe: slope is 55 to 75 percent; stony and rocky.	Severe: slope is 55 to 75 percent; stony and rocky.	D
Severe: slope is 12 to 75 percent; rocky.	Severe: rock outcrops; slope.	Severe: rock outcrops.	Severe: rock outcrops.	Severe: slope is 12 to 75 percent; rocky.	Severe: slope is 12 to 75 percent; rocky.	D
Severe: moderate shrink-swell potential; cut slopes erode; plastic.	Moderate: moderate shrink-swell potential; small areas immediately along arroyos subject to flooding.	Moderate on upper slopes: clay loam. Severe on lower slopes: areas immediately along arroyos subject to flooding.	Slight -----	Severe: slowly permeable.	Slight if slope is 1 to 2 percent, moderate if 2 to 7 percent, severe if 7 to 8 percent.	C
Moderate: low strength; disturbed and cut slopes erode; slightly plastic.	Slight: some small areas may be flooded from side drainageways.	Slight: some small areas may be flooded from side drainageways.	Slight -----	Slight -----	Severe: gravel beds below a depth of 50 inches.	B
Severe: slope is 12 to 55 percent; stony.	Severe: slope is 12 to 55 percent; stony.	Severe: slope is 12 to 55 percent; stony.	Severe: slope is 12 to 55 percent; stony.	Severe: slope is 12 to 55 percent.	Severe: slope is 12 to 55 percent.	C

TABLE 7.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—			
	Topsoil	Sand and gravel	Road fill	Winter grading	Terraces and diversions	Farm ponds	
						Reservoir areas	Embankments
Supervisor: SU ---	Poor: very stony.	Poor: SM material.	Poor: bedrock at a depth of 1.5 to 3.5 feet; slope is 12 to 65 percent.	Often snow covered; deep drifts are common.	Slope is 12 to 65 percent; bedrock at a depth of 20 to 40 inches; very stony.	Slope is 12 to 65 percent; bedrock at a depth of 20 to 40 inches; moderately rapidly permeable; very stony.	Medium shear strength; medium to low permeability when compacted; medium to high piping hazard; slope is 12 to 65 percent; bedrock at a depth of 20 to 40 inches.
Telefono: TC, TE ---	Fair: clay loam.	Unsuited: fine grained.	Poor: MH and CL material; bedrock at a depth of 20 to 40 inches.	Difficult to break frozen clods; often snow covered.	Bedrock at a depth of 20 to 40 inches; very cobbly substratum; moderate shrink-swell potential.	Bedrock at a depth of 20 to 40 inches; very cobbly substratum; slowly permeable; slope is 3 to 25 percent.	Bedrock at a depth of 20 to 40 inches; low to medium shear strength; low permeability when compacted; medium to low piping hazard.
Terrace escarpments: TR.	Poor: slope is 12 to 55 percent.	Too variable to rate.	Too variable to rate.	Winter creates no additional problems.	Severe: slope is 12 to 55 percent.	Slope is 12 to 55 percent.	Slope is 12 to 55 percent.
Tularosa: TU -----	Fair: silty clay loam.	Unsuited: fine grained.	Poor: CL or CH material.	Plastic when wet; frozen during winter; often snow covered.	Medium to low shear strength; moderate shrink-swell potential.	Side slopes erode; moderately slowly permeable.	Medium to low shear strength; low permeability when compacted; low to medium piping hazard.

¹ Onsite study is needed of the underlying strata and water table to determine the hazards of aquifer pollution and drainage into

Hydrologic groups are used to estimate runoff from rainfall. Soil properties are considered that influence the minimum rate of infiltration obtained for a bare soil after prolonged wetting. These properties are depth to seasonal high water table, intake rate, permeability after prolonged wetting, and depth to very slowly permeable material. The influence of ground cover is treated independently, not in hydrologic groups.

The soils have been classified into four hydrologic groups, A to D.

- A. (Low runoff potential.) Soils having high infiltration rates when thoroughly wet and consisting mainly of deep, well-drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

interpretations—Continued

Degree and kind of limitation affecting—						Hydro-logic group
Local roads and streets	Dwellings without basements	Sanitary landfill (trench type) ¹	Shallow excavations	Septic tank absorption fields	Sewage lagoons	
Severe: bedrock at a depth of 20 to 40 inches; slope is 12 to 65 percent; very stony.	Severe: slope is 12 to 65 percent; very stony.	Severe: bedrock at a depth of 20 to 40 inches; slope is 12 to 65 percent; very stony.	Severe: bedrock at a depth of 20 to 40 inches; slope is 12 to 65 percent; very stony.	Severe: bedrock at a depth of 20 to 40 inches; slope is 12 to 65 percent; very stony.	Severe: slope is 12 to 65 percent; bedrock at a depth of 20 to 40 inches.	C
Severe: bedrock at a depth of 20 to 40 inches; very cobbly substratum; susceptible to frost heave; plastic; slope is 3 to 25 percent slopes.	Moderate: moderate shrink-swell potential; bedrock at a depth of 20 to 40 inches. Severe if slope is 15 to 25 percent.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches; slowly permeable; slope is 3 to 25 percent.	Severe: bedrock at a depth of 20 to 40 inches; very cobbly substratum; slope is 3 to 25 percent.	C
Too variable to rate -----	Severe: slopes susceptible to sliding.	Severe: slopes; severe hazard of erosion.	Severe: slopes; subject to slumping.	Severe: slope is 12 to 55 percent.	Severe: slope is 12 to 55 percent.	B or C
Moderate: plastic; moderate shrink-swell potential; cut slopes erode; susceptible to frost heave.	Moderate: moderate shrink-swell potential; areas immediately along arroyos subject to flooding.	Moderate on upper slopes: clay loam. Severe on lower slopes: areas immediately along arroyos subject to flooding.	Slight -----	Severe: moderately slowly permeable; slope is 1 to 12 percent.	Slight if slope is 1 to 2 percent, moderate if 2 to 7 percent, severe if 7 to 12 percent.	B

ground water in landfill deeper than 5 or 6 feet.

- B. (Moderately low runoff potential.) Soils having moderate infiltration rates when thoroughly wet and consisting mainly of moderately deep to deep, moderately well drained soils that are moderately fine textured to moderately coarse textured. These soils have a moderate rate of water transmission.
- C. (Moderately high runoff potential.) Soils hav-

ing slow infiltration rates when thoroughly wet and consisting mainly of soils that have a layer that impedes downward movement of water, soils that are moderately fine textured to fine textured, or soils that have a water table at a moderate depth. These soils may be somewhat poorly drained.

