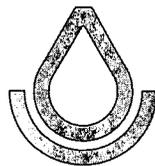


SOIL SURVEY OF

Washington County Area, Utah



**United States Department of Agriculture
Soil Conservation Service and
United States Department of the Interior
Bureau of Land Management and
National Park Service**

In cooperation with

Utah Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experimental 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 1967-71. Soil names and descriptions were approved in 1971. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1971. This survey was made cooperatively by the Soil Conservation Service; the Bureau of Land Management; the National Park Service, which contributed funds for the soil survey of Zion National Park; and the Utah Agricultural Experiment Station. It is part of the technical assistance furnished to the Dixie Soil Conservation District.

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

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

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

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

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

Farmers and those who work with farmers can learn about use and management of the soils from the section "Crops and Pasture," from the soil descriptions, and from the descriptions of the capability units.

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

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

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

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

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

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

Newcomers to the survey area will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They will also be interested in the section "Additional Facts about the Area."

Cover: View of a fork of the Virgin River from Potato Hollow looking east in Zion National Park. Rock outcrop is in the upper part of the picture, and Stony colluvial land is below.

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SOIL SURVEY OF WASHINGTON COUNTY AREA, UTAH

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, AND UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF LAND MANAGEMENT AND NATIONAL PARK SERVICE, IN COOPERATION WITH UTAH AGRICULTURAL EXPERIMENT STATION

WASHINGTON COUNTY AREA (fig. 1) consists of most of Washington County, a small part of Kane County, a small part of Iron County in the New Harmony area, and Zion National Park; the Forest Service lands in Pine Valley and the Bull Valley Mountains are not included. The survey area is bordered by the State of Nevada on the west and the State of Arizona on the south.

The survey area covers about 1,076,400 acres, or 1,682 square miles. About 18,300 acres is used for irrigated crops; 15,400 acres, for nonirrigated crops; and the rest, for range, recreation, wildlife habitat, and watershed.

The survey area is drained by the Virgin River and its tributaries, Santa Clara Creek, Ash Creek, La Verkin

Creek, North Creek, Coalpits Wash, Goulds Wash, and the Beaver Dam Wash. The nearly level to gently sloping flood plains and alluvial fans along these streams are the major areas used for irrigated farming. The soils in these areas are used for alfalfa, small grain, sugar beet seed, sorghum for silage, and milo.

The major nonirrigated areas are on the Big Plain and Smith Mesa and in the New Harmony area.

The topography ranges from nearly level bottom land to very steep mountains and nearly vertical cliffs. Elevation ranges from about 2,500 to 8,200 feet.

St. George is the county seat of Washington County and is the largest city in the survey area. Other communities in the survey area are Hurricane, Washington, Santa Clara, Springdale, Rockville, Virgin, La Verkin, Toquerville, Pintura, Veyo, Gunlock, New Harmony, Ivins, Leeds, and Central.

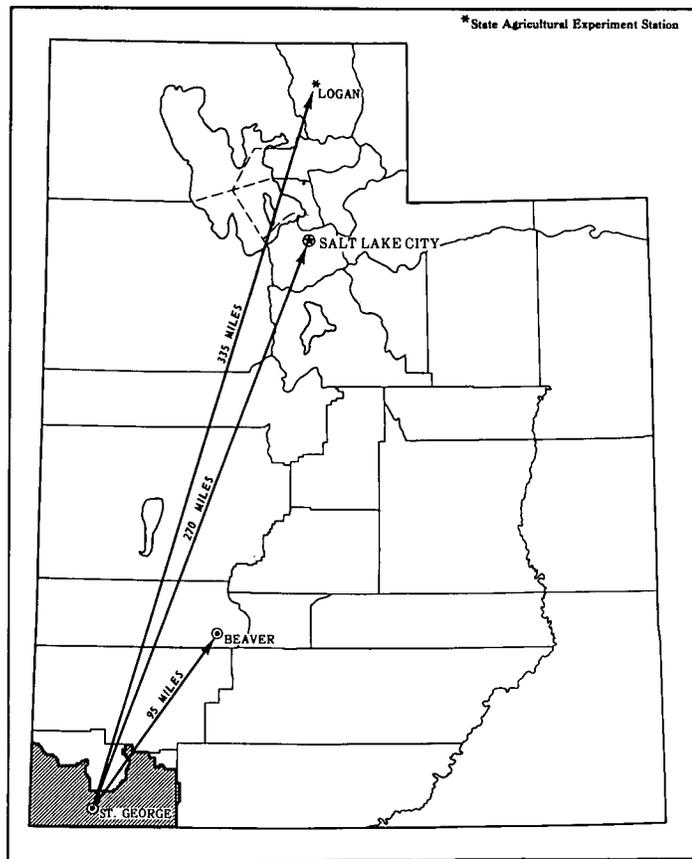


Figure 1.—Location of Washington County Area in Utah.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in the Washington County Area, where they are located, and how they can be used. The soil scientists went into the county 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 size and speed of streams; the kinds of native plants or crops; 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 counties 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. All the soils of one series have major horizons that are

¹ Also contributing to the preparation of the survey were MARVIN L. BARNEY, EARL H. JENSEN, JUNGI SHIOZAKI, and WOODROW NIELSON, Soil Conservation Service.

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. Kolob and Motoqua, 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, Leeds silty clay loam, 0 to 1 percent slopes, is one of several phases within the Leeds series.

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

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

Some mapping units are made up of soils of different series or of different phases within one series. Two such kinds of mapping units are shown on the soil map of the Washington County Area, soil complexes and soil associations.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Dagflat-Motoqua complex, 30 to 70 percent slopes, is an example.

A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the 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. Kolob-Detra association is an example.

Also mapped in the survey area are soils that are classified at a higher level in the system of soil classification. An example is Fluvaquents and Torrifluvents, sandy. These soils are classified at the great group level.

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

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory analyses and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated 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, and they relate this failure to slow permeability or to a high water table. They see that streets, road pavements, and foundations for houses 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 farmers, 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.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in the Washington County Area. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and is named for the major soils or land types. The soils in one association may occur in another, but in a different pattern. Other kinds of soil are present in each soil association but are not extensive enough to be included in the name.

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

The soil associations in this survey area have been grouped into four general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations in each group are described in the following pages. The terms for texture used in the title for several of the associations apply to the texture of the surface layer. For example, in the title of association 1, the words "fine sandy loam and silty clay loam" refer to the texture of the surface layer.

Dominantly Well Drained and Somewhat Excessively Drained, Nearly Level to Steep, Shallow to Deep Soils; on Alluvial Fans, Flood Plains, Mesas, and Mountains

The soils in this group are on alluvial fans, flood plains, mesas, and mountains. Elevation ranges from 2,400 to 4,200 feet. Average annual precipitation ranges from 6 to 11 inches, average annual temperature ranges from 57° to 67° F, and the frost-free period ranges from 190 to 205 days. The soils are used mainly for irrigated crops, range, and wildlife habitat.

Four of the associations in Washington County Area are in this group. They make up about 24 percent of the survey area.

1. Tobler-Harrisburg-Junction association

Well-drained, nearly level to moderately steep, moderately deep and deep fine sandy loams and silty clay loams, on alluvial fans, flood plains, and mesas

This association is in the south-central part of the survey area. It is in several areas near St. George, Washington, Hurricane, and Warner Valley. Slopes are dominantly 1 to 5 percent but range to 20 percent. The soils formed mainly in alluvium and in residuum weathered from sandstone and shale.

The native vegetation is mainly creosotebush, blackbrush, Mormon tea, galleta, Indian ricegrass, filaree, and cactus. Willows, sedges, wiregrass, and cattails grow in some areas along the Virgin River. Elevation is 2,500 to 3,500 feet. The climate is arid. Average annual precipitation is 8 to 11 inches, the average annual temperature is 57° to 67° F, and the frost-free period is 190 to 195 days.

This association makes up about 7 percent of the survey area. It is about 20 percent Tobler soils; 15 percent Harrisburg soils; 10 percent each of Junction, Nikey, and St. George soils; and 35 percent the minor La Verkin, Leeds, Hobog, Isom, Hantz, and Vekol soils; Fluvaquents and Torrifluvents, sandy; and Rock land.

Tobler soils are on alluvial fans and flood plains. They are deep soils that commonly are red fine sandy loam to a depth of 5 feet or more. In some areas they are stratified with loamy fine sand, and in others they have a surface layer of silty clay loam.

Harrisburg soils are on desert mesas. They are moderately deep soils that consist of yellowish-red fine sandy loam underlain by an indurated, carbonate-cemented hardpan between depths of 24 and 40 inches.

Junction soils are on alluvial fans and flood plains. They are deep, red fine sandy loam soils that contain crystals of gypsum in horizons below the surface layer.

This association is used mainly for irrigated crops. The chief crops are alfalfa, small grain, milo, sorghum for silage, pasture, and sugar beet seed. Some areas are used for range and urban developments.

2. Winkel-Rock land association

Well-drained, gently sloping to steep, shallow gravelly fine sandy loams and Rock land; on mesas and mountains

This association is in the central part of the survey area. It is on the eastern side of the Beaver Dam Mountains, west of Hurricane, and near St. George.

The native vegetation is mainly creosotebush, blackbrush, Mormon tea, galleta, and cactus. Elevation is 2,800 to 4,000 feet. The climate is arid. Average annual precipitation is 8 to 11 inches, the average annual temperature is 57° to 67° F, and the frost-free period is 190 to 195 days.

This association makes up about 5 percent of the survey area. It is about 40 percent Winkel soils, 30 percent Rock land, and 30 percent the minor Bermesa, Hobog, and Renbac soils.

Winkel soils formed in material weathered from basalt and limestone and mixed with sandy eolian material. They are on mesas and lower mountain side slopes. They are shallow, well-drained soils that have a surface layer of reddish-brown gravelly fine sandy loam. An indurated carbonate-cemented hardpan is at a depth of 11 to 19 inches.

Rock land consists mainly of outcrops of basalt and limestone intermingled with small areas of very shallow soils that are underlain by basalt or limestone bedrock.

This association is used mainly for range and wildlife habitat.

3. Pintura-Toquerville-Dune land association

Somewhat excessively drained, gently sloping to moderately steep, shallow to deep loamy fine sands and fine sands and Dune land; in valleys and on mountains

This association is on Sand Mountain, near Ivins, in Warner Valley, and in several smaller areas north of Washington and northwest of La Verkin. Slopes are dominantly 1 to 10 percent but range to 20 percent. The soils formed in eolian sand deposits.

The native vegetation is mainly sand sage, creosotebush, blackbrush, Indian ricegrass, galleta, and cholla cactus. The Dune land part is essentially barren. Elevation is 2,600 to 4,000 feet. The climate is arid. Average annual precipitation is 8 to 11 inches, the average annual temperature is 57° to 67° F, and the frost-free period is 190 to 195 days.

This association makes up about 4 percent of the survey area. It is about 60 percent Pintura soils, 10 percent Toquerville soils, 10 percent Dune land, and 20 percent the minor Tobler and Ivins soils and Rock land.

Pintura soils are on mountain side slopes and in valleys. They are deep, somewhat excessively drained, reddish-yellow loamy fine sand.

Toquerville soils are on mountain side slopes. They are shallow, somewhat excessively drained, reddish-yellow fine sand and are underlain by sandstone at a depth of about 8 to 20 inches.

Dune land is actively shifting sand dunes intermingled throughout the association.

This association is used mainly for range and as wildlife habitat for small desert animals.

4. Cave association

Well-drained, gently sloping to steep, shallow gravelly sandy loams; on alluvial fans

This association is in the western part of the survey area along both sides of the Beaver Dam Wash. Slopes are mainly 7 to 15 percent but range from 2 to 30 percent. The soils formed in alluvium washed from mixed sedimentary and igneous rocks.

The native vegetation is mainly creosotebush, blackbrush, bursage, Mormon tea, desert almond, galleta, cheat-

grass, cactus, and Joshua-tree. Elevation is 2,400 to 4,200 feet. The climate is arid. Average annual precipitation is 6 to 10 inches, the average annual temperature is 57° to 67°F, and the frost-free period is 190 to 205 days.

This association makes up about 8 percent of the survey area. It is about 95 percent Cave soils and 5 percent Riverwash and Rough broken land.

Cave soils are on old coalescing alluvial fans. They are shallow, well-drained, brown gravelly sandy loam that is 8 to 20 inches deep over an indurated, carbonate-cemented hardpan.

This association is used for range and wildlife habitat.

Dominantly Rock outcrop, Rock land, and Badland and Well Drained or Somewhat Excessively Drained, Gently Sloping to Very Steep, Shallow and Moderately Deep Soils; in Desert Basins and on Uplands

The soils of this group are in desert basins and on uplands. Elevation ranges from 2,600 to 7,000 feet. The average annual precipitation ranges from 8 to 14 inches, average annual temperature ranges from 52° to 59°F, and the frost-free period ranges from 160 to 195 days. These soils are used mainly for esthetic purposes, range, and wildlife habitat.

Four of the associations in Washington County Area are in this group. They make up about 40 percent of the survey area.

5. Badland-Eroded land association

Rolling to very steep Badland and Eroded land; in desert basins and on uplands

This association is mostly west and south of St. George and north and south of Virgin. It is also in smaller areas in the upper Pahcoon area and east of Washington. It consists of rolling, dissected, eroded areas of exposed shale and siltstone. Slopes range from 5 to 70 percent.

The native vegetation is very sparse. It is a mixture of creosotebush, desert almond, cholla cactus, pricklypear, and annual grasses. Elevation is 2,600 to 5,000 feet. The climate is arid. Average annual precipitation is 8 to 11 inches, and the frost-free period is 170 to 195 days. Most of the precipitation runs off, carrying large amounts of sediment.

This association makes up about 11 percent of the survey area. It is about 70 percent Badland, 15 percent Eroded land, and 15 percent the minor Junction, Schmutz, and Shalet soils and Stony colluvial land.

Badland is nearly bare, is rolling to very steep, and consists of varicolored beds of eroded shale and layers of gypsum. Some areas of Badland are capped with sandstone or conglomerate. Erosion is active, and runoff is very rapid.

Eroded land is rolling. It consists of stratified shale beds that contain gypsum. Erosion is active.

This association is used only by artists, photographers, and tourists vacationing in the survey area.

6. Bond-Rock land association

Well-drained, gently sloping to strongly sloping, shallow sandy loams and Rock land; on mesas

The association is mostly on Little Creek Mountain and Gooseberry Mesa. Smaller areas are on Smith Mesa and north of Rockville. Slopes range from 1 to 10 percent.

The native vegetation is galleta, Indian ricegrass, bitterbrush, big sagebrush, Utah juniper, and pinyon pine. Elevation is 4,500 to 6,000 feet. The climate is semiarid. Average annual precipitation is 12 to 14 inches, the average annual temperature is 56° to 59°F, and the frost-free period is 160 to 170 days.

This association makes up about 3 percent of the survey area. It is about 80 percent Bond soils, 10 percent Rock land, and 10 percent the minor Clovis and Redbank soils, Rock outcrop, and Cinder land.

Bond soils are on mesas. They formed in material weathered from conglomerate and sandstone. They have a surface layer of reddish-brown sandy loam and a subsoil of reddish-brown or yellowish-red gravelly sandy clay loam. Conglomerate bedrock is at a depth of 10 to 20 inches.

Rock land is on ridges and strongly sloping breaks on the edges of the association.

This association is used for range and wildlife habitat. Mule deer and many smaller animals inhabit areas of this association, particularly during winter.

7. Rock land-Mathis association

Somewhat excessively drained, steep and very steep Rock land and moderately deep very stony loamy fine sands; on uplands

This association is mostly in an area near Rockville and Springdale. A smaller part is in the breaks south and east of Smith Mesa. Slopes are 20 to 70 percent.

The native vegetation is mostly galleta, black grama, Indian ricegrass, big sagebrush, bitterbrush, Utah juniper, and pinyon pine. Elevation is 4,000 to 5,500 feet. The climate is semiarid. Average annual precipitation is 12 to 14 inches, the average annual temperature is 52° to 56°F, and the frost-free period is 165 to 170 days.

This association makes up about 5 percent of the survey area. It is about 60 percent Rock land, 30 percent Mathis soils, and 10 percent mostly the minor Tacan soils, Stony colluvial land, Rock outcrop, and Eroded land.

Rock land consists of areas of Rock outcrop and stony and bouldery, very shallow soils that have slopes of dominantly 30 to 70 percent. Some nearly vertical sandstone cliffs occur in this association.

Mathis soils are on mountain side slopes. They formed in material weathered from sandstone. They have a surface layer of reddish-brown very stony loamy fine sand and underlying material of light reddish-brown very gravelly loamy sand and pink very gravelly fine sand. Bedrock is at a depth of 20 to 40 inches.

This association is used mainly for wildlife habitat and to a limited extent for range.

8. Rock outcrop-Rock land association

Gently sloping to very steep bare bedrock, and very shallow soils over bedrock; in desert basins and on uplands

This association is mostly northwest, southwest, and north of St. George; in the southeastern part of the survey area; and in the area of Zion National Park. Slopes range from 2 percent to nearly vertical cliffs.

This association is mainly barren. Elevation is 2,600 to

7,000 feet.

This association makes up 21 percent of the survey area. It is about 60 percent Rock outcrop, 35 percent Rock land, and 5 percent Cinder land and Lava flows.

Rock outcrop consists of areas of exposed bedrock, mainly sandstone, limestone, conglomerate, and basalt.

Rock land is 60 to 80 percent Rock outcrop and 20 to 40 percent very shallow soils that are underlain by bedrock at a depth of 1 inch to 8 inches.

This association is used mainly for esthetic purposes. It is of interest to tourists, artists, and photographers.

Dominantly Well Drained to Excessively Drained, Nearly Level to Steep, Shallow to Deep Soils; on Alluvial Fans, Mesas, Plateaus, and Valley Bottoms

The soils in this group are on alluvial fans, mesas, and plateaus and on valley bottoms. Elevation ranges from 3,300 to 6,300 feet. Average annual precipitation ranges from 10 to 15 inches, average annual temperature ranges from 45° to 59°F, and the frost-free period ranges from 120 to 170 days. The soils are used mainly for wildlife habitat, recreation, nonirrigated crops, and range.

Three of the associations in Washington County Area are in this group. They make up about 19 percent of the survey area.

9. Naplene-Redbank-Schmutz association

Well-drained, nearly level to sloping, deep silt loams, fine sandy loams, or loams; on alluvial fans, flood plains, and stream terraces

This association is mostly on the Big Plain. Smaller areas are near Virgin and Rockville, on Smith Mesa, east of New Harmony, near Central, and in Diamond Valley. Slopes are dominantly 0 to 6 percent. Most of the soils formed in alluvium washed from sedimentary and igneous rocks.

The native vegetation is mostly galleta, Indian ricegrass, squirreltail, sand dropseed, big sagebrush, globemallow, and scattered Utah juniper and pinyon pine. Elevation is 3,300 to 5,500 feet. The climate is semiarid or dry subhumid. Average annual precipitation is 10 to 15 inches, the average annual temperature is 45° to 59°F, and the frost-free period is 140 to 170 days.

This association makes up about 8 percent of the survey area. It is about 15 percent Naplene soils; 15 percent Redbank soils; 10 percent each of Schmutz soils and Palma soils; 5 percent each of the minor Clovis, Spenco, Lavate, and Caval soils; and 30 percent the minor Ildefonso and Springerville soils, Eroded land, Badland, and Stony colluvial land.

Naplene soils are on alluvial fans and stream terraces. They are deep, well-drained, dominantly brown and reddish-brown silt loams.

Redbank soils are on alluvial fans and flood plains, dominantly on the Big Plain. They are deep, well-drained soils that have a surface layer of yellowish-red fine sandy loam and underlying material of red or yellowish-red fine sandy loam and yellowish-red loam.

Schmutz soils are on alluvial fans and in valley bottoms of the uplands, mainly on the Big Plain. They are deep,

well-drained loams that have a high amount of gypsum.

This association is used for range, wildlife habitat, recreation, and nonirrigated crops. The main crop is wheat, and it is commonly grown in a crop-fallow rotation. Mule deer winter on the soils in this association.

10. Mespun-Rock land association

Excessively drained, nearly level to strongly sloping, deep fine sands and Rock land; on alluvial fans, in mountain valleys, and on plateaus

This association is in areas north of Leeds, east of Zion National Park, and near Shivwits and Gunlock. Slopes range from 0 to 10 percent, and in places the topography is slightly hummocky. The soils formed in eolian sand.

The native vegetation is sand sage, Mormon tea, snake-weed, desert marigold, Indian ricegrass, black grama, galleta, Utah juniper, and pinyon pine. Elevation is 3,500 to 6,240 feet. The climate is semiarid and dry subhumid. Average annual precipitation is 11 to 15 inches, the average annual temperature is 54° to 59°F, and the frost-free period is 120 to 170 days.

This association makes up about 2 percent of the survey area. It is about 60 percent Mespun soils, 15 percent Rock land, and 25 percent mostly the minor Caval and Redbank soils and Rock outcrop.

Mespun soils are on alluvial fans, in mountain valleys, and on plateaus. They are deep, excessively drained, reddish-yellow fine sand.

Rock land consists of areas of Rock outcrop and very shallow, sandy soils that are underlain by sandstone bedrock.

This association is used for wildlife habitat, recreation, and range.

11. Curhollow-Pastura-Magotsu association

Well-drained, gently sloping to steep, shallow gravelly fine sandy loams, gravelly loams, and very cobbly loams; on mesas, alluvial fans, and mountains

This association is mostly in the area of Veyo and Central. Other parts are along the east slopes of the West Mountains and in a narrow band above the Hurricane fault east of Hurricane. Slopes are dominantly 2 to 30 percent. The soils formed mainly in residuum or alluvium derived from basalt and a mixture of sedimentary and igneous rocks. Most of the soils have an indurated carbonate-cemented hardpan at a depth of 10 to 20 inches.

The native vegetation is dominantly big sagebrush, blackbrush, cliffrose, Indian ricegrass, galleta, and scattered Utah juniper and pinyon pine. Elevation is 3,500 to 6,300 feet. The climate is semiarid or arid. Average annual precipitation is 10 to 13 inches, the average annual temperature is 46° to 59°F, and the frost-free period is 155 to 170 days.

This association makes up 9 percent of the survey area. It is about 20 percent Curhollow soils; 20 percent Pastura soils; 15 percent Magotsu soils; 5 percent each of the minor Veyo, Yaki, Shalet, and Zukan soils; and 25 percent the minor Clovis and Esplin soils, Eroded land, Gullied land, Cinder land, Rock land, and Rock outcrop.

Curhollow soils are on old alluvial fans and mountain side slopes. They are shallow, well-drained soils. These soils have a surface layer of brown gravelly fine sandy loam and underlying material of light-brown gravelly loam

or very gravelly fine sandy loam. A carbonate-cemented hardpan is at a depth of 10 to 20 inches.

Pastura soils are on basalt flow mesas. They are shallow, well-drained, brown gravelly loams that have an indurated, carbonate-cemented hardpan at a depth of 10 to 20 inches.

Magotsu soils are on basalt flow mesas. They are shallow, well-drained soils that have a surface layer of dark-brown very cobbly loam and a subsoil of dominantly clay. An indurated, carbonate-cemented hardpan is at a depth of 10 to 20 inches.

This association is used mainly for range and wildlife habitat. Some small areas are used for crops.

Dominantly Well Drained or Somewhat Excessively Drained, Nearly Level to Very Steep, Shallow to Deep Soils; on Mountains and Fans

The soils in this group are on mountains and fans. Elevation ranges from 3,700 to 8,000 feet. Average annual precipitation ranges from 12 to 18 inches, average annual temperature ranges from 42° to 56°F, and the frost-free period ranges from 70 to 170 days. These soils are used mainly for range, recreation, and wildlife habitat.

Four of the associations in Washington County Area are in this group. They make up about 17 percent of the survey area.

12. Motoqua-Quazo-Dagflat association

Well-drained, very steep, shallow and moderately deep very gravelly sandy loams, very cobbly coarse sandy loams, and very cobbly or very gravelly sandy loams; on mountains

This association is mainly in the northwestern corner of the survey area. Smaller areas are on West Mountain and north of New Harmony. Slopes are dominantly 30 to 50 percent but range from 30 to 70 percent. The soils formed mainly in material weathered from acid igneous rocks.

The native vegetation is tall native bluegrass, Indian ricegrass, big sagebrush, serviceberry, bitterbrush, live oak, Utah juniper, and pinyon pine. Elevation is 3,700 to 6,700 feet. The climate is semiarid and dry subhumid. Average annual precipitation is 12 to 15 inches, the average annual temperature is 45° to 56°F, and the frost-free period is 120 to 170 days.

This association makes up about 6 percent of the survey area. It is about 40 percent Motoqua soils, 25 percent Quazo soils, 15 percent Dagflat soils, and 20 percent mostly the minor Mokiak and Nehar soils, Rock land, and Rock outcrop.

Motoqua soils are mainly on north- and east-facing mountain side slopes. They are shallow, well-drained soils that have a surface layer of dark-brown very gravelly or very cobbly sandy loam and a subsoil of dark-brown gravelly loam and brown or dark-brown very gravelly sandy clay loam. Bedrock is at a depth of 8 to 20 inches.

Quazo soils are on south- and west-facing mountain side slopes. They are shallow, well-drained soils that have a surface layer of brown very gravelly sandy loam and a subsoil of brown or reddish-brown gravelly sandy clay loam.

Bedrock is at a depth of 11 to 20 inches.

Dagflat soils are on north- and east-facing, steep mountain side slopes. They are moderately deep, well-drained soils that have a surface layer of dark reddish-gray very cobbly coarse sandy loam and a subsoil of reddish-brown coarse sandy clay loam or coarse sandy loam. Bedrock is at a depth of 21 to 40 inches.

This association is used for range and wildlife habitat.

13. Welring-Tortugas-Rock outcrop association

Well drained and somewhat excessively drained, steep and very steep, shallow very gravelly loams and Rock outcrop; on mountains

This association is in the western part of the survey area, in two areas on West Mountain. Slopes are dominantly 20 to 50 percent but range from 20 to 70 percent. The Welring and Tortugas soils formed in material weathered from limestone.

The native vegetation is dominantly tall native bluegrass, Indian ricegrass, galleta, three-awn, big sagebrush, Utah juniper, and pinyon pine. Elevation is 4,600 to 6,900 feet. Average annual precipitation is about 14 inches, the average annual temperature is 47° to 56°F, and the frost-free period is 120 to 160 days.

This association makes up about 3 percent of the survey area. It is about 35 percent Welring soils, 25 percent Tortugas soils, 25 percent Rock outcrop, and 15 percent mostly the minor Chilton and Motoqua soils and Rock land.

Welring soils are on mountain side slopes. They are shallow, well-drained, brown very gravelly loams that are underlain by limestone bedrock at a depth of 10 to 20 inches.

Tortugas soils are on mountain side slopes. They are shallow, somewhat excessively drained, brown very gravelly loams that are underlain at a depth of 10 to 20 inches by limestone bedrock.

Rock outcrop consists mainly of areas of nearly bare exposures of limestone rock.

This association is used for wildlife habitat and range.

14. Collbran-Tacan-Nehar association

Well-drained, gently sloping to very steep, deep very cobbly clay loams and very stony sandy loams; on mountains, hills, and alluvial fans

This association is mainly in the areas near New Harmony and Pinto. Smaller areas are west of Gunlock, on the upper part of Grapevine Wash, and near Veyo. Slopes are dominantly 2 to 30 percent but range from 2 to 70 percent. The soils formed mainly in alluvium and colluvium derived from a mixture of igneous and sedimentary rock.

The native vegetation is Indian ricegrass, mountain brome, bitterbrush, big sagebrush, live oak, blackbrush, Utah juniper, and pinyon pine. Elevation is 4,200 to 6,300 feet. The climate is semiarid and dry subhumid. Average annual precipitation is 13 to 15 inches, the average annual temperature is 45° to 48° F, and the frost-free period is 120 to 160 days.

This association makes up about 4 percent of the survey area. It is about 20 percent Collbran soils; 15 percent Tacan soils; 15 percent Nehar soils; 10 percent each of the minor Tobish soils, Stony colluvial land, and Rock outcrop; and 20

percent mostly the minor Chilton, Magotsu, Motoqua, Menefee, and Quazo soils and Rock land.

Collbran soils are on mountain side slopes. They are deep, well-drained soils that have a surface layer of brown very cobbly clay loam and a subsoil of dark-brown or reddish-brown clay or clay loam.

Tacan soils are on mountain side slopes. They are deep, well-drained soils that have a surface layer of reddish-brown very stony sandy loam and a subsoil of red very gravelly fine sandy clay loam.

Nehar soils are on alluvial fans and rolling hills. They are deep, well-drained soils that have a surface layer of brown very stony sandy loam and a subsoil of reddish-brown stony clay, yellowish-red stony sandy clay, and yellowish-red very stony sandy clay loam.

This association is used for range, recreation, and wildlife habitat.

15. Paunsaugunt-Kolob-Dalcan association

Somewhat excessively drained and well drained, nearly level to very steep, shallow to deep gravelly silt loams, fine sandy loams, and cobbly loams; on mountains

This association is mainly in the mountain area of Zion National Park. Smaller areas are on Kanarra Mountain and West Mountain. Slopes are dominantly 5 to 30 percent but range from 0 to 60 percent. The Paunsaugunt, Kolob, and Detra soils formed in material weathered dominantly from limestone. The Dalcan soils formed in material weathered from basalt.

The native vegetation is dominantly brome grass, Kentucky bluegrass, slender wheatgrass, Gambel oak, big sagebrush, serviceberry, squawapple, snowberry, pinyon pine, juniper, and ponderosa pine. Elevation is 6,000 to 8,000 feet. The climate is moist subhumid or dry subhumid. Average annual precipitation is 16 to 18 inches, the average annual temperature is 42° to 50° F, and the frost-free period is 70 to 120 days.

This association makes up about 4 percent of the survey area. It is about 25 percent Paunsaugunt soils, 20 percent Kolob soils, 10 percent each of Dalcan soils and Detra soils, and 35 percent the minor Kinesava and Hogg soils, Kolob variant soils, Paunsaugunt variant soils, and Rock outcrop.

Paunsaugunt soils are on mountain side slopes. They are shallow, somewhat excessively drained soils. The surface layer is dark grayish-brown gravelly silt loam, and the subsurface layer is dark grayish-brown very gravelly loam. Limestone bedrock is at a depth of 10 to 19 inches.

Kolob soils are on mesa tops and on mountain side slopes. They are deep, well-drained soils that have a surface layer of dark-brown fine sandy loam and a subsoil of dark-brown and reddish-brown clay loam and gravelly and very gravelly clay loam. Bedrock is at a depth of 40 to 60 inches.

Dalcan soils are on lava flows on mountain foot slopes. They are moderately deep, well-drained soils that have a surface layer of dark-brown cobbly loam and a subsoil of dark-brown cobbly silty clay loam and very cobbly clay loam and brown very cobbly clay. Basalt bedrock at is a depth of 21 to 34 inches.

This association is used for range, wildlife habitat, and recreation.

Descriptions of the Soils

This section describes the soil series and mapping units in the Washington County Area. Each soil series is described in considerable 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, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of the soils. Unless otherwise stated, the colors given in the descriptions are those of a dry soil. 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 for the series, the differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made," not all mapping units are in a soil series. Badland, 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 detailed soil map. Listed at the end of each description of a mapping unit are the capability unit symbol and the names of the range site and wildlife suitability group to which the mapping unit has been assigned. The pages for the descriptions of each capability unit and range site to which each soil has been assigned can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The approximate 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 end of the survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (12).²

Badland

Badland (BA) consists of nearly barren, multicolored beds of actively eroding shale, shale interbedded with sandstone, and shale interbedded with layers of gypsum. The landscape is rolling and severely dissected, and channels of intermittent streams form a branching pattern.

Included with this land type in mapping are small areas of shallow soils in drainageways.

Runoff is very rapid. The sediment potential is high during intense thunderstorms in summer.

Badland supports only a sparse stand of vegetation. It is used mainly for esthetic purposes. Capability unit VIII_s-3, nonirrigated; wildlife suitability group 4444; range site not assigned.

² Italic numbers in parentheses refer to Literature Cited, p. 135.

TABLE 1.—Approximate acreage and proportionate extent of soils

Soil	Acres	Percent	Soil	Acres	Percent
Badland -----	43,600	4.0	Naplene silt loam, 2 to 6 percent slopes -----	12,400	1.2
Badland, very steep -----	46,800	4.4	Nehar very stony sandy loam, 3 to 30 percent slopes -----	5,090	.5
Bermesa fine sandy loam, 1 to 10 percent slopes -----	3,445	0.3	Nehar-Ildefonso complex, 3 to 30 percent slopes -----	3,020	.3
Bermesa-Rock land association -----	675	.1	Nikey sandy loam, 1 to 3 percent slopes -----	880	.1
Bond sandy loam, 1 to 10 percent slopes -----	35,840	3.3	Nikey sandy loam, 3 to 15 percent slopes -----	3,425	.3
Caval fine sandy loam, 2 to 10 percent slopes -----	4,025	.4	Nikey very stony sandy loam, 2 to 15 percent slopes -----	560	.1
Cave gravelly sandy loam, 7 to 30 percent slopes -----	22,010	2.0	Nikey-Isom complex, 3 to 30 percent slopes -----	3,765	.3
Cave gravelly sandy loam, low rainfall, 2 to 7 percent slopes -----	63,700	5.9	Palma loamy fine sand, 1 to 5 percent slopes -----	4,480	.4
Chilton gravelly loam, 5 to 30 percent slopes -----	2,950	.3	Palma fine sandy loam, 1 to 5 percent slopes -----	2,990	.3
Cinder land -----	3,600	.3	Pastura loam, 2 to 5 percent slopes -----	1,720	.2
Clovis fine sandy loam, 1 to 5 percent slopes -----	5,510	.5	Pastura-Esplin complex, 0 to 10 percent slopes -----	9,780	1.0
Clovis-Pastura complex, 1 to 10 percent slopes -----	1,550	.1	Paunsaugunt gravelly silt loam, 30 to 50 percent slopes -----	8,290	.8
Collbran very cobbly clay loam, 2 to 30 percent slopes -----	8,900	.8	Paunsaugunt-Kolob association -----	2,470	.2
Curhollow gravelly fine sandy loam, 2 to 10 percent slopes -----	10,380	1.0	Paunsaugunt-Rock outcrop complex, 2 to 30 percent slopes -----	1,715	.2
Curhollow-Rock outcrop complex, 10 to 30 percent slopes -----	9,885	.9	Pintura loamy fine sand, 1 to 5 percent slopes -----	3,270	.3
Dagflat-Motoqua complex, 30 to 70 percent slopes -----	24,150	2.3	Pintura loamy fine sand, hummocky, 1 to 10 percent slopes -----	20,310	1.9
Dalcan cobbly loam, 0 to 15 percent slopes -----	4,600	.4	Pintura-Toquerville complex, 1 to 20 percent slopes -----	8,500	.8
Detra-Kolob complex, 20 to 50 percent slopes -----	2,140	.2	Quazo-Motoqua very gravelly sandy loams, 30 to 70 percent slopes -----	39,745	3.7
Draper loam, 2 to 5 percent slopes -----	345	(¹)	Redbank fine sandy loam, 1 to 5 percent slopes -----	10,425	1.0
Dune land -----	3,695	.3	Redbank silty clay loam, 0 to 2 percent slopes -----	815	.1
Eroded land-Shalet complex -----	20,425	1.9	Renbac-Rock land association -----	6,710	.6
Eroded land-Shalet complex, warm -----	14,080	1.3	Riverwash -----	6,035	.6
Fluvaquents and Torrifluvents, sandy -----	6,730	.6	Rock land -----	65,605	6.1
Gullied land -----	5,925	.6	Rock land, stony -----	28,730	2.7
Hantz silty clay loam -----	835	.1	Rock land-Hobog association -----	2,340	.2
Harrisburg fine sandy loam, 1 to 5 percent slopes -----	9,370	.9	Rock outcrop -----	137,345	12.6
Harrisburg-Rock land association -----	2,220	.2	Rough broken land -----	18,605	1.7
Hobog-Rock land association -----	5,585	.5	St. George silt loam -----	1,170	.1
Isom cobbly sandy loam, 3 to 30 percent slopes -----	720	.1	St. George silt loam, strongly saline -----	660	.1
Ivins loamy fine sand -----	1,500	.1	St. George silty clay loam -----	3,585	.3
Ivins loamy fine sand, hummocky -----	405	(¹)	St. George silty clay loam, moderately saline -----	450	(¹)
Junction fine sandy loam, 1 to 2 percent slopes -----	3,405	.3	St. George silty clay loam, shallow water table -----	435	(¹)
Junction fine sandy loam, 2 to 5 percent slopes -----	3,875	.4	Schmutz loam -----	8,950	.8
Kinesava fine sandy loam, 15 to 25 percent slopes -----	775	.1	Spenlo very fine sandy loam, 2 to 10 percent slopes -----	5,585	.5
Kinesava-Detra fine sandy loams, 2 to 15 percent slopes -----	1,070	.1	Springerville clay, 0 to 5 percent slopes -----	735	.1
Kinesava complex, 2 to 30 percent slopes -----	1,215	.1	Stony colluvial land -----	53,170	4.9
Kolob-Detra association -----	9,290	.9	Tacan very stony sandy loam, 30 to 70 percent slopes -----	6,955	.6
Kolob-Hogg complex, 2 to 8 percent slopes -----	1,255	.1	Tobish very cobbly clay loam, 5 to 30 percent slopes -----	4,435	.4
Kolob-Paunsaugunt complex, 20 to 60 percent slopes -----	2,385	.2	Tobler fine sandy loam -----	11,220	1.0
Lava flows -----	2,135	.2	Tobler silty clay loam -----	2,895	.3
Lavate sandy loam -----	4,080	.4	Tortugas-Rock land association -----	2,485	.2
LaVerkin fine sandy loam, 1 to 2 percent slopes -----	760	.1	Vekol sandy loam, 0 to 2 percent slopes -----	655	.1
LaVerkin fine sandy loam, 2 to 5 percent slopes -----	1,605	.1	Vekol sandy loam, 2 to 10 percent slopes -----	655	.1
LaVerkin silty clay loam, 1 to 2 percent slopes -----	555	.1	Veyo-Curhollow complex, 3 to 10 percent slopes -----	2,220	.2
Leeds silty clay loam, 0 to 1 percent slopes -----	760	.1	Veyo-Pastura complex, 1 to 10 percent slopes -----	10,220	.9
Leeds silty clay loam, 1 to 2 percent slopes -----	1,645	.2	Welring-Tortugas very gravelly loams, 20 to 70 percent slopes -----	31,050	2.9
Leeds silty clay loam, 5 to 10 percent slopes -----	405	(¹)	Winkel gravelly fine sandy loam, 1 to 8 percent slopes -----	11,260	1.0
Magotsu-Pastura complex, 2 to 20 percent slopes -----	23,150	2.2	Winkel-Rock outcrop complex, 8 to 30 percent slopes -----	10,105	.9
Mathis-Rock outcrop complex, 20 to 50 percent slopes -----	29,170	2.7	Yaki very cobbly loam, 3 to 35 percent slopes -----	1,170	.1
Menefee-Rock outcrop complex, 25 to 60 percent slopes -----	7,320	.7	Yaki-Zukan complex, 1 to 35 percent slopes -----	9,540	.9
Mespun fine sand, 0 to 10 percent slopes -----	10,880	1.0	Total -----	1,076,400	100.0
Motoqua-Mokiak very cobbly sandy loams, 30 to 70 percent slopes -----	9,150	.9			
Motoqua-Rock outcrop complex, 30 to 70 percent slopes -----	7,295	.7			

¹ Less than 0.05 percent.

Badland, Very Steep

Badland, very steep (BB), consists of very steep escarpments and desert hills of barren, multicolored layers of shale that are generally capped with sandstone or conglomerate.

Erosion is active, and the sediment potential is very high during intense thunderstorms.

Badland, very steep, is used mainly by artists, photographers, and tourists vacationing in the survey area. Capability unit VIII_s-3, nonirrigated; wildlife suitability group 4444; range site not assigned.

Bermesa Series

The Bermesa series consists of well-drained soils. These soils formed in residuum weathered from basalt overlain by wind-blown deposits derived from sandstone and shale. Slopes range from 1 to 10 percent. Elevation is 2,600 to 3,400 feet. The native vegetation is desert shrubs, forbs, and grasses. Average annual precipitation is 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period is 190 to 195 days. Bermesa soils are most commonly associated with Harrisburg, Junction, Tobler, and Winkel soils.

In a representative profile the surface layer is reddish-brown fine sandy loam about 3 inches thick. The next layer is reddish-brown fine sandy loam about 11 inches thick. The upper part of the subsoil is yellowish-red very gravelly sandy clay loam about 7 inches thick. The lower part of the subsoil is light reddish-brown very cobbly sandy clay loam about 5 inches thick that is underlain by a carbonate-cemented hardpan about 2 inches thick. Basalt bedrock is at a depth of about 28 inches.

Permeability is moderate above the hardpan. The hardpan stops water penetration. Available water capacity, above the hardpan, is 2.5 to 4.0 inches. The water supplying capacity is about 4 to 6 inches. Roots penetrate to a depth of 21 to 40 inches.

Bermesa soils are used for range and wildlife habitat.

Representative profile of Bermesa fine sandy loam, 1 to 10 percent slopes, in an area of range about 3 miles west of Hurricane, about 700 feet north and 50 feet east of the southwest corner of sec. 31, T. 41 S., R. 13 W.:

- A1—0 to 3 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) when moist; weak, medium, platy structure that parts to weak, fine, granular; soft, very friable, slightly sticky and nonplastic; few fine and very fine roots; slightly calcareous, lime is disseminated; moderately alkaline; abrupt, smooth boundary.
- C1—3 to 14 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) when moist; massive; soft, very friable, slightly sticky and nonplastic; few fine and very fine roots; slightly calcareous, lime is disseminated; strongly alkaline; clear, irregular boundary.
- B21tb—14 to 21 inches, yellowish-red (5YR 5/6) very gravelly sandy clay loam, yellowish red (5YR 4/6) when moist; moderate, medium, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; few fine and very fine roots; few very fine and fine pores; common thin clay films as bridges between sand grains; 50 percent gravel and 10 percent cobbles; moderately calcareous, lime is disseminated; strongly alkaline; clear, irregular boundary.
- B22tcab—21 to 26 inches, light reddish-brown (5YR 6/4) very cobbly sandy clay loam, yellowish red (5YR 5/6) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine and very fine roots; few fine and very fine, discontinuous pores; few thin clay films as bridges

between sand grains; 70 percent angular gravel and cobbles; strongly calcareous, lime is disseminated; strongly alkaline; abrupt, wavy boundary.

C2camb—26 to 28 inches, pink (5YR 8/3) indurated lime-cemented hardpan.

R—28 inches, basalt bedrock.

Depth to the hardpan ranges from 21 to 40 inches. The average annual soil temperature at a depth of 20 inches is 59° to 67° F. The profile is moderately alkaline or strongly alkaline.

The A1 horizon has value of 5 or 6 when dry and chroma of 4 to 7. It ranges from fine sandy loam to loamy fine sand that is 0 to 20 percent gravel. It ranges from 1 inch to 4 inches in thickness.

The C1 horizon is similar to the A1 horizon in color and texture, and it ranges from 5 to 21 inches in thickness.

The B2tb horizon has value of 4 to 6 when dry and chroma of 4 to 8. It is very gravelly sandy clay loam, very cobbly sandy clay loam, very cobbly loam, or very gravelly clay loam that is 35 to 60 percent cobbles and gravel.

The C2camb horizon ranges from 2 to 6 inches in thickness.

Bermesa fine sandy loam, 1 to 10 percent slopes (BED).—This soil is on large, irregularly shaped desert slopes of old basalt flow areas. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is moderate. Roots penetrate as far down as the hardpan.

Included with this soil in mapping are small areas of Winkel gravelly fine sandy loam, 1 to 8 percent slopes, and Bermesa loamy fine sand that has slopes of 1 to 10 percent. Also included are small areas, along drainageways in the area of Berry Springs, of LaVerkin fine sandy loam, 2 to 5 percent slopes, and about 1 percent areas of Rock land.

This Bermesa soil is used for range and wildlife habitat. The native vegetation is creosotebush, blackbrush, galleta, Indian ricegrass, and cholla cactus. Capability unit VII_s-C4, nonirrigated; Southern Desert Stony Loam range site; wildlife suitability group 4343.

Bermesa-Rock land association (BF).—This association is about 70 percent Bermesa loamy fine sand, 1 to 10 percent slopes; 20 percent Rock land; and 10 percent other soils. The Bermesa soil and the areas of Rock land are intermingled and are in no definite pattern on the landscape, except that the areas of Rock land are on slightly higher ridges that are more subject to soil blowing. Runoff is slow, and the hazard of soil blowing is moderate to severe. Roots penetrate as far down as the hardpan.

The Bermesa soil has a profile similar to the one described as representative of the Bermesa series, but the surface layer is loamy fine sand and hummocks 10 to 24 inches high are on the surface.

Included with these soils in mapping are about 5 percent each areas of Pintura loamy fine sand, 1 to 5 percent slopes, and Winkel gravelly fine sandy loam, 1 to 8 percent slopes.

The soils in this association are used for range. The native vegetation is mostly creosotebush, blackbrush, galleta, Indian ricegrass, and cholla cactus. Wildlife suitability group 4343; Bermesa soil in capability unit VII_s-C4, nonirrigated, and Southern Desert Stony Loam range site; Rock land in capability unit VIII_s-X, nonirrigated, and range site not assigned.

Bond Series

The Bond series consists of shallow, well-drained soils on high mesa tops on the Little Creek terrace, Gooseberry

Mesa, and Lower Kolob terrace and in the southwestern part of Zion National Park. These soils formed in residuum weathered from conglomerate and sandstone. Slopes range from 1 to 10 percent. Elevation is 4,500 to 6,000 feet. The native vegetation is pinyon pine, juniper, sagebrush, and grasses. Average annual precipitation is 12 to 14 inches, average annual air temperature is 56° to 59° F, and the frost-free period is 160 to 170 days. Bond soils are commonly associated with Clovis and Mathis soils.

In a representative profile the surface layer is reddish-brown sandy loam about 2 inches thick. The subsoil is reddish-brown and yellowish-red gravelly sandy clay loam about 14 inches thick. Conglomerate bedrock is at a depth of about 16 inches. The profile is noncalcareous throughout and is mildly alkaline to moderately alkaline.

Permeability is moderately slow. Available water capacity is 2 to 3 inches. The water supplying capacity is 5 to 8 inches. Roots penetrate as far down as bedrock.

Bond soils are used for range, wildlife habitat, and recreation.

Representative profile of Bond sandy loam, 1 to 10 percent slopes, in an area of range about 600 feet south and 600 feet west of the east quarter corner of sec. 18, T. 42 S., R. 11 W., on Gooseberry Mountain:

- A1—0 to 2 inches, reddish-brown (5YR 4/4) sandy loam, dark reddish brown (5YR 3/4) when moist; weak, medium, granular structure; loose, very friable, nonsticky and nonplastic; many fine and medium roots; mildly alkaline; abrupt, smooth boundary.
- B1t—2 to 4 inches, reddish-brown (5YR 5/4) gravelly sandy clay loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; common fine vesicular pores; few thin clay films in pores; about 20 percent gravel; mildly alkaline; clear, smooth boundary.
- B2t—4 to 16 inches, yellowish-red (5YR 4/6) gravelly sandy clay loam, yellowish red (5YR 3/6) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and slightly plastic; common fine and medium and few coarse roots; common fine and very fine vesicular pores; few thin clay films in pores and as bridges between sand grains; 25 percent gravel; moderately alkaline; abrupt, smooth boundary.
- R—16 inches, conglomerate bedrock.

Depth to bedrock ranges from 10 to 20 inches. The average annual soil temperature at a depth of 20 inches ranges from 55° to 58° F, and the average summer soil temperature is 71° to 76°. The profile is noncalcareous. It ranges from neutral to moderately alkaline.

The A horizon has hue of 5YR or 7.5YR, value of 4 or 5 when dry, and chroma of 2 to 4. It is dominantly sandy loam, but it ranges to fine sandy loam or gravelly sandy loam. It is 0 to 30 percent gravel.

The B2t horizon has hue of 5YR or 2.5YR and chroma of 4 to 8. It is dominantly gravelly sandy clay loam, but it ranges to clay loam or gravelly clay loam. It is 10 to 25 percent gravel.

Bond sandy loam, 1 to 10 percent slopes (BOD).— This soil is on broad mesas. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Clovis fine sandy loam, 1 to 5 percent slopes; Redbank fine sandy loam, 1 to 5 percent slopes; a deep sandy clay loam in depressions; and a shallow, calcareous cobbly loam on ridges. Also included and making up about 10 percent of the area is Rock land.

This Bond soil is used for range, wildlife habitat, and recreation. The native vegetation is pinyon pine, juniper, big sagebrush, galleta, and prickly-pear cactus. Capability unit V1s-V3, nonirrigated; Southern Upland Shallow Loam (Juniper-Pinyon) range site; wildlife suitability group 3242.

Caval Series

The Caval series consists of well-drained soils on lava flows and mesas on the lower part of Kolob terrace, near the west edge of Zion National Park. These soils formed in eolian deposits derived from sandstone. Slopes range from 2 to 10 percent. Elevation is 5,600 to 7,000 feet. The native vegetation is dominantly big sage, Gambel oak, pinyon pine, juniper, shrubs, and grasses. Average annual precipitation is 14 to 16 inches, average annual air temperature is 45° to 51° F, and the frost-free period is 120 to 160 days. Caval soils are commonly associated with Mespun, Bond, and Mathis soils.

In a representative profile the soil is brown fine sandy loam to a depth of 51 inches and is reddish-brown sandy clay loam between depths of 51 and 60 inches. The profile is neutral in reaction.

Permeability is moderately rapid to a depth of about 50 inches and moderately slow below. Available water capacity to a depth of 5 feet is 7 to 9 inches. The water supplying capacity is 9 to 11 inches. Roots penetrate to a depth of 5 feet or more.

Caval soils are used for range, nonirrigated crops, recreation, and wildlife habitat.

Representative profile of Caval fine sandy loam, 2 to 10 percent slopes, in a cultivated area about 660 feet east and 330 feet south of the northwest corner of sec. 15, T. 40 S., R. 11 W., in Lee Valley:

- A11—0 to 9 inches, brown (7.5YR 5/3) fine sandy loam, dark brown (7.5YR 3/3) when moist; weak, medium, subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few fine roots; common very fine tubular pores and many very fine interstitial pores; neutral; clear, smooth boundary.
- A12—9 to 16 inches, brown (7.5YR 5/3) fine sandy loam, dark brown (7.5YR 3/3) when moist; weak, medium, subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few fine roots; common fine and very fine tubular pores and many very fine interstitial pores; neutral; gradual, smooth boundary.
- A13—16 to 23 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 3/3) when moist; weak, medium, subangular blocky structure; hard, very friable, nonsticky and nonplastic; few fine roots; common fine and very fine tubular pores and many very fine interstitial pores; neutral; gradual, smooth boundary.
- C1—23 to 41 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 3/4) when moist; weak, coarse, subangular blocky structure; hard, very friable, nonsticky and nonplastic; few fine roots; common fine and very fine pores; neutral; clear, smooth boundary.
- B1b—41 to 51 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 3/4) when moist; moderate, medium, subangular blocky structure; hard, very friable, nonsticky and nonplastic; few fine roots; common fine and many very fine tubular pores; neutral; clear, wavy boundary.
- B2tb—51 to 60 inches, reddish-brown (5YR 5/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; few fine roots; few fine and common very fine tubular pores; many moderately thick clay films on ped faces and in pores; neutral.

The average annual soil temperature at a depth of 20 inches ranges from 47° to 53° F, and the average summer soil temperature is 65° to 68°. The profile is noncalcareous throughout.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry, and chroma of 2 to 4. It is fine sandy loam or light fine sandy loam.

The C horizon has hue of 7.5YR or 5YR, value of 3 to 5 when dry and 3 or 4 when moist, and chroma of 2 to 4. It ranges from loamy fine sand to very fine sandy loam.

A buried B horizon occurs in some places between depths of 36 and 60 inches or more.

Caval fine sandy loam, 2 to 10 percent slopes (CaD).—

This gently rolling to rolling soil is on eolian-capped lava flows and mesas. Runoff is slow. The hazard of erosion is slight, and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Mespuen fine sand, 0 to 10 percent slopes, and areas in Cave Valley and Lee Valley of soils that have 10 to 15 inches of wind-deposited loamy fine sand on the surface. Also included, and making up about 5 percent of the area, is Rock land.

This Caval soil is used mainly for range, nonirrigated crops, recreation, and wildlife habitat. The cultivated crop is wheat. The native vegetation is galleta, Indian ricegrass, squirreltail, sand dropseed, big sagebrush, and globemallow. Capability unit IVE-V, nonirrigated; Upland Loam (Summer Precipitation) range site; wildlife suitability group 2141.

Cave Series

The Cave series consists of well-drained soils that are shallow over a carbonate-cemented hardpan. These soils are on coalescing alluvial fans or bajada. They formed in gravelly alluvium weathered from gneiss, limestone, dolomite, quartzite, shale, and acid igneous rocks. Slopes are 2 to 30 percent. Elevation is 2,400 to 4,200 feet. The native vegetation is desert shrubs, cactus, and grasses. Average annual precipitation ranges from 6 to 10 inches, average annual air temperature ranges from 57° to 67° F, and the frost-free period is 190 to 205 days. Cave soils are commonly associated with Tortugas and Welring soils.

In a representative profile the surface layer is brown gravelly sandy loam about 2 inches thick. The underlying material is brown gravelly sandy loam about 10 inches thick. An indurated carbonate-cemented hardpan is at a depth of about 12 inches. The profile is calcareous throughout and is moderately alkaline.

Permeability is moderately rapid above the hardpan. Available water capacity, above the hardpan, is 1 inch to 2.5 inches. The water supplying capacity is 2 to 4 inches. Roots do not penetrate the hardpan, but in places they follow cracks in it.

Cave soils are used for range and wildlife habitat.

Representative profile of Cave gravelly sandy loam, 7 to 30 percent slopes, in an area of range about 250 feet north of the center of sec. 16, T. 42 S., R. 19 W., about 2½ miles southeast of Lytle Ranch:

- A1—0 to 2 inches, brown (10YR 5/3) gravelly sandy loam, dark brown (10YR 3/3) when moist; weak, thin and medium, platy structure that parts to weak, very fine, subangular blocky; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine vesicular pores; 40 percent gravel; moderately calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.
- C1—2 to 12 inches, brown (7.5YR 5/4) gravelly sandy loam, dark brown (7.5YR 4/3) when moist; massive; soft, very friable, nonsticky and slightly plastic; few fine and very fine roots; common very fine tubular pores and many very fine interstitial pores; 30 percent gravel; moderately calcareous, lime is disseminated and in coatings on the underside of rock fragments; moderately alkaline; abrupt, wavy boundary.
- C2cam—12 inches, gravelly indurated carbonate-cemented hardpan; hardpan has thin laminar upper layer.

Depth to the hardpan ranges from 8 to 20 inches. Gravel on the surface of the soil forms a pavement, and a few stones are on the surface. A layer high in carbonate accumulation is immediately above the hardpan in some places. The average annual soil tempera-

ture at a depth of 20 inches is 59° to 65° F.

The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 3 or 4. It ranges from gravelly sandy loam to very gravelly loam that is 20 to 50 percent gravel and cobbles.

The C horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 4 to 6 when moist, and chroma of 3 or 4. It ranges from gravelly light sandy loam to gravelly loam that is 15 to 35 percent gravel and cobbles.

The hardpan ranges from 2 to 60 inches or more in thickness. In some places two or more hardpan layers are separated by thin layers of gravelly sandy loam.

Cave gravelly sandy loam, 7 to 30 percent slopes (CEF)—This soil is on dissected, old, coalescing alluvial fans or bajada. It has the profile described as representative of the series. Elevation is 3,000 to 4,200 feet. The average annual precipitation is 8 to 10 inches. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Cave gravelly sandy loam, low rainfall, 2 to 7 percent slopes, and a shallow soil that has stones on the surface. Also included are areas of Riverwash.

This Cave soil is used for range and wildlife habitat. The native vegetation is bursage, Joshua-tree, galleta, filaree, and cactus. Capability unit VIIs-R3, nonirrigated; Southern Semidesert Shallow Hardpan, 8- to 10-inch precipitation zone, range site; wildlife suitability group 4343.

Cave gravelly sandy loam, low rainfall, 2 to 7 percent slopes (CFD)—This soil is on the lower end of fans. It has a profile similar to the one described as representative of the series, but it is less steep. Elevation is 2,400 to 3,200 feet. The average annual precipitation is 6 to 8 inches. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Cave gravelly sandy loam, 7 to 30 percent slopes; a deep gravelly sandy loam; and Riverwash.

This Cave soil is used for range and wildlife habitat. The native vegetation is creosotebush, Joshua-tree, desert rice, galleta, and filaree. Capability unit VIIs-C3, nonirrigated; Southern Desert Shallow Hardpan range site; wildlife suitability group 4343.

Chilton Series

The Chilton series consists of well-drained soils on alluvial fans at the base of limestone cliffs throughout the survey area. These soils formed in mixed alluvium weathered from limestone and some sandstone and basalt. Slopes range from 5 to 30 percent. Elevation is 3,900 to 4,600 feet. The native vegetation is juniper, pinyon pine, blackbrush, big sagebrush, and grasses. Average annual precipitation ranges from 12 to 14 inches, average annual air temperature is 52° to 56° F, and the frost-free period is 165 to 170 days. Chilton soils are commonly associated with Redbank, Isom, and Naplene soils.

In a representative profile the surface layer is pinkish-gray gravelly loam about 4 inches thick. The underlying material is light-brown or pink gravelly loam or very gravelly loam to a depth of 70 inches. The profile is moderately calcareous or strongly calcareous and is strongly alkaline.

Permeability is moderate. Available water capacity is 5 to 7 inches to a depth of 5 feet. The water supplying capacity is 6 to 9 inches. Roots penetrate to a depth of 5 feet or more.

Chilton soils are used for range and wildlife habitat. They also are a source of borrow material for road construction.

Representative profile of Chilton gravelly loam, 5 to 30 percent slopes, in an area of range 525 feet west and 260 feet north of the southeast corner of sec. 32, T. 42 S., R. 17 W., 2 miles northeast of the Apex Mine:

- A1—0 to 4 inches, pinkish-gray (7.5YR 6/2) gravelly loam, dark brown (7.5YR 3/2) when moist; moderate, very fine, granular structure; soft, friable, slightly sticky and slightly plastic; many very fine roots; few fine and many very fine tubular pores; 25 percent gravel, 2 to 3 percent stones on the surface; moderately calcareous, lime is disseminated; strongly alkaline; clear, smooth boundary.
- C1—4 to 13 inches, light-brown (7.5YR 6/3) gravelly loam, brown (7.5YR 4/2) when moist; moderate, medium and coarse, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and common very fine roots; common fine and many very fine tubular pores; 25 percent gravel; strongly calcareous, lime is disseminated; strongly alkaline; gradual, wavy boundary.
- C2—13 to 33 inches, pink (7.5YR 7/3) gravelly loam, brown (7.5YR 4/3) when moist; moderate, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; few fine and very fine roots; few fine and medium and many very fine tubular pores; 45 percent gravel; strongly calcareous, lime is disseminated; strongly alkaline; gradual, wavy boundary.
- C3—33 to 70 inches, pink (7.5YR 7/3) very gravelly loam, brown (7.5YR 5/4) when moist; weak, fine, subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few fine and very fine roots; few fine and medium and common very fine tubular pores; 75 percent gravel; strongly calcareous, lime is disseminated; strongly alkaline.

As much as 3 percent of the surface is covered with stones in some areas. The profile is calcareous throughout. It is moderately alkaline or strongly alkaline. Average annual soil temperature at a depth of 20 inches is 54° to 58° F.

The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 when dry and 3 or 4 when moist, and chroma of 2 to 4. It is gravelly loam, cobbly loam, or gravelly sandy loam that is 20 to 50 percent gravel and cobbles. It ranges from 2 to 8 inches in thickness.

The C horizon has a hue of 7.5YR or 10YR, value of 6 or 7 when dry and 4 or 5 when moist, and chroma of 2 to 5. It is gravelly or very gravelly loam, very gravelly sandy loam, or very cobbly sandy loam and contains some strata of very gravelly loamy sand in places. It is 20 to 80 percent rock fragments.

Chilton gravelly loam, 5 to 30 percent slopes (CHF).—This soil is on convex, short alluvial fans at the base of limestone cliffs. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of a soil that is similar to this Chilton soil but has a dark-colored surface layer and areas of Redbank fine sandy loam, 1 to 5 percent slopes. Also included, and making up about 2 percent of the area, is Stony colluvial land.

This Chilton soil is used for range and wildlife habitat and as a source of borrow material for highway construction. The native vegetation is juniper, pinyon pine, big sagebrush, galleta, and Indian ricegrass. Capability unit VI_s-V₄, nonirrigated; Upland Stony Loam (Pinyon-Juniper) Summer Precipitation range site; wildlife suitability group 3242.

Cinder Land

Cinder land (C_l) is mostly very steep, cone-shaped deposits of reddish-brown or black volcanic cinders. Very little or no soil is on the cones.

Cinder land supports only a small amount of brush and

grass, but very steep slopes and the rough surface prevent grazing use. In some areas the cones have commercial value as material for highway construction and surfacing. Capability unit VIII_e-X, nonirrigated; wildlife suitability group 4444; range site not assigned.

Clovis Series

The Clovis series consists of well-drained soils on old alluvial fans, in valleys, and on mesas. These soils formed in mixed alluvium derived from sandstone, shale, and limestone. Slopes are generally smooth and range from 1 to 5 percent. Elevation is 4,200 to 5,800 feet. The native vegetation is pinyon pine, juniper, shrubs, and grasses. Average annual precipitation is 11 to 14 inches, average annual air temperature is 56° to 59° F, and the frost-free period is 165 to 170 days. Clovis soils commonly are associated with Redbank, Bond, Mathis, Palma, and Pastura soils.

In a representative profile the surface layer is reddish-brown fine sandy loam about 8 inches thick. The subsoil is yellowish-red sandy clay loam and clay loam about 14 inches thick. The substratum is light reddish-brown and reddish-brown clay loam to a depth of 60 inches. The profile is noncalcareous and neutral in the surface layer and subsoil and moderately calcareous and strongly alkaline in the substratum.

Permeability is moderate. Available water capacity is 8 to 12 inches to a depth of 5 feet. The water supplying capacity is 6 to 9 inches. Roots penetrate to a depth of 5 feet or more.

Clovis soils are used for range, wildlife habitat, and recreation. Some areas are used for nonirrigated crops in years of above-average precipitation.

Representative profile of Clovis fine sandy loam, 1 to 5 percent slopes, one-half mile south of the county road to Rockville junction with Utah Highway 59, about 600 feet south and 300 feet east of the northwest corner of sec. 9, T. 43, S., R. 11 W.:

- Ap—0 to 8 inches, reddish-brown (5YR 5/4) fine sandy loam, dark reddish brown (5YR 3/4) when moist; weak, medium, subangular blocky structure that parts to moderate, fine, granular; slightly hard, very friable, nonsticky and nonplastic; few fine and very fine roots; few medium and many fine and very fine pores; neutral; clear, smooth boundary.
- B21t—8 to 14 inches, yellowish-red (5YR 4/6) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few fine and very fine roots; few fine and common very fine pores; few thin clay films on ped faces; neutral; clear, smooth boundary.
- B22t—14 to 22 inches, yellowish-red (5YR 4/6) clay loam, dark reddish brown (2.5YR 3/4) when moist; weak, medium, prismatic structure that parts to weak, medium, subangular blocky; very hard, very firm, sticky and plastic; few fine and very fine roots; common very fine pores; common thin clay films on ped faces; neutral; clear, smooth boundary.
- C1ca—22 to 34 inches, light reddish-brown (5YR 6/4) clay loam, reddish brown (2.5YR 4/4) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; common very fine pores; moderately calcareous; strongly alkaline; clear, wavy boundary.
- C2—34 to 60 inches, reddish-brown (2.5YR 5/4) clay loam, reddish brown (2.5YR 4/5) when moist; weak, medium, subangular blocky structure; hard, firm, slightly sticky and plastic; few very fine roots; common very firm pores; moderately calcareous; strongly alkaline.

The average annual soil temperature at a depth of 20 inches is 55° to 58° F, and the average summer soil temperature is 71° to 76°.

The A horizon has hue of 7.5YR or 5YR, value of 4 to 6 when dry

and 3 or 4 when moist, and chroma of 2 to 4. It is dominantly fine sandy loam, but it ranges to sandy loam and light loam. This horizon is neutral or mildly alkaline. It ranges from 5 to 11 inches in thickness.

The B2t horizon has hue of 5YR or 2.5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 4 to 6. It is dominantly heavy sandy clay loam, but it ranges to clay loam. This horizon is neutral or mildly alkaline. It ranges from 6 to 24 inches in thickness.

The Cca horizon ranges from sandy clay loam or clay loam to sandy loam. It is moderately alkaline or strongly alkaline and is moderately calcareous or strongly calcareous.

Clovis fine sandy loam, 1 to 5 percent slopes (CoC).—This soil is on smooth old alluvial fans, in valleys, and on mesas. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Redbank fine sandy loam, 1 to 5 percent slopes, and Palma fine sandy loam, 1 to 5 percent slopes.

This Clovis soil is generally used for range and wildlife habitat. Some areas are used for nonirrigated crops in years of above-average precipitation. Wheat is the main crop. The native vegetation is big sagebrush, galleta, Indian ricegrass, squirreltail, muttongrass, and scattered pinyon pine and juniper. Capability unit VIe-V, nonirrigated; Southern Upland Loam range site; wildlife suitability group 2242.

Clovis-Pastura complex, 1 to 10 percent slopes (CPD).—This complex is mainly on old basalt mesas. It is about 60 percent Clovis fine sandy loam, 1 to 5 percent slopes; 30 percent Pastura gravelly loam, 2 to 10 percent slopes; and 10 percent other soils and Rock land. The Clovis soil is in gently sloping swales, and the Pastura soil is on ridges and slightly steeper slopes.

The Clovis soil has a profile similar to the one described as representative of the Clovis series, but the surface layer is 5 to 7 inches thick and grades to a light loam. The Pastura soil has a profile similar to the one described as representative of the Pastura series, but the surface layer is 20 to 35 percent gravel.

Included with these soils in mapping are small areas of Esplin loam, 0 to 2 percent slopes, and Veyo cobbly sandy loam, 1 to 10 percent slopes. Also included, and making up about 5 percent of the area, is basalt Rock land.

The soils in this complex are used for range and wildlife habitat. The native vegetation is mainly big sagebrush, blackbrush, galleta, and Indian ricegrass. Capability unit VIe-V, nonirrigated; Clovis soil in Southern Upland Loam range site and wildlife suitability group 2242; Pastura soil in Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone, range site and wildlife suitability group 3242.

Collbran Series

The Collbran series consists of well-drained soils on old lava flows on mountain side slopes, mainly south of New Harmony and in smaller areas on the lower Kolob terrace. These soils formed in alluvium and colluvium derived from basalt and some shale and sandstone. Slopes are dominantly 2 to 15 percent but range from 2 to 30 percent. Elevation is 4,500 to 5,400 feet. The native vegetation is juniper, pinyon pine, shrubs, and grasses. Average annual precipitation is 14 or 15 inches, average annual air tem-

perature is 45° to 52° F, and the frost-free period is 120 to 160 days. Collbran soils are commonly associated with Tacan, Pastura, and Magotsu soils.

In a representative profile the surface layer is brown very cobbly clay loam about 2 inches thick. The subsoil is dark-brown clay loam, reddish-brown clay, and light reddish-brown clay loam about 46 inches thick. The substratum is pink clay loam to a depth of 60 inches. The profile is noncalcareous in the surface layer and upper part of the subsoil and moderately calcareous or strongly calcareous in the lower part of the subsoil and in the substratum.

Permeability is slow. Available water capacity is 8 to 12 inches to a depth of 5 feet. The water supplying capacity is 9 to 11 inches. Roots penetrate to a depth of 5 feet or more.

Collbran soils are used for range and wildlife habitat.

Representative profile of Collbran very cobbly clay loam, 2 to 30 percent slopes, in an area of range about 1½ miles west of the Black Ridge exit on Interstate 15, near the center of sec. 12, T. 39 S., R. 13 W.:

- A1—0 to 2 inches, brown (7.5YR 4/2) very cobbly clay loam, dark brown (7.5YR 3/3) when moist; weak, thin, platy structure that parts to moderate, fine, granular; slightly hard, firm, sticky and plastic; common fine and very fine roots; common fine tubular pores; 60 to 80 percent cobbles and 1 percent stones; neutral; abrupt, smooth boundary.
- B1—2 to 4 inches, dark-brown (7.5YR 3/2) clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; common fine and very fine roots; common fine and very fine tubular pores; neutral; clear, smooth boundary.
- B21t—4 to 16 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) when moist; strong, medium and fine, subangular blocky; extremely hard, extremely firm, very sticky and very plastic; common fine and few medium and coarse roots; common fine tubular pores; continuous moderately thick clay films on faces of pedis; mildly alkaline; gradual, wavy boundary.
- B22t—16 to 31 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/4) when moist; weak, medium, prismatic structure that parts to strong, medium, subangular blocky; extremely hard, extremely firm, very sticky and very plastic; common fine and few medium and coarse roots; common fine tubular pores; many moderately thick clay films on faces of pedis; slightly calcareous; moderately alkaline; gradual, smooth boundary.
- B23tca—31 to 41 inches, reddish-brown (5YR 5/3) clay, dark reddish brown (5YR 3/4) when moist; weak, medium, prismatic structure that parts to strong, medium, subangular blocky; extremely hard, extremely firm, very sticky and very plastic; common fine and few medium and coarse roots; common fine tubular pores; common moderately thick clay films on faces of pedis; moderately calcareous, lime is segregated in soft nodules; moderately alkaline; gradual, smooth boundary.
- B3ca—41 to 48 inches, light reddish-brown (5YR 6/3) clay loam, brown (7.5YR 4/4) when moist; moderate, medium, subangular blocky structure; very hard, firm, sticky and plastic; few fine and medium roots; few fine tubular pores; strongly calcareous; moderately alkaline; gradual, smooth boundary.
- Cca—48 to 60 inches, pink (5YR 7/3) clay loam, brown (7.5YR 5/4) when moist; massive; hard, firm, sticky and plastic; few fine roots; few fine tubular pores; strongly calcareous; moderately alkaline.

Rock fragments on the surface range from 50 to 90 percent cobbles and 1 to 3 percent stones. The average annual soil temperature at a depth of 20 inches is 50° to 54° F, and the average summer soil temperature is 65° to 70°.

The A horizon has hue of 7.5YR or 5YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It is dominantly very cobbly clay loam but ranges to very cobbly loam. It is 1 inch or 2 inches thick.

The B1 horizon is 2 to 5 inches thick. The B2t horizon has hue of 7.5YR or 5YR, value of 4 or 5 when dry and 3 when moist, and chroma of 2 to 4. It is 3 to 30 percent gravel and cobbles.

The Cca horizon has hue of 7.5YR or 5YR, value of 6 or 7 when dry

and 5 when moist, and chroma of 3 or 4. It is clay loam or heavy loam and is moderately calcareous or strongly calcareous.

Collbran very cobbly clay loam, 2 to 30 percent slopes (CRF).—This soil is on dominantly east-facing lower parts of mountain side slopes. Slopes are medium to long and are slightly convex. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of a moderately deep very cobbly clay soil; Magotsu very cobbly loam, 2 to 20 percent slopes; and Nehar very stony sandy loam, 3 to 30 percent slopes. Also included, and making up about 5 percent of the mapped area, is Rock outcrop.

This Collbran soil is used for range and wildlife habitat. The native vegetation is mainly juniper, pinyon pine, live oak, big sagebrush, bitterbrush, bluebunch wheatgrass, and muttongrass. Capability unit VIIs-V, nonirrigated; Southern Upland Loam (Shrub) range site; wildlife suitability group 3242.

Curhollow Series

The Curhollow series consists of shallow, well-drained soils that have an indurated carbonate-cemented hardpan at a depth of 10 to 20 inches. These soils are on old alluvial fans and low mountain side slopes in the southern and central parts of the survey area. They formed in alluvium and residuum weathered from sedimentary and igneous rocks. Slopes range from 2 to 30 percent. Elevation is 3,500 to 5,200 feet. The native vegetation is pinyon pine, juniper, shrubs, and grasses. Average annual precipitation is 10 to 12 inches, average annual air temperature is 52° to 56° F, and the frost-free period is 165 to 170 days. Curhollow soils are commonly associated with Pastura, Yaki, Winkel, and Veyo soils.

In a representative profile the surface layer is brown gravelly fine sandy loam about 3 inches thick. The underlying material is light-brown gravelly loam and very gravelly fine sandy loam about 12 inches thick. An indurated carbonate-cemented hardpan is at a depth of 15 inches.

Permeability is moderate. Available water capacity, above the hardpan, is 1 inch to 2 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as the hardpan.

Curhollow soils are used mainly for range.

Representative profile of Curhollow gravelly fine sandy loam, 10 to 30 percent slopes, in an area of Curhollow-Rock outcrop complex, 10 to 30 percent slopes, in an area of range 4½ miles southeast of the Apex Mine, 1,580 feet east and 200 feet north of the southwest corner of sec. 28, T. 43 S., R. 17 W.:

A1—0 to 3 inches, brown (7.5YR 5/4) gravelly fine sandy loam, dark brown (7.5YR 3/4) when moist; moderate, very fine, granular structure; soft, very friable, nonsticky and nonplastic; few fine and common very fine roots; few fine and common very fine interstitial pores; 50 percent gravel; moderately calcareous, lime is disseminated; strongly alkaline; clear, smooth boundary.

C1—3 to 10 inches, light-brown (7.5YR 6/4) gravelly loam, dark brown (7.5YR 4/4) when moist; weak, fine, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and medium and common very fine roots; few fine and medium and common very fine tubular pores; 45 percent gravel and cobbles; strongly calcareous, lime is disseminated; strongly alkaline; clear, wavy, boundary.

C2ca—10 to 15 inches, light-brown (7.5YR 6/4) very gravelly fine sandy loam, brown (7.5YR 5/4) when moist; moderate, very fine, granular structure; soft, very friable, nonsticky and nonplastic;

few fine and common very fine roots; few fine and common very fine interstitial pores; 55 percent gravel and cobbles; strongly calcareous, lime is disseminated; strongly alkaline; abrupt, wavy boundary.

Ccam—15 inches, indurated carbonate-cemented hardpan.

Depth to the hardpan ranges from 10 to 20 inches. The average annual soil temperature at a depth of 20 inches is 54° to 58° F, and the average summer soil temperature is 71° to 76°. The profile ranges from moderately alkaline to strongly alkaline.

The A horizon has hue of 7.5YR or 5YR, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 2 to 4. It is gravelly fine sandy loam or very stony sandy loam that ranges from 25 to 50 percent gravel, cobbles, and stones.

The C horizon has hue of 7.5YR or 5YR, value of 5 to 8 when dry and 3 to 5 when moist, and chroma of 3 to 5. It is gravelly loam, very gravelly loam, very cobbly heavy loam, very gravelly fine sandy loam, or very gravelly sandy clay loam. It is 35 to 70 percent gravel, cobbles, and stones in the upper part and 50 to 90 percent near the hardpan. It is moderately calcareous or strongly calcareous.

Curhollow gravelly fine sandy loam, 2 to 10 percent slopes (CSE).—This soil is on short, convex alluvial fans. It has a profile similar to the one described as representative of the series, but it is less steep and depth to the hardpan ranges from 15 to 20 inches. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Pastura gravelly loam, 2 to 10 percent slopes; Esplin loam, 0 to 2 percent slopes; and Chilton gravelly loam, 5 to 30 percent slopes. Also included are areas of Rock outcrop, which make up about 2 percent of the mapped area.

This Curhollow soil is used mainly for range. The native vegetation is big sagebrush, blackbrush, range ratany, Mormon tea, Indian ricegrass, needleandthread, galleta, and cactus. Capability unit VIIs-R3, nonirrigated; Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone, range site; wildlife suitability group 3242.

Curhollow-Rock outcrop complex, 10 to 30 percent slopes (CUF).—This complex is in the south-central part of the survey area on dissected, low mountain side slopes. It is about 65 percent Curhollow gravelly fine sandy loam, 10 to 30 percent slopes; 15 percent Rock outcrop; and 20 percent other soils. The Curhollow soil is on slightly convex side slopes. Rock outcrop is on rounded ridgetops and along the edges of steep, dissected drainageways. Runoff is medium, and the hazard of erosion is moderate.

The Curhollow soil has the profile described as representative of the Curhollow series.

Included with these soils in mapping are small areas of Esplin loam, 0 to 2 percent slopes; a shallow soil that is similar to this Curhollow soil but is less than 10 inches deep; and Yaki very cobbly loam, 3 to 35 percent slopes.

The Curhollow soil in this complex is used mainly for range. The native vegetation is big sagebrush, range ratany, cliffrose, Mormon tea, yellowbrush, Indian ricegrass, galleta, and cactus. Capability unit VIIs-R3, nonirrigated; Curhollow soil in Southern Semidesert Shallow Hardpan, 10- to 12- inch precipitation zone, range site and wildlife suitability group 3242; Rock outcrop in wildlife suitability group 4444 and range site not assigned.

Dagflat Series

The Dagflat series consists of well-drained soils on mountain side slopes in the northwestern part of the survey area. These soils formed in material weathered from

coarse-grained acid igneous rocks. Slopes range from 30 to 60 percent. Elevation is 4,500 to 6,500 feet. The native vegetation is pinyon pine, juniper, shrubs, and grasses. Average annual precipitation is 14 to 15 inches, average annual air temperature is 45° to 52° F, and the frost-free period is 120 to 160 days. Dagflat soils commonly are associated with Motoqua, Quazo, and Tacan soils.

In a representative profile the surface layer is dark reddish-gray very cobbly coarse sandy loam and coarse sandy loam about 6 inches thick. The subsoil is reddish-brown coarse sandy clay loam and coarse sandy loam about 20 inches thick. The substratum is light-brown coarse loamy sand about 4 inches thick. Acid igneous bedrock is at a depth of about 30 inches.

Permeability is moderately slow. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 4 to 6 inches. The water supplying capacity is 5 to 8 inches. Roots penetrate as far down as bedrock.

Dagflat soils are used mainly for range and wildlife habitat.

Representative profile of Dagflat very cobbly sandy loam, 30 to 60 percent slopes, in an area of Dagflat-Motoqua complex, 30 to 70 percent slopes, in the area of the East Fork of Beaver Dam Wash, near Hamburg Peak, at the southwest corner of sec. 14, T. 39 S., R. 18 W.:

- A11—0 to 2 inches, dark reddish-gray (5YR 4/2) very cobbly coarse sandy loam, dark reddish brown (5YR 2/2) when moist; moderate, fine, granular structure; loose, friable, slightly sticky and slightly plastic; many fine roots; 65 percent of surface covered with cobbles and stones; slightly acid; clear, smooth boundary.
- A12—2 to 6 inches, dark reddish-gray (5YR 4/2) coarse sandy loam, dark reddish brown (5YR 2/2) when moist; moderate, fine and medium, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; slightly acid; clear, smooth boundary.
- B1t—6 to 9 inches, reddish-brown (5YR 5/3) coarse sandy loam, dark reddish brown (5YR 3/3) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few fine, medium, and coarse roots; common fine pores; slightly acid; gradual, wavy boundary.
- B21t—9 to 17 inches, reddish-brown (5YR 5/3) coarse sandy clay loam, dark reddish brown (5YR 3/3) when moist; strong, coarse, subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few fine and medium roots; common fine pores; common thin clay films on faces of peds and in pores; slightly acid; gradual, wavy boundary.
- B22t—17 to 26 inches, reddish-brown (5YR 5/3) coarse sandy loam, reddish brown (5YR 4/3) when moist; strong, coarse, subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few fine and medium roots; common fine pores; common thin clay films on faces of peds and in pores; slightly acid; gradual, wavy boundary.
- C—26 to 30 inches, light-brown (7.5YR 6/4) coarse loamy sand, brown (7.5YR 4/2) when moist; massive; extremely hard, weathered bedrock that can be cut with a spade.
- R—30 inches, bedrock (dacite).

The average annual soil temperature at a depth of 20 inches is 47° to 54° F. The profile ranges from slightly acid to neutral and is non-calcareous throughout.

The A horizon has hue of 5YR, 7.5YR, or 10YR; value of 3 to 5 when dry and 2 or 3 when moist; and chroma of 2 or 3. It is very cobbly sandy loam or very cobbly loam that is 50 to 80 percent cobbles and gravel.

The B2t horizon has hue of 5YR, 7.5YR, or 10YR; value of 4 to 6 when dry and 2 to 4 when moist; and chroma of 2 to 4. It is coarse sandy clay loam or sandy clay loam.

The C horizon is coarse sandy loam or coarse loamy sand. It is mainly weathered rock that is very hard but can be cut with a spade.

part of the survey area. It is about 50 percent Dagflat very cobbly sandy loam, 30 to 60 percent slopes; 30 percent Motoqua very gravelly sandy loam, 30 to 70 percent slopes; and 20 percent other soils. The Dagflat soil is on mountain side slopes, and the Motoqua soil is dominantly on ridge crests and on some of the steeper south- and west-facing slopes.

Included with these soils in mapping are small areas of Quazo very gravelly sandy loam, 30 to 70 percent slopes; a sandy clay loam that is very shallow over bedrock; and Rock outcrop, which is about 5 percent of the area. Also included, in the area known as Daggett Flat, are areas of a soil that is similar to this Dagflat soil but has slopes of 10 to 30 percent and is 40 to 60 inches deep over bedrock.

The soils in this complex are used for range and wildlife habitat. The native vegetation is live oak, serviceberry, big sagebrush, Nevada bluegrass, and scattered pinyon pine and juniper. Capability unit VII_s-V, nonirrigated; wildlife suitability group 3242; Dagflat soil in Southern Upland Loam (Shrub) range site; Motoqua soil in Upland Stony Hills (Juniper) Summer Precipitation range site.

Dalcan Series

The Dalcan series consists of well-drained soils on old lava flows on foothills and fans in the Lava Point area of Zion National Park. These soils formed in material weathered from basalt. Slopes range from 0 to 15 percent. Elevation is 6,000 to 8,000 feet. The native vegetation is dominantly Gambel oak, ponderosa pine, sagebrush, and grasses. Average annual precipitation is 16 to 18 inches, average annual air temperature is 42° to 45° F, and the frost-free period is 90 to 110 days. Dalcan soils are commonly associated with Paunsaugunt, Detra, and Kolob soils.

In a representative profile the surface layer is dark-brown cobbly loam about 4 inches thick. The subsoil is dark-brown cobbly silty clay loam and very cobbly clay loam and brown very cobbly clay about 23 inches thick. Bedrock is at a depth of about 27 inches.

Permeability is slow. Available water capacity is 2.5 to 4 inches. The water supplying capacity is 5 to 7 inches. Roots penetrate as far down as bedrock.

Dalcan soils are used for recreation, wildlife habitat, and range.

Representative profile of Dalcan cobbly loam, 0 to 15 percent slopes, in an area of range about 1,000 feet north of the south quarter corner of sec. 26, T. 39 S., R. 11 W., in Zion National Park:

- A1—0 to 4 inches, dark-brown (7.5YR 4/3) cobbly loam, very dark brown (7.5YR 2/2) when moist; weak, very thick, platy structure; soft, friable, slightly sticky and slightly plastic; few medium and fine and common very fine roots; few fine and many very fine vesicular pores; 40 percent gravel, cobbles, and stones; neutral; clear, smooth boundary.
- B1—4 to 9 inches, dark-brown (7.5YR 3/3) cobbly silty clay loam, very dark brown (7.5YR 2/2) when moist; moderate, fine, subangular blocky; hard, firm, sticky and plastic; few medium, fine, and very fine roots; many very fine tubular pores; 40 percent gravel, cobbles, and stones; common thin clay films on faces of peds; neutral; clear, wavy boundary.
- B21t—9 to 16 inches, dark-brown (7.5YR 3/3) very cobbly heavy clay loam, dark brown (7.5YR 3/2) when moist; moderate, fine, prismatic structure that parts to moderate, fine, angular blocky; very hard, very firm, sticky and very plastic; few fine and very fine roots; many very fine tubular pores; 55 percent gravel, cobbles, and stones; many moderately thick clay films on faces

Dagflat-Motoqua complex, 30 to 70 percent slopes (DAG).—This complex is on mountains in the northwestern

of peds; neutral; gradual, wavy boundary.

B22t—16 to 27 inches, very cobbly clay, brown (7.5YR 4/4) when crushed and dark brown (7.5YR 3/2) when moist; dark-brown (7.5YR 3/2) ped surfaces; strong, medium and fine, prismatic structure that parts to moderate, medium and fine, angular blocky; extremely hard, extremely firm, very sticky and very plastic; few very fine roots; many very fine tubular pores; 65 percent gravel, cobbles, and stones; many thick clay films on faces of peds and on coarse fragments; neutral; abrupt, wavy boundary.

R—27 inches, fractured, somewhat weathered basalt bedrock.

Depth to bedrock ranges from 21 to 34 inches. The average annual soil temperature at a depth of 20 inches is 44° to 47° F, and the average summer soil temperature is 62° to 65°. The profile is noncalcareous throughout and is neutral or slightly acid.

The A1 horizon has hue of 7.5YR or 10YR, value of 3 or 4 when dry and 2 or 3 when moist, and chroma of 2 or 3 when dry and 1 or 2 when moist. It ranges from very cobbly fine sandy loam to cobbly heavy loam and, in some small areas, to stony loam. It is 1 inch to 4 inches thick.

The B2t horizon has hue of 7.5YR or 5YR, value of 3 or 4 when dry and 2 or 3 when moist, and chroma of 2 to 4. It ranges from very cobbly heavy clay loam to very cobbly or cobbly clay that is 35 to 70 percent rock fragments.

Dalcan cobbly loam, 0 to 15 percent slopes (DBD)—This undulating soil is on old lava flows. Runoff is medium, and the hazard of erosion is slight. Slopes are medium in length.

Included with this soil in mapping are small areas of Kolob very stony silt loam, 20 to 50 percent slopes; Detra fine sandy loam, 5 to 20 percent slopes; Kolob silt loam, brown variant, 10 to 30 percent slopes; Rock outcrop, which is 2 percent of the areas; and Stony colluvial land, which is 4 percent of the areas.

This Dalcan soil is used mainly for recreation, wildlife habitat, and range. The native vegetation is muttongrass, letterman needlegrass, western wheatgrass, Gambel oak, manzanita, ponderosa pine, and concolor fir. Capability unit VIIs-L, nonirrigated; Mountain Stony Loam (Summer Precipitation) range site; wildlife suitability group 3141.

Detra Series

The Detra series consists of well-drained soils on mesa tops and mountain side slopes in Zion National Park. These soils formed in material weathered from limestone and some sandstone. Slopes range from 2 to 30 percent. Elevation is 6,200 to 8,200 feet. The native vegetation is shrubs, grasses, and scattered Gambel oak. Average annual precipitation ranges from 16 to 18 inches, average annual air temperature is 42° to 45° F, and the frost-free period is 90 to 120 days. Detra soils are commonly associated with Kolob, Dalcan, and Kinesava soils.

In a representative profile the surface layer is dark-brown fine sandy loam about 8 inches thick. The subsoil is dark-brown and yellowish-red sandy clay loam and clay loam about 36 inches thick. Bedrock is at a depth of about 44 inches.

Permeability is moderate. Runoff is slow, and the hazard of erosion is slight. Available water capacity is about 5 to 7 inches. The water supplying capacity is 11 to 14 inches. Roots easily penetrate as far down as bedrock.

Detra soils are used for recreation, wildlife habitat, and range.

Representative profile of Detra fine sandy loam, 2 to 5 percent slopes, in an area of Kinesava-Detra fine sandy loams, 2 to 15 percent slopes, on Cable Mountain Road near

the deer enclosure area, about 1,200 feet south and 800 feet east of the northeast corner of sec. 13, T. 41 S., R. 10 W.:

A11—0 to 3 inches, dark-brown (7.5YR 3/2) fine sandy loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; mildly alkaline; clear, smooth boundary.

A12—3 to 8 inches, dark-brown (7.5YR 3/2) fine sandy loam, very dark brown (10YR 2/2) when moist; moderate, coarse, subangular blocky structure that parts to moderate, medium, granular; slightly hard, friable, slightly sticky and slightly plastic; many fine and common medium roots; mildly alkaline; clear, smooth boundary.

B1t—8 to 14 inches, dark-brown (7.5YR 3/2) sandy clay loam, very dark brown (7.5YR 2/2) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; common fine and few medium roots; common fine and few medium pores; mildly alkaline; clear, smooth boundary.

B2t—14 to 27 inches, dark-brown (7.5YR 4/2) sandy clay loam, dark brown (7.5YR 3/2) when moist; moderate, coarse, subangular blocky structure; very hard, firm, sticky and plastic; common fine roots; common fine and few medium pores; few thin clay films; mildly alkaline; clear, wavy boundary.

B22t—27 to 44 inches, yellowish-red (5YR 4/6) clay loam, yellowish red (5YR 4/6) when moist; strong, medium, prismatic structure that parts to moderate, medium, subangular blocky; extremely hard, extremely firm, very sticky and very plastic; common fine roots; few fine pores; common moderately thick clay films; moderately alkaline; abrupt, irregular boundary.

R—44 inches, limestone bedrock; clay loam from B22t horizon extends into the cracks.

Depth to bedrock ranges from 40 to about 60 inches. The average annual soil temperature at a depth of 20 inches is 44° to 47° F, and the average summer soil temperature is 62° to 65°.

The A horizon has hue of 7.5YR, 10YR, or 5YR; value of 2 to 4 when dry and 2 or 3 when moist; and chroma of 1 to 3. It is dominantly fine sandy loam but ranges to light sandy clay loam.

The B2t horizon has hue of 7.5YR or 5YR, value of 4 or 5 when dry and 2 to 4 when moist, and chroma of 2 to 6. It is dominantly clay loam but ranges to sandy clay loam in the upper part.

Detra-Kolob complex, 20 to 50 percent slopes (DKG)—This complex is mainly on the Horse Pasture Plateau near Lava Point Lookout in Zion National Park. It is about 50 percent Detra fine sandy loam, 20 to 30 percent slopes; 40 percent Kolob very stony silt loam, 20 to 50 percent slopes; and 10 percent other soils. The Detra soil has short slopes and is on mountains. The Kolob soil is steep to very steep, has short slopes, and is on mountains below outcrops of basalt rock.

The Detra soil has a profile similar to the one described as representative of the Detra series, but it has slopes of 20 to 30 percent. The Kolob soil has profile similar to the one described as representative of the Kolob series, but the surface layer is about 30 percent stones.

Included with these soils in mapping are small areas of Stony colluvial land; Kinesava fine sandy loam, 2 to 15 percent slopes; and Rock outcrops, which is about 2 percent of the areas.

The soils in this complex are used mainly for recreation, wildlife habitat, and range. Capability unit VIIs-L, nonirrigated; Detra soil in Mountain Loam (Summer Precipitation) range site and wildlife suitability group 2141; Kolob soil in Mountain Stony Loam (Summer Precipitation) range site and wildlife suitability group 3141.

Draper Series

The Draper series consists of somewhat poorly drained soils on alluvial fans and on the North Ash Creek flood

plain near New Harmony. These soils formed in mixed, noncalcareous or slightly calcareous alluvium weathered from coarse-grained acid igneous rock and some basalt. Slopes are short and convex, and they range from 2 to 5 percent. Elevation is 5,000 to 5,400 feet. The native vegetation is meadow sedges and grasses. Average annual precipitation is about 15 inches, average annual air temperature is 45° to 52° F, and the frost-free period is 140 to 150 days. Draper soils commonly are associated with Lavate and Naplene soils.

In a representative profile the surface layer is dark-gray loam about 7 inches thick. The underlying material is dark grayish-brown sandy loam and grayish-brown or brown loam to a depth of 60 inches.

Permeability is moderate. Available water capacity is 8 to 11 inches to a depth of 5 feet. Roots penetrate to a depth of 5 feet or more.

Draper soils are used for irrigated pasture, apples, and native meadow pasture.

Representative profile of Draper loam, 2 to 5 percent slopes, in an area of pasture one-half mile southwest of New Harmony, 2,030 feet north and 875 feet west of the southeast corner of sec. 21, T. 38 S., R. 13 W.:

- Ap—0 to 7 inches, dark-gray (10YR 4/1) loam, black (7.5YR 2/1) when moist; moderate, medium, subangular blocky structure that parts to moderate, very fine, granular; slightly hard, very friable, slightly sticky and nonplastic; many very fine and fine roots; few fine and many very fine tubular pores; 15 percent gravel 2 to 3 millimeters in diameter; slightly acid; clear, smooth boundary.
- C1—7 to 11 inches, dark grayish-brown (10YR 4/2) coarse sandy loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure that parts to moderate, fine, granular; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; few fine and many very fine tubular pores; 15 to 20 percent gravel 2 to 4 millimeters in diameter; slightly acid; clear, smooth boundary.
- C2—11 to 36 inches, grayish-brown (10YR 5/2) loam, very dark brown (10YR 2/2) when moist; moderate, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine and many very fine tubular pores; 15 percent gravel 2 to 4 millimeters in diameter; neutral; gradual, smooth boundary.
- C3—36 to 60 inches, brown (7.5YR 5/2) loam, dark brown (7.5YR 3/2) when moist; very fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; 15 to 20 percent gravel 2 to 5 millimeters in diameter; neutral.

Gravel ranges from 2 to 5 millimeters in diameter. The profile ranges from slightly acid to mildly alkaline. It is generally noncalcareous but is slightly calcareous in places. The average annual soil temperature at a depth of 20 inches is 45° to 57° F, and the average summer temperature is 65° to 70°.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 1 or 2. It is loam that is marginal to sandy loam. It ranges from 7 to 12 inches in thickness.

The C horizon has value of 4 to 6 when dry and 2 to 4 when moist and chroma of 1 or 2. It is sandy loam, loam, or sandy clay loam, and in many places it is stratified.

Draper loam, 2 to 5 percent slopes (DrB).—This soil is on alluvial fans and on the flood plain of North Ash Creek near Harmony. Runoff is slow, and the hazard of erosion is none to slight. Depth to the water table is 36 to 60 inches.

Included with this soil in mapping are small areas of a soil that is similar to Draper loam but has a calcareous layer at a depth of about 30 inches; a deep, well-drained gravelly clay loam soil that has a dark-colored surface layer more than 20 inches thick; and noncalcareous, poorly

drained silty clay loam soils in small swales.

This Draper soil is used for irrigated pasture, native meadow pasture, and, in small areas, apples. The native vegetation is slender wheatgrass, muttongrass, tufted hairgrass, sedges, edible valerian, and peavine. Capability unit IIw-1, irrigated; Semiwet Meadows range site; wildlife suitability group 1242-I.

Dune Land

Dune land (DU) consists of sand-sized particles that are drifted and piled up by the wind. The dunes are actively shifting, so that no soil horizons have developed. Slopes are short and broken. Runoff is very slow.

Very little vegetation occurs on these areas, except for short-lived annual grasses. Capability unit VIIIs-6, non-irrigated; wildlife suitability group 4444; range site not assigned.

Eroded Land

Eroded land consists of stratified shale and gypsum. Slopes are gently rolling to steep and are strongly dissected. Erosion is active, and sediment production is high.

The native vegetation is sparse and is dominated by shrubs and forbs. Scattered juniper and pinyon trees are at the higher elevations. Eroded land is mapped only with Shalet soils.

Eroded land-Shalet complex (EA).—This complex is about 60 percent Eroded land and 35 percent Shalet clay loam, 2 to 60 percent slopes. The Shalet soil is in protected swales and on side slopes intermingled with Eroded land. The Shalet soil has the profile described as representative of the Shalet series. Included in mapping, and making up about 5 percent of the acreage, are areas of Schmutz loam.

The soils in this complex are used for wildlife habitat and range. The native vegetation is a very sparse stand of galleta, blackbrush, desert almond, Mormon tea, and pricklypear. Capability unit VIIe-R3, nonirrigated; Shalet soil in Southern Semidesert Shallow Loam range site and wildlife suitability group 4343; Eroded land in wildlife suitability group 4444 and range site not assigned.

Eroded land-Shalet complex, warm (EB).—This complex is about 80 percent Eroded land and 20 percent Shalet clay loam, warm, 2 to 20 percent slopes. The gently sloping Shalet soil is in swales intermingled with Eroded land. Included in mapping are small areas of Badland.

The Shalet soil has a profile similar to the one described as representative of the Shalet series. The average annual air temperature is 59° to 67° F, the frost-free period is about 195 days, and the elevation is 2,600 to 3,600 feet.

The soils in this complex are used mainly for range. The native vegetation is a very sparse stand of galleta, cholla cactus, blackbrush, desert almond, and pricklypear. Capability unit VIIe-C3, nonirrigated; Shalet soil in Southern Desert Stony Loam range site and wildlife suitability group 4343; Eroded land in wildlife suitability group 4444 and range site not assigned.

Esplin Series

The Esplin series consists of shallow, well-drained soils

that are underlain by an indurated carbonate-cemented hardpan. These soils are on old basalt flows and alluvial fans. They formed in material weathered from basalt and in alluvium washed from basalt, limestone, quartzite, and shale. Slopes range from 0 to 3 percent. Elevation is 3,800 to 4,600 feet. The native vegetation is desert shrubs, forbs, grasses, and cactus. Average annual precipitation ranges from 10 to 13 inches, average annual air temperature is 52° to 56° F, and the frost-free period is 160 to 170 days. Esplin soils are commonly associated with Pastura soils.

In a representative profile the surface layer is reddish-brown loam about 3 inches thick. The subsoil is dark-red and yellowish-red clay loam and silty clay loam about 7 inches thick. The substratum is light reddish-brown silt loam about 8 inches thick. A carbonate-cemented hardpan is at a depth of about 18 inches.

Permeability is moderate above the hardpan. Runoff is medium, and the hazard of erosion is moderate. Available water capacity, above the hardpan, is 2 to 3 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as the hardpan.

Esplin soils are used for range.

Representative profile of Esplin loam, 0 to 2 percent slopes, in an area of the Pastura-Esplin complex, 0 to 10 percent slopes, in an area of range about three-fourths mile southwest of Frog Hollow Dam, 400 feet south and 300 feet west of the northeast corner of sec. 26, T. 42 S., R. 13 W.:

- A1—0 to 3 inches, reddish-brown (5YR 4/4) loam, yellowish red (5YR 3/6) when moist; moderate, very fine, granular structure; soft, friable, slightly sticky and slightly plastic; common fine and few medium roots; many vesicular pores; about 10 percent of the surface is covered with fragments of basalt gravel and the hardpan; noncalcareous; moderately alkaline; clear, smooth boundary.
- B2t—3 to 7 inches, dark-red (2.5YR 3/6) clay loam, dark red (2.5YR 3/6) when moist; weak, coarse, prismatic structure that parts to moderate, medium, subangular blocky; very hard, firm, sticky and plastic; common fine and medium roots; common fine and few medium interstitial pores; common moderately thick clay films in pores and on faces of ped; noncalcareous; moderately alkaline; clear, smooth boundary.
- B3ca—7 to 10 inches, yellowish-red (5YR 4/6) light silty clay loam, yellowish red (5YR 3/6) when moist; moderate, medium, subangular blocky structure; hard, friable, sticky and plastic; common fine and medium roots; common fine and few medium interstitial pores; strongly calcareous, lime occurs as accretions and veins; strongly alkaline; clear, wavy boundary.
- C1ca—10 to 18 inches, light reddish-brown (5YR 6/4) silt loam, yellowish red (5YR 5/6) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and few medium roots; common fine and few medium interstitial pores; strongly calcareous, lime occurs as accretions and veins; strongly alkaline; abrupt, smooth boundary.
- C2cam—18 inches, indurated carbonate-cemented hardpan.

Depth to the hardpan ranges from 13 to 20 inches. Gravel covers 3 to 80 percent of the soil surface. The average annual soil temperature at a depth of 20 inches is 54° to 58° F, and the average summer soil temperature is 71° to 76°. The profile is mildly alkaline to strongly alkaline.

The A1 horizon has hue of 5YR or 7.5YR, value of 4 to 6 when dry and 3 or 4 when moist, and chroma of 2 to 6. It is loam or fine sandy loam.

The B2t horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 3 to 5 when dry and 3 or 4 when moist; and chroma of 2 to 6. It is clay loam or sandy clay loam.

Esplin soils in the Washington County Area are mapped only with Pastura soils.

Fluvaquents and Torrifluents, Sandy

Fluvaquents and Torrifluents, sandy (FA), is on flood plains of the Virgin River, mainly in the area of Hurricane and St. George. This mapping unit is about 60 percent Fluvaquents and 40 percent Torrifluents. Fluvaquents are in swales and oxbows, and Torrifluents are on slightly higher terraces and benches, mostly along the edges of the flood plain. Included in mapping are small areas of Tobler fine sandy loam, Tobler silty clay loam, and Riverwash.

Fluvaquents are deep, somewhat poorly drained and poorly drained soils that formed in sandy alluvial deposits derived from sandstone, limestone, and shale. Slopes range from 0 to 2 percent. Elevation is 2,500 to 3,000 feet. The native vegetation is sedges, wiregrass, and cattails. Average annual precipitation is 8 to 11 inches, average annual temperature is 57° to 67° F, and the frost-free period is 190 to 205 days.

Fluvaquents are dominantly fine sand but are commonly stratified with fine sandy loam, silt loam, and loamy fine sand.

Depth to the water table fluctuates with the water level of the river. During periods of high runoff, many areas of Fluvaquents are flooded for short periods of time. High runoff can occur in winter, in spring, or late in summer. Permeability is rapid. Runoff is slow, and the hazard of erosion is severe.

Torrifluents are deep, well drained and moderately well drained soils that formed in alluvial deposits derived from sandstone, limestone, and shale. Slopes range from 0 to 3 percent. Elevation is 2,500 to 3,000 feet. The native vegetation is Kentucky bluegrass, galleta, saltgrass, red willow, and black willow. Average annual precipitation is 8 to 11 inches, average annual temperature is 57° to 67° F, and the frost-free period is 190 to 195 days.

Torrifluents are dominantly loamy fine sand and fine sandy loam stratified with silt loam and loam.

Depth to the water table fluctuates with the water level of the river, but normally it is more than 40 inches. Permeability is rapid. Runoff is slow, and the hazard of erosion is moderate to severe.

These soils are suited to limited use for grazing and wildlife habitat. Capability unit VIIw-07, nonirrigated; Semi-wet Stream Bottoms range site; wildlife suitability group 4424.

Gullied Land

Gullied land (GA) consists of areas that are so cut by gullies that any soil profiles have been destroyed. These areas support little or no vegetation and have no value for farming. Most have shallow soil material, but leveling is not practical. Gullied land is suited to limited use for grazing and wildlife habitat. Capability unit VIIIe-E, nonirrigated; wildlife suitability group 4444; range site not assigned.

Hantz Series

The Hantz series consists of well-drained soils on alluvial flood plains. These soils formed in mixed alluvium derived from limestone, shale, and sandstone. Slopes are 0

to 2 percent. Elevation is 2,700 to 3,300 feet. The native vegetation is desert shrubs and grasses. Average annual precipitation is 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period is 190 to 200 days. Hantz soils are associated with St. George, Tobler, and Leeds soils.

In a representative profile the surface layer is brown silty clay loam about 9 inches thick. The underlying material is light-brown or light reddish-brown silty clay to a depth of 70 inches. The profile is calcareous and moderately alkaline throughout.

Permeability is slow. Available water capacity is 8 to 12 inches to a depth of 5 feet. Roots penetrate to a depth of 60 inches or more. In some places the water table is at a depth of 4 to 5 feet during the irrigation season.

Hantz soils are used for irrigated crops.

Representative profile of Hantz silty clay loam, in an area of irrigated crops 2 miles south of Washington, about 600 feet east of the north quarter corner of sec. 34, T. 42 S., R. 15 W.:

Ap—0 to 9 inches, brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/2) when moist; weak, medium, subangular blocky structure; very hard, friable, slightly sticky and plastic; common fine roots; common fine and few medium tubular pores; slightly calcareous; moderately alkaline; clear, smooth boundary.

C1—9 to 19 inches, light-brown (7.5YR 6/4) silty clay, dark brown (7.5YR 3/4) when moist; massive; hard, firm, sticky and very plastic; few fine roots; common fine tubular pores; moderately calcareous; moderately alkaline; clear, smooth boundary.

C2—19 to 47 inches, light reddish-brown (5YR 6/4) silty clay, reddish brown (5YR 4/4) when moist; massive; hard, firm, sticky and very plastic; few fine roots; common fine and few medium tubular pores; 2-inch layer of loamy sand between depths of 45 and 47 inches; moderately calcareous; moderately alkaline; gradual, wavy boundary.

C3—47 to 70 inches, light reddish-brown (5YR 6/4) silty clay, yellowish red (5YR 4/8) when moist; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; hard, firm, sticky and plastic; few fine roots; common fine tubular pores; about 3 percent common fine, soft masses of gypsum; moderately calcareous; moderately alkaline.

The average annual soil temperature at a depth of 20 inches ranges from 59° to 67° F. The profile is slightly calcareous to moderately calcareous.

The A horizon has hue of 7.5YR or 5YR, value of 5 or 6 when dry and 4 when moist, and chroma of 2 to 4. It is dominantly silty clay loam, but in places it is light silty clay. It ranges from 7 to 10 inches in thickness.

The C horizon has hue of 7.5YR or 5YR, value of 6 when dry and 3 or 4 when moist, and chroma of 4 to 8. It is dominantly silty clay or clay, but thin strata of sandy loam, loam, and loamy sand are in the lower part. It is less than 5 percent, by volume, small masses or veins of gypsum.

Hantz silty clay loam (Ha).—This soil is on old alluvial flood plains near St. George and in the area of Bench Lake. Slopes are 0 to 2 percent. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of St. George silty clay loam, moderately saline; Tobler silty clay loam; and Leeds silty clay loam, 0 to 1 percent slopes.

This Hantz soil is used for irrigated small grain and pasture. Capability unit IIIs-05, irrigated; wildlife suitability group 1242-I; range site not assigned.

Harrisburg Series

The Harrisburg series consists of well-drained soils that are underlain by a carbonate-cemented hardpan at a depth

of 24 to 40 inches. These soils are on desert mesas. They formed in residuum weathered from sandstone and wind-blown sediments derived from sandstone, volcanic ash, and shale. Slopes range from 0 to 20 percent. Elevation is 2,800 to 3,500 feet. The native vegetation is creosotebush, galleta, filaree, yellowbrush, and cheatgrass. Average annual precipitation ranges from 8 to 11 inches, average annual air temperature is 57° to 65° F, and the frost-free period is 190 to 195 days. Harrisburg soils are commonly associated with Bermesa, Pintura, Tobler, and Winkel soils.

In a representative profile the surface layer is yellowish-red fine sandy loam about 2 inches thick. The underlying material is yellowish-red fine sandy loam to a depth of 35 inches. An indurated carbonate-cemented hardpan is at a depth of 35 inches. The profile is moderately alkaline throughout.

Permeability is moderately rapid. Available water capacity, above the hardpan, is 3.5 to 5.0 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as the hardpan.

Harrisburg soils are used mainly for range. Small irrigated areas are used for small grain, alfalfa, and pasture.

Representative profile of Harrisburg fine sandy loam, 1 to 5 percent slopes, in an area of range east of the old St. George Airport, 1,600 feet south and 1,600 feet east of the northwest corner of sec. 24, T. 43 S., R. 15 W.:

A1—0 to 2 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) when moist; weak, thin, platy structure; loose, very friable, nonsticky and nonplastic; common fine and very fine roots; common fine and very fine vesicular pores; 5 percent gravel; slightly calcareous; moderately alkaline; abrupt, smooth boundary.

C1—2 to 26 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) when moist; weak, medium, subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; common fine and very fine tubular pores; 5 percent gravel; slightly calcareous; moderately alkaline; clear, smooth boundary.

C2—26 to 35 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) when moist; weak, medium, subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; common fine and very fine tubular pores; slightly calcareous; moderately alkaline; abrupt, wavy boundary.

C3cam—35 inches, indurated carbonate-cemented hardpan.

Depth to the hardpan ranges from 24 to 40 inches. The average annual soil temperature at a depth of 20 inches is 59° to 63° F, and the average summer soil temperature is 77° to 82°.

The A horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist, and chroma of 4 to 6. It is fine sandy loam or loamy fine sand that ranges from neutral to moderately alkaline.

The C horizon has hue of 5YR or 2.5YR, value of 5 or 6 when dry and 3 to 5 when moist, and chroma of 4 to 8. It ranges from fine sandy loam to very fine sandy loam or loamy fine sand or gravelly fine sandy loam that is 5 to 30 percent gravel. It is moderately calcareous to strongly calcareous and mildly alkaline to strongly alkaline.

Harrisburg fine sandy loam, 1 to 5 percent slopes (HbC).—This nearly level to sloping soil is on mesas. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Toquerville fine sand, 2 to 20 percent slopes; Pintura loamy fine sand, 1 to 5 percent slopes; and Tobler fine sandy loam. Also included are areas of Rock land, which make up about 2 percent of the mapped area.

This Harrisburg soil is used mainly for range. Some small areas are used for irrigated alfalfa, small grain, and

pasture. The native vegetation is mainly creosotebush, galleta, filaree, yellowbrush, and blackbrush. Capability units IIIs-03, irrigated, VIIe-C, nonirrigated; Southern Desert Loam range site; wildlife suitability group 4343.

Harrisburg-Rock land association (HD).— This soil association is on mesa remnants about 1 mile to 3 miles north and northeast of St. George. It is about 65 percent Harrisburg fine sandy loam, 5 to 20 percent slopes; 15 percent Rock land; and 20 percent other soils. Rock land is interspersed areas of bare rock and rock that has a thin covering of fine sand. In most places it is somewhat higher on the slope than the Harrisburg soil. Runoff is medium, and the hazard of erosion is moderate.

The Harrisburg soil has a profile similar to the one described as representative of the Harrisburg series, but it is steeper. It has a sparse vegetative cover of creosotebush, blackbrush, galleta, cheatgrass, and filaree.

Included with this association in mapping are small areas of Toquerville fine sand, 2 to 20 percent slopes, and Pintura loamy fine sand, hummocky, 1 to 10 percent slopes.

The soil in this mapping unit is used for range. Wildlife suitability group 4343; Harrisburg soil in capability unit VIIe-C, nonirrigated, and Southern Desert Loam range site; Rock land in capability unit VIIIs-X, nonirrigated; range site not assigned.

Hobog Series

The Hobog series consists of shallow, well-drained soils that are 8 to 20 inches deep over bedrock. These soils are on mesas and mountain side slopes. They formed in material weathered from sandstone. Slopes range from 3 to 40 percent. Elevation is 2,600 to 3,800 feet. The native vegetation is desert shrubs, forbs, grasses, and cactus. Average annual precipitation is 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period is 190 to 195 days. Hobog soils are commonly associated with Renbac and Tobler soils.

In a representative profile the surface layer is reddish-brown very cobbly loam about 4 inches thick. The underlying material is reddish-yellow very flaggy loam about 9 inches thick. Sandstone bedrock is at a depth of about 13 inches.

Permeability is moderate. Runoff is rapid, and the hazard of erosion is severe. Available water holding capacity is 1 inch to 2 inches. The water supplying capacity is 2 to 4 inches. Roots penetrate as far down as bedrock.

Hobog soils are used for range.

Representative profile of Hobog very cobbly loam, 3 to 40 percent slopes, in an area of Hobog-Rock land association, in an area of range about 3 miles southeast of St. George, 400 feet north and 1,200 feet east of the southwest corner of sec. 34, T. 42 S., R. 15 W.:

A1—0 to 4 inches, reddish-brown (5YR 5/4) very cobbly loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure (uppermost ¼ inch has weak, thin, platy structure); slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; moderately calcareous, lime is disseminated; strongly alkaline; clear, smooth boundary.

Cca—4 to 13 inches, reddish-yellow (5YR 6/6) very flaggy loam, reddish brown (5YR 4/4) when moist; massive; slightly hard, friable, sticky and plastic; few fine roots; few fine tubular pores; moderately calcareous, lime is mainly disseminated, but some hard coatings on undersides of rock fragments are strongly calcareous; moderately alkaline; abrupt, wavy boundary.

R—13 inches, sandstone bedrock.

Depth to bedrock ranges from 8 to 20 inches. The average annual soil temperature at a depth of 20 inches is 59° to 65° F, and the average summer soil temperature is 77° to 82° F. The profile is moderately alkaline or strongly alkaline. It is 35 to 75 percent rock fragments.

The A1 horizon has hue of 5YR or 7.5YR and chroma of 3 or 4. It ranges from very cobbly loam to gravelly fine sandy loam.

The C horizon has hue of 5YR or 7.5YR. It ranges from very flaggy loam to very gravelly loam.

Hobog-Rock land association (HG).— This association is about 50 percent Hobog very cobbly loam, 3 to 40 percent slopes; 40 percent Rock land; and 10 percent other soils. The Hobog soil is on mesas, and Rock land is on ridges and sharp breaks along drainageways.

Included with this soil in mapping are small areas of Renbac channery clay loam, 2 to 30 percent slopes, and exposed bedrock, which makes up about 5 percent of the areas.

The Hobog soil in this association is used for range. The native vegetation is creosotebush, blackbrush, bursage, Mormon tea, desert almond, galleta, cheatgrass, and cholla cactus. Wildlife suitability group 4343; Hobog soil in capability unit VIIs-C3, nonirrigated, and Southern Desert Stony Loam range site; Rock land in capability unit VIIIs-X, nonirrigated, and range site not assigned.

Hogg Series

The Hogg series consists of well-drained soils on smooth mesa tops in the northeastern part of Zion National Park. These soils formed in material weathered from limestone and sandstone. Slopes range from 2 to 5 percent. Elevation is 6,000 to 7,000 feet. The native vegetation is dominantly ponderosa pine, Gambel oak, shrubs, and grasses. Average annual precipitation ranges from 16 to 18 inches, average annual air temperature is 45° to 50° F, and the frost-free period is 90 to 120 days. Hogg soils are most commonly associated with Paunsaugant and Detra soils.

In a representative profile the surface layer is brown and light-brown fine sandy loam about 25 inches thick. The subsoil is yellowish-red and pink fine sandy loam and clay about 27 inches thick. Limestone bedrock is at a depth of about 52 inches.

Permeability is moderately slow. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 6 to 8 inches to a depth of 5 feet. The water supplying capacity is 11 to 14 inches. Roots penetrate as far down as bedrock.

Hogg soils are used for recreation, wildlife habitat, and range.

Representative profile of Hogg fine sandy loam, 2 to 5 percent slopes, in an area of the Kolob-Hogg complex, 2 to 8 percent slopes, along observation point road in the NW¼NW¼ sec. 36, T. 40 S., E. 10 W.:

O1—¼ inch to 0, leaves and twigs.

A11—0 to 4 inches, brown (10YR 5/3) fine sandy loam, dark brown (7.5YR 3/2) when moist; weak, moderately thick, platy structure that parts to moderate, fine, granular; soft, very friable, non-sticky and nonplastic; few fine roots; mildly alkaline; clear, smooth boundary.

A12—4 to 12 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) when moist; weak, medium, subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and few medium roots; few fine, medium, and coarse pores;

mildly alkaline; clear, smooth boundary.

- A13—12 to 25 inches, light-brown (7.5YR 6/4) fine sandy loam, reddish brown (5YR 4/4) when moist; moderate, medium, subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few fine, medium, and coarse roots; few fine, medium, and coarse pores; mildly alkaline; clear, smooth boundary.
- B1—25 to 36 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) when moist; moderate, medium, subangular blocky structure; very hard, friable, slightly sticky and nonplastic; few fine, medium, and coarse roots; common very fine pores and few fine and medium pores; mildly alkaline; clear, smooth boundary.
- B21t—36 to 49 inches, yellowish-red (5YR 4/8) clay, dark red (2.5YR 3/6) when moist; strong, coarse, prismatic structure; extremely hard, extremely firm; very sticky and plastic; few fine, medium, and coarse roots; few very fine and fine pores; many moderately thick clay films on faces of peds; mildly alkaline; abrupt, smooth boundary.
- B22tca—49 to 52 inches, yellowish-red (5YR 4/8) and pink (7.5YR 8/4) clay, dark red (2.5YR 3/6) and pink (7.5YR 7/4) when moist; moderate, medium, prismatic structure; extremely hard, extremely firm, very sticky and plastic; few medium and coarse roots; few fine pores; common moderately thick clay films on faces of peds; moderately calcareous, lime is segregated in seams; moderately alkaline; abrupt, smooth boundary.
- R—52 inches, limestone bedrock.

The average annual soil temperature at a depth of 20 inches ranges from 44° to 49° F, and the average summer soil temperature is 62° to 65°. The profile ranges from neutral to moderately alkaline.

The A horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 to 6 when dry and 3 or 4 when moist; and chroma of 2 to 4. It ranges from fine sandy loam to light sandy loam.

The B2t horizon has hue of 2.5YR or 5YR, value of 3 to 5 when dry and 3 or 4 when moist, and chroma of 5 to 8.

Hogg soils in the Washington County Area are mapped only with Kolob soils.

Ildefonso Series

The Ildefonso series consists of well-drained soils that are underlain by limestone bedrock. These soils are on low, rolling hills in the north-central part of the survey area. They formed in materials weathered from limestone, conglomerate, sandstone, and some acid igneous rocks. Slopes range from 5 to 30 percent. Elevation is 5,000 to 5,400 feet. The native vegetation is juniper, pinyon pine, shrubs, and grasses. Average annual precipitation is 14 to 15 inches, average annual air temperature is 45° to 52° F, and the frost-free period is 120 to 160 days. Ildefonso soils commonly are associated with Naplene and Nehar soils.

In a representative profile the surface layer is brown very gravelly sandy loam and very gravelly loam about 10 inches thick. The underlying material is pinkish-white and pink very gravelly sandy loam and very cobbly sandy loam to a depth of 40 inches. Limestone bedrock is at a depth of about 40 inches.

Permeability is rapid. Runoff is slow, and the hazard of erosion is moderate. Available water capacity is 3 to 5 inches. The water supplying capacity is 4 to 6 inches. Roots penetrate as far down as bedrock.

Ildefonso soils are used for range and wildlife habitat.

Representative profile of Ildefonso very gravelly sandy loam, 5 to 30 percent slopes, in an area of the Nehar-Ildefonso complex, 3 to 30 percent slopes, in an area of range 3¾ miles southeast of New Harmony, 1,450 feet east and 1,320 feet north of the southwest corner of sec. 31, T. 38 S., R. 12 W.:

- A11—0 to 5 inches, brown (7.5YR 5/3) very gravelly sandy loam, dark brown (7.5YR 3/2) when moist; weak, thick, platy structure that parts to moderate, fine and very fine, granular; slightly

hard, very friable, nonsticky and nonplastic; few fine and common very fine roots; few fine and common very fine vesicular pores; 55 percent gravel and cobbles; strongly calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.

- A12—5 to 10 inches, brown (10YR 5/3) very gravelly loam, dark brown (7.5YR 4/2) when moist; moderate, very fine, granular structure; soft, friable, slightly sticky and nonplastic; few medium and fine and common very fine roots; common fine and very fine pores; strongly calcareous, lime is disseminated; moderately alkaline; clear, wavy boundary.
- C1ca—10 to 21 inches, pinkish-white (7.5YR 8/2) very gravelly sandy loam, light brown (7.5YR 6/4) when moist; weak, coarse, subangular blocky structure; very hard, very friable, nonsticky and nonplastic; few medium, fine, and very fine roots; few medium and fine and common very fine pores; 55 percent gravel and cobbles; very strongly calcareous, lime is disseminated and weakly indurated; moderately alkaline; gradual, wavy boundary.
- C2ca—21 to 28 inches, pink (5YR 7/3) very gravelly sandy loam, light reddish brown (5YR 6/4) when moist; weak, fine, subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few medium, fine, and very fine roots; common very fine pores; very strongly calcareous, lime is disseminated; strongly alkaline; clear, wavy boundary.
- C3—28 to 40 inches, pink (5YR 7/4) very cobbly sandy loam, reddish brown (5YR 5/4) when moist; massive; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; common very fine pores; strongly alkaline; clear, wavy boundary.
- R—40 inches, weathered limestone.

Depth to bedrock ranges from 40 to 50 inches. In some areas as much as 3 percent of the surface is covered with stones. Depth to the Cca horizon is 9 to 16 inches. The profile is moderately alkaline to strongly alkaline. The average annual soil temperature at a depth of 20 inches is 47° to 54° F.

The A horizon has value of 4 to 6 when dry and chroma of 2 to 4. It is sandy loam or loam that is 35 to 60 percent rock fragments of gravel or cobble size. It ranges from 2 to 10 inches in thickness.

The C horizon has hue of 7.5YR, 5 YR, or 10YR; value of 5 to 8 when dry and 4 to 6 when moist; and chroma of 2 to 5. It is sandy loam, loam, sandy clay loam, or clay loam that is 40 to 70 percent rock fragments of gravel size.

Ildefonso soils in the Washington County Area are mapped only with Nehar soils.

Isom Series

The Isom series consists of well-drained soils on alluvial fans and cones. These soils formed in cobbly alluvium washed from limestone, sandstone, and shale. Slopes range from 3 to 30 percent. Elevation is 2,700 to 3,900 feet. The native vegetation is desert shrubs, grasses, and cactus. Average annual precipitation is 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period ranges from 175 to 195 days. Isom soils are commonly associated with Junction, Leeds, Nikey, and Tobler soils.

In a representative profile the surface layer is brown cobbly sandy loam about 2 inches thick. The underlying material is light-brown or pink cobbly sandy loam and very cobbly sandy loam to a depth of 60 inches or more.

Permeability is moderately rapid. Available water capacity is 2 to 5 inches to a depth of 5 feet. The water supplying capacity is 3 to 5 inches. Roots penetrate to a depth of 40 inches or more.

Isom soils are used for range and wildlife habitat.

Representative profile of Isom cobbly sandy loam, 3 to 30 percent slopes, in an area of Nikey-Isom complex, 3 to 30 percent slopes, in an area of range about 8¾ miles south of Hurricane, 1,140 feet south and 1,000 feet east of the northwest corner of sec. 15, T. 43 S., R. 13 W.:

- A1—0 to 2 inches, brown (7.5YR 5/4) cobbly sandy loam, dark brown (7.5YR 4/4) when moist; weak, very fine, granular structure;

soft, very friable, slightly sticky and nonplastic; 50 percent cobbles and gravel; strongly calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.

- C1—2 to 10 inches, light-brown (7.5YR 6/4) cobbly sandy loam, dark brown (7.5YR 4/4) when moist; massive; soft, very friable, slightly sticky and nonplastic; 35 percent cobbles and gravel; strongly calcareous, lime is disseminated; moderately alkaline; clear, wavy boundary.
- C2—10 to 22 inches, light-brown (7.5YR 6/4) very cobbly sandy loam, brown (7.5YR 5/4) when moist; massive; soft, very friable, slightly sticky and nonplastic; 50 percent cobbles and gravel; coating of gypsum on cobbles and pebbles; strongly calcareous, lime is disseminated; moderately alkaline; gradual, wavy boundary.
- C3—22 to 60 inches, pink (7.5YR 7/4) very cobbly sandy loam, light brown (7.5YR 6/5) when moist; single grained; loose, very friable, nonsticky and nonplastic; 65 percent cobbles and gravel; coating of gypsum on cobbles and pebbles; strongly calcareous, lime is disseminated; moderately alkaline.

The soil ranges from 40 to 60 inches or more in thickness. It is 35 to 80 percent cobbles and gravel. It is moderately alkaline to strongly alkaline. The average annual soil temperature at a depth of 20 inches is 59° to 67° F, and the average summer soil temperature is 78° to 83°.

The A horizon has value of 5 or 6 when dry. It is cobbly fine sandy loam, cobbly sandy loam, or gravelly sandy loam.

The C horizon has hue of 7.5YR or 5YR and chroma of 3 to 5. It ranges from cobbly or very cobbly very sandy loam to very gravelly sandy loam.

Isom cobbly sandy loam, 3 to 30 percent slopes (IAF).—This rolling soil is on dissected hills and alluvial fans. Runoff is medium, and the hazard of erosion is moderate to high. Roots penetrate to a depth of 40 inches or more.

Included with this soil in mapping are small areas of Nikey sandy loam, 3 to 15 percent slopes, and a shallow very gravelly sandy loam soil on ridge crests.

This Isom soil is used for range. The native vegetation is creosotebush, Mormon tea, cholla cactus, galleta, Indian ricegrass, and cheatgrass. Capability unit VIIs-C4, nonirrigated; Southern Desert Stony Loam range site; wildlife suitability group 4343.

Ivins Series

The Ivins series consists of somewhat excessively drained soils on desert benches or terraces. These soils formed in sandy eolian deposits derived from sandstone and shale. Slopes range from 1 to 5 percent. Elevation is 2,800 to 3,800 feet. The native vegetation is desert shrubs, forbs, and grasses. Average annual precipitation ranges from 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period is 170 to 195 days. Ivins soils are commonly associated with Junction, Pintura, and Tobler soils.

In a representative profile the soil is red loamy fine sand to a depth of about 24 inches. This is underlain by dark-red or red and pink sandy clay loam or dark-red sandy clay to a depth of about 64 inches.

Permeability is rapid to a depth of 24 inches and moderately slow below. Available water capacity is 6 to 9 inches to a depth of 5 feet. The water supplying capacity is 5 to 6 inches. Roots penetrate to a depth of 5 feet or more. Ivins soils are used for range and irrigated crops.

Representative profile of Ivins loamy fine sand, about 1 mile west of Ivins turnoff on Highway 91, 150 feet north of highway, 1,200 feet north and 200 feet east of the south quarter corner of sec. 6, T. 42 S., R. 16 W.:

A1—0 to 4 inches, red (2.5YR 4/8) loamy fine sand, yellowish red (5YR 3/6) when moist; weak, thin, platy structure; soft, very friable; common fine and very fine roots; few fine tubular and many fine interstitial pores; mildly alkaline; clear, smooth boundary.

C—4 to 24 inches, red (2.5YR 4/8) loamy fine sand, yellowish red (5YR 3/6) when moist; single grained; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine and few tubular pores; moderately alkaline; gradual, slightly wavy boundary.

IIB21tb—24 to 30 inches, dark-red (2.5YR 3/8) sandy clay loam, dark red (10YR 3/6) when moist; weak, medium and coarse, prismatic structure; very hard, friable, sticky and plastic; few very fine roots; common fine and very fine pores; few thin clay films on faces of peds; mildly alkaline; irregular, wavy boundary.

IIB22tb—30 to 39 inches, dark-red (2.5YR 3/6) light sandy clay, dark red (10YR 3/6) when moist; moderate, medium and coarse, prismatic structure; extremely hard, firm, sticky and very plastic; few very fine roots; common very fine and fine and few medium pores; many thin clay films on faces of peds and in pores; peds are slightly calcareous, lime is disseminated and in soft irregular accretions and veins that are strongly calcareous; mildly alkaline; clear, wavy boundary.

IIB3cab—39 to 64 inches, red (2.5YR 4/6) and pink (5YR 7/4) sandy clay loam, dark red (2.5YR 3/6) and reddish yellow (5YR 6/6) when moist; weak, medium, prismatic structure that parts to moderate, subangular blocky; very hard, firm, sticky and plastic; few very fine roots, mostly in upper part; few very fine pores; few stones and cobbles that increase in amount with increasing depth; strongly calcareous, lime coatings on faces of peds and in irregular nodules and veins.

The loamy fine sand material ranges from 18 to 39 inches in thickness. The average annual soil temperature at a depth of 20 inches is 59° to 68° F, and the average summer soil temperature is 77° to 82°.

The A and C horizons have hue of 2.5YR or 5YR, value of 4 or 5 when dry, and chroma of 6 to 8.

The IIB2tb horizon has hue of 2.5YR or 10YR and chroma of 4 to 8. The IIB3cab horizon has hue of 2.5YR or 5YR, value of 3 to 7 when dry and 3 to 6 when moist, and chroma of 4 to 6.

A weak, thin, carbonate-cemented hardpan is at a depth of about 50 inches in some places.

Ivins loamy fine sand (Ib).—This soil is on desert benches or terraces that are capped with sandy eolian deposits. Slopes range from 1 to 5 percent. This soil has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Pintura loamy fine sand, 1 to 5 percent slopes; Tobler fine sandy loam; and Ivins loamy fine sand, hummocky.

This Ivins soil is used mainly for range and irrigated alfalfa and small grain. Capability units IIIs-06, irrigated, VIIs-C6, nonirrigated; Southern Desert Sand range site; wildlife suitability groups 2242-I and 4343.

Ivins loamy fine sand, hummocky (Ic).—This soil is on desert benches or terraces that are capped with sandy eolian deposits. Slopes range from 1 to 5 percent. This soil has a profile similar to the one described as representative of the series, but hummocks 18 to 36 inches high are on the surface. Runoff is slow, and the hazard of soil blowing is severe.

Included with this soil in mapping are small areas of Pintura loamy fine sand, 1 to 5 percent slopes, and Dune land, which makes up about 2 percent of the mapped areas.

This Ivins soil is used for range. Capability unit VIIs-C6, nonirrigated; Southern Desert Sand range site; wildlife suitability group 4343.

Junction Series

The Junction series consists of well-drained soils on

alluvial fans and flood plains and in desert valleys. These soils formed in alluvium washed from sandstone and shale. Slopes range from 1 to 5 percent. Elevation is 2,700 to 3,400 feet. The native vegetation is desert shrubs, forbs, and grasses. Average annual precipitation is 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period is 190 to 195 days. Junction soils are commonly associated with Pintura, St. George, and Tobler soils.

In a representative profile the soil is red fine sandy loam to a depth of 60 inches or more. The profile is mildly alkaline.

Permeability is moderately rapid. Available water capacity is 6 to 8 inches to a depth of 5 feet. The water supplying capacity is 5 to 6 inches. Roots penetrate to a depth of 60 inches or more.

Junction soils are used for irrigated crops and range.

Representative profile of Junction fine sandy loam, 1 to 2 percent slopes, about 4.5 miles south of Washington, in the SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 12, T. 43 S., R. 15 W.:

- A1—0 to 2 inches, red (2.5YR 5/6) fine sandy loam, red (2.5YR 4/6) when moist; weak, fine, granular structure; soft, very friable, nonsticky and nonplastic; few very fine and few medium roots; few very fine pores; noncalcareous; mildly alkaline; clear, wavy boundary.
- C1—2 to 9 inches, red (2.5YR 5/6) fine sandy loam, red (2.5YR 4/6) when moist; massive; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; few fine and very fine pores; moderately calcareous, lime is disseminated; mildly alkaline; gradual, smooth boundary.
- C2—9 to 21 inches, red (2.5YR 5/6) fine sandy loam, red (2.5YR 4/6) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots; moderately calcareous, lime is disseminated; mildly alkaline; gradual, smooth boundary.
- C3—21 to 32 inches, red (2.5YR 5/6) fine sandy loam, red (2.5YR 4/6) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots, few fine and very fine pores; few fine white gypsum crystals; moderately calcareous, lime is disseminated; mildly alkaline; clear, smooth boundary.
- C4—32 to 60 inches, red (2.5YR 5/6) fine sandy loam, red (2.5YR 4/6) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; few fine and very fine pores; many fine white gypsum crystals less than 1 millimeter in diameter; 10 percent shale fragments less than 1 inch in size; moderately calcareous, lime is disseminated; mildly alkaline.

The average annual soil temperature at a depth of 20 inches is 59° to 67° F, and the average summer soil temperature is 77° to 82°. The profile is mildly alkaline to moderately alkaline.

The A horizon has hue of 2.5YR or 5YR, value of 4 to 6 when dry and 4 when moist, and chroma of 4 to 6. It is dominantly fine sandy loam, but in places it is light fine sand 1 inch to 6 inches thick. It is noncalcareous to moderately calcareous.

The C horizon has hue of 5YR or 2.5YR, value of 4 to 6 when dry and 3 or 4 when moist, and chroma of 4 to 8. It ranges from fine sandy loam to loamy fine sand. In places it is 10 to 15 percent gravel. The lower part of the C horizon has few to many gypsum crystals less than 5 millimeters in diameter. It is moderately calcareous to strongly calcareous.

Junction fine sandy loam, 1 to 2 percent slopes (JaB).—This soil is on alluvial fans and in desert valleys. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Tobler fine sandy loam; Pintura loamy fine sand, 1 to 5 percent slopes; and Harrisburg fine sandy loam, 1 to 5 percent slopes.

This Junction soil is used for irrigated alfalfa, small grain, sugar beet seed, sorghum silage, and pasture and for range. The native vegetation is creosotebush, Mormon tea,

Indian ricegrass, galleta, and cholla cactus. Capability units IIe-0, irrigated, VIIe-C, nonirrigated; Southern Desert Loam range site; wildlife suitability groups 1242-I and 4343.

Junction fine sandy loam, 2 to 5 percent slopes (JaC).—This soil is on alluvial fans and desert slopes (fig. 2). Runoff is slow, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Junction fine sandy loam, 1 to 2 percent slopes; Harrisburg fine sandy loam, 1 to 5 percent slopes; and Tobler fine sandy loam.

This Junction soil is used for irrigated alfalfa, small grain, sugar beet seed, sorghum silage, and pasture and for range. The native vegetation is creosotebush, Mormon tea, Indian ricegrass, galleta, and cholla cactus. Capability units IIIe-0, irrigated, VIIe-C, nonirrigated; Southern Desert Loam range site; wildlife suitability groups 2242-I and 4343.

Kinesava Series

The Kinesava series consists of well-drained soils on mesa tops and mountain side slopes in Zion National Park. These soils formed in material weathered from limestone and some sandstone. Slopes range from 2 to 25 percent. Elevation is 6,200 to 8,000 feet. The native vegetation is dominantly Gambel oak, snowberry, peavine, big sagebrush, and grasses. Average annual precipitation is 16 to 18 inches, average annual air temperature is 42° to 45° F, and the frost-free period is 90 to 120 days. Kinesava soils are commonly associated with Detra, Kolob, and Paunsaugunt soils.

In a representative profile the surface layer is dark grayish-brown, dark-brown, and brown fine sandy loam about 31 inches thick. The subsoil is brown sandy clay loam and yellowish-red and reddish-yellow clay to a depth of 60 inches.

Permeability is moderately slow. Available water capacity is 8 to 10 inches to a depth of 5 feet. The water supplying capacity is 14 to 16 inches. Roots penetrate to a depth of 60 inches or more or to bedrock at a depth of 42 to 60 inches.

Kinesava soils are used for recreation, wildlife habitat, and range.

Representative profile of Kinesava fine sandy loam, 2 to 15 percent slopes, in an area of Kinesava-Detra fine sandy loams, 2 to 15 percent slopes, in Zion National Park in the area of Deer Trap Mountain, about 1,800 feet north and 400 feet east of the southwest corner of sec. 13, T. 41 S., R. 10 W.:

- A11—0 to 5 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; few fine and very fine vesicular pores; mildly alkaline; clear, smooth boundary.
- A12—5 to 25 inches, dark-brown (7.5YR 4/2) fine sandy loam, dark brown (7.5YR 3/2) when moist; slightly hard, very friable, nonsticky and nonplastic; weak, medium, subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common fine and very fine roots; common medium and few fine tubular pores; mildly alkaline; gradual, wavy boundary.
- A13—25 to 31 inches, brown (7.5YR 4/2) fine sandy loam, dark brown (7.5YR 3/3) when moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; common fine and very fine tubular pores; mildly alkaline.

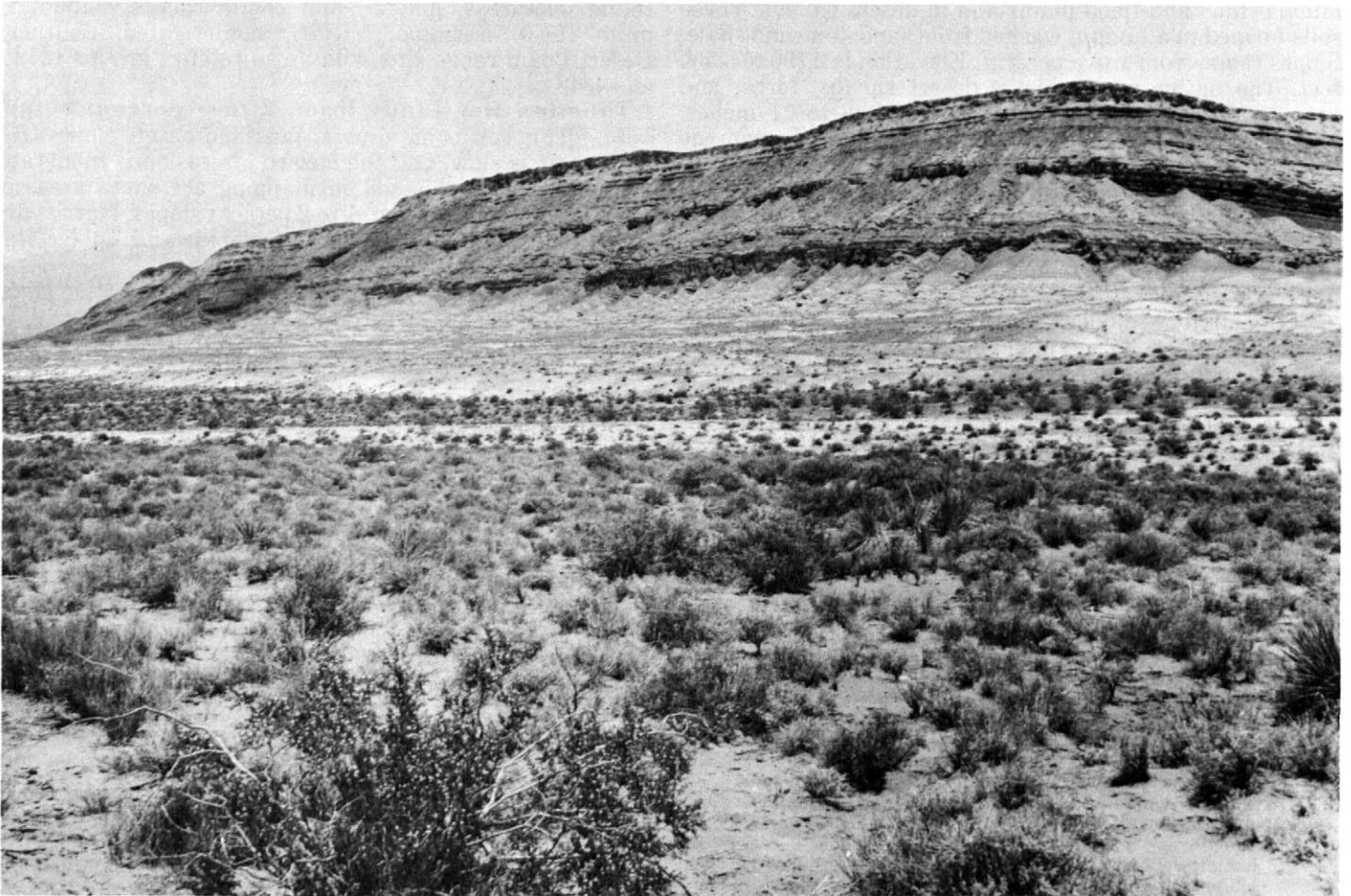


Figure 2.—An area of Junction fine sandy loam, 2 to 5 percent slopes, is in the foreground. Badland, very steep, is in the background.

line; clear, smooth boundary.

- B1t—31 to 39 inches, brown (7.5YR 4/3) sandy clay loam, dark brown (7.5YR 3/3) when moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; few medium and very fine roots; few very fine tubular pores; few thin clay films on faces of peds; mildly alkaline; abrupt, wavy boundary.
- B21t—39 to 49 inches, yellowish-red (5YR 5/6) clay, yellowish red (5YR 4/8) when moist; moderate, coarse, prismatic structure that parts to strong, coarse, subangular blocky; extremely hard, extremely firm, very sticky and very plastic; few medium and very fine roots; few very fine tubular pores; common thin clay films on faces of peds; mildly alkaline; abrupt, wavy boundary.
- B22t—49 to 60 inches, reddish-yellow (7.5YR 6/6) clay, strong brown (7.5YR 5/6) when moist; moderate, coarse, subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few medium and very fine roots; few very fine tubular pores; common thin clay films on faces of peds; mildly alkaline.

Depth to bedrock ranges from 42 to more than 60 inches. The average annual soil temperature at a depth of 20 inches is 44° to 49° F, and the average summer soil temperature is 62° to 65°. The profile ranges from slightly acid to moderately alkaline.

The A horizon has value of 3 or 4 when dry and 2 or 3 when moist and chroma of 2 or 3. It ranges from sandy loam to very fine sandy loam and is 20 to 40 inches thick.

The B2t horizon has value of 4 to 6 when dry and 3 to 5 when moist and chroma of 4 to 8. It ranges from clay or sandy clay to heavy sandy clay loam and is 12 to 30 inches thick.

Kinesava fine sandy loam, 15 to 25 percent slopes

(KAE).—This soil is mainly in and around mountain valleys in the area of Potato Hollow and Deer Trap Mountain in Zion National Park. Runoff is slow, and the hazard of erosion is slight.

Included with the soil in mapping in the bottom of most of these valleys are areas of a deep, dark loamy fine sand that is underlain by sandstone bedrock; smaller areas of Detra fine sandy loam, 5 to 20 percent slopes; and areas of Hogg fine sandy loam, 2 to 5 percent slopes.

This Kinesava soil is used mainly for recreation, wildlife habitat, and range. The native vegetation is Gambel oak, big sagebrush, serviceberry, snowberry, squaw-apple, pea-vine, Kentucky bluegrass, mountain brome, and slender wheatgrass. Capability unit VIe-L, nonirrigated; Mountain Loam (Oak) range site; wildlife suitability group 2141.

Kinesava-Detra fine sandy loams, 2 to 15 percent slopes (KBD).—This complex is mainly on Deer Trap Mountain in Zion National Park. It is about 50 percent Kinesava fine sandy loam, 2 to 15 percent slopes; 40 percent Detra fine sandy loam, 2 to 5 percent slopes; and 10 percent other soils. The Kinesava soil is on mesa tops and mountain side slopes under a dense stand of Gambel oak. The Detra soil is on mesa tops in open areas of sagebrush and grass. Runoff is slow, and the hazard of erosion is slight.

The Kinesava and Detra soils have the profiles described as representative of the Kinesava and Detra series.

Included with these soils in mapping and making up 9 percent of the area is Kolob cobbly fine sandy loam, 2 to 8 percent slopes; Hogg fine sandy loam, 2 to 5 percent slopes; and a deep sandy loam. About 1 percent of the mapped area is Rock land.

The soils in this complex are used mainly for recreation and wildlife habitat. The native vegetation is Gambel oak, sagebrush, serviceberry, peavine, Kentucky bluegrass, mountain brome, and slender wheatgrass. Capability unit VIe-L, nonirrigated; wildlife suitability group 2141; Kinesava soil in Mountain Loam (Oak) range site; Detra soil in Mountain Loam (Summer Precipitation) range site.

Kinesava complex, 2 to 30 percent slopes (KCE).— This complex is about 50 percent Kolob silt loam, brown variant, 10 to 30 percent slopes; 30 percent Kinesava fine sandy loam, 2 to 15 percent slopes; and 20 percent other soils. The Kolob variant soil is on mountain side slopes. The Kinesava soil is on north- and east-facing mountain side slopes.

The Kolob variant soil has the profile described as representative of the Kolob variant. The Kinesava soil has a profile similar to the one described as representative of the Kinesava series, but depth to bedrock ranges from 42 to 50 inches and the surface layer ranges from 20 to 28 inches in thickness.

Included with these soils in mapping, and making up about 15 percent of the area, are Paunsaugunt gravelly silt loam, 10 to 30 percent slopes, and Kolob cobbly fine sandy loam, 8 to 12 percent slopes. About 5 percent of the mapped area is Rock outcrop.

The soils in this complex are used for range, wildlife habitat, and recreation. The native vegetation is Gambel oak, scattered juniper, big sagebrush, serviceberry, snowberry, peavine, Kentucky bluegrass, mountain brome, and slender wheatgrass. Capability unit VIe-L, nonirrigated; Kinesava soil in Mountain Loam (Oak) range site and wildlife suitability group 2141; Kolob variant soil in Mountain Stony Loam (Summer Precipitation) range site and wildlife suitability group 3242.

Kolob Series

The Kolob series consists of well-drained soils on mesa tops and mountain side slopes in Zion National Park. These soils formed in material weathered from limestone and sandstone. Slopes range from 2 to 60 percent. Elevation is 6,000 to 8,000 feet. The native vegetation is dominantly Gambel oak, shrubs, and grasses. Average annual precipitation ranges from 16 to 18 inches, average annual temperature is 42° to 50° F, and the frost-free period is 90 to 120 days. Kolob soils are commonly associated with Detra, Hogg, Kinesava, and Paunsaugunt soils.

In a representative profile an organic layer of leaves and twigs about 4¼ inches thick overlies the surface layer of dark-brown fine sandy loam about 6 inches thick. The subsoil is dark-brown and reddish-brown clay loam and reddish brown or brown gravelly and very gravelly clay loam. Limestone bedrock is at a depth of about 52 inches.

Permeability is moderately slow. Runoff is medium, and the hazard of erosion is slight to moderate. Available water capacity is 5 to 7 inches. The water supplying capac-

ity is 8 to 11 inches. Roots penetrate as far down as bedrock.

Kolob soils are used for recreation, wildlife habitat, and range.

Representative profile of Kolob fine sandy loam, 20 to 50 percent slopes, in an area of Kolob-Detra association about 1 mile east of Lava Point, in the SW¼SE¼ sec. 30, T. 39 S., R. 10 W.:

- O1—4¼ to 3 inches, oak leaves and twigs.
- O2—3 inches to 0, decayed leaves and twigs.
- A1—0 to 6 inches, dark-brown (7.5YR 3/2) fine sandy loam, dark reddish brown (5YR 2/2) when moist; moderate, medium, granular structure; hard, friable, sticky and plastic; many fine and few medium and coarse roots; moderately alkaline; clear, smooth boundary.
- B21—6 to 10 inches, dark-brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, subangular blocky structure; very hard, very firm, sticky and plastic; few fine, medium, and coarse roots; common very fine and fine and few medium pores; few thin clay films in pores; mildly alkaline; clear, smooth boundary.
- B22—10 to 18 inches, reddish-brown (5YR 5/3) clay loam, reddish brown (5YR 4/3) when moist; strong, medium, subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; few fine, medium, and coarse roots; common very fine and fine and few medium pores; common moderately thick clay films on faces of peds; 10 percent gravel; mildly alkaline; gradual, wavy boundary.
- B23—18 to 28 inches, reddish-brown (5YR 5/4) gravelly heavy clay loam, reddish brown (5YR 4/3) when moist; moderate, medium, subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine, medium, and coarse roots; common very fine and fine and few medium pores; common thin clay films on faces of peds; 40 percent gravel; mildly alkaline; clear, wavy boundary.
- B24—28 to 39 inches, reddish-brown (5YR 5/4) very gravelly heavy clay loam, dark brown (7.5YR 3/4) when moist; moderate, fine, subangular blocky structure; very hard, firm, very sticky and very plastic; few fine, medium, and coarse roots; common very fine and few fine pores; common thin clay films on faces of peds; 70 percent gravel; moderately alkaline; clear, smooth boundary.
- B25—39 to 52 inches, brown (7.5YR 5/4) very gravelly clay loam, dark brown (7.5YR 4/4) when moist; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few very fine and fine pores; few thin clay films in pores; 70 percent gravel and cobbles; moderately alkaline; abrupt, wavy boundary.
- R—52 inches, fractured limestone bedrock; clay loam from B25t horizon extends into cracks.

Depth to bedrock ranges from 40 to 60 inches. The average annual soil temperature at a depth of 20 inches is 44° to 49° F, and the average summer soil temperature is 62° to 65°. The profile is noncalcareous throughout. It ranges from neutral to moderately alkaline.

The A horizon has hue of 10YR, 7.5YR, or 5YR; value of 3 to 5 when dry and 2 or 3 when moist; and chroma of 2 to 4. It is fine sandy loam, very stony silt loam, or cobbly fine sandy loam 3 to 8 inches thick.

The B2 horizon has hue of 2.5YR, 5YR, or 7.5YR and value of 4 or 5 when dry. It ranges from light clay or heavy clay loam to very gravelly heavy clay loam or very stony clay. The upper 4 to 8 inches ranges from 10 to 50 percent rock fragments, and the lower part, from 40 to 90 percent. In most areas the rock fragments are of gravel and cobble size, but in some places they are stones 10 to 14 inches in diameter.

Kolob-Detra association (KD).— This association is about 40 percent Kolob fine sandy loam, 20 to 50 percent slopes; 35 percent Detra fine sandy loam, 5 to 20 percent slopes; and 25 percent other soils and Rock outcrop. The Detra soil is on the lower parts of mountain side slopes. The Kolob soil is on the steeper upper parts of slopes.

The Kolob soil has the profile described as representative of the Kolob series. The Detra soil has a profile similar to the one described as representative of the Detra series, but slopes are 5 to 20 percent.

Included with these soils in mapping are small areas of Paunsaugunt gravelly silt loam, 30 to 50 percent slopes, on ridge crests; areas of a deep, black very gravelly silt loam; and areas of Rock outcrop, which make up about 3 percent of the mapped area.

The soils in this association are used for recreation, wildlife habitat, and range. The native vegetation is Gambel oak, snowberry, squaw-apple, serviceberry, yarrow, and muttongrass. Wildlife suitability group 2141; Kolob soil in capability unit VIIe-L, nonirrigated, and Mountain Stony Loam (Summer Precipitation) range site; Detra soil in capability unit VIe-L, nonirrigated, and Mountain Loam (Summer Precipitation) range site.

Kolob-Hogg complex, 2 to 8 percent slopes (KHC).—This complex is about 45 percent Kolob cobbly fine sandy loam, 2 to 8 percent slopes; 45 percent Hogg fine sandy loam, 2 to 5 percent slopes; and 10 percent other soils. The Kolob soil is on mountain ridges, and the Hogg soil is on broader mesa tops in Zion National Park.

The Kolob soil has a profile similar to the one described as representative of the Kolob series, but the surface layer is cobbly, depth to bedrock is about 40 inches, and slopes are 2 to 8 percent. The Hogg soil has the profile described as representative of the Hogg series.

Included with these soils in mapping are small areas of Paunsaugunt gravelly silt loam, 30 to 50 percent slopes, and Detra fine sandy loam, 2 to 5 percent slopes.

The soils in this complex are used for recreation, wildlife habitat, and range. The native vegetation is Gambel oak, ponderosa pine, snowberry, squaw-apple, manzanita, squirreltail, and muttongrass. Capability unit VIe-L, nonirrigated; wildlife suitability group 2141; Kolob soil in Mountain Stony Loam (Summer Precipitation) range site; Hogg soil in Mountain Loam (Ponderosa Pine) range site.

Kolob-Paunsaugunt complex, 20 to 60 percent slopes (KLG).—This complex is about 60 percent Kolob cobbly fine sandy loam, 20 to 60 percent slopes; 35 percent Paunsaugunt gravelly silt loam, 30 to 50 percent slopes; and 5 percent other soils. The Kolob soil is on north- and east-facing slopes. The Paunsaugunt soil is on south- and west-facing slopes in the area of West Mountain.

The Kolob soil has a profile similar to the one described as representative of the Kolob series, but the surface layer is 20 to 30 percent cobbles.

Included with these soils in mapping are small areas of Kolob very stony silt loam, 20 to 50 percent slopes, and areas of Rock land, which make up about 3 percent of the mapped area.

The soils in this association are used for range and wildlife habitat. The native vegetation is Gambel oak; scattered ponderosa pine, juniper, and pinyon pine; manzanita; cliff-rose; bitterbrush; serviceberry; and muttongrass. Capability unit VIIe-L, nonirrigated; Kolob soil in Mountain Stony Loam (Summer Precipitation) range site and wildlife suitability group 3141; Paunsaugunt soil in Mountain Shallow Loam (Ponderosa Pine) range site and wildlife suitability group 3242.

Kolob Variant

The Kolob variant consists of well-drained soils on mountain side slopes in the Zion National Park. These soils

formed in material weathered from shale, limestone, and sandstone. Slopes range from 10 to 30 percent. Elevation is 6,400 to 7,000 feet. The native vegetation is dominantly Gambel oak, ponderosa pine, shrubs, and grasses. Average annual precipitation ranges from 16 to 18 inches, average annual air temperature is 45° to 50° F, and the frost-free period is 90 to 120 days. Kolob variant soils are commonly associated with Paunsaugunt, Kolob, and Kinesava soils.

In a representative profile the surface layer is dark grayish-brown silt loam about 4 inches thick. The subsoil is dark-brown gravelly silty clay loam, pale-brown silty clay, and light yellowish-brown very gravelly silty clay and gravelly silty clay loam. Bedrock is at a depth of about 30 inches.

Permeability is moderately slow. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 3 to 5 inches. The water supplying capacity is 5 to 7 inches. Roots easily penetrate as far down as bedrock.

Kolob variant soils are used for recreation, wildlife habitat, and range.

Representative profile of Kolob silt loam, brown variant, 10 to 30 percent slopes, in an area of Kinesava complex, 2 to 30 percent slopes, about one-fourth mile south of the Deer Trap Mountain entrance to Zion National Park, in the NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 12, T. 41 S., R. 10 W.:

- A1—0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; hard, friable, sticky and plastic; common very fine and fine and few medium roots; common very fine and fine vesicular pores; mildly alkaline; clear, smooth boundary.
- B1—4 to 8 inches, dark-brown (10YR 4/3) gravelly silty clay loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure that parts to moderate, medium, granular; hard, very firm, very sticky and plastic; common fine and medium roots; common very fine and fine pores; 20 percent gravel; moderately alkaline; clear, smooth boundary.
- B21t—8 to 13 inches, pale-brown (10YR 6/3) silty clay, brown (10YR 4/3) when moist; moderate, fine, subangular blocky structure; very hard, very firm, very sticky and plastic; common fine and medium roots; common very fine and fine pores; few fine clay films on faces of peds and in pores; 15 percent gravel; moderately calcareous; moderately alkaline; clear, smooth boundary.
- B22t—13 to 19 inches, light yellowish-brown (2.5Y 6/4) very gravelly silty clay, olive brown (2.5Y 4/3) when moist; weak, medium, prismatic structure that parts to moderate, medium, subangular blocky; very hard, very firm, very sticky and plastic; common fine and medium and few coarse roots; common very fine and fine pores; 40 percent gravel; few fine clay films on faces of peds and in pores; moderately calcareous; moderately alkaline; clear, smooth boundary.
- B23t—19 to 30 inches, light yellowish-brown (2.5Y 6/4) gravelly silty clay loam, olive brown (2.5Y 4/4) when moist; weak, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard, firm, sticky and plastic; common fine and medium and few coarse roots; common very fine and fine pores; 30 percent gravel; few thin clay films in pores; moderately calcareous; strongly alkaline; abrupt, smooth boundary.
- R—30 inches, partly weathered shale and limestone.

Depth to bedrock ranges from 25 to 34 inches. The average summer soil temperature at a depth of 20 inches is 62° to 65° F, and the average annual soil temperature is 44° to 49°. The profile ranges from mildly alkaline to strongly alkaline. It is 15 to 40 percent rock fragments above the B2t horizon and less than 35 percent in the B2t horizon.

The A horizon has hue of 7.5YR or 10YR and chroma of 1 or 2. It is silt loam or heavy silt loam 3 to 6 inches thick.

The B2t horizon has hue of 2.5Y, 10YR, or 7.5YR; value of 4 to 6 when dry and 3 or 4 when moist; and chroma of 2 to 4. It ranges from gravelly silty clay loam to very gravelly silty clay.

Kolob variant soils in the Washington County Area are mapped only with Kinesava soils.

Lava Flows

Lava flows (LA) consists of areas that are covered with basalt lava rock, mainly in the area of Santa Clara and Snow's Canyon. The lava flows have a sharp, rough, jagged surface and many crevices and pockets. Sandy soil material has blown into the pockets, and desert grasses and shrubs grow in some places. Slopes are gently sloping to steep. Runoff is slow to rapid.

Because of the rough surface, livestock avoid the areas and no use is made of the forage. Capability unit VIII-X, nonirrigated; wildlife suitability group 4444; range site not assigned.

Lavate Series

The Lavate series consists of well-drained soils on alluvial fans near New Harmony and Central. These soils formed in mixed alluvium weathered from acid igneous rock. Slopes range from 2 to 4 percent. Elevation is 4,800 to 5,600 feet. The native vegetation is shrubs and grasses. Average annual precipitation is 14 to 15 inches, average annual air temperature is 45° to 52° F, and the frost-free period is 120 to 160 days. Lavate soils commonly are associated with Ildefonso, Naplene, and Nehar soils.

In a representative profile the surface layer is brown sandy loam about 4 inches thick. The subsoil is brown and light-brown sandy clay loam and clay loam about 46 inches thick. The substratum is reddish-yellow sandy clay loam to a depth of 60 inches.

Permeability is moderately slow. Available water capacity is 8 to 10 inches to a depth of 5 feet. The water supplying capacity is 9 to 11 inches. Roots penetrate to a depth of 60 inches or more.

Lavate soils are used for nonirrigated small grain and for range.

Representative profile of Lavate sandy loam, in a cultivated area 2 miles east of New Harmony, 525 feet east and 200 feet north of the southwest corner of sec. 13, T. 38 S., R. 13 W.:

- Ap—0 to 4 inches, brown (7.5YR 5/3) sandy loam, very dark brown (7.5YR 2/2) when moist; moderate, medium and fine, subangular blocky structure (upper 1 inch has medium, moderately thick, platy structure); hard, very friable, slightly sticky and slightly plastic; few very fine roots; few fine and common very fine pores (upper 1 inch has many very fine and fine vesicular pores); mildly alkaline; abrupt, smooth boundary.
- B1—4 to 9 inches, brown (7.5YR 5/3) sandy clay loam, very dark brown (7.5YR 2/2) when moist; moderate, medium, subangular blocky structure that parts to moderate, very fine, subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots; few medium and fine and common very fine pores; 3 percent gravel; mildly alkaline; clear, smooth boundary.
- B21t—9 to 19 inches, brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 3/2) when moist; weak, coarse, prismatic structure that parts to moderate, very fine and fine, subangular blocky; few fine and very fine roots; few medium, common fine, and many very fine pores; many moderately thick clay films on faces of peds; 5 percent gravel; mildly alkaline; clear, wavy boundary.
- B22t—19 to 33 inches, light-brown (7.5YR 6/4) clay loam, dark reddish brown (5YR 3/4) when moist; common, fine and medium, distinct strong-brown (7.5YR 5/6 and 5/8) mottles in the lower part; moderate, medium, prismatic structure that parts to moderate, fine, angular blocky; very hard, firm, sticky and plastic; few very fine roots; few medium, fine, and very fine pores; continuous moderately thick clay films on faces of peds; 5 percent gravel; mildly alkaline; clear, wavy boundary.
- B3—33 to 50 inches, light-brown (7.5YR 6/4) sandy clay loam, reddish brown (5YR 4/4) when moist; common, fine and medium,

distinct strong-brown (7.5YR 5/6 and 5/8) mottles; weak, coarse, prismatic structure that parts to moderate, fine, subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots; few fine and common very fine pores; few thin clay films on faces of peds and as bridges between sand grains; 5 to 10 percent gravel; mildly alkaline; gradual, wavy boundary.

- C—50 to 60 inches, reddish-yellow (7.5YR 6/5) light sandy clay loam, reddish brown (5YR 4/4) when moist; massive, hard, very friable, slightly sticky and slightly plastic; few fine and very fine pores; 15 to 20 percent gravel; mildly alkaline.

The average annual soil temperature at a depth of 20 inches is 47° to 54° F. The profile ranges from neutral to moderately alkaline.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It is dominantly sandy loam, but it ranges to loam in places. It ranges from 4 to 9 inches in thickness.

The B2t horizon has hue of 7.5YR or 5YR, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 2 to 4. It is heavy sandy clay loam or clay loam.

The C horizon has hue of 7.5YR or 5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 2 to 5. It is sandy clay loam, loam, or gravelly sandy loam that ranges from 15 to 25 percent gravel. It is dominantly noncalcareous but is slightly calcareous in places.

Lavate sandy loam (Lb).—This slightly undulating soil is on medium-length alluvial fans. Slope ranges from 2 to 4 percent. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Naplene silt loam, 2 to 6 percent slopes; Clovis fine sandy loam, 1 to 5 percent slopes; and a deep soil that has a light-colored surface layer and a subsoil of cobbly clay loam.

This Lavate soil is used for dryfarmed wheat and range. The native vegetation is Indian ricegrass, galleta, squirrel-tail, tall native bluegrass, and big sagebrush. Capability unit IVe-V, nonirrigated; Upland Loam (Summer Precipitation) range site; wildlife suitability group 2242.

LaVerkin Series

The LaVerkin series consists of well-drained soils on alluvial fans, in valleys, and on stream terraces. These soils formed in mixed alluvium washed from limestone, sandstone, and shale. Slopes range from 1 to 5 percent. Elevation is 2,650 to 3,300 feet. The native vegetation is desert shrubs, grasses, and cactus. Average annual precipitation is 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period is 190 to 195 days. LaVerkin soils are commonly associated with Hantz, Leeds, Nikey, and Tobler soils.

In a representative profile the surface layer is brown fine sandy loam about 3 inches thick. The subsoil is reddish-brown fine sandy loam or sandy clay loam about 27 inches thick. The substratum is reddish-brown and light reddish-brown sandy clay loam to a depth of 60 inches.

Permeability is moderate. Available water capacity is 7.5 to 10 inches to a depth of 5 feet. The water supplying capacity is 5 to 6 inches. Roots penetrate to a depth of 5 feet or more.

LaVerkin soils are used for irrigated crops, range, and wildlife habitat.

Representative profile of LaVerkin fine sandy loam, 1 to 2 percent slopes, in an area of range about 2 miles southwest of Bloomington, 1,200 feet north and 1,200 feet east of the southwest corner of sec. 23, T. 43 S., R. 16 W.:

- A1—0 to 3 inches, brown (7.5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) when moist; moderate, fine, granular structure; soft, very friable, slightly sticky and nonplastic; common fine roots;

moderately calcareous, lime is disseminated; strongly alkaline; clear, smooth boundary.

B21—3 to 16 inches, reddish-brown (5YR 5/4) fine sandy loam, yellowish red (5YR 4/6) when moist; very weak, medium, subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; few fine pores; moderately calcareous, lime is disseminated; strongly alkaline; clear, wavy boundary.

B22—16 to 30 inches, reddish-brown (5YR 5/4) sandy clay loam, yellowish red (5YR 4/6) when moist; weak, medium, subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few fine and medium roots; common fine and few medium pores; moderately calcareous; strongly alkaline; clear, wavy boundary.

C1ca—30 to 42 inches, reddish-brown (5YR 5/4) sandy clay loam, yellowish red (5YR 4/6) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and slightly plastic; few fine and medium roots; common fine pores; strongly calcareous, lime is mostly in veins; strongly alkaline; clear, wavy boundary.

C2—42 to 60 inches, light reddish-brown (5YR 6/4) light sandy clay loam, yellowish red (5YR 4/6) moist; moderate, medium, subangular blocky structure; hard, firm, sticky and slightly plastic; few fine roots; common fine pores; strongly calcareous; strongly alkaline.

The soil ranges from 2 to 15 percent gravel above a depth of 40 inches. The profile is thinly stratified with loam, fine sandy loam, and silt loam. The average annual soil temperature at a depth of 20 inches is 59° to 68° F. The profile is moderately alkaline or strongly alkaline.

The A horizon has hue of 5YR or 7.5YR, value of 3 or 4 when moist, and chroma of 3 to 6. It ranges from fine sandy loam to silty clay loam where irrigation water has deposited sediments.

The B2 horizon has hue of 5YR or 2.5YR, value of 4 or 5 when dry, and chroma of 4 to 6.

The Cca and C horizons have hue of 5YR or 2.5YR, value of 4 to 7 when dry and 4 to 6 when moist, and chroma of 3 to 6. They are strongly calcareous or very strongly calcareous. In places the C horizon is less than 5 percent, by volume, gypsum.

LaVerkin fine sandy loam, 1 to 2 percent slopes (LcB).—This soil is on smooth, medium to short alluvial fans and stream terraces. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Nikey sandy loam, 1 to 3 percent slopes; small areas of Tobler fine sandy loam; and small areas of Riverwash, which make up about 2 percent of the mapped area.

This LaVerkin soil is used mainly for range. Small areas are used for irrigated alfalfa, barley, sugar beet seed, milo, sorghum, and pasture. The native vegetation is galleta, Indian ricegrass, blackgrama, sand dropseed, creosotebush, and blackbrush. Capability units IIe-0, irrigated, VIIe-C, nonirrigated; Southern Desert Loam range site; wildlife suitability groups 1242-I and 4343.

LaVerkin fine sandy loam, 2 to 5 percent slopes (LcC).—This soil is on alluvial fans and stream terraces. It has a profile similar to the one described as representative of the series, but slopes are 2 to 5 percent. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Nikey sandy loam, 3 to 15 percent slopes, and Tobler fine sandy loam.

This soil is used mostly for range. The native vegetation is creosotebush, blackbrush, galleta, Indian ricegrass, filaree, and cholla cactus. Small areas are used for irrigated alfalfa, barley, sorghum, and milo. Capability units IIIe-0, irrigated, and VIIe-C, nonirrigated; Southern Desert Loam range site; wildlife suitability groups 2242-I and 4343.

LaVerkin silty clay loam, 1 to 2 percent slopes (LdB).—

This soil is on alluvial fans and stream terraces. It has a profile similar to the one described as representative of the series, but the surface layer is silty clay loam 6 to 14 inches thick. This finer texture is the result of the application of irrigation water that is heavily laden with sediment. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Hantz silty clay loam; Leeds silty clay loam, 0 to 1 percent slopes; and Tobler silty clay loam.

This LaVerkin soil is used for irrigated alfalfa, barley, sugar beet seed, and sorghum. Capability unit IIe-0, irrigated; wildlife suitability group 2242-I; range site not assigned.

Leeds Series

The Leeds series consists of well-drained soils on alluvial fans and in valleys. These soils formed in mixed alluvium washed from sandstone, limestone, and shale. Slopes range from 0 to 10 percent. Elevation is 2,640 to 3,300 feet. The native vegetation is desert shrubs and grasses. Average annual precipitation is 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period is 190 to 200 days. Leeds soils are associated with Hantz, Junction, LaVerkin, Nikey, and St. George soils.

In a representative profile the surface layer is brown silty clay loam about 15 inches thick. The underlying material is reddish-brown sandy loam and silt loam to a depth of 60 inches or more. The profile is moderately alkaline in the surface layer and strongly alkaline below a depth of 15 inches.

Permeability is slow. Available water capacity is 8 to 12 inches to a depth of 5 feet. Roots penetrate to a depth of 60 inches or more. A high water table is at a depth of 40 to 60 inches in some areas during the season of irrigating.

Leeds soils are used mainly for irrigated crops.

Representative profile of Leeds silty clay loam, 0 to 1 percent slopes, 2.5 miles south of Washington, 800 feet north and 1,250 feet west of the southeast corner of sec. 34, T. 42 S., R. 15 W.:

Ap—0 to 8 inches, brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 3/4) when moist; weak, medium, subangular blocky structure that parts to moderate, medium, granular; hard, firm, sticky and slightly plastic; common very fine and fine and few medium roots; common fine and very fine pores; moderately calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.

A12—8 to 15 inches, brown (7.5YR 5/4) silty clay loam, dark reddish brown (5YR 3/4) when moist; weak, medium, subangular blocky structure; hard, firm, sticky and plastic; common fine and very fine roots; few fine and common very fine pores; moderately calcareous, lime is disseminated; moderately alkaline; abrupt, wavy boundary.

C1—15 to 23 inches, reddish-brown (5YR 5/4) sandy loam, dark red (2.5YR 3/6) when moist; massive; soft, very friable, slightly sticky and nonplastic; common fine and very fine roots; few fine and very fine pores; moderately calcareous, lime is disseminated; strongly alkaline; clear, smooth boundary.

C2—23 to 60 inches, reddish-brown (5YR 5/4) silt loam, dark red (2.5YR 3/6) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; moderately calcareous, lime is disseminated; strongly alkaline.

The profile ranges from moderately calcareous to strongly calcareous. It is moderately alkaline to strongly alkaline. The average annual soil temperature at a depth of 20 inches is 59° to 68° F.

The A horizon has hue of 7.5YR or 5YR, value of 4 to 6 when dry and 3 to 6 when moist, and chroma of 2 to 4. It is dominantly silty

clay loam, but in places it is heavy silt loam. It ranges from 4 to 19 inches in thickness.

The C horizon has hue of 5YR, 7.5YR, or 2.5YR; value of 5 to 7 when dry and 3 to 5 when moist; and chroma of 4 to 6. It is commonly stratified and ranges from sandy loam or silt loam to light silty clay loam or clay loam. In places it ranges from 5 to 20 percent gravel.

Leeds silty clay loam, 0 to 1 percent slopes (LeA).— This soil is in alluvial valleys in the south-central part of the survey area. It has the profile described as representative of the series. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of St. George silty clay loam, moderately saline; Tobler silty clay loam; and Hantz silty clay loam.

This Leeds soil is used for irrigated crops of alfalfa, small grain, sugar beet seed, milo, sorghum silage, and irrigated pasture. Capability unit IIIs-05, irrigated; wildlife suitability group 2242-I; range site not assigned.

Leeds silty clay loam, 1 to 2 percent slopes (LeB).— This soil is in the alluvial valley of the Virgin River flood plain. It has a profile similar to the one described as representative of the series, but slopes are 1 to 2 percent. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Leeds silty clay loam, 0 to 1 percent slopes; St. George silty

clay loam; Hantz silty clay loam; and Tobler silty clay loam.

This Leeds soil is used for irrigated alfalfa (fig. 3), barley, sugar beet seed, milo, sorghum silage, and irrigated pasture. Capability unit IIIs-05, irrigated; wildlife suitability group 2242-I; range site not assigned.

Leeds silty clay loam, 5 to 10 percent slopes (LeD).— This soil is on alluvial fans in the area of Hurricane and LaVerkin. It formed in material weathered dominantly from limestone. It has a profile similar to the one described as representative of the series, but slopes are 5 to 10 percent and the surface layer is heavy silt loam in places. The underlying material contains 10 to 25 percent gravel in some places. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Nikey sandy loam, 3 to 15 percent slopes, and Isom cobbly sandy loam, 3 to 30 percent slopes.

This Leeds soil is used for irrigated alfalfa, barley, and pasture. Capability unit IIIe-05, irrigated; wildlife suitability group 2242-I; range site not assigned.

Magotsu Series

The Magotsu series consists of shallow, well-drained

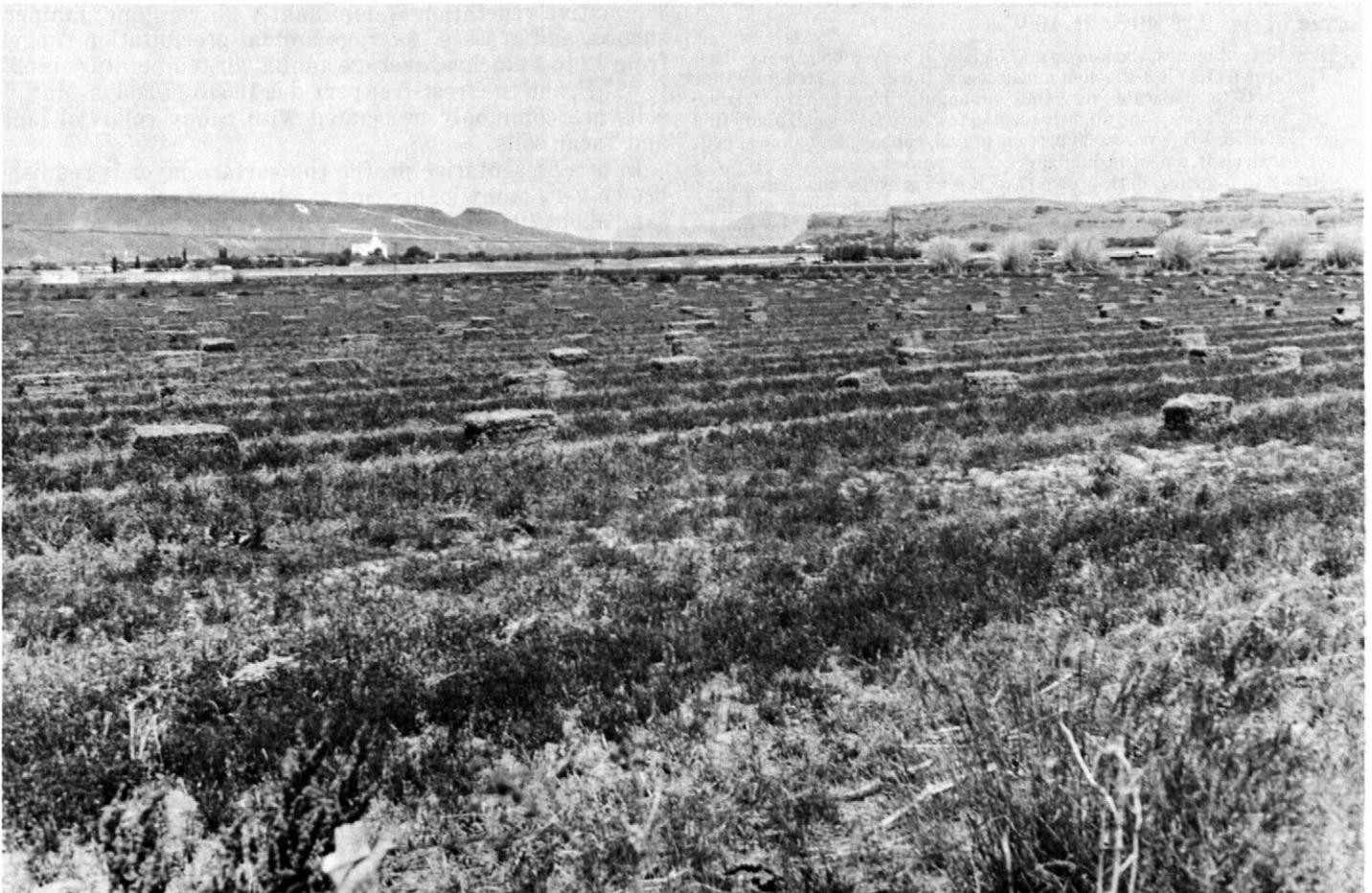


Figure 3.—Alfalfa in an area of Leeds silty clay loam, 1 to 2 percent slopes. The city of St. George is in the background.

soils that are underlain by an indurated carbonate-cemented hardpan at a depth of 10 to 20 inches. These soils are on basalt lava flows in the central part of the survey area. They formed in residuum derived from basalt and some limestone and sandstone. Slopes range from 2 to 20 percent. Elevation is 4,200 to 6,300 feet. The native vegetation is pinyon pine, juniper, shrubs, and grasses. Average annual precipitation ranges from 10 to 13 inches, average annual air temperature is 46° to 53° F, and the frost-free period is 155 to 170 days. Magotsu soils are commonly associated with Veyo, Pastura, and Collbran soils.

In a representative profile the surface layer is dark-brown very cobbly loam about 2 inches thick. The subsoil is dark-brown gravelly clay loam or clay and brown gravelly clay loam about 15 inches thick. This is underlain by an indurated carbonate-cemented hardpan about 4 inches thick. Basalt bedrock is at a depth of about 21 inches.

Permeability is moderately slow. Available water capacity, above the hardpan, is 2 to 3 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as the hardpan.

Magotsu soils are used for range, wildlife habitat, and recreation.

Representative profile of Magotsu very cobbly loam, 2 to 20 percent slopes, in an area of Magotsu-Pastura complex, 2 to 20 percent slopes, about 4 miles east of the town of Veyo, 650 feet east and 1,700 feet south of the northwest corner of sec. 2, T. 40 S., R. 16 W.:

- A1—0 to 2 inches, dark-brown (7.5YR 4/3) very cobbly loam, dark brown (7.5YR 3/2) when moist; weak, thick, platy structure that parts to moderate, very fine, subangular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots; many fine and very fine pores; 60 percent gravel, cobbles, and stones; neutral; clear, smooth boundary.
- B1—2 to 5 inches, dark-brown (7.5YR 4/2) gravelly clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium and fine, prismatic structure that parts to strong, very fine, granular; slightly hard, friable, sticky and plastic; few fine and very fine roots; few fine and many very fine pores; common thin clay films on faces of peds and in pores; 25 percent gravel and cobbles; mildly alkaline; clear, wavy boundary.
- B2t—5 to 14 inches, dark-brown (7.5YR 4/3) clay, dark brown (7.5YR 3/2) when moist; moderate, medium, prismatic structure that parts to moderate, medium and fine, blocky; extremely hard, very firm, very sticky and very plastic; few fine and very fine roots; few fine and very fine pores; common moderately thick clay films on faces of peds; 10 percent gravel and cobbles; mildly alkaline; clear, smooth boundary.
- B3ca—14 to 17 inches, brown (7.5YR 5/3) gravelly heavy clay loam, dark brown (7.5YR 4/3) when moist; moderate, medium, prismatic structure that parts to moderate, fine and very fine, blocky; very hard, firm, very sticky and very plastic; few very fine roots; common very fine pores; few moderately thick clay films on faces of peds and in pores; 15 percent gravel and cobbles; strongly calcareous; moderately alkaline; abrupt, wavy boundary.
- Ccam—17 to 21 inches, indurated carbonate-cemented hardpan; laminar upper surface.
- R—21 inches, basalt bedrock.

Depth to the hardpan ranges from 10 to 20 inches. The surface layer ranges from 50 to 60 percent rock fragments. The average annual soil temperature at a depth of 20 inches is 50° to 54° F, and the average summer soil temperature is 65° to 70°.

The A horizon has value of 4 or 5 when dry and chroma of 2 to 4. It ranges from very cobbly light loam to very cobbly heavy loam.

The B2t horizon has hue of 7.5YR or 5YR, value of 3 to 5 when dry and 3 or 4 when moist, and chroma of 2 to 4. It ranges from light clay to heavy clay loam. It is 10 to 30 percent gravel and cobbles.

Magotsu-Pastura complex, 2 to 20 percent slopes (MAE).—This complex is about 55 percent Magotsu very

cobbly loam, 2 to 20 percent slopes; 25 percent Pastura gravelly loam, 2 to 10 percent slopes; and 20 percent other soils and Rock outcrop. These soils are intermingled. Runoff is medium, and the hazard of erosion is moderate.

The Magotsu and Pastura soils have the profiles described as representative of the Magotsu and Pastura series.

Included with these soils in mapping are areas of a Pastura gravelly loam that has slopes of more than 10 percent; Veyo extremely stony loam, 3 to 10 percent slopes; and a soil that is similar to this Magotsu soil but ranges from 20 to 30 inches deep over a hardpan. Also included are areas of Rock outcrop, which make up about 5 percent of the mapped area.

The soils in this complex are used for range and wildlife habitat. Capability unit VIIs-R3, nonirrigated; Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone, range site; wildlife suitability group 3242.

Mathis Series

The Mathis series consists of somewhat excessively drained soils on severely eroded, dissected mountain side slopes and mesa remnants. These soils formed in material derived mainly from sandstone. Slopes are uneven and range from 20 to 50 percent. Elevation is 4,000 to 5,500 feet. The native vegetation is dominantly pinyon pine, juniper, shrubs, and grasses. Average annual precipitation ranges from 12 to 14 inches, average annual air temperature is 52° to 59° F, and the frost-free period is 165 to 170 days. Mathis soils are commonly associated with Stony colluvial land and Tacan soils.

In a representative profile the surface layer is reddish-brown very stony loamy fine sand and gravelly loamy fine sand about 10 inches thick. The underlying material is light reddish-brown very gravelly loamy sand and pink very gravelly fine sand about 23 inches thick. Sandstone bedrock is at a depth of about 33 inches. The profile is mildly alkaline in the upper part and strongly alkaline below a depth of about 4 inches.

Permeability is moderately rapid. Runoff is rapid, and the hazards of sheet erosion and gullyng are severe. Available water capacity is 1 inch to 2 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as bedrock.

Mathis soils are used for range, recreation, and wildlife habitat.

Representative profile of Mathis very stony loamy fine sand, 20 to 50 percent slopes, in an area of Mathis-Rock outcrop complex, 20 to 50 percent slopes in an area of range near Scoggins Wash, near the west quarter corner of sec. 24, T. 41 S., R. 11 W.:

- A11—0 to 4 inches, reddish-brown (5YR 5/4) very stony loamy fine sand, reddish brown (5YR 4/4) when moist; weak, medium, granular structure; loose, nonsticky and nonplastic; common fine and medium roots; 25 percent gravel, cobbles, and stones; slightly calcareous, lime is disseminated; mildly alkaline; clear, smooth boundary.
- A12—4 to 10 inches, reddish-brown (5YR 5/4) gravelly loamy fine sand, reddish brown (5YR 4/4) when moist; single grained; loose, nonsticky and nonplastic; common very fine and fine and few medium roots; 25 percent gravel and cobbles; moderately calcareous, lime is disseminated; strongly alkaline; clear, smooth boundary.
- C1—10 to 26 inches, light reddish-brown (2.5YR 6/4) very gravelly

loamy sand, reddish brown (2.5YR 5/5) when moist; single grained; loose, nonsticky and nonplastic; common very fine and fine and few medium roots; 50 percent gravel and cobbles; strongly calcareous, lime is disseminated; strongly alkaline; gradual, wavy boundary.

C2—26 to 33 inches, pink (5YR 7/4) very gravelly fine sand, reddish brown (2.5YR 5/5) when moist; single grained; loose, nonsticky and nonplastic; few fine and medium roots; 65 percent gravel and cobbles; strongly calcareous, lime is disseminated; strongly alkaline.

R—33 inches, sandstone.

The surface area is 15 to 40 percent stones and boulders. Depth to bedrock ranges from 20 to 40 inches. The average annual soil temperature at a depth of 20 inches is 52° to 59° F, and the average summer soil temperature is 69° to 74°. The profile ranges from mildly alkaline to strongly alkaline.

The A horizon has hue of 5YR or 2.5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 3 to 6. It is dominantly very stony loamy fine sand, but it ranges to loamy sand. It is noncalcareous to moderately calcareous.

The C horizon has hue of 2.5, 5YR, or 7.5YR; value of 5 to 8 when dry and 4 to 6 when moist; and chroma of 3 to 6. It ranges from very gravelly loamy sand or sand to very gravelly fine sandy loam that is 35 to 75 percent gravel, cobbles, and stones. It is moderately calcareous to strongly calcareous.

Mathis-Rock outcrop complex, 20 to 50 percent slopes (MBG).—This complex (fig. 4) is on severely eroded, dissected mountain side slopes and mesa remnants. It is about 50 percent Mathis very stony loamy fine sand, 20 to

50 percent slopes; 20 percent Rock outcrop; and 30 percent other soils. The Mathis soil has the profile described as representative of the Mathis series.

Included with these soils in mapping are small areas of Redbank fine sandy loam, 1 to 5 percent slopes; Bond sandy loam, 1 to 10 percent slopes; Tacan very stony sandy loam, 30 to 70 percent slopes; and a soil that is similar to this Mathis soil but has a subsoil of very cobbly heavy sandy loam to very cobbly clay loam. Also included are areas of Rock land, stony, and Eroded land.

The soils in this complex are used for range, recreation, and wildlife habitat. The native vegetation is pinyon pine, juniper, big sagebrush, galleta, Indian ricegrass, black grama, and squirreltail. Capability unit VII_s-V₄, nonirrigated; Mathis soil in Southern Upland Stony Sand (Juniper-Pinyon) range site and wildlife suitability group 3242; Rock outcrop in wildlife suitability group 4444 and range site not assigned.

Menefee Series

The Menefee series consists of shallow, well-drained soils on west-facing mountain side slopes in the Kolob Canyon section of Zion National Park. These soils formed in material weathered from shale. Slopes range from 25 to



Figure 4.—Landscape view of Mathis very stony loamy fine sand, 20 to 50 percent slopes, in the foreground. Badland, very steep, is in the background.

60 percent. Elevation is 4,700 to 5,900 feet. The native vegetation is pinyon pine, juniper, shrubs, and grasses. Average annual precipitation is 14 to 15 inches, average annual air temperature is 48° to 52° F, and the frost-free period is 120 to 160 days. Menefee soils are commonly associated with Naplene, Tacan, and Chilton soils.

In a representative profile the surface layer is yellowish-brown shaly loam about 2 inches thick. The underlying layer is olive-yellow silt loam about 17 inches thick. Weathered shale is at a depth of about 19 inches.

Permeability is slow. Available water capacity, above the shale, is 2 to 3 inches. The water supplying capacity is 4 to 6 inches. A few fine roots penetrate into the weathered shale.

Menefee soils are used for recreation, wildlife habitat, and range.

Representative profile of Menefee shaly loam, 25 to 60 percent slopes, in an area of Menefee-Rock outcrop complex, 25 to 60 percent slopes, in an area of range about one-half mile northeast of the New Harmony interchange on Interstate 15, in the NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 16, T. 38 S., R. 12 W.:

- A1—0 to 2 inches, yellowish-brown (10YR 5/4) shaly loam, brown (10YR 4/3) when moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; 30 percent shale fragments; strongly calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.
- C1—2 to 19 inches, olive-yellow (2.5Y 6/6) silt loam, light olive brown (2.5Y 5/6) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few medium and coarse roots; common fine and very fine and few medium and coarse pores; 15 percent shale fragments; strongly calcareous, lime is disseminated; strongly alkaline; gradual, smooth boundary.
- C2—19 inches, weathered shale.

The profile is moderately calcareous to strongly calcareous. Depth to weathered shale ranges from 8 to 20 inches. The average annual soil temperature at a depth of 20 inches is 46° to 54° F, and the average summer soil temperature is 64° to 70°.

The A horizon has value of 5 to 7 when dry and 4 or 5 when moist and chroma of 3 or 4. It ranges from loam to silty clay loam and is 20 to 30 percent shale fragments less than 3 inches in diameter. It ranges from 1 inch to 2 inches in thickness.

The C horizon has hue of 2.5Y or 10YR, value of 6 or 7 when dry and 5 or 6 when moist, and chroma of 3 to 6. It ranges from silt loam to silty clay loam and is 7 to 18 inches thick.

Menefee-Rock outcrop complex, 25 to 60 percent slopes (MEG).—This complex is about 50 percent Menefee shaly loam, 25 to 60 percent slopes; 25 percent Rock outcrop; and 25 percent other soils, Eroded land, and Badland. The Menefee soil and Rock outcrop are intermingled, but Rock outcrop occurs as ledges of limestone exposed at the surface along the slope. The Menefee soil has the profile described as representative of the Menefee series. Runoff is rapid, and the hazard of erosion is severe.

Included with these soils in mapping are small areas of a shallow soil that is similar to this Menefee soil but is redder and is gravelly loam; Eroded land; and Badland, very steep.

The Menefee soil in this complex is used for recreation, wildlife habitat, and range. The native vegetation is juniper, pinyon pine, serviceberry, live oak, Indian ricegrass, and galleta. Capability unit VIIIs-V3, nonirrigated; Menefee soil in Upland Shallow Shale (Pinyon-Juniper) Summer Precipitation range site and wildlife suitability group 3242; Rock outcrop in wildlife suitability group 4444 and range site not assigned.

Mespun Series

The Mespun series consists of excessively drained soils on fans and plateau slopes and in narrow alluvial valleys. These soils formed in hummocky eolian sand deposits derived from sandstone. Slopes range from 0 to 10 percent. Elevation is 3,500 to 6,240 feet. The native vegetation is juniper, pinyon pine, shrubs, and grasses. Average annual precipitation is 11 to 15 inches, average annual air temperature is 54° to 59° F, and the frost-free period is 120 to 170 days. Mespun soils are commonly associated with Pintura and Caval soils.

In a representative profile the soil is reddish-yellow fine sand to a depth of 60 inches.

Permeability is very rapid. Available water capacity is 3 to 5 inches to a depth of 5 feet. The water supplying capacity is 4 to 6 inches. Roots penetrate to a depth of 5 feet or more.

Mespun soils are used for range, recreation, and wildlife habitat.

Representative profile of Mespun fine sand, 0 to 10 percent slopes, in an area of range 1.2 miles south of Anderson Junction and Interstate 15,800 feet east of the west quarter corner of sec. 33, T. 40 S., R. 13 W.:

- A1—0 to 11 inches, reddish-yellow (7.5YR 6/6) fine sand, strong brown (7.5YR 5/6) when moist; single grained; loose; common fine roots; few fine pores; mildly alkaline; gradual, smooth boundary.
- C1—11 to 25 inches, reddish-yellow (5YR 6/6) fine sand, yellowish red (5YR 5/6) when moist; single grained; loose; common fine roots; few fine pores; mildly alkaline; gradual, smooth to wavy boundary.
- C2—25 to 60 inches, reddish-yellow (7.5YR 7/6) fine sand, yellowish red (5YR 5/8) when moist; single grained; few fine roots; few fine pores; mildly alkaline.

The average annual soil temperature at a depth of 20 inches ranges from 48° to 54° F, and the average summer soil temperature is 65° to 70°. The profile ranges from medium acid to mildly alkaline.

The A horizon has hue of 7.5YR or 5YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 2 to 6. It is loamy fine sand or fine sand 2 to 11 inches thick.

The C horizon has value of 4 to 7 when dry and 3 to 5 when moist and chroma of 4 to 8. It is fine sand or loamy fine sand.

Mespun fine sand, 0 to 10 percent slopes (MFD).—This soil is on medium-length plateau slopes and in valleys near sandstone outcrops. Runoff is very slow, and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Pintura loamy fine sand, hummocky, 1 to 10 percent slopes; a shallow sandy soil; Redbank fine sandy loam, 1 to 5 percent slopes; and Caval fine sandy loam, 2 to 10 percent slopes. Also included is about 1 percent areas of Rock land.

This Mespun soil is used mainly for range, recreation, and wildlife habitat. The native vegetation is sand sagebrush, big sagebrush, Mormon tea, snakeweed, desert marigold, Indian ricegrass, juniper, and pinyon pine. Capability unit VIIIs-V6, nonirrigated; Upland Sand (Juniper-Pinyon) Summer Precipitation range site; wildlife suitability group 3242.

Mokiak Series

The Mokiak series consists of well-drained soils on mountain side slopes in the southwestern part of the survey area. These soils formed in material weathered from gneiss and schist rock and some quartzite. Slopes range

from 30 to 70 percent. Elevation is 4,300 to 6,700 feet. The native vegetation is pinyon pine, juniper, shrubs, and grasses. Average annual precipitation is about 14 inches, average annual air temperature is 47° to 52° F, and the frost-free period is 120 to 160 days. Mokiak soils commonly are associated with Tortugas, Dagflat, Motoqua, and Welring soils.

In a representative profile the surface layer is brown very cobbly sandy loam about 6 inches thick. The subsoil is brown very cobbly sandy loam and yellowish-brown or light yellowish-brown very cobbly sandy clay loam about 32 inches thick. Bedrock is at a depth of about 38 inches.

Permeability is moderate. Available water capacity is 2 to 3.5 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as bedrock.

Mokiak soils are used for range and wildlife habitat.

Representative profile of Mokiak very cobbly sandy loam, 30 to 70 percent slopes, in an area of Motoqua-Mokiak very cobbly sandy loams, 30 to 70 percent slopes, in an area of range 1½ miles south of the TV relay tower in the Beaver Dam Mountains, 1,850 feet south and 525 feet west of the northeast corner of sec. 18, T. 42 S., R. 18 W.:

- A1—0 to 6 inches, brown (10YR 5/3) very cobbly sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, very fine, granular structure; loose, very friable, nonsticky and nonplastic; common fine and medium and many very fine roots; few fine and common very fine pores; 50 percent cobbles and gravel; mildly alkaline; clear, wavy boundary.
- B1—6 to 11 inches, brown (10YR 5/3) very cobbly heavy sandy loam, dark brown (10YR 3/3) when moist; moderate, medium, subangular blocky structure that parts to moderate, very fine, subangular blocky; slightly hard, very friable, slightly sticky and nonplastic; common fine, medium, and very fine roots; few fine and medium and common very fine pores; 50 percent cobbles and gravel; mildly alkaline; clear, wavy boundary.
- B21t—11 to 29 inches, yellowish-brown (10YR 5/4) very cobbly sandy clay loam, brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure that parts to moderate, fine, subangular blocky; very hard, friable, slightly sticky and slightly plastic; few medium, fine, and very fine roots; few coarse and medium and common fine and very fine pores; 55 percent cobbles and gravel; mildly alkaline; gradual, wavy boundary.
- B22t—29 to 38 inches, light yellowish-brown (10YR 6/4) very cobbly sandy clay loam, yellowish brown (10YR 5/4) when moist; weak, fine, subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; few medium, fine, and very fine roots; few fine and common very fine pores; 80 percent cobbles and gravel; mildly alkaline; abrupt, wavy boundary.
- R—38 inches, fractured gneiss and schist bedrock.

The average annual soil temperature at a depth of 20 inches ranges from 50° to 54° F. In some areas 5 to 10 percent of the surface is covered with stones.

The A horizon ranges from 4 to 6 inches in thickness.

The B2t horizon has hue of 10YR or 7.5YR and value of 3 to 5 when moist. It ranges from 20 to 29 inches in thickness.

Mokiak soils in the Washington County Area are mapped only with Motoqua soils.

Motoqua Series

The Motoqua series consists of well-drained soils that are shallow over bedrock. These soils are on mountain side slopes in the western part of the survey area. They formed in material weathered from acid igneous rock. Slopes range from 30 to 70 percent. Elevation is 4,700 to 6,700 feet. The native vegetation is pinyon pine, juniper, shrubs, and grasses. Average annual precipitation is 13 to 14 inches, average annual air temperature is 46° to 52° F, and the

frost-free period is 120 to 160 days. Motoqua soils commonly are associated with Dagflat, Nehar, Quazo, Tortugas, and Welring soils.

In a representative profile the surface layer is dark-brown very gravelly sandy loam about 2 inches thick. The subsoil is dark-brown gravelly loam and brown or dark-brown very gravelly sandy clay loam about 14 inches thick. Bedrock is at a depth of about 16 inches.

Permeability is moderate. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 1 inch to 2 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as bedrock.

Motoqua soils are used for range and wildlife habitat.

Representative profile of Motoqua very gravelly sandy loam, 30 to 70 percent slopes, in an area of Quazo-Motoqua very gravelly sandy loams, 30 to 70 percent slopes, in an area of range in the upper part of Beaver Dam Wash, one-half mile southwest of the Middle Ridge Inclosure, 1,320 feet east and 1,585 feet north of the southwest corner of sec. 32, T. 38 S., R. 19 W.:

- A1—0 to 2 inches, dark-brown (7.5YR 4/2) very gravelly sandy loam, very dark brown (7.5YR 2/2) when moist; weak, medium, platy structure that parts to moderate, very fine and fine, granular; soft, friable, nonsticky and nonplastic; few very fine roots; many fine and very fine pores; 80 percent of the surface is covered with gravel, 55 percent gravel in the horizon; slightly acid; clear, smooth boundary.
- B1—2 to 8 inches, dark-brown (7.5YR 4/2) gravelly heavy loam, dark brown (7.5YR 3/2) when moist; weak, medium, subangular blocky structure that parts to moderate, very fine and fine, granular; soft, friable, slightly sticky and slightly plastic; few fine and common very fine roots; many very fine pores; 40 percent gravel; neutral; clear, smooth boundary.
- B21t—8 to 12 inches, dark-brown (7.5YR 4/2) very gravelly sandy clay loam, dark brown (7.5YR 3/2) when moist; weak, medium, prismatic structure that parts to moderate, fine, subangular blocky; hard, firm, sticky and plastic; few medium, fine, and very fine roots; few fine and common very fine pores; 50 percent gravel; neutral; clear, smooth boundary.
- B22t—12 to 16 inches, brown (7.5YR 5/3) very gravelly sandy clay loam, dark brown (7.5YR 4/3) when moist; weak, medium, prismatic structure that parts to weak, fine, subangular blocky; hard, firm, sticky and plastic; few fine and very fine roots; common very fine pores; 50 percent gravel; slightly acid; clear, wavy boundary.
- R—16 inches, extrusive acid igneous rock.

Depth to bedrock ranges from 8 to 20 inches. Gravel and cobbles cover 40 to 80 percent of the surface, and stones in some areas cover as much as 25 percent. Most of the gravel is less than ¼ inch in diameter. The average annual soil temperature at a depth of 20 inches is 47° to 54° F. The profile ranges from slightly acid to mildly alkaline.

The A horizon has hue of 7.5YR, 10YR, or 5YR; value of 4 or 5 when dry and 2 or 3 when moist; and chroma of 2 or 3. It is very gravelly sandy loam or very cobbly sandy loam that ranges from 40 to 70 percent rock fragments.

The B2t horizon has hue of 7.5YR, 10YR, or 5YR; value of 3 to 6 when dry; and chroma of 2 to 5. It is very gravelly sandy clay loam, very cobbly clay loam, or very gravelly clay loam that ranges from 35 to 80 percent rock fragments.

Motoqua-Mokiak very cobbly sandy loams, 30 to 70 percent slopes (MMG).—This complex is on mountain side slopes in the Beaver Dam Mountains. It is about 35 percent Motoqua very cobbly sandy loam, 30 to 70 percent slopes; 35 percent Mokiak very cobbly sandy loam, 30 to 70 percent slopes; 10 percent Rock outcrop; and 20 percent other soils. The Motoqua soil has south- and west-facing slopes, and the Mokiak soil has north- and east-facing slopes.

The Motoqua soil has a profile similar to the one described as representative of the Motoqua series, but the surface layer is very cobbly sandy loam. The Mokiak soil has the profile described as representative of the Mokiak series.

Included with these soils in mapping are small areas of Quazo very gravelly sandy loam, 30 to 70 percent slopes; and a soil that is similar to this Mokiak soil but is deep, has a light-colored surface layer, and has layer of carbonate accumulation at a depth of 24 to 30 inches.

The soils in this complex are used for range and wildlife habitat. The native vegetation is juniper, pinyon pine, live oak, serviceberry, manzanita, peavine, muttongrass, needleandthread, and Indian ricegrass. Capability unit VIIs-V4, nonirrigated; wildlife suitability group 3242; Motoqua soil in Upland Stony Hills (Juniper) Summer Precipitation range site; Mokiak soil in Upland Stony Loam (Pinyon-Juniper) Summer Precipitation range site.

Motoqua-Rock outcrop complex, 30 to 70 percent slopes (MOG).— This complex is in the foothills of the Pine Valley Mountains and in the Harmony Mountains. It is about 65 percent Motoqua very cobbly sandy loam, 30 to 70 percent slopes; 15 percent Rock outcrop; and 20 percent other soils. The Motoqua soil and Rock outcrop are intermingled, but Rock outcrop is mainly on ridges and points.

The Motoqua soil has a profile similar to the one described as representative of the Motoqua series, but the surface layer is very cobbly sandy loam.

Included with these soils in mapping are small areas of Nehar very stony sandy loam, 3 to 30 percent slopes; Quazo very gravelly sandy loam, 30 to 70 percent slopes; and Dagflat very cobbly sandy loam, 30 to 60 percent slopes.

Motoqua soil in this complex is used for range and wildlife habitat. The native vegetation is juniper, pinyon pine, big sagebrush, serviceberry, muttongrass, and Indian ricegrass. Capability unit VIIs-V4, nonirrigated; Motoqua soil in Upland Stony Hills (Juniper) Summer Precipitation range site and wildlife suitability group 3242; Rock outcrop in wildlife suitability group 4444 and range site not assigned.

Naplene Series

The Naplene series consists of well-drained soils on alluvial fans and stream terraces. These soils formed in mixed alluvium derived from sedimentary and igneous rocks. Slopes range from 2 to 6 percent. Elevation is 3,600 to 5,300 feet. The native vegetation is dominantly shrubs and grasses. Average annual precipitation is 14 to 15 inches, average annual air temperature ranges from 45° to 52° F, and the frost-free period is 140 to 160 days. Naplene soils are commonly associated with Redbank, Clovis, and Schmutz soils.

In a representative profile the surface layer is brown silt loam about 7 inches thick. The underlying material is reddish-brown clay loam and reddish-brown and brown silt loam to a depth of 60 inches.

Permeability is moderately slow. Available water capacity is 9 to 12 inches to a depth of 5 feet. The water supplying capacity is 9 to 11 inches. Roots penetrate to a depth of 5 feet or more.

Naplene soils are used for nonirrigated and irrigated crops, recreation, wildlife habitat, and range.

Representative profile of Naplene silt loam, 2 to 6 percent slopes, about 600 feet northwest of the New Harmony interchange on Interstate 15, 2,100 feet west and 525 feet north of the southeast corner of sec. 17, T. 38 S., R. 12 W.:

A11—0 to 2 inches, brown (7.5YR 5/4) silt loam, dark reddish brown (5YR 3/4) when moist; moderate, thin, platy structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common fine vesicular pores; moderately calcareous, lime is disseminated; strongly alkaline; abrupt, smooth boundary.

A12—2 to 7 inches, brown (7.5YR 5/4) silt loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, platy structure; hard, friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; common fine and very fine vesicular pores; moderately calcareous, lime is disseminated; strongly alkaline; abrupt, smooth boundary.

C1—7 to 15 inches, brown (7.4YR 5/4) silt loam, dark reddish brown (5YR 3/4) when moist; moderate, coarse, subangular blocky structure that parts to moderate, medium, subangular blocky; very hard, friable, sticky and plastic; few fine and medium roots; common fine and few medium pores; strongly calcareous, lime is disseminated; strongly alkaline; gradual, wavy boundary.

C2—15 to 22 inches, reddish-brown (5YR 5/4) light clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; very hard, friable, sticky and plastic; common fine and very fine roots; common fine pores; strongly calcareous, lime is disseminated and veined; strongly alkaline; gradual, wavy boundary.

C3—22 to 39 inches, reddish-brown (5YR 5/4) silt loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; very hard, friable, sticky and plastic; few fine and very fine roots; common fine pores; strongly calcareous, lime is disseminated; strongly alkaline; gradual, wavy boundary.

C4—39 to 60 inches, brown (7.5YR 5/4) silt loam, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; very hard, friable, sticky and plastic; few very fine roots; common fine pores; strongly calcareous, lime is disseminated and veined; strongly alkaline.

The average annual soil temperature at a depth of 20 inches ranges from 47° to 54° F, and the average summer soil temperature is 65° to 70°. The profile ranges from mildly alkaline to strongly alkaline.

The A horizon has hue of 7.5YR or 5YR and chroma of 3 or 4. It ranges from heavy silt loam to fine sandy loam to 2 to 8 inches thick.

The C horizon has hue of 5YR, 7.5YR, or 2.5YR; value of 4 to 6 when dry and 3 or 4 when moist; and chroma of 4 to 6. It ranges from light clay loam to silt loam or, in places, fine sandy loam.

Naplene silt loam, 2 to 6 percent slopes (NaC)— This soil is on smooth, medium-length alluvial fans and in broad alluvial valleys and on terraces along streams. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Redbank fine sandy loam, 1 to 5 percent slopes; Schmutz loam; Mespun fine sand, 0 to 10 percent slopes; Clovis fine sandy loam, 1 to 5 percent slopes; and Chilton gravelly loam, 5 to 30 percent slopes.

This Naplene soil is used for irrigated alfalfa, barley, and pasture and for nonirrigated wheat and range. The native vegetation is galleta, Indian ricegrass, sand dropseed, globemallow, and big sagebrush. Capability units IIIe-1, irrigated, IVe-V, nonirrigated; Upland Loam (Summer Precipitation) range site; wildlife suitability groups 2242-I and 2242.

Nehar Series

The Nehar series consists of well-drained soils on alluvial fans and low, rolling hills in the north-central part of the survey area. These soils formed in material weathered from coarse-grained acid igneous rock. Slopes range from 3 to 30 percent. Elevation is 4,200 to 6,100 feet. The native

vegetation is pinyon pine, juniper, shrubs, and grasses. Average annual precipitation is 13 to 15 inches, average annual air temperature is 52° to 58° F, and the frost-free period is 120 to 160 days. Nehar soils commonly are associated with Collbran, Ildefonso, Lavate, Motoqua, and Naplene soils.

In a representative profile the surface layer is brown very stony sandy loam about 5 inches thick. The subsoil is reddish-brown stony clay, yellowish-red stony sandy clay, and yellowish-red very stony sandy clay loam about 42 inches thick. The substratum is light-brown stony sandy loam to a depth of 60 inches.

Permeability is moderately slow. Available water capacity is 5 to 7 inches to a depth of 5 feet. The water supplying capacity is 6 to 9 inches. Roots penetrate to a depth of 50 inches or more.

Nehar soils are used for range and wildlife habitat.

Representative profile of Nehar very stony sandy loam, 3 to 30 percent slopes, in an area of range 0.2 mile west of the Browse interchange on Interstate 15, 1,320 feet east and 800 feet south of the northwest corner of sec. 11, T. 40 S., R. 13 W.:

A1—0 to 5 inches, brown (7.5YR 5/4) very stony sandy loam, dark brown (7.5YR 3/2) when moist; moderate, very fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; few fine and common very fine pores; 25 percent of the surface covered with stones, 50 percent stones, cobbles, and gravel in horizon; neutral; abrupt, smooth boundary.

B21t—5 to 16 inches, reddish-brown (5YR 5/4) stony clay, reddish brown (5YR 4/4) when moist; strong, coarse, prismatic structure that parts to moderate, fine, angular blocky; extremely hard, very firm, very sticky and plastic; few medium and common very fine roots; common fine and many very fine pores; many moderately thick clay films on faces of peds and as bridges; 40 percent stones, cobbles, and gravel; slightly acid; gradual, wavy boundary.

B22t—16 to 29 inches, yellowish-red (5YR 5/6) stony sandy clay, reddish brown (5YR 4/4) when moist; moderate, coarse, prismatic structure that parts to moderate, fine and very fine, subangular blocky; very hard, firm, sticky and plastic; few fine and very fine roots; common fine and many very fine pores; common moderately thick clay films on faces of peds and as bridges; 50 percent stones, cobbles, and gravel; slightly acid; gradual, wavy boundary.

B3—29 to 47 inches, yellowish-red (5YR 5/6) very stony sandy clay loam, reddish brown (5YR 4/4) when moist; moderate, medium and fine, subangular blocky structure; very hard, firm, sticky and plastic; few fine and very fine roots; few medium, common fine, and many very fine pores; few thin clay films on faces of peds and in pores; 55 percent stones, cobbles, and gravel; slightly acid; gradual, smooth boundary.

C—47 to 60 inches, light-brown (7.5YR 6/4) stony sandy loam, reddish brown (5YR 4/4) when moist; massive; very hard, friable, slightly sticky and nonplastic; few fine and many very fine pores; 55 percent stones, cobbles, and gravel; slightly acid.

The profile ranges from slightly acid to mildly alkaline. Stones cover 5 to 25 percent of the soil surface. The average annual soil temperature at a depth of 20 inches is 50° to 57° F.

The A horizon has hue of 7.5YR, 10YR, or 5YR; value of 4 to 6 when dry and 2 or 3 when moist; and chroma of 2 to 4. It ranges from 2 to 8 inches in thickness.

The B2t horizon has hue of 5YR or 7.5YR, value of 4 to 6 when dry and 3 or 4 when moist, and chroma of 2 to 6. It is stony clay, very gravelly clay, stony sandy clay, very stony sandy clay, cobbly sandy clay, or very gravelly sandy clay that ranges from 35 to 70 percent rock fragments. It is 15 to 27 inches thick.

The C horizon has hue of 5YR or 7.5YR, value of 4 or 5 when moist and chroma of 3 to 6. It is stony sandy loam, very stony sandy loam, or very cobbly sandy loam that ranges from 35 to 80 percent rock fragments.

Nehar very stony sandy loam, 3 to 30 percent slopes (NEF)—This soil is on smooth, medium-length alluvial fans and low rolling hills (fig. 5). It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of a soil that is similar to this Nehar soil but is less than 35 percent coarse fragments and small areas of Motoqua very gravelly sandy loam, 30 to 70 percent slopes.

This Nehar soil is used for range and wildlife habitat. Capability unit VIIs-V4, nonirrigated; Upland Stony Loam (Pinyon-Juniper) Summer Precipitation range site; wildlife suitability group 3242.

Nehar-Ildefonso complex, 3 to 30 percent slopes (NIF)—This complex is on low, rolling hills. It is about 45 percent Nehar very stony sandy loam, 3 to 30 percent slopes; 35 percent Ildefonso very gravelly sandy loam, 5 to 30 percent slopes; and 20 percent other soils. The Nehar and Ildefonso soils occur in areas of interbedded limestone and quartzite rock. The Nehar soil is on the higher convex parts of rolling hills, and the Ildefonso soil is on the lower, generally concave part of the slopes. The Ildefonso soil has the profile described as representative of the Ildefonso series.

Included with these soils in mapping are small areas of a soil that is similar to Nehar soils but is less than 35 percent coarse fragments and small areas of Tacan very stony sandy loam, 30 to 70 percent slopes.

The soils in this complex are used for range and wildlife habitat. The native vegetation is juniper, pinyon pine, live oak, big sagebrush, Indian ricegrass, and squirreltail. Capability unit VIIs-V4, nonirrigated; Upland Stony Loam (Pinyon-Juniper) Summer Precipitation range site; wildlife suitability group 3242.

Nikey Series

The Nikey series consists of well-drained soils on alluvial fans and desert foothill slopes. These soils formed in gravelly alluvium washed from limestone, sandstone, and shale. Slopes range from 1 to 15 percent. Elevation is 2,650 to 3,500 feet. The native vegetation is desert shrubs, forbs, and grasses. Average annual precipitation is 8 to 11 inches, average annual air temperature is 59° to 62° F, and the frost-free period is 180 to 195 days. Nikey soils are commonly associated with Isom, Junction, Leeds, and Tobler soils.

In a representative profile the surface layer is brown sandy loam and yellowish-red fine sandy loam about 26 inches thick. The underlying material is light reddish-brown or pink gravelly loam to a depth of 60 inches.

Permeability is moderate, and runoff is medium. Available water capacity is 5 to 7 inches to a depth of 5 feet. The water supplying capacity is 4 to 6 inches. Roots penetrate to a depth of 40 inches or more.

Nikey soils are used for range and wildlife habitat.

Representative profile of Nikey sandy loam, 3 to 15 percent slopes, in an area of Nikey-Isom complex, 3 to 30 percent slopes, in an area of range about 7½ miles south of Hurricane, 350 feet north and 500 feet east of the southwest corner of sec. 3, T. 43 S., R. 13 W.:

A1—0 to 3 inches, brown (7.5YR 5/4) sandy loam, dark brown (7.5YR



Figure 5.—An area of Nehar very stony sandy loam, 3 to 30 percent slopes.

4/4) when moist; weak, thin, platy structure; loose, very friable, nonsticky and nonplastic; few fine roots; few fine pores; moderately calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.

A12—3 to 26 inches, yellowish-red (5YR 5/6) fine sandy loam, reddish brown (5YR 4/4) when moist; weak, medium, subangular blocky structure; hard, very friable, nonsticky and slightly plastic; few fine and medium roots; common fine and medium pores; 15 percent gravel; moderately calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.

IIC1c2—26 to 38 inches, light reddish-brown (5YR 6/4) gravelly loam, reddish brown (5YR 5/4) when moist; massive; very hard, firm, sticky and plastic; few fine roots; common fine pores; 40 percent gravel; strongly calcareous, lime is disseminated; strongly alkaline; gradual, wavy boundary.

IIC2ca—38 to 46 inches, pink (5YR 7/3) gravelly loam, light reddish brown (5YR 6/4) when moist; massive; very hard, firm, sticky and plastic; few fine roots; few fine pores; 50 percent gravel; very strongly calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.

IIC3—46 to 60 inches, pink (5YR 7/3) gravelly loam, light reddish brown (5YR 6/4) when moist; massive; hard, friable, sticky and plastic; few fine pores; 40 percent gravel; strongly calcareous; moderately alkaline.

The average annual soil temperature at a depth of 20 inches ranges from 59° to 63° F, and the average summer soil temperature is 77° to 82°. The soil is moderately alkaline or strongly alkaline. In most places a gravel pavement covers 10 to 40 percent of the surface.

The A horizon has hue of 7.5YR or 5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 to 6. It is sandy loam, loam, fine sandy loam, or very stony loam.

The C horizon has hue of 5YR or 7.5YR, value of 5 or 6 when dry, and chroma of 4 to 8.

The IICca horizon has hue of 5YR or 7.5YR, value of 6 to 8 when dry and 4 to 6 when moist, and chroma of 3 to 6. It ranges from gravelly loamy fine sand to gravelly loam and stony loam that is 30 to 50 percent gravel, cobbles, and stones. In some places the lower part of the IICca horizon contains many fine to medium gypsum crystals.

Nikey sandy loam, 1 to 3 percent slopes (NkC).—This soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but slopes are 1 to 3 percent. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of LaVerkin fine sandy loam, 2 to 5 percent slopes; Tobler fine sandy loam; and Isom cobbly sandy loam, 3 to 30 percent slopes.

This Nikey soil is used for irrigated barley and alfalfa and for range. The native vegetation is creosotebush, Mormon tea, range ratany, Indian ricegrass, mesa dropseed, galleta, and sand dropseed. Capability units IIe-0, irrigated, VIIe-C, nonirrigated; Southern Desert Loam range site; wildlife suitability groups 1242-I and 4343.

Nikey sandy loam, 3 to 15 percent slopes (NLE) — This soil is on desert alluvial fans. It has a profile similar to the one described as representative of the series, but the lower part of the underlying material is 1 to 10 percent, by volume, fine to medium crystals of gypsum. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of

Nikey very stony sandy loam, 2 to 15 percent slopes; Isom cobbly sandy loam, 3 to 30 percent slopes; and Hobog very cobbly loam, 3 to 40 percent slopes.

This Nikey soil is used for range. The native vegetation is creosotebush, blackbrush, Mormon tea, galleta, and cholla cactus. Capability unit VIIe-C, nonirrigated; Southern Desert Loam range site; wildlife suitability group 4343.

Nikey very stony sandy loam, 2 to 15 percent slopes (NME).—This soil is on desert slopes. It has a profile similar to the one described as representative of the series, but slopes are 2 to 15 percent, the surface layer is very stony sandy loam, and the profile is 3 to 5 percent stones. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Nikey sandy loam, 1 to 3 percent slopes; Isom cobbly sandy loam, 3 to 30 percent slopes; and Harrisburg fine sandy loam, 5 to 20 percent slopes.

This Nikey soil is used for range. The native vegetation is creosotebush, Mormon tea, Indian ricegrass, galleta, cholla cactus, and Spanish dagger. Capability unit VIIIs-C4, nonirrigated; Southern Desert Stony Loam range site; wildlife suitability group 4343.

Nikey-Isom complex, 3 to 30 percent slopes (NNE).—This complex is on alluvial fans. It is about 45 percent Nikey sandy loam, 3 to 15 percent slopes; 40 percent Isom very cobbly fine sandy loam, 3 to 30 percent slopes; and 15 percent other soils. The Nikey soil is more gently sloping and is on the lower parts of alluvial fans. The Isom soil is at the heads of the fans near the cliffs.

The Nikey and Isom soils have the profiles described as representative of the Nikey and Isom series.

Included with these soils in mapping are small areas of Riverwash, Gullied land, and Stony colluvial land. Also included are areas of Nikey very stony sandy loam, 2 to 15 percent slopes.

The soils in this complex are used for range. The native vegetation is creosotebush, Mormon tea, cholla, cheatgrass, and redtop bromegrass. Capability unit VIIe-C, nonirrigated; wildlife suitability group 4343; Nikey soil in Southern Desert Loam range site; Isom soil in Southern Desert Stony Loam range site.

Palma Series

The Palma series consists of well-drained soils on old alluvial fans and in alluvial valleys in the Big Plain. These soils formed in mixed alluvium weathered from sandstone, siltstone, and shale. Slopes range from 1 to 5 percent. Elevation is 4,500 to 5,200 feet. The native vegetation is shrubs, forbs, and grasses. Average annual precipitation is 12 to 14 inches, average annual air temperature is 52° to 56° F, and the frost-free period is 165 to 170 days. Palma soils commonly are associated with Redbank, Bond, Mespun, Clovis, and Schmutz soils.

In a representative profile the surface layer is reddish-brown fine sandy loam about 9 inches thick. The subsoil is red or yellowish-red fine sandy loam about 16 inches thick. The substratum is yellowish-red fine sandy loam to a depth of 60 inches.

Permeability is moderate. Available water capacity is 6 to 8.5 inches to a depth of 5 feet. The water supplying capacity is 6 to 9 inches. Roots penetrate to a depth of 60 inches or more.

Palma soils are used for range and nonirrigated crops.

Representative profile of Palma fine sandy loam, 1 to 5 percent slopes, in a field of nonirrigated wheat in the Big Plains, 400 feet north and 400 feet west of the center of sec. 30, T. 42 S., R. 12 W.:

- Ap—0 to 6 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) when moist; weak, fine, granular and subangular blocky structure; slightly hard, very friable, non-sticky and nonplastic; common fine and very fine roots; few fine pores; noncalcareous; moderately alkaline; abrupt, smooth boundary.
- A3 — 6 to 9 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) when moist; weak, fine, subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common fine and very fine roots; few fine pores; slightly calcareous; moderately alkaline; clear, smooth boundary.
- B2t—9 to 15 inches, red (2.5 YR 4/6) heavy fine sandy loam, dark red (2.5YR 3/6) when moist; weak, medium, prismatic structure that parts to moderate, medium, subangular blocky; hard, friable, sticky and slightly plastic; common fine and very fine roots; common fine and very fine pores; few thin clay films in pores and as bridges between sand grains; moderately calcareous; moderately alkaline; clear, wavy boundary.
- B3—15 to 25 inches, yellowish-red (5YR 5/6) fine sandy loam, reddish brown (2.5YR 4/4) when moist; weak, medium, subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few fine and very fine roots; common fine and very fine pores; strongly calcareous; moderately alkaline; clear, wavy boundary.
- C—25 to 60 inches, yellowish-red (5YR 5/6) fine sandy loam, red (2.5YR 4/6) when moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; few fine pores; strongly calcareous, common soft lime; strongly alkaline.

The average annual soil temperature at a depth of 20 inches is 54° to 58° F. The profile ranges from mildly alkaline to strongly alkaline.

The A horizon has hue of 5YR, 2.5YR, or 7.5YR; value of 4 or 5 when dry and 3 or 4 when moist; and chroma of 3 or 4. It is fine sandy loam or loamy fine sand that ranges from 4 to 11 inches in thickness.

The B2t horizon has hue of 2.5YR or 5YR, value of 3 to 5 when dry and 3 or 4 when moist, and chroma of 4 to 6. It is heavy fine sandy loam, fine sandy clay loam, and light clay loam. It ranges from non-calcareous to strongly calcareous and is 6 to 18 inches thick.

The C horizon has hue of 5YR or 2.5YR, value of 5 to 7 when dry and 3 to 6 when moist, and chroma of 3 to 6. It is loamy fine sand, fine sandy loam, loamy sand, loam, and thin strata of sand. It ranges from moderately calcareous to strongly calcareous.

Palma loamy fine sand, 1 to 5 percent slopes (PAC).—This soil is on dissected alluvial fans and in alluvial valleys in the area of Big Plain. It has a profile similar to the one described as representative of the series, but the surface layer is loamy fine sand. Available water capacity is 6.0 to 7.5 inches to a depth of 5 feet. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Mespun fine sand, 0 to 10 percent slopes, and Redbank fine sandy loam, 1 to 5 percent slopes.

This Palma soil is used for range. The native vegetation is galleta, Indian ricegrass, black grama, big sagebrush, sand sagebrush, and scattered juniper. Capability unit VIIIs-V6, nonirrigated; Southern Upland Loam range site; wildlife suitability group 2242.

Palma fine sandy loam, 1 to 5 percent slopes (PbC).—This soil is on medium-length alluvial fans and in alluvial valleys in the area of Big Plain (fig. 6). It has the profile described as representative of the series. Available water capacity is 7.5 to 8.5 inches to a depth of 5 feet. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Clovis fine sandy loam, 1 to 5 percent slopes, and Redbank fine sandy loam, 1 to 5 percent slopes.

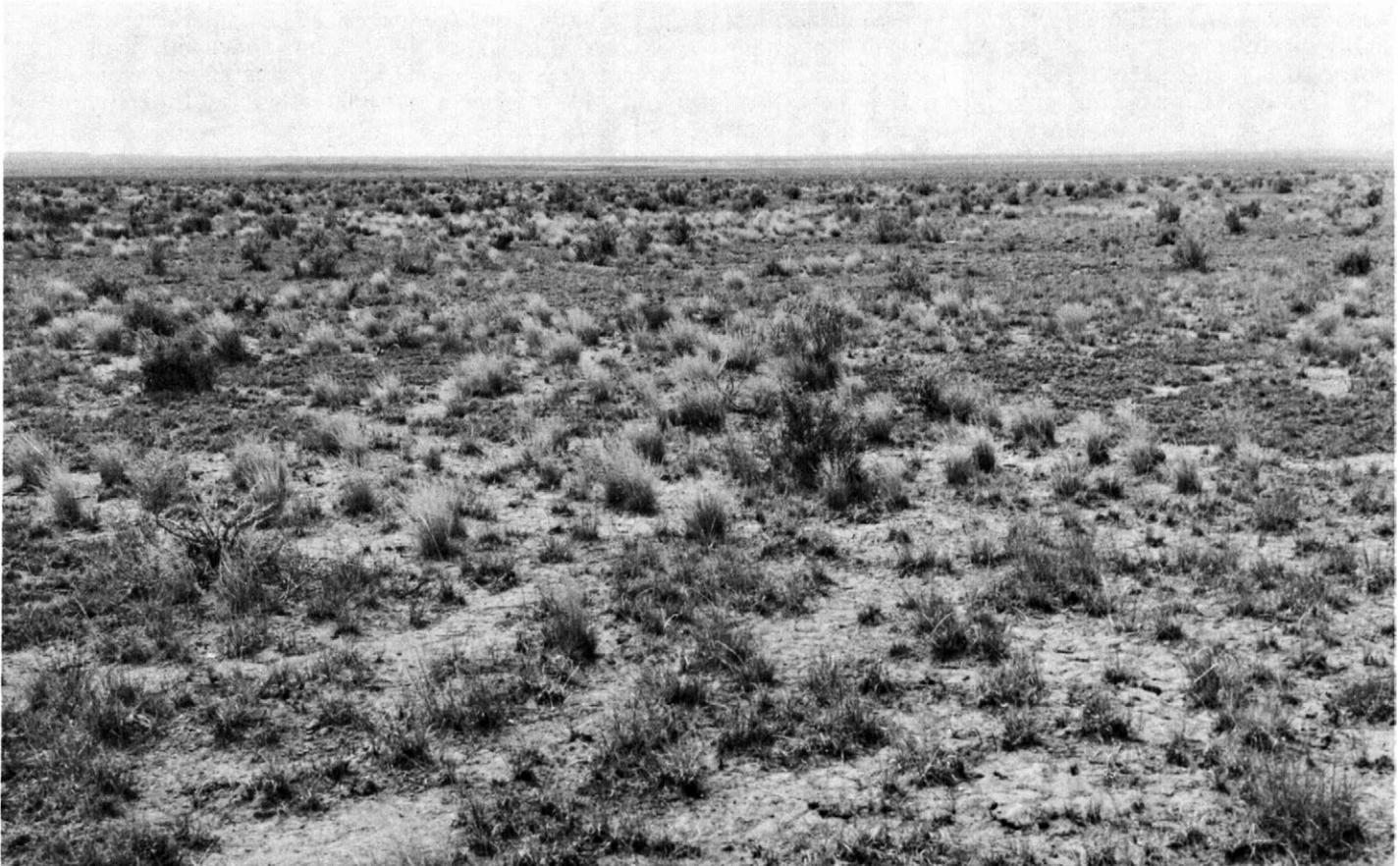


Figure 6.—An area of Palma fine sandy loam, 1 to 5 percent slopes.

This Palma soil is used for range and nonirrigated wheat. The native vegetation is galleta, Indian ricegrass, needleandthread, sand dropseed, black grama, big sagebrush, and scattered juniper. Capability unit VIe-V, nonirrigated; Southern Upland Loam range site; wildlife suitability group 2242.

Pastura Series

The Pastura series consists of shallow, well-drained soils that have a hardpan at a depth of 10 to 20 inches. These soils are on old basalt flows in the central part of the survey area. They formed in material weathered from basalt and in eolian material derived from sandstone and shale. Slopes range from 2 to 10 percent. Elevation is 3,800 to 5,000 feet. The native vegetation is desert shrubs and grasses. Average annual precipitation ranges from 10 to 12 inches, average annual air temperature is 56° to 59° F, and the frost-free period is 165 to 170 days. Pastura soils are commonly associated with Clovis, Magotsu, Veyo, and Esplin soils.

In a representative profile the soil is brown gravelly loam about 15 inches thick that is underlain by about 3 inches of brown gravelly clay loam. An indurated carbonate-cemented hardpan is at a depth of about 18 inches.

Permeability is moderate above the hardpan. Runoff is

medium, and the hazard of erosion is moderate. Available water capacity, above the hardpan, is 2 to 3 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as the hardpan.

Pastura soils are used mainly for range and wildlife habitat. Small areas in the vicinity of Veyo are used for irrigated crops.

Representative profile of Pastura gravelly loam, 2 to 10 percent slopes, in an area of Magotsu-Pastura complex, 2 to 20 percent slopes, in an area of range about 1½ miles southwest of Upper Sand Cove Reservoir, 400 feet south and 800 feet west of the northeast corner of sec. 26, T. 40 S., R. 17 W.:

- A1—0 to 2 inches, brown (7.5YR 5/3) gravelly loam, dark brown (7.5YR 4/3) when moist; weak, medium, platy structure that parts to moderate, fine, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine and many very fine vesicular pores; 15 percent gravel; slightly calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.
- C1—2 to 8 inches, brown (7.5YR 5/4) gravelly loam, dark brown (7.5YR 4/3) when moist; weak, medium and coarse, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; few very fine, fine, and medium roots; few fine and medium pores; 20 percent gravel; moderately calcareous, lime is disseminated; moderately alkaline; gradual, smooth boundary.
- C2ca—8 to 15 inches, brown (7.5YR 5/4) gravelly loam, dark brown (7.5YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; few

very fine and fine roots; common very fine pores; 30 percent gravel; very strongly calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.

C3ca—15 to 18 inches, brown (7.5YR 5/4) gravelly light clay loam, dark brown (7.5YR 4/3) when moist; massive; slightly hard, firm, slightly sticky and plastic; few very fine and fine roots; common fine and very fine pores; 30 percent gravel; very strongly calcareous, lime is concentrated in irregularly shaped masses; moderately alkaline; abrupt, smooth boundary.

C4cam—18 to 27 inches, indurated carbonate-cemented hardpan.

Depth to the hardpan ranges from 10 to 20 inches. Rock fragments cover 10 to 35 percent of the surface area. The average annual soil temperature at a depth of 20 inches is 55° to 58° F, and the average summer soil temperature is 76° to 79°.

The A horizon has hue of 5YR or 7.5YR, value of 4 to 6 when dry and 3 or 4 when moist, and chroma of 4 to 6. It ranges from loam to gravelly loam that is 0 to 35 percent rock fragments. It ranges from 1 inch to 6 inches in thickness.

The C horizon has hue of 7.5YR or 5YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 4 to 6. It is light loam, heavy loam, or light clay loam that ranges from 10 to 35 percent rock fragments. It is moderately calcareous in the upper part and, generally, strongly calcareous or very strongly calcareous just above the hardpan.

Pastura loam, 2 to 5 percent slopes (PcC).— This soil is on basalt flows near the town of Veyo. It has a profile similar to the one described as representative of the series, but the surface layer is less than 5 percent gravel, depth to the hardpan is generally 16 to 20 inches, and slopes are 2 to 5 percent. Most areas of this soil are irrigated. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Esplin loam, 0 to 2 percent slopes; Veyo cobbly sandy loam, 1 to 10 percent slopes; and Naplene silt loam, 2 to 6 percent slopes.

This Pastura soil is used for irrigated alfalfa, small grain, and pasture. Capability unit IVs-13, irrigated; wildlife suitability group 2242-I; range site not assigned.

Pastura-Esplin complex, 0 to 10 percent slopes (PED).— This complex is on old basalt flows. It is about 50 percent Pastura gravelly loam, 2 to 10 percent slopes; 35 percent Esplin loam, 0 to 2 percent slopes; and 15 percent other soils.

The Esplin soil has the profile described as representative of the Esplin series.

Included with these soils in mapping are small areas of Redbank fine sandy loam, 1 to 5 percent slopes; Yaki very cobbly loam, 3 to 35 percent slopes; Zukan fine sandy loam, 1 to 10 percent slopes; Veyo extremely stony sandy loam, 3 to 10 percent slopes; and a soil that is similar to this Esplin soil but is 20 to 32 inches deep over the hardpan. Also included are areas of Rock land and Rock outcrop, each of which makes up about 1 percent of the mapped area.

The soils in this complex are used for range. The native vegetation is blackbrush, squirreltail, galleta, bush muhly, Mormon tea, snakeweed, and cholla cactus. Capability unit VIIs-R3, nonirrigated; Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone, range site; Pastura soil in wildlife suitability group 3242; Esplin soil in wildlife suitability group 4343.

Paunsaugunt Series

The Paunsaugunt series consists of shallow, somewhat excessively drained soils that are underlain by bedrock at a depth of 10 to 19 inches. These soils are on north- and

east-facing mountain side slopes in the area of Lava Point and Potato Hollow and in the eastern part of Zion National Park. They formed in material weathered from limestone. Slopes range from 10 to 50 percent. Elevation is 6,000 to 7,500 feet. The native vegetation is pinyon pine, juniper, ponderosa pine, shrubs, and grasses. Average annual precipitation is 16 to 18 inches, average annual air temperature is 42° to 45° F, and the frost-free period is 70 to 90 days. Paunsaugunt soils are commonly associated with Kolob, Detra, and Kinesava soils.

In a representative profile the soil is dark grayish-brown gravelly silt loam and very gravelly loam about 13 inches thick that is underlain by limestone bedrock.

Permeability is moderate. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 1 inch to 2 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as bedrock.

Paunsaugunt soils are used for recreation, wildlife habitat, and range.

Representative profile of Paunsaugunt gravelly silt loam, 10 to 30 percent slopes, in an area of Paunsaugunt-Kolob association, in an area of range in Zion National Park near Deer Trap Mountain, about one-fourth mile southeast of Sawmill Spring, in the NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 12, T. 41 S., R. 10 W.:

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) gravelly silt loam, very dark brown (7.5YR 2/2) when moist; moderate, medium, granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and fine pores; 20 percent gravel; strongly calcareous, lime is disseminated; strongly alkaline; clear, smooth boundary.

A12—4 to 13 inches, dark grayish-brown (10YR 4/2) very gravelly loam, very dark brown (7.5YR 2/2) when moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and medium and few coarse roots; common fine pores and few medium pores; 60 percent gravel; strongly calcareous, lime is disseminated; moderately alkaline; abrupt, smooth boundary.

R—13 inches, limestone bedrock.

Depth to bedrock ranges from 10 to 19 inches. Coarse fragments on the surface range from 20 to 35 percent. The profile ranges from moderately calcareous to strongly calcareous. The average annual soil temperature at a depth of 20 inches is 44° to 47° F, and the average summer soil temperature is 62° to 64°.

The A11 horizon has hue of 10YR, 7.5YR, or 2.5Y; value of 3 to 5 when dry and 2 or 3 when moist; and chroma of 2 or 3. It is gravelly silt loam, gravelly loam, or very gravelly silt loam. The A12 horizon has hue of 10YR, 7.5YR, or 2.5Y; value of 3 to 6 when dry and 2 to 4 when moist; and chroma of 2 or 3. It is very gravelly loam, very gravelly silt loam, or very gravelly very fine sandy loam that is 60 to 90 percent gravel.

Paunsaugunt gravelly silt loam, 30 to 50 percent slopes (PFG).— This soil is on short to medium-length, north- and east-facing mountain side slopes. It has a profile similar to the one described as representative of the series, but slopes are 30 to 50 percent and the surface layer ranges from 3 to 6 inches in thickness. Runoff is moderately rapid, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of a soil that is similar to this Paunsaugunt soil, but the surface layer is light brown, pale brown, or very pale brown when dry; Detra fine sandy loam, 5 to 20 percent slopes; and Kolob silt loam, brown variant, 10 to 30 percent slopes. Also included are areas of Rock outcrop, which make up about 5 percent of the mapped areas.

This Paunsaugunt soil is used for recreation, wildlife habitat, and range. The native vegetation is scattered pon-

derosa pine, juniper, pinyon pine, muttongrass, serviceberry, bitterbrush, and squaw-apple. Capability unit VIIs-L, nonirrigated; Mountain Shallow Loam (Ponderosa Pine) range site; wildlife suitability group 3242.

Paunsaugunt-Kolob association (PG).— This association is about 60 percent Paunsaugunt gravelly silt loam, 10 to 30 percent slopes; 30 percent Kolob cobbly fine sandy loam, 8 to 12 percent slopes; and 10 percent other soils and Rock outcrop. The Paunsaugunt soil is on ridges and steep side slopes. The Kolob soil is on mesa tops.

The Paunsaugunt soil has the profile described as representative of the Paunsaugunt series. The Kolob soil has a profile similar to the one described as representative of the Kolob series, but slopes are 8 to 12 percent and the surface is cobbly.

Included with these soils in mapping are small areas of Kolob silt loam, brown variant, 10 to 30 percent slopes; a deep very gravelly loam soil on north-facing foot slopes; and Rock outcrop, which is about 2 percent of the areas.

The soils in this association are used mainly for recreation, wildlife habitat, and range. The native vegetation is ponderosa pine, pinyon pine, juniper, serviceberry, bitterbrush, Indian ricegrass, muttongrass, and dryland sedge. Paunsaugunt soil in capability unit VIIs-L, nonirrigated; Mountain Shallow Loam (Ponderosa Pine) range site; wildlife suitability group 3242. Kolob soil in capability unit VIe-L, nonirrigated; Mountain Stony Loam (Summer Precipitation) range site; wildlife suitability group 2141.

Paunsaugunt Variant

The Paunsaugunt variant consists of shallow, well-drained soils that are underlain by bedrock at a depth of 10 to 18 inches. These soils are on mesa tops and ridgetops in Zion National Park. They formed in material weathered from limestone. Slopes range from 2 to 8 percent. Elevation is 6,900 to 7,400 feet. Average annual precipitation is 16 to 18 inches, average annual air temperature is 42° to 45° F, and the frost-free period is 90 to 120 days. Paunsaugunt variant soils are commonly associated with Paunsaugunt and Kolob soils.

In a representative profile the surface layer is dark-brown cobbly silt loam about 2 inches thick. The subsoil is brown cobbly light silty clay loam and reddish-brown very cobbly silty clay about 10 inches thick. Limestone bedrock is at a depth of about 12 inches.

Permeability is moderately slow. Runoff is slow, and the hazard of erosion is moderate. Available water capacity is 1.5 to 3 inches. The water supplying capacity is 3 to 6 inches. Roots penetrate as far down as bedrock.

Paunsaugunt variant soils are used for recreation, wildlife habitat, and range.

Representative profile of Paunsaugunt cobbly silt loam, clayey subsoil variant, 2 to 8 percent slopes, in an area of the Paunsaugunt-Rock outcrop complex, 2 to 30 percent slopes, about three-fourths mile southeast of Lava Point Lookout in Zion National Park, in the NW¼SE¼ sec. 31, T. 39 S., R. 10 W.:

A1—0 to 2 inches, dark-brown (7.5YR 3/2) cobbly silt loam, very dark brown (7.5YR 2/2) when moist; weak, medium, subangular blocky structure that parts to moderate, medium, granular; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine and few medium roots; common very fine

and fine pores; 30 percent cobbles and gravel; mildly alkaline; abrupt, smooth boundary.

B1—2 to 4 inches, brown (7.5YR 4/2) cobbly light silty clay loam, dark brown (7.5YR 3/2) when moist; moderate, medium, subangular blocky structure; hard, firm, slightly sticky and plastic; common fine and medium and few coarse roots; common very fine and fine pores; 25 percent cobbles and gravel; mildly alkaline; abrupt, smooth boundary.

B2t—4 to 12 inches, reddish-brown (5YR 4/4) very cobbly silty clay, dark reddish brown (5YR 3/4) when moist; moderate, medium, subangular blocky structure; very hard, very firm, very sticky and very plastic; common fine, medium, and coarse roots; common fine and medium pores; 80 percent cobbles and gravel; common moderately thick clay films on faces of peds and in pores; mildly alkaline; abrupt, smooth boundary.

R—12 inches, fractured limestone bedrock.

Depth to bedrock ranges from 10 to 18 inches. The profile is non-calcareous throughout. The average annual soil temperature at a depth of 20 inches is 44° to 49° F, and the average summer soil temperature is 62° to 65°.

The A horizon has value of 3 or 4 when dry and 2 or 3 when moist. It is 30 to 50 percent cobbles and gravel.

The B2t horizon has hue of 7.5YR or 5YR and chroma of 2 to 4. It is 25 to 50 percent cobbles and gravel in the upper 2 to 4 inches and is 60 to 80 percent in the lower part.

Paunsaugunt variant soils in the Washington County Area are mapped only with Rock outcrop.

Paunsaugunt-Rock outcrop complex, 2 to 30 percent slopes (PKE).— This complex is about 50 percent Paunsaugunt cobbly silt loam, clayey subsoil variant, 2 to 8 percent slopes; 25 percent Paunsaugunt gravelly silt loam, 10 to 30 percent slopes; 15 percent Rock outcrop; and 10 percent other soils. The Paunsaugunt variant soil is gently sloping to sloping and is on narrow mesas and ridges. The Paunsaugunt soil is steep and is on side slopes.

Included with these soils in mapping are small areas of Kolob cobbly fine sandy loam, 2 to 8 percent slopes, and Kolob fine sandy loam, 20 to 50 percent slopes.

The soils in this complex are used for range, wildlife habitat, and recreation. The native vegetation is ponderosa pine, manzanita, bitterbrush, Gambel oak, serviceberry, Indian ricegrass, and tall native bluegrass. Capability unit VIIs-L; Paunsaugunt soils in Mountain Shallow Loam (Ponderosa Pine) range site and wildlife suitability group 3242; Rock outcrop in wildlife suitability group 4444 and range site not assigned.

Pintura Series

The Pintura series consists of somewhat excessively drained soils on desert slopes and mountain side slopes in the south-central part of the survey area. These soils formed in windblown sand weathered from sandstone. Slopes range from 1 to 10 percent. Elevation is 2,600 to 3,600 feet. The native vegetation is desert shrubs and grasses. Average annual precipitation is 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period is 190 to 195 days. Pintura soils commonly are associated with Mespun, Ivins, Tobler, and Toquerville soils.

In a representative profile the soil is reddish-yellow loamy fine sand and fine sand to a depth of 65 inches or more.

Permeability is rapid. Much of the area has deposits of windblown sand in hummocks that range from 10 to 36 inches high. Available water capacity is 3 to 6 inches to a depth of 5 feet. The water supplying capacity is 3 to 5 in-

ches. Roots penetrate to a depth of 5 feet or more.

Pintura soils are used for range.

Representative profile of Pintura loamy fine sand, hummocky, 1 to 10 percent slopes, in an area of range on Sand Mountain, 75 feet southwest of the northeast corner of sec. 36, T. 42 S., R. 14 W.:

C1—0 to 3 inches, reddish-yellow (5YR 6/8) loamy fine sand, yellowish red (5YR 5/8) when moist; single grained; loose, nonsticky and nonplastic; common fine and very fine roots; mildly alkaline; diffuse, smooth boundary.

C2—3 to 65 inches, reddish-yellow (5YR 6/8) fine sand, yellowish red (5YR 5/8) when moist; single grained; loose, nonsticky and nonplastic; few fine roots; mildly alkaline.

Depth to bedrock is 40 to more than 60 inches. The profile ranges from neutral to strongly alkaline and from noncalcareous to moderately calcareous. It is 0 to 15 percent gravel. The average annual soil temperature at a depth of 20 inches is 59° to 68° F.

The C horizon has hue of 5YR or 2.5YR, value of 4 to 6 when dry and 3 to 5 when moist, and chroma of 4 to 8. It is loamy fine sand, fine sand, loamy sand, and, in places, sandy loam below a depth of 40 inches.

Pintura loamy fine sand, 1 to 5 percent slopes (PnC).—This undulating soil is on desert slopes. It has a profile similar to the one described as representative of the series, but it is not so sloping. Runoff is very slow, and the hazard of erosion is slight to moderate.

Included with this soil in mapping are small areas of Tobler fine sandy loam; Harrisburg fine sandy loam, 1 to 5 percent slopes; Toquerville fine sand, 2 to 20 percent slopes; and Ivins loamy fine sand, hummocky.

This Pintura soil is used for range. Capability units IIIs-06, irrigated, VIIs-C6, nonirrigated; Southern Desert Sand range site; wildlife suitability groups 4343 and 2242-I.

Pintura loamy fine sand, hummocky, 1 to 10 percent slopes (PoD3).—This soil is on hummocky desert slopes and mountain side slopes. It has the profile described as representative of the series. Runoff is very slow, and the hazard of erosion is moderate to severe.

Included with this soil in mapping are small areas of Toquerville fine sand, 2 to 20 percent slopes, and Pintura loamy fine sand that has slopes of 10 to 20 percent. Also included is Dune land, which makes up about 5 percent of the area.

This Pintura soil is used for range. The native vegetation is sand sage, snakeweed, creosotebush, blackbrush, Indian ricegrass, galleta, and cactus. Capability unit VIIs-C6, nonirrigated; Southern Desert Sand range site; wildlife suitability group 4343.

Pintura-Toquerville complex, 1 to 20 percent slopes (PTE).—This complex is on mountain side slopes. It is about 50 percent Pintura loamy fine sand, hummocky, 1 to 10 percent slopes; 40 percent Toquerville fine sand, 2 to 20 percent slopes; and 10 percent other soils and Rock outcrop. The Pintura soil is on the leeward side of ridges and the lower parts of slopes, where wind tends to deposit drifting sand. The Toquerville soil is on the windward side of ridges, ridgetops, and blown-out areas. The Toquerville soil has the profile described as representative of the Toquerville series.

Included with these soils in mapping are small areas of a soil that is similar to this Toquerville soil but is 20 to 40 inches deep over sandstone bedrock; Ivins loamy fine sand, hummocky; and a very shallow sandy soil that is less than 10 inches deep over sandstone bedrock. Also included are

areas of Rock outcrop, which make up about 2 percent of the mapped area.

The soils in this complex are used for range. The native vegetation is sand sagebrush, Mormon tea, Indian ricegrass, galleta, blackbrush, and cholla cactus. Capability unit VIIs-C6, nonirrigated; Southern Desert Sand range site; wildlife suitability group 4343.

Quazo Series

The Quazo series consists of shallow, well-drained soils that are underlain by bedrock at a depth of 11 to 20 inches. These soils are on mountain side slopes in the northwestern part of the survey area. They formed in material weathered from acid igneous rock. Slopes range from 30 to 70 percent. Elevation is 3,700 to 6,700 feet. The native vegetation is big sagebrush, pinyon pine, juniper, cliffrose, and Nevada bluegrass. Average annual precipitation ranges from 12 to 14 inches, average annual air temperature is 46° to 56° F, and the frost-free period is 120 to 170 days. Quazo soils commonly are associated with Dagflat and Motoqua soils.

In a representative profile the surface layer is brown very gravelly sandy loam about 2 inches thick. The subsoil is brown and reddish-brown gravelly sandy clay loam about 16 inches thick. Bedrock is at a depth of about 18 inches.

Permeability is moderate. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 1 inch to 2 inches. The water supplying capacity is 2 to 4 inches. Roots penetrate as far down as bedrock.

Quazo soils are used for range and wildlife habitat.

Representative profile of Quazo very gravelly sandy loam, 30 to 70 percent slopes, in an area of Quazo-Motoqua very gravelly sandy loams, 30 to 70 percent slopes, on the upper part of Beaver Dam Wash, 1,400 feet south and 1,300 feet east of the northwest corner of sec. 1, T. 39 S., R. 19 W.:

A1—0 to 2 inches, brown (10YR 5/3) very gravelly sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, thick, platy structure that parts to moderate, very fine, subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; few fine and medium and common very fine vesicular pores; 55 percent gravel; neutral; abrupt, smooth boundary.

B1—2 to 3 inches, brown (10YR 5/3) gravelly sandy clay loam, very dark grayish brown (10YR 3/2) when moist; weak, thin, platy structure that parts to strong, very fine, subangular blocky; slightly hard, friable, sticky and plastic; few fine and very fine roots; few fine and very fine pores; 40 percent gravel; neutral; abrupt, smooth boundary.

B21t—3 to 9 inches, brown (10YR 5/3) gravelly sandy clay loam, dark brown (7.5YR 4/2) when moist, moderate, coarse, subangular blocky structure that parts to moderate, very fine, subangular blocky; very hard, firm, sticky and plastic; few fine and very fine roots; few fine and common very fine pores; 40 percent gravel; neutral; clear, wavy boundary.

B22t—9 to 18 inches, reddish-brown (5YR 5/4) gravelly sandy clay loam, reddish brown (5YR 4/4) when moist; moderate, coarse, prismatic structure that parts to moderate, fine, subangular blocky; extremely hard, firm, sticky and plastic; few medium, fine, and very fine roots; few fine and common very fine pores; 45 percent gravel; neutral; gradual, wavy boundary.

R—18 inches, somewhat weathered, extrusive, acid igneous bedrock.

Depth to bedrock ranges from 11 to 20 inches. The profile ranges from 35 to 70 percent gravel and cobbles, and more than half of the gravel is less than ¼ inch in diameter. The average annual soil temperature at a depth of 20 inches is 47° to 58° F. The profile ranges

from slightly acid to mildly alkaline and is noncalcareous.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 2 to 4. It is very gravelly sandy loam or gravelly sandy loam 1 inch to 3 inches thick.

The B_{2t} horizon has hue of 10YR, 7.5YR, or 5YR; value of 3 to 6 when dry and 3 or 4 when moist; and chroma of 2 to 4. It is gravelly sandy clay loam or very gravelly sandy clay loam that is marginal to gravelly sandy clay. It ranges from 8 to 15 inches in thickness.

Quazo-Motoqua very gravelly sandy loams, 30 to 70 percent slopes (QMG).— This complex is in the hills adjacent to upper Beaver Dam Wash in the northwestern part of the survey area. It is about 40 percent Quazo very gravelly sandy loam, 30 to 70 percent slopes; 30 percent Motoqua very gravelly sandy loam, 30 to 70 percent slopes; 10 percent Rock outcrop; and 20 percent other soils. Quazo soils have south-, west-, and east-facing slopes. Motoqua soils have north- and east-facing slopes. Rock outcrop is intermingled with Quazo and Motoqua soils. The Quazo and Motoqua soils have the profiles described as representative of the Quazo and Motoqua series.

Included with these soils in mapping are small areas of Motoqua very cobbly sandy loam, 30 to 70 percent slopes; Quazo very gravelly sandy loam that has slopes of 5 to 30 percent in the southwestern part of the area, west of the confluence of the East Fork of Beaver Dam Wash; and a soil that is similar to this Quazo soil but has a carbonate-cemented hardpan above the bedrock.

The soils in this complex are used for range and wildlife habitat. The native vegetation is pinyon pine, juniper, cliffrose, live oak, sagebrush, Mormon tea, and Nevada bluegrass. Capability unit VII_s-V₄, nonirrigated; Upland Stony Hills (Juniper) Summer Precipitation range site; wildlife suitability group 3242.

Redbank Series

The Redbank series consists of well-drained soils on alluvial fans, in valleys, and on flood plains. These soils formed in mixed alluvium derived from sandstone, shale, and limestone. Slopes range from 0 to 5 percent. Elevation is 3,300 to 5,500 feet. The native vegetation is big sagebrush, galleta, squirreltail, Indian ricegrass, and scattered juniper. Average annual precipitation ranges from 12 to 14 inches, average annual air temperature ranges from 52° to 56° F, and the frost-free period is 165 to 170 days. Redbank soils are commonly associated with Bond, Palma, Mathis, Naplene, Clovis, and Schmutz soils.

In a representative profile the surface layer is yellowish-red fine sandy loam about 5 inches thick. The underlying material, to a depth of 60 inches, is red and yellowish-red fine sandy loam and yellowish-red loam stratified with lenses of silt loam and fine sand.

Permeability is moderate. Available water capacity is 7 to 9 inches to a depth of 5 feet. The water supplying capacity is 6 to 9 inches. Roots penetrate to a depth of 5 feet or more.

Redbank soils are used for dryfarmed wheat, irrigated alfalfa and small grain, range, and wildlife habitat.

Representative profile of Redbank fine sandy loam, 1 to 5 percent slopes, in a cultivated area about 2 miles north of the Big Plain Junction, east of the county road, 200 feet south and 200 feet east of the west quarter corner of sec. 28, T. 42 S., R. 11 W.:

Ap—0 to 5 inches, yellowish-red (5YR 4/6) fine sandy loam, dark red

(2.5YR 3/6) when moist; very weak, medium, subangular blocky structure that parts to weak, fine, granular; slightly hard, very friable, slightly sticky and nonplastic; common very fine and fine roots; few fine pores; slightly calcareous, lime is disseminated; moderately alkaline; abrupt, smooth boundary.

C1—5 to 16 inches, red (2.5YR 4/6) fine sandy loam, dark red (2.5YR 3/6) when moist; weak, medium, subangular blocky structure; soft, very friable, slightly sticky and nonplastic; many very fine and fine roots; common fine and very fine pores; slightly calcareous, lime is disseminated; strongly alkaline; clear, smooth boundary.

C2—16 to 35 inches, yellowish-red (5YR 4/6) fine sandy loam, yellowish red (5YR 3/6) when moist; single grained; loose, very friable, nonsticky and nonplastic; few fine roots; moderately calcareous, lime is disseminated; strongly alkaline; clear, smooth boundary.

C3—35 to 60 inches, yellowish-red (5YR 4/8) loam, dark red (2.5YR 3/8) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; moderately calcareous, lime is disseminated; strongly alkaline.

The average annual soil temperature at a depth of 20 inches ranges from 54° to 58° F, and the average summer soil temperature ranges from 71° to 76°.

The A horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 4 to 6 when dry and 3 or 4 when moist; and chroma of 2 to 6. It is generally fine sandy loam, but it is silty clay loam where irrigation water has deposited silty sediments. It is moderately alkaline and is noncalcareous or slightly calcareous.

The C horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 4 to 6 when dry and 3 to 5 when moist; and chroma of 4 to 8. It is fine sandy loam and sandy loam stratified with silt loam, loam, and fine sand.

Redbank fine sandy loam, 1 to 5 percent slopes (RaC).— This soil is on large alluvial fans and in upland valleys. It has the profile described as representative of the series. Permeability is moderately rapid to a depth of 40 inches and moderate below. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Palma fine sandy loam, 1 to 5 percent slopes; Palma loamy fine sand, 1 to 5 percent slopes; and Clovis fine sandy loam, 1 to 5 percent slopes.

This Redbank soil is used for nonirrigated and irrigated crops and for range. Wheat is the principal nonirrigated crop, and alfalfa and small grain are the main irrigated crops. The native vegetation is galleta, Indian ricegrass, squirreltail, black grama, sand dropseed, and big sagebrush. Capability units II_e-1, irrigated, VI_e-V, nonirrigated; Southern Upland Loam range site; wildlife suitability groups 1242-I and 2242.

Redbank silty clay loam, 0 to 2 percent slopes (RbA).— This soil is on alluvial flood plains along the Virgin River. It has a profile similar to the one described as representative of the series, but the surface layer is silty clay loam 8 to 12 inches thick. Permeability is moderate. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Naplene silt loam, 2 to 6 percent slopes, and a somewhat poorly drained sandy loam soil in isolated oxbows.

This Redbank soil is used for irrigated alfalfa and small grain. Capability unit I-1, irrigated; wildlife suitability group 1242-I; range site not assigned.

Renbac Series

The Renbac series consists of shallow, well-drained soils that are underlain by bedrock at a depth of 8 to 17 inches. These soils are on mesas and mountain side slopes. They formed in material weathered from sandstone, con-

glomerate, and shale. Slopes range from 2 to 30 percent. Elevation is 2,800 to 4,000 feet. The native vegetation is blackbrush, Mormon tea, bursage, creosotebush, filaree, and cheatgrass. Average annual precipitation ranges from 8 to 11 inches, average annual air temperature is 57° to 61° F, and the frost-free period is 190 to 195 days. Renbac soils are commonly associated with Hobog soils.

In a representative profile the surface layer is brown channery clay loam about ½ inch thick. The subsoil is reddish-brown channery clay loam and very channery clay about 8½ inches thick. The substratum is light-brown very flaggy sandy loam. Bedrock is at a depth of about 12 inches.

Permeability is moderately slow. Runoff is rapid, and the hazard of erosion is severe. Available water capacity is 1 inch to 2 inches. The water supplying capacity is 2 to 4 inches. Roots penetrate as far down as bedrock.

Renbac soils are used for range.

Representative profile of Renbac channery clay loam, 2 to 30 percent slopes, in an area of the Renbac-Rock land association, in an area of range about 1½ miles southwest of Ivins, 480 feet south and 500 feet west of the northeast corner of sec. 12, T. 42 S., R. 17 W.:

- A1—0 to ½ inch, brown (7.5YR 5/5) channery clay loam, dark brown (7.5YR 4/4) when moist; weak, thin and medium, platy structure; slightly hard, friable, slightly sticky and plastic; few fine roots; many very fine vesicular pores; 40 percent rock fragments; slightly calcareous; moderately alkaline; clear, smooth boundary.
- B1—½ inch to 2 inches, reddish-brown (5YR 5/5) channery clay loam, reddish brown (5YR 4/4) when moist; strong, fine and very fine, granular structure; soft, friable, sticky and plastic; few fine roots; common fine and many very fine pores; 20 percent rock fragments; slightly calcareous; moderately alkaline; clear, smooth boundary.
- B21t—2 to 5 inches, reddish-brown (5YR 5/5) very channery clay, yellowish red (5YR 4/6) when moist; moderate, fine and very fine, blocky structure; very hard, very fine, very sticky and very plastic; few fine roots; many very fine pores; 50 percent rock fragments; common moderately thick clay films on faces of peds; noncalcareous; moderately alkaline; clear, wavy boundary.
- B22tca—5 to 9 inches, reddish-brown (5YR 5/5) very channery clay, yellowish red (5YR 4/6) when moist; moderate, fine and very fine, blocky structure; very hard, very firm, very sticky and very plastic; few fine roots; many very fine pores; 60 percent rock fragments; common moderately thick clay films on faces of peds; moderately calcareous; moderately alkaline; clear, wavy boundary.
- Cca—9 to 12 inches, light-brown (7.5YR 6/4) very flaggy sandy loam, brown (7.5YR 5/4) when moist; massive; slightly hard, friable, nonsticky and nonplastic; few fine roots; many very fine pores; 80 percent rock fragments; moderately calcareous; strongly alkaline; abrupt, irregular boundary.
- R—12 inches, somewhat weathered sandstone bedrock.

Depth to bedrock ranges from 8 to 17 inches. The average annual soil temperature at a depth of 20 inches is 59° to 63° F, and the average summer soil temperature is 77° to 82°. The profile ranges from mildly alkaline to strongly alkaline. It is 40 to 75 percent rock fragments.

The A horizon has chroma of 2 to 5. It ranges from channery clay loam to very channery sandy loam.

The B2t horizon has value of 4 to 5 when dry and chroma of 4 to 6. It ranges from very channery clay to very channery heavy clay loam. It is noncalcareous to moderately calcareous. In many places it rests on bedrock and there is no C horizon.

Renbac-Rock land association (RE).— This association is on mountain side slopes. It is about 60 percent Renbac channery clay loam, 2 to 30 percent slopes; 25 percent Rock land; and 15 percent other soils. Rock land occurs as scattered areas of sandstone or conglomerate that has a thin

layer of sandy loam or loam 1 inch to 6 inches thick. The Renbac soil has the profile described as representative of the Renbac series.

Included with these soils in mapping are areas of Hobog very cobbly loam, 3 to 40 percent slopes.

The soils in this association are used for range. The native vegetation is blackbrush, Mormon tea, creosotebush, filaree, galleta, and cholla cactus. Wildlife suitability group 4343; Renbac soil in capability unit VIIIs-C3, nonirrigated, and Southern Desert Stony Loam range site; Rock land in capability unit VIIIIs-X, nonirrigated, and range site not assigned.

Riverwash

Riverwash (RI) consists of stratified, dominantly coarse-textured, gravelly, cobbly, or stony material in washes and narrow drainageways. The largest areas are in Beaver Dam Wash. Other areas are in the smaller drainageways. The material varies considerably over a short distance and is moved from place to place during periods of high runoff.

Some sparse vegetation occurs on higher areas that have not been flooded for several years. Riverwash has some value as road fill, but it has little or no value for farming. Capability unit VIIIw-4, nonirrigated; wildlife suitability group 4343; range site not assigned.

Rock Land

Rock land (RO) consists of 60 to 80 percent Rock outcrop and 20 to 40 percent soils that are very shallow over bedrock. Slopes are gently sloping to steep. Soils have formed on a few small included areas, but the kinds of soils are not identified because of their wide variation. On some of these areas of soil accumulation there is native vegetation. The vegetation is mainly shrubs and forbs at lower elevations, sparse and scrubby pinyon pine and juniper at intermediate elevations, and ponderosa pine at the higher elevations in the vicinity of Zion National Park. This mapping unit is extensive throughout the survey area.

Rock land is used mainly by vacationers, artists, and photographers. Capability unit VIIIIs-X, nonirrigated; wildlife suitability group 4343; range site not assigned.

Rock Land, Stony

Rock land, stony (RP), consists of stony and bouldery soils that have slopes of 30 to 70 percent. Sandstone outcrops and cliffs occur mainly on the upper parts of the slopes in this unit. The stones and boulders originate from these cliffs and are commonly underlain by sand, shale, or siltstone and weathered, shattered remnants of the rock. Soil development is minor because of continual deposits of material from higher lying positions. Erosion is moderate, and the sediment production is low to medium depending upon the amount and kind of vegetation.

Rock land, stony, has a sparse vegetative cover of shrubs and grasses. Pinyon pine and juniper are at the higher elevations. Capability unit VIIIIs-X, nonirrigated; wildlife suitability group 4343; range site not assigned.

Rock Land-Hobog Association

Rock land-Hobog association (RR), is on mountain side slopes. It is about 40 percent Rock land; 30 percent Hobog very cobbly loam, 3 to 40 percent slopes; and 30 percent Renbac channery clay loam, 2 to 30 percent slopes. The Hobog and Renbac soils are in depressions interspersed in the areas of Rock land.

The soils in this association are used for range. The native vegetation is creosotebush, blackbrush, Mormon tea, galleta, sand dropseed, Indian ricegrass, and cholla cactus. Wildlife suitability group 4343; Hobog and Renbac soils in capability unit VIIIs-C3, nonirrigated, and Southern Desert Stony Loam range site; Rock land in capability unit VIIIIs-X, nonirrigated, and range site not assigned.

Rock Outcrop

Rock outcrop (RT) consists of exposures of bare bedrock, mostly sandstone, limestone, conglomerate, or basalt. This mapping unit is extensive throughout the survey area. Slopes are variable, ranging from sloping to very steep or nearly vertical.

Rock outcrop generally has no vegetation, but in some places stunted pinyon or ponderosa pine grow in crevices or pockets of soil material (fig. 7). Capability unit VIIIIs-X,

nonirrigated; wildlife suitability group 4444; range site not assigned.

Rough Broken Land

Rough broken land (RU) is mainly on the very steep breaks into the Beaver Dam Wash. It is deeply dissected by narrow, V-shaped valleys and sharp ridges and is broken by many intermittent drainageways from surrounding areas. The surface generally has a pavement of gravel, cobbles, and stones that covers 70 to 80 percent of the surface.

Rough broken land commonly has a vegetative cover of grass, shrubs, and forbs. The landscape is too rough and too steep for livestock to graze. Capability unit VIIIIs-E, nonirrigated; wildlife suitability group 4343; range site not assigned.

St. George Series

The St. George series consists of well drained or moderately well drained soils on flood plains and alluvial fans. These soils formed in alluvium washed from sandstone, siltstone, and shale. Slopes range from 0 to 5 percent. Elevation is 2,450 to 3,400 feet. The native vegetation is desert

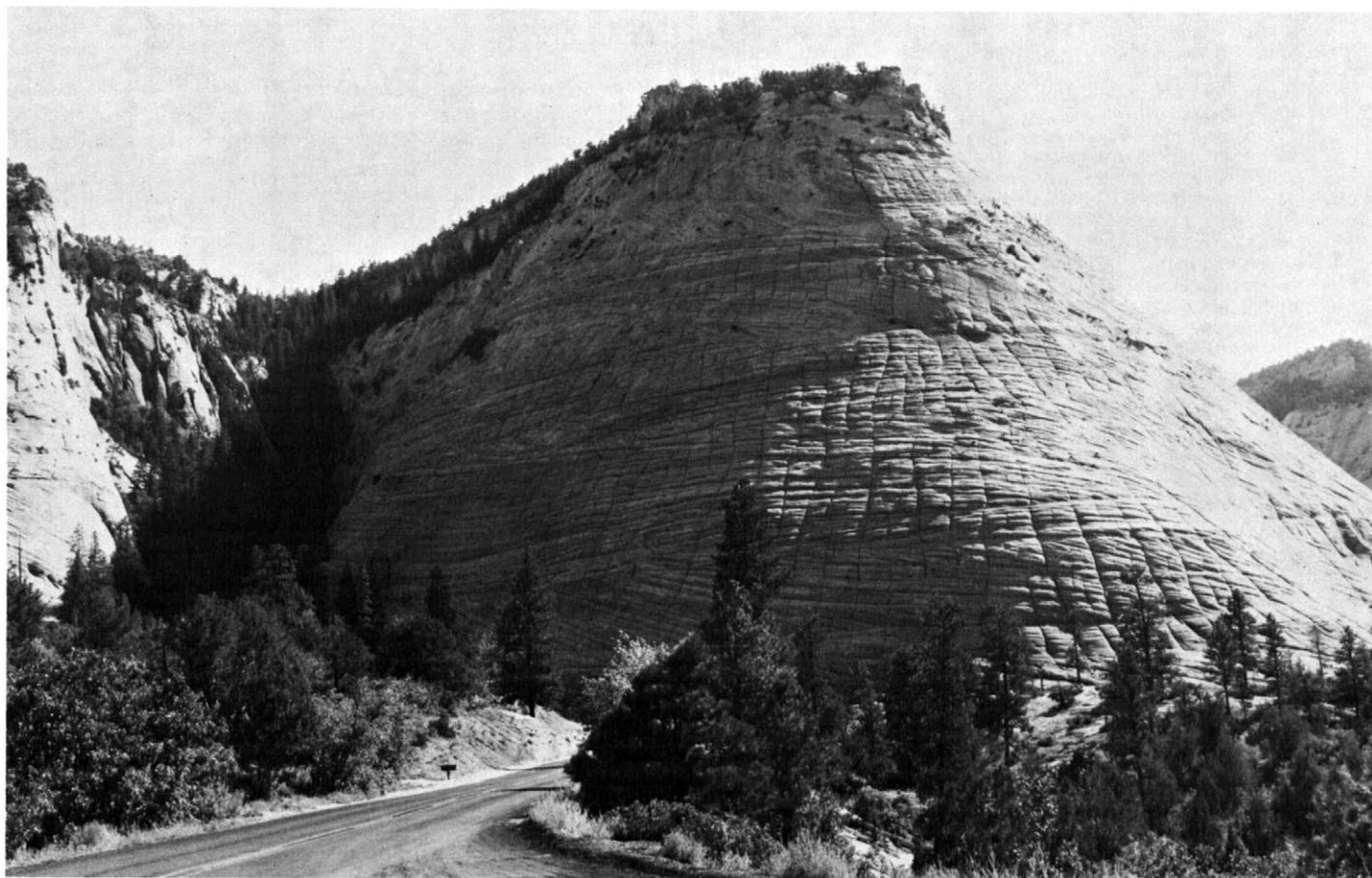


Figure 7.—Rock outcrop in an area of Checkerboard Mountain in Zion National Park.

shrubs, forbs, and grasses. Average annual precipitation ranges from 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period is 190 to 195 days. St. George soils are commonly associated with Tobler, Junction, Leeds, and Hantz soils.

In a representative profile the surface layer is light-brown silt loam about 9 inches thick. The underlying material is strong-brown and reddish-yellow loam and light reddish-brown silt loam to a depth of 60 inches or more. The profile is 1 to 30 percent, by volume, granules of gypsum.

Permeability is moderately slow. Available water capacity is 7.5 to 12 inches to a depth of 5 feet. The water supplying capacity is about 5 to 8 inches. Roots penetrate to a depth of 60 inches or more.

St. George soils are used for irrigated crops and range.

Representative profile of St. George silt loam, 1 mile southwest of the Hurricane Airport, near the center of sec. 16, T. 42 S., R. 13 W.:

- Ap—0 to 9 inches, light-brown (7.5YR 6/4) silt loam, reddish brown (5YR 4/4) when moist; moderate, medium, subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; common fine and few medium and coarse roots; moderately calcareous, lime is disseminated; moderately alkaline; diffuse, smooth boundary.
- C1—9 to 20 inches, strong-brown (7.5YR 5/5) loam, yellowish red (5YR 4/5) when moist; weak, medium, subangular blocky structure; slightly hard, very friable, slightly sticky and plastic; common fine and few medium and coarse roots; many fine pores; common fine granules of gypsum; moderately calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.
- C2—20 to 29 inches, light reddish-brown (5YR 6/4) silt loam, reddish brown (5YR 4/4) when moist; massive; slightly hard, friable, slightly sticky and plastic; common fine and few medium roots; many fine and few medium pores; common fine granules of gypsum; strata of fine sand ¼ inch to 2 inches thick; moderately calcareous, lime is disseminated; moderately alkaline; gradual, smooth boundary.
- C3—29 to 38 inches, light reddish-brown (5YR 6/4) silt loam, yellowish red (5YR 4/6) when moist; massive; soft, very friable, slightly sticky and slightly plastic; common fine roots; many fine and very fine pores; common fine granules of gypsum; strata of fine sand ¼ inch to 2 inches thick; moderately calcareous, lime is disseminated; moderately alkaline; gradual, smooth boundary.
- C4—38 to 60 inches, reddish-yellow (5YR 6/6) loam, yellowish red (5YR 4/6) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; many fine and very fine pores; strata of fine sand ¼ inch to 2 inches thick; moderately calcareous, lime is disseminated; mildly alkaline.

The average annual soil temperature at a depth of 20 inches ranges from 59° to 67° F, and the average summer soil temperature is 77° to 82°. The profile is 1 to 30 percent, by volume, soft to hard granules and crystals of gypsum that range from about silt size to 3 millimeters in diameter.

The A horizon ranges from silt loam or loam to silty clay loam. The silty clay loam texture is the result of silty irrigation water. This horizon typically has hue of 7.5YR or 5YR but ranges to 10YR in areas that have a shallow water table; value of 4 to 6 when dry and 3 to 5 when moist; and chroma of 2 to 6.

The C horizon has hue of 7.5YR, 5YR, or 2.5YR; value of 5 to 7 when dry and 3 to 5 when moist; and chroma of 3 to 8. It ranges from loamy sand to silty clay loam and is commonly stratified.

St. George silt loam (Sa).—This well-drained soil is on the alluvial flood plain of the Virgin River. It has the profile described as representative of the series. Slopes are 1 to 5 percent. Runoff is slow, and the hazard of erosion is slight. Roots penetrate to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Junction fine sandy loam, 2 to 5 percent slopes; St. George

silty clay loam; and Leeds silty clay loam, 1 to 2 percent slopes.

This St. George Soil is used for range. The native vegetation is galleta, filaree, saltgrass, creosotebush, and cholla cactus. Capability unit VIIe-C, nonirrigated; Southern Desert Loam range site; wildlife suitability group 4343.

St. George silt loam, strongly saline (Sb).—This moderately well drained soil is on alluvial fans in the vicinity of St. George. It has a profile similar to the one described as representative of the series, but slopes are 2 to 5 percent and it has a high concentration of salt and gypsum throughout the profile. Runoff is slow, and the hazard of erosion is slight. Roots of salt-tolerant plants penetrate to a depth of 60 inches. The water table is at a depth of 24 to 40 inches.

Included with this soil in mapping are small areas of St. George silty clay loam and Junction fine sandy loam, 2 to 5 percent slopes.

This St. George soil is used for range. The native vegetation is saltgrass, alkali sacaton, and greasewood. Capability unit VIIw-07, nonirrigated; Salt Meadow range site; wildlife suitability group 4424.

St. George silty clay loam (Sc).—This well-drained soil is on flood plains of the Virgin River near Washington, St. George, and Hurricane. It has a profile similar to the one described as representative of the series, but the surface layer is silty clay loam where irrigation water has deposited silty sediment. Slopes are 0 to 2 percent. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of Leeds silty clay loam, 1 to 2 percent slopes; St. George silty clay loam, moderately saline; and Hantz silty clay loam.

This St. George soil is used mainly for irrigated alfalfa, barley, sugar beet seed, milo, sorghum silage, and improved pasture. Capability unit I-0, irrigated; wildlife suitability group 1242-I; range site not assigned.

St. George silty clay loam, moderately saline (Sd).—This moderately well drained soil is on flood plains and valley bottoms of the Virgin River. It has a profile similar to the one described as representative of the series, but the surface layer is silty clay loam and the profile is moderately saline. Slopes are 0 to 2 percent. Runoff is slow, and the hazard of erosion is slight. The water table is at a depth of 24 to 40 inches.

Included with this soil in mapping are small areas of St. George silty clay loam, shallow water table; St. George silty clay loam; and Leeds silty clay loam, 1 to 2 percent slopes.

This St. George soil is used for range and native pasture. The native vegetation is alkali bluegrass, saltgrass, alkali sacaton, sedges, and greasewood. Capability unit VIw-07, nonirrigated; Salt Meadow range site; wildlife suitability group 4424.

St. George silty clay loam, shallow water table (Se).—This poorly drained soil is on low river flood plains in fields near St. George and Washington. It has a profile similar to the one described as representative of the series, but the surface layer is silty clay loam. Slopes are 0 to 1 percent. Runoff is slow, and the hazard of erosion is slight. The water table is at a depth of 12 to 24 inches.

Included with this soil in mapping are small areas of St. George silty clay loam, moderately saline, and Tobler

silty clay loam.

This St. George soil is used for native pasture. The native vegetation is saltgrass, alkali sacaton, sedges, cattails, and willows. Capability unit VIIw-07, nonirrigated; Salt Meadow range site; wildlife suitability group 4424.

Schmutz Series

The Schmutz series consists of well-drained soils that are high in content of gypsum. These soils are in alluvial valleys and on alluvial fans. They formed in mixed alluvium weathered from sandstone, gypsiferous siltstone, and shale. Slopes range from 1 to 5 percent. Elevation is 3,600 to 4,800 feet. The native vegetation is desert shrubs, grasses, and cactus. Average annual precipitation is 10 to 13 inches, average annual air temperature is 52° to 56° F, and the frost-free period is 165 to 170 days. Schmutz soils are commonly associated with Redbank, Naplene, and Shalet soils.

In a representative profile the surface layer is brown loam about 4 inches thick. The underlying material is reddish-brown and light reddish-brown loam to a depth of 60 inches.

Permeability is moderate. Available water capacity is 8 to 10 inches to a depth of 5 feet. The water supplying capacity is 6 to 8 inches. Roots penetrate to a depth of 5 feet or more.

Schmutz soils are used mainly for range.

Representative profile of Schmutz loam, in an area of range about 1.3 miles southeast of Rancho Vue Desert Guest Ranch, 500 feet north and 1,600 feet west of the southeast corner of sec. 19, T. 42 S., R. 12 W.:

A1—0 to 4 inches, brown (7.5YR 5/4) loam, dark reddish brown (5YR 3/4) when moist; moderate, thin, platy structure that parts to moderate, very fine, granular; slightly hard, friable, slightly sticky and plastic; few fine and common very fine roots; common fine and very fine pores; moderately calcareous; moderately alkaline; clear, smooth boundary.

C1—4 to 24 inches, reddish-brown (5YR 5/4) loam, reddish brown (5YR 4/4) when moist; massive; slightly hard, friable, slightly sticky and plastic; few fine roots; common fine and many very fine pores; fine crystals and thin filaments of gypsum; moderately calcareous, lime is disseminated and in filaments; strongly alkaline; clear, smooth boundary.

C2—24 to 60 inches, light reddish-brown (5YR 6/3) loam, reddish brown (5YR 4/4) when moist; massive; weakly cemented in places; soft, friable, slightly sticky and nonplastic; many fine and very fine pores; many gypsum crystals, 0.10 millimeter to 5 millimeters in diameter; moderately calcareous; moderately alkaline.

The average annual soil temperature at a depth of 20 inches ranges from 54° to 58° F, and the average summer soil temperature is 71° to 76°. The profile is moderately alkaline or strongly alkaline.

The A horizon has hue of 7.5YR or 5YR. It is dominantly loam but ranges from sandy loam to silt loam.

The C horizon has hue of 5YR or 7.5YR and value of 5 or 6 when dry and 3 or 4 when moist. Below a depth of 24 inches the horizon is commonly stratified with silty clay loam, heavy loam, and silt loam, and it is about 50 percent, by volume, soft to hard gypsum crystals 0.1 millimeter to 5 millimeters in diameter.

Schmutz loam (SH).—This soil is on alluvial fans and in valleys. Slopes are 1 to 5 percent. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Naplene silt loam, 2 to 6 percent slopes, and Shalet clay loam, 2 to 20 percent slopes. Also included are areas of

Badland, which make up about 5 percent of the mapped area, and Gullied land, which make up about 3 percent.

This Schmutz soil is used for range. The native vegetation is big sagebrush, rabbitbrush, galleta, Indian ricegrass, and cholla cactus. Capability unit VIIe-R, nonirrigated; Southern Semidesert Loam range site; wildlife suitability group 3242.

Shalet Series

The Shalet series consists of shallow or very shallow, well-drained soils that are underlain by shale bedrock at a depth of 4 to 15 inches. These soils are on undulating desert slopes and desert benches. They formed in material weathered from shale. Slopes are short and convex, and they range from 2 to 20 percent. Elevation is 3,600 to 5,500 feet. The native vegetation is desert shrubs and grasses. Average annual precipitation is 10 to 13 inches, average annual air temperature is 52° to 58° F, and the frost-free period is 165 to 175 days. Shalet soils are commonly associated with Schmutz soils.

In a representative profile the surface layer is reddish-brown clay loam about 4 inches thick. The underlying material is yellowish-red clay loam about 8 inches thick. Shale bedrock is at a depth of about 12 inches.

Permeability is slow. Runoff is rapid, and the hazard of erosion is severe. Available water capacity is 1.5 to 2.5 inches. The water supplying capacity is about 2 to 4 inches. Roots penetrate as far down as bedrock.

Shalet soils are used for range.

Representative profile of Shalet clay loam, 2 to 20 percent slopes, in an area of Eroded land-Shalet complex, warm, about 1 mile southwest of the end of the Hurricane Mesa Test Track, 1,000 feet north of the southeast corner of sec. 19, T. 41 S., R. 1 W.:

A1—0 to 4 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) when moist; moderate, fine, granular structure; slightly hard, friable, sticky and slightly plastic; few fine roots; many fine pores; moderately calcareous; strongly alkaline; clear, smooth boundary.

C1—4 to 12 inches, yellowish-red (5YR 5/6) clay loam, yellowish red (5YR 4/6) when moist; weak, medium, subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few fine roots; common fine and medium pores; moderately calcareous; strongly alkaline; abrupt, smooth boundary.

C2—12 inches, fractured shale.

Depth to bedrock ranges from 4 to 15 inches. The average annual soil temperature at a depth of 20 inches is 54° to 59° F, and the average summer soil temperature is 72° to 78°. Fine crystals of gypsum, 0.05 millimeter to 2.0 millimeters in diameter, occur throughout the profile. The content of gravel ranges from 5 to 20 percent, and in many areas a desert pavement of gravel covers 20 percent of the surface.

The A horizon has hue of 5YR or 2.5YR and chroma of 4 to 6. It is clay or light loam.

The C horizon has hue of 5YR or 2.5YR, value of 3 to 5 when dry and 3 or 4 when moist, and chroma of 4 to 6. It ranges from clay loam to light loam. In places the C1 horizon contains fragments of shale.

Shalet soils in the Washington County Area are mapped only with Eroded land.

Spenlo Series

The Spenlo series consists of well-drained soils on old alluvial fans and in valleys on Smith Mesa. These soils formed in alluvium washed from sandstone, shale, lime-

stone, and siltstone. Slopes range from 2 to 10 percent. Elevation is 5,200 to 5,900 feet. The native vegetation is shrubs, forbs, and grasses. Average annual precipitation is about 14 inches, average annual air temperature is 52° to 56° F, and the frost-free period is 165 to 170 days. Spenlo soils are associated with Bond, Lavate, Mathis, and Red-bank soils.

In a representative profile the surface layer is brown very fine sandy loam about 6 inches thick. The subsoil is yellowish-red fine sandy loam and yellowish-red and red fine sandy clay loam about 45 inches thick. The substratum is pink clay loam about 13 inches thick. Sandstone bedrock is at a depth of about 64 inches.

Permeability is moderately slow. Available water capacity is 7 to 11 inches to a depth of 5 feet. The water supplying capacity is 9 to 11 inches. Roots penetrate to a depth of 60 inches or more.

Spenlo soils are used for range and nonirrigated crops.

Representative profile of Spenlo very fine sandy loam, 2 to 10 percent slopes, on the upper part of Smith Mesa, in the SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 21, T. 40 S., R. 12 W.:

- Ap—0 to 6 inches, brown (7.5YR 5/4) very fine sandy loam, dark brown (7.5YR 3/4) when moist; weak, medium, granular structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; neutral; clear, smooth boundary.
- B1—6 to 14 inches, yellowish-red (5YR 4/6) fine sandy loam, yellowish red (5YR 3/6) when moist; moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky, and plastic; common fine and medium roots; common fine and medium pores; neutral; clear, smooth boundary.
- B21t—14 to 27 inches, yellowish-red (5YR 4/8) fine sandy clay loam, dark red (2.5YR 3/6) when moist; moderate, medium, subangular blocky structure; hard, firm, slightly sticky and plastic; common fine and medium roots; common very fine and fine pores; few thin clay films on faces of peds and in pores; neutral; clear, smooth boundary.
- B22t—27 to 44 inches, red (2.5YR 4/6) fine sandy clay loam, dark red (2.5YR 3/6) when moist; moderate, medium, prismatic structure that parts to moderate, medium, angular blocky; hard, firm, sticky and plastic; common fine roots; common very fine and fine pores; common thin clay films on faces of peds; neutral; clear, wavy boundary.
- B3ca—44 to 51 inches, red (2.5YR 4/6) fine sandy clay loam, dark red (2.5YR 3/6) when moist; tongues of pink (5YR 7/4) clay loam from Cca horizon, reddish yellow (5YR 6/6) when moist; moderate, medium, angular blocky structure; hard, firm, sticky and plastic; few fine roots; common very fine pores; few thin clay films on faces of peds; noncalcareous, but tongues are moderately calcareous; strongly alkaline; clear, wavy boundary.
- Cca—51 to 64 inches, pink (5YR 7/4) clay loam, yellowish red (5YR 4/6) when moist; massive; hard, firm, slightly sticky and slightly plastic; common very fine and fine pores; strongly calcareous; strongly alkaline; abrupt, wavy boundary.
- R—64 inches, sandstone.

Depth to Cca horizon ranges from 40 to 56 inches. The average annual soil temperature at a depth of 20 inches is 54° to 58° F, and the average summer soil temperature is 71° to 76° in some areas the soil is as much as 20 percent gravel, and in places the surface has a gravelly pavement.

The A horizon has hue of 7.5YR or 5YR, value of 4 or 5 when dry and 3 when moist, and chroma of 2 to 5. It is very fine sandy loam or fine sandy loam.

The B2t horizon has value of 3 to 5 when dry and chroma of 4 to 8. It is fine sandy clay loam, heavy clay loam, or heavy sandy clay loam that is about 25 to 35 percent clay. It is noncalcareous to a depth of 35 to 44 inches. In places there is a Bstca horizon above the Cca horizon.

The Cca horizon has hue of 5YR or 2.5YR, value of 6 or 7 when dry and 3 or 4 when moist, and chroma of 4 to 6. It ranges from clay loam to fine sandy clay loam.

Spenlo very fine sandy loam, 2 to 10 percent slopes (SPD) — This soil is on old alluvial fans. Runoff is medium,

and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Palma fine sandy loam, 1 to 5 percent slopes; Clovis fine sandy loam, 1 to 5 percent slopes; Caval fine sandy loam, 2 to 10 percent slopes; and Bond sandy loam, 1 to 10 percent slopes.

This Spenlo soil is used for nonirrigated wheat and for range. The native vegetation is pinyon pine, juniper, big sagebrush, serviceberry, galleta, black grama, Indian ricegrass, and sand dropseed. Capability unit IVe-V, nonirrigated; Southern Upland Loam range site; wildlife suitability group 2242.

Springerville Series

The Springerville series consists of well-drained soils on alluvial fans on the Hurricane Mesa. These soils formed in alluvium weathered from shale. Slopes range from 0 to 5 percent. Elevation is 4,900 to 5,100 feet. The native vegetation is shrubs, forbs, and grasses. Average annual precipitation is 12 to 14 inches, average annual air temperature is 52° to 56° F, and the frost-free period is 165 to 170 days. Springerville soils commonly are associated with Bond, Clovis, and Spenlo series.

In a representative profile the soil is reddish-brown clay to a depth of 60 inches or more.

Permeability is very slow. Available water capacity is 8 to 12 inches to a depth of 5 feet. The water supplying capacity is 6 to 9 inches. Roots easily penetrate to a depth of 36 inches, and some fine roots penetrate to a depth of 48 to 60 inches.

Springerville soils are used for range and nonirrigated crops.

Representative profile of Springerville clay, 0 to 5 percent slopes, in a cultivated area about one-mile north of the Hurricane Mesa Test Tract, 2,000 feet north and 800 feet east of the southwest corner of sec. 33, T. 41 S., R. 12 W.:

- Ap—0 to 5 inches, reddish-brown (5YR 4/4) light clay, dark reddish brown (5YR 3/4) when moist; moderate, thick, platy structure that parts to strong, fine, granular; hard, very firm, sticky and very plastic; common fine and few medium roots; common very fine and fine discontinuous pores; slightly calcareous, lime is disseminated; moderately alkaline; abrupt, smooth boundary.
- Ac—5 to 23 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; strong, coarse, prismatic structure that parts to strong, medium, subangular blocky; very hard, extremely firm, very sticky and very plastic; few fine and medium roots; common silken sides; few very fine pores; slightly calcareous, lime is disseminated; moderately alkaline; diffuse, wavy boundary.
- C1—23 to 38 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; massive; extremely hard, extremely firm, very sticky and very plastic; few very fine and fine roots; few very fine pores; slightly calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.
- C2—38 to 60 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; massive; extremely hard, extremely firm, very sticky and very plastic; slightly calcareous, lime is disseminated; strongly alkaline.

The average annual soil temperature at a depth of 20 inches ranges from 54° to 58° F. When dry, the profile has cracks that extend to a depth of 20 to 32 inches.

The A horizon mainly has hue of 5YR but ranges to 2.5YR, value of 4 or 5 when dry and 3 when moist, and chroma of 4 to 6. The AC horizon has value of 4 or 5 when dry and chroma of 4 to 6. It ranges from clay to silty clay.

The C horizon has hue of 5YR or 2.5YR and chroma of 4 to 6. It ranges from clay to silty clay.

Springerville clay, 0 to 5 percent slopes (SrC).— This soil is on short fans and in valleys. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Clovis fine sandy loam, 1 to 5 percent slopes, and Bond sandy loam, 1 to 10 percent slopes.

This Springerville soil is used for nonirrigated wheat and range. The native vegetation is scattered juniper, pinyon pine, galleta, black grama, and Indian ricegrass. Capability unit IVe-V, nonirrigated; Southern Upland Loam range site; wildlife suitability group 2242.

Stony Colluvial Land

Stony colluvial land (SY) consists of unconsolidated colluvial land covered with stones and rock fragments that accumulate on slopes and at the base of slopes, mainly by gravity. Shale bedrock is at a variable depth, but generally at a depth of less than 12 inches. There are a few small areas of shallow soils. Slopes are 30 to 70 percent. Erosion is moderate, and sediment production is low to medium, depending on the vegetative cover.

Most areas have a cover of grasses, shrubs, and forbs. Pinyon pine and juniper are at the higher elevations. Capability unit VIIs-R3, nonirrigated; Southern Semidesert Malpai range site; wildlife suitability group 4343.

Tacan Series

The Tacan series consists of well-drained soils on north- and east-facing mountain side slopes in the Kolob Canyon part of Zion National Park. These soils formed in alluvium and colluvium derived from sandstone, siltstone, and shale. Slopes range from 30 to 70 percent. Elevation is 5,000 to 6,300 feet. The native vegetation is mainly Gambel oak, snowberry, pinyon, juniper, shrubs, and grasses. Average annual precipitation is 14 to 15 inches, average annual air temperature is 45° to 52° F, and the frost-free period is 120 to 160 days. Tacan soils are commonly associated with Collbran, Mathis, and Menefee soils.

In a representative profile the surface layer is reddish-brown very stony sandy loam about 8 inches thick. The subsoil is red very gravelly heavy fine sandy clay loam about 18 inches thick. The substratum is red gravelly and very gravelly fine sandy clay loam to a depth of 60 inches.

Permeability is moderate. Available water capacity is 5 to 6 inches to a depth of 5 feet. The water supplying capacity is 6 to 9 inches. Roots penetrate to a depth of 5 feet.

Tacan soils are used for recreation, wildlife habitat, and range.

Representative profile of Tacan very stony sandy loam, 30 to 70 percent slopes, in an area of range in the Kolob Canyon section of Zion National Park, about 1,320 feet east and 2,125 feet north of the southwest corner of sec. 34, T. 38 S., R. 12 W.:

A1—0 to 8 inches, reddish-brown (2.5YR 4/4) very stony sandy loam, dark reddish brown (2.5YR 3/4) when moist; weak, very fine and fine, granular structure; soft, very friable, nonsticky and nonplastic; few fine and common very fine roots; few fine and common very fine pores; 50 percent cobbles and stones; moderately alkaline; clear, smooth boundary.

B2t—8 to 26 inches, red (2.5YR 4/6) very gravelly heavy fine sandy clay loam, dark reddish brown (2.5YR 3/5) when moist; strong,

fine and medium, subangular blocky structure; very hard, firm, sticky and plastic; few medium, fine, and very fine roots; few fine and medium and common very fine pores; few thin clay films on faces of peds; 50 percent gravel and cobbles; mildly alkaline; gradual, wavy boundary.

C1—26 to 48 inches, red (2.5YR 5/6) gravelly fine sandy clay loam, dark red (2.5YR 3/6) when moist; massive; very hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine and common very fine pores; 30 percent gravel and cobbles; mildly alkaline; gradual, wavy boundary.

C2—48 to 60 inches, red (2.5YR 5/6) very gravelly fine sandy clay loam, dark red (2.5YR 3/6) when moist; massive; very hard, friable, sticky and slightly plastic; few very fine roots; few fine and common very fine pores; 50 percent gravel and cobbles; few small lime veins below a depth of 57 inches; mildly alkaline.

Depth to bedrock ranges from 40 to more than 60 inches. The profile is generally noncalcareous in the A and B horizons and ranges from noncalcareous to strongly calcareous in the C horizon. Rock fragments on the soil surface range from 10 to 25 percent stones and cobbles. The average annual soil temperature at a depth of 20 inches is 50° to 54° F, and the average summer soil temperature is 65° to 70°.

The A horizon has hue of 7.5YR, 5YR, or 2.5YR; value of 4 or 5 when dry and 3 or 4 when moist; and chroma of 2 to 4. It is dominantly very stony sandy loam, but it ranges to very fine sandy loam. It is 2 to 8 inches thick. It ranges from 40 to 70 percent rock fragments.

The B2t horizon has hue of 2.5YR or 5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 3 to 6. It ranges from very gravelly heavy fine sandy clay loam to light clay loam that is 35 to 60 percent gravel and cobbles. It ranges from 14 to 19 inches in thickness.

The C horizon is similar in color to the B2t horizon. It ranges from very gravelly fine sandy loam to light clay loam and is 20 to 70 percent gravel and cobbles.

Tacan very stony sandy loam, 30 to 70 percent slopes (TAG).— This soil is on medium-length, east-facing mountain side slopes. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Mathis very stony loamy fine sand, 20 to 50 percent slopes, of a shallow sandy loam, and of Rock outcrop, which makes up about 5 percent of the mapped area.

This Tacan soil is used for recreation, wildlife habitat, and range. The native vegetation is Gambel oak, live oak, serviceberry, big sagebrush, Indian ricegrass, Nevada bluegrass, juniper, and pinyon pine. Capability unit VIIs-V4, nonirrigated; Upland Stony Loam (Pinyon-Juniper) Summer Precipitation range site; wildlife suitability group 3242.

Tobish Series

The Tobish series consists of well-drained soils on mountain side slopes and old alluvial fans. These soils formed in material weathered from sandstone and shale. Slopes range from 5 to 30 percent. Elevation is 4,100 to 5,000 feet. The native vegetation is desert shrubs and grasses. Average annual precipitation ranges from 10 to 13 inches, average annual air temperature is 48° to 57° F, and the frost-free period is 160 to 170 days. Tobish soils are commonly associated with Yaki soils.

In a representative profile the surface layer is brown very cobbly clay loam about 1 inch thick. The subsoil is dark-brown cobbly clay loam, brown gravelly clay loam, and yellowish-red gravelly clay and sandy clay loam. Bedrock is at a depth of about 35 inches.

Permeability is slow. Available water capacity is 4 to 5 inches. The water supplying capacity is 4 to 6 inches. Roots penetrate as far down as bedrock.

Tobish soils are used for range and wildlife habitat.

Representative profile of Tobish very cobbly clay loam, 5 to 30 percent slopes, in an area of range about one-half mile north of Diamond Valley, 400 feet east and 160 feet south of the north quarter corner of sec. 35, T. 40 S., R. 16 W.:

- A1—0 to 1 inch, brown (7.5YR 5/4) very cobbly clay loam, dark brown (7.5YR 4/3) when moist; moderate, very fine, granular structure; soft, friable, slightly sticky and plastic; few very fine and fine roots; many very fine pores; 75 percent cobbles and gravel; mildly alkaline; clear, smooth boundary.
- B1t—1 inch to 5 inches, dark-brown (7.5YR 4/4) cobbly clay loam, dark brown (7.5YR 4/4) when moist; weak, medium, prismatic structure that parts to moderate, medium and fine, blocky; hard, firm, sticky and plastic; few fine and very fine roots; few to many very fine pores; 30 percent cobbles and gravel; few moderately thick clay films on faces of ped; mildly alkaline; gradual, smooth boundary.
- B21t—5 to 17 inches, brown (7.5YR 5/4) gravelly heavy clay loam, dark brown (7.5YR 4/4) when moist; moderate, medium, prismatic structure that parts to moderate, medium and fine, blocky; hard, very firm, sticky and very plastic; few medium, fine, and very fine roots; few fine and common very fine pores; 20 percent gravel; common moderately thick clay films on faces of ped and in pores; mildly alkaline; gradual, smooth boundary.
- B22t—17 to 31 inches, yellowish-red (5YR 5/6) gravelly clay, yellowish red (5YR 4/6) when moist; moderate, coarse, prismatic structure that parts to moderate, coarse, blocky; very hard, very firm, very sticky and very plastic; few fine and very fine roots; common very fine pores; 20 percent gravel; many moderately thick clay films on faces of ped and in pores; mildly alkaline; gradual, wavy boundary.
- B3—31 to 35 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) when moist; weak, coarse, blocky structure; very hard, firm, sticky and plastic; few fine and very fine roots; few very fine pores; few moderately thick clay films on faces of ped and in pores; slightly calcareous; moderately alkaline; gradual, smooth boundary.

Depth to bedrock ranges from 22 to 35 inches. The average annual soil temperature at a depth of 20 inches is 50° to 57° F, and the average summer soil temperature is 69° to 72°. The profile is mildly alkaline or moderately alkaline.

The A horizon has hue of 7.5YR or 5YR, value of 3 or 4 when moist, and chroma of 2 to 4. It ranges from very cobbly light clay loam to very cobbly heavy sandy loam that is 50 to 75 percent cobbles and gravel.

The B2t horizon has hue of 7.5YR, 5YR, or 2.5YR, value of 3 to 5 when dry and 3 or 4 when moist; and chroma of 4 to 6. It is gravelly or cobbly heavy clay loam, gravelly or cobbly clay, or gravelly or cobbly sandy clay.

Tobish very cobbly clay loam, 5 to 30 percent slopes (TBF).—This soil is on short to medium-length, low mountain side slopes and old alluvial fans. Runoff is medium, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Nihar very stony sandy loam, 3 to 30 percent slopes, and Yaki very cobbly loam, 3 to 35 percent slopes. Also included are areas of Rock land, which make up about 5 percent of the mapped area.

This Tobish soil is used for range and wildlife habitat. Capability unit VIIs-R, nonirrigated; Southern Semidesert Loam range site; wildlife suitability group 3242.

Tobler Series

The Tobler series consists of well-drained soils on alluvial fans and flood plains in the south-central part of the survey area. These soils formed in alluvium weathered from sandstone and shale. Slopes range from 1 to 10 percent. Elevation is 2,500 to 3,500 feet. The native vegetation is desert shrubs, grasses, and cactus. Average annual precipitation is 8 to 11 inches, average annual air temperature

is 57° to 67° F, and the frost-free period is 190 to 195 days. Tobler soils commonly are associated with Harrisburg, Junction, Leeds, Pintura, and St. George soils.

In a representative profile the soil is red, moderately alkaline fine sandy loam to a depth of 60 inches or more.

Permeability is moderately rapid or moderate. Available water capacity is 6.0 to 7.5 inches to a depth of 5 feet. The water supplying capacity is 5 to 6 inches. Roots extend to a depth of 60 inches or more.

Tobler soils are used for irrigated alfalfa, barley, sugar beet seed, sorghum, and milo and for range.

Representative profile of Tobler fine sandy loam, in an area of range in Warner Valley, about 400 feet north of the west quarter corner of sec. 8, T. 43 S., R. 14 W.:

- A1—0 to 4 inches, red (2.5YR 4/6) fine sandy loam, dark red (2.5YR 3/6) when moist; weak, thin, platy structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; many very fine and fine vesicular pores; slightly calcareous; moderately alkaline; clear, smooth boundary.
- C1—4 to 13 inches, red (2.5YR 4/6) fine sandy loam, dark red (2.5YR 3/6) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; common fine and medium pores; slightly calcareous; moderately alkaline; clear, smooth boundary.
- C2—13 to 38 inches, red (2.5YR 4/6) fine sandy loam, dark red (2.5YR 3/5) when moist; weak, medium, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; common fine and very fine pores; slightly calcareous; moderately alkaline; clear, smooth boundary.
- C3—38 to 60 inches, red (2.5YR 4/6) fine sandy loam, dark red (2.5YR 3/6) when moist; weak, fine, subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few fine and medium roots; common very fine pores; slightly calcareous; moderately alkaline.

The profile ranges from mildly alkaline to strongly alkaline. It is slightly calcareous to moderately calcareous. The content of gravel ranges from 5 to 10 percent. The average annual soil temperature at a depth of 20 inches is 59° to 68° F.

The A horizon has hue of 2.5YR or 5YR, value of 4 to 6 when dry and 3 or 4 when moist, and chroma of 4 to 6. It is mainly fine sandy loam, but in places it is loamy fine sand. It ranges from 1 inch to 10 inches in thickness.

The C horizon has hue of 2.5YR or 5YR, value of 4 to 6 when dry and 3 or 4 when moist, and chroma of 4 to 8. It is dominantly fine sandy loam or loamy fine sand, but it has common strata of sandy loam, loam, and loamy sand.

Tobler fine sandy loam (Tc).—This soil is on alluvial fans, in alluvial valleys, and on desert slopes (fig. 8) in the central part of the survey area. It has the profile described as representative of the series. Slopes are 1 to 5 percent. Permeability is moderately rapid. Runoff is slow, and the hazard of erosion is moderate. Available water capacity is 6.0 to 7.5 inches. The water supplying capacity is 5 to 6 inches.

Included with this soil in mapping are small areas of Pintura loamy fine sand, 1 to 5 percent slopes; Ivins loamy fine sand; Harrisburg fine sandy loam, 1 to 5 percent slopes; and Junction fine sandy loam, 2 to 5 percent slopes.

This Tobler soil is used for range and irrigated alfalfa, barley, sugar beet seed, milo, sorghum silage, and pasture. The native vegetation is creosotebush, galleta, Indian ricegrass, and cholla cactus. Capability units III-0, irrigated, VIIe-C, nonirrigated; Southern Desert Loam range site; wildlife suitability groups 1242-I and 4343.

Tobler silty clay loam (Td)—This nearly level soil is in smooth alluvial valleys and on flood plains and terraces. It has a profile similar to the one described as representative of the series, but the surface layer is silty clay loam 6 to 18

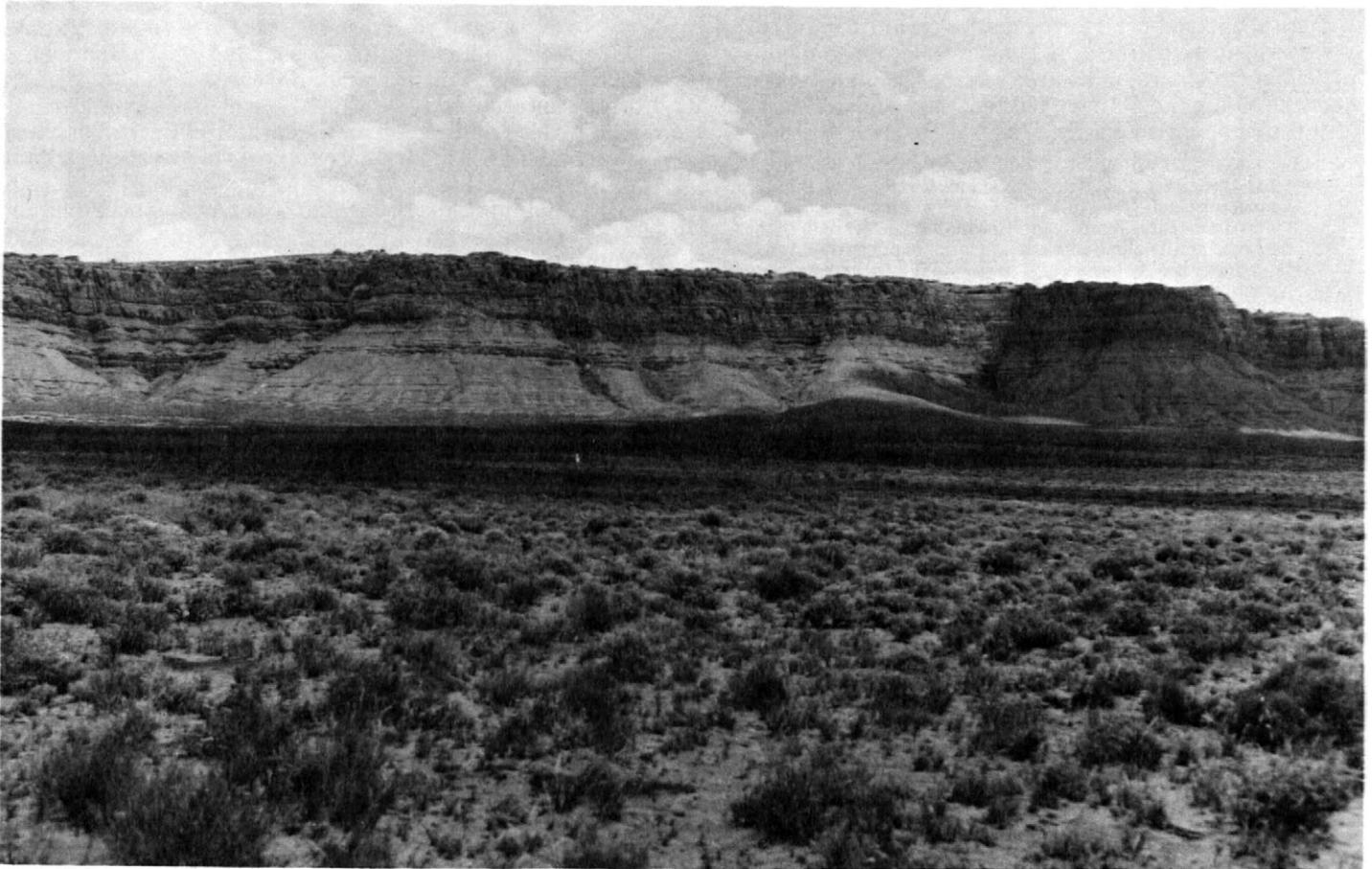


Figure 8.—An area of Tobler fine sandy loam is in the foreground.

inches thick. Slopes are 1 to 2 percent. Also, in the area of Beaver Dam Wash, Ash Creek, and LaVerkin Creek, the color is yellower, the surface layer ranges to heavy loam and light clay loam, and the underlying material has thin strata of gravelly sandy loam. Permeability is moderate in the surface layer and moderately rapid in the underlying material. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 7.0 to 7.5 inches. Roots penetrate to a depth of 5 feet or more.

Included with this soil in mapping are small areas of Leeds silty clay loam, 0 to 1 percent slopes; Leeds silty clay loam, 1 to 2 percent slopes; Leeds silty clay loam, 5 to 10 percent slopes; and Tobler fine sandy loam.

This Tobler soil is used for irrigated alfalfa, small grain, sugar beet seed, sorghum, pasture, and milo. Capability unit IIe-0, irrigated; wildlife suitability group 1242-I; range site not assigned.

Toquerville Series

The Toquerville series consists of shallow, somewhat excessively drained soils that are underlain by sandstone bedrock at a depth of 8 to 20 inches. These soils are on desert slopes in the south-central part of the survey area. They formed in deposits of windblown sand weathered from Navajo sandstone. Slopes range from 2 to 20 percent. Ele-

vation is 2,700 to 4,000 feet. The native vegetation is desert shrubs, forbs, grasses, and cactus. Average annual precipitation is 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period is 190 to 195 days. Toquerville soils commonly are associated with Bermesa, Harrisburg, and Pintura soils.

In a representative profile the soil is reddish-yellow fine sand about 16 inches thick that is underlain by sandstone bedrock.

Permeability is very rapid above the bedrock. Available water capacity is 1 inch to 2 inches. The water supplying capacity is 2 to 4 inches. Roots penetrate as far down as bedrock.

Toquerville soils are used for range.

Representative profile of Toquerville fine sand, 2 to 20 percent slopes, in an area of the Pintura-Toquerville complex, 1 to 20 percent slopes, in an area of range on Sand Mountain, about 400 feet west of the northeast corner of sec. 12, T. 43 S., R. 14 W.:

- C1—0 to 16 inches, reddish-yellow (5YR 6/8) fine sand, yellowish red (5YR 5/8) when moist; single grained; loose; few fine and medium roots; neutral; abrupt, wavy boundary.
- R—16 inches, sandstone.

Depth to bedrock ranges from 8 to 20 inches. The profile ranges from neutral to moderately alkaline. It is noncalcareous to moderately calcareous. In places sand hummocks range from 12 to 30 inches

high. The average annual soil temperature at a depth of 20 inches is 59° to 63° F.

The C horizon has hue of 5YR or 2.5YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 6 to 8. It is fine sand and loamy fine sand.

Toquerville soils in the Washington County Area are mapped only with Pintura soils.

Tortugas Series

The Tortuga series consists of shallow, somewhat excessively drained soils that are 10 to 20 inches deep over limestone bedrock. These soils are on mountain side slopes in the southwestern part of the survey area. They formed in material weathered from limestone. Slopes range from 20 to 70 percent. Elevation is 4,800 to 6,900 feet. The native vegetation is pinyon pine, juniper, shrubs, and grasses. Average annual precipitation is about 14 inches, average annual air temperature is 47° to 52° F, and the frost-free period is 120 to 160 days. Tortugas soils are commonly associated with Mokiak, Motoqua, and Welring soils.

In a representative profile the surface layer is brown very gravelly loam about 7 inches thick. The underlying material is pale-brown very gravelly loam and very pale brown very gravelly very fine sandy loam. Limestone bedrock is at a depth of about 19 inches.

Permeability is moderately rapid above the bedrock. Available water capacity is 1 inch to 2 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as bedrock.

Tortugas soils are used for range and wildlife habitat.

Representative profile of Tortugas very gravelly loam, 20 to 70 percent slopes, in an area of Tortugas-Rock land association, in an area of range about 3 miles southeast of the TV relay tower in the Beaver Dam Mountains, 2,375 feet north and 265 feet east of the northwest corner of sec. 22, T. 42 S., R. 18 W.:

A11—0 to 2 inches, brown (10YR 5/3) very gravelly loam, dark brown (7.5YR 3/2) when moist; weak, very fine, subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine and common very fine roots; 60 percent of the surface is covered with gravel and cobbles, 25 percent gravel and cobbles in horizon; noncalcareous; mildly alkaline; clear, smooth boundary.

A12—2 to 7 inches, brown (10YR 5/3) very gravelly loam, dark brown (7.5YR 3/3) when moist; moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few medium and fine and very fine roots; few medium and fine and common very fine pores; 40 percent gravel and cobbles; slightly calcareous, lime is disseminated; moderately alkaline; clear, wavy boundary.

C1—7 to 16 inches, pale-brown (10YR 6/3) very gravelly loam, brown (7.5YR 4/2) when moist; moderate, fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few medium and very fine and common fine roots; common fine and very fine pores; 50 percent gravel and cobbles; moderately calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.

C2—16 to 19 inches, very pale brown (10YR 7/3) very gravelly heavy very fine sandy loam, brown (10YR 5/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine and common very fine pores; 80 percent gravel and cobbles; moderately calcareous, lime is disseminated; moderately alkaline; abrupt, wavy boundary.

R—19 inches, fractured limestone bedrock.

Depth to bedrock ranges from 10 to 20 inches. Rock fragments cover 40 to 80 percent of the surface. The average annual soil temperature at a depth of 20 inches is 50° to 54° F. The profile is mildly alkaline or moderately alkaline.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 when dry and 2 or 3 when moist, and chroma of 2 or 3. It is gravelly or very gravelly loam that is marginal to very gravelly fine sandy loam or

very gravelly silt loam and ranges from 50 to 60 percent gravel, cobbles, and stones.

The C horizon has hue of 7.5YR or 10YR, value of 5 to 7 when dry and 3 to 5 when moist, and chroma of 2 to 4. It ranges from very gravelly heavy loam to very gravelly heavy fine sandy loam. The upper part of the C horizon ranges from 35 to 50 percent rock fragments, and the lower part increases to 90 percent near the bedrock.

Tortugas-Rock Land association (TG).— This association is on mountain side slopes. It is about 55 percent Tortugas very gravelly loam, 20 to 70 percent slopes; 20 percent Rock land; and 25 percent other soils. The Tortugas soils and Rock land are intermingled and in no definite pattern on the landscape. Runoff is medium, and the hazard of erosion is high.

The Tortugas soil has the profile described as representative of the Tortugas series. Rock land consists of very shallow, droughty soils that are less than 10 inches deep over limestone and quartzite bedrock.

Included with this soil in mapping are small areas of shallow, noncalcareous, dark-brown soils that have a subsoil of very gravelly clay loam; a soil that is similar to this Tortugas soil but has a carbonate-cemented hardpan at a depth of about 20 inches; and Welring very gravelly loam, 30 to 70 percent slopes.

The soils in this association are used for range and wildlife habitat. The native vegetation is pinyon pine, juniper, big sagebrush, Apache-plume, Mormon tea, serviceberry, bitterbrush, and sand dropseed. Tortugas soil in capability unit VII_s-V3, nonirrigated; Upland Stony Hills (Juniper) Summer Precipitation range site; wildlife suitability group 3242. Rock land in capability unit VIII_s-X, nonirrigated; wildlife suitability group 4343; range site not assigned.

Vekol Series

The Vekol series consists of well-drained soils on valley plains and alluvial fans. These soils formed in mixed alluvium washed from shale, sandstone, and limestone. Slopes range from 0 to 10 percent. Elevation is 2,900 to 3,100 feet. The native vegetation is desert shrubs, grasses, and cactus. Average annual precipitation is 8 to 11 inches, average annual air temperature is 57° to 67° F, and the frost-free period is 190 to 195 days. Vekol soils are commonly associated with Junction, Harrisburg, and St. George soils.

In a representative profile the surface layer is yellowish-red sandy loam about 10 inches thick. The subsoil is yellowish-red sandy clay loam, yellowish-red sandy clay, reddish-yellow silty clay loam, and yellowish-red sandy clay to a depth of 60 inches or more.

Permeability is slow. Available water capacity is 8 to 12 inches to a depth of 5 feet. The water supplying capacity is 5 to 6 inches. Roots penetrate to a depth of 40 to 60 inches.

Vekol soils are used for range and wildlife habitat.

Representative profile of Vekol sandy loam, 0 to 2 percent slopes, in an area of range in Warner Valley, 215 feet north and 100 feet west of the east quarter corner of sec. 18, T. 43 S., R. 14 W.:

A11—0 to 3 inches, yellowish-red (5YR 4/6) heavy sandy loam, yellowish red (5YR 3/6) when moist; weak, medium, platy structure; soft, friable, nonsticky and slightly plastic; few fine roots; common fine vesicular pores; moderately calcareous, lime is disseminated; moderately alkaline; clear, smooth boundary.

A12—3 to 10 inches, yellowish-red (5YR 4/6) sandy loam, yellowish red (5YR 3/6) when moist; moderate, medium, subangular blocky structure; hard, very friable, nonsticky and slightly plastic; few fine roots; few fine and medium pores; moderately calc-

careous, lime is disseminated; strongly alkaline; abrupt, smooth boundary.

B21t—10 to 22 inches, yellowish-red (5YR 4/8) heavy sandy clay loam, yellowish red (5YR 3/6) when moist; moderate, medium, prismatic structure; very hard, firm, sticky and plastic; few very fine roots; common very fine and fine and few medium pores; common thin clay films on faces of peds; moderately calcareous, lime is disseminated; moderately alkaline; gradual, wavy boundary.

B22t—22 to 35 inches, yellowish-red (5YR 4/6) light sandy clay, yellowish red (5YR 3/6) when moist; strong, coarse, prismatic structure; extremely hard, very firm, sticky and plastic; few fine and very fine roots; common very fine and fine pores; many thin clay films on faces of peds; moderately calcareous; moderately alkaline; gradual, irregular boundary.

B23tca—35 to 48 inches, reddish-yellow (5YR 6/6) silty clay loam, yellowish red (5YR 4/8) when moist; moderate, fine, blocky structure; extremely hard, firm, sticky and plastic; few fine and very fine roots; common very fine and fine pores; common thin clay films on faces of peds; strongly calcareous; moderately alkaline; gradual, wavy boundary.

B24tca—48 to 60 inches, yellowish-red (5YR 4/6) sandy clay, yellowish red (5YR 3/6) when moist; moderate, medium, prismatic structure; very hard, very firm, sticky and plastic; few very fine roots; common very fine and fine pores; strongly calcareous; moderately alkaline.

The average annual soil temperature at a depth of 20 inches ranges from 59° to 68° F, and the average summer soil temperature ranges from 77° to 82°.

The A horizon dominantly has hue of 5YR, but it ranges to 2.5YR in places; value of 4 or 5 when dry and 3 or 4 when moist; and chroma of 4 to 6. It is sandy loam or fine sandy loam 6 to 10 inches thick.

The B2t horizon has value of 4 to 6 when dry and chroma of 4 to 8. It is heavy sandy clay loam, sandy clay, clay, or silty clay loam. The B2tca horizon is strongly calcareous or moderately calcareous.

Vekol sandy loam, 0 to 2 percent slopes (VeA).— This soil is on low valley plains. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of LaVerkin silty clay loam, 1 to 2 percent slopes; Tobler fine sandy loam; and Hantz silty clay loam.

This Vekol soil is used for range. The native vegetation is galleta, Indian ricegrass, buckwheat, creosotebush, and cholla cactus. Capability unit VIIe-C, nonirrigated; Southern Desert Loam range site; wildlife suitability group 4343.

Vekol sandy loam, 2 to 10 percent slopes (VFD).— This soil is on old alluvial fans that have been dissected by erosion. It has a profile similar to the one described as representative of the series, but it is steeper. Runoff is medium, and the hazard of erosion is slight.

Included with this soil in mapping are small areas of LaVerkin fine sandy loam, 2 to 5 percent slopes; Tobler fine sandy loam; and Harrisburg fine sandy loam, 1 to 5 percent slopes.

This Vekol soil is used for range. The native vegetation is galleta, black grama, creosotebush, Mormon tea, and cholla cactus. Capability unit VIIe-C, nonirrigated; Southern Desert Loam range site; wildlife suitability group 4343.

Veyo Series

The Veyo series consists of shallow, well-drained soils that are 15 to 20 inches deep over an indurated carbonate-cemented hardpan. These soils are on old lava flows deposited on fans and foothills. They formed in material weathered dominantly from basalt. Slopes range from 2 to 10 percent. Elevation is 3,800 to 5,000 feet. The native vegetation is juniper, shrubs, and grasses. Average annual pre-

cipitation is 10 to 12 inches, average annual air temperature is 45° to 52° F, and the frost-free period is 120 to 160 days. Veyo soils are commonly associated with Clovis, Collbran, Magotsu, and Pastura soils.

In a representative profile the surface layer is brown cobbly sandy loam about 2 inches thick. The subsoil is brown cobbly clay loam, yellowish-red and reddish-brown very cobbly clay, and brown very cobbly sandy clay loam. An indurated carbonate-cemented hardpan is at a depth of about 19 inches.

Permeability is slow above the hardpan. Runoff is medium, and the hazard of erosion is moderate. Available water capacity, above the hardpan, is 1.5 to 2 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as the hardpan.

Veyo soils are used for range, wildlife habitat, and recreation.

Representative profile of Veyo cobbly sandy loam, 1 to 10 percent slopes, in an area of the Veyo-Pastura complex, 1 to 10 percent slopes, in an area of range about 300 feet east of blackbrush enclosure northwest of Gunlock, near the north quarter corner of sec. 9, T. 40 S., R. 17 W.:

A1—0 to 2 inches, brown (7.5YR 5/3) cobbly sandy loam, dark brown (7.5YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; moderately alkaline; clear, smooth boundary.

B1—2 to 6 inches, brown (7.5YR 4/4) cobbly clay loam, brown (7.5YR 4/2) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; common fine and medium roots; 35 percent cobbles and gravel; moderately alkaline; clear, smooth boundary.

B21t—6 to 12 inches, yellowish-red (5YR 4/6) very cobbly clay, reddish brown (5YR 4/4) when moist; strong, medium, prismatic structure; very hard, very firm, sticky and plastic; common fine and medium roots; 40 percent cobbles and gravel; many thin clay films; mildly alkaline; clear, wavy boundary.

B22t—12 to 17 inches, reddish-brown (5YR 5/4) very cobbly clay, reddish brown (5YR 4/4) when moist; weak, medium, prismatic structure that parts to strong, medium, subangular blocky; very hard, very firm, sticky and plastic; common fine and medium roots; 50 percent cobbles and gravel; many thin clay films; mildly alkaline; clear, wavy boundary.

B3ca—17 to 19 inches, brown (7.5YR 5/4) very cobbly heavy sandy clay loam, brown (7.5YR 5/4) when moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few fine and medium roots; 50 percent cobbles and gravel; strongly calcareous, lime is disseminated; moderately alkaline; abrupt, wavy boundary.

Ccam—19 to 23 inches, carbonate-cemented hardpan.

Depth to the hardpan ranges from 15 to 20 inches. The average annual soil temperature at a depth of 20 inches is 47° to 54° F, and the average summer soil temperature is 65° to 75°. The profile is neutral to moderately alkaline.

The A horizon has hue of 7.5YR or 5YR, value of 4 or 5 when dry, and chroma of 2 to 4. It ranges from extremely stony sandy loam to cobbly sandy loam 1 inch to 3 inches thick.

The B2t horizon has hue of 5YR or 2.5YR, value of 4 or 5 when dry and 3 or 4 when moist, and chroma of 4 to 6. It ranges from stony heavy clay loam to cobbly or very cobbly clay that is 30 to 50 percent cobbles, gravel, and stones.

Veyo-Curhollow complex, 3 to 10 percent slopes (VHD).—This complex is on old alluvial fans. It is about 50 percent Veyo extremely stony sandy loam, 3 to 10 percent slopes; about 40 percent Curhollow very stony sandy loam, 5 to 10 percent slopes; and 10 percent other soils. Runoff is medium, and the hazard of erosion is moderate.

The Veyo soil has a profile similar to the one described as representative of the Veyo series, but the surface layer is about 25 percent stones and slopes are 3 to 10 percent. The

Curhollow soil has a profile similar to the one described as representative of the Curhollow series, but the surface layer is 10 to 15 percent stones and slopes are 5 to 10 percent.

Included with these soils in mapping are small areas of Lavate sandy loam (2 to 4 percent slopes); Tobish very cobbly clay loam, 5 to 30 percent slopes; and Rough broken land.

The soils in this complex are used for range. The native vegetation is juniper, blackbrush, Mormon tea, big sagebrush, cheatgrass, and pricklypear. Capