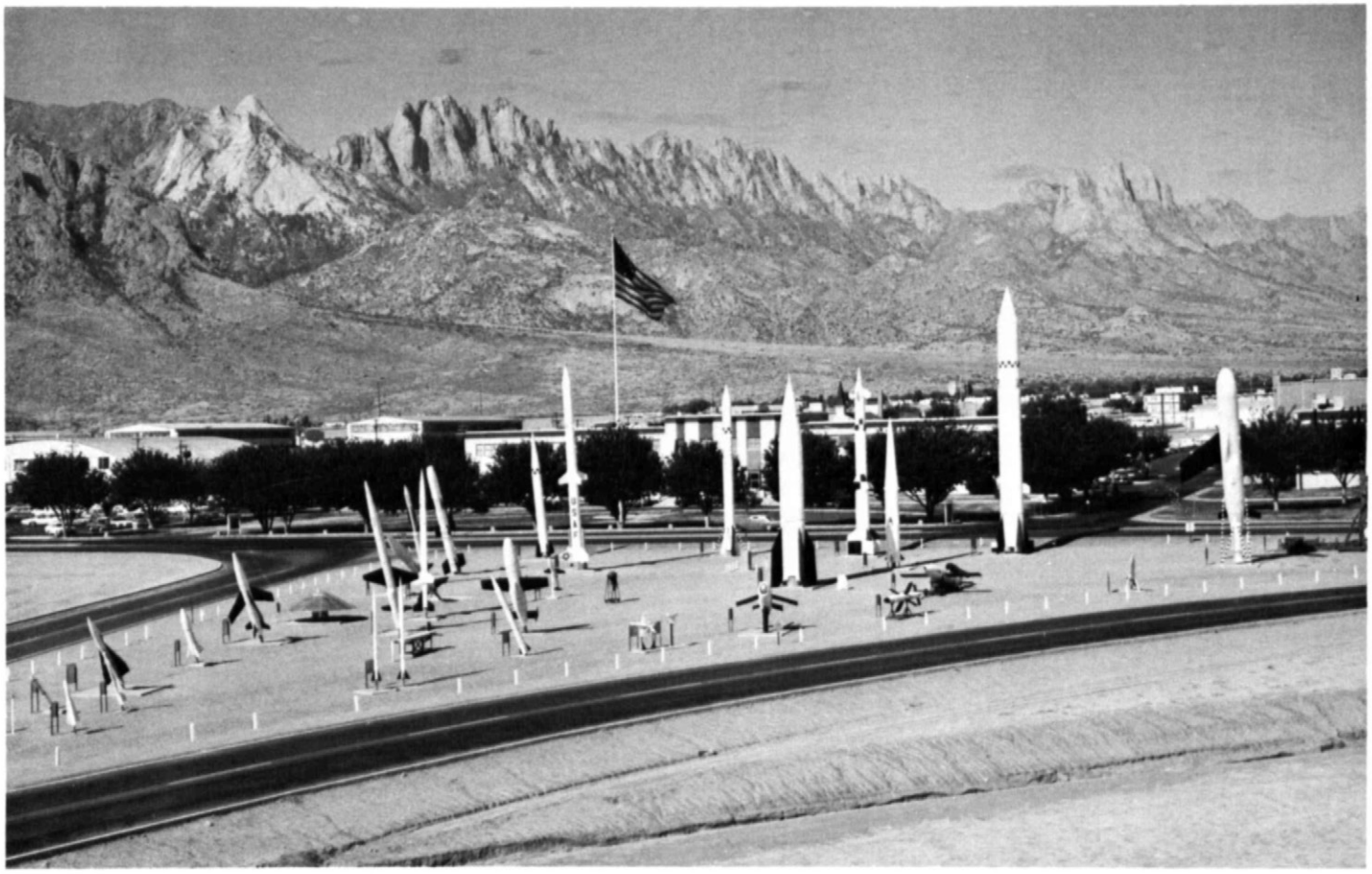
SOIL SURVEY OF

White Sands Missile Range, New Mexico

Parts of Dona Ana, Lincoln, Otero, Sierra, and Socorro Counties



United States Department of Agriculture
Soil Conservation Service
In cooperation with
United States Department of the Army
White Sands Missile Range
and the
New Mexico Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the 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 1969–70. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in the publication refer to conditions in the area in 1971. This survey was made cooperatively by the Soil Conservation Service, the White Sands Missile Range, and the New Mexico Agricultural Experiment Station. It is part of the technical assistance furnished to the United States Department of the Army, White Sands Missile Range.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing land for military use, wildlife habitat, and conservation purposes, and also in selecting sites for missile testing and evaluating facilities, roads, ponds, buildings, and other structures. In the event that in the future this area should not be totally required for military purposes, information included can be used in management of the area for farming or industrial purposes. This is a reconnaissance soil survey. It is suitable for only general program planning. It is not a substitute for a detailed survey, but it has a purpose in the planning process, particularly for broad area planning. Onsite investigation in any particular area or site is necessary for detailed planning.

Locating Soils

All the soils of White Sands Missile Range are shown on the reconnaissance map at the back of this publication. This map consists of several sheets made from a line map. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

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

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the White Sands Missile Range in alphabetic order by map symbol and gives the capability subclass of each. It also shows the page where each soil is described and the vegetative group to which the soil has been assigned.

Individual colored maps that show the relative suitability or degree of limitation 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.

Agronomists can learn about use and management of the soils from the soil descriptions and from the descriptions of the vegetative groups.

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

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

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 White Sands Missile Range may be interested in the information in the section "Environmental Factors Affecting Soil Use."

Cover: **White Sands Missile Range headquarters in an area of Sonoita-Pinaleno-Aladdin association. The Organ Mountains are in the background.**

Contents

Issued January 1976

SOIL SURVEY OF WHITE SANDS MISSILE RANGE, NEW MEXICO

PARTS OF OTERO, LINCOLN, DONA ANA, SIERRA, AND SOCORRO COUNTIES

BY RAYMOND E. NEHER AND ORAN F. BAILEY, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE UNITED STATES DEPARTMENT OF THE ARMY, WHITE SANDS MISSILE RANGE, AND THE NEW MEXICO AGRICULTURAL EXPERIMENT STATION

THE WHITE SANDS MISSILE RANGE is in the south-central part of New Mexico (fig. 1). It covers an area of 2,168,727 acres,[1] or about 3,388 square miles. The area is 25 to 40 miles wide and about 125 miles long. It consists of parts of Otero, Lincoln, Dona Ana, Sierra, and Socorro Counties. The entire area is administered by the United States Department of the Army as a site for military testing. No towns are within the area.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the White Sands Missile Range, where they are located, and how they can be used. The soil scientists went into the area knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; 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 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 of soil classification most used in a local survey.

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. Holloman and Marcial, 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 undisturbed landscape.

Soils of one series can differ 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, Holloman very fine sandy loam is one of several phases within the Holloman 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 the roads and trails maps.

The areas shown on a reconnaissance soil map are called mapping units. Most mapping units detailed enough for broad area planning contain more than one soil phase. It is not practical to show all the small, scattered bits of soil that have been seen within an area that is dominantly of a single 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 reconnaissance soil map of White Sands Missile Range: soil complexes and soil associations.

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

A soil association is made up of geographically associated soils that occur as areas large enough to be shown individually on the reconnaissance soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. The name of an association consists of the names of the dominant soils, joined by a hyphen. Onite-Bluepoint-Wink association is an example.

[1] This acreage was calculated at the time the survey was made in 1969. Some minor adjustments have been made since then.

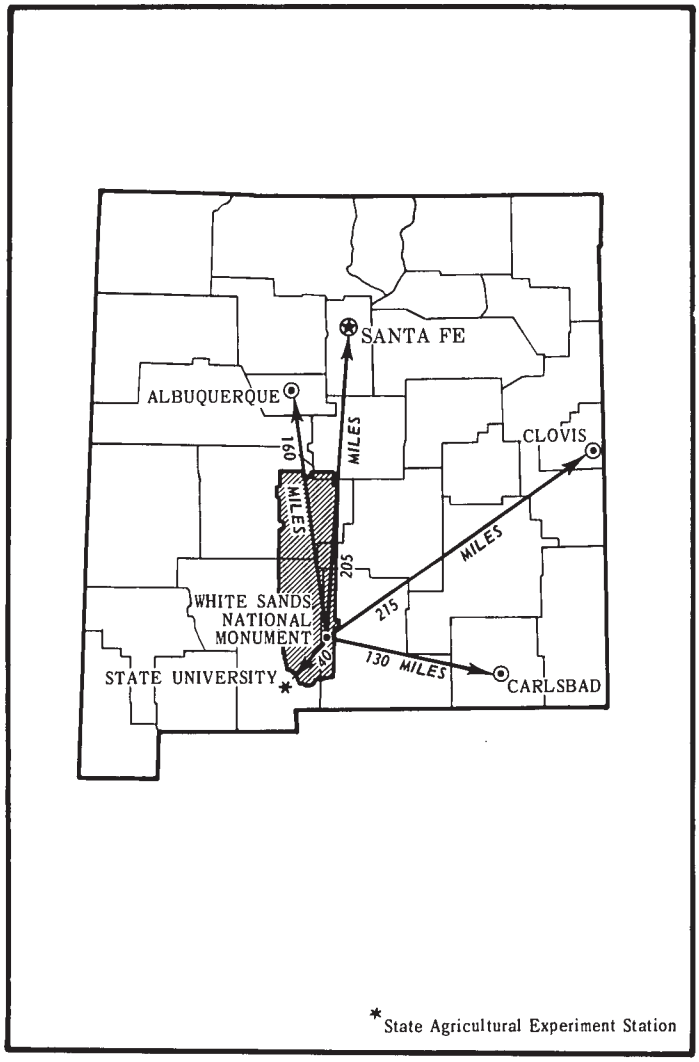


Figure 1.—**Location of White Sands Missile Range in New Mexico.**

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified as a 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. Gypsum land, hummocky, and Rock land, cool, are two examples.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled.

Soil scientists observe how soils behave when used as a growing medium for native plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, they relate this failure to slow permeability or a high water table. They see that streets, road pavements, and foundations for low buildings crack on a given kind of soil, and they relate this failure to a high shrink-swell potential. Thus, they use observation and knowledge of soil properties, together with available research data, to predict the limitations or suitability of a soil for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with agronomists, engineers, and others. They then adjust the groups according to the results of their study and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

Descriptions of the Soils

This section describes the soil series and mapping units within the White Sands Missile Range. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms and consistence are for dry soil unless otherwise stated.

The profile described in the series is representative of mapping units in that series. If the profile of a given mapping unit differs from the one described as representative of the series, these differences are stated in the mapping unit description, or they are differences that are apparent in the name of the mapping unit.

In the detailed description of profiles, a range in thickness is shown at the end of each horizon. This is the range in thickness of that horizon of the soil profile as it occurs in White Sands Missile Range. Unless otherwise noted, the pH was determined with colorimetric indicators by using soil and water in a ratio of 1 to 5. If such features as wet consistence, roots, coarse fragments, and carbonates (calcareous) are not mentioned in the description of a horizon, that feature was either absent or not determined.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Gypsum land, hummocky, for example, does not belong to a soil series but, nevertheless, is 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 reconnaissance soil map. Listed at the end

TABLE 1.—*Approximate acreage and proportionate extent of soils*

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent* [1]		*Acres*	*Percent* [1]
Active dune land, gypsum	95,800	4.4	Mimbres-Glendale association	74,300	3.4
Aladdin association	5,300	.3	Nickel-Tencee association	219,700	10.1
Berino-Dona Ana association	58,700	2.8	Onite-Bluepoint-Wink association	127,400	5.9
Deama-Rock outcrop complex	59,000	2.7	Oscura silty clay	3,600	.2
Dona Ana-Pajarito-Bluepoint association	13,700	.6	Rock land, cool	210,300	9.6
Dune land-Dona Ana complex	163,500	7.5	Rock land, warm	81,200	3.7
Dune land-Yesum association	65,500	3.0	Shale rock land	16,600	.8
Gilland-Rock outcrop complex	79,200	3.7	Sonoita-Pinaleno-Aladdin association	46,100	2.1
Gypsum land, hummocky	22,400	1.0	Sotim-Russler association	32,600	1.5
Gypsum land, level	78,100	3.6	Tencee-Nickel association, gently sloping	17,300	.8
Gypsum rock land	4,800	.2	Tencee-Nickel association, steep	32,500	1.5
La Fonda association	7,300	.3	Yesum-Holloman association	249,927	11.6
Lava flows	40,700	1.9	Yesum very fine sandy loam	40,800	1.9
Lozier-Rock outcrop complex	162,200	7.5	Intermittent lakes	19,000	.9
Marcial-Ubar association	115,200	5.3			
Mead silt loam	26,000	1.2	Total	2,168,727	100.0

[1] Percent rounded to the nearest 0.1.

of each description of a mapping unit are the capability subclass and vegetative group to which the mapping unit has been assigned.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the back of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*5*).[2]

Active Dune Land, Gypsum

Active dune land, gypsum (AC) consists of the gypsum sand dunes known as White Sands (fig. 2). The dunes are dominantly about 30 feet high, but range from 3 to 100 feet and are continually shifted by wind action. The gypsum crystals are carried by wind from a relict lakebed in a bolson southwest of the dunes. Lake Lucero, which is at the lowest elevation in the bolson, is a remnant of that old lake. The gypsum has been deposited in the lake by runoff water from the numerous gypsum formations in the surrounding mountains and other landscapes, particularly to the north. When the water in the lake evaporates, gypsum crystals left there are redeposited by prevailing winds on the dunes to the northeast.

The only vegetation is scattered, isolated patches of mid and tall grasses, chamiza, iodinebush, and seepweed. Elevation ranges from 3,900 to 4,100 feet. Precipitation is 7 to 9 inches, mean annual air temperature is 60° to 62° F., and the frost-free season is 190 to 210 days.

During the windy season, the gypsum sands are highly susceptible to soil blowing. Because the gypsum is white and reflects the bright sunshine, the pattern of this area is clearly visible from the mountains to the east and west and from aircraft or space vehicles many miles away.

Active dune land, gypsum, has esthetic value and is used for military purposes, wildlife, and recreation. Capability subclass VIIIe; vegetative group 5.

Aladdin Series

The Aladdin series consists of deep, well-drained soils. These soils formed in sandy sediments on alluvial fans. Slope is 1 to 15 percent. Elevation is 4,800 to 6,000 feet. The vegetation is mid grasses, chamiza, sand sagebrush, soaptree yucca, agave, and mesquite. Precipitation is 9 to 12 inches, mean annual air temperature is 55° to 62° F., and the frost-free season is 180 to 210 days.

In a representative profile the surface layer is brown gravelly loamy sand about 7 inches thick. The underlying layer is brown gravelly light sandy loam about 39 inches thick and light-brown gravelly loamy sand to a depth of 60 inches or more. The soil is neutral throughout.

Aladdin soils are moderately rapidly permeable. Roots can penetrate to a depth of 60 inches and more, but available water capacity is only moderate.

These soils are used for military purposes and wildlife habitat.

Representative profile of the Aladdin gravelly loamy sand in an area of Sonoita-Pinaleno-Aladdin association, about 1,000 feet east-northeast of the south water tower at White Sands Missile Range Post Area and about 40 feet south of road to Cox's Ranch Headquarters, Dona Ana County:

A1—0 to 7 inches, brown (7.5YR 5/2) gravelly loamy sand, dark brown (7.5YR 3/2) moist; weak, coarse, granular structure; soft dry, very friable moist; many fine roots; common fine interstitial pores; 25 percent fine, angular, acid igneous gravel; neutral (pH 7.1); clear, smooth boundary. 2 to 16 inches thick.

AC—7 to 46 inches, brown (7.5YR 5/3) gravelly light sandy loam, dark brown (7.5YR 3/3) moist; weak, coarse, subangular blocky structure; slightly hard dry, very friable moist; common fine roots to a depth of 30 inches, few fine roots to a depth of 46

[2] Italic numbers in parentheses refer to Literature Cited, p. 62.

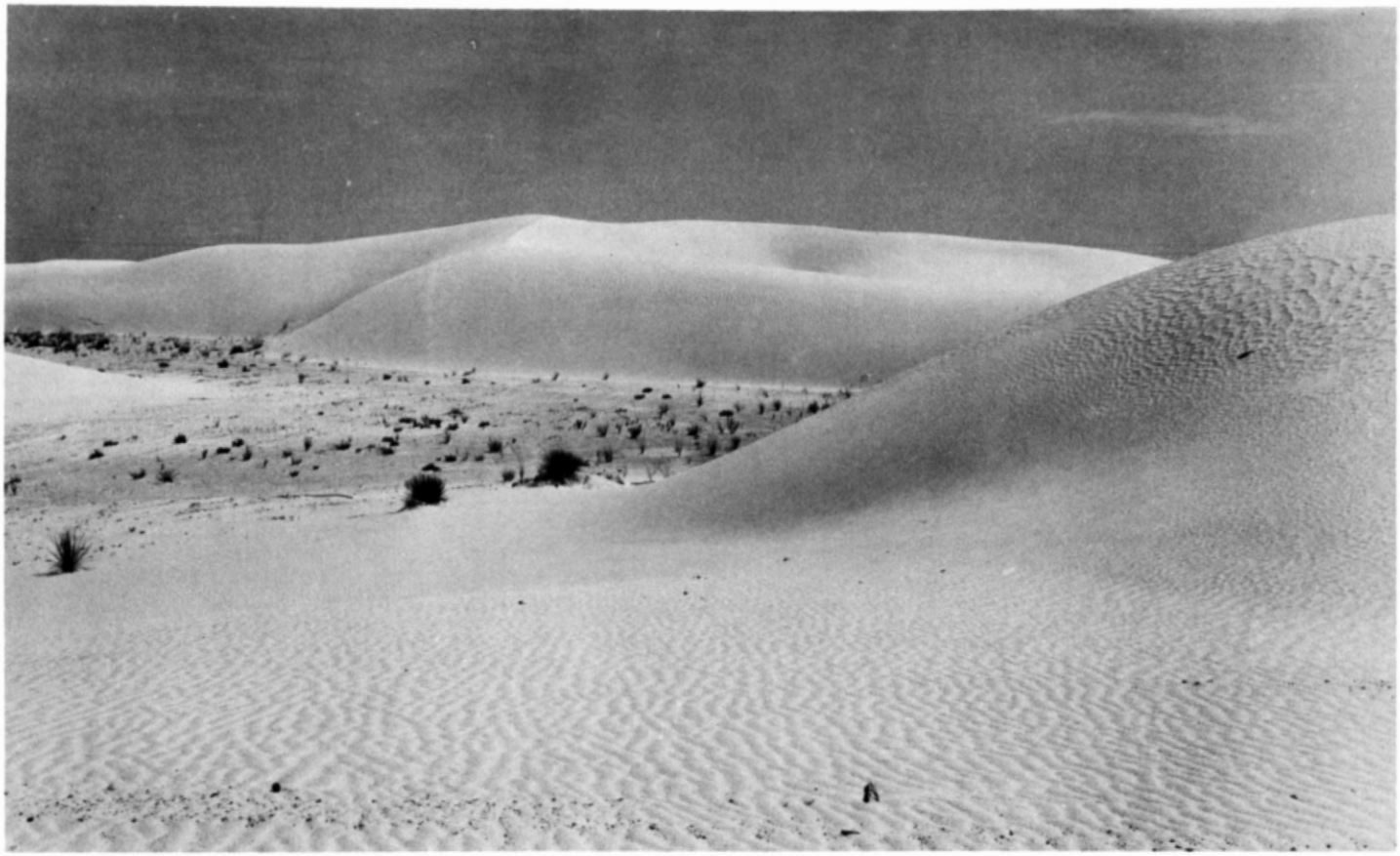


Figure 2.—**Gypsum dunes. The White Sands National Monument is predominantly Active dune land, gypsum.**

inches; common fine interstitial pores; 20 percent fine, angular, acid igneous gravel; neutral (pH 7.2); clear, smooth boundary. 18 to 48 inches thick.

C—46 to 66 inches, light-brown (7.5YR 6/4) gravelly loamy sand, brown (7.5YR 4/4) moist; massive; soft dry, very friable moist; common fine interstitial pores; 30 percent fine, angular, acid igneous gravel; noncalcareous, few small slightly calcareous masses; neutral (pH 7.3).

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 to 3. It ranges from sandy loam or gravelly sandy loam to gravelly loamy sand. The AC and C horizons have hue of 7.5YR or 10YR. They range from gravelly sandy loam to gravelly loam in the upper part. They generally are noncalcareous to a depth of 40 inches or more, but in places are slightly calcareous below a depth of 20 inches. Reaction ranges from neutral to mildly alkaline throughout. The percentage of gravel is 15 to 35 percent throughout.

Aladdin association (AD).—This mapping unit is about 30 percent Aladdin gravelly loamy sand and 55 percent Pinaleno gravelly sandy loam, noncalcareous variant. The Aladdin soil is a nearly level to strongly sloping soil on recent alluvial fans. The Pinaleno noncalcareous variant is a moderately sloping to strongly sloping soil on ridges along mountain toe slopes. It formed in old alluvial sediments over weathered granitic bedrock. The profiles of these soils are the ones described as representative of the respective series.

Included with these soils in mapping are areas of stony rock land, rock outcrop, and arroyo washes.

Runoff generally is slow, but during intensive rainstorms is rapid. Water erosion and soil blowing are moderate hazards.

These soils are used for military purposes. They also provide wildlife habitat. Capability subclass VIIe; vegetative group 7.

Alicia Series, High Gypsum Substratum Variant

The Alicia high gypsum substratum variant consists of deep, well-drained soils on old alluvial fans. These soils formed in fine-textured sediments high in content of gypsum. Slope is 3 to 9 percent. Elevation is 6,000 to 6,500 feet. The vegetation is mid and short grasses, winterfat, walkingstick cholla, yucca, and a few widely scattered pinyon pine and oneseed juniper. Precipitation is 11 to 15 inches, mean annual air temperature is 50° to 57° F., and the frost-free season is 180 to 200 days.

In a representative profile the surface layer is brown loam about 6 inches thick. The subsoil is reddish-brown loam about 12 inches thick. The substratum is reddish-brown clay loam to a depth of 60 inches and more. It is high in content of gypsum below a depth of 30 inches. The soil is slightly calcar-

eous to a depth of 18 inches and moderately calcareous below.

Alicia soils are moderately slowly permeable. Roots can penetrate to a depth of 60 inches and more, and available water capacity is high.

These soils are used for military purposes and wildlife habitat.

The Alicia soils in the White Sands Missile Range are mapped only with La Fonda soils.

Representative profile of Alicia loam, high gypsum substratum variant, in an area of La Fonda association, 0.1 mile southwest from the gate where Route 9 leaves the White Sands Missile Range in the northeast corner and 20 feet southwest of the road, Socorro County:

A1—0 to 6 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 3/4) moist; moderate, fine, granular structure; slightly hard dry, very friable moist; common fine roots; many very fine interstitial pores; slightly calcareous; mildly alkaline (pH 7.5); clear, smooth boundary. 3 to 8 inches thick.

B21—6 to 12 inches, reddish-brown (5YR 5/4) loam, dark reddish brown (5YR 3/4) moist; moderate, medium, subangular blocky structure; hard dry, very friable moist; common fine roots; common very fine interstitial pores; slightly calcareous; mildly alkaline (pH 7.6); clear, smooth boundary. 4 to 12 inches thick.

B22ca—12 to 18 inches, reddish-brown (5YR 5/4) loam, dark reddish brown (5YR 3/4) moist; moderate, medium, subangular blocky structure; hard dry, friable moist; few fine roots; common very fine interstitial pores and few fine tubular pores; slightly calcareous, few fine distinct threads of lime; moderately alkaline (pH 7.9); clear, smooth boundary. 4 to 12 inches thick.

C1ca—18 to 30 inches, reddish-brown (5YR 5/4) clay loam, dark reddish brown (5YR 3/4) moist; weak, medium, subangular blocky structure; hard dry, friable moist, slightly sticky and slightly plastic wet; common very fine tubular pores; moderately calcareous, common distinct threads of lime; moderately alkaline (pH 8.2); clear, smooth boundary. 6 to 18 inches thick.

C2cs—30 to 60 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; weak, coarse, subangular blocky structure; hard dry, friable moist, slightly sticky and slightly plastic wet; few very fine tubular pores; many fine gypsum crystals that decrease with depth below a depth of 40 inches; moderately calcareous, few, fine, soft masses and threads of lime; moderately alkaline (pH 7.9).

The A horizon has hue of 5YR to 10YR, value of 5 or 6 dry and 3 or 4 moist, and chroma of 3 or 4. It is noncalcareous or slightly calcareous. Reaction is neutral to mildly alkaline. The B2 horizon has hue of 5YR or 7.5YR, value of 5 or 6 dry and 3 or 4 moist, and chroma of 3 or 4. It is heavy silt loam, loam, light silty clay loam, or light clay loam. It is noncalcareous to moderately calcareous. Reaction is neutral to moderately alkaline. The C horizon has hue of 5YR to 10YR, value of 5 to 7 dry and 3 to 6 moist, and chroma of 2 to 5. It ranges from sandy loam to light clay loam. It is moderately calcareous to strongly calcareous and mildly alkaline to moderately alkaline. The lower part contains many fine gypsum crystals or soft "flourlike" gypsum.

Berino Series

The Berino series consists of deep, well-drained soils. These soils formed in sandy alluvial sediments on broad upland fans. Slope is 1 to 3 percent. Elevation is 4,000 to 5,000 feet. The vegetation is mid and short grasses, winterfat, chamiza, soaptree yucca, mesquite, broom snakeweed, and annuals. Precipitation is 8 to 10 inches, mean annual air temperature is 56° to 62° F., and the frost-free season is 190 to 210 days.

In a representative profile the surface layer is light-brown sandy loam about 10 inches thick. The subsoil is reddish-brown sandy clay loam about 12 inches thick. The substratum is light-brown sandy loam and pink loamy sand to a depth of 60 inches and more. The soil is noncalcareous to a depth of 22 inches and calcareous below.

Berino soils are moderately permeable. Roots can penetrate to a depth of 60 inches and more, but available water capacity is only moderate.

These soils are used for military purposes and wildlife habitat.

Representative profile of Berino sandy loam in an area of Berino-Dona Ana association, 500 feet south of the entrance to the Stallion Range Center, Socorro County:

A1—0 to 10 inches, light-brown (7.5YR 6/4) sandy loam, brown (7.5YR 4/4) moist; weak, medium, platy structure; soft dry, very friable moist; common fine roots; common fine interstitial pores; mildly alkaline (pH 7.4); clear, wavy boundary. 3 to 14 inches thick.

B2t—10 to 22 inches, reddish-brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard dry, very friable moist, slightly sticky and slightly plastic wet; few fine roots; common fine interstitial pores; common clay bridges between sand grains and clay films lining pores; mildly alkaline (pH 7.5); clear, smooth boundary. 10 to 28 inches thick.

C1ca—22 to 44 inches, light-brown (7.5YR 6/4) sandy loam, brown (7.5YR 5/4) moist; massive; slightly hard dry, very friable moist; few very fine roots; common fine interstitial pores; moderately calcareous, few, thin, fine threads and flecks of lime; moderately alkaline (pH 8.2); clear, smooth boundary. 11 to 30 inches.

C2ca—44 to 60 inches, pink (7.5YR 7/4) loamy sand, brown (7.5YR 5/4) moist; massive; soft dry, very friable moist; common fine interstitial pores; 10 percent mixed gravel; strongly calcareous, common fine flecks and threads of lime; moderately alkaline (pH 8.3).

The A horizon has hue of 5YR to 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 3 to 6. It ranges from loamy fine sand to fine sandy loam. Reaction is neutral to mildly alkaline. The B2t horizon has hue of 2.5YR or 5YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 3 to 6. It is sandy clay loam or heavy sandy loam. It is noncalcareous or slightly calcareous. The Cca horizon has hue of 5YR to 10YR, value of 6 to 8 dry and 5 or 6 moist, and chroma of 3 to 5. It is sandy loam or sandy clay loam in the upper part and sandy loam, sandy clay loam, or loamy sand in the lower part.

Berino-Dona Ana association (BD).—This mapping unit is about 50 percent Berino sandy loam and 30 percent Dona Ana sandy loam. The Berino soil is slightly above the Dona Ana soil. These are gently undulating soils on old alluvial fans. Their profiles are the ones described as representative of the respective series.

Included in mapping are areas of Wink, Bluepoint, and Mimbres soils. Sinks and potholes are prominent features on the landscape. Included areas make up about 20 percent of the mapping unit.

Runoff is slow, and water erosion is a slight hazard. Soil blowing is a severe hazard. In some small areas the soils are actively blowing.

This mapping unit is used for military purposes and wildlife habitat. Capability subclass VIIe; vegetative group 3.

Bluepoint Series

The Bluepoint series consists of deep, somewhat excessively drained soils. These soils formed in sandy alluvial sediments that have been reworked by wind. Slope is 1 to 4 percent. Elevation is 4,100 to 4,600 feet. The vegetation is tall and mid grasses, sand sagebrush, mesquite, chamiza, longleaf ephedra, creosotebush, and soaptree yucca. Precipitation is 8 to 10 inches, mean annual air temperature is 56° to 62° F., and the frost-free season is 190 to 210 days.

In a representative profile the soil is light-brown and pink loamy fine sand to a depth of 60 inches or more (fig. 3). It is slightly calcareous to a depth of 36 inches and moderately calcareous below.

Bluepoint soils are rapidly permeable. Roots can penetrate to a depth of 60 inches and more, but available water capacity is low.

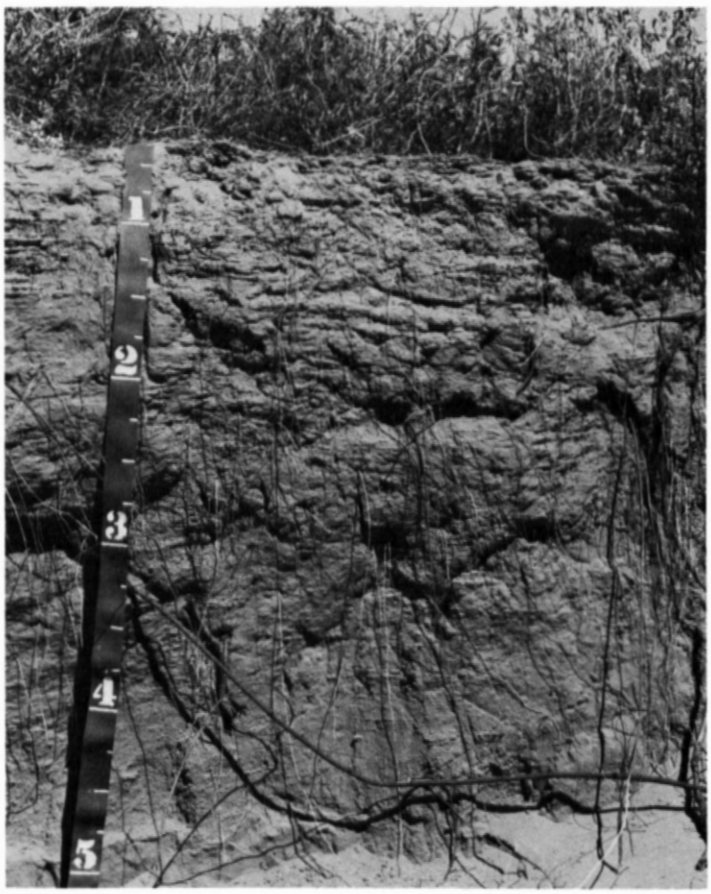


Figure 3.—**Profile of a Bluepoint soil showing thin stratification caused by wind deposition.**

These soils are used for military purposes and wildlife habitat.

The Bluepoint soils in the White Sands Missile Range are mapped only with Dona Ana, Onite, Pajarito, and Wink soils.

Representative profile of Bluepoint loamy fine sand in an area of Dona Ana-Pajarito-Bluepoint association, 4 miles west of Phillips Hills, 1.1 miles east of the basalt flow, and 5.1 miles north of the Russ site, Lincoln County:

C1—0 to 36 inches, light-brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 4/4) moist; massive; soft dry, very friable moist; few fine roots; common fine interstitial pores; slightly calcareous; mildly alkaline (pH 7.5); clear, smooth boundary. 24 to 48 inches thick.

C2—36 to 60 inches, pink (7.5YR 7/4) loamy fine sand and thin strata of fine sand, brown (7.5YR 4/4) moist; massive; soft dry, very friable moist; few very fine roots; common fine interstitial pores; moderately calcareous; moderately alkaline (pH 8.0).

In some areas there is an A horizon as much as 11 inches thick. The soil has hue of 5YR to 10YR, value of 5 or 6 dry in the upper part and 6 or 7 dry in the lower part, value of 4 to 6 moist throughout, and chroma of 3 to 5. It is dominantly loamy fine sand or loamy sand, but is stratified with fine sand. It is noncalcareous to slightly calcareous in the upper 24 inches and slightly calcareous to moderately calcareous to a depth of 60 inches.

Deama Series

The Deama series consists of very shallow to shallow, well-drained soils. These soils formed in material weathered from limestone bedrock. Slope is 5 to 55 percent. Elevation is 5,800 to 8,000 feet. The vegetation is short and mid grasses, scattered pinyon pine and oneseed juniper, mountainmahogany, sacahuista, and soaptree yucca. Precipitation is 12 to 16 inches, mean annual air temperature is 45° to 57° F., and the frost-free season is 150 to 180 days.

In a representative profile the surface layer is dark grayish-brown stony loam about 7 inches thick. The underlying layer is brown stony loam about 3 inches thick. Limestone is at a depth of 10 inches. The surface layer is slightly calcareous and moderately calcareous, and the underlying layer is strongly calcareous.

Deama soils are moderately permeable. Roots can penetrate to a depth of only 7 to 20 inches, and available water capacity is very low.

These soils are used for military purposes and wildlife habitat.

Representative profile of Deama stony loam in an area of Deama-Rock outcrop complex, 1.5 miles north of the intersection of Roads 332 and 331 on the west side of the road, east of North Oscura Peak, Socorro County:

A11—0 to 3 inches, dark grayish-brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard dry, very friable moist; many fine roots; many fine interstitial pores; 10 percent limestone stones, 5 percent cobblestones, 20 percent gravel; slightly calcareous, thin patchy coatings of lime on bottom sides of coarse fragments; mildly alkaline (pH 7.6); clear, smooth boundary. 2 to 7 inches thick.

A12—3 to 7 inches, dark grayish-brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure; slightly hard dry, very friable moist; common fine roots; common fine interstitial pores; 40 percent limestone stones, 10 percent cobblestones, 20 percent gravel; moderately calcareous, thin patchy coatings of lime on coarse fragments; moderately alkaline (pH 8.0); clear, smooth boundary. 1 to 10 inches thick.

Cca—7 to 10 inches, brown (10YR 4/3) stony loam, dark brown (10YR 3/3) moist; weak, medium, subangular blocky structure; slightly hard dry, very friable moist; common fine roots; common fine interstitial pores; 10 percent limestone stones, 10 percent cobblestones, 30 percent gravel; continuous coatings of lime on coarse fragments and hard caliche fragments; strongly calcareous; moderately alkaline (pH 8.2); abrupt, wavy boundary. 1 to 3 inches thick.

R—10 inches, limestone.

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 stony loam or stony fine sandy loam. The Cca horizon has hue of 7.5YR or 10YR, value of 4 to 8 dry and 3 to 5 moist, and chroma of 2 to 4. It is stony loam or stony light clay loam. Content of coarse fragments throughout the profile ranges from 35 to 70 percent. Content of calcium carbonate in the lower part of the profile, which includes all hard fragments gravel size and smaller, is more than 40 percent. Depth to bedrock ranges from 7 to 20 inches.

Deama-Rock outcrop complex (DO).—This mapping unit is about 40 percent Deama stony loam and 40 percent Rock outcrop. The Deama soil is moderately sloping to steep and is on ridgetops, saddles, and benches above cliffs. Rock outcrop generally occurs as rolling areas along breaks and cliffs and as very steep rock faces. The profile of the Deama soil is the one described as representative of the series.

Included in mapping are areas of stony colluvial land, Shale rock land, arroyo bottoms, and recent loamy alluvial soils on narrow valley floors. Included areas make up about 20 percent of the mapping unit.

Runoff is medium to rapid. Water erosion is a slight to moderate hazard.

This mapping unit is used for military purposes and wildlife habitat. Capability subclass VIIs; vegetative group 9.

Dona Ana Series

The Dona Ana series consists of deep, well-drained soils. These soils formed in calcareous loamy sediments on old alluvial fans. Slope is 1 to 4 percent. Elevation is 4,000 to 5,000 feet. The vegetation is short and mid grasses, mesquite, creosotebush, winterfat, American tarbush, soaptree yucca, broom snakeweed, and annuals. Precipitation is 8 to 10 inches, mean annual air temperature is 56° to 62° F., and the frost-free season is 190 to 210 days.

In a representative profile the surface layer is light-brown sandy loam about 4 inches thick. The subsoil is brown and light-brown light clay loam about 20 inches thick. The substratum consists of two parts. The upper part is pink loam high in content of lime, and the lower part is light-brown clay loam to a depth of 60 inches or more. The soil is slightly calcareous in the surface layer, moderately calcareous in the subsoil, and strongly calcareous in the substratum (fig. 4).

Figure 4.—**Profile of a Dona Ana soil showing accumulation of lime between depths of 28 and 45 inches.**

Dona Ana soils are moderately permeable. Roots can penetrate to a depth of 60 inches and more, and available water capacity is high.

These soils are used for military purposes and wildlife habitat.

Representative profile of Dona Ana sandy loam in an area of Berino-Dona Ana association, 500 feet north of the intersection of Road 20 with the Trinity site and 40 feet west, Socorro County:

A1—0 to 4 inches, light-brown (7.5YR 6/4) sandy loam, dark brown (7.5YR 3/4) moist; weak, medium, platy structure parting to weak, coarse, granular; slightly hard dry, very friable moist; few fine roots; few fine tubular pores and common fine interstitial pores; slightly calcareous; mildly alkaline (pH 7.7); clear, smooth boundary. 2 to 6 inches thick.

B21t—4 to 16 inches, brown (7.5YR 5/4) light clay loam, dark brown (7.5YR 3/4) moist; weak, medium, subangular blocky structure; hard dry, friable moist, slightly sticky and slightly plastic wet; few fine roots; common fine interstitial pores; about 5 percent fine mixed gravel; moderately calcareous; mildly alkaline (pH 7.7); clear, smooth boundary. 4 to 18 inches thick.

B22t—16 to 24 inches, light-brown (7.5YR 6/4) light clay loam, brown (7.5YR 4/4) moist; weak, medium, subangular blocky structure; hard dry, friable moist, slightly sticky and slightly plastic wet; few fine roots; common fine interstitial pores; moderately calcareous; moderately alkaline (pH 7.9); clear, smooth boundary. 6 to 10 inches thick.

C1ca—24 to 36 inches, pink (7.5YR 7/4) loam, light brown (7.5YR 6/4) moist; massive; slightly hard dry, very friable moist, sticky and slightly plastic wet; few fine interstitial pores; about 10 percent fine

gravel; strongly calcareous, lime coatings on about 70 percent of the pebbles and common, coarse, soft masses of lime; moderately alkaline (pH 8.2); clear, smooth boundary. 10 to 24 inches thick.

C2ca—36 to 60 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; weak, medium, subangular blocky structure; hard dry, friable moist, slightly sticky and slightly plastic wet; few fine tubular pores; strongly calcareous, few, medium, soft masses of lime; moderately alkaline (pH 8.2).

The A horizon has hue of 5YR to 10YR, value of 5 to 7 dry and 3 to 5 moist, and chroma of 3 to 5. It ranges from sandy loam to sandy clay loam. It is noncalcareous to slightly calcareous. Reaction is mildly alkaline to moderately alkaline. The Bt horizon has hue of 2.5YR to 7.5YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 3 to 6. It is heavy sandy loam, heavy loam, sandy clay loam, or clay loam. It is slightly calcareous to moderately calcareous. The Cca horizon has hue of 5YR to 10YR, value of 6 to 8 dry, and chroma of 3 or 4. It is sandy loam, loam, clay loam, or sandy clay loam.

Dona Ana-Pajarito-Bluepoint association (DP).—This mapping unit is about 30 percent Dona Ana sandy loam, 30 percent Pajarito sandy loam, and 25 percent Bluepoint loamy fine sand. The Dona Ana and Pajarito soils are nearly level or gently undulating. The Bluepoint soil is undulating and is on low dunes. The profiles of these soils are the ones described as representative of the respective series.

Included in mapping are areas of Mimbres, Glendale, and Yesum soils and deep, very gravelly sandy soils. Included areas make up about 15 percent of the mapping unit.

Runoff is slow, and water erosion is a moderate hazard. Soil blowing is a severe hazard. In some small areas the soils are actively blowing.

This mapping unit is used for military purposes and wildlife habitat. Capability subclass VIIe; vegetative group 3.

Dune Land

Dune land consists of blowouts and wind-sifted active sand dunes that are bare or nearly bare of vegetation. The dunes are 4 to 20 feet high. Slopes range from 5 to 75 percent.

The vegetation, mainly in the sand dunes, is scattered mesquite, chamiza, soaptree yucca, sand dropseed, broom snakeweed, and annuals. The elevation is 3,900 to 5,000 feet. Precipitation is 7 to 10 inches, mean annual air temperature is 57° to 62° F., and the frost-free season is 190 to 210 days.

Permeability is very rapid. Runoff is very slow. The hazard of soil blowing is very severe.

Dune land-Dona Ana complex (DU).—This mapping unit is about 40 percent Dune land, 25 percent Dona Ana sandy loam, and 20 percent Bluepoint loamy fine sand. Dune land is mainly loamy fine sand or fine sand. The Dona Ana soil is a gently undulating to undulating soil between the dunes (fig. 5). The Bluepoint soil is a gently undulating soil near low dunes. The profiles of these soils are the ones described as representative of the respective series.

Included in mapping are areas of Berino, Nickel, Yesum, and Holloman soils. Included areas make up about 15 percent of the mapping unit.

Runoff is slow. Water erosion is a slight hazard. The hazard of soil blowing is high. In many areas the sand is actively blowing.

This mapping unit is used for military purposes. It also provides habitat for wildlife, esthetic enjoyment, and recreation sites. Capability subclass VIIe; vegetative group 3.

Dune land-Yesum association (DY.)—This mapping unit is about 55 percent Dune land and 30 percent Yesum very fine sandy loam. Dune land is mainly gypsum crystals the size of fine sand. The Yesum soil is a nearly level soil in areas between partly stabilized gypsum sand dunes. The profile of the Yesum soil is the one described as representative of the Yesum series.

Included in mapping are areas of Holloman soils and Gypsum land and intermittent lakes. Included areas make up about 15 percent of the mapping unit.

Runoff is slow, and water erosion is a slight hazard. Soil blowing is a severe hazard. In some areas the sand is actively blowing.

This mapping unit is used for military purposes. It also provides habitat for wildlife, esthetic enjoyment, and recreation sites. Capability subclass VIIIe for Dune land and VIIe for Yesum soil; vegetative group 4.

Gilland Series

The Gilland series consists of moderately deep, well-drained soils. These soils formed in material weathered from red sandstone and shale. Slope is 5 to 35 percent. Elevation is 4,500 to 6,000 feet. The vegetation is mid and short grasses, cholla, soaptree yucca, and isolated pinyon pine and oneseed juniper. Precipitation is 8 to 13 inches, mean annual air temperature is 56° to 62° F., and the frost-free season is 180 to 200 days.

In a representative profile the surface layer is reddish-brown stony loam about 7 inches thick. The subsoil is reddish-brown stony loam about 13 inches thick. The substratum is light reddish-brown stony loam and weathered shale over sandstone. The soil is moderately calcareous in the surface layer and subsoil and strongly calcareous in the substratum.

Gilland soils are moderately permeable. Roots can penetrate to a depth of only 24 to 36 inches, and available water capacity is low to very low.

These soils are used for military purposes and wildlife habitat.

Representative profile of Gilland stony loam in an area of Gilland-Rock outcrop complex, 5.35 miles south of the junction of Road 16 and Route 5, 450 feet east, Sierra County:

A1—0 to 7 inches, reddish-brown (5YR 4/3) stony loam, dark reddish brown (5YR 3/3) moist; moderate, fine, granular structure; slightly hard dry, very friable moist; many fine roots; many fine interstitial pores; 60 percent angular sandstone fragments; moderately calcareous; mildly alkaline (pH 7.5); clear, smooth boundary. 3 to 10 inches thick.

B2—7 to 20 inches, reddish-brown (2.5YR 5/3) stony loam, reddish brown (2.5YR 4/3) moist; moderate, medium and fine, granular structure; slightly hard dry, friable moist, slightly sticky and slightly

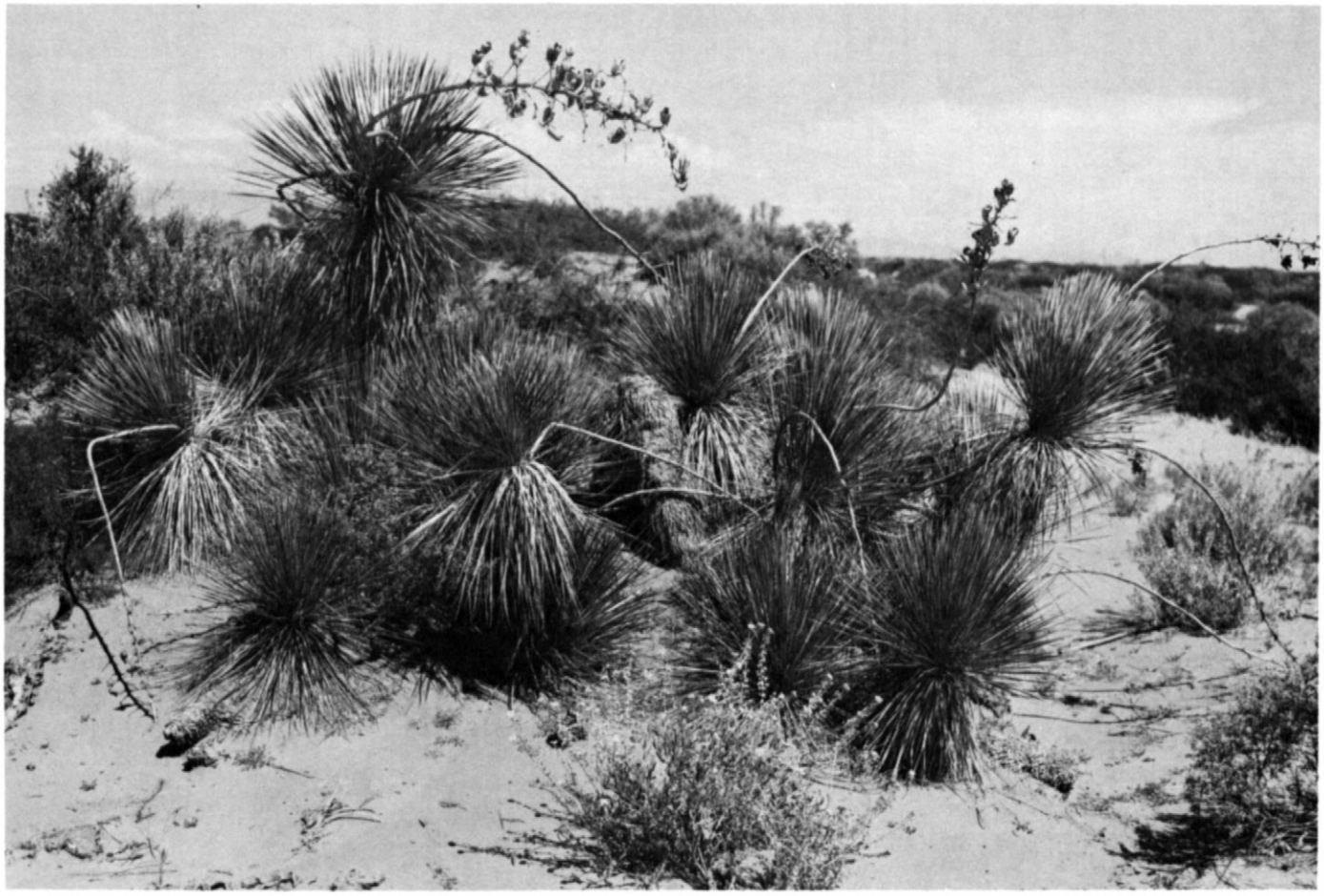


Figure 5.—**Soaptree yucca on Dona Ana sandy loam in a low area of Dune land-Dona Ana complex.**

plastic wet; many fine roots; many fine interstitial pores; 70 percent angular sandstone fragments; moderately calcareous, lime coatings on bottom sides of coarse fragments; mildly alkaline (pH 7.7); clear, wavy boundary. 4 to 16 inches thick.

C1ca—20 to 28 inches, light reddish-brown (2.5YR 6/3) stony loam, reddish brown (2.5YR 4/3) moist; weak, medium, subangular blocky structure; slightly hard dry, friable moist, slightly sticky and slightly plastic wet; common fine roots; common fine interstitial pores and few fine tubular pores; 60 percent angular sandstone fragments; strongly calcareous, many fine threads and soft masses of lime and lime coatings on coarse fragments; moderately alkaline (pH 8.0); clear, wavy boundary. 4 to 16 inches thick.

C2—28 to 48 inches, partly weathered light reddish-brown, strongly calcareous shale; easily dug with shovel. 6 to 32 inches thick.

R—48 inches, red sandstone.

The A horizon has hue of 2.5YR to 7.5YR, value of 4 to 6 dry and 2 to 4 moist, and chroma of 3 or 4. It is stony loam or stony fine sandy loam. It is slightly calcareous to moderately calcareous. The B2 horizon has hue of 2.5YR or 5YR, value of 4 to 6 dry and 3 or 4 moist, and chroma of 3 or 4. It is stony loam or stony light clay loam. It is slightly calcareous to moderately calcareous. Reaction is mildly alkaline to moderately alkaline. The Cca horizon has hue of 2.5YR to 7.5YR, value of 5 to 7 dry and 4 to 6 moist, and chroma of 2 to 4. It is stony loam, stony light clay loam, or stony fine sandy loam. Depth to partly weathered shale ranges from 20 to 30 inches. Depth to sandstone bedrock ranges from 40 to 72 inches.

Gilland-Rock outcrop complex (GR).—This mapping unit is about 40 percent Gilland stony loam and 35 percent Rock outcrop (fig. 6). The Gilland soil is moderately sloping to moderately steep and is generally on the tops and sides of mesas. Rock outcrop generally is steep and very steep and is on cliffs and breaks. It is at higher elevations than the Gilland soil, in some areas as high as 6,500 feet. The profile of the Gilland soil is described as representative of the Gilland series.

Included in mapping are areas of deep alluvial soils on narrow valley floors, shallow and very shallow stony soils over sandstone bedrock, stony land, arroyos, and talus slope deposits.

Runoff is medium. Water erosion is a moderate hazard, and soil blowing is a slight hazard.

This mapping unit is used for military purposes and wildlife habitat. Capability subclass VIIe; vegetative group 9.

Glendale Series

The Glendale series consists of deep, well-drained soils. These soils formed in silty alluvial sediments on

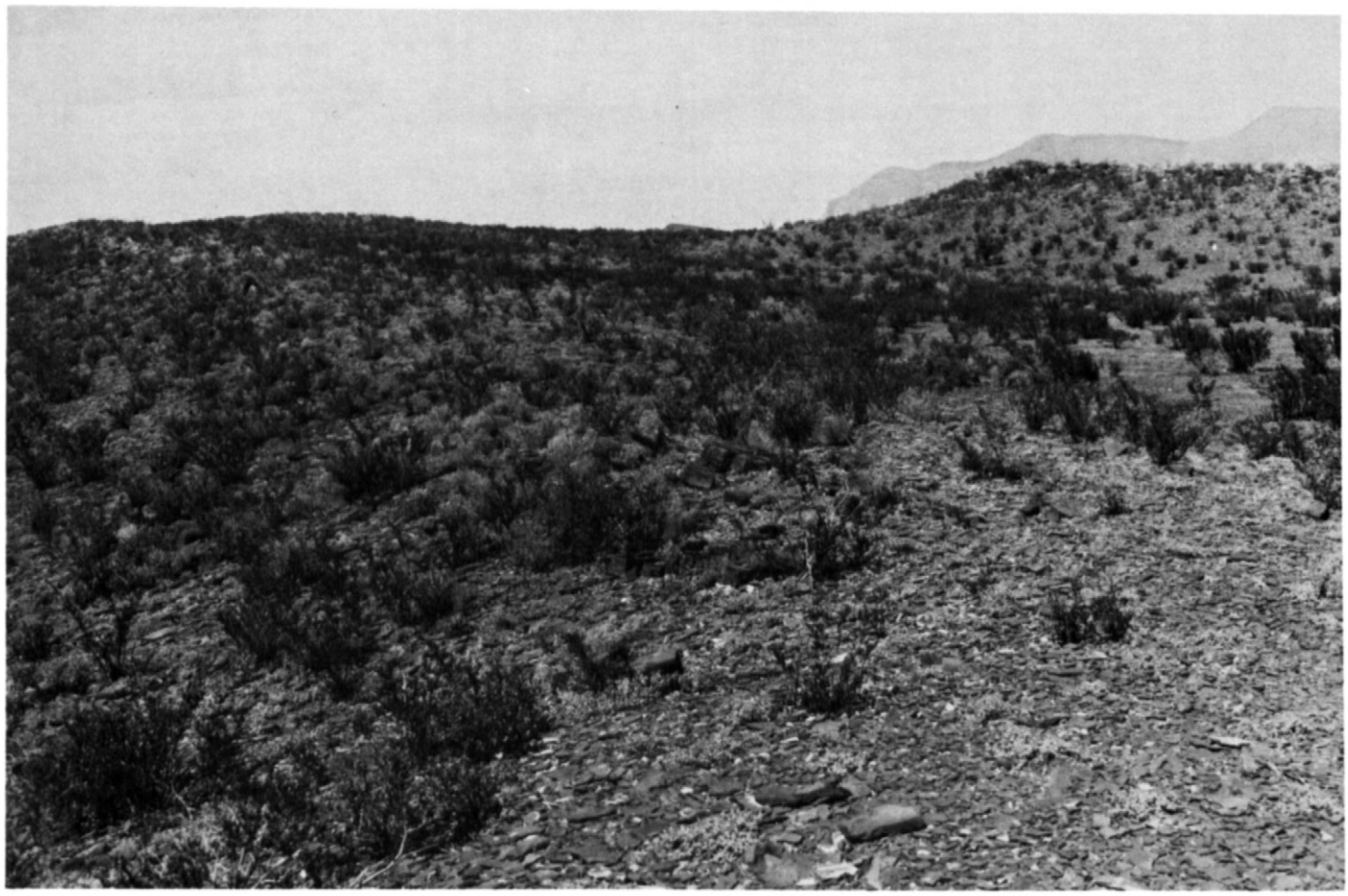


Figure 6.—**Gilland-Rock outcrop complex. Rock outcrop is in the foreground. Gilland stony loam supports only sparse vegetation.**

old alluvial fans. Slope is 0 to 3 percent. Elevation is 4,000 to 4,600 feet. The vegetation is short and mid grasses, creosotebush, chamiza, and mesquite. Precipitation is 8 to 10 inches, mean annual air temperature is 58° to 62° F., and the frost-free season is 190 to 205 days.

In a representative profile the surface layer is pale-brown silt loam about 6 inches thick (fig. 7). The underlying layers to a depth of 60 inches or more are brown, pale brown, light brown, and pink and are stratified with dominantly silt loam soil material. The soil is strongly calcareous throughout.

Glendale soils are moderately slowly permeable. Roots can penetrate to a depth of 60 inches and more, and available water capacity is high.

These soils are used for military purposes and wildlife habitat.

The Glendale soils in the White Sands Missile Range are mapped only with Mimbres soils.

Representative profile of Glendale silt loam in an area of Mimbres-Glendale association, 1.3 miles south of S.W. 70 site on Route 7, 70 feet west of road, in gully 0.2 mile north of jog in Route 7, Sierra County:

A1—0 to 6 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak, thick, platy structure; slightly hard dry, very friable moist; few fine and medium roots; common fine vesicular pores; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary. 3 to 8 inches thick.

C1—6 to 22 inches, brown (10YR 5/3) silt loam, brown (10YR 4/3) moist; weak, coarse, subangular blocky structure; hard dry, very friable moist, slightly sticky wet; few fine and medium roots; common very fine interstitial pores and few fine tubular pores; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary. 8 to 24 inches thick.

C2—22 to 48 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 3/3) moist; weak, coarse, subangular blocky structure; hard dry, very friable moist, nonsticky and nonplastic wet; very few fine roots; common very fine interstitial pores; strongly calcareous, few, fine, faint lime threads; moderately alkaline (pH 8.4); clear, wavy boundary. 8 to 30 inches thick.

C3—48 to 54 inches, pale-brown (10YR 6/3) gravelly silt loam, dark brown (10YR 3/3) moist; massive; hard dry, very friable moist; common very fine interstitial pores; 20 percent gravel; strongly calcareous, few thin lime coatings on gravel; moderately alkaline (pH 8.2); clear, wavy boundary. 0 to 8 inches thick.

C4—54 to 72 inches, light-brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 4/4) moist; massive; hard dry, very friable moist; common very fine interstitial pores; strongly calcareous; moderately alka-

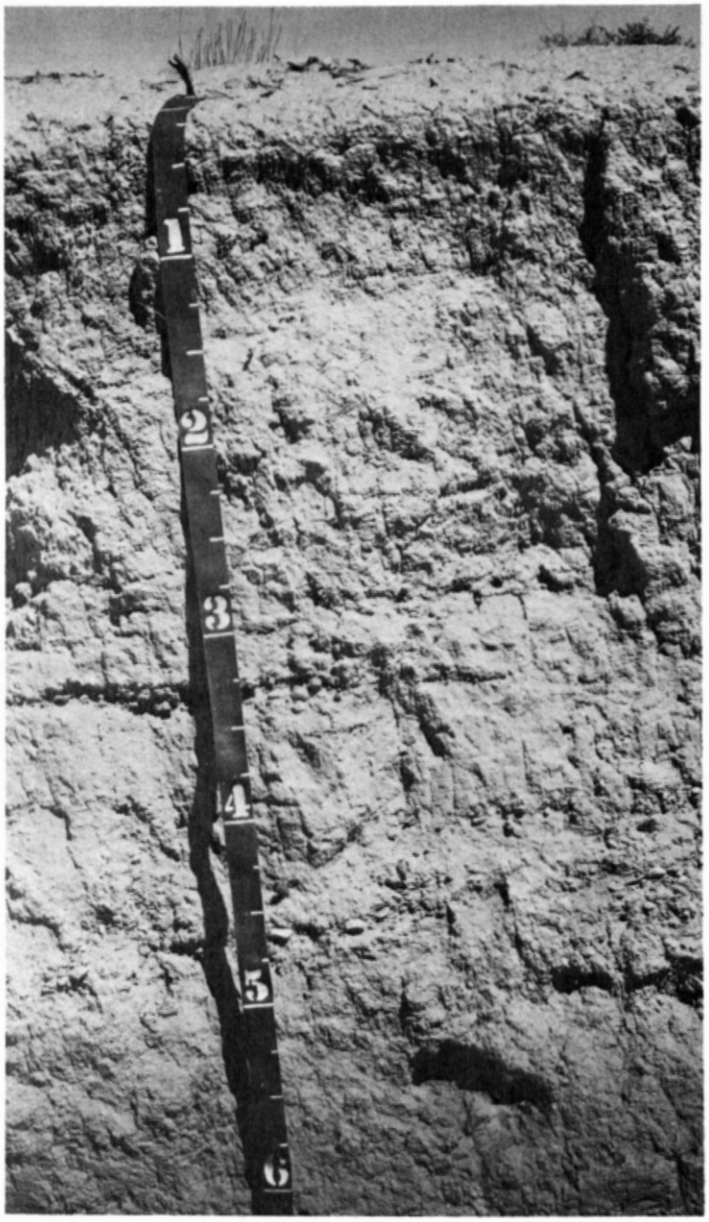


Figure 7.—**Profile of Glendale silt loam. This soil formed in silty alluvial sediments.**

line (pH 8.4); abrupt, wavy boundary. 2 to 20 inches thick.

IIC5ca—72 to 84 inches, pink (7.5YR 7/4) silty clay loam, brown (7.5YR 5/4) moist; massive; very hard dry, friable moist, sticky and plastic wet; few very fine and micro interstitial pores; strongly calcareous, many, common, distinct, soft masses of lime; moderately alkaline (pH 8.4).

The A horizon has hue of 7.5YR or 10YR, value of 5 to 7 dry and 3 or 4 moist, and chroma of 2 to 4. The C horizon has value of 5 to 7 dry and 3 to 5 moist and chroma of 2 to 4. It is slightly calcareous to strongly calcareous throughout. Reaction is mildly alkaline to moderately alkaline. The soil is dominantly heavy silt loam or silty clay loam, but is thinly stratified with fine sandy loam or clay loam.

Gypsum Land

Gypsum land consists of deposits of gypsum in old lakebeds and associated gypsum dunes. Slope is 0 to 15 percent. Elevation is 3,850 to 4,050 feet. The vegetation is sparse. It is mainly rough coldenia, chamiza-knifeleaf condalia, and iodinebush. Precipitation is 7 to 9 inches, mean annual air temperature is 60° to 62° F., and the frost-free season is 190 to 210 days.

The gypsum material is mainly saline, white, chalky earth. It contains common gypsum crystals the size of sand.

Gypsum land is used for military purposes, wildlife habitat, and recreation. It also has esthetic value.

Gypsum land, hummocky (GS).—This mapping unit consists of gently undulating to rolling gypsum dunes. It is partly stabilized and is subject to little or no soil blowing. The gypsum crystals were carried by wind from a relict lakebed to the southwest. The gypsum beds are covered with less than 4 inches of very fine sandy loam.

The only vegetation is lichens, moss, a trace of mid and short grasses, rough coldenia, chamiza, knifeleaf condalia, mesquite, and Torrey ephedra. Elevation ranges from 3,850 to 4,050 feet. Precipitation is 7 to 9 inches, mean annual air temperature is 60° to 62° F., and the frost-free season is 190 to 210 days.

Included in mapping are areas of Holloman and Yesum soils and active gypsum dunes. Included areas make up about 15 percent of the mapping unit.

Runoff is slow. Water erosion is a slight hazard. The hazard of soil blowing is high. Small areas are actively blowing.

Gypsum land, hummocky, is used for military purposes and wildlife habitat. Capability subclass VIIe; vegetative group 4.

Gypsum land, level (GU).—This mapping unit consists of level to nearly level gypsum deposits in an old lakebed. The thickness of gypsum over the underlying lacustrine sediments ranges from about 1 foot along the outer margins of the old lakebed to more than 5 feet near the center. In many areas the water table is within a depth of 5 feet.

The only vegetation is scattered iodinebush. It occurs where the gypsum is less than 3 feet deep over lacustrine sediments and the water table is near the surface (fig. 8). Elevation ranges from 3,885 to 3,975 feet. Precipitation is 7 to 9 inches, mean annual air temperature is 60° to 62° F., and the frost-free season is 190 to 210 days.

Included in mapping are areas of Active dune land, gypsum, which make up about 5 percent of the mapping unit.

Runoff is slow. Water erosion is a slight hazard, and soil blowing is a high hazard. Fine gypsum crystals moved by wind form the Active dune land, gypsum, to the northeast.

Gypsum land, level, is used for military purposes. It also provides esthetic enjoyment and recreation sites. Capability subclass VIIIs; vegetative group 6.

Gypsum rock land (GV).—This mapping unit is about 50 percent Gypsum rock land and 35 percent Rance gravelly loam, shallow variant. Gypsum rock

Figure 8.—Barren landscape of Gypsum land, level.

land occurs as rock exposures capping narrow ridges and as steep to very steep cliffs and scarps. In many places the gypsum rock is covered with as much as 4 inches of gravelly loam. The Rance shallow variant is a moderately sloping to moderately steep soil intermingled with Gypsum rock land on hilltops, benches, saddles, and lower foot slopes. The profile of the Rance shallow variant is the one described as representative of the Rance series, shallow variant.

Included in mapping are areas of limestone rock land, soft shale badlands, mixed alluvial land, and arroyo bottoms. Included areas make up about 15 percent of the mapping unit.

Runoff is rapid. Water erosion is a moderate hazard, and soil blowing is a slight hazard.

Gypsum rock land is used for military purposes and wildlife habitat. Capability subclass VIIIs for Gypsum rock land and VIIe for Rance shallow variant; vegetative group 9.

Holloman Series

The Holloman series consists of shallow, well-drained soils. These soils formed in loamy and sandy alluvium deposited over gypsum beds. Slope is 0 to 5 percent. Elevation is 3,800 to 4,800 feet. The vegetation is mid and short grasses, chamiza, winterfat, mesquite, and American tarbush. Precipitation is 8 to 10 inches, mean annual air temperature is 56° to 62° F., and the frost-free season is 190 to 210 days.

In a representative profile the surface layer is light-brown very fine sandy loam about 3 inches thick. Below this is pink very fine sandy loam about 13 inches thick over white finely divided gypsum that extends to a depth of 60 inches or more. The thin strata of gypsum are weakly cemented. The soil is moderately calcareous throughout.

Holloman soils are moderately permeable. Roots can penetrate to a depth of no more than 20 inches, and available water capacity in the gypsum layer is very low.

These soils are used for military purposes and wildlife habitat.

The Holloman soils in the White Sands Missile Range are mapped only with Yesum soils.

Representative profile of Holloman very fine sandy loam in an area of Yesum-Holloman association, southwest of the Stallion Range Center, 3.4 miles west of Route 13, on straight road that goes from Sotim 4 to Queen 16, Socorro County:

A1—0 to 3 inches, light-brown (7.5YR 6/4) very fine sandy loam, brown (7.5YR 4/4) moist; weak, medium,

platy structure; slightly hard dry, very friable moist; common fine roots; few fine vesicular pores and common fine interstitial pores; moderately calcareous; mildly alkaline (pH 7.7); clear, smooth boundary. 2 to 9 inches thick.

C1cs—3 to 16 inches, pink (7.5YR 7/4) very fine sandy loam, brown (7.5YR 5/4) moist; massive; hard dry, very friable moist; common fine roots; common fine interstitial pores; many, fine, distinct gypsum crystals; moderately calcareous; moderately alkaline (pH 7.9); abrupt, wavy boundary. 2 to 14 inches thick.

C2—16 to 60 inches, finely divided white gypsum of "flour-like" and sand-size crystals; thin strata are weakly cemented.

The A horizon has hue of 5YR to 10YR, value of 5 to 7 dry and 4 or 5 moist, and chroma of 2 to 4. It is slightly calcareous to moderately calcareous. The Ccs horizon has hue of 5YR to 10YR, value of 6 or 7 dry and 5 or 6 moist, and chroma of 2 to 4. It is fine sandy loam, very fine sandy loam, or loam. It is slightly calcareous to moderately calcareous. Reaction is mildly alkaline to moderately alkaline throughout. Depth to gypsum ranges from 4 to 20 inches. The gypsum layer ranges from soft to hard or is weakly cemented.

La Fonda Series

The La Fonda series consists of deep, well-drained soils. These soils formed in moderately fine textured alluvial sediments on old alluvial fans. Slope is 3 to 9 percent. Elevation is 6,000 to 6,500 feet. The vegetation is mid and short grasses, winterfat, cholla, soaptree yucca, and a few widely scattered pinyon pine and oneseed juniper. Precipitation is 11 to 15 inches, mean annual air temperature is 50° to 57° F., and the frost-free season is 160 to 180 days.

In a representative profile the surface layer is reddish-brown loam about 6 inches thick. The subsoil is reddish-brown clay loam about 34 inches thick. The substratum is reddish-brown clay loam to a depth of 60 inches and more (fig. 9). The soil is noncalcareous to a depth of 40 inches and slightly calcareous below.

La Fonda soils are moderately permeable. Roots can penetrate to a depth of 60 inches and more, and available water capacity is high.

These soils are used for military purposes and wildlife habitat.

Representative profile of La Fonda loam in an area of La Fonda association, 1 mile north of Hardin Ranch Headquarters and about 50 feet west of the road near eroded gully, Sierra County:

A1—0 to 6 inches, reddish-brown (5YR 5/4) loam, dark reddish brown (5YR 3/4) moist; moderate, fine, granular structure; slightly hard dry, very friable moist, slightly sticky wet; common fine roots; common very fine interstitial pores; neutral (pH 7.2); clear, smooth boundary. 3 to 7 inches thick.

B21—6 to 28 inches, reddish-brown (2.5YR 5/4) clay loam, dark reddish brown (2.5YR 3/4) moist; weak, coarse, subangular blocky structure; hard dry, friable moist, sticky and slightly plastic wet; common fine roots; common very fine interstitial pores and few fine tubular pores; neutral (pH 7.2); clear, smooth boundary. 6 to 24 inches thick.

B22—28 to 40 inches, reddish-brown (2.5YR 5/4) clay loam, dark reddish brown (2.5YR 3/4) moist; weak, medium, subangular blocky structure; hard dry, friable moist, sticky and slightly plastic wet; few fine roots; mildly alkaline (pH 7.5); clear, smooth boundary. 9 to 20 inches thick.

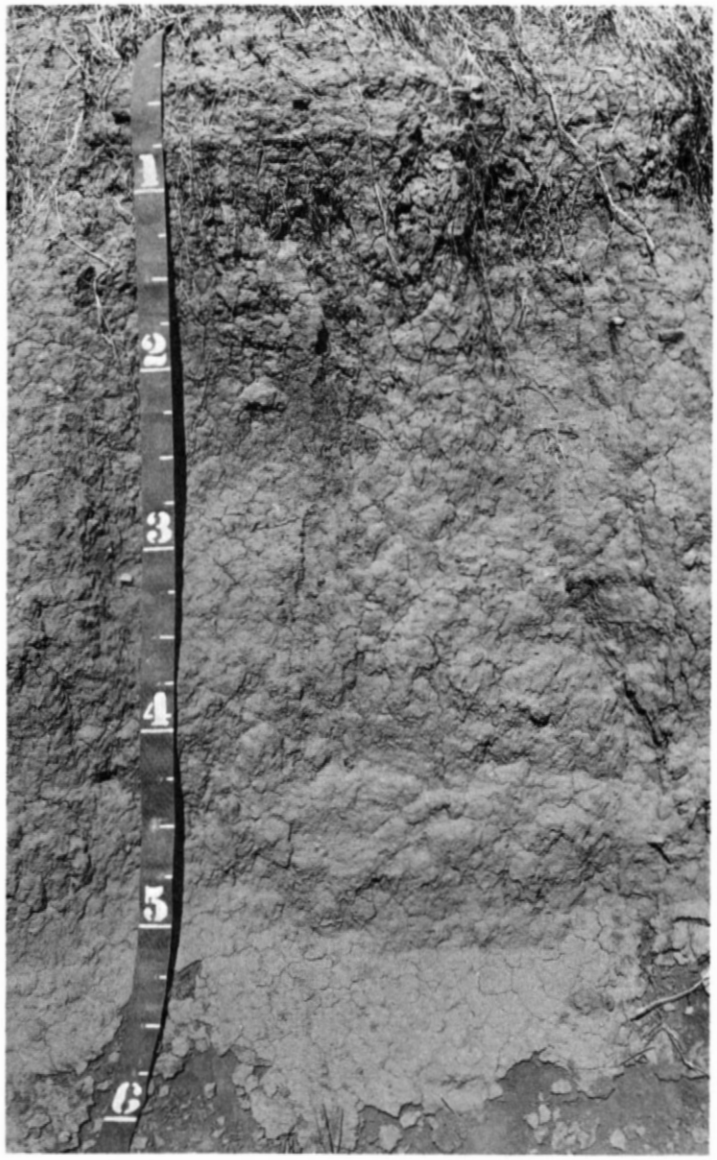


Figure 9.—**Profile of La Fonda loam. This soil formed in moderately fine textured alluvial sediments.**

C—40 to 60 inches, reddish-brown (2.5YR 5/5) clay loam, dark reddish brown (2.5YR 3/5) moist; weak, coarse, subangular blocky structure; hard dry, friable moist, sticky and slightly plastic wet; common very fine interstitial pores; slightly calcareous; mildly alkaline (pH 7.8).

The A horizon has hue of 2.5YR to 7.5YR, value of 5 or 6 dry and 3 or 4 moist, and chroma of 3 to 5. It is noncalcareous or slightly calcareous. Reaction is neutral or mildly alkaline. The B2 horizon has hue of 2.5YR to 7.5YR, value of 5 to 7 dry and 3 to 5 moist, and chroma of 4 to 6. It is heavy loam, sandy clay loam, or clay loam. It is noncalcareous to moderately calcareous. Reaction is neutral to mildly alkaline in the upper part and mildly alkaline to moderately alkaline in the lower part. The C horizon has hue of 2.5YR to 7.5YR, value of 5 to 7 dry and 3 to 6 moist, and chroma of 3 to 6. It ranges from fine sandy loam to clay loam. It is slightly calcareous to moderately calcareous. Reaction is mildly alkaline to moderately alkaline.

La Fonda association (LA).—This mapping unit is about 45 percent La Fonda loam and 40 percent Alicia loam, high gypsum substratum variant (fig. 10). The Alicia variant occurs where gypsum influences the material deposited on the alluvial fans. The La Fonda soil is lower on the landscape. Both are gently sloping to moderately sloping. Their profiles are the ones described as representative of the respective series.

Included in mapping are areas of soils that have a distinct zone of lime accumulation at a depth of 7 to 16 inches and soils that have darker colors in the upper 18 inches. Also included are shallow to very shallow soils over soft gypsum beds. Included areas make up about 15 percent of the mapping unit.

Runoff is medium. Water erosion is a severe hazard, and soil blowing is a slight hazard.

This mapping unit is used for military purposes and wildlife habitat. Capability subclass VIe; vegetative group 9.

Lava Flows

Lava flows (LF) is geologically recent basalt lava that has been deposited on low parts of the landscape. It consists of angular boulders or continuous flows that have sharp jagged surfaces and crevices and few smooth areas. The deposits range from a few feet to about 65 feet high (fig. 11).

For the most part, Lava flows is barren of vegetation. Numerous shrubs grow in isolated cracks and crevices where wind-deposited soil material has been trapped. Elevation ranges from 4,100 to 4,750 feet. Precipitation is 8 to 10 inches, mean annual air temperature is 56° to 62° F., and the frost-free season is 190 to 205 days.

Water trapped in crevices of these lava flows and concentrated in some areas creates a few springs and seeps where wildlife can obtain water. The pattern of these areas is clearly visible from the mountains to the east and from aircraft or space vehicles many miles away.

Lava flows is used for military purposes. It also provides habitat for wildlife and has esthetic value. Capability subclass VIIIs; vegetative group 12.

Lozier Series

The Lozier series consists of very shallow to shallow, well-drained soils. These soils formed in material weathered from limestone. Slope is 5 to 35 percent. Elevation is 4,300 to 6,000 feet. The vegetation is mid and short grasses, creosotebush, mariola parthenium,

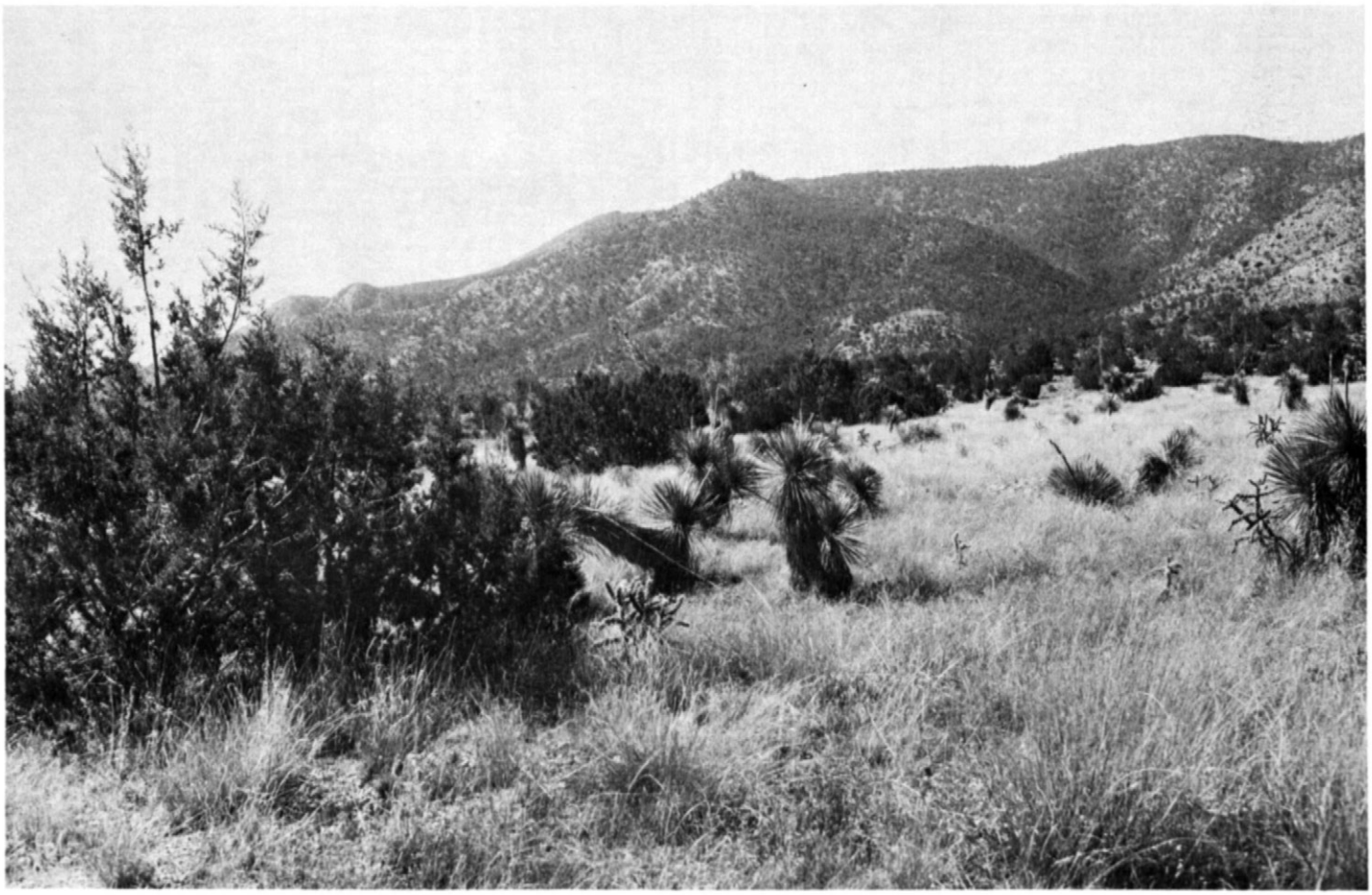


Figure 10.—**La Fonda association in foreground. Rock land, cool, is on mountain slopes in the background.**

Figure 11.—**Basalt lava flow. Access into this rough, rocky area is difficult.**

ocotillo, and soaptree yucca. Precipitation is 8 to 13 inches, mean annual air temperature is 56° to 62° F., and the frost-free season is 180 to 205 days.

In a representative profile the surface layer is brown and light-brown stony loam about 10 inches thick. The underlying layer is pale-brown stony loam. Bedrock is at a depth of about 14 inches. The soil is moderately calcareous in the upper part and strongly calcareous in the lower part.

Lozier soils are moderately permeable. Roots can penetrate to a depth of only 4 to 20 inches, and available water capacity is very low.

These soils are used for military purposes and wildlife habitat.

Representative profile of Lozier stony loam in an area of Lozier-Rock outcrop complex, 100 yards southwest on south side of road from Gap site, near Mockingbird Gap, Socorro County:

A11—0 to 4 inches, brown (7.5YR 5/3) stony loam, brown (7.5YR 4/3) moist; moderate, fine, granular structure; slightly hard dry, very friable moist; many fine roots; many fine interstitial pores; 5 percent each of stones and cobblestones, 10 percent gravel; moderately calcareous, thin lime coatings on gravel; moderately alkaline (pH 8.0); clear, smooth boundary. 1 to 8 inches thick.

A12—4 to 10 inches, light-brown (7.5YR 6/3) stony loam, brown (7.5YR 4/3) moist; weak, medium, subangular blocky structure; slightly hard dry, very friable moist; common fine roots; common fine interstitial pores; 5 percent stones, 15 percent each cobblestones and gravel; moderately calcareous, thin lime coatings on gravel, cobblestones, and stones; moderately alkaline (pH 8.2); clear, smooth boundary. 2 to 8 inches thick.

Cca—10 to 14 inches, pale-brown (10YR 6/3) stony loam, brown (10YR 5/3) moist; weak, medium, subangular blocky structure; slightly hard dry, very friable moist; few fine roots; common fine interstitial pores; 5 percent stones, 10 percent cobblestones, 20 percent gravel, and 10 percent hard caliche fragments less than 1 inch in diameter; strongly calcareous; moderately alkaline (pH 8.3); abrupt, wavy boundary. 1 to 12 inches thick.

R—14 inches, limestone.

The A horizon has hue of 7.5YR or 10YR, value of 5 to 7 dry and 4 or 5 moist, and chroma of 2 to 4. It is stony or very stony fine sandy loam to light clay loam. It is slightly calcareous to moderately calcareous. Reaction is mildly alkaline to moderately alkaline. The Cca horizon has hue of 7.5YR or 10YR, value of 6 or 7 dry and 5 or 6 moist, and chroma of 2 to 4. It is stony or very stony loam or light clay loam. It is moderately calcareous to strongly calcareous. Depth to limestone ranges from 4 to 20 inches.

Lozier-Rock outcrop complex (LR).—This mapping unit is about 45 percent Lozier stony loam and 35 per-

cent Rock outcrop. The Lozier soil is a moderately sloping to moderately steep soil intermingled with Rock outcrop in small, irregularly shaped areas. Generally it is in the less sloping areas, for example, on ridges, narrow benches between rock ledges, hilltops, and lower foot slopes. Rock outcrop occurs as steep and very steep scarps, breaks, ledges, and narrow ridgetops (fig. 12). The profile of the Lozier soil is the one described as representative of the Lozier series.

Included in mapping are areas of Deama soils, stony land, colluvial land, shale outcrops, gypsum hills, arroyos, and recent alluvial land in narrow valleys. Included areas make up about 20 percent of the mapping unit.

Runoff is rapid. Water erosion and soil blowing are slight hazards. Small areas in narrow valleys are gullied.

This mapping unit is used for military purposes and wildlife habitat. Capability subclass VIIs; vegetative group 11.

Marcial Series

The Marcial series consists of deep, moderately well drained soils. These soils formed in fine-textured recent alluvial sediments on the basin floor. Slope is 0 to 1 percent. Elevation is 4,000 to 4,700 feet. The vegetation is mid and short grasses, chamiza, seepweed, and iodinebush. About 50 percent of the surface area is bare of vegetation. Precipitation is 8 to 10 inches, mean annual air temperature is 58° to 62° F., and the frost-free season is 190 to 205 days.

In a representative profile the surface layer is reddish-brown heavy silty clay loam about 6 inches thick. The subsoil is reddish-brown silty clay about 32 inches thick. The substratum is reddish-brown heavy silty clay loam. Gypsum is at a depth of about 52 inches (fig. 13). The soil is strongly calcareous and saline throughout.

Marcial soils are slowly permeable. Roots can penetrate to a depth of about 52 inches, and available water capacity is moderate.

These soils are used for military purposes and wildlife habitat.

Representative profile of Marcial silty clay loam in an area of Marcial-Ubar association, about 2.2 miles southwest of Marcial site and Route 5 junction, on gravel road, south side of bar pit by the well, Socorro County:

A1—0 to 6 inches, reddish-brown (5YR 5/4) heavy silty clay loam, dark reddish brown (5YR 3/4) moist; moderate, thick, platy structure; hard dry, friable

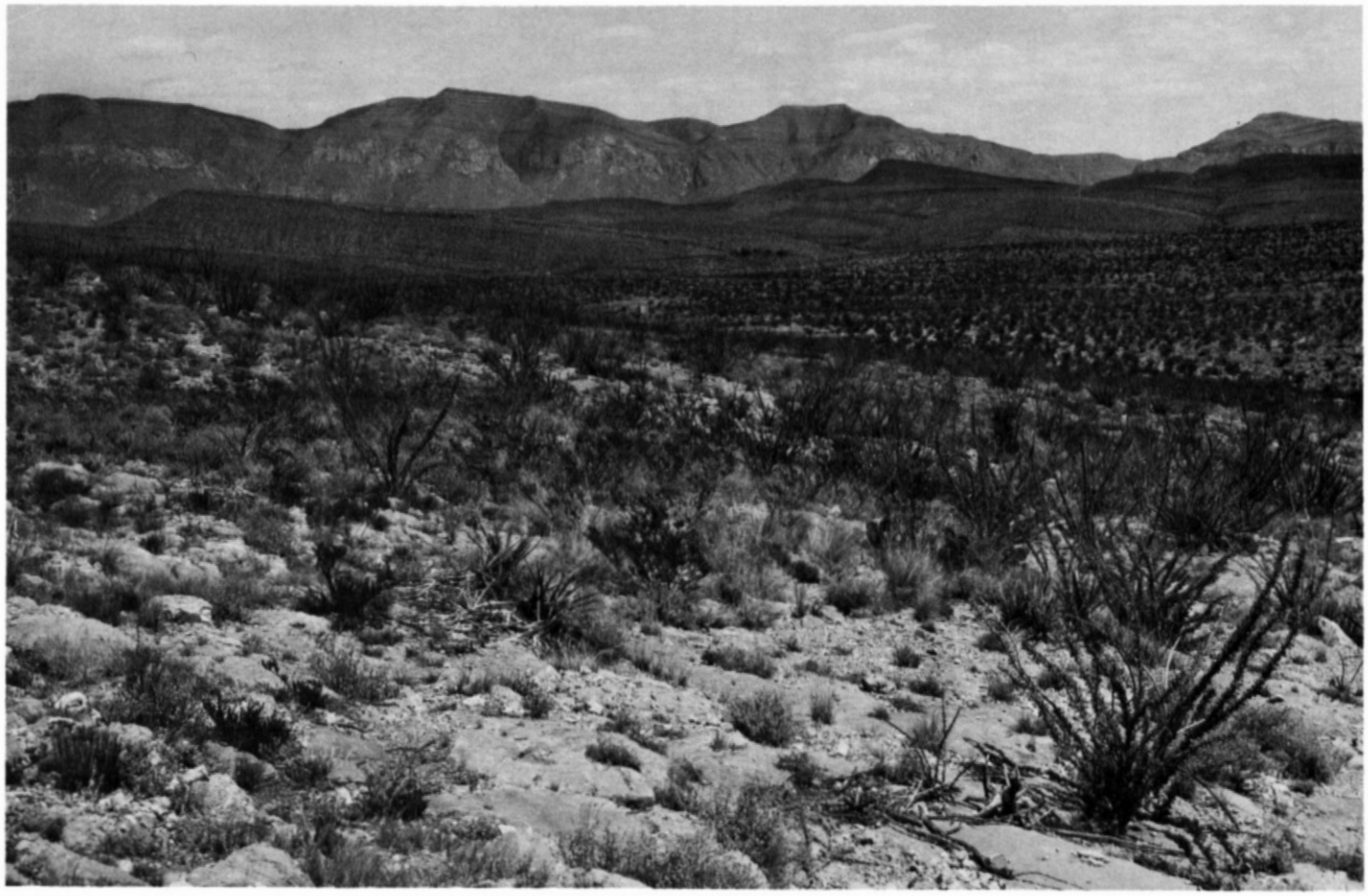


Figure 12.—**Lozier-Rock outcrop complex. The shallow Lozier stony loam is in pockets between the exposed limestone bedrock.**

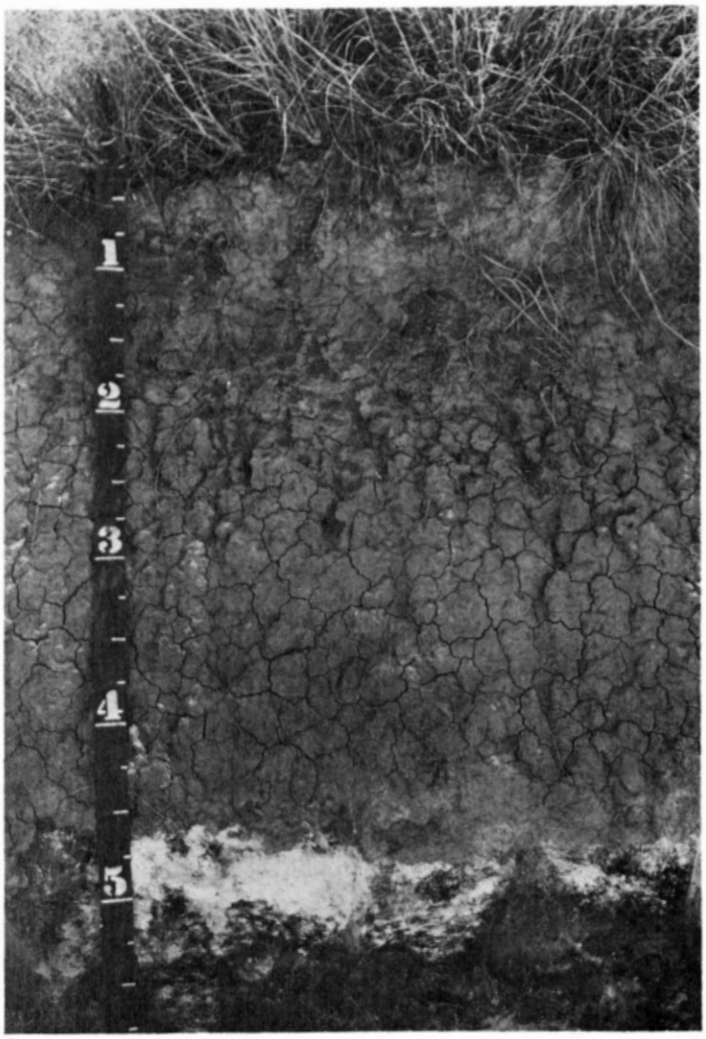


Figure 13.—**Profile of Marcial silty clay loam showing layer of gypsum at a depth of 5 feet. This soil formed in fine-textured alluvival sediments.**

moist, slightly sticky and slightly plastic wet; common fine roots; common fine vesicular pores; moderately saline; few pinpoint-size salt crystals; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary. 3 to 10 inches thick.

B2—6 to 38 inches, reddish-brown (2.5YR 5/4) silty clay, dark reddish brown (2.5YR 3/4) moist; moderate, medium, subangular blocky structure; very hard dry, firm moist, sticky and plastic wet; common fine roots; common fine tubular pores; moderately saline; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary. 14 to 41 inches thick.

C1cs—38 to 52 inches, reddish-brown (5YR 5/4) heavy silty clay loam, reddish brown (5YR 4/4) moist; massive; hard dry, friable moist, sticky and plastic wet; common micro interstitial pores; distinct threads of lime; moderately saline, common fine gypsum crystals; strongly calcareous; moderately alkaline (pH 8.2); abrupt, wavy boundary. 3 to 26 inches thick.

IIC2cs—52 to 60 inches, pink (7.5YR 8/4)gypsum, pink (7.5YR 7/4) moist.

The A horizon has hue of 2.5YR to 7.5YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 3 or 4. It is heavy silty clay loam, silty clay, or clay. The B horizon has hue of 2.5YR or 5YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 3 or 4. It is silty clay loam, silty clay, or clay. The Ccs horizon has hue of 5YR or 7.5YR, value of 5 to 7 dry and 4 to 6 moist, and chroma of 3 or 4. It is heavy silt loam, heavy silty clay loam, silty clay, or clay. The soil is moderately calcareous to strongly calcareous. Reaction is moderately alkaline to strongly alkaline throughout. Depth to gypsum ranges from 40 to 72 inches, but in some areas there is no gypsum.

Marcial-Ubar association (MA).—This mapping unit is about 55 percent Marcial silty clay loam and 35 percent Ubar silt loam. These soils are level and occur on the same landscape (fig. 14). The light-brown Ubar soil occurs higher on the landscape than the reddish-brown Marcial soil. The profiles of these soils are described as representative of the respective series.

Included in mapping are areas of Yesum and Holloman soils, intermittent lakes, rough broken land along lake benches or arroyos, and Gypsum land. Rough broken land is nonstony land that has short very steep slopes and is dissected by numerous intermittent drainageways. Included areas make up about 10 percent of the mapping unit.

Runoff is slow, and water erosion is a slight hazard. Soil blowing is a moderate hazard. In some small areas the soils are actively blowing.

This mapping unit is used for military purposes and wildlife. Capability subclass VIIe; vegetative group 2.

Mead Series

The Mead series consists of deep, saline, somewhat poorly drained soils. These soils formed in fine-textured recent alluvial sediments on basin floors. Slope is less than 1 percent. Elevation is 3,900 to 4,050 feet. The vegetation is sparse. It consists of a few scattered clumps of alkali sacaton, chamiza, iodinebush, and seepweed. Precipitation is 8 to 9 inches, mean annual air temperature is 59° to 63° F., and the frost-free season is 190 to 210 days.

In a representative profile the surface layer is pink silt loam and light reddish-brown heavy clay loam about 5 inches thick. The underlying layer is light reddish-brown clay about 43 inches thick over lacustrine material. The soil is moderately calcareous and slightly calcareous.

Mead soils are very slowly permeable. A seasonal water table fluctuates between depths of 36 and 84 inches during the rainy season in summer. Roots can penetrate to a depth of about 48 inches, but available water capacity is low because the soil contains soluble salts.

These soils are used for military purposes.

Representative profile of Mead silt loam, 3.2 miles south and 0.6 mile east of Gun site, Sierra County:

A11cs—0 to 3 inches, pink (5YR 7/4) silt loam, reddish brown (5YR 5/4) moist; weak, medium, platy structure; hard dry, friable moist; common fine vesicular pores and common micro interstitial pores; many, fine, prominent gypsum crystals; moderately calcareous; strongly alkaline (pH 8.5); abrupt, smooth boundary. 1 to 4 inches thick.

A12cs—3 to 5 inches, light reddish-brown (2.5YR 6/4) heavy clay loam, reddish brown (2.5YR 4/4)

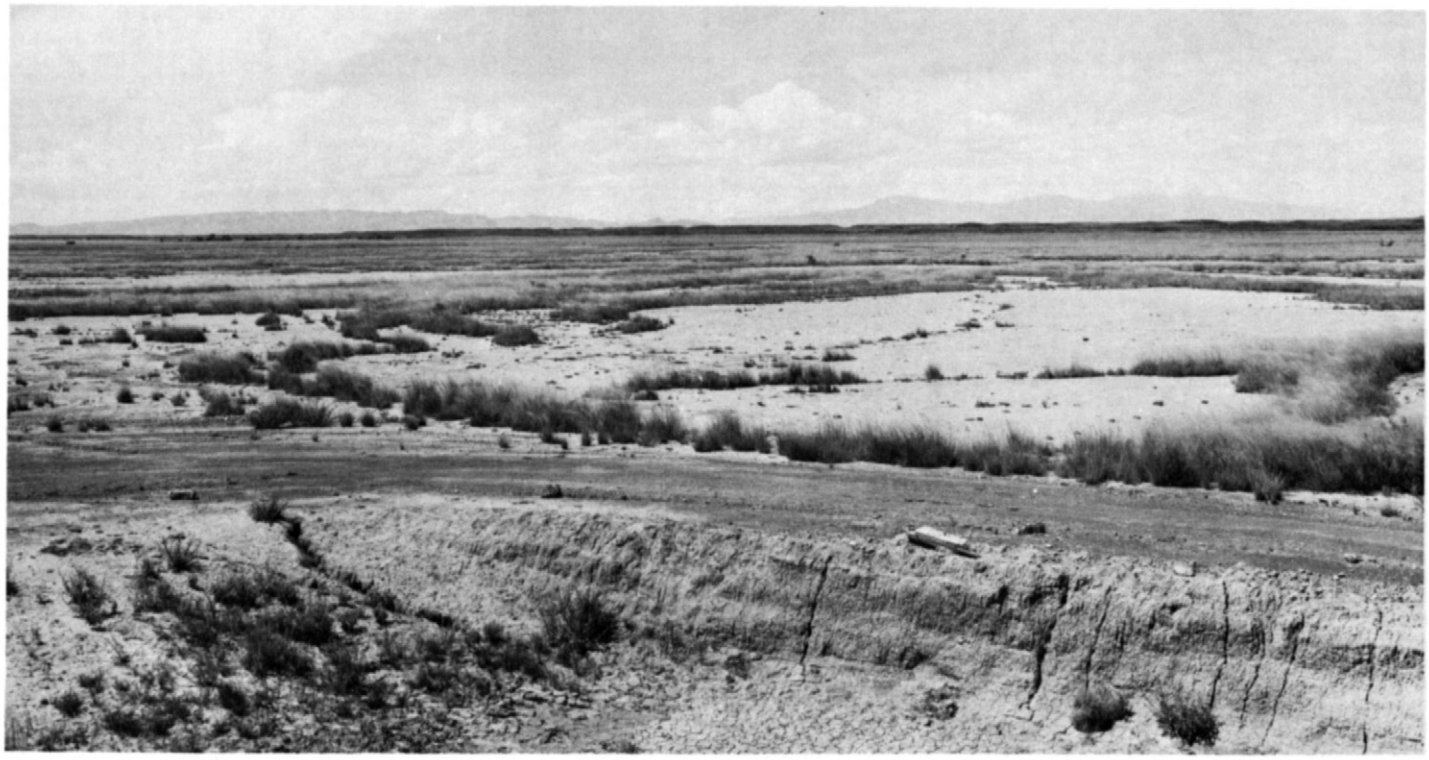


Figure 14.—**Marcial-Ubar association. This soil is in the Salt Flats range site of vegetative group 2.**

moist; common, thin and medium, platy structure; very hard dry, firm moist, sticky and plastic wet; few fine and common micro vesicular pores; about 25 percent of soil material is fine prominent gypsum crystals; moderately calcareous; moderately alkaline (pH 8.4); clear, smooth boundary. 1 to 5 inches thick.

C1cs—5 to 48 inches, light reddish-brown (5YR 6/4) clay, reddish brown (5YR 4/4) moist; massive; very hard dry, firm moist, very sticky and plastic wet; common very fine vesicular pores; about 30 percent fine prominent gypsum crystals; slightly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary. 18 to 63 inches thick.

IIC2cs—48 to 60 inches, lacustrine material.

The A horizon has hue of 2.5YR to 10YR, value of 5 to 7 dry and 3 to 5 moist, and chroma of 3 to 5. It is silt loam, silty clay loam, heavy clay loam, or silty clay. It is slightly calcareous to strongly calcareous. Reaction is moderately alkaline to strongly alkaline. The C horizon has hue of 2.5YR to 7.5YR, value of 5 to 7 dry and 3 to 5 moist, and chroma of 3 to 5. It is heavy clay loam, silty clay loam, silty clay, or clay. It is slightly calcareous to strongly calcareous. Reaction is moderately alkaline to strongly alkaline. The lower part of the profile is moist to wet most of the time. Depth to the underlying lacustrine material ranges from 20 to 72 inches.

Mead silt loam (ME).—This nearly level soil is on the basin floor of an old lake. It is a saline and alkali soil that is nearly barren of vegetation.

Included with this soil in mapping are areas of shallow and very shallow, strongly saline-alkali soils over lacustrine sediments; exposures of lacustrine sediments; intermitten lakes; and rough broken land along old lake benches. Included areas make up about 20 percent of the mapping unit.

Runoff is very slow, and water erosion is a slight hazard. Soil blowing is a moderate hazard. In some small areas the soil is actively blowing.

This soil is used for military purposes. Capability subclass VIIIs; vegetative group 2.

Mimbres Series

The Mimbres series consists of deep, well-drained soils. These soils formed in moderately fine textured recent alluvial sediments on alluvial fans and in broad waterways. Slope is 0 to 3 percent. Elevation is 4,000 to 4,600 feet. The vegetation is mid and short grasses, creosotebush, chamiza, and mesquite. Precipitation is 8 to 10 inches, mean annual air temperature is 58° to 62° F., and the frost-free season is 190 to 205 days.

In a representative profile the surface layer is light-brown silt loam about 3 inches thick. The subsoil is light-brown clay loam and silty clay loam about 25 inches thick. The substratum is light-brown clay loam and loam to a depth of 60 inches and more. The soil is strongly calcareous throughout.

Mimbres soils are moderately slowly permeable. Roots can penetrate to a depth of 60 inches and more, and available water capacity is high.

These soils are used for military purposes and wildlife habitat.

Representative profile of Mimbres silt loam in an area of Mimbres-Glendale association, 1.8 miles north of intersection of Routes 7 and 8 and 50 feet west of road, Lincoln County:

A1—0 to 3 inches, light-brown (7.5YR 6/3) silt loam, brown (7.5YR 4/3) moist; weak, thin, platy struc-

ture; slightly hard dry, very friable moist, slightly sticky wet; common fine roots; common very fine vesicular pores and common very fine interstitial pores; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary. 2 to 6 inches thick.

B21—3 to 14 inches, light-brown (7.5YR 6/3) clay loam, brown (7.5YR 4/3) moist; weak, medium and coarse, subangular blocky structure; hard dry, very friable moist, slightly sticky and slightly plastic wet; few fine roots; common very fine interstitial pores and few fine tubular pores; strongly calcareous; moderately alkaline (pH 8.2); clear, smooth boundary. 6 to 20 inches thick.

B22—14 to 28 inches, light-brown (7.5YR 6/3) silty clay loam, brown (7.5YR 4/3) moist; weak, coarse, subangular blocky structure; hard dry, friable moist, sticky and plastic wet; common very fine interstitial pores and few fine tubular pores; strongly calcareous; moderately alkaline (pH 8.1); clear, smooth boundary. 7 to 20 inches thick.

C1ca—28 to 48 inches, light-brown (7.5YR 6/3) clay loam, brown (7.5YR 5/3) moist; massive; hard dry, friable moist, sticky and plastic wet; common very fine interstitial pores and few fine tubular pores; strongly calcareous, few fine, faint, soft masses of lime; moderately alkaline (pH 8.0); clear, smooth boundary. 10 to 30 inches thick.

C2—48 to 60 inches, light-brown (7.5YR 6/4) loam, brown (7.5YR 4/4) moist; massive; hard dry, friable moist, slightly sticky and slightly plastic wet; few fine tubular pores; strongly calcareous; moderately alkaline (pH 7.9).

The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 2 to 4. It is silt loam, silty clay loam, or clay loam. It is slightly calcareous to strongly calcareous. Reaction is mildly alkaline to moderately alkaline. The B horizon has hue of 5YR to 10YR, value of 4 to 7 dry and 3 to 6 moist, and chroma of 2 to 4. It is stratified with material that is high in content of silt and averages silty clay loam, silt loam, or clay loam. It is moderately calcareous to strongly calcareous. Reaction is mildly alkaline to moderately alkaline. The C horizon has hue of 5YR to 10YR, value of 4 to 7 dry and 3 to 6 moist, and chroma of 2 to 4.

Mimbres-Glendale association (MG).—This mapping unit is about 55 percent Mimbres silt loam and 25 percent Glendale silt loam. The Mimbres soil is on the slightly higher and older landscapes, and the Glendale soil is on the more recent alluvial sediments, lower on the landscape. Both soils are dominantly nearly level, but range to gently sloping on alluvial fans near the basin floor. Their profiles are described as representative of the respective series.

Included in mapping are areas of Sotim, Yesum, and Nickel soils, which make up about 15 percent of the mapping unit.

Runoff is medium, and the hazards of water erosion and soil blowing are moderate. In some small areas the soils are actively blowing. The Mimbres soil is subject to minor flooding during periods of high runoff. The Glendale soil is channeled and is not subject to flooding.

This mapping unit is used for military purposes and wildlife habitat. Capability subclass VIIe; vegetative group 1.

Nickel Series

The Nickel series consists of deep, well-drained soils on old alluvial fans. These soils formed in gravelly, medium-textured alluvial sediments. Slope is 1 to 55 percent. Elevation is 4,100 to 6,000 feet. The vegetation is mid and short grasses, creosotebush, American tarbush, mesquite, soaptree yucca, mariola parthenium, and annuals. Precipitation is 8 to 13 inches, mean annual air temperature is 57° to 62° F., and the frost-free season is 185 to 205 days.

In a representative profile the surface layer is light-brown gravelly fine sandy loam about 3 inches thick. The underlying material to a depth of 60 inches or more is pink gravelly loam and very gravelly loam. The gravel content is about 50 percent. The soil is strongly calcareous throughout.

Nickel soils are moderately slowly permeable. Roots can penetrate to a depth of 60 inches or more, but available water capacity is low.

These soils are used for military purposes. They also provide habitat for wildlife and are a source of gravel for use in construction.

Representative profile of Nickel gravelly fine sandy loam in an area of Nickel-Tencee association, 1.1 miles west of the intersection of Route 12 and road to Wood site, 1.5 miles north on unimproved road, Lincoln County:

A1—0 to 3 inches, light-brown (7.5YR 6/3) gravelly fine sandy loam, brown (7.5YR 4/3) moist; weak, fine, granular structure; slightly hard dry, very friable moist; common fine roots; common fine interstitial pores; about 60 percent gravel on the surface, 30 percent gravel within horizon; strongly calcareous, patchy coatings of lime on pebbles; moderately alkaline (pH 8.2); clear, smooth boundary. 2 to 5 inches thick.

C1—3 to 16 inches, pink (7.5YR 7/3) very gravelly loam, brown (7.5YR 5/3) moist; weak, coarse, subangular blocky structure; hard dry, friable moist, slightly sticky wet; common fine roots; common fine interstitial pores; 30 percent limestone gravel and 10 percent caliche fragments; strongly calcareous, patchy coatings of lime on pebbles; moderately alkaline (pH 8.2); clear, wavy boundary. 3 to 15 inches thick.

C2ca—16 to 26 inches, pink (7.5YR 8/3) very gravelly loam, light brown (7.5YR 6/3) moist; massive; hard dry, friable moist; few fine roots in upper 2 inches; common fine interstitial pores; about 40 percent limestone gravel and 15 percent caliche fragments; strongly calcareous, thick lime coatings on pebbles; moderately alkaline (pH 8.3); clear, wavy boundary. 7 to 14 inches thick.

C3—26 to 60 inches, pink (7.5YR 7/3) gravelly loam with thin strata of very gravelly loamy sand below a depth of 40 inches, brown (7.5YR 5/3) moist; massive; hard dry, friable moist; common fine interstitial pores; about 25 percent limestone gravel and 5 percent caliche fragments; strongly calcareous, patchy lime coatings on pebbles; moderately alkaline (pH 8.0).

The A and C horizons have hue of 7.5YR or 10YR and chroma of 2 to 4. The Cca horizon has hue of 7.5YR or 10YR, value of 7 or 8 dry and 5 to 7 moist, and chroma of 2 to 4. Depth to the Cca horizon ranges from 5 to 20 inches. The Cca horizon contains soft lime segregations that have hard coatings on the coarse fragments. In places it is weakly cemented. The soil is gravelly or very gravelly loam, fine sandy loam, or sandy loam and in places is cobbly. Strata of very gravelly loamy sand are common below a depth of 40 inches.

Nickel-Tencee association (NT).—This mapping unit is about 60 percent Nickel gravelly fine sandy loam and 25 percent Tencee very gravelly loam. These soils

are gently sloping to moderately sloping and are in similar positions on alluvial fans. The Tencee soil is dominant on the older, more stable landscapes where the source of alluvial material was limestone rock. The profiles of these soils are the ones described as representative of the respective series.

Included in mapping are areas of Mimbres and Sonoita soils, colluvial land, and arroyo bottoms. Included areas make up about 15 percent of the mapping unit.

Runoff is medium. Water erosion is a severe hazard, and soil blowing is a slight hazard.

This mapping unit is used for military purposes. It also provides habitat for wildlife (fig. 15) and is a source of gravel for use in construction. Capability subclass VIIe; vegetative group 8.

Onite Series

The Onite series consists of deep, well-drained soils. These soils formed in sandy alluvial sediments on old alluvial fans. Slope is 0 to 3 percent. Elevation is 4,100 to 5,000 feet. The vegetation is tall grasses, mid grasses, sand sagebrush, soaptree yucca, broom snakeweed, and annuals. Precipitation is 8 to 10 inches, mean annual air temperature is 58° to 62° F., and the frost-free season is 190 to 210 days.

In a representative profile the surface layer is brown loamy fine sand about 12 inches thick. The subsoil is reddish-brown sandy loam about 24 inches thick. The substratum is light reddish-brown and pink loamy fine sand and fine sandy loam to a depth of 60 inches and more. The soil is noncalcareous to a depth of 24 inches and slightly calcareous to strongly calcareous below.

Onite soils are moderately rapidly permeable. Roots can penetrate to a depth of 60 inches and more, but available water capacity is only moderate.

These soils are used for military purposes and wildlife habitat.

Representative profile of Onite loamy fine sand in an area of Onite-Bluepoint-Wink association, 1 mile south of Granjean, 40 feet north of Road 22, and 100 feet east of the road intersection, Socorro County:

A1—0 to 12 inches, brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; weak, thick, platy structure; soft dry, very friable moist; common fine roots; common fine interstitial pores; neutral (pH 7.1); clear, smooth boundary. 8 to 12 inches thick.

B2t—12 to 24 inches, reddish-brown (5YR 5/4) sandy loam, dark reddish brown (5YR 3/4) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; hard dry, very friable moist, slightly sticky wet; common fine roots;

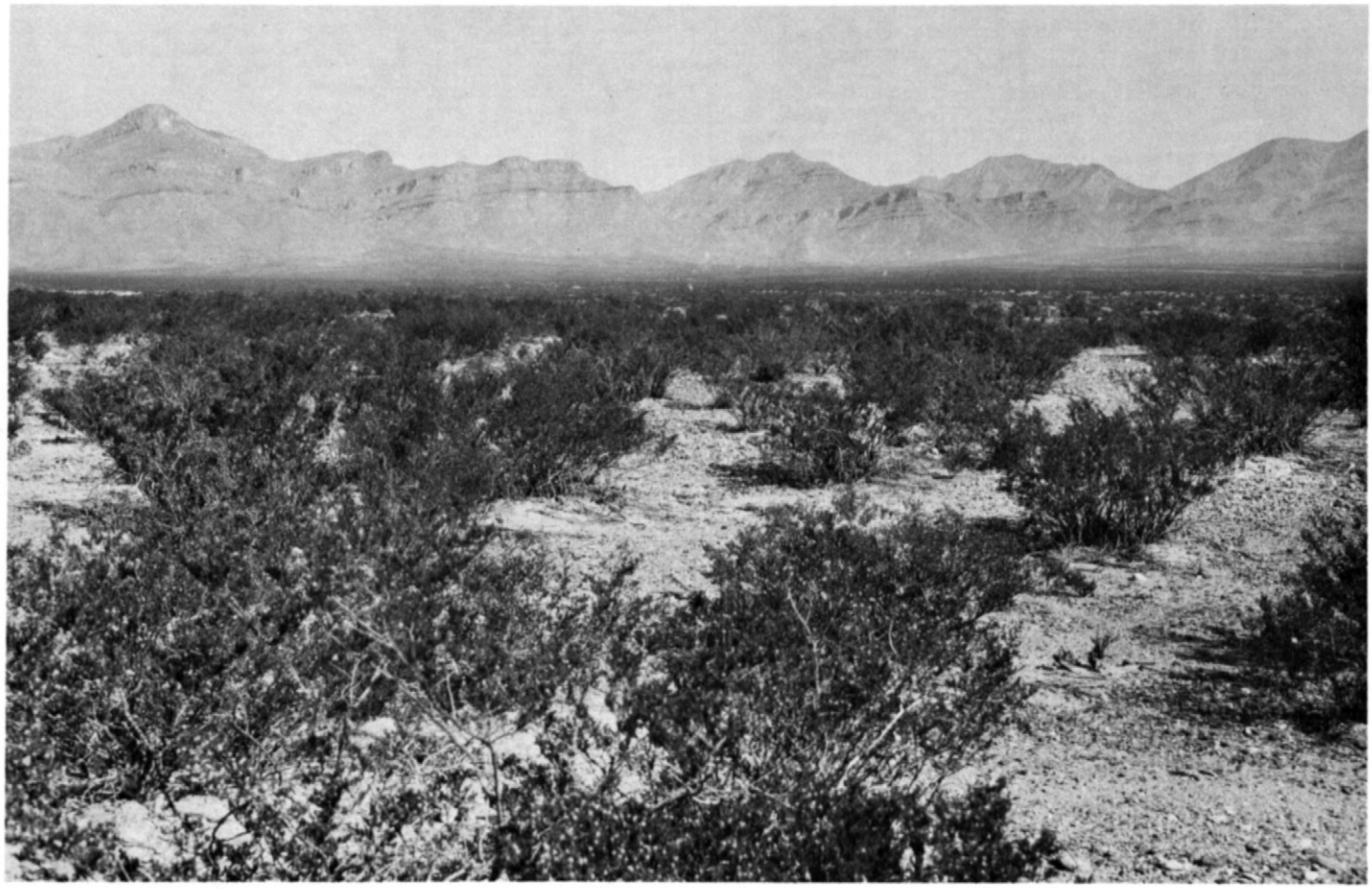


Figure 15.—**Nickel-Tencee association. Creosotebush is the dominant vegetation.**

common fine interstitial pores; clay films bridging and coating sand grains; mildly alkaline (pH 7.5); clear, smooth boundary. 8 to 14 inches thick.

B3ca—24 to 36 inches, reddish-brown (5YR 5/4) sandy loam, reddish brown (5YR 4/4) moist; weak, coarse, subangular blocky structure; hard dry, very friable moist; few fine roots; common fine interstitial pores; slightly calcareous, common fine threads of lime; mildly alkaline (pH 7.7); clear, smooth boundary. 0 to 12 inches thick.

C1ca—36 to 48 inches, light reddish-brown (5YR 6/4) loamy fine sand, reddish brown (5YR 5/4) moist; weak, coarse, subangular blocky structure; slightly hard dry, very friable moist; common fine interstitial pores; moderately calcareous, common small masses and fine threads of lime; moderately alkaline (pH 8.0); abrupt, wavy boundary. 6 to 22 inches thick.

C2ca—48 to 60 inches, pink (5YR 8/4) fine sandy loam, light reddish brown (5YR 6/4) moist; massive; hard dry, friable moist, slightly sticky wet; few fine interstitial pores; strongly calcareous; moderately alkaline (pH 8.3).

The A horizon has hue of 5YR or 7.5YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 3 or 4. It ranges from loamy fine sand to coarse sandy loam. It is noncalcareous or slightly calcareous. Reaction is neutral or mildly alkaline. The B2t horizon has hue of 5YR or 7.5YR, value of 5 or 6 dry and 3 to 5 moist, and chroma of 4 to 6. It is sandy loam or fine sandy loam. It is noncalcareous or slightly calcareous. Reaction is mildly alkaline or moderately alkaline. The Cca horizon has hue of 5YR or 7.5YR and chroma of 3 or 4.

Onite-Bluepoint-Wink association (OB).—This mapping unit is about 40 percent Onite loamy fine sand, 25 percent Bluepoint fine sand, and 20 percent Wink loamy fine sand. The Onite and Wink soils are nearly level to gently undulating and are on old alluvial fans. The Bluepoint soil is in low, undulating dunelike areas. The profiles of these soils are the ones described as representative of the respective series.

Included in mapping are areas of Berino, Pajarito, and Yesum soils, which make up about 15 percent of the mapping unit.

Runoff is slow, and the hazard of water erosion is slight. Soil blowing is a severe hazard (fig. 16). In some small areas the soils are actively blowing.

This mapping unit is used for military purposes and wildlife habitat. Capability subclass VIIe; vegetative group 3.

Oscura Series

The Oscura series consists of deep, well-drained soils on flood plains and in waterways. These soils formed in fine-textured recent alluvial sediments. Slope is less than 1 percent. Elevation is 4,300 to 4,700 feet. The vegetation is tall, mid, and short grasses; chamiza; mesquite; and soaptree yucca. Pre-

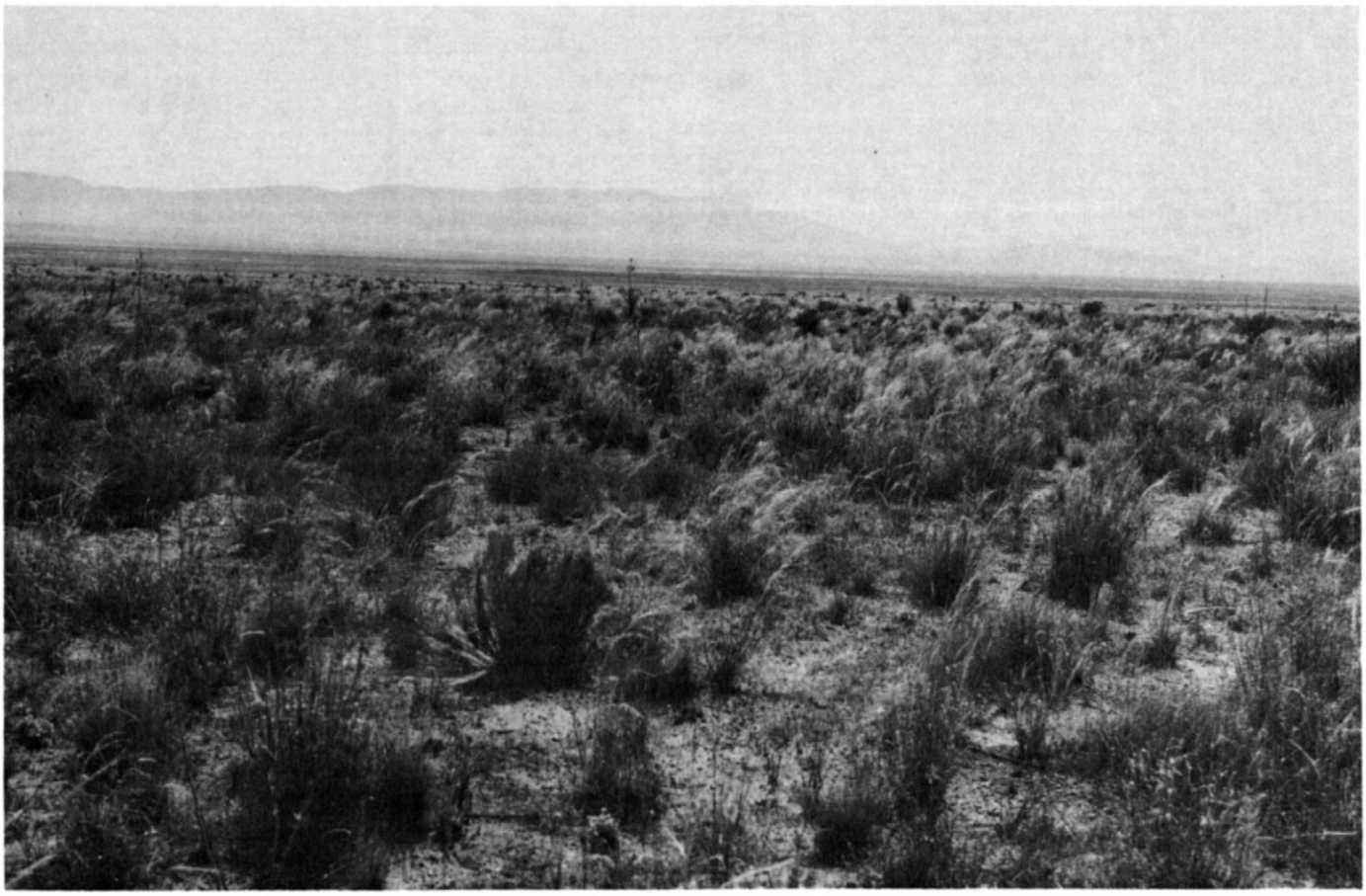


Figure 16.—**Onite-Bluepoint-Wink association. The hazard of soil blowing is severe.**

cipitation is 8 to 10 inches, mean annual air temperature is 58° to 62° F., and the frost-free season is 190 to 205 days.

In a representative profile the surface layer is light-brown silty clay about 10 inches thick. The underlying material extends to a depth of 60 inches or more. It is light-brown, pinkish-gray, and brown clay and heavy silty clay loam thinly stratified with very fine sandy loam. The soil is moderately calcareous throughout.

Oscura soils are slowly permeable. Roots can penetrate to a depth of 60 inches or more, and available water capacity is high. The hazard of flooding is moderate.

These soils are used for military purposes and provide habitat for wildlife.

Representative profile of Oscura silty clay in the northeast corner of the Range, 0.9 mile east of basalt lava flow on Road 12, then 200 yards north and just west of the fence, Lincoln County:

A1—0 to 10 inches, light-brown (7.5YR 6/4) silty clay, dark brown (7.5YR 3/4) moist; weak, thin, platy structure in the upper 2 inches and weak, fine, subangular blocky below; very hard dry, friable moist, sticky and plastic wet; many fine roots; many micro interstitial pores; moderately calcareous; mildly alkaline (pH 7.4); abrupt, smooth boundary. 6 to 16 inches thick.

C1—10 to 13 inches, light-brown (7.5YR 6/4) very fine sandy loam, dark brown (7.5YR 3/4) moist; massive; slightly hard dry, very friable moist; common fine roots; common fine interstitial pores and few fine tubular pores; moderately calcareous; mildly alkaline (pH 7.4); abrupt, smooth boundary. 0 to 5 inches thick.

C2—13 to 18 inches, pinkish-gray (7.5YR 6/2) clay, brown (7.5YR 4/2) moist; massive; very hard dry, firm moist, sticky and plastic wet; common fine roots; few fine and very fine soft salt crystals; common fine interstitial pores and few fine tubular pores; moderately calcareous; mildly alkaline (pH 7.7); abrupt, smooth boundary. 3 to 10 inches thick.

C3—18 to 22 inches, pinkish-gray (7.5YR 6/2) very fine sandy loam, brown (7.5YR 4/2) moist; massive; slightly hard dry, very friable moist; common fine roots; common fine interstitial pores; moderately calcareous; mildly alkaline (pH 7.7); abrupt, smooth boundary. 0 to 5 inches thick.

C4—22 to 39 inches, light-brown (7.5YR 6/4) clay, dark brown (7.5YR 3/4) moist; massive; very hard dry, firm moist, sticky and plastic wet; few fine roots; common micro interstitial pores and few tubular pores; moderately calcareous; mildly alkaline (pH 7.8); clear, smooth boundary. 15 to 30 inches thick.

C5—39 to 60 inches, brown (10YR 5/3) heavy silty clay loam, dark brown (10YR 3/3) moist; massive; hard dry, friable moist, sticky and plastic wet; common fine interstitial pores; moderately calcareous; mildly alkaline (pH 7.8).

The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 dry and 3 or 4 moist, and chroma of 2 to 4. It is silt loam, silty clay loam, silty clay, or clay. The C horizon has value of 5 to 7 dry. It is stratified, dominantly with silty clay loam, silty clay, and clay and in places with thin strata, less than 5 inches thick, of very fine sandy loam. This horizon is typically 35 to 50 percent clay.

Oscura silty clay (OS).—This is a level on flood plains of intermittent waterways. Included in mapping are areas of Marcial, Yesum, and Mimbres soils, which make up about 15 percent of the mapping unit. Runoff is slow. Water erosion and soil blowing are moderate hazards. Seasonal flooding is common.

This soil is used for military purposes. It also provides habitat for wildlife. Capability subclass VIIe; vegetative group 1.

Pajarito Series

The Pajarito series consists of deep, well-drained soils. These soils formed in sandy alluvial sediments on old alluvial fans. Slope is 1 to 4 percent. Elevation is 4,100 to 4,600 feet. The vegetation is tall and mid grasses, mesquite, chamiza, creosotebush, winterfat, American tarbush, soaptree yucca, and annuals. Precipitation is 8 to 10 inches, mean annual air temperature is 58° to 62° F., and the frost-free season is 190 to 205 days.

In a representative profile the surface layer is light reddish-brown sandy loam about 5 inches thick. The subsoil is light reddish-brown sandy loam about 10 inches thick. The substratum is light-brown and pink loamy fine sand and sandy loam to a depth of 60 inches and more. The soil is moderately calcareous throughout.

Pajarito soils are moderately rapidly permeable. Roots can penetrate to a depth of 60 inches and more, but available water capacity is only moderate.

These soils are used for military purposes and wildlife habitat.

The Pajarito soils in the White Sands Missile Range are mapped only with Dona Ana and Bluepoint soils.

Representative profile of Pajarito sandy loam in an area of Dona Ana-Pajarito-Bluepoint association, 0.5 mile east and 1.3 miles north of Russ site, Otero County:

A1—0 to 5 inches, light reddish-brown (5YR 6/4) sandy loam, reddish brown (5YR 4/4) moist; weak, medium, granular structure; slightly hard dry, very friable moist; few fine roots; common fine and medium interstitial pores; moderately calcareous; moderately alkaline (pH 7.9); clear, smooth boundary. 4 to 12 inches thick.

B2—5 to 15 inches, light reddish-brown (5YR 6/4) sandy loam, reddish brown (5YR 4/4) moist; weak, coarse, subangular blocky structure; slightly hard dry, very friable moist; few fine roots; common fine and medium interstitial pores; moderately calcareous; moderately alkaline (pH 8.0); clear, smooth boundary. 6 to 24 inches thick.

C1—15 to 23 inches, light-brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 4/4) moist; massive;slightly hard dry, very friable moist; common fine and medium interstitial pores; moderately calcareous; moderately alkaline (pH 8.0); clear, smooth boundary. 8 to 30 inches thick.

C2ca—23 to 60 inches, pink (7.5YR 7/4) sandy loam, brown (7.5YR 4/4) moist; massive; slightly hard dry, very friable moist; common fine and medium interstitial pores; few fine and medium gypsum crystals; moderately calcareous, common fine threads of lime; moderately alkaline (pH 7.9).

The A horizon has hue of 2.5YR to 7.5YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 2 to 5. It is loamy sand or sandy loam. It is noncalcareous to moderately calcareous. Reaction is mildly alkaline to moderately alkaline. The B horizon has hue of 2.5YR to 7.5YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 4 to 6. It is sandy loam, fine sandy loam, or loam. It is slightly calcareous to

moderately calcareous. The C horizon has hue of 5YR or 7.5YR, value of 5 to 7 dry and 4 or 5 moist, and chroma of 3 to 5. It is moderately calcareous to strongly calcareous.

Pinaleno Series

The Pinaleno series consists of deep, well-drained soils. These soils formed in gravelly and sandy loam alluvial sediments on old alluvial fans. Slope is 1 to 9 percent. Elevation is 4,000 to 5,900 feet. The vegetation is mid and short grasses, sand sagebrush, mesquite, soaptree yucca, and annuals. Precipitation is 9 to 12 inches, mean annual air temperature is 55° to 62° F., and the frost-free season is 185 to 210 days.

In a representative profile the surface layer is brown gravelly sandy loam about 3 inches thick. The subsoil is about 26 inches thick. It is brown and reddish-brown gravelly sandy clay loam in the upper part and pink very gravelly heavy sandy loam in the lower part. The substratum is pink very gravelly sandy loam to a depth of 60 inches and more. The soil is noncalcareous to a depth of 11 inches and slightly calcareous to strongly calcareous below.

Pinaleno soils are moderately slowly permeable. Roots can penetrate to a depth of 60 inches and more, but available water capacity is low.

These soils are used for military purposes and wildlife habitat.

The Pinaleno soils in the White Sands Missile Range are mapped only with Sonoita and Aladdin soils.

Representative profile of Pinaleno gravelly sandy loam in an area of Sonoita-Pinaleno-Aladdin association, 0.4 mile south of Murray Well turnoff in Mockingbird Gap on the west side of Route 7 in road cut, Socorro County:

A1—0 to 3 inches, brown (7.5YR 5/4) gravelly sandy loam, dark brown (7.5YR 3/4) moist; weak, medium, platy structure parting to weak, medium, granular; slightly hard dry, very friable moist; common fine roots; few fine vesicular pores and common fine interstitial pores; 20 percent angular acid igneous gravel; mildly alkaline (pH 7.5); clear, smooth boundary. 1 to 5 inches thick.

B21t—3 to 11 inches, brown (7.5YR 5/4) gravelly sandy clay loam, dark brown (7.5YR 3/4) moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; hard dry, very friable moist, slightly sticky wet; common fine roots; common fine interstitial pores; clay bridges between sand grains, clay films in pores and on pebbles; 25 percent angular acid igneous gravel; mildly alkaline (pH 7.5); clear, smooth boundary. 4 to 17 inches thick.

B22tca—11 to 15 inches, reddish-brown (5YR 5/5) gravelly sandy clay loam, reddish brown (5YR 4/5) moist; weak, coarse, subangular blocky structure; hard dry, very friable moist, slightly sticky wet; few fine roots; common fine interstitial pores; clay bridges between some sand grains and clay films in some pores; 30 percent acid igneous gravel; slightly calcareous, common fine threads of lime and patchy lime coatings on bottoms of pebbles; mildly alkaline (pH 7.8); clear, smooth boundary. 3 to 10 inches thick.

B3ca—15 to 29 inches, pink (7.5YR 7/4) very gravelly heavy sandy loam, brown (7.5YR 5/4) moist; weak, coarse, subangular blocky structure; hard dry, very friable moist; few fine interstitial pores; about 40 percent acid igneous gravel; moderately calcareous, nearly continuous lime coatings on pebbles and many, coarse, distinct, soft masses of lime; moderately alkaline (pH 8.0); clear, smooth boundary. 7 to 18 inches thick.

C1ca—29 to 42 inches, pink (7.5YR 8/4) very gravelly sandy loam, light brown (7.5YR 6/4) moist; massive; hard dry, very friable moist; few fine interstitial pores; 40 percent acid igneous gravel; strongly calcareous, continuous lime coatings on pebbles; moderately alkaline (pH 8.2); clear, wavy boundary. 10 to 24 inches thick.

C2ca—42 to 60 inches, pink (7.5YR 7/4) very gravelly sandy loam, light brown (7.5YR 6/4) moist; massive; hard dry, very friable moist; few fine interstitial pores; 40 percent acid igneous gravel; strongly calcareous, patchy lime coatings on pebbles; moderately alkaline (pH 8.2).

The A horizon has hue of 5YR or 7.5YR, value of 4 to 6 dry and 3 or 4 moist, and chroma of 3 or 4. It ranges from gravelly sandy loam to very gravelly loamy sand. It is noncalcareous to slightly calcareous. Reaction is neutral to mildly alkaline. The B2t horizon has hue of 5YR or 7.5YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 3 to 5. It is gravelly or very gravelly sandy clay loam or clay loam. It ranges from noncalcareous to slightly calcareous in the upper part and slightly calcareous to moderately calcareous in the lower part. Reaction is mildly alkaline to moderately alkaline. The Cca horizon has hue of 5YR to 10YR, value of 6 to 8 dry and 5 or 6 moist, and chroma of 3 to 5. The percentage of gravel commonly increases with increasing depth. It ranges from 15 to 70 percent and averages more than 35 percent below the A horizon.

Pinaleno Series, Noncalcareous Variant

The Pinaleno series, noncalcareous variant, consists of well-drained soils. These soils formed in gravelly sandy loam alluvial sediments over weathered granitic igneous bedrock. Slope is 5 to 15 percent. Elevation is 5,000 to 6,000 feet. The vegetation is mid and short grasses, soaptree yucca, shrub live oak, and Gambel oak in protected areas. Precipitation is 9 to 12 inches, mean annual air temperature is 55° to 62° F., and the frost-free season is 185 to 200 days.

In a representative profile the surface layer is brown gravelly sandy loam about 3 inches thick. The subsoil is reddish-brown and reddish-yellow gravelly clay loam and very gravelly sandy clay loam. It is about 30 inches thick over weathered granitic bedrock that readily breaks into individual crystals.

Pinaleno soils, noncalcareous variant, are moderately slowly permeable. Roots can penetrate to a depth of only about 33 inches, and available water capacity is low.

These soils are used for military purposes and wildlife habitat.

The Pinaleno noncalcareous variant in the White Sands Missile Range is mapped only with Aladdin soils.

Representative profile of Pinaleno gravelly sandy loam, noncalcareous variant, in an area of Aladdin association, on U.S. Highway 70, 1 mile east of the Rocket Park on San Augustin Pass, in road cut on north side, Dona Ana County:

A1—0 to 3 inches, brown (10YR 5/3) gravelly sandy loam, dark brown (10YR 3/3) moist; weak, fine, granular structure; slightly hard dry, very friable moist; many fine roots; many fine interstitial pores; 30 percent fine angular granitic gravel;

surface covered with 50 percent gravel and 10 percent cobblestones; neutral (pH 7.0); clear, smooth boundary. 2 to 7 inches thick.

B21t—3 to 13 inches, reddish-brown (5YR 5/4) gravelly clay loam, reddish brown (5YR 4/4) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky; hard dry, friable moist, sticky and slightly plastic wet; common fine roots; many micro interstitial pores; clay bridges between and coatings on sand grains and clay films lining pores; 30 percent fine angular granitic gravel; neutral (pH 7.2); clear, wavy boundary. 4 to 12 inches thick.

B22t—13 to 17 inches, reddish-yellow (5YR 6/6) gravelly clay loam, yellowish red (5YR 4/6) moist; weak, medium, subangular blocky structure; hard dry, friable moist, sticky and slightly plastic wet; common fine roots; many micro and fine interstitial pores; clay bridges between and coatings on sand grains and clay films lining pores; 40 percent fine angular granitic gravel; neutral (pH 7.2); clear, wavy boundary. 4 to 10 inches thick.

B31t—17 to 22 inches, reddish-yellow (5YR 6/6) very gravelly heavy sandy clay loam, yellowish red (5YR 5/6) moist; weak, coarse, subangular blocky structure; hard dry, friable moist, sticky and slightly plastic wet; few fine roots; common fine interstitial pores; clay coatings on sand grains and clay films lining pores; 60 percent fine angular granitic gravel; neutral (pH 7.2); clear, wavy boundary. 5 to 13 inches thick.

B32t—22 to 33 inches, reddish-yellow (7.5YR 6/6) very gravelly sandy clay loam, strong brown (7.5YR 5/6) moist; weak, coarse, subangular blocky structure; hard dry, friable moist, slightly sticky wet; few fine roots; common fine interstitial pores; few clay coatings on sand grains and clay films lining pores; 80 percent fine angular granitic gravel, mostly in its original position in what was bedrock; neutral (pH 7.2); clear, wavy boundary. 5 to 13 inches thick.

C—33 inches, weathered granitic bedrock that breaks into individual crystals about ¼ inch across (small gravel size).

The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry and 3 or 4 moist, and chroma of 3 or 4. It is gravelly sandy loam or gravelly sandy clay loam. The soil is noncalcareous in the A and B2t horizons and noncalcareous to slightly calcareous in the B3t horizon. Reaction is neutral to mildly alkaline. The B2t horizon has hue of 2.5YR to 7.5YR and value of 4 to 6 dry and 3 or 4 moist. It is gravelly or very gravelly clay loam or sandy clay loam. Depth to weathered granitic bedrock is 20 to 48 inches.

Rance Series, Shallow Variant

The Rance series, shallow variant, consists of shallow, well-drained soils. These soils formed in loamy alluvial sediments influenced by underlying gypsum bedrock. Slope is 5 to 35 percent. Elevation is 5,600 to 7,000 feet. The vegetation is mid and short grasses, rough coldenia, sacahuista, soaptree yucca, and scattered pinyon pine and oneseed juniper. Precipitation is 12 to 15 inches, mean annual air temperature is 50° to 57° F., and the frost-free season is 160 to 180 days.

In a representative profile the surface layer is brown gravelly loam and pale-brown loam about 8 inches thick. The underlying layer is very pale brown loam about 7 inches thick over hard gypsum bedrock. The soil is slightly calcareous to moderately calcareous throughout.

Rance soils are moderately permeable. Roots can penetrate to a depth of only 4 to 20 inches, and available water capacity is very low.

These soils are used for military purposes and wildlife habitat.

The Rance shallow variant in the White Sands Missile Range is mapped only with Gypsum rock land.

Representative profile of Rance gravelly loam, shallow variant, in an area of Gypsum rock land, 3 miles northwest of the gate in the northeast corner of the White Sands Missile Range, on the north side of U.S. Highway 380 in the road cut, Socorro County:

A11—0 to 4 inches, brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; moderate, fine, granular structure; slightly hard dry, very friable moist; many fine roots; common fine interstitial pores; 40 percent of surface covered with limestone and gypsum gravel; 20 percent limestone gravel; slightly calcareous; mildly alkaline (pH 7.5); clear, smooth boundary. 2 to 5 inches thick.

A12—4 to 8 inches, pale-brown (10YR 6/3) loam, brown (10YR 4/3) moist; weak, medium, subangular blocky structure; slightly hard dry, very friable moist; many fine roots; common fine interstitial pores; 10 to 15 percent limestone gravel; moderately calcareous, patchy lime coatings on coarse fragments; mildly alkaline (pH 7.8); clear, smooth boundary. 2 to 6 inches thick.

Ccacs—8 to 15 inches, very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist; massive; slightly hard dry, very friable moist; common fine roots; common micro and fine interstitial pores; 10 to 15 percent limestone gravel; moderately calcareous, nearly continuous lime coatings on coarse fragments; moderately alkaline (pH 8.0); abrupt, wavy boundary. 0 to 9 inches thick.

R—15 inches, hard gypsum bedrock.

The A horizon has hue of 7.5YR or 10YR and chroma of 3 or 4. It is gravelly loam, gravelly fine sandy loam, fine sandy loam, or loam. It is noncalcareous to moderately calcareous. Reaction is neutral to mildly alkaline. The Ccacs horizon has hue of 7.5YR or 10 YR, value of 6 or 7 dry and 4 or 5 moist, and chroma of 3 or 4. It ranges from loam to light clay loam. It is slightly calcareous to moderately calcareous. Reaction is mildly alkaline to moderately alkaline. Depth to gypsum bedrock ranges from 4 to 20 inches.

Rock Land

Rock land is about 35 percent barren rock outcrop, 30 percent stony land, and about 20 percent shallow and very shallow soils.

Rock land, cool (RK).—Rock land, cool, consists of very steep, rough, mountainous slopes, escarpments, ledges, cliffs, and canyons. The rock outcrop is limestone, acid igneous rock, sandstone, basalt, shale, and gypsum exposures. Limestone generally caps the tops of the mountains. The shallow and very shallow soils are interspersed between the rock outcrop. Stony land is mostly below but adjacent to the rock outcrop.

Included in mapping are areas of La Fonda soils, colluvial land, and alluvial soils on numerous narrow valley floors and in arroyos. Included areas make up about 15 percent of the mapping unit.

The vegetation is sparse and is limited to areas of soil material or to cracks and fissures in the rock. It consists of mid and tall grasses, mountainmahogany, pinyon pine, oneseed juniper, and Gambel oak. Elevation ranges from 6,000 to 8,000 feet. The lower elevations occur on the more northerly slopes. Precipitation is 12 to 16 inches, mean annual air temperature is

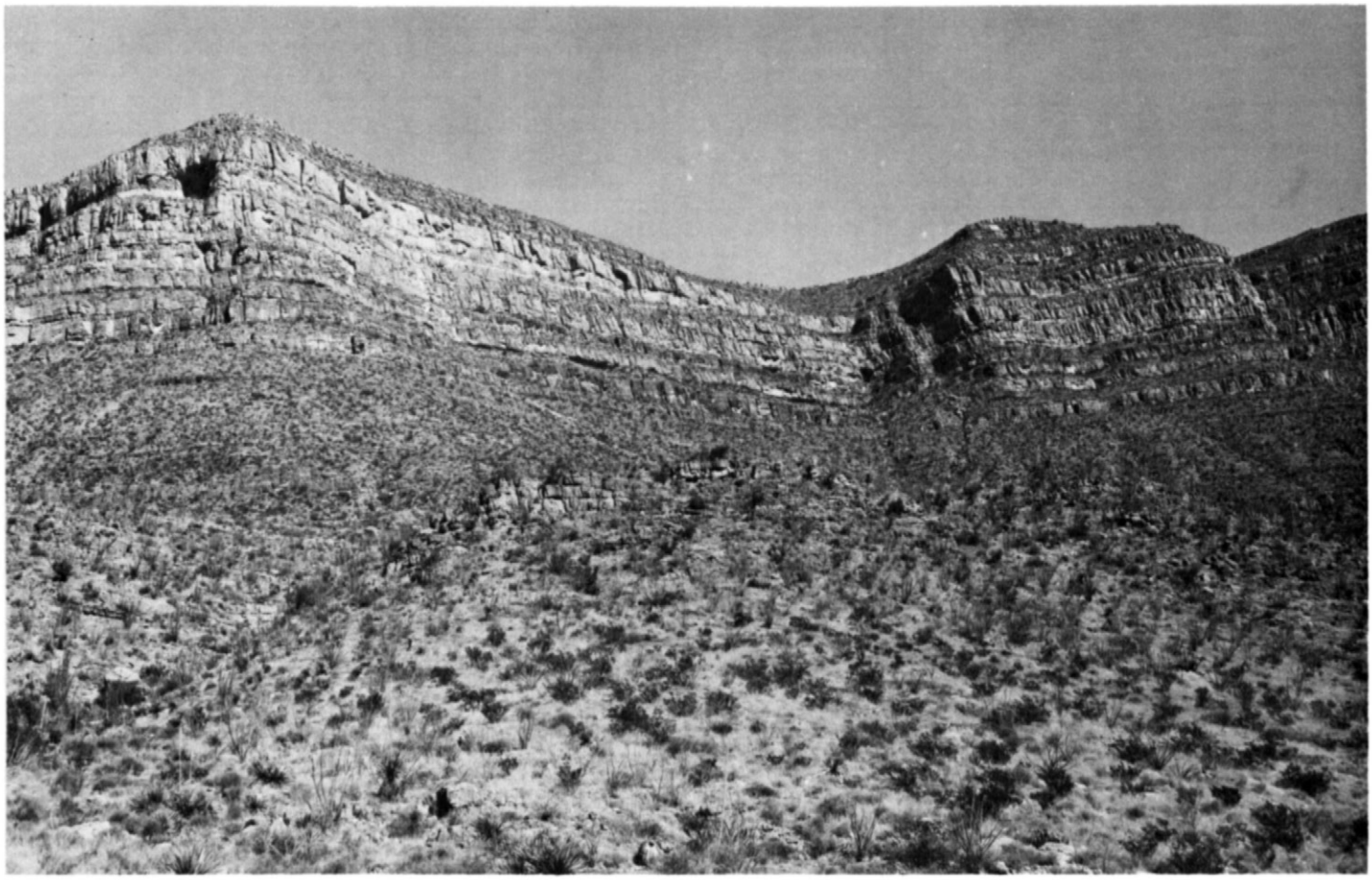


Figure 17.—**Typical area of Rock land, warm.**

45° to 57° F., and the frost-free season is 150 to 180 days.

Rock land, cool, is used for military purposes. It also provides habitat for wildlife and has esthetic value. Capability subclass VIIIs; vegetative group 9.

Rock land, warm (RL).—Rock land, warm, consists of very steep rough foothills and low mountain slopes, escarpments, ledges, cliffs, and canyons (fig. 17). The rock outcrop is limestone, acid igneous rock, sandstone, basalt, shale, and gypsum. Limestone generally caps the tops of the hills and the low mountain slopes. The shallow and very shallow soils are interspersed between the rock outcrop. Stony land is mostly below, but adjacent to the rock outcrop.

Included in mapping are areas of Mimbres soils, colluvial land, and alluvial soils on numerous narrow valley floorsand in arroyos. Included areas make up about 15 percent of the mapping unit.

The vegetation is sparse and is limited to areas of soil material and to cracks and fissures in the rock. It consists of mid and short grasses, algerita, shrub live oak, mountainmahogany, and soaptree yucca. Elevation ranges from 4,300 to 6,500 feet. The lower elevations occur on the more northerly slopes, and the higher elevations on the more southerly slopes. Precipitation is 8 to 13 inches, mean annual air temperature is 57° to 62° F., and the frost-free season is 170 to 205 days.

Rock land, warm, is used for military purposes and wildlife habitat. Capability subclass VIIIs; vegetative group 10.

Russler Series

The Russler series consists of deep, well-drained soils. These soils formed in moderately fine textured alluvial sediments on old alluvial fans. Slope is 1 to 5 percent. Elevation is 4,100 to 4,800 feet. The vegetation is mid and short grasses, chamiza, creosotebush, and American tarbush. Precipitation is 8 to 10 inches, mean annual air temperature is 58° to 62° F., and the frost-free season is 190 to 205 days.

In a representative profile the surface layer is reddish-brown silt loam about 4 inches thick. The subsoil is reddish-brown clay loam about 10 inches thick. The substratum is red and light reddish-brown silty clay loam over unconformable reddish-brown gravelly sandy loam that extends to a depth of 60 inches and more. The substratum has a high content of fine gypsum crystals. The soil is moderately calcareous to strongly calcareous throughout.

Russler soils are moderately slowly permeable.

Roots can penetrate to a depth of 60 inches and more, but available water capacity is only moderate.

These soils are used for military purposes and wildlife habitat.

The Russler soils in the White Sands Missile Range are mapped only with Sotim soils.

Representative profile of Russler silt loam in an area of Sotim-Russler association, 1.5 miles east on north side of road from intersection of Route 11 and Road 336, Lincoln County:

A1—0 to 4 inches, reddish-brown (5YR 5/4) silt loam, dark reddish brown (5YR 3/4) moist; weak, thick, platy structure; slightly hard dry, very friable moist, slightly sticky wet; few fine roots; common fine vesicular pores and many fine interstitial pores; moderately calcareous; moderately alkaline (pH 8.0); clear, smooth boundary. 3 to 10 inches thick.

B2—4 to 14 inches, reddish-brown (2.5YR 5/4) clay loam, dark reddish brown (2.5YR 3/4) moist; weak, medium, subangular blocky structure; hard dry, friable moist, slightly sticky and slightly plastic wet; common fine roots; common very fine interstitial pores and few fine tubular pores; moderately calcareous, few fine, faint threads of lime; moderately alkaline (pH 8.1); clear, smooth boundary. 9 to 26 inches thick.

C1cs—14 to 36 inches, red (2.5YR 5/5) silty clay loam, dark red (2.5YR 3/5) moist; massive; hard dry, friable moist, slightly sticky and slightly plastic wet; few fine roots; common very fine interstitial pores and few fine tubular pores; many, fine, prominent gypsum crystals; moderately calcareous; moderately alkaline (pH 8.1); clear, smooth boundary. 6 to 26 inches thick.

C2cs—36 to 50 inches, light reddish-brown (5YR 6/4) silty clay loam, reddish brown (5YR 4/4) moist; massive; hard dry, friable moist, slightly sticky and slightly plastic wet; common very fine interstitial pores; many, fine, distinct gypsum crystals; strongly calcareous, few fine, distinct threads of lime; moderately alkaline (pH 8.2); clear, wavy boundary. 10 to 30 inches thick.

IIC3—50 to 60 inches, reddish-brown (2.5YR 5/4) gravelly sandy loam, reddish brown (2.5YR 4/4) moist; massive; hard dry, very friable moist; common very fine interstitial pores; 20 percent gravel; few, fine, distinct gypsum crystals; strongly calcareous, thin coatings on coarse fragments; moderately alkaline (pH 8.0).

The A horizon has hue of 5YR to 10YR, value of 5 or 6 dry and 3 or 4 moist, and chroma of 2 to 4. It is loam, silt loam, or silty clay loam. It is noncalcareous to moderately calcareous. Reaction is mildly alkaline to moderately alkaline. The B2 horizon has hue of 2.5YR or 5YR, value of 4 to 6 dry and 3 or 4 moist, and chroma of 2 to 4. It is clay loam or silty clay loam. It is slightly calcareous to moderately calcareous. Reaction is mildly alkaline to moderately alkaline. The C horizon has value of 5 to 7 dry and 3 to 5 moist and chroma of 3 to 6. It is silty clay loam, clay loam, or silt loam. It is moderately calcareous to strongly calcareous. Reaction is mildly alkaline to moderately alkaline. The IIC2 horizon is discontinuous. Depth to the C1cs horizon ranges from 12 to 29 inches.

Shale Rock Land

Shale rock land (SH) is about 35 percent barren shale outcrop, 35 percent stony land, and 15 percent very shallow and shallow soils. It occurs as steep and very steep rough hillsides and mountainsides, escarpments, ledges, cliffs, and canyons. The shale outcrop is bedded sandstone and soft shale that in places is capped with limestone. Rock outcrop and stony land dominate the landscape, except in narrow valleys and small irregularly shaped areas of shallow and very shallow soils and deep, fine-textured soils.

Included in mapping are about 15 percent areas of Deama, Gilland, and alluvial soils and arroyo bottoms.

The vegetation is sparse in areas of Shale rock land. Included soils have a plant cover of mid and short grasses, mountainmahogany, winterfat, shrub live oak, soaptree yucca, pinyon pine, and oneseed juniper. Elevation ranges from 5,800 to 7,600 feet. Precipitation is 12 to 15 inches, mean annual air temperature is 48° to 57° F., and the frost-free season is 165 to 190 days.

Shale rock land is used for military purposes. It also provides habitat for wildlife and has esthetic value. Capability subclass VIIIs; vegetative group 9.

Sonoita Series

The Sonoita series consists of deep, well-drained soils. These soils formed in gravelly sandy alluvial sediments on old alluvial fans. Slope is 1 to 9 percent. Elevation is 4,000 to 5,900 feet. The vegetation is mid and short grasses, chamiza, soaptree yucca, mesquite, broom snakeweed, and annuals. Precipitation is 9 to 12 inches, mean annual air temperature is 58° to 62° F., and the frost-free season is 185 to 210 days.

In a representative profile the surface layer is brown gravelly sandy loam about 5 inches thick. The subsoil is about 45 inches thick. It is reddish-brown and light reddish-brown gravelly sandy clay loam in the upper part and light-brown gravelly sandy loam in the lower part. The substratum is pink gravelly sandy clay loam to a depth of 60 inches or more. The soil is noncalcareous to a depth of 36 inches and calcareous below.

Sonoita soils are moderately permeable. Roots can penetrate to a depth of 60 inches and more, but available water capacity is only moderate.

These soils are used for military purposes and wildlife habitat.

Representative profile of Sonoita gravelly sandy loam in an area of Sonoita-Pinaleno-Aladdin association, 0.3 mile southeast on Route 1 from 500K turnoff and about 40 feet south of the road, southeast of White Sands Missile Range Post area, Dona Ana County:

A1—0 to 5 inches, brown (7.5YR 5/4) gravelly sandy loam, dark brown (7.5YR 3/4) moist; weak, medium, platy structure; slightly hard dry, very friable moist; common fine roots; few fine vesicular pores and common fine interstitial pores; 25 percent angular acid igneous gravel; mildly alkaline (pH 7.4); clear, smooth boundary. 4 to 12 inches thick.

B21t—5 to 23 inches, reddish-brown (5YR 5/4) gravelly sandy clay loam, dark reddish brown (5YR 3/4) moist; weak, medium, subangular blocky structure; hard dry, very friable moist, slightly sticky wet; few fine roots; common fine interstitial pores; clay bridges between sand grains and clay films lining pores; 25 percent angular acid igneous gravel; mildly alkaline (pH 7.4); clear, smooth boundary. 11 to 27 inches thick.

B22t—23 to 36 inches, light reddish-brown (5YR 6/4) gravelly sandy loam, reddish brown (5YR 4/4) moist; weak, coarse, subangular blocky structure;

hard dry, friable moist, slightly sticky wet; few medium roots; common fine interstitial pores; clay bridges between sand grains and clay films lining pores; 25 percent angular acid igneous gravel; mildly alkaline (pH 7.5); clear, wavy boundary. 9 to 30 inches thick.

B3ca—36 to 50 inches, light-brown (7.5YR 6/4) gravelly sandy loam, brown (7.5YR 4/4) moist; massive; hard dry, very friable moist; common fine interstitial pores; 25 percent angular acid igneous gravel; slightly calcareous, few, fine, faint lime threads and patchy coatings on bottom sides of pebbles; mildly alkaline (pH 7.8); clear, wavy boundary. 10 to 24 inches thick.

C—50 to 60 inches, pink (7.5YR 7/4) gravelly sandy clay loam, light brown (7.5YR 6/4) moist; massive; hard dry, very friable moist; common fine interstitial pores; 20 percent angular acid igneous gravel; moderately calcareous, nearly continuous lime coatings on pebbles; moderately alkaline (pH 8.0).

The A horizon has hue of 5YR to 10YR, value of 4 to 6 dry and 3 or 4 moist, and chroma of 3 or 4. It is gravelly loamy fine sand or gravelly sandy loam. The B horizon has hue of 2.5YR to 7.5YR, value of 4 to 6 or 7 in the lower part dry, and chroma of 3 to 6. It is gravelly sandy loam to gravelly sandy clay loam that is 15 to 35 percent gravel and less than 18 percent clay. It is mildly alkaline to moderately alkaline. The C horizon has hue of 5YR or 7.5YR, value of 6 or 7 dry and 4 to 6 moist, and chroma of 3 or 4.

Sonoita-Pinaleno-Aladdin association (SP).—This mapping unit is about 35 percent Sonoita gravelly sandy loam, 25 percent Pinaleno gravelly sandy loam, and 20 percent Aladdin gravelly loamy sand. Sonoita and Pinaleno soils are gently undulating to gently rolling and occur as broad areas on old alluvial fans. The Aladdin soil is gently sloping to strongly sloping and is on younger surfaces associated with arroyos or narrow elongated ridges along arroyos. The profiles of these soils are the ones described as representative of the respective series.

Included in mapping are areas of Rock outcrop and arroyo beds. Also included are areas of deep, light-colored gravelly sandy loams; deep, light-colored gravelly loamy sands; and deep, dark-colored gravelly loamy sands. Included areas make up about 20 percent of the mapping unit.

Runoff is medium, and the hazard of water erosion is severe. Soil blowing is a moderate hazard, and in some small areas the soil is actively eroding and blowing.

This mapping unit is used for military purposes and wildlife habitat. Capability subclass VIIe; vegetative group 7.

Sotim Series

The Sotim series consists of deep, well-drained soils. These soils formed in moderately fine textured alluvial sediments on old alluvial fans. Slope is 1 to 5 percent. Elevation is 4,100 to 4,800 feet. The vegetation is mid and short grasses, chamiza, creosotebush, and American tarbush. Precipitation is 8 to 10 inches, mean annual air temperature is 58° to 62° F., and the frost-free season is 190 to 205 days.

In a representative profile the surface layer is reddish-brown clay loam about 4 inches thick. The subsoil is reddish-brown and red clay loam about 32 inches thick. The substratum extends to a depth of 60 inches and more. It is light reddish-brown clay loam in the upper part and reddish-brown gravelly sandy loam in the lower part. The soil is moderately calcareous to strongly calcareous throughout.

Sotim soils are moderately slowly permeable. Roots can penetrate to a depth of 60 inches and more, and available water capacity is high.

These soils are used for military purposes and wildlife habitat.

Representative profile of Sotim clay loam in an area of Sotim-Russler association, 0.4 mile west on Road 336 from east side of the Range and 0.3 mile west of the Panther site, on north side of the road in bar ditch, Lincoln County:

A1—0 to 4 inches, reddish-brown (2.5YR 5/4) clay loam, dark reddish brown (2.5YR 3/4) moist; weak, thick, platy structure; slightly hard dry, friable moist, slightly sticky and slightly plastic wet; few fine roots; few fine vesicular pores and common very fine interstitial pores; moderately calcareous; mildly alkaline (pH 7.6); clear, smooth boundary. 2 to 6 inches thick.

B21—4 to 14 inches, reddish-brown (2.5YR 5/4) clay loam, dark reddish brown (2.5YR 3/4) moist; moderate, medium, subangular blocky structure; hard dry, friable moist, slightly sticky and slightly plastic wet; few fine and medium roots; common very fine interstitial pores and few fine tubular pores; moderately calcareous; moderately alkaline (pH 8.0); clear, smooth boundary. 8 to 16 inches thick.

B22—14 to 36 inches, red (2.5YR 4/6) clay loam, dark red (2.5YR 3/6) moist; weak, coarse, subangular blocky structure; hard dry, friable moist, sticky and plastic wet; few medium roots; common fine tubular pores; strongly calcareous, few, fine, distinct, soft lime masses; moderately alkaline (pH 8.2); clear, smooth boundary. 10 to 24 inches thick.

C1ca—36 to 50 inches, light reddish-brown (2.5YR 6/4) clay loam, reddish brown (2.5YR 5/4) moist; massive; hard dry, friable moist, sticky and plastic wet; few micro interstitial pores; strongly calcareous, common, fine, soft lime masses; moderately alkaline (pH 8.4); clear, smooth boundary. 8 to 24 inches thick.

IIC2—50 to 60 inches, reddish-brown (2.5YR 5/4) gravelly sandy loam, reddish brown (2.5YR 4/4) moist; massive; hard dry, very friable moist; common fine interstitial pores; 15 percent gravel; few, fine, distinct gypsum crystals; strongly calcareous, thin lime coatings on coarse fragments; moderately alkaline (pH 8.0).

The A horizon has hue of 2.5YR or 5YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 3 or 4. It is clay loam, silt loam, or loam. It is noncalcareous to moderately calcareous. Reaction is mildly alkaline to moderately alkaline. The B horizon has hue of 5YR to 10R, value of 4 to 6 dry and 3 to 5 moist, and chroma of 3 to 6. It is heavy loam or clay loam. It is slightly calcareous to moderately calcareous in the upper part and moderately calcareous to strongly calcareous in the lower part. Reaction is mildly alkaline to moderately alkaline. The Cca horizon has hue of 2.5YR to 7.5YR, value of 5 to 7 dry and 4 or 5 moist, and chroma of 3 to 5. It is clay loam, loam, or fine sandy loam. It is moderately calcareous to strongly calcareous. The IIC2 horizon is discontinuous.

Sotim-Russler association (SR).—This mapping unit is about 60 percent Sotim clay loam and 25 percent Russler silt loam. Both soils are nearly level to gently sloping and are on old alluvial fans. The Russler soil can be distinguished by the abundance of gyp-

sum crystals within 40 inches of the surface. The profiles of these soils are the ones described as representative of the respective series.

Included in mapping are areas of Marcial, Yesum, Mimbres, and Nickel soils and Gypsum land, which make up about 15 percent of the mapping unit.

Runoff is medium, and the hazard of water erosion is severe. Soil blowing is a moderate hazard. In some small areas gullies are forming.

This mapping unit is used for military purposes and wildlife habitat. Capability subclass VIIe; vegetative group 1.

Tencee Series

The Tencee series consists of very shallow to shallow, well-drained soils. These soils formed in calcareous gravelly loamy alluvial sediments on old alluvial fans. Slope is 1 to 35 percent. Elevation is 4,100 to 6,000 feet. The vegetation is mid and short grasses, creosotebush, American tarbush, mesquite, soaptree yucca, mariola parthenium, and annuals. Precipitation is 8 to 13 inches, mean annual air temperature is 57° to 62° F., and the frost-free season is 185 to 205 days.

In a representative profile the surface layer is brown very gravelly loam about 3 inches thick. Below this is about 9 inches of brown gravelly loam and light-brown very gravelly loam over pink indurated caliche.

Tencee soils are moderately permeable. Roots can penetrate to a depth of only 4 to 20 inches, and available water capacity is very low.

These soils are used for military purposes and wildlife habitat. They also are a source of gravel for use in construction.

Representative profile of Tencee very gravelly loam in an area of Nickel-Tencee association, 1.9 miles south of School site, about 1 mile northwest of the intersection of Route 5 and Road 16, Sierra County:

A1—0 to 3 inches, brown (7.5YR 5/4) very gravelly loam, dark brown (7.5YR 3/4) moist; weak, thick, platy structure; slightly hard dry, very friable moist; common fine roots; common fine vesicular pores and common fine interstitial pores; about 45 percent limestone and caliche gravel; strongly calcareous, nearly continuous lime coatings on all pebbles; moderately alkaline (pH 8.0); clear, smooth boundary. 0 to 5 inches thick.

C1—3 to 8 inches, brown (7.5YR 5/4) gravelly loam, dark brown (7.5YR 3/4) moist; weak, coarse, subangular blocky structure; slightly hard dry, very friable moist; common fine roots; common fine interstitial pores; approximately 30 percent limestone and caliche gravel; strongly calcareous, nearly continuous lime coatings on all pebbles; moderately alkaline (pH 8.1); clear, smooth boundary. 2 to 7 inches thick.

C2ca—8 to 12 inches, light-brown (7.5YR 6/4) very gravelly loam, brown (7.5YR 4/4) moist; massive; slightly hard dry, very friable moist; few fine roots; common fine interstitial pores; approximately 40 percent limestone and caliche gravel; strongly calcereous lime coatings on all pebbles; moderately alkaline (pH 8.3); clear, smooth boundary. 2 to 8 inches thick.

C3cam—12 inches, pink (7.5YR 8/4) indurated caliche containing limestone gravel; upper one-fourth inch is laminated; the amount of cementation decreases with depth below 27 to 60 inches.

The A and C horizons, except for the Ccam horizon, have hue of 5YR to 10YR, value of 5 to 7 dry and 3 to 5 moist, and chroma of 2 to 4. They are gravelly or very gravelly loam or sandy loam. They are moderately calcareous to strongly calcareous and contain few to many hard caliche fragments. The percentage of gravel in the profile ranges from 35 to 70 percent. Depth to the Ccam horizon ranges from 4 to 20 inches.

Tencee-Nickel association, gently sloping (TC).—This mapping unit is about 65 percent Tencee very gravelly loam and 20 percent Nickel gravelly fine sandy loam. These soils are nearly level to gently sloping and are on old alluvial fans. The Tencee soil generally occurs on older landscapes on slightly elevated ridges above the Nickel soil. The profiles of these soils are the ones described as representative of the respective series.

Included in mapping are arroyo bottoms and areas of soils similar to Tencee and Nickel soils except they are less than 35 percent coarse fragments. Included areas make up about 15 percent of the mapping unit.

Runoff is medium. Water erosion is a moderate hazard, and soil blowing is a slight hazard.

This mapping unit is used for military purposes and wildlife habitat. It is also a source of gravel for use in construction. Capability subclass VIIe; vegetative group 8.

Tencee-Nickel association, steep (TK).—This mapping unit is about 45 percent Tencee very gravelly loam and 40 percent Nickel gravelly fine sandy loam. The Tencee soil is a moderately sloping to steep soil on ridges and saddles of the landscape, and the Nickel soil is a rolling to steep soil on broken areas of the landscape. The profiles of these soils are the ones described as representative of the respective series.

Included with these soils in mapping are areas of gravelly soils, badland, stony rock land, and arroyos. The gravelly soils are less than 35 percent coarse fragments. Included areas make up about 15 percent of the mapping unit.

Runoff is rapid. Water erosion is a severe hazard, and soil blowing is a slight hazard.

This mapping unit is used for military purposes and wildlife habitat. It is also a source of gravel for use in construction. Capability subclass VIIe; vegetative group 8.

Ubar Series

The Ubar series consists of deep, well-drained soils. These soils formed in fine-textured recent alluvial sediments on basin floors. Slope is less than 1 percent. Elevation is 4,000 to 4,700 feet. The vegetation is mid and short grasses, chamiza, seepweed, and iodinebush. About 50 percent of the surface area is large bare patches. Precipitation is 8 to 10 inches, mean annual air temperature is 58° to 62° F., and the frost-free season is 190 to 205 days.

In a representative profile the surface layer is light yellowish-brown silt loam about 2 inches thick. The subsoil is light-brown heavy silty clay loam and silty clay about 38 inches thick. The substratum is very pale brown heavy silty clay loam to a depth of 60

inches and more. These soils are moderately saline and alkali affected.

Ubar soils are slowly permeable. Roots can penetrate to a depth of 60 inches and more, but available water capacity is only moderate.

These soils are used for military purposes and wildlife habitat.

The Ubar soils in the White Sands Missile Range are mapped only with Marcial soils.

Representative profile of Ubar silt loam in an area of Marcial-Ubar association, about 0.45 mile south and 0.1 mile east of the intersection of Routes 7 and 13 on the north side of trail, Sierra County:

A1—0 to 2 inches, light yellowish-brown (10YR 6/4) silt loam, brown (7.5YR 4/4) moist; moderate, thin, platy structure; slightly hard dry, very friable moist; few fine roots; common fine vesicular pores; strongly calcareous; moderately alkaline (pH 8.3); abrupt, smooth boundary. 2 to 6 inches thick.

B21—2 to 13 inches, light-brown (7.5YR 6/4) heavy silty clay loam, brown (7.5YR 4/4) moist; weak, thick, platy structure and weak, medium, subangular blocky; hard dry, friable moist, sticky and plastic wet; few fine roots; common micro interstitial pores; few, fine, distinct, soft masses of salt crystals; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary. 4 to 14 inches thick.

B22—13 to 30 inches, light-brown (7.5YR 6/4) silty clay, brown (7.5YR 4/4) moist; weak, medium, subangular blocky structure; very hard dry, friable moist, sticky and plastic wet; common micro interstitial pores; strongly calcareous; moderately alkaline (pH 8.4); clear, smooth boundary. 6 to 18 inches thick.

B23ca—30 to 40 inches, light-brown (7.5YR 6/4) silty clay, brown (7.5YR 4/4) moist; weak, medium, subangular blocky structure; very hard dry, friable moist, sticky and plastic wet; few micro interstitial pores; strongly calcareous, few, common, distinct, soft lime masses; moderately alkaline (pH 8.4); clear, smooth boundary. 6 to 20 inches thick.

Ccs—40 to 60 inches, very pale brown (10YR 7/4) heavy silty clay loam, light yellowish brown (10YR 6/4) moist; massive; hard dry, friable moist, sticky and plastic wet; few micro interstitial pores; few, coarse, prominent gypsum crystals; moderately calcareous; mildly alkaline (pH 7.5).

The A horizon has hue of 7.5YR or 10YR, value of 6 or 7 dry and 3 to 5 moist, and chroma of 2 to 4. It is silt loam, silty clay loam, or silty clay. The B horizon has hue of 7.5YR or 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 2 to 4. It is heavy clay loam, heavy silty clay loam, silty clay, or clay. The Ccs horizon has hue of 7.5YR or 10YR, value of 6 or 7 dry and 4 to 6 moist, and chroma of 2 to 4. It has texture similar to that of the B horizon. The soil is mildly alkaline to strongly alkaline throughout.

Wink Series

The Wink series consists of deep, well-drained soils. These soils formed in sandy alluvial sediments on old alluvial fans. Slope is 0 to 3 percent. Elevation is 4,100 to 5,000 feet. The vegetation is tall and mid grasses, sand sagebrush, soaptree yucca, broom snakeweed, and annuals. Precipitation is 8 to 10 inches, mean annual air temperature is 58° to 62° F., and the frost-free season is 190 to 210 days.

In a representative profile the surface layer is light-brown loamy fine sand about 8 inches thick. The subsoil is light-brown sandy loam about 12 inches thick. The substratum is pink fine sandy loam to a depth of 60 inches or more. The soil is calcareous throughout and is strongly calcareous in the substratum.

Wink soils are moderately rapidly permeable. Roots can penetrate to a depth of 60 inches and more, but available water capacity is only moderate.

These soils are used for military purposes and wildlife habitat.

The Wink soils in the White Sands Missile Range are mapped only with Onite and Bluepoint soils.

Representative profile of Wink loamy fine sand in an area of Onite-Bluepoint-Wink association, 32 miles north of the junction of Road 349 and Route 5 and 0.3 mile west, Socorro County:

A1—0 to 8 inches, light-brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 4/4) moist; single grained; loose moist and dry; few to common fine roots; common fine interstitial pores; slightly calcareous; mildly alkaline (pH 7.6); clear, smooth boundary. 2 to 13 inches thick.

B2—8 to 20 inches, light-brown (7.5YR 6/4) sandy loam, brown (7.5YR 5/4) moist; weak, coarse, subangular blocky structure; soft dry, very friable moist; few fine roots; common fine interstitial pores; moderately calcareous; mildly alkaline (pH 7.8); clear, smooth boundary. 8 to 32 inches thick.

C1ca—20 to 30 inches, pink (7.5YR 7/4) fine sandy loam, light brown (7.5YR 6/4) moist; massive; soft dry, very friable moist, slightly sticky and slightly plastic wet; common fine interstitial pores; strongly calcareous, common medium soft lime masses; moderately alkaline (pH 8.2); clear, smooth boundary. 6 to 30 inches thick.

C2ca—30 to 60 inches, pink (7.5YR 8/4) fine sandy loam, pink (7.5YR 7/4) moist; massive; hard dry, very friable moist; few fine interstitial pores; strongly calcareous, few, fine, medium lime concretions; moderately alkaline (pH 8.2).

The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 3 or 4. It is loamy fine sand or sandy loam. Reaction is mildly alkaline to moderately alkaline. The B2 horizon has hue of 7.5YR or 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 3 or 4. It is sandy loam, fine sandy loam, or loam. It is slightly calcareous to moderately calcareous. Reaction is mildly alkaline to moderately alkaline. The Cca horizon has hue of 7.5YR to 10YR and chroma of 3 or 4. It is sandy loam, fine sandy loam, or loam, but in places is thinly stratified with loamy fine sand. The Cca horizon in places is weakly cemented.

Yesum Series

The Yesum series consists of deep, well-drained soils. These soils formed in moderately coarse textured, wind-laid deposits very high in content of gypsum. Slope is 0 to 5 percent. Elevation is 3,800 to 4,800 feet. The vegetation is mid and short grasses, chamiza, winterfat, mesquite, and American tarbush. Precipitation is 8 to 10 inches, mean annual air temperature is 56° to 62° F., and the frost-free season is 190 to 210 days.

In a representative profile the surface layer is light-brown very fine sandy loam about 3 inches thick. The underlying material to a depth of 60 inches or more is light-brown and pink fine sandy loam and very fine sandy loam. The soil is slightly calcareous

throughout. It contains many fine gypsum crystals the size of fine and very fine sand.

Yesum soils are moderately permeable. Roots can penetrate to a depth of 60 inches and more, but available water capacity is only moderate.

These soils are used for military purposes. They also provide habitat for wildlife.

Representative profile of Yesum very fine sandy loam in an area of Yesum-Holloman association, 2.9 miles south of Norm site on Route 9, then 0.15 mile east on gravel road and 50 feet north, 2.7 miles north of intersection of Routes 9 and 10 near Holloman Air Force Base, Otero County:

A1—0 to 3 inches, light-brown (7.5YR 6/4) very fine sandy loam, brown (7.5YR 4/4) moist; weak, thin, platy structure; slightly hard dry, very friable moist; common fine roots; few fine vesicular pores and common interstitial pores; many fine gypsum crystals; slightly calcareous; mildly alkaline (pH 7.4); clear, smooth boundary. 2 to 6 inches thick.

C1cs—3 to 12 inches, light-brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; weak, coarse, subangular blocky structure; slightly hard dry, very friable moist; common fine roots; common fine interstitial pores; many fine gypsum crystals; slightly calcareous; mildly alkaline (pH 7.6); clear, smooth boundary. 7 to 18 inches thick.

C2cs—12 to 26 inches, pink (7.5YR 7/4) very fine sandy loam, light brown (7.5YR 6/4) moist; massive; slightly hard dry, very friable moist; few fine roots; common fine interstitial pores; many fine and very fine gypsum crystals; slightly calcareous; mildly alkaline (pH 7.5); clear, smooth boundary. 6 to 30 inches thick.

C3cs—26 to 65 inches, pink (7.5YR 7/4) very fine sandy loam, light brown (7.5YR 6/5) moist; massive; slightly hard dry, very friable moist; fine interstitial pores; many fine and very fine gypsum crystals; slightly calcareous; mildly alkaline (pH 7.8).

The A horizon has hue of 7.5YR or 10YR, value of 5 to 7 dry and 4 or 5 moist, and chroma of 3 or 4. It is loam, very fine sandy loam, or fine sandy loam. The Ccs horizon has hue of 7.5YR or 10YR, value of 5 to 7 dry and 3 to 6 moist, and chroma of 3 to 6. It is loam, very fine sandy loam, fine sandy loam, or sandy loam. Most of the sand-size particles are gypsum crystals. The content of gypsum ranges from 40 to 80 percent in the Ccs horizon. The soil is slightly calcareous to moderately calcareous throughout. Reaction ranges from mildly alkaline to moderately alkaline throughout.

Yesum very fine sandy loam (YE).—This is a nearly level to undulating soil on broad wind-deposited plains. It has the profile described as representative of the series.

Included with this soil in mappping are areas of Holloman very fine sandy loam in slight depressions and old lake basins and areas of Marcial and Mimbres soils; Gypsum land, hummocky; and intermittent lakes. Included areas make up about 15 percent of the mapping unit.

Runoff is slow. Water erosion is a slight hazard, and soil blowing is a severe hazard. In some small areas the soil is actively blowing.

This soil is used for military purposes. It also provides habitat for wildlife. Capability subclass VIIe; vegetative group 4.

Yesum-Holloman association (YH).—This mapping unit is about 35 percent Yesum very fine sandy loam, 30 percent Holloman very fine sandy loam, and 20 percent Gypsum land, hummocky (fig. 18). The Yesum soil is a nearly level to undulating soil on wind-deposited plains. The Holloman soil is a level to gently sloping soil in slight depressions and old lake basins. Gypsum land, hummocky, is in undulating dunelike areas. The profiles of these soils are the ones described as representative of the respective series.

Included with these soils in mapping are areas of Marcial and Mimbres soils and intermittent lakes.

Runoff is slow. Water erosion is a slight hazard, and soil blowing is a severe hazard. In some small areas the soil is actively blowing.

These soils are used for military purposes. They also provide habitat for wildlife. Capability subclass VIIe; vegetative group 4.

Use and Management of the Soils

The most important use of the soils within the White Sands Missile Range is for the testing of military equipment. In addition, the soil supports many military buildings, urban residences for military personnel and their families, and roads. Use of the soils in engineering is described on the pages that follow. Data from engineering tests and interpretations of soil properties that affect highway construction and other engineering structures are shown in tables 2, 3, and 4.

This section also contains suggestions for management of the soil for range and wildlife. The range vegetation is described and grouped into vegetative groups, and the common plant names are listed in the Plant Glossary. Wildlife management is described by wildlife habitat soil groups. The capability classification system used by the Soil Conservation Service is explained.

Engineering Uses of the Soils [3]

This section provides information of special interest to planners, engineers, contractors, and others who use soil as structural material or as foundation for structures.

The properties of a soil, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, buried electrical cables, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse. Among the properties of soils highly important in engineering are permeability, strength, compaction characteristics, drainage condition, shrink-swell potential, grain size, plasticity, reaction, depth to the water table, depth to bedrock, and slope.

Information concerning these and related soil properties is given in tables 2, 3, and 4. The estimates and interpretations in these tables can be used to—

1. Select areas for potential residential, recreational, and military use.

[3] MYRON H. NAMKEN, civil engineer, SCS, helped prepare this section.

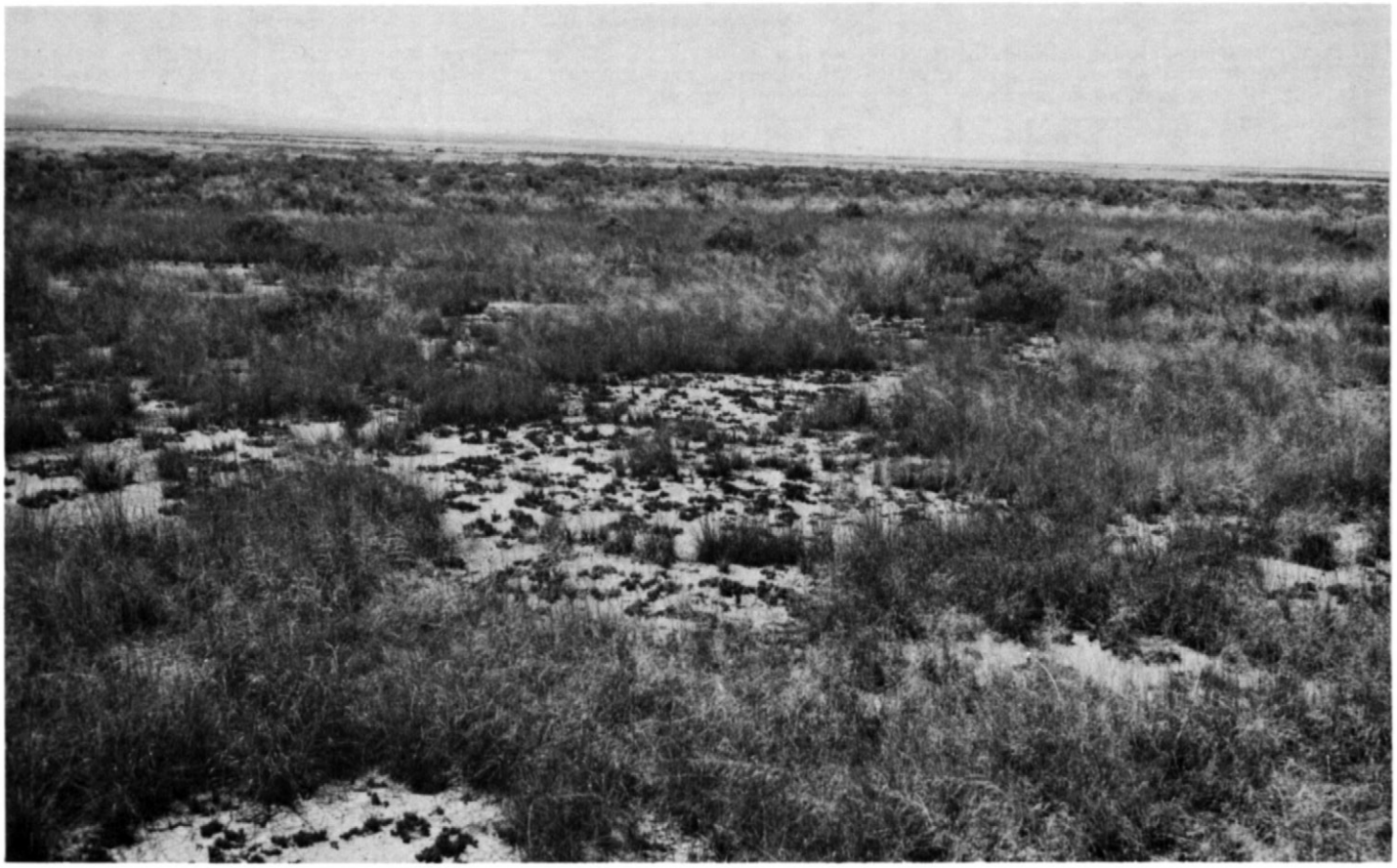


Figure 18.—**Yesum-Holloman association. Yesum soil is in the foreground, and Holloman soil is in slight depressions in the background.**

2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Locate probable sources of gravel, sand, or clay.
4. Plan 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 kind 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.

Tables 2, 3, and 4 show, respectively, estimates of soil properties significant in engineering, interpretations for various engineering uses, and results of engineering laboratory tests on selected soil samples.

The information in these tables does not eliminate the need for sampling and testing at the site of specific engineering works, especially those that involve heavy loads or that require excavations to depths greater than those shown in the tables (generally more than 5 feet). Also, a site that is designated as a given mapping unit can contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for engineering uses.

Some terms have special meanings in soil science that may not be familiar to engineers. These terms are explained in the Glossary.

Engineering classification systems

The two systems most commonly used in classifying soils for engineering are the Unified system (*2, 9*), used by engineers of the Soil Conservation Service, the Department of Defense, and others, and the system adopted by the American Association of State Highway Officials (AASHO) (*1*). These systems are further explained in the PCA Soil Primer (*4*).

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils. The dominantly gravelly soils are identified as GW, GP, GM, and GC, and the dominantly sandy soils are SW, SP, SM, and SC. There are six classes of fine-grained soils. Those that have low liquid limits are identified as ML, CL, and OL, and those that have high liquid limits are MH, CH, and OH. There is one

TABLE 2.—*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. The soils in such to other series that appear in the first column of this table. Absence of data indicates that the soil is too variable to be rated or that no estimate planning. It is not intended for specific site selection or design purposes]

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction more than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHO	
	Feet	*Feet*	*Inches*				*Percent*
Active dune land, gypsum: AC	>5	1->5	0-60	Fine sand	SP-SM or SM	A-3 or A-2	
*Aladdin: AD For Pinaleno part, see Pinaleno series, noncalcareous variant.	>5	>5	0-46 46-66	Gravelly sandy loam Gravelly loamy sand	SM SM	A-2 or A-1 A-1	0-5 0-5
Alicia Mapped only with La Fonda soils.	>5	>5	0-18 18-30 30-60	Loam Clay loam Clay loam	CL CL CL	A-6, A-4 A-6 A-6	
*Berino: BD For Dona Ana part, see Dona Ana series.	>5	>5	0-10 10-22 22-44 44-60	Sandy loam Sandy clay loam Sandy loam Loamy sand	SM CL or SC SM SM	A-2 or A-4 A-6 A-2 A-2	
Bluepoint Mapped only with Dona Ana, Onite, Pajarito, and Wink soils.	>5	>5	0-60	Loamy fine sand	SP-SM or SM	A-2 or A-3	0-5
Deama: DO No valid estimates can be made for Rock outcrop part.	0.5-1.5	>5	0-10 10	Stony loam Limestone bedrock.	GM or SM	A-2	25-50
*Dona Ana: DP For Pajarito part, see Pajarito series. For Bluepoint part, see Bluepoint series.	>5	>5	0-24 24-60	Light clay loam Loam or clay loam	SC or CL SC or CL	A-6 A-6	0-5
*Dune land: DU, DY For Dona Ana part of DU, see Dona Ana series. For Yesum part of DY, see Yesum series.	>5	>5	0-60	Loamy fine sand or fine sand.	SP-SM or SM	A-3 or A-2	
Gilland: GR No valid estimates can be made for Rock outcrop part.	1.5-2.5 to shale	>5	0-28 28-60	Stony loam Shale and sandstone.	SM	A-2 or A-4	50-70
Glendale Mapped only with Mimbres soils.	>5	>5	0-48 48-84	Silt loam Stratified gravelly silt loam, fine sandy loam, silty clay loam.	ML or CL ML or CL	A-4 or A-6 A-4 or A-6	0-5
Gypsum land, hummocky: GS No valid estimates can be made.	0-1 to gypsum	>5		Gypsum			
Gypsum land, level: GU No valid estimates can be made.	0-1 to gypsum	<5		Gypsum			
*Gypsum rock land: GV No valid estimates can be made for Gypsum rock land part. For Rance part, see Rance shallow variant.	0-1	>5		Gypsum			
Holloman Mapped only with Yesum soils.	0.5-1.5	>5	0-16 16	Very fine sandy loam. Gypsum.	ML or SM	A-4	

See footnotes at end of table.

properties significant in engineering

mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring was made. The symbol > means more than; the symbol < means less than. Information in this table should be limited to use in broad area

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Risk of corrosion to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						Uncoated steel	Concrete [1]
				Inches per hour	*In/in of soil*	*pH*	*Mmhos/cm at 25° C*			
100	100	100	5–25	6.0–20.0	0.04–0.06	6.6–7.8	>15	Low	High	High.
80–90	50–75	25–35	20–30	2.0–6.0	0.09–0.11	6.6–7.8	<1	Low	Moderate	Low.
80–90	50–75	20–30	10–20	6.0–20.0	0.06–0.08	6.6–7.3	<1	Low	Moderate	Low.
100	95–100	80–95	50–60	0.6–2.0	0.13–0.17	6.6–8.4	<2	Moderate	High	Low.
100	100	80–95	60–70	0.2–0.6	0.15–0.19	7.4–8.4	2–4	Moderate	High	Moderate.
100	100	80–95	60–70	0.2–0.6	0.05–0.07	7.4–8.4	4–15	Moderate	High	High.
100	100	60–80	30–40	2.0–6.0	0.08–0.13	6.6–7.8	<2	Low	Moderate	Low.
100	100	65–85	35–55	0.6–2.0	0.13–0.17	7.4–7.8	<2	Moderate	Moderate	Low.
95–100	95–100	50–65	25–35	2.0–6.0	0.10–0.13	7.9–8.4	2–4	Low	High	Low.
85–100	80–100	50–75	15–30	2.0–6.0	0.08–0.10	7.9–8.4	<2	Low	High	Low.
95–100	95–100	70–100	5–25	6.0–20.0	0.06–0.09	7.4–8.4	<2	Low	Low	Low.
40–70	35–65	25–50	20–35	0.6–2.0	0.02–0.09	7.4–8.4	1–4	Low	High	Low.
95–100	95–100	65–80	45–65	0.6–2.0	0.15–0.19	7.4–8.5	<1	Moderate	High	Low.
80–100	80–100	60–80	35–65	0.6–2.0	0.15–0.19	7.9–8.5	2–4	Low to moderate.	High	Low.
100	100	65–80	5–35	6.3–20.0	0.06–0.08	7.4–8.4	2–15	Low	High	Low to high.
70–80	60–70	50–65	30–45	0.6–2.0	0.09–0.14	7.4–8.4	<1	Low	High	Low.
95–100	95–100	95–100	75–90	0.2–0.6	0.15–0.19	7.4–8.4	2–4	Moderate	High	Low.
90–100	90–100	90–100	75–90	0.2–0.6	0.12–0.16	7.4–8.4	2–4	Moderate	High	Low.
									High	High.
									High	High.
									High	High.
95–100	95–100	85–95	40–60	0.6–2.0	0.13–0.17	7.4–8.4	4–16	Low	High	High.
										High.

TABLE 2.—*Estimates of soil*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction more than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHO	
	Feet	*Feet*	*Inches*				*Percent*
*La Fonda: LA For Alicia part, see Alicia high gypsum substratum variant.	>5	>5	0–60	Clay loam	CL	A–6	
Lava flows: LF No valid estimates can be made.	0–0.5	>5		Basalt.			
Lozier: LR No valid estimates can be made for Rock outcrop part.	0.5–1.5	>5	0–14 14	Stony loam Limestone bedrock.	GM	A–4 or A–2	25–35
*Marcial: MA For Ubar part, see Ubar series.	>5	>5	0–52 52–60	Heavy silty clay loam or silty clay. Soft gypsum.	CL or ML	A–4 or A–6	
Mead: ME	>5	3–7	0–48 48–60	Clay Lacustrine sediments	CL or ML	A–4 or A–6	
*Mimbres: MG For Glendale part, see Glendale series.	>5	>5	0–48 48–60	Clay loam, silty clay loam. Loam	ML or CL ML	A–4 or A–6 A–4	
*Nickel: NT For Tencee part, see Tencee series.	>5	>5	0–60	Gravelly and very gravelly loam.	GM	A–2 or A–1	0–25
*Onite: OB For Bluepoint and Wink parts, see their respective series.	>5	>5	0–12 12–60	Loamy fine sand Sandy loam, loamy fine sand, and fine sandy loam.	SM SM	A–2 or A–4 A–2 or A–4	
Oscura: OS	>5	>5	0–60	Silty clay, clay, or silty clay loam.	CL or CH	A–6 or A–7	
Pajarito Mapped only with Dona Ana and Bluepoint soils.	>5	>5	0–60	Sandy loam to loamy fine sand.	SM	A–2	
Pinaleno Mapped only with Sonoita soils.	>5	>5	0–15 15–60	Gravelly sandy clay loam. Very gravelly sandy loam.	SC GM	A–2 or A–6 A–1	
Pinaleno noncalcareous variant Mapped only with Aladdin soils.	1.5–4	>5	0–17 17–33 33	Gravelly clay loam Very gravelly sandy clay loam. Granite bedrock rippable.	SC GC or GP–GC	A–6 A–2	0–15
Rance shallow variant. Mapped only with Gypsum rock land.	0.5–1.5	>5	0–15 15	Gravelly loam and loam. Gypsum bedrock.	ML or CL	A–4	
Rock land, cool: RK No valid estimates can be made.	0–.5	>5		Variable bedrock.			
Rock land, warm: RL No valid estimates can be made.	0–.5	>5		Variable bedrock.			
Rock outcrop Mapped only with Deama, Gilland, and Lozier soils. No valid estimates can be made for Rock outcrop part.	0–0.5	>5		Variable bedrock.			
Russler Mapped only with Sotim soils.	>5	>5	0–60	Silty clay loam and clay loam.	CL	A–6 or A–7	

See footnotes at end of table.

properties significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Risk of corrosion to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						Uncoated steel	Concrete [1]
				Inches per hour	*In/in of soil*	*pH*	*Mmhos/cm at 25° C.*			
95–100	95–100	80–95	60–70	0.6–2.0	0.15–0.19	6.6–8.4	<1	Moderate	Moderate	Low.
55–70	50–65	45–55	30–45	0.6–2.0	0.07–0.13	7.4–8.4	<1	Low	High	Low.
100	100	90–100	75–95	0.06–0.2	0.09–0.12	7.9–9.0	8–15	Moderate	High	Moderate to high.
100	100	90–100	70–90	<0.06	0.06–0.10	7.9–9.0	>25	Moderate	High	High.
				<0.06						
100	100	95–100	75–90	0.2–0.6	0.15–0.19	7.4–8.4	<2	Moderate	High	Low.
100	95–100	80–95	50–60	0.6–2.0	0.13–0.17	7.9–8.4	<2	Low	High	Low.
40–60	35–55	30–45	15–35	0.2–0.6	0.07–0.08	7.9–8.4	<2	Low	High	Low.
95–100	95–100	50–90	10–40	2.0–6.0	0.06–0.08	6.6–7.8	<1	Low	Low	Low.
95–100	95–100	75–95	20–40	2.0–6.0	0.09–0.13	7.4–8.4	<1	Low	Low	Low.
100	100	90–100	75–95	0.06–0.2	0.13–0.17	7.4–7.8	2–4	High	High	Low.
95–100	95–100	60–80	20–35	2.0–6.0	0.09–0.13	7.4–8.4	<1	Low	Low	Low.
75–85	70–85	45–55	30–40	0.6–2.0	0.07–0.11	6.6–7.8	<1	Low	Low	Low.
35–50	35–50	20–35	15–25	0.2–0.6	0.03–0.05	7.4–8.4	<1	Low	Low	Low.
75–85	70–85	50–60	40–50	0.2–0.6	0.06–0.12	6.6–7.8	<1	Low to moderate.	Moderate	Low.
25–50	10–40	10–35	5–25	0.6–2.0	0.04–0.08	6.6–7.8	<1	Low	Moderate	Low.
95–100	95–100	80–95	50–60	0.6–2.0	0.13–0.17	6.6–8.4	4–8	Moderate	High	High.
100	95–100	95–100	75–90	0.2–0.6	0.10–0.12	7.4–8.4	4–15	Moderate	High	High.

TABLE 2.—*Estimates of soil*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction more than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHO	
	Feet	*Feet*	*Inches*				*Percent*
Shale rock land: SH No valid estimates can be made.	0–1	>5		Bedded shale and sandstone bedrock.			
*Sonoita: SP For Pinaleno and Aladdin parts, see their respective series.	>5	>5	0–60	Gravelly sandy clay loam.	SC	A–2, A–4, or A–6	
*Sotim: SR For Russler part, see Russler series.	>5	>5	0–50 50–60	Clay loam Gravelly sandy loam	CL SM	A–6 A–2 or A–1	
*Tencee: TC, TK For Nickel part, see Nickel series.	0.5–1.5	>5	0–12 12	Very gravelly loam Indurated caliche.	GM or GP–GM	A–2 or A–1	0–15
Ubar Mapped only with Marcial soils.	>5	>5	0–60	Silty clay or heavy silty clay loam.	CL	A–6	
Wink Mapped only with Bluepoint and Onite soils.	>5	>5	0–60	Fine sandy loam and sandy loam.	SM	A–2	
*Yesum: YE, YH For Holloman part of YH, see Holloman series.	>5	5–50	0–60	Very fine sandy loam and fine sandy loam (sand fraction in gypsum crystals).	ML or SM	A–4	

[1] Type II cement should be used as a precaution against moderate sulfate attack where soil samples are between 0.1 and 0.2 percent water-soluble sulfate (as SO_4). Type V cement should be used where concrete will be exposed to soils that are more than 0.2 percent water-soluble sulfate (as SO_4).

class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, SP-SM.

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is classified in one of seven basic groups on the basis of grain-size distribution, liquid limit, and plasticity index. These groups range from A–1, which consists of soils that have the highest bearing strength and are the best soils for subgrade, to A–7, which consists of soils that have low strength when wet and are the poorest soils for subgrade. If 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, A1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the relative engineering value within each group is 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 4; the estimated classification, without group index numbers, is given in table 2 for all soils mapped in the survey area.

Soil scientists use the USDA textural classification. In this, the texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 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. Textural modifiers, such as gravelly, stony, shaly, and cobbly, are used as needed.

Engineering properties

Table 2 shows estimates of soil properties that are significant in engineering. These estimates are made for selected soils by layers of the profile that have significantly different properties. The estimates are based on field observations, test data for these and similar soils, and experience with the same kinds of soil in other areas. Some of the terms for which data are shown are explained in the following paragraphs.

Depth to bedrock is the distance from the surface of the soil to the upper surface of a rock layer within the depth of observation.

Depth to the seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Coarse fraction greater than 3 inches was estimated in percent by weight of the soil mass. In field sampling this part of the soil was discarded, and only the smaller size fractions were estimated.

Percentages of all soil material less than 3 inches in

properties significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Risk of corrosion to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						Uncoated steel	Concrete [1]
				Inches per hour	*In/in of soil*	*pH*	*Mmhos/cm at 25° C.*			
70–85	50–75	40–70	30–45	0.6–2.0	0.08–0.11	7.4–8.4	<1	Low	High	Low.
95–100	95–100	80–95	65–90	0.2–0.6	0.15–0.19	7.4–8.4	2–4	Moderate	High	Low.
75–85	70–85	40–60	20–35	2.0–6.0	0.06–0.10	7.9–8.4	2–4	Low	High	Moderate.
30–50	25–50	15–45	10–35	0.6–2.0	0.04–0.10	7.9–8.4	2–4	Low	High	Low.
100	100	90–100	70–95	0.06–0.12	0.10–0.12	7.9–9.0	4–15	Moderate	High	High.
95–100	95–100	75–95	25–35	2.0–6.0	0.08–0.12	7.4–8.4	<2	Low	Moderate	Low.
100	95–100	75–95	40–60	0.6–2.0	0.10–0.12	7.4–8.4	4–15	Low	High	High.

diameter were estimated for the number 4, 10, 40, and 200 sieve sizes. These estimates are based on the assumption that material up to 3 inches in diameter equals 100 percent. This limit coincides with that used in both the AASHO and the Unified classification systems.

Permeability is a quality that enables a soil to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 2 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 crops.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Salinity refers to the amount of soluble salts more soluble than gypsum 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 crop production, 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 with changes in moisture content, or the extent to which the soil shrinks as it dries out and swells when it gets wet. The extent of changes is influenced by the amount and kind of clay in the soil. 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 having this rating.

Corrosion, as used in table 2, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion on uncoated steel is related to such soil properties as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity in concrete is influenced mainly by the content of sodium or magnesium sulfate, and also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. The risk of corrosion is *low* if there is a low probability of soil-induced corrosion damage. A rating of *high* indicates a high probability of damage; protective measures for steel and more

TABLE 3.—*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. The soils in such
to other series that appear in

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Foundations for low buildings without basements	Sanitary landfill [1]	Local roads and streets
Active dune land, gypsum: AC.	Slight [2]	Severe: rapid permeability.	Severe: sidewall instability.	Severe: high gypsum hazard to concrete.	Severe: rapid permeability.	Severe: hazard of soil blowing; high gypsum hazard to concrete.
*Aladdin: AD. For Pinaleno part of AD, see Pinaleno series, noncalcareous variant.	Slight [2]	Severe: moderately rapid permeability.	Slight	Slight	Severe: rapid permeability below a depth of 46 inches.	Slight [3]
Alicia. Mapped only with La Fonda soils.	Severe: moderately slow permeability.	Severe: solution of gypsum causes leakage.	Slight	Moderate: moderate shrink-swell potential; high gypsum hazard to concrete below a depth of 30 inches.	Severe: solution of gypsum causes leakage.	Moderate: moderate shrink-swell potential; low strength.
*Berino: BD. For Dona Ana part, see Dona Ana series.	Slight	Severe: moderately rapid permeability below a depth of 22 inches.	Slight	Slight	Severe: moderately rapid permeability below a depth of 22 inches.	Slight
Bluepoint. Mapped only with Dona Ana, Onite, Pajarito, and Wink soils.	Slight [2]	Severe: rapid permeability.	Severe: sidewall instability.	Slight	Severe: sidewall instability; hazard of soil blowing; rapid permeability.	Slight: hazard of soil blowing in places.
*Deama: DO. For Rock outcrop part of DO, see Rock outcrop.	Severe: bedrock at a depth less than 20 inches; slope of 5 to 55 percent.	Severe: stony; bedrock at a depth of less than 20 inches; slope of 5 to 55 percent.	Severe: bedrock at a depth less than 20 inches.	Severe: bedrock at a depth less than 20 inches; slope of 5 to 55 percent.	Severe: bedrock at a depth less than 20 inches; slope of 5 to 55 percent.	Severe: stony; bedrock at a depth less than 20 inches; slope of 5 to 55 percent.
*Dona Ana: DP. For Pajarito part, see Pajarito series. For Bluepoint part, see Bluepoint series.	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight	Moderate: moderate shrink-swell potential.	Slight	Moderate: low shear strength.
*Dune land: DU, DY. For Dona Ana part of DU, see Dona Ana series. For Yesum part of DY, see Yesum series.	Slight [2]	Severe: rapid permeability.	Severe: sidewall instability.	Slight: hazard of soil blowing.	Severe: rapid permeability; sidewall instability.	Severe: hazard of soil blowing; high gypsum hazard to concrete in DY.

See footnotes at end of table.

interpretations

mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring the first column of this table]

Suitability as a source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation
Good: high gypsum hazard to concrete.	Fair to poor for sand: too many fines. Unsuitable for gravel.	Poor: sandy; hazard of soil blowing.	Rapid permeability; gypsum.	Medium shear strength and compacted permeability; high piping hazard.	Excessively drained.	Hazard of soil blowing; very low available water capacity; rapid permeability.
Good	Poor for sand and gravel: too many fines.	Poor: gravelly loamy sand surface layer.	Rapid permeability below a depth of 46 inches.	Medium shear strength and compacted permeability; medium piping hazard.	Well drained	Moderate available water capacity; moderately rapid permeability.
Fair: moderate shrink-swell potential; low strength; high gypsum content below a depth of 30 inches.	Unsuited	Good	Gypsum in substratum; piping hazard.	Medium to low shear strength; medium piping hazard.	Well drained	High available water capacity; moderately slow permeability.
Good if thoroughly mixed.	Unsuited	Good	Moderate permeability in subsoil.	Medium shear strength; medium compacted permeability; medium piping hazard.	Well drained	Moderate available water capacity; severe hazard of soil blowing; moderate permeability.
Good: hazard of soil blowing in places.	Poor for sand: too many fines. Unsuitable for gravel.	Poor: loamy fine sand; hazard of soil blowing.	Rapid permeability.	Medium shear strength and compacted permeability; high piping hazard.	Somewhat excessively drained.	Rapid permeability; low available water capacity; severe soil blowing hazard.
Poor: stony; bedrock at a depth less than 20 inches; slope of 5 to 55 percent.	Unsuited	Poor: stony; bedrock at a depth of less than 20 inches; slope of 5 to 55 percent.	Bedrock at a depth of less than 20 inches; slope of 5 to 55 percent.	Bedrock at a depth of less than 20 inches.	Well drained	Stony; bedrock at a depth of less than 20 inches; slope of 5 to 55 percent.
Fair: moderate shrink-swell potential; low shear strength.	Unsuited	Good	Moderate permeability.	Medium shear strength; medium piping hazard.	Well drained	Moderate permeability; high available water capacity.
Good in DU, poor in DY: high gypsum hazard to concrete.	Fair to poor for sand: too many fines. Unsuitable for gravel.	Poor: sandy; hazard of soil blowing.	Rapid permeability.	Medium shear strength and compacted permeability; high piping hazard.	Excessively drained.	Very low available water capacity; hazard of soil blowing; rapid permeability.

TABLE 3.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Foundations for low buildings without basements	Sanitary landfill [1]	Local roads and streets
*Gilland: GR. For Rock outcrop part, see Rock outcrop.	Severe: bedrock at a depth of 20 to 30 inches; slope of 5 to 35 percent.	Severe: bedrock at a depth of 20 to 30 inches; slope of 5 to 35 percent.	Moderate to severe: bedrock at a depth of 20 to 30 inches; slope of 5 to 35 percent; stony.	Moderate to severe: stony; slope of 5 to 35 percent.	Severe: stony; bedrock at a depth of 20 to 30 inches; slope of 5 to 35 percent.	Severe: stony; slope of 5 to 35 percent.
Glendale. Mapped only with Mimbres soils.	Severe: moderately slow permeability.	Slight: surface water diversion needed in places.	Slight	Moderate: moderate shrink-swell potential.	Slight: surface water diversion needed in places.	Moderate: moderate shrink-swell potential; low shear strength.
Gypsum land, hummocky: GS.	Slight [2]	Severe: rapid permeability.	Severe: sidewall instability.	Severe: high corrosion hazard to concrete.	Severe: rapid permeability.	Severe: severe hazard of soil blowing; high corrosion hazard to concrete.
Gypsum land, level: GU.	Severe: water table at a depth of less than 60 inches; nearly pure gypsum.	Severe: water table at a depth of less than 60 inches; nearly pure gypsum.	Severe: water table at a depth less than 60 inches.	Severe: wet; high gypsum hazard to concrete.	Severe: water table at a depth of less than 60 inches.	Severe: high gypsum hazard to concrete; water table at a depth of less than 60 inches.
*Gypsum rock land: GV. For Rance part, see Rance series, shallow variant.	Severe: bedrock at a depth of less than 4 inches.	Severe: bedrock at a depth of less than 4 inches.	Severe: bedrock at a depth of less than 4 inches.	Severe: bedrock at a depth of less than 4 inches.	Severe: bedrock at a depth of less than 4 inches.	Severe: bedrock at a depth of less than 4 inches.
Holloman. Mapped only with Yesum soils.	Severe: gypsum deposit within a depth of 20 inches.	Severe: gypsum deposit within a depth of 20 inches.	Moderate: difficult to excavate.	Severe: high gyspum hazard to concrete.	Severe: gypsum deposit within a depth of 20 inches.	Slight: high gypsum hazard to concrete.
*La Fonda: LA. For Alicia part, see Alicia high gypsum substratum variant.	Moderate: moderate permeability.	Moderate: slope of 5 to 9 percent; moderate permeability.	Slight	Moderate: moderate shrink-swell potential.	Slight	Moderate: moderate shrink-swell potential; low shear strength.
Lava flows: LF.	Severe: bedrock at a depth of less than 4 inches.	Severe: bedrock at a depth of less than 4 inches.	Severe: bedrock at a depth of less than 4 inches.	Severe: bedrock at a depth of less than 4 inches.	Severe: bedrock at a depth of less than 4 inches.	Severe: bedrock at a depth of less than 4 inches.
*Lozier: LR. For Rock outcrop part, see Rock outcrop.	Severe: bedrock at a depth of less than 20 inches; slope of 5 to 35 percent.	Severe: bedrock at a depth of less than 20 inches; slope of 5 to 35 percent.	Severe: bedrock at a depth of less than 20 inches.	Severe: bedrock at a depth of less than 20 inches; slope of 5 to 35 percent.	Severe: stony; bedrock at a depth of less than 20 inches; slope of 5 to 35 percent.	Severe: bedrock at a depth of less than 20 inches; slope of 5 to 35 percent.
*Marcial: MA. For Ubar part of MA, see Ubar series.	Severe: slow permeability.	Severe: gypsum substratum creates piping hazard.	Moderate: too clayey.	Moderate: moderate shrink-swell potential.	Severe: surface runoff diversions needed in places; gypsum substratum creates piping hazard.	Severe: moderate shrink-swell potential; low strength.

See footnotes at end of table.

interpretations—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation
Poor: stony; bedrock at a depth of 20 to 30 inches; slope of 5 to 35 percent.	Unsuited	Poor: stony; slope of 5 to 35 percent.	Stony; bedrock at a depth of 20 to 30 inches; slope of 5 to 35 percent.	Stony; bedrock at a depth of 20 to 30 inches; slope of 5 to 35 percent.	Well drained	Stony; bedrock at a depth of 20 to 30 inches; slope of 5 to 35 percent.
Fair: moderate shrink-swell potential; low shear strength.	Unsuited	Fair: too clayey.	Moderately slow permeability.	Low shear strength; high piping hazard.	Well drained	Moderately slow permeability; high available water capacity.
Poor: high corrosion hazard to concrete; gypsum subject to solution.	Unsuited	Poor: sandy; hazard of soil blowing; saline.	Rapid permeability; gypsum.	Nearly pure gypsum; high piping hazard.	Well drained	Very low available water capacity; saline.
Poor: high gypsum hazard to concrete; nearly pure gypsum.	Unsuited	Poor: nearly pure gypsum.	Nearly pure gypsum; wet.	Nearly pure gypsum; high piping hazard.	Poorly drained; water table at a depth of less than 60 inches.	Unsuited.
Poor: bedrock at a depth of less than 4 inches.	Unsuited	Poor: bedrock at a depth of less than 4 inches.	Bedrock at a depth of less than 4 inches.	Bedrock at a depth of less than 4 inches.	Bedrock at a depth of less than 4 inches.	Bedrock at a depth of less than 4 inches.
Poor: gypsum deposit within a depth of 20 inches.	Unsuited	Poor: saline; high in salts.	Gypsum within a depth of 20 inches; moderate permeability.	Gypsum within a depth of 20 inches.	Well drained	Gypsum within a depth of 20 inches; very low available water capacity; moderate permeability.
Fair: moderate shrink-swell potential; low strength.	Unsuited	Good to a depth of 6 inches, fair below: moderate permeability in subsoil; clay loam texture.	All features favorable.	Medium to low shear strength; low to medium piping hazard.	Well drained	Moderate permeability; slope of 3 to 9 percent; high available water capacity.
Poor: bedrock at a depth of less than 4 inches.	Unsuited	Poor: bedrock at a depth of less than 4 inches.	Bedrock at a depth of less than 4 inches.	Bedrock at a depth of less than 4 inches.	Bedrock at a depth of less than 4 inches.	Bedrock at a depth of less than 4 inches.
Severe: stony; bedrock at a depth of less than 20 inches; slope of 5 to 35 percent.	Unsuited	Poor: stony; bedrock at a depth of less than 20 inches.	Stony; bedrock at a depth of less than 20 inches; slope.	Bedrock at a depth of less than 20 inches.	Well drained	Stony; bedrock at a depth of less than 20 inches; slope of 5 to 35 percent.
Poor: moderate shrink-swell potential; low strength.	Unsuited	Poor: clayey; high in salts.	Slow permeability.	Medium shear strength; medium piping hazard; gypsum below depth of 3.5 to 4.5 feet.	Moderately well drained.	Slow permeability; saline; moderate available water capacity.

TABLE 3.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Foundations for low buildings without basements	Sanitary landfill [1]	Local roads and streets
Mead: ME	Severe: very slow permeability.	Severe: water table at a depth of 36 to 84 inches.	Moderate: water table at a depth of 36 to 84 inches.	Severe: water table at a depth of 36 to 84 inches; high gypsum hazard to concrete.	Severe: water table at a depth of 36 to 84 inches.	Severe: water table at a depth of 36 to 84 inches; high gypsum hazard to concrete.
*Mimbres: MG. For Glendale part, see Glendale series.	Severe: moderately slow permeability; subject to flooding.	Severe: subject to flooding.	Slight; severe during rainy season when subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
*Nickel: NT. For Tencee part, see Tencee series.	Severe: moderately slow permeability; slope of 1 to 55 percent.	Severe: slope of 1 to 55 percent; coarse fragments.	Severe: very gravelly; slope of 1 to 55 percent.	Slight if slope is 3 to 8 percent, moderate if 8 to 15 percent, severe if 15 to 55 percent.	Slight if slope is less than 15 percent, moderate if 15 to 25 percent, severe if more than 25 percent.	Slight if slope is less than 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.
*Onite: OB. For Bluepoint and Wink parts, see their respective series.	Slight	Severe: moderately rapid permeability.	Slight	Slight	Severe: moderately rapid permeability.	Slight: hazard of soil blowing in places.
Oscura: OS	Severe: slow permeability; subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: high shrink-swell potential; subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding; high shrink-swell potential.
Pajarito. Mapped only with Dona Ana and Bluepoint soils.	Slight	Severe: moderately rapid permeability.	Slight	Slight	Severe: moderately rapid permeability.	Slight: hazard of soil blowing in places.
Pinaleno. Mapped only with Sonoita soils.	Slight if installed below a depth of 42 inches.	Severe: moderately rapid permeability below a depth of 42 inches.	Severe: very gravelly.	Slight	Severe: moderately rapid permeability below a depth of 42 inches.	Slight: hazard of soil blowing in places.
Pinaleno noncalcarious variant. Mapped only with Aladdin soils.	Severe: bedrock at a depth of 1.5 to 4 feet.	Severe: slope; bedrock at a depth of 1.5 to 4 feet.	Severe: very gravelly.	Slight if slope is 5 to 8 percent; moderate if 8 to 15 percent.	Severe: bedrock at a depth of 1.5 to 4 feet.	Slight if slope is 5 to 8 percent; moderate if 8 to 15 percent.
Rance shallow variant. Mapped only with Gypsum rock land.	Severe: gypsum at a depth of less than 20 inches.	Severe: gypsum at a depth of less than 20 inches; slope.	Severe: gypsum at a depth of less than 20 inches; slope.	Severe: gypsum at a depth of less than 20 inches; slope.	Severe: gypsum at a depth of less than 20 inches.	Severe: gypsum at a depth of less than 20 inches; slope.

See footnotes at end of table.

interpretations—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation
Poor: moderate shrink-swell potential; high in salts; low shear strength.	Unsuited	Poor: high in salts; clayey.	Gypsum goes into solution when wet; water table at a depth of 36 to 84 inches.	Low shear strength; medium piping hazard; high salt and gypsum content.	Somewhat poorly drained; water table at a depth of 36 to 84 inches.	Very slow permeability; low available water capacity; saline.
Fair: low shear strength.	Unsuited	Fair: too clayey.	Moderately slow permeability.	Low shear strength; medium to low compacted permeability; medium piping hazard.	Well drained; subject to flooding.	Moderately slow permeability; high available water capacity; subject to flooding.
Good if slope is 3 to 15 percent, fair if 15 to 25 percent, severe if more than 25 percent.	Poor for gravel: fines. Unsuitable for sand.	Poor: too gravelly.	Moderately slow permeability; gravelly; slope of 1 to 55 percent.	Medium compacted permeability; medium piping hazard.	Well drained	Slope of 1 to 55 percent; gravelly; low available water capacity; easily eroded.
Good: hazard of soil blowing in places.	Poor for sand: too many fines. Unsuitable for gravel.	Poor: surface layer of loamy fine sand; severe hazard of soil blowing.	Moderately rapid permeability; severe hazard of soil blowing.	Medium shear strength; medium compacted permeability; high piping hazard.	Well drained	Moderate available water capacity; severe hazard of soil blowing; moderately rapid permeability.
Poor: high shrink-swell potential.	Unsuited	Poor: too clayey.	Slow permeability.	Low shear strength; low piping hazard.	Well drained	Slow permeability; subject to flooding; high available water capacity.
Good: hazard of soil blowing in places.	Poor for gravel: too many fines. Unsuitable for sand.	Good	Moderately rapid permeability; severe hazard of soil blowing.	Medium shear strength; medium to low compacted permeability; medium to high piping hazard.	Well drained	Moderate available water capacity; severe hazard of soil blowing; moderately rapid permeability.
Good: hazard of soil blowing in places.	Poor for sand and gravel: fines.[4]	Poor: too gravelly.	Moderately rapid permeability below a depth of 42 inches; very gravelly underlying layers.	Medium shear strength; medium to low compacted permeability and piping hazard.	Well drained	Low available water capacity; moderately slow permeability.
Fair to poor: bedrock at a depth of 1.5 to 4 feet.	Unsuited	Poor: too gravelly.	Very gravelly; bedrock at a depth of 1.5 to 4 feet; gypsum at a depth of less than 20 inches.	Medium shear strength.	Well drained	Low available water capacity; slope of 5 to 15 percent; bedrock at a depth of 1.5 to 4 feet.
Poor: gypsum at a depth of less than 20 inches; slope.	Unsuited	Poor: high in salt content; slope.	Less than 20 inches to gypsum.	Medium to low piping hazard; bedrock at a depth of 1.5 to 4 feet; gypsum at a depth of less than 20 inches.	Well drained	Gypsum at a depth of less than 20 inches; slope of 5 to 35 percent.

TABLE 3.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Foundations for low buildings without basements	Sanitary landfill [1]	Local roads and streets
Rock land, cool: RK.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.
Rock land, warm: RL.	Severe: bedrock at a depth of 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.
Rock outcrop. Mapped only with Deama, Gillard, and Lozier soils.	Severe: bedrock at a depth of less than 7 inches.	Severe: bedrock at a depth of less than 7 inches.	Severe: bedrock at a depth of less than 7 inches.	Severe: bedrock at a depth of less than 7 inches.	Severe: bedrock at a depth of less than 7 inches.	Severe: bedrock at a depth of less than 7 inches.
Russler. Mapped only with Sotim soils.	Severe: moderately slow permeability.	Severe: solution of gypsum can cause leakage.	Slight	Moderate: moderate shrink-swell potential; severe hazard of gypsum to concrete.	Severe: solution of gypsum can cause seepage.	Moderate: moderate shrink-swell potential; unstable when wet.
Shale rock land: SH.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.	Severe: bedrock at a depth of less than 20 inches; slope.
*Sonoita: SP. For Pinaleno and Aladdin parts, see their respective series.	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight	Slight	Slight	Fair: low shear strength.
*Sotim: SR. For Russler part, see Russler series.	Severe: moderately slow permeability.	Slight if slope is 1 to 2 percent; moderate if more than 2 percent; moderately rapid permeability below a depth of 50 inches.	Slight	Moderate: moderate shrink-swell potential.	Slight	Moderate: moderate shrink-swell potential.
*Tencee: TC, TK. For Nickel part, see Nickel series.	Severe: shallow over indurated caliche; slope of 1 to 35 percent.	Severe: shallow over indurated caliche; slope of 1 to 35 percent.	Severe: shallow over indurated caliche.	Severe: shallow over indurated caliche; slope of 1 to 35 percent.	Severe: shallow over indurated caliche; slope of 1 to 35 percent.	Severe: shallow over indurated caliche; slope of 1 to 35 percent.
Ubar. Mapped only with Marcial soils.	Severe: slow permeability.	Slight: runoff water needs to be diverted in places.	Moderate: too clayey.	Moderate: moderate shrink-swell potential; low shear strength.	Slight: runoff water needs to be diverted in places.	Severe: low shear strength; moderate shrink-swell potential.
Wink. Mapped only with Blue-point and Onite soils.	Slight	Severe: moderately rapid permeability.	Slight	Slight	Severe: moderately rapid permeability.	Slight: hazard of soil blowing in places.

See footnotes at end of table.

interpretations—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation
Poor: bedrock at a depth of less than 20 inches; slope.	Unsuited	Poor: bedrock at a depth of less than 20 inches; slope.	Bedrock at a depth of less than 20 inches; slope.	Bedrock at a depth of less than 20 inches; slope.	Bedrock at a depth of less than 20 inches.	Bedrock at a depth of less than 20 inches; slope.
Poor: bedrock at a depth of less than 20 inches; slope.	Unsuited	Poor: bedrock at a depth of less than 20 inches; slope.	Bedrock at a depth of less than 20 inches; slope.	Bedrock at a depth of less than 20 inches; slope.	Bedrock at a depth of less than 20 inches.	Bedrock at a depth of less than 20 inches; slope.
Poor: bedrock at a depth of less than 7 inches.	Unsuited	Poor: bedrock at a depth of less than 7 inches.	Bedrock at a depth of less than 7 inches.	Bedrock at a depth of less than 7 inches.	Bedrock at a depth of less than 7 inches.	Bedrock at a depth of less than 7 inches.
Fair: moderate shrink-swell potential.	Unsuited	Fair: too clayey.	Moderately slow permeability; gypsum in subsoil.	Low shear strength; medium piping hazard.	Well drained	Moderately slow permeability; severe hazard of water erosion; moderate available water capacity.
Poor: bedrock at a depth of less than 20 inches; slope.	Unsuited	Poor: bedrock at a depth of less than 20 inches; slope.	Bedrock at a depth of less than 20 inches; slope.	Bedrock at a depth of less than 20 inches; slope.	Bedrock at a depth of less than 20 inches.	Bedrock at a depth of less than 20 inches; slope.
Fair: low shear strength.	Unsuited	Poor: too gravelly.	Moderate permeability.	Medium shear strength; low compacted permeability; medium to low piping hazard.	Well drained	Moderate permeability; moderate available water capacity.
Fair: moderate shrink-swell potential.	Unsuited	Fair: too clayey.	Moderately slow permeability to a depth of 50 inches, moderately rapid permeability below.	Medium to low shear strength; low compacted permeability; low to medium piping hazard.	Well drained	Moderately slow permeability; severe hazard of water erosion; high available water capacity.
Poor: shallow over indurated caliche; slope of more than 15 percent in places.	Unsuited	Poor: too gravelly.	Shallow over indurated caliche.	Very gravelly; shallow over indurated caliche.	Well drained	Very gravelly; shallow over caliche; slope of 1 to 35 percent.
Poor: low shear strength; moderate shrink-swell potential.	Unsuited	Poor: too clayey; high in salt content.	Slow permeability.	Low shear strength; medium piping hazard; medium compressibility.	Well drained; saline and alkali affected.	Slow permeability; saline; moderate available water capacity.
Good: hazard of soil blowing in places.	Poor for sand: too many fines. Unsuitable for gravel.	Good: hazard of soil blowing in places.	Moderately rapid permeability; severe hazard of soil blowing.	Medium shear strength; medium compacted permeability; medium piping hazard.	Well drained	Moderate available water capacity; severe hazard of soil blowing; moderately rapid permeability.

TABLE 3.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Foundations for low buildings without basements	Sanitary landfill [1]	Local roads and streets
*Yesum: YE, YH—For Holloman part of YH, see Holloman series.	Severe: severe hazard of gypsum to concrete.	Severe: solution of gypsum causes leakage.	Slight	Severe: severe hazard of gypsum to concrete.	Severe: solution of gypsum causes leakage.	Slight: severe hazard of gypsum to concrete.

[1] Onsite study is needed of the underlying strata, the water table, and the hazards of aquifer pollution and drainage into ground water in landfill deeper than 5 to 6 feet.

[2] Pollution of ground water may be a hazard in some places as a result of excessive permeability in the substratum.

resistant concrete should be used to avoid or minimize damage.

Engineering interpretations

The interpretations in table 3 are based on the engineering properties of soils shown in table 2, 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 White Sands Missile Range. The ratings summarize the limitation or suitability of the soils for all listed purposes.

Soil limitations are indicated by the ratings slight, moderate, severe, and very severe. *Slight* means that soil properties generally are 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 so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required. *Very severe* indicates one or more soil properties so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly is not practical for the rated use.

Soil suitability is rated *good, fair,* and *poor.*

Explanations of the engineering uses interpreted in table 3 follow.

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 from a depth of 18 inches to 5 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 permeability, depth to water table or rock, and susceptibility to flooding. Slope 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 interpretations apply to lagoons in which the embankment is compacted to medium density and the pond is protected from flooding. Properties that affect the pond floor are permeability, organic-matter content, and slope. If the floor needs leveling, depth to bedrock is important. Properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification and the number of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations require digging or trenching to a depth of less than 5 feet and are used for pipelines, sewer lines, phone and power transmission lines, basements, and open ditches and in cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slope, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Foundations for low buildings without basements, as rated in table 3, are for buildings no more than three stories high that are supported by foundation footings placed in undisturbed soil. The rating is based on the capacity of the soil to support load and resist settlement under load and on the 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. Soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils for sanitary landfill have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 3 apply only to a depth of about 6 feet. If trenches are to be much deeper, limitation ratings of *slight* or *moderate* may not be valid.

Local roads and streets, as rated in table 3, have an all-weather surface expected to carry traffic all year.

interpretations—Continued

Suitability as a source of—			Soil features affecting—			
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation
Good: severe hazard of gypsum to concrete.	Unsuited[3]	Poor: high in salt content; high in gypsum content.	Moderate permeability; high in gypsum content.	Medium shear strength; medium compacted permeability; high piping hazard.	Well drained[4]	Saline.

[3] Severe soil blowing is a hazard in some places.
[4] After sieving, recovery of sand or gravel is adequate.

They have a subgrade of soil material; a base 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 5 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity, stability of the material, and 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 and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect the ease of excavation and the amount of cut and fill needed to reach an even grade.

Road fill is soil material used in constructing subgrade for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in a subgrade that has been properly compacted and provided with adequate drainage. The ease of excavating the material at borrow areas is also considered.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 3 provide guidance on 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 6 feet of the surface. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials. Also, they do not indicate the quality of the deposit.

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 in preparing a seedbed; natural fertility of the material, or the response of plants if fertilizer is applied; and the absence of substances toxic to plants. Texture of the soil material and the content of stone fragments are characteristics that affect suitability. Also considered in the ratings is damage that results at the area from which topsoil is taken.

Pond reservoir areas hold water in a pit or behind embankments. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that resists seepage and piping and has favorable stability, shrink-swell potential, shear strength, and compactibility. Stones or organic material, for example, are unfavorable factors.

Drainage is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or the depth to the water table or bedrock.

Engineering test data

Table 4 contains engineering test data for some of the major soil series in White Sands Missile Range. 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 combined sieve and hydrometer methods.

Liquid limit and plasticity index relate to soil moisture and provide important clues to soil behavior. If water is added to dry soil that contains at least some clay and silt, the soil becomes plastic. The moisture content at which the soil becomes plastic is the plastic limit. If more water is added, the plastic soil becomes a fluid. The moisture content at which the soil changes from a plastic to a fluid state is the liquid limit. The difference between liquid limit and plastic limit is the plastic index. Some soils, such as sandy soils, do not exhibit plasticity and therefore do not have a plastic-

TABLE 4.—*Engineering*

[Tests made by New Mexico State Highway Department, Materials Testing Laboratory,

Soil name and location	New Mexico State highway department report number	Depth	Mechanical analysis [1]		
			Percentage passing sieve—		
			1 in	¾ in	⅜ in
		Inches			
Bluepoint loamy fine sand:					
4 miles west of Phillips Hill, 1.1 miles east of basalt flow, and 5.1 miles north of the Russ site. (Modal)	70–0940	0–12	100	100	100
Marcial silty clay loam:					
2.2 miles southwest of junction of Marcial site and Rt. 5 on gravel road on south side of bar pit by well. (Modal)	70–0947	0–6	100	100	100
	70–0948	6–38	100	100	100
Mead silty clay:					
3.2 miles south of Gun site and 0.6 mile east. (Modal)	70–0953	5–48	100	100	100
Mimbres silt loam:					
1.8 miles north of intersection of Rts. 7 and 8 and 50 feet west of road. (Modal)	70–0954	3–14	100	100	100
Nickel gravelly fine sandy loam:					
1.1 miles west of intersection of Rt. 12 and road to Wood site, and 1.5 miles north on unimproved road. (Modal)	70–0955	3–16	94	87	69
Onite loamy fine sand:					
1 mile south of Granjean, 40 feet north of Rd. 22, and 100 feet east of the road intersection. (Modal)	70–0944	0–12	100	100	100
	70–0945	12–24	100	100	100
	70–0946	36–48	100	100	100
Wink loamy fine sand:					
3.2 miles north of junction of Rd. 349 and Rt. 5, and 0.3 mile west. (Modal)	70–0941	0–8	100	100	100
	70–0942	8–20	100	100	100
	70–0943	30–60	100	100	100
Yesum very fine sandy loam:					
2.9 miles south of Norm site on Rt 9. then 0.15 mile east on gravel road and 50 feet north. (Modal)	70–0949	3–12	100	100	100
	70–0950	12–20	100	100	100
	70–0951	26–56	100	100	100

[1] Mechanical analysis according to AASHO Designation T 88–57(*1*). Results by this procedure may differ somewhat from the results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all material up to and including that 3 inches in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from the calculation of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming textural classes of soil.

ity index. These soils are designated "NP," or nonplastic.

Capability Classification

The entire area is managed mainly for military testing. Capability classification of soils is not used in current management and is not expected to be used in the foreseeable future. The system is described here, however, and can be used as a reference and as a basis for comparing soils in the area with soils in adjoining areas or in other published soil surveys.

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These levels are described in the following paragraphs.

test data

Santa Fe, N. Mex. Absence of entry indicates no determination was made]

Mechanical analysis [1]—Continued				Liquid limit [2]	Plasticity index [3]	Classification	
Percentage passing sieve—Continued							
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)			AASHO [4]	Unified [5]
				Percent			
100	100	99	8	[6] NP	[6] NP	A-3(0)	SP-SM
100	100	98	88	32	11	A-6(9)	CL
100	100	96	80	33	8	A-4(8)	ML
100	100	88	78	30	6	A-4(8)	ML
100	100	96	72	32	10	A-4(8)	CL
56	46	34	19	31	9	A-2-4(0)	GC
100	100	94	13	NP	NP	A-2-4(0)	SM
100	100	91	21	NP	NP	A-2-4(0)	SM
100	100	93	20	NP	NP	A-2-4(0)	SM
100	100	94	26	NP	NP	A-2-4(0)	SM
100	100	94	24	NP	NP	A-2-4(0)	SM
100	100	95	21	NP	NP	A-2-4(0)	SM
100	100	96	57	NP	NP	A-4(4)	ML
100	100	90	49	NP	NP	A-4(3)	SM
100	100	97	32	NP	NP	A-2-4(0)	SM

[2] Based on AASHO Designation T 89–6 (*1*).
[3] Based on AASHO Designation T 90–56 and AASHO Designation T 91–54 (*1*).
[4] Based on AASHO Designation M 145–49 (*1*).
[5] Based on ASTM Designation D2487–66T (*2*).
[6] NP = Nonplastic.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

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 subject to little or no erosion 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 unsuitable for cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuitable for 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, or water supply or to 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, IIe. 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 largely to pasture or range, woodland, wildlife, or recreation.

The soils in the White Sands Missile Range are grouped only in the capability class and subclass under dryland conditions. The capability class and subclass for each soil in the survey area are indicated at the end of the mapping unit description.

Range and Wildlife [4]

Most of the White Sands Missile Range has not been grazed by livestock for many years, although there is some unauthorized grazing by livestock from adjoining areas. The land management plan of the Missile Range (*8*) does not call for any planned grazing by livestock in the future.[5] It does call for maintaining as much of the native vegetation as possible to prevent soil blowing and water erosion and to increase the effectiveness of the Range for military uses by reducing dust in the air, thereby increasing visibility.

A brief discussion of range sites and vegetative groups, which can be used to compare this area with other areas, follows.

Vegetative groups are areas that contain one or more range sites having similar climate, geology, topography, and soils. Individual range sites are not described. A general description of the vegetative groups and range sites follows.

Vegetative groups, range sites, and condition classes

Soils that have the capacity to produce the same kinds, amounts, and proportions of range plants are grouped into vegetative groups and range sites.

The native plant community of a range site, in the absence of abnormal grazing use or other disturbance that results in significant physical site deterioration, is the natural potential, or climax, plant community for that site. A climax plant community is not a precise, fixed composition. It varies, within reasonable limits, from year to year and from place to place.

Abnormal disturbance, such as overuse by livestock, scraping the surface bare, excessive burning, extensive mowing, or plowing, results in change or even complete destruction of the climax plant community. If the range site is not deteriorated significantly under such disturbance by water erosion or soil blowing, secondary plant succession progresses in the direction of the natural potential, or climax, plant community for the site.

Range condition is the present state of the vegetation or plant community on a range site as related to the climax plant community for the site. The primary purpose of determining range condition is to provide an index of the change that has taken place in the plant cover. If the potential plant community for a site is known, the present condition can be determined. It thereby provides a basis for predicting the nature and direction of changes in the plant community to be expected from management.

Range plants are classified as decreasers, increasers, and invaders, according to their response to grazing on a specific site. This response depends upon the kind of livestock, the season of use, and the degree to which plant tissue is removed. Decreasers are those species in the climax vegetation that decrease in number if the site is subject to continuous close grazing. Increasers are those plants in the climax vegetation that become more abundant as the decreasers decline. Invaders are plants that are part of the potential plant community but that invade the site and become established if the climax vegetation is depleted.

The composition of the plant community, both climax and present condition, together with other range site information provides the interpretative basis for selecting management objectives, managing wildlife, and evaluating hydrologic conditions.

The management objective on range is to increase desirable plants and restore range to as near climax condition as is reasonably feasible. It can be to create or maintain plant communities somewhat removed from the climax vegetation, to fit specific needs in the management program, to provide for wildlife habitat, or for other benefits. Any management objective should be compatible with the conservation objective of providing plant communities that will protect and improve soil and water resources and should also meet the needs of the operator.

Descriptions of vegetative groups

Plant communities that grow in areas of similar climate, geology, topography, and soils are classified in 12 vegetative groups. The characteristics of the range sites and land types that support these groups are summarized in table 5. Groups 9 and 10, which are the characteristic plant cover on about 261,184 acres, are at elevations of more than 6,000 feet. All other groups are at lower elevations. Annual precipitation in the areas above 6,000 feet averages 12 to 16 inches. Below, it ranges from 8 to 12 inches. Following are brief descriptions of the vegetative groups:

1. Clay Grasslands. This vegetative group is on flood plains and nearly level alluvial fans. Flood plains are productive because they receive additional moisture from runoff of higher lying soils. The soils are clays and clay loams. The plant cover is dominantly vine-

[4] DONALD R. ROBERTSON and HENRY D. GALT, range conservationists, Soil Conservation Service, helped prepare this section.

[5] The Jornada Experimental Range, in the west-central part of the area, is a co-use area. The grassland on the Range is managed entirely by the Jornada Experimental Range.

mesquite and lesser amounts of sacaton and tobosa. In the upland areas alkali sacaton, tobosa, fluffgrass, burrograss, and chamiza are typical.

2. Salt Flats. About 80 percent of this vegetative group is on slightly saline to moderately saline soils. Alkali sacaton is the principal vegetation. Chamiza is an important shrub. The rest of the group is on strongly saline soils. Alkali sacaton, iodinebush, inland saltgrass, and chamiza grow in sparse clumps.
3. Sand Grasslands and Dunes. This group consists of most of the plant communities on sandy soils. More than half the area is presently covered by coppice dunes formed by the drifting of sand around mesquite. Chamiza also is commonly associated with the sand dunes. Grasses are nearly eliminated by the strong competition of the mesquite for available moisture. About one-third of this group is on nearly level to gently undulating, deep sands. Giant dropseed, mesa dropseed, spike dropseed, and sand sagebrush are the most abundant plants. The rest is on sandy loams. This plant community is dominantly spike dropseed, mesa dropseed, tobosa, black grama, and soaptree yucca. On a small acreage of the nonsaline sandy loams a generally saline-related plant community is dominated by alkali sacaton and chamiza.
4. Gypsum Grasslands and Dunes. This is the most abundant vegetative group. The soils range from very shallow soils over gypsum, which support a sparse cover of rough coldenia, gypgrass, Torrey ephedra, alkali sacaton, and lichens, to deeper gypsum soils, which support a fairly productive plant community of alkali sacaton, chamiza, Torrey ephedra, and gyp grama. A small but unique plant community is on gypsum dunes. Torrey ephedra dominates the other plants, which include chamiza, rubber rabbitbrush, Indian ricegrass, gyp grama, little bluestem, and mesquite.
5. Gypsum Dunes, Barren. No vegetation grows on the dunes, but a sparse plant community of giant dropseed, spike dropseed, Indian ricegrass, little bluestem, rubber rabbitbrush, chamiza, seepweed, and iodinebush grows between the dunes.
6. Intermittent Lakes and Level Gypland. Only scattered iodinebush persists in this area.
7. Foot Slope Grasslands. This group, one of the most stable plant communities on the range, is grama grassland. It grows at the foot of the mountains on sloping alluvial fans. The soils are gravelly loams and sandy loams. Black grama, blue grama, and side-oats grama make up more than two-thirds of the plant community. Other plants are bush muhly, chamiza, sand sagebrush, soaptree yucca, and broom snakeweed.
8. Semidesert Shrubs. The gravelly very limy soils just below the Foot Slope Grasslands are almost exclusively covered with creosotebush. Other significant plants are mesquite, American tarbush, and mariola panthenium. A few areas in good condition are dominated by black grama, and creosotebush is reduced to about 20 percent of the total composition, by weight.
9. Pinyon-Juniper Mountains. Sparse to dense pinyon pine and oneseed juniper dominate this vegetative group, which is above an elevation of 6,000 feet. Pinyon pine is abundant only at the higher elevations. Oneseed juniper is dominant at the lower elevations. One very small area at the top of Salinas Peak has an overstory of ponderosa pine. Understory plants in pinyon-juniper areas are Metcalfe muhly, pine muhly, Chihuahua lovegrass, side-oats grama, Fendler three-awn, mountainmahogany, and soaptree yucca. This is an important food and cover area for mule deer. The largest part of the area covered by this vegetative group is either steep, stony vegetated breaks or bare rock outcrop. A significant number of productive deep soils, however, are in the valleys and on alluvial fans. The resultant higher forage production plus the more favorable climate and availability of water made this the center of the former livestock ranches on the Missile Range.
10. Mountains, Nonwooded. This group also occurs above an elevation of 6,000 feet. No pinyon pine and oneseed juniper grow here. A productive plant community of black grama, blue grama, side-oats grama, mountainmahogany, algerita, shrub live oak, and soaptree yucca is most common. High-producing, but narrow, valleys and alluvial fans are numerous. The steeper terrain, the abundance of mountainmahogany and some desert ceanothus and Wrights silktassel, and the availability of water make this a very favorable area for mule deer.
11. Semidesert Hills and Rock land. Much of this vegetative group is on the steep escarpments and breaks that rise from the floor of the range. Areas are below an elevation of 6,000 feet. Vegetation is sparse. The breaks areas produce black grama, creosotebush, fluffgrass, ocotillo, and mariola parthenium. Interspersed deeper soils support more black grama and sand dropseed. At least half the area is bare rock outcrop.
12. Lava Flows. Only sparse vegetation that grows in pockets of soil in the rock is typical of this vegetative group. The rest of the area is barren. Chamiza and creosotebush dominate over black grama, alkali sacaton, and mariola parthenium. This area has some food and cover value for mule deer and is the favorite hideout of the wild horses on the range.

The range sites and land types of each vegetative group are evaluated in table 5. The Glossary contains definitions of terms used.

TABLE 5.—*Characteristics of*

[Units designated as "Not assigned" in column

Vegetative group	Range site	Mapping unit	Principal plants (Listed in order of abundance)
1. Clay Grasslands.	Bottomland	Oscura: OS	Vine-mesquite, sacaton, tobosa
	Clayey	Sotim part of SR, Russler part of SR, Mimbres part of MG, Glendale part of MG.	Alkali sacaton, tobosa, chamiza, creosotebush, burrograss.
2. Salt Flats.	Salt Flats	Marcial part of MA, Ubar part of MA.	Inland saltgrass, alkali sacaton, tobosa, chamiza, vine-mesquite.
	Barren Saline Land	Mead: ME	Alkali sacaton, iodinebush, seepweed.
3. Sand Grasslands and Dunes.	Deep Sand	Onite part of OB, Wink part of OB.	Giant dropseed, mesa dropseed, spike dropseed, sand sagebrush.
	Sand Hills	Bluepoint part of OB and DP, Dune land part of DU.	Mesquite, chamiza, sand dropseed, longleaf ephedra, mesa dropseed.
	Sandy	Pajarito part of DP, Berino part of BD, Dona Ana part of BD, DP, and DU.	Spike dropseed, chamiza, winterfat, mesquite, mesa dropseed, tobosa, black grama.
4. Gypsum Grasslands and Dunes.	Gyp Flats	Yesum part of DY, YE, and YH; Holloman part of YH.	Alkali sacaton, chamiza, mesquite, gyp grama.
	Not assigned	Gypsum land, hummocky: GS, Dune land part of DY.	Torrey ephedra, chamiza, mesquite, hoary rosemary-mint.
5. Gypsum Dunes, Barren.	Not assigned	Active dune land, gypsum: AC.	Giant dropseed, iodinebush, seepweed, spike dropseed, Indian ricegrass. (Between dunes.)
6. Intermittent Lakes and Level Gypland.	Not assigned	Gypsum land, level: GU	Iodinebush (Few.)
7. Foot Slope Grasslands.	Loamy	Sonoita part of SP	Black grama, blue grama
	Sandy	Aladdin part of SP	Black grama, chamiza, sand sagebrush.
	Gravelly	Pinaleno part of SP, Pinaleno, noncalcareous variant part of SP.	Black grama, blue grama, side-oats grama.
8. Semidesert Shrubs.	Limy	Nickel part of NT, TC, and TK; Tencee part of NT, TC, and TK.	Creosotebush, American tarbush, mesquite, mariola parthenium.
9. Pinyon-Juniper Mountains.	Breaks, Hills, or Limestone Hills	Rock land, cool: RK, Deama part of DO.	Oneseed juniper, pinyon pine, pine muhly, Metcalf muhly, Chihuahua lovegrass, mountainmahogany.
	Not assigned	Shale rock land: SH	
	Loamy	La Fonda: LA, Alicia part of LA.	Blue grama, black grama, oneseed juniper, pinyon pine.
	Gravelly	Gilland part of GR	Black, blue, and side-oats grama; oneseed juniper, mountainmahogany.
	Gyp Hills	Gypsum rock land: GV, Rance shallow variant part of GV.	Rough coldenia, blue grama, sand dropseed, oneseed juniper.
	Not assigned	Rock outcrop part of DO, GR, and LR.	None
10. Mountains, Nonwooded.	Breaks, Hills, or Limestone Hills.	Rock land, warm: RL	Black grama, side-oats grama, blue grama, algerita, shrub live oak, mountainmahogany, soaptree yucca.

vegetative groups

Range site support little or no vegetation]

Estimate total annual yield	Range condition	Percent ground cover	Wildlife value (Mainly mule deer and antelope)	Livestock-grazing value
Lb/acre air dry				
2,000 to 3,000	Good to excellent	50	Good forage for antelope	Good forage for cattle.
300 to 600	30 percent good to excellent, 70 percent poor to fair.	25	Good forage for antelope	Good forage for cattle.
300 to 700	40 percent good to excellent, 60 percent poor to fair.	[1] 10 to 50	Good forage for antelope	Good forage for cattle.
0 to 200		1	None	None.
300 to 700	Fair to good	20	Good forage for antelope	Good forage for cattle.
200 to 500	Poor to fair	5 to 25	None	Poor in present condition; potential for improvement.
400 to 700	Fair to good	25	Good forage for antelope	Good forage for cattle.
200 to 600	Fair to good	15	Good forage for antelope	Good forage for cattle.
50 to 100		5	None	Too erodible for grazing.
			None	None.
			None	None.
400 to 700	Good to excellent	25	Good forage for antelope	Good forage for cattle.
300 to 700	Good to excellent	25	Good forage for antelope	Good forage for cattle.
300 to 800	Good to excellent	30	Good forage for antelope	Good forage for cattle.
100 to 400	90 percent poor to fair, 10 percent good.	10	None	None to poor.
400 to 1,000	Good to excellent	25	Good habitat for mule deer and desert bighorn sheep.	Fair to good for cattle and sheep.
None			Protection for deer	None.
400 to 800	Good to excellent	25	Fair for mule deer	Good for cattle.
200 to 500	Good to excellent	20	Good habitat for mule deer	Fair for cattle; good for sheep.
200 to 400	Good	10	Poor	Poor.
			Protection for desert bighorn sheep.	None.
400	Good to excellent	25	Good for mule deer and desert bighorn sheep.	Fair for cattle; good for sheep.

TABLE 5.—*Characteristics of*

Vegetative group	Range site	Mapping unit	Principal plants (Listed in order of abundance)
11. Semidesert Hills and Rock land.	Not assigned	Rock outcrop part of DO, GR, and LR.	None
	Limestone Hills	Lozier part of LR	Black grama, creosotebush, sand dropseed, mariola parthenium.
12. Lava Flows.	Not assigned	Lava flows: LF	Chamiza, creosotebush, mariola parthenium, black grama, alkali sacaton.

[1] Cover is typically patchy.

Wildlife

Most soils of the White Sands Missile Range provide suitable habitat for one or more kinds of wildlife.

Wildlife habitat can be correlated in a general way with groups of soil mapping units that occur on the reconnaissance soil map at the back of this soil survey. In a broad sense, these areas are physiographic more than individual soil types.

Both game species and nongame species of wildlife find habitat within the White Sands Missile Range. Big-game species include mule deer, bighorn sheep, and antelope. Except for antelope, these species are concentrated mainly at the higher elevations. Small-game species of the lowlands or basin areas are mourning dove and scaled quail. Nongame species are wild horses, kangaroo rats, prairie dogs, pocket mice, plains jackrabbits, cottontail rabbits, pocket gophers, skunks, porcupines, badgers, and variouus kinds of snakes and lizards. Nongame birds are falcons, sparrow hawks, red-tailed hawks, Cooper's hawks, marsh hawks, western kingbird, horned larks, ravens, vultures, and several kinds of warblers.

No areas are suitable for stocking with fish.

Hunting is restricted to special permits only. Permits are given only for areas within the San Andres and Oscura Mountains. These hunting permits are issued for mule deer and bighorn sheep.

Withdrawal of land for military uses has seriously reduced water availability that was developed by man. The White Sands Missile Range land management plan is aimed at correcting this deficiency (*8*).

The availability of water, more than kinds of soil, influences the distribution of game species. Lack of water has made the availability of food for wildlife a problem. A few springs and wells that have windmills have been established.

Plant glossary

Following is a list of the plants in the White Sands Missile Range. Many of these plants are mentioned in the sections "Range and Wildlife" and "Descriptions of the Soils."

SHRUBS AND TREES

Scientific Name	*Common Name*
Agave parryi	Agave; century plant
Allenrolfea occidentalis	Pickleweed; iodinebush
Artemisia filifolia	Sand sagebrush
Atriplex canescens	Chamiza; fourwing saltbush
Berberis trifoliolata (Mahonia trifoliolata)	Algerita; laredo mahonia
Ceanothus greggii	Desert ceanothus
Cercocarpus montanus	Mountainmahogany
Chrysothamnus nauseosus	Rubber rabbitbrush
Coldenia hispidissima	Rough coldenia
Condalia spathulata	Knifeleaf condalia
Ephedra torreyana	Longleaf ephedra
Ephedra trifurca	Torrey ephedra
Eurotia lanata	Winterfat
Flourensia cernua	American tarbush
Fouquieria splendens	Ocotillo
Garrya wrightii	Wrights silktassel
Gutierrezia sarothrae	Broom snakeweed
Juniperus monosperma	Oneseed juniper
Larrea divaricata	Creosotebush
Nolina microcarpa	Sacahuista
Opuntia imbricata	Cholla
Parthenium incanum	Mariola parthenium
Pinus edulis	Pinyon pine
Pinus ponderosa	Ponderosa pine
Poliomintha incana	Hoary rosemarymint
Prosopis juliflora	Mesquite; honey mesquite
Quercus gambelii	Gambel oak
Quercus turbinella	Shrub live oak
Yucca elata	Soaptree yucca

FORBS

Scientific Name	*Common Name*
Suaeda suffrutescens	Seepweed

GRASSES

Scientific Name	*Common Name*
Bouteloua breviseta	Gyp grama
Bouteloua curtipendula	Side-oats grama
Bouteloua eriopoda	Black grama
Bouteloua gracilis	Blue grama
Distichlis stricta	Inland saltgrass
Eragrostis erosa	Chihuahua lovegrass
Hilaria mutica	Tobosa
Muhlenbergia dubia	Pine muhly
Muhlenbergia metcalfei	Metcalfe muhly
Oryzopsis hymeniodes	Indian ricegrass
Panicum obtusum	Vine-mesquite
Schleropogon brevifolius	Burrograss

vegetative groups—Continued

Estimate total annual yield	Range condition	Percent ground cover	Wildlife value (Mainly mule deer and antelope)	Livestock-grazing value
			Protection for desert bighorn sheep.	None.
200 to 500	Fair	15		Fair for sheep.
50 to 150		5	Fair for mule deer	Poor for sheep; not suitable for cattle; protection and some food for wild horses.

Sporobolus airoides	Alkali sacaton
Sporobolus contractus	Spike dropseed
Sporobolus cryptandrus	Sand dropseed
Sporobolus flexuosus	Mesa dropseed
Sporobolus giganteus	Giant dropseed
Sporobolus nealleyi	Gypgrass
Sporobolus wrightii	Sacaton
Tridens pulchellus	Fluffgrass

Formation and Classification of the Soils

This section tells how the factors of soil formation have affected the soils in the White Sands Missile Range. It also explains the current system of soil classification and classifies the soil series represented on the Range according to that system.

Factors of Soil Formation

Soil forms through processes that act on material deposited or accumulated by geologic agencies. The characteristics of a soil at any given point depend on the interaction of (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life are the active factors of soil formation. They act on the parent material, which has accumulated through the weathering of rocks, and slowly change it into soil material that has genetically related horizons. The parent material affects the kind of profile that can be formed and, in some cases, determines it almost entirely. The effects of climate and plant and animal life are also conditioned by relief. Time is needed to change the parent material into a soil profile. Generally, a long time is required for the formation of distinct horizons.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made about the effect of any one factor unless conditions are specified for the other four.

Parent material

Most of the White Sands Missile Range is made up of two physiographic types: intermountain sediments, known as valley deposits, and the semiarid San Andres and Oscura Mountains. The valley deposits were derived from the nearby mountains and the Chupadera Mesa and deposited as alluvium in the Tularosa and Jornada del Muerto Basins. These basins were formed during the uplift of the mountains and the faulting that occurred in the Tertiary period and continued into the Quaternary. The Tularosa and Jornada del Muerto Basins are both closed basins. The mountains and Chupadera Mesa consist of tilted sedimentary rocks of the Yeso, Abo, and San Andres Formations (*3*), which are dominantly limestone, gypsum, sandstone, and shale. Underlying these formations is acid igneous rock. Most of the drainage is into Lake Lucero, an intermittent dry lake in the western part of Tularosa Basin.

Considerable gypsum is dissolved in runoff water, both surface and subsurface, from the mountains and deposited in Lake Lucero. As the lake water evaporates, gypsum precipitates as fine crystals. During windy periods some of the gypsum is picked up by wind and deposited to the northeast, the direction of the prevailing winds. These processes formed the mapping units Active dune land, gypsum; Gypsum land, level; and Gypsum land, hummocky. In addition, fine gypsum particles mixed with other alluvial sediment is the parent material for the Yesum and Holloman soils (see table 6).

Limestone is the main source of much of the lime that occurs in most of the soils of the area. Depending on the relative proximity to its source, the limestone may be in the form of gravel, cobblestones or stones, sand, or even silt. In time, water from normal precipitation and surface runoff dissolves some or all of the lime in the surface layer and subsoil and redeposits it deeper within the profile to form a horizon of lime accumulation (caliche). The depth of caliche approximates the normal depth of wetting under normal precipitation. Soils that formed in this manner are the Berino, Dona Ana, Nickel, and Tencee soils. Nearly all other soils in the area are young. They have not been in place long enough for the formation of a definite caliche horizon.

Runoff that terminates in the basin carries much

TABLE 6.—*Gypsum content of specified soils*

Soil name and location	Horizon	Depth	Texture	Gypsum percent [1]
Holloman very fine sandy loam (modal): 3.4 miles west of Route 13 on straight road that goes from SOTIM 4 to QUEEN 16. Sample No. 70 NM 28-68 (1-3).	A1	0-3	Very fine sandy loam	37.8
	C1cs	3-16	Very fine sandy loam	64.4
	C2cs	16-60	Gypsum	97.9
Yesum very fine sandy loam (modal): 2.9 miles south of Norm site on Route 9 and 0.15 mile east on gravel road, then 50 feet north.	A1	0-3	Very fine sandy loam	50.0
	C1cs	3-12	Fine sandy loam	69.1
	C2cs	12-20	Very fine sandy loam	81.2
	C2cs	20-26	Very fine sandy loam	60.5
	C3cs	26-65	Very fine sandy loam	38.5

[1] Determined from water extract by precipitation in acetone.

clayey material. As the slope levels off and water spreads laterally, the flow becomes slower. Before entering the intermittent lakes, the water drops, or deposits, some of the clayey material. Fine textured and moderately fine textured sediments thus deposited are the parent material of the La Fonda, Marcial, Mead, Mimbres, Russler, Sotim, and Ubar soils.

Soils that formed in material weathered in place from limestone, sandstone, and shale are the Deama, Lozier, and Gilland soils. These soils are fairly shallow over the parent rock and contain appreciable amounts of rock fragments.

Sandy sediments deposited by water within the lake basin, then reworked and sorted by wind, are the parent material of the coarse textured and moderately coarse textured Aladdin, Bluepoint, Onite, Pajarito, Sonoita, and Wink soils.

Exposed rock within the mountain areas has been mapped as Gypsum rock land; Rock land, cool; Rock land, warm; and Shale rock land. A recent basalt lava flow occurs in the northeastern and northwestern parts of the White Sands Missile Range. In this survey it is designated as Lava flows.

Climate

Climatic forces that act on the parent material of soils are the amount and distribution of precipitation, temperature, humidity, and wind. Climate directly affects soil formation through its influence on weathering; leaching of carbonates, soluble salts, or gypsum; formation and subsequent translocation of clay; and rate of erosion. Climatic forces also cause some of the variations in the plant and animal life on and in the soils.

The climate of the Missile Range is characterized as arid, except for the Chupadera Mesa and higher elevations within the San Andres and Oscura Mountains, which are characterized as semiarid. Spring and fall are warm, summer is hot, and winter is mild. Precipitation increases and temperature decreases with elevation on the Chupadera Mesa and in the mountains. Most of the precipitation falls during summer and early in fall, but appreciable amounts fall during winter in the form of high-intensity thunderstorms, which can cause erosion of the soils on which the rains fall, considerable surface runoff, and subsequent flooding of lower lying soils. High winds early in spring cause considerable soil blowing on soils unprotected by vegetation or coarse fragments, such as Bluepoint soils.

Because precipitation is limited, the soils have not been leached of their bases, nor have all of the soluble salts been completely removed from all of the soils. As a result, most of the soils have a high base saturation and some have soluble salts in the lower part of the profile. Many soils, for example, Berino and Dona Ana soils, show evidence of some leaching and redepositing of lime. These soils have little or no lime in the surface layer and subsoil, but have accumulations of lime in the substratum (Cca horizon). The same is true of soils high in content of gypsum. The Yesum soil is a typical example of a soil in which gypsum has been partly removed from the surface layer and redeposited (see table 6). The presence and depth of lime and gypsum accumulations in soils indicate the average depth to which water moves within the soil. Also, the available water capacity can influence the depth of water movement. Fine-textured soils tend to have a lime zone at a shallower depth than coarse-textured soils because they have a higher available water capacity and water does not penetrate to so great a depth. Young soils in swales, on flood plains, in basin fills, and on recent alluvial fans occasionally do not have a lime zone because they have been subject to the active forces of soil formation for only a short time. The Glendale soil is an example.

Some soils show evidence of clay formation and the translocation of clay by water from the A horizon into the Bt horizon and within the Bt horizon. The Berino and Pinaleno soils are examples. Wetting and drying of these clayey materials result in shrinking and swelling, which influence the formation of moderate or strong grades of structure in the Bt horizon.

Organic-matter content in the soil depends upon the amount and decomposition of vegetative growth on and in the soil. Soils in the mountain valleys and on the Chupadera Mesa that receive the most precipitation support the luxuriant vegetative cover of the area. The La Fonda soils contain more organic matter and are darker colored than most other soils in the area.

Additional climatic data are in the section "Environmental Factors Affecting Soil Use."

Plant and animal life

Plants, micro-organisms, earthworms, and other forms of life on or in the soil are active in soil-forming processes. They provide organic matter, help decompose plant residue, affect the chemistry and structure of the soil, and hasten soil formation. Living organisms also help convert plant nutrients into a form readily available to higher plants.

Plants, mainly desert shrubs, have affected soil formation in this area more than other living organisms. Soils, such as the Dona Ana soils, that formed under desert shrubs generally have low organic-matter content. Desert shrubs are generally sparse and contribute little organic matter to the soils, provide little shade, and afford little protection against erosion. The long periods of sunshine and heat cause organic matter to decompose rapidly and oxidize.

Man has had little influence on soil formation in this area.

Relief

Relief influences the formation of the soils through its local effect on drainage and runoff, rate of soil erosion, plant cover, and exposure to sun and wind.

The soils range from nearly level within the valley floor of the Tularosa Basin and the Jornada del Muerto Basin to very steep in the mountains. Soils that formed in the nearly level areas are young. They are deep, except where they formed over hardened gypsum deposits. Soils that formed on gently sloping to steep areas of the uplands are generally older and shallow to deep over deposits of caliche. In time, lime from within the soil and from calcareous dust has been leached from the upper soil horizons and precipitated at the depth to which rainfall normally penetrates and has formed a caliche layer or zone of lime accumulation. Such layers formed in the Berino, Dona Ana, Nickel, Tencee, and Wink soils.

No soil has formed in very steep mountainous areas, where the rate of geologic erosion is about the same as that of soil formation. In less sloping mountainous areas the soils are shallow because runoff tends to remove the soil almost as fast as it forms.

Time

A long time generally is required for the formation of a soil that has distinct horizons. This can require several hundred years. Differences in the length of time that the parent material has been in place are commonly reflected in the degree of formation of the soil profile.

The soils range from young to old. The young soils show little or no horizonation, but the older soils have well-defined horizons. Glendale, Marcial, Mead, Mimbres, and Ubar soils, on the valley floor of the Tularosa Basin, are examples of young soils. Slightly older soils are those on the lower parts of piedmont slopes between the mountains and the valley floor. Examples of these are the Russler, Sotim, and Yesum soils. These soils formed in alluvium deposited from the mountains, but they are subject to sedimentation. Some structure has formed in the A and B horizons, and some calcium carbonates have been leached. The carbonates have accumulated as concretions, coatings on coarse fragments, soft masses, and threads in the lower part of the subsoil or the upper part of the substratum.

The oldest soils, such as Berino, Dona Ana, Nickel, Tencee, and Wink soils, have thick, soft to indurated accumulations of caliche. The thickness and degree of cementation by carbonates suggest that the soils have been forming for a long time.

Classification of Soils

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

The narrow categories of classification, such as those used in soil surveys, allow us to organize and apply knowledge about soils for interpretations that apply to engineering work or any other use. Soils are assigned to broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (*6*). Because this system is under continual study, readers interested in developments of the current system should search the latest literature available.

The current system of classification has six categories. Beginning with the broadest, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that soils of similar genesis, or mode of origin, are grouped. In table 7, the soil series of the White Sands Missile Range are classified in four categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER.—Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Ent-i-sol).

SUBORDER.—Each order is divided into suborders, based primarily on those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the order. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences that result from climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Psamment* (*Psamm* meaning sand, and *ent*, from Entisol).

GREAT GROUP.—Soil suborders are divided into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus has accumulated; those that have pans that interefere with growth of roots, movement of water, or both; and thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is *Torripsamment* (*Torri* meaning hot and dry, *Psamm* for sand, and *ent* from Entisols).

SUBGROUP.—Great groups are divided into subgroups, one that represents the central (typic) segment of the group and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups can also be made in those instances where soil properties integrade outside of the range of any 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 *Typic Torripsamment* (a typical Torripsamment).

FAMILY.—Soil families are established within a subgroup primarily on the basis of properties important to the growth of plants or the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae (see table 7). An example is the Berino series in the fine-loamy, mixed, thermic family of Typic Haplargids.

Mechanical and Chemical Analysis

The limited data obtained by mechanical and chemical analyses of some selected soils in the White Sands Missile Range are shown in table 8. The profile of each of these soil series is described in the series description. The data in table 8 are useful to soil scientists in classifying soils and in developing concepts of soil genesis. They are also helpful in estimating available water capacity, water erosion, fertility, and tilth and in making various engineering interpretations and other practical soil management decisions.

The samples used to obtain the data in table 8 were collected from pits carefully selected to be representative of the soil material. All of the soil particles are finer than 2 millimeters in diameter. The data are reported on an ovendry basis.

Data in table 8 are based on the following standard United States Department of Agriculture soil survey laboratory procedures (7). Each of the procedures or methods used is designated by numbers and letters. For example, the method used to determine particle-size distribution is designated as 3A1.

Particle-size distribution.—Pipette method, disper-

TABLE 7.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Aladdin	Coarse-loamy, mixed, thermic	Torriorthentic Haplustolls	Mollisols.
Alicia high gypsum substratum variant	Fine-loamy, mixed, mesic	Typic Camborthids	Aridisols.
Berino	Fine-loamy, mixed, thermic	Typic Haplargids	Aridisols.
Bluepoint	Mixed, thermic	Typic Torripsamments	Entisols.
Deama	Loamy-skeletal, carbonatic, mesic	Lithic Calciustolls	Mollisols.
Dona Ana	Fine-loamy, mixed, thermic	Typic Haplargids	Aridisols.
Gilland	Loamy-skeletal, mixed, thermic	Ustollic Camborthids	Aridisols.
Glendale	Fine-silty, mixed (calcareous), thermic	Typic Torrifluvents	Entisols.
Holloman	Fine-loamy, gypsic, thermic, shallow	Typic Torriorthents	Entisols.
La Fonda	Fine-loamy, mixed, mesic	Ustollic Camborthids	Aridisols.
Lozier	Loamy-skeletal, carbonatic, thermic	Lithic Calciorthids	Aridisols.
Marcial	Fine, illitic, thermic	Typic Camborthids	Aridisols.
Mead	Fine, mixed, thermic	Typic Salorthids	Aridisols.
Mimbres	Fine-silty, mixed, thermic	Typic Camborthids	Aridisols.
Nickel	Loamy-skeletal, mixed, thermic	Typic Calciorthids	Aridisols.
Onite	Coarse-loamy, mixed, thermic	Typic Haplargids	Aridisols.
Oscura	Fine, mixed (calcareous), thermic	Ustic Torrifluvents	Entisols.
Pajarito	Coarse-loamy, mixed, thermic	Typic Camborthids	Aridisols.
Pinaleno	Loamy-skeletal, mixed, thermic	Typic Haplargids	Aridisols.
Pinaleno noncalcareous variant	Loamy-skeletal, mixed, thermic	Ustollic Haplargids	Aridisols.
Rance shallow variant	Fine-loamy, mixed, thermic, shallow	Typic Torriorthents	Entisols.
Russler	Fine-silty, mixed, thermic	Typic Camborthids	Aridisols.
Sonoita	Coarse-loamy, mixed, thermic	Typic Haplargids	Aridisols.
Sotim	Fine-loamy, mixed, thermic	Typic Calciorthids	Aridisols.
Tencee	Loamy-skeletal, carbonatic, thermic, shallow.	Typic Paleorthids	Aridisols.
Ubar	Fine, mixed, thermic	Typic Camborthids	Aridisols.
Wink	Coarse-loamy, mixed, thermic	Typic Calciorthids	Aridisols.
Yesum	Coarse-loamy, gypsic, thermic	Typic Gypsiorthids	Aridisols.

sion with hexametaphosphate and mechanical shaking. (3A1)

Electrical conductivity.—Electrical conductivity of the saturation extract in millimhos per centimeter at 25° C. (8A1a)

Ions in saturated extract.—Extraction by filtration of saturated paste:

Ca and Mg by atomic absorption. (6N1b; 601b)
Na and K by flame photometry. (6P1a; 6Q1b)
HCO_3 by acid titration. (6J1a)
Cl by Mohr titration. (6K1a)
SO_4 by EDTA titration. (6L1b)

Sodium-absorption ratio.—SAR equation. (5E)

Cation-exchange capacity.—Direct distillation using NH_4OAc. (5A6a)

Environmental Factors Affecting Soil Use

The White Sands Missile Range, formerly the White Sands Proving Ground, was established in 1945 (*8*). Initially it was 164,960 acres of military land and approximately 1,500,000 acres of co-use range. Management of the co-use range rested with the ownership. In 1950 the co-use contracts on the range proper were rescinded and the land was placed under the exclusive control of the military. A co-use range extension about 50 miles square was later added to the north end of the original range. It is known as the Range Extension.

The ownership and control of the land in the White Sands Missile Range were and remain diversified. Ownership resides mainly with the Federal Government and the State of New Mexico. Federal lands within the Missile Range are parts of the White Sands National Monument, the Jornada Experimental Range, the San Andres National Wildlife Refuge, and large segments of Public Domain (mainly the Taylor Grazing Act Lands).

On August 19, 1953, the Secretary of Defense declared that all land within the range proper was to be under the command, management, and operational responsibility of the Department of the Army. At about the same time, all Federal land within the range proper, except the National Monument, the Jornada Experimental Range, and the Wildlife Refuge, were withdrawn for military use. Land under exclusive control of the White Sands Missile Range, including couse of the Wildlife Refuge, the Jornada Experimental Range, and the National Monument, makes up some 2,168,727 acres.[6]

The White Sands Missile Range has two primary missions: to operate a National Missile Range and to test and evaluate Army missiles and rockets. No large-scale change in mission or land requirements is now anticipated.

Physiography, Drainage, and Water Supply

The area is cut from north to south by the San Andres, Organ, and Oscuro Mountain Ranges. White Sands National Monument lies within the area. The major part of the area lies within the landlocked Tularosa Basin, and a lesser part within the Jornada del Muerto Basin and several smaller closed basins. The mountain ranges make up approximately 35 percent of the area. About 80 percent of the drainage is into the Tularosa Basin, and the rest is into Jornada del Muerto Basin. Physiographic features located within the basins are intermittent lakes, gypsum sand dunes, intermountain valley slopes, and eolian deposits. Rock types within the area vary widely and consist of gypsum, sandstone, shale, limestone, basalt, and mixed acid igneous rocks.

Few water supplies within the White Sands Missile Range are of the quality that is usable for livestock, wildlife, or domestic use. These are limited to wells within built-up areas, a few isolated wells in the foothills for wildlife use, and a few springs. Water sources for livestock that had been developed by former ranchers prior to military use have since been abandoned. A large area of the Tularosa Basin has a shallow water table of poor quality. Some springs of poor-quality water also are within the basin. These waters are brackish and unfit for domestic and most animal use.

Climate [7]

Most of the White Sands Missile Range is in the closed Tularosa Basin, a nearly flat valley that is about 125 miles long from north to south and 25 to 40 miles wide. Elevation ranges from as low as 3,887 feet on the alkali flats of Lake Lucero to 8,958 feet at Salinas Peak in the mountains in the western part.

Southeasterly winds in the general circulation from over the Gulf of Mexico bring most of the moisture that falls over the eastern part of New Mexico. The Sacramento Mountains, which have peaks as high as 12,000 feet, east of the Range retard the winds and prevent much of the precipitation from reaching the Range. Average annual precipitation in the Tularosa Basin is light, less than 8 inches in the southeast and less than 9 inches in the west-central part of the Range. Average annual precipitation increases to about 16 inches at the higher elevations of the Range, generally increasing with increasing elevation. In the higher parts of the Sacramento Mountains, east of the range, annual average precipitation is more than 25 inches. The main source of winter precipitation is moisture from the eastward-moving storms from the Pacific Ocean. Much of this moisture is lost over the mountains to the west, and therefore winter is the dry season and generally has light precipitation.

The rainy season, from July to September, averages half the annual precipitation. On the average, the area has 42 thunderstorms a year, generally brief, but occasionally heavy and sometimes accompanied by hail. Precipitation varies widely from year to year and month to month. For example, at White Sands National Monument, it was 20.89 inches in 1941 and 2.80

[6] Acreage as calculated during the time of the soil survey. Some adjustments are being made from time to time according to ownership adjustments along border areas.

[7] By FRANK E. HOUGHTON, National Oceanic and Atmospheric Administration, climatologist for N. Mex.

TABLE 8.—*Mechanical and*

[Laboratory data by Dr. Klaus W.

Soil name, location, and number	Horizon	Depth	Texture	Particle-size distribution		
				Sand (2–0.05mm)	Silt (0.05–0.002mm)	Clay (<0.002mm)
		Inches		*Percent*	*Percent*	*Percent*
Marcial silty clay loam (modal): 2.2 miles southwest from Marcial site and Route 5 junction, on gravel road, south side of bar pit. (Sample No. 70 NM 28–9–2; Laboratory No. Calf. 32)	B2	6–38	Silty clay	3.5	48.6	47.9
Mead silt loam (modal): 3.2 miles south of Gun site and 0.6 mile east. (Sample No. 70 NM–27–59–3)	Clcs	5–48	Clay			
Ubar silt loam (modal): 0.45 mile south and 0.1 mile east of the intersection of Routes 7 and 13 on north side of Trail Road. (Sample No. 70 NM–27–55–3)	B22	13–30	Silty clay	4.7	55.2	40.1

inches in 1956. This same place had 9.68 inches in September 1941 and none in September 1959.

The greatest rainfall in a 24-hour period, as recorded by a weighing rain gauge, was 5.31 inches on September 21 to 22, 1941.

Snowfall at the lower elevations is generally light and seldom remains on the ground for more than a day. Annual average snowfall at White Sands National Monument is 2 inches, and at Bingham, on the Range extension, 8 inches. At Bingham, an average of less than 3 days a year have 1 inch or more snow cover, and the average depth on these days is 2 inches. At Hardin Ranch, the average snowfall is 19 inches for an 8-year period. Some winters go without snowfall. The greatest snowfall in a 1-month period ranges from 7 inches at White Sands National Monument to 24 inches at Hardin Ranch.

Table 9 illustrates the patterns of temperature and precipitation at White Sands National Monument. These are generally representative of the Range, except for the mountains.

Mean annual air temperature ranges from 62°F. in the south to 54° in the north. Moderately hot summers and mild winters are the general rule. Because the elevation is moderately high and the air is dry, the average diurnal temperature range is near 37°. On most days from mid-May to mid-September the temperature reaches 90°. Nighttime temperatures reach freezing on most nights from November to mid-March, but an average of only 1 day a year remains freezing, and an average of only 1 day a year reaches zero. Extreme temperatures on the Range have been 110° on July 8, 1951, and −25 on January 11, 1962. The probabilities of various threshold temperatures in spring and fall are shown in table 10. The average freeze-free period at White Sands National Monument is from late April to mid-October, 177 days or nearly 6 months.

The mountains to the east ward off many invasions of extremely cold air from the eastern plains. Radiational cooling at night and downward flow of cooled air along the mountain slopes into the basin result in some very low temperatures in winter.

Average annual sunshine is about 3,500 hours, or 80 percent of the possible amount, and is fairly evenly distributed throughout the year. Relative humidity is low. At White Sands Missile Range Headquarters, relative humidity in January ranges from 55 percent early in the morning to 32 percent late in the afternoon. In May, relative humidity ranges from 35 percent early in the morning to 15 percent in the hot afternoon. Average annual windspeed is 6.1 miles per hour and is stronger in spring and lighter in fall. The prevailing wind is from the west. Strongest gusts have been 82 miles per hour from the southwest. Evaporation, estimated from Class A pan measurements, averages 105 inches for the year. It is 67 inches from May to October.

Natural Resources and Transportation

Mining of natural resources within the area is restricted by military use. Various locations within the San Andres and Oscura Mountains were mined on a small scale or as exploratory prior to World War II. Minerals mined were zinc, gold, silver, and copper. Sand and gravel needed for construction are in plentiful supply in localized areas. The Tencee and Nickel soils have been the main sources.

Other natural resources include the world's largest gypsum deposits, known as "White Sands," from which the White Sands Missile Range got its name. Areas that have stands of oneseed juniper trees, at higher elevations to the north, supply quality fenceposts used in the area.

chemical analysis

Flack, SCS, Riverside, Calif.]

Electrical conductivity (Ec × 10³)	Extractable ions (Milliequivalents per liter of saturated extract)							Sodium-absorption rate	Cation-exchange capacity
	Ca	Mg	Na	K	HCO_3	CL	SO4		
Mmhos/cm at 25° C									*Meq/100 gm of soil*
29.9	49.7	44.7	349.0	2.1	1.8	320.0	86.1	51.0	
16.7	105.8	43.7	111.0	3.1	2.8	183.0	17.4	13.0	18.8

Quality water is limited within the White Sands Missile Range. Ground water is shallow in most of the Tularosa Basin. Although this water is brackish, it could be of good quality if it were desalinized. A desalinization plant is in operation at the Stallion Range Center at the northwest corner of the area.

Transportation throughout the area is limited to military traffic, except for U.S. Highway 70–82 across the southern part. The closest railroad to the White Sands Missile Range is through the Rio Grande Valley to the west and along the eastern side from El Paso, Texas through Alamogordo and Carrizozo, N. Mex.

TABLE 9.—*Temperature and precipitation*

[All data from White Sands National Monument, Otero County, N. Mex., 1939–68]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average monthly maximum	Average monthly minimum	Average monthly total	One year in 10 will have—		Average number of days with precipitation of—	
						Less than—	More than—	0.10 inch or more	0.25 inch or more
	°F	°F	°F	°F	*Inches*	*Inches*	*Inches*		
January	56	22	70	5	0.5	(1)	1.2	1	1
February	63	24	75	9	.3	(1)	.6	1	1
March	70	31	82	14	.3	(1)	.6	1	1
April	79	40	89	25	.3	(1)	.6	1	(2)
May	88	48	101	34	.3	(1)	.6	1	(2)
June	97	58	101	46	.6	(1)	1.1	2	1
July	97	64	105	56	1.4	0.4	2.8	3	2
August	95	62	102	55	1.3	.5	2.2	4	2
September	90	55	98	43	1.2	(1)	2.3	3	1
October	80	41	89	26	.7	(1)	1.4	2	1
November	67	27	78	12	.3	(1)	.8	1	(2)
December	58	22	70	6	.5	(1)	1.1	1	1
Year	78	41	[3] 106	[4] 0	7.7	4.5	10.0	21	11

[1] Less than 0.05 inch.
[2] Less than half a day.
[3] Average annual highest temperature.
[4] Average annual lowest temperature.

TABLE 10.—*Probability of last freezing temperatures in spring and first in fall*

[All data from White Sands National Monument, Otero County, N. Mex., 1949–68]

Probability	Dates for given probability and temperature						
	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	March 22	April 6	April 19	May 4	May 13	May 20	June 4
2 years in 10 later than	March 16	March 29	April 13	April 29	May 7	May 14	May 30
5 years in 10 later than	March 3	March 14	April 1	April 18	April 25	May 3	May 18
Fall:							
1 year in 10 earlier than	November 10	November 2	October 28	October 17	October 11	October 6	September 22
2 years in 10 earlier than	November 15	November 4	October 31	October 19	October 14	October 8	September 27
5 years in 10 earlier than	November 27	November 11	November 6	October 27	October 20	October 14	October 7

Farming and Industry

All farm and industrial uses are under military control. The Jornada Experimental Range along the western slope of the San Andres is the only area where grazing is permitted. In this area cattle are grazed in cooperation with the Agricultural Research Service.

All industry is military oriented. White Sands Missile Range currently employs about 4,000 civilian employees and has a military detachment of about 1,800 men.

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Glossary

Air-dry. To dry or dehumidify forage or hay by means of natural air movement, often in the open air.

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

Animal-unit month. The amount of forage or feed required to maintain one animal unit for a period of 30 days. Abbreviated: A.U.M.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

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. The terms used to describe available water capacity in this manuscript are:

High	More than 7.5 inches
Moderate	5 to 7.5 inches
Low	3.75 to 5 inches
Very low	Less than 3.75 inches

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface. Depth over bedrock is expressed as:

Very shallow	Less than 10 inches
Shallow	10 to 20 inches
Moderately deep	20 to 40 inches
Deep	More than 40 inches

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.

Cobblestone. 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.

Complex, soil. A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

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.

Coppice dunes. Mounds of eolian or wind-deposited material around desert shrubs; dunes average 3 to 8 feet in height.

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

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

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

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

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

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

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

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

Effective depth. The depth to which a soil is readily penetrated by roots and utilized for extraction of water and plant nutrients. Terms used to express effective depth are:

Very shallow	Less than 10 inches
Shallow	10 to 20 inches
Moderately deep	20 to 40 inches
Deep	Over 40 inches

Erosion. The wearing away of the land surface by running water, wind, ice, or other geological agents. The following terms are used to describe different kinds of erosion.

Accelerated erosion. Erosion which has been significantly increased by human activity or by domestic animals.

Geologic erosion. Erosion caused by the natural action of the geological agents upon the land surface. (Same as natural erosion.)

Sheet erosion. Erosion caused by water moving more or less uniformly over the land surface.

Gravel. Coarse fragments that are from 2 millimeters to 3 inches in size.

Ground cover. All herbaceous plants and low-growing shrubs in a forest.

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

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

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

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

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

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

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

Inherent fertility. The relative capacity of the soil to supply nutrients to growing plants without the addition of fertilizers or soil amendments.

Land type (as used in the vegetative section). An area of undifferentiated soils usually having little or no potential for vegetation or too steep for livestock.

Miscellaneous land type. A mapping unit for areas of land that have little or no natural soil; or that are too nearly inaccessible for orderly examination; or that occur where, for other reasons, it is not feasible to classify the soil.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Permeability. The rate at which water may penetrate or pass through a soil mass or soil horizon. These are as follows:

Very slow	Less than 0.06 in./hr.
Slow	0.06-0.20 in./hr.
Moderately slow	0.20-0.63 in./hr.
Moderate	0.63-2.0 in./hr.
Moderately rapid	2.0-6.3 in./hr.
Rapid	6.3-20.0 in./hr.
Very rapid	More than 20.0 in./hr.

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.

Pores. Space not occupied by soil particles or coarse fragments in a bulk volume of soil. Types of pores are:

Interstitial. Irregularly shaped pores that have faces that are curved inward; formed by curved or angular faces of adjacent mineral grains, peds, or both.

Tubular. Pores that are more or less cylindrical in shape and elongated in one direction.

Vesicular. Pores that are roughly spherical or ellipsoidal in shape and are not appreciably elongated in any direction.

Numbers of pores are expressed as:

Few	1 to 3 per square inch
Common	4 to 14 per square inch
Many	More than 14 per square inch

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

Range condition. The state of health or productivity of both soil and forage in a given range, in terms of what productivity could or should be under normal climate and the best practical management. Condition classes generally recognized are—*excellent*, *good*, *fair*, and *poor*. The classification is based on the percentage of original, or climax, vegetation on the site, as compared to what ought to grow on it if management were good.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind of climax vegetation.

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

Relief. The elevations or inequalities of a land surface, considered collectively.

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.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

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.

Slope class. Slope classes used in this survey are:

Percent	*Single slope*	*Complex slope*
0-1	Level	Nearly level
1-3	Nearly level	Gently undulating
3-5	Gently sloping	Undulating
5-9	Moderately sloping	Gently rolling
9-15	Strongly sloping	Rolling
15-30	Moderately steep	Hilly
30-50	Steep	Steep
50-80	Very steep	Very steep

Soil variant. A soil having properties sufficiently different from those of other known soils to suggest establishing a new soil series, but a soil of such limited known area that creation of a new series is not believed to be justified.

Stones. Rock fragments greater than 10 inches in diameter if rounded, and greater than 15 inches along the longer axis if flat.

Stratified. Composed of, or arranged in, strata, or layers, such as stratified alluvium. The term is confined to geological material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

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).

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.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their usefulness or behavior.

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.

Value. As related to color; the relative lightness or intensity of color.

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

GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. For information on vegetative groups and range sites and also on wildlife, see "Range and Wildlife," page 50. Other information is given in tables as follows:

Acreage and extent, table 1, page 3.

Engineering, tables 2, 3, and 4, pages 32 through 49.

Map symbol	Mapping unit	Page	Capability subclass	Vegetative group
AC	Active dune land, gypsum	3	VIIIe	5
AD	Aladdin association	4	VIIe	7
BD	Berino-Dona Ana association	5	VIIe	3
DO	Deama-Rock outcrop complex	7	VIIs	9
DP	Dona Ana-Pajarito-Bluepoint association	8	VIIe	3
DU	Dune land-Dona Ana complex	8	VIIe	3
DY	Dune land-Yesum association	8	-----	4
	Dune land	--	VIIIe	--
	Yesum soil	--	VIIe	--
GR	Gilland-Rock outcrop complex	9	VIIe	9
GS	Gypsum land, hummocky	11	VIIe	4
GU	Gypsum land, level	11	VIIIs	6
GV	Gypsum rock land	11	-----	9
	Gypsum rock land	--	VIIIs	--
	Rance shallow variant	--	VIIe	--
LA	La Fonda association	14	VIe	9
LF	Lava flows	14	VIIIs	12
LR	Lozier-Rock outcrop complex	15	VIIs	11
MA	Marcial-Ubar association	17	VIIe	2
ME	Mead silt loam	18	VIIIs	2
MG	Mimbres-Glendale association	19	VIIe	1
NT	Nickel-Tencee association	19	VIIe	8
OB	Onite-Bluepoint-Wink association	21	VIIe	3
OS	Oscura silty clay	22	VIIe	1
RK	Rock land, cool	24	VIIIs	9
RL	Rock land, warm	25	VIIIs	10
SH	Shale rock land	26	VIIIs	9
SP	Sonoita-Pinaleno-Aladdin association	27	VIIe	7
SR	Sotim-Russler association	27	VIIe	1
TC	Tencee-Nickel association, gently sloping	28	VIIe	8
TK	Tencee-Nickel association, steep	28	VIIe	8
YE	Yesum very fine sandy loam	30	VIIe	4
YH	Yesum-Holloman association	30	VIIe	4

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