- D. (High runoff potential.) Soils having very

slow infiltration rates when thoroughly wet and consisting mainly of clay soils that have a high swelling potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Soils and Recreation

The Mescalero-Apache Area occupies a large part of the high, cool Sacramento Mountains and Sierra Blanca and is surrounded by large expanses of plains and deserts. Consequently, it has an unusually high potential for outdoor recreation. A small fee is paid by many picnickers, campers, hunters, hikers, sightseers, and fishermen in search of recreation. Eagle Lake is a major attraction for campers, picnickers, and fishermen and a staging area for hikers, hunters, and sightseers. The Mescalero Agency has already planned and developed better housing in the Area.

Because soils have certain characteristics that affect community development, the information in the paragraphs that follow and in table 8 will be useful to planners and others who use soil material for landscaping or recreational sites. Table 8 is for the general guidance of planning officials and developers who are concerned with using land and avoiding mistakes and costly changes in plans. These interpretations, however, do not replace the need for the direct, detailed onsite investigation in the planning of any development.

In table 8 the soils of the Mescalero-Apache Area are rated according to limitations that affect their suitability for camp areas, playgrounds, picnic areas, paths and trails, and lawns and golf courses.

Limitations for the specified uses shown in table 8 are expressed as slight, moderate, or severe. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they easily can be overcome. A *moderate* limitation is one that can be overcome or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these is required. For all these ratings, it is assumed that a good cover of vegetation can be established and maintained.

Lawns, shrubs, and golf fairways are affected by the suitability of the soil for grasses and shrubs. Irrigation water must be available when needed. Ordinarily, native grasses and shrubs can be grown without irrigation, particularly at higher elevations where more precipitation is received. Soil factors considered are surface texture, coarse fragments, and slope.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes and good drainage, are free of rocks and coarse fragments, are not flooded during periods of heavy use, and are firm after rain but not dusty when dry.

Picnic areas are attractive natural or landscaped

tracts. These areas are subject to heavy foot traffic. Most of the vehicular traffic is confined to access roads. The best soils are firm when wet but not dusty when dry, are not flooded during the season of use, and do not have slopes or stoniness that greatly increases cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use withstand intensive foot traffic. The best soils are nearly level, are free of coarse fragments and rock outcrop, are not flooded during periods of heavy use, have good drainage, and are firm after rain but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross country travel by foot or horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded no more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Formation and Classification of the Soils

This section tells how the factors of soil formation affected soils in the Mescalero-Apache Area. It also explains the current system of soil classification and classifies each soil series according to that system.

Factors of Soil Formation

Soil is the product of soil-forming processes acting on accumulated or deposited geologic material. The five important factors in soil formation are time, relief, parent material, climate, and plant and animal life. These factors control the kind of soil-forming processes and the rate at which they progress. All five factors are active in the formation of every soil, although one factor may dominate the others.

Time.—The kind of horizons and the degree of their formation depend in part on the length of time that the other factors are active.

The lowest degree of formation is in soils that formed in recent water-laid deposits or alluvium. Examples in the Mescalero-Apache Area are Arosa and Brycan soils. These soils receive sediments from the films of sheet water that spread over the Area. The source of the sediments is the very short drainageways that head into the adjoining steeper slopes. The water runs over the area only occasionally and in thin sheets, and it does not create hazards for most land use. Organic matter has accumulated in the surface layer, forming an A horizon. Further differentiation of horizons is weakly expressed.

Ruidoso and Remunda soils are on older geologic terraces of the inner valley. These soils are older, and their horizons are more strongly expressed. They have an A horizon and a well-expressed B2t horizon that has more clay than the A horizon. A weak horizon of precipitated lime is within about 4 feet of the surface. The accumulation of lime and clay in the B2t horizon indicates that these soils are older than the more recently deposited alluvium.

TABLE 8.—Degree and kind of limitations for selected recreational facilities

Soil series and map symbols	Lawns, shrubs, and golf fairways ¹	Campsites	Picnic areas	Playgrounds	Paths and trails
Arosa: AR -----	Moderate: slope is 1 to 12 percent.	Moderate: silty clay loam surface layer is dusty when dry and sticky when wet.	Moderate: silty clay loam surface layer is dusty when dry and sticky when wet.	Slight if slope is 1 to 2 percent, moderate if 2 to 8 percent, severe if 8 to 15 percent.	Moderate: silty clay loam surface layer is dusty when dry and sticky when wet.
Blamer: BM -----	Severe: very stony; slope is 12 to 55 percent.	Severe: slope is 12 to 55 percent; very stony.	Severe: slope is 12 to 55 percent.	Severe: slope is 12 to 55 percent; very stony.	Moderate to severe: slope is 12 to 55 percent; very stony.
Blanca: BN -----	Severe: slope is 25 to 55 percent; stony.	Severe: slope is 25 to 55 percent.	Severe: slope is 25 to 55 percent.	Severe: slope is 25 to 55 percent.	Severe: slope is 25 to 55 percent.
Brycan: BR, BS ----	Moderate to severe: slope is 3 to 25 percent.	Slight to severe: slope is 3 to 25 percent.	Slight to severe: slope is 3 to 25 percent.	Moderate to severe: slope is 3 to 25 percent.	Slight to moderate: slope is 3 to 25 percent.
Caballo: CA, CB, CD-	Severe if slope is 25 to 55 percent, moderate if 3 to 25 percent.	Severe if slope is 15 to 55 percent, moderate if 8 to 15 percent, slight if 3 to 8 percent.	Severe if slope is 15 to 55 percent, moderate if 8 to 15 percent, slight if 3 to 8 percent.	Moderate if slope is less than 8 percent, severe if more than 8 percent.	Slight if slope is 3 to 15 percent, moderate if 15 to 25 percent, severe if 25 to 55 percent.
Deama: DA, DE ----	Severe: shallow over bedrock; very stony.	Severe: slope is 1 to 55 percent; very stony.	Moderate if slope is 1 to 15 percent, severe if 15 to 55 percent; very stony.	Severe: slope is 1 to 55 percent; very stony.	Moderate to severe: slope is 1 to 55 percent; very stony.
Firo: FR, FS ----- For Stony land part of FS, see Stony land.	Severe: slope is 12 to 55 percent; very stony.	Severe: slope is 12 to 55 percent; very stony.	Severe: slope is 12 to 55 percent; very stony.	Severe: slope is 12 to 55 percent; very stony.	Moderate to severe: slope is 12 to 55 percent; very stony.
Gabaldon: GA -----	Moderate: slope is 1 to 8 percent.	Slight -----	Slight -----	Moderate: slope is 1 to 8 percent.	Slight -----
Gaines: GC -----	Moderate: slope is 1 to 25 percent.	Moderate if slope is 1 to 8 percent: silty clay loam surface layer is dusty when dry and sticky when wet. Severe if slope is 15 to 25 percent.	Moderate if slope is 1 to 8 percent: silty clay loam surface layer is dusty when dry and sticky when wet. Severe if slope is 15 to 25 percent.	Moderate if slope is 1 to 8 percent: surface layer is dusty when dry and sticky when wet. Severe if slope is 8 to 25 percent.	Moderate: surface layer is dusty when dry and sticky when wet; slope.
Gaines thin surface variant: GE.	Severe: slope; slowly permeable.	Severe: slope ----	Severe: slope is 12 to 55 percent.	Severe: slope is 12 to 55 percent.	Moderate to severe: slope is 12 to 55 percent.
Hesperus: HT ----- For Tularosa part, see Tularosa series.	Moderate: slope is 1 to 25 percent.	Slight if slope is 1 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 25 percent.	Slight if slope is 1 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 25 percent.	Moderate if slope is less than 8 percent, severe if more than 8 percent.	Slight -----
Irock ----- Mapped only with Pena soils.	Severe: slope is 12 to 55 percent; cobbly; low water holding capacity.	Severe: slope is 12 to 55 percent; cobbly.	Severe: slope is 12 to 55 percent; cobbly.	Severe: slope is 12 to 55 percent; cobbly.	Moderate to severe: slope is 12 to 55 percent; cobbly.
Jarita: JR ----- For Remunda part, see Remunda series.	Moderate: slope is 1 to 12 percent.	Slight to moderate: slope is 1 to 12 percent.	Slight to moderate: slope is 1 to 12 percent.	Moderate to severe: slope is 1 to 12 percent.	Slight -----
Kuma: KU -----	Moderate: slope is 1 to 8 percent.	Slight -----	Slight -----	Moderate: slope is 1 to 8 percent.	Slight -----

TABLE 8.—Degree and kind of limitations for selected recreational facilities—Continued

Soil series and map symbols	Lawns, shrubs, and golf fairways ¹	Campsites	Picnic areas	Playgrounds	Paths and trails
Limestone rock land: LM.	Severe: very shallow; very stony.	Severe: slope is 12 to 55 percent; very stony.	Severe: slope is 12 to 55 percent; very stony.	Severe: slope is 12 to 55 percent; very stony.	Moderate to severe: slope is 12 to 55 percent; very stony; rocky.
Mescalero: ME -----	Severe: bedrock at a depth of 20 to 40 inches; stony.	Moderate: silty clay loam surface layer becomes sticky when wet; stony.	Moderate: silty clay loam surface layer becomes sticky when wet; stony.	Severe: slope is 1 to 12 percent; stony.	Moderate: silty clay loam surface layer becomes sticky when wet; stony.
Oro Grande: OR --- For Rock land part, see Rock land.	Severe: slope is 12 to 55 percent; shallow; stony.	Severe: slope is 12 to 55 percent; stony.	Severe: slope is 12 to 55 percent; stony.	Severe: slope is 12 to 55 percent; stony.	Moderate to severe: slope is 12 to 55 percent; stony.
Pena: PA ----- For Irock part, see Irock series.	Moderate to severe: slope is 1 to 25 percent; available water holding capacity is 5 or 6 inches.	Slight if slope is 1 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 25 percent.	Slight if slope is 1 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 25 percent.	Moderate if slope is 1 to 8 percent, severe if 8 to 25 percent.	Slight if slope is 1 to 15 percent, moderate if 15 to 25 percent.
Peso: PB, PC ----- For Caballo part of PC, see Caballo series.	Severe: slope is 12 to 55 percent; very cobbly.	Severe: slope is 12 to 55 percent; very cobbly.	Severe: slope is 12 to 55 percent; very cobbly.	Severe: slope is 12 to 55 percent; very cobbly.	Moderate if slope is 12 to 25 percent; very cobbly. Severe if slope is 25 to 55 percent.
Pinkel: PK -----	Severe: slope is 12 to 55 percent; very cobbly.	Severe: slope is 12 to 55 percent; very cobbly.	Severe: slope is 12 to 55 percent; very cobbly.	Severe: slope is 12 to 55 percent; very cobbly.	Moderate if slope is 12 to 25 percent; very cobbly. Severe if slope is 25 to 55 percent.
Remunda: RC -----	Moderate: slope is 1 to 12 percent.	Moderate: silty clay loam surface layer; sticky when wet.	Moderate: silty clay loam surface layer; sticky when wet.	Moderate if slope is 1 to 8 percent, severe if 8 to 12 percent.	Moderate: silty clay loam surface layer is sticky when wet.
Rock land: RD, RE --	Severe: steep and very steep; stony and rocky.	Severe: steep and very steep; stony and rocky.	Severe: steep and very steep; stony and rocky.	Severe: steep and very steep; stony and rocky.	Severe: steep and very steep; stony and rocky.
Rock outcrop: RG, RK. For Oro Grande and Supervisor parts, see their respective series.	Severe: rock outcrops.	Severe: rock outcrops.	Severe: rock outcrops.	Severe: rock outcrops.	Severe: rock outcrops.
Ruidoso: RU -----	Moderate: slope is 1 to 8 percent.	Moderate: clay loam surface layer is sticky when wet.	Moderate: clay loam surface layer is sticky when wet.	Moderate: slope is 1 to 8 percent.	Moderate: clay loam surface layer is dusty when dry and sticky when wet.
Shanta: SH -----	Moderate: slope is 1 to 8 percent.	Slight -----	Slight -----	Moderate: slope is 1 to 8 percent.	Slight.
Stony land ----- Mapped only with Firo soils.	Severe: slope is 12 to 55 percent; stony.	Severe: slope is 12 to 55 percent; stony.	Severe: slope is 12 to 55 percent; stony.	Severe: slope is 12 to 55 percent; stony.	Severe: slope is 12 to 55 percent; stony.
Supervisor: SU -----	Severe: slope is 12 to 65 percent; very stony; bedrock at a depth of 20 to 40 inches.	Severe: slope is 12 to 65 percent; very stony.	Severe: slope is 12 to 65 percent; very stony.	Severe: slope is 12 to 65 percent; very stony.	Moderate if slope is 12 to 25 percent; very stony. Severe if slope is 25 to 65 percent.

TABLE 8.—Degree and kind of limitations for selected recreational facilities—Continued

Soil series and map symbols	Lawns, shrubs, and golf fairways ¹	Campsites	Picnic areas	Playgrounds	Paths and trails
Telefono: TC, TE ---	Moderate if slope is 3 to 12 percent, severe if 12 to 25 percent.	Moderate if slope is 3 to 15 percent: clay loam surface layer. Severe if slope is 15 to 25 percent.	Moderate if slope is 3 to 15 percent: clay loam surface layer is sticky when wet. Severe if slope is 15 to 25 percent.	Moderate if slope is 3 to 8 percent: clay loam surface layer is sticky when wet. Severe if slope is 8 to 25 percent.	Moderate: slope is 3 to 25 percent: clay loam surface layer is sticky when wet.
Terrace escarpments: TR.	Severe: slope; severe hazard of erosion.	Severe: slope ----	Severe: slope ----	Severe: slope ----	Moderate if slope is 12 to 25 percent, severe if 25 to 55 percent.
Tularosa: TU -----	Moderate: slope is 1 to 12 percent.	Moderate: silty clay loam surface layer is dusty when dry and sticky when wet; slope.	Moderate: silty clay loam surface layer is dusty when dry and sticky when wet; slope.	Moderate if slope is 1 to 8 percent, severe if 8 to 12 percent.	Moderate: silty clay loam surface layer is dusty when dry and sticky when wet.

¹ Irrigation is essential in establishing and maintaining lawns, shrubs, and golf fairways within vegetative belts 1, 2, and 3. Native shrubs and grasses can be grown without irrigation.

The soils derived from limestone formed more slowly than other soils in the Area.

Relief.—Relief, or lay of the land, influences soil formation by its effect on moisture, temperature, and erosion. Differences in elevation and aspect are associated with differences in climate and vegetation. Generally, the deeper and more strongly developed soils are in areas of gentle topography where runoff is slower and the loss of soil through erosion is less. Examples are Remunda and Ruidoso soils. The shallower, less strongly formed soils, such as Firo and Oro Grande soils, are on ridgetops and moderately steep to steep slopes where runoff is faster and more soil is lost through erosion.

Northerly and southerly exposures differ markedly in their effects on soil formation in this Area, especially at the higher elevations and on the steeper slopes. The soils on north-facing slopes have a thicker layer of litter and a darker and thicker A1 horizon than the soils on south-facing slopes. An example is where the Peso soils on southerly exposures are associated with the Caballo soils on northerly exposures. These elevations are about 7,900 to 9,000 feet. At lower elevations and on more gentle topography, differences in aspect have much less effect on soil formations.

Parent material.—Igneous rocks, mostly acid; sedimentary rocks, including shales; and unconsolidated deposits have all contributed to the parent material of the soils of the Mescalero-Apache Area. The soils on hills and mountainsides formed in residuum weathered from various kinds of rock and shale. The valley fill and terrace soils formed in mixed sediment derived from alluvium and from rocks and soils of the foothills and mountains. Dust from adjacent arid areas has been deposited by wind over all parts of the Area and has also influenced the soils.

Limestone is widespread. It has strongly influenced the formation of many of the soils. Deama, Mescalero, and Peso soils formed in limestone. They generally have more lime in at least some part of the profile. Some

fine-grained sandstone, siltstone, and shale are the source of the parent material of Blamer and Pinkel soils. Hard acid igneous rocks are a source of parent material for Oro Grande, Firo, and Supervisor soils. These soils have considerably less lime in their profiles than similar soils that formed in limestone parent material.

Old valley fills, old terrace deposits, and recent alluvial deposits contain a mixture of parent material that varies widely in composition and texture. Sediments derived from acid igneous rock are coarser textured than those derived from limestone, sandstone, and shale.

In some small areas parent material has characteristics of glacial deposits. For example, the Blanca and Caballo soils in the northwestern part of the Area near the Sierra Blanca are deep and very cobbly.

Climate.—Climate strongly affects the kind of vegetation, the rate at which organic matter decomposes, the rate of minerals' weathering, and the removal or accumulation of material in different soil horizons.

The climate of the Mescalero-Apache Area ranges from warm semiarid to cold subhumid. The average annual precipitation ranges from about 11 inches at lower elevations, or about 5,500 to 6,500 feet, to more than 26 inches at Sierra Blanca Peak, which has an elevation of slightly more than 12,000 feet.

Because the climate at lower elevations is warm and dry, the surface layer contains little organic matter. In the cooler climate at higher elevations, the rate of organic matter decomposition decreases and the more vigorous vegetative growth supplies more organic matter.

The soils at lower elevations usually contain more lime or are shallower over lime than the soils at higher elevations. The depth to which the lime is leached depends largely on the amount of water that has moved downward through the soil. The amount of water that moves into and through the soil depends on the amount of rainfall and the length of time the soil is exposed

to rainfall. Examples are Ruidoso soils, which average 11 to 15 inches of annual precipitation and are leached of lime to a depth of 28 inches, and the Arosa soils, which average 18 to 22 inches of annual precipitation and are leached of lime to a depth of 52 inches. These soils are similar and are derived from similar parent material.

Climate largely controls the natural vegetation that grows in the Area, for example, the open mid and short grasses at the lower elevations and the heavy stands of timber at the higher elevations.

Plant and animal life.—Trees, shrubs, and grasses and earthworms, gophers, badgers, and other burrowing animals and micro-organisms are important in soil formation. By introducing grazing animals, man has reduced the amount of vegetation on the soil and thus has gradually decreased the amount of organic matter in the soil. Many activities of living organisms and animals in the soil increase the water intake rate and depth to which moisture can penetrate. Micro-organisms decompose organic matter and release plant nutrients for use by the plant.

Classification of the Soils

Soils are classified so that it is easier to remember their significant characteristics. Classification enables one to assemble knowledge about soils and to see their relationship to one another and to the whole environment. Classification makes it easier to develop principles that help us to understand the behavior of soils and their response to manipulation. Through classification and the use of soil maps, one can apply knowledge of soils to specific areas or tracts of land.

In detailed soil surveys soils are placed in narrow classes so that knowledge about the soil can be organized and applied in managing rangeland or woodland,

in developing rural or urban areas, in engineering works, and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965 (9). This system is under continual study.

Table 9 shows the classification of each soil series in the Soil Taxonomy by family, subgroup, and order. The categories are briefly defined in the following paragraphs. A description of each soil series in the Area, including a representative profile description, is in the section "Descriptions of the Soils."

Order.—Ten orders are recognized in Soil Taxonomy. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols.

The properties used to differentiate among the soil orders are those that tend to give broad climatic groupings of the soils. The exceptions, Entisols and Histosols, occur in many different climates.

Table 9 shows two soil orders in the Mescalero-Apache Area, Mollisols and Alfisols. Mollisols have a dark-colored surface layer that is friable and soft, is more than 1 percent organic matter, and has a high supply of bases. Alfisols have a horizon of clay accumulation. Their surface layer is either lighter in color, lower in bases, or lower in content of organic matter than that of Mollisols.

Suborder.—Each order is divided into suborders, mainly on the basis of those characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect soil differences that result from climate or vegetation.

Great group.—Each suborder is divided into great

TABLE 9.—Soil series classified according to the current system of classification

Series	Family	Subgroup	Order
Arosa	Fine, mixed	Cumulic Udic Haploborolls	Mollisols.
Blamer	Loamy-skeletal, mixed	Ruptic-Lithic Haploborolls	Mollisols.
Blanca	Loamy-skeletal, mixed	Pachic Cryoborolls	Mollisols.
Brycan	Fine-loamy, mixed	Cumulic Haploborolls	Mollisols.
Caballo	Loamy-skeletal, mixed	Pachic Cryoborolls	Mollisols.
Deama	Loamy-skeletal, carbonatic, mesic	Lithic Calcistolls	Mollisols.
Firo	Loamy-skeletal, mixed	Lithic Haploborolls	Mollisols.
Gabaldon	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Gaines	Fine, mixed	Pachic Argiborolls	Mollisols.
Gaines thin surface variant	Fine, mixed	Mollic Eutroboralfs	Alfisols.
Hesperus	Fine-loamy, mixed	Pachic Argiborolls	Mollisols.
Irock	Loamy-skeletal, mixed, mesic	Aridic Argiustolls	Mollisols.
Jarita	Fine-loamy, mixed, mesic	Pachic Argiustolls	Mollisols.
Kuma	Fine-silty, mixed, mesic	Pachic Argiustolls	Mollisols.
Mescalero	Loamy-skeletal, mixed	Pachic Haploborolls	Mollisols.
Oro Grande	Loamy-skeletal, mixed, mesic	Lithic Haplustolls	Mollisols.
Pena	Loamy-skeletal, mixed, mesic	Aridic Calcistolls	Mollisols.
Peso	Loamy-skeletal, mixed	Typic Haploborolls	Mollisols.
Pinkel	Loamy-skeletal, mixed, mesic	Ruptic-Lithic Haplustolls	Mollisols.
Remunda	Fine, mixed, mesic	Aridic Argiustolls	Mollisols.
Ruidoso	Fine, mixed, mesic	Pachic Argiustolls	Mollisols.
Shanta	Fine-loamy, mixed, mesic	Cumulic Haplustolls	Mollisols.
Supervisor	Loamy-skeletal, mixed	Typic Cryoborolls	Mollisols.
Telefono	Fine, mixed	Argic Pachic Cryoborolls	Mollisols.
Tularosa	Fine-silty, mixed	Pachic Cryoborolls	Mollisols.

groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. Criteria used in this Area are presence or absence of horizons of clay or carbonate accumulation.

Subgroup.—Each great group is divided into subgroups, one that represents the central (typic) segment of the group and others, called intergrades, that have properties of one great group and also one or more properties of another great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives in front of the name of the great group. An example is Pachic Argiustolls.

Family.—Families are established within each subgroup mainly on the basis of properties important to the growth of plants or behavior of soils where used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, and thickness of horizons. An example is the fine-loamy, mixed, mesic family of Pachic Argiustolls.

Laboratory Analysis

The results of laboratory analysis of samples taken,

by horizons, from selected soil profiles are shown in table 10. Unless otherwise stated, samples were analyzed and the determinations made at the Soils Laboratory, Bureau of Indian Affairs, Gallup, N. Mex. The analyses were made according to procedures described in the U.S. Department of Agriculture Handbook No. 60 (8) and Soil Survey Investigations Report No. 1 (10). The profiles listed are described in the section "Descriptions of the Soils" unless otherwise noted in the table.

General Nature of the Area

This section was prepared for those who want general information about the Mescalero-Apache Area. It describes the geology, relief, drainage, and climate of the Area and the transportation.

Geology, Relief, and Drainage

Most of the Area is mountainous. The crest of the Sacramento Mountains and the Sierra Blanca runs

TABLE 10.—Laboratory analysis of selected soils

[Dashes indicate no analysis]

Soils	Horizon	Depth from surface	Reaction		Electrical conductivity (ECx10 ³)	Organic-matter content	Mechanical analysis ¹		
			Paste	1:5 suspension			Sand	Silt	Clay
		Inches	pH	pH	Percent	Percent	Percent	Percent	Percent
Blanca stony sandy loam. ²	A11	0-16	5.8	6.2	0.47	4.12	63	21	16
	A12								
Brycan loam. ³	B2	16-40					38	33	29
Gabaldon loam. ²	A11	0-4	7.7	8.5	1.08	5.01	28	48	24
	A12	4-16	7.6	8.5	1.25	3.73	25	48	27
	B2	16-31	7.6	8.5	3.20	2.80	28	46	26
Kuma loam. ²	A1	0-5	7.4	8.0	.95	3.29	36	42	22
	B21t	5-11	7.8	8.5	1.20	2.27	34	38	28
	B22t	11-22	7.8	8.5	1.63	1.88	34	38	28
	B23t	22-37	7.9	8.4	3.05	1.04	36	36	28
	B2tb	37-60	7.5	7.8	3.60	.36	40	22	38
Pena gravelly loam. ²	A1	0-8	7.6	8.5	.97	3.03	52	30	18
	AC	8-18	7.9	8.5	1.43	1.89	50	30	20
	C1ca	18-30	8.0	8.1	3.30	.55	50	24	26
Remunda silty clay loam. ³	B21t	19-38					17	32	51
Telefono clay loam. ²	A1	0-2	6.5	6.9	.89	15.54	26	46	28
	B21t	2-6			.60	5.12	18	44	38
Telefono clay loam. ³	B22t	6-14					8	40	52
Tularosa silty clay loam. ^{2,4}	B2	9-31	7.6	8.1	.55	5.8	22	47	31

¹ Coarse fragments coarser than sand (2.0 millimeters) discarded in sampling. The percentages of sand, silt, and clay are of material less than 2 millimeters in diameter.

² Analysis by Bureau of Indian Affairs, Area soils laboratory, Gallup, N. Mex. The hydrometer method was used for particle-size distribution.

³ Analysis by Soil Conservation Service Survey Laboratory, Lincoln, Nebr. The particle-size distribution was determined by Method 3A1 (10).

⁴ Profile is not the one described in the section "Descriptions of the Soils," but is nearby.

north and south through the Area. The Sierra Blanca, or White Mountains, are in the northwestern part, and the Sacramento Mountains are in the south-central and southwestern parts. The east slope drains into small closed basins and out of the Area into the Pecos River. The west slope drains out of the Area into the Tularosa Basin. The highest point is the 12,003-foot summit of Sierra Blanca Peak. The lowest point is at approximately 5,450 feet in the extreme northwest corner where Indian Creek leaves the Area.

San Andres Limestone and rock outcrop of the Yeso Formation cover most of the Area; at the higher elevations in the northwestern corner, however, is mixed intrusive igneous material that is Tertiary in age. Narrow bands of Cretaceous rock formations, mainly Mancos Shales and Dakota Sandstone, outcrop in an area that extends from southwest to northeast just south of the Sierra Blanca. Figure 16 shows the general geologic pattern of the Area (3). Most of the Area is stony and rocky. Deep alluvial soils are near waterways. The largest areas of deep alluvial deposits are along the eastern boundary and in the northwest corner.

Climate⁴

The Mescalero Apache Indian Reservation is in a relatively high, mountainous, forested area where the elevation changes within short distances and thus causes considerable variation in local climate. Elevations range from nearly 5,500 feet in the lower valleys to more than 12,000 feet at Sierra Blanca Peak.

The main source of moisture for the Area is the Gulf of Mexico. Moisture-laden air from the Gulf moves around the Bermuda high-pressure area and enters New Mexico in the clockwise general circulation from the southeast. This path results in an upslope flow of moist air on the mountains and a general increase in precipitation as the altitude increases. More than half the average annual precipitation falls during the period July to September. The average number of thunderstorms in the rainy season is 27. These storms, resulting from solar heating aided by the upslope flow of moist air, are brief, but often heavy. On the average, 10 to 15 days a year have precipitation of 0.50 inch or more. The frequency generally increases with increasing elevation. Indicative of rainfall intensity in the Area are the greatest 24-hour rainfall of 4.78 inches at White Tail on September 21-22, 1941, and values at Mescalero of 0.53 inch in 15 minutes, July 28, 1939; and 1.40 inches in 40 minutes, August 13, 1939.

Because the mountains have a shielding effect, the average annual precipitation in valleys, such as at Mescalero, is about 18 inches. In the higher mountains of the central and northwestern parts, the annual average precipitation is 24 inches or more.

Precipitation is lightest in spring and fall. The main source of moisture in winter is storms from the Pacific Ocean that move eastward in the general air circulation. The increase in precipitation in winter is small because much of the moisture from the ocean is re-

moved by the mountains to the west before it reaches New Mexico.

The amount of precipitation varies greatly from year to year, as shown by annual totals at White Tail of 62.45 inches in 1941 and 13.02 inches in 1934, and September totals of 16.18 inches in 1941 and 0.20 inch in 1945.

Snowfall, which depends upon temperature as well as moisture supply, is even more variable with elevation than total precipitation. Average annual snowfall ranges from about 2 feet at lower elevations to 4 feet at elevations of about 7,500 feet, 6 feet at elevations of about 8,500 feet, and even more in the highest mountains. The main snowfall period at Mescalero, December to March, has a monthly average of 5 to 6 inches. April and November average 1 inch to 2 inches. At White Tail, snowfall is similar in distribution, but about double that at Mescalero, and the snowfall season is longer.

The general patterns of precipitation and temperatures at Mescalero are shown in table 11. These are representative of other localities if allowance is made for differences of elevation and topography.

Because of elevation, temperatures are generally cool throughout the year. Mean annual temperature is about 50° F. at Mescalero (6,800 feet) and decreases about 3½ degrees for each 1,000 feet of increase in elevation. At valley locations the average minimum temperature is frequently lower than would otherwise be expected, because of radiational cooling of the air and resulting drainage of the cooled air from the adjacent mountainsides into the valleys.

Temperatures of 90° or higher occur an average of 5 days a year at Mescalero, but are unlikely above an elevation of 9,000 feet. Freezing temperatures occur an average of 153 days a year at Mescalero, and probably about 200 days a year at an elevation of 9,000 feet. Extremes at Mescalero have been 100° and -19°.

The probability of occurrence of spring and fall temperature thresholds at Mescalero is shown in table 12. The average number of days between the freezing temperature thresholds at Mescalero is 148 days, or a growing season of approximately 5 months. Elevation and topography greatly influence the length of the growing season in other areas.

Sunshine occurs an average of approximately 3,400 hours annually, or about 75 percent of the possible hours. Relative humidity is fairly low and averages about 45 percent in spring and early in summer and 55 percent in other seasons. Average annual evaporation, as measured from a Class A pan, is estimated at 93 inches a year, of which 62 inches occur from May to October. The prevailing wind direction at Mescalero is west, except for east in the summer rainy season. The east-west orientation of the valley at Mescalero influences the surface wind direction. Winds in other parts of the Area are likely to be more southerly. Winds are stronger in spring. Average windspeed is 14 miles per hour in spring and 8 miles per hour in summer. No tornadoes have been reported in the Area.

Transportation

The Mescalero-Apache Area has adequate transportation facilities. U.S. Highway No. 70 crosses the Area

⁴ By FRANK E. HOUGHTON, National Oceanic and Atmospheric Administration, climatologist for New Mexico.

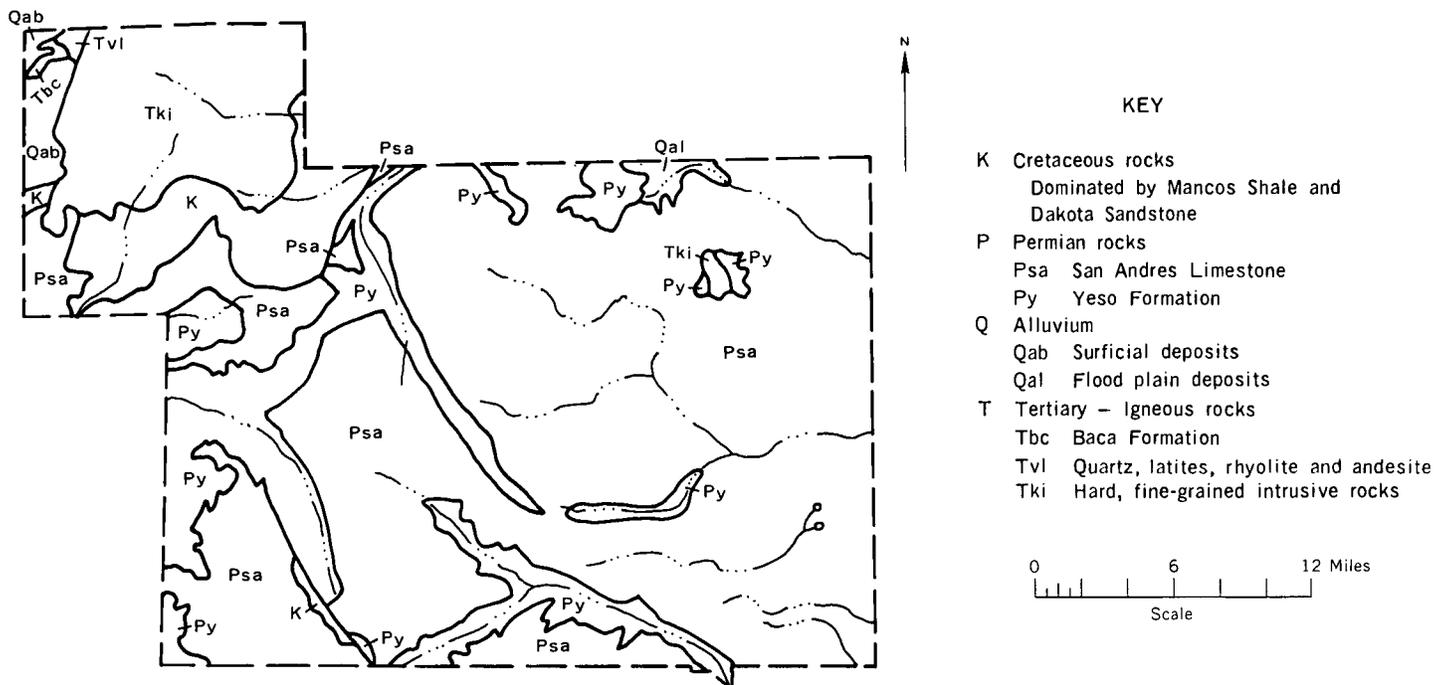


Figure 16.—Geology map of Mescalero-Apache Area.

TABLE 11.—Temperature and precipitation
[All data from Mescalero, N. Mexico., 1931-60]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average total	One year in 10 will have—		Average number of days with precipitation of—	
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—	0.10 inch or more	0.25 inch or more
	°F	°F	°F	°F	Inches	Inches	Inches		
January	48	20	60	7	1.1	0.1	2.1	2	1
February	52	23	64	8	1.0	.1	2.0	3	2
March	57	26	68	15	.9	.1	1.8	2	1
April	66	33	77	23	.7	(¹)	1.3	2	1
May	73	41	83	30	.9	(¹)	2.3	2	1
June	82	46	90	40	1.4	.3	2.8	4	2
July	82	52	89	45	3.6	1.6	5.2	9	5
August	80	51	87	46	3.7	1.6	5.8	7	5
September	77	44	85	38	2.1	.3	4.8	4	3
October	68	37	78	28	1.3	.3	2.5	3	2
November	58	27	68	15	.7	(¹)	1.5	2	1
December	50	22	62	8	1.1	.1	2.2	3	1
Year	66	35	^a 92	^a 0	18.5	11.2	29.4	43	25

¹ Less than 0.05 inch.
^a Average annual maximum.

^a Average annual minimum.

TABLE 12.—Probabilities of last freezing temperatures in spring and first in fall

[All data from Mescalero, Otero County, N. Mex., 1929–49, 1952–60]

Probability	Dates for given probability at temperature of—						
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower	36° F. or lower	40° F. or lower
Spring:							
1 year in 10 later than -----	April 5	April 22	May 4	May 16	May 31	June 8	June 21
2 years in 10 later than -----	March 29	April 14	April 27	May 13	May 26	June 4	June 17
5 years in 10 later than -----	March 15	March 31	April 13	May 2	May 16	May 26	June 9
Fall:							
1 year in 10 earlier than ----	November 1	October 26	October 17	October 9	September 28	September 18	July 29
2 years in 10 earlier than ----	November 7	October 31	October 22	October 13	September 30	September 23	August 11
5 years in 10 earlier than ----	November 17	November 11	November 1	October 22	October 11	October 3	September 5

in a southwest-northeast direction. All-weather roads go from Mescalero within the Area to Cloudcroft, New Mexico and several other points. Another paved road goes from Ruidoso north of the Area up to the Sierra Blanca ski area, which is operated by the Mescalero Agency. It is on the north slope of Sierra Blanca, which is partly within the Area.

The closest railroad for freight is at Tularosa. There are connections by commercial bus lines from Alamogordo, Tularosa, and Ruidoso to various points throughout the country.

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Glossary

- Alkali soil.** Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.
- Alluvium.** Soil material, such as sand, silt, or clay, that has been deposited on land by streams.
- Available water capacity** (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.
- Calcareous soil.** A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.
- Caliche.** A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.
- 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.
- Coarse fragments.** Mineral or rock particles more than 2 millimeters in diameter.
- Cobble.** A rounded or partly rounded fragment of rock, 3 to 10 inches in diameter.
- Colluvium.** Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.
- Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—
- Loose.*—Noncoherent when dry or moist; does not hold together in a mass.
- Friable.*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
- Firm.*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

- Plastic.**—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a “wire” when rolled between thumb and forefinger.
- Sticky.**—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.
- Hard.**—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
- Soft.**—When dry, breaks into powder or individual grains under very slight pressure.
- Cemented.**—Hard and brittle; little affected by moistening.
- Erosion.** The wearing away of the land surface by wind (sand-blast), running water, and other geological agents.
- Horizon, soil.** A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:
- O horizon.**—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.
- A horizon.**—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).
- B horizon.**—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.
- C horizon.**—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.
- R layer.**—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.
- Igneous rock.** Rock that has been formed by the cooling of molten mineral material. Examples: Granite, syenite, diorite, and gabbro.
- Parent material.** Disintegrated and partly weathered rock from which soil has formed.
- Permeability.** The quality that enables the soil to transmit water or air. Terms used to describe permeability, are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid, and very rapid.*
- pH value.** A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.
- Reaction, soil.** The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or “sour,” soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		pH
Medium acid	-----5.6 to 6.0	Strongly alkaline	---8.5 to 9.0
Slightly acid	-----6.1 to 6.5	Very strongly alkaline	----9.1 and higher

- Saline soil.** A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.
- Sand.** Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.
- Silt.** Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.
- Soil.** A 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 on earthly parent material, as conditioned by relief over periods of time.
- Solum.** The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.
- Stones.** Rock fragments greater than 10 inches in diameter if rounded, and greater than 15 inches along the longer axis if flat.
- Structure, soil.** The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).
- Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.
- Substratum.** Technically, the part of the soil below the solum.
- Surface soil.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.
- Terrace (geological).** An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.
- Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.”
- Topsoil.** A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

	pH		pH
Extremely acid	---Below 4.5	Neutral	-----6.6 to 7.3
Very strongly acid	---4.5 to 5.0	Mildly alkaline	----7.4 to 7.8
Strongly acid	-----5.1 to 5.5	Moderately alkaline	-7.9 to 8.4

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a range site, timber group, or wildlife habitat group, read the introduction to the section it is in for general information about its management. Other information is given in tables as follows:

Acreeage and extent, table 1, page 6.
Estimated yields, table 2, page 32.

Engineering, tables 5, 6, and 7, pages 52 through 69.
Recreation, table 8, page 71.

Map symbol	Mapping unit	Page	Name	Symbols	Page	Range site	Timber group	Wildlife habitat group
AR	Arosa silty clay loam, 1 to 12 percent slopes-----	7	Clayey	3Cy, 3cCy	31		---	B
BM	Blamer very stony loam, 12 to 55 percent slopes-----	7	Steep Shallow	3cSSw, 3dSSw	37		3	F
BN	Blanca stony sandy loam, 25 to 55 percent slopes-----	8	Steep	5St	36		6	F
BR	Brycan loam, 3 to 25 percent slopes-----	8	Loamy	3Lo, 3cLo	35		2	B
BS	Brycan silty clay loam, 3 to 25 percent slopes-----	9	Clayey	3Cy, 3cCy,	31		2	B
CA	Caballo clay loam, 25 to 55 percent slopes-----	10	Steep	3dCy 4cSt, 4dSt	36		5	F
CB	Caballo loam, 3 to 25 percent slopes-----	10	Loamy	4Lo	35		---	F
CD	Caballo loam, 25 to 55 percent slopes-----	10	Steep	4St	36		---	F
DA	Deama very stony loam, 1 to 12 percent slopes-----	10	Limestone	1Li, 2Li, 2aLi	34		---	C
DE	Deama very stony loam, 12 to 55 percent slopes-----	10	Steep Shallow	2SSw, 2aSSw	37		---	C
FR	Firo very stony loam, 12 to 55 percent slopes-----	12	Steep Shallow	3cSSw, 3dSSw	37		4	F
FS	Firo-Stony land complex, 12 to 55 percent slopes-----	12	Steep Shallow	4cSSw, 4dSSw	37		5	F
GA	Gabaldon loam, 1 to 8 percent slopes-----	12	Loamy	2Lo, 2aLo	35		---	A
GC	Gaines silty clay loam, 1 to 25 percent slopes-----	14	Clayey	3cCy, 3dCy	31		1	B
GE	Gaines clay loam, thin surface variant, 12 to 55 percent slopes-----	14	Steep Shallow	3cSSw, 3dSSw	37		3	F
HT	Hesperus-Tularosa association, strongly sloping-----	15	Loamy	3Lo, 3cLo	35		---	B
JR	Jarita-Remunda association, gently sloping-----	17	Clayey	2Cy	31		---	---
	Jarita soil-----	--	-----	-----	---		---	D
	Remunda soil-----	--	-----	-----	---		---	A
KU	Kuma loam, 1 to 8 percent slopes-----	18	Loamy	2Lo, 2aLo	35		---	A
LM	Limestone rock land-----	18	Steep Very Shallow	1SVS, 2SVS	39		---	C
ME	Mescalero stony silty clay loam, 3 to 12 percent slopes-----	19	Limestone	3Li, 3cLi	34		3	F
OR	Oro Grande-Rock land complex, 12 to 55 percent slopes-----	20	Steep Shallow	2SSw, 2aSSw	37		---	C
PA	Pena-Irock association, strongly sloping-----	21	-----	-----	--		---	---
	Pena soil-----	--	Loamy	2Lo	35		---	D
	Irock soil-----	--	Steep Gravelly	2aSGr, 2SGr	37		---	C
PB	Peso very cobbly clay loam, 12 to 55 percent slopes-----	21	Steep Shallow	3cSSw, 3dSSw	37		3	F

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Range site		Page	Timber group	Wildlife habitat group
			Name	Symbols		Symbol	Symbol
PC	Peso-Caballo association, steep---	22	Steep Shallow	4cSSw, 4dSSw	37	5	F
PK	Pinkel very cobbly loam, 12 to 55 percent slopes-----	22	Steep Shallow	2SSw, 2aSSw	37	---	C
RC	Remunda silty clay loam, 1 to 12 percent slopes-----	23	Clayey	2Cy	31	---	A
RD	Rock land-----	23	Rough Broken	1RB, 2RB	39	---	E
RE	Rock land, cool-----	23	Rough Broken	3RB, 4RB	39	---	G
RG	Rock outcrop-Oro Grande complex, very steep-----	23	Steep Very Shallow	1SVS	39	---	C
RK	Rock outcrop-Supervisor complex, very steep-----	24	Rough Broken	5RB	39	---	G
RU	Ruidoso clay loam, 1 to 8 percent slopes-----	24	Clayey	1Cy	31	---	A
SH	Shanta loam, 1 to 8 percent slopes-----	25	Loamy	1Lo	35	---	A
SU	Supervisor very stony sandy loam, 12 to 55 percent slopes---	26	Steep Shallow	5SSw, 5cSSw	37	6	F
TC	Telefono clay loam, 3 to 8 percent slopes-----	27	Clayey	4dCy	31	5	F
TE	Telefono clay loam, 8 to 25 percent slopes-----	27	Clayey	4cCy, 4dCy	31	5	F
TR	Terrace escarpments-----	27	Steep Very Shallow	1SVS	39	---	C
TU	Tularosa silty clay loam, 1 to 12 percent slopes-----	28	Clayey	4Cy, 4cCy	31	---	B

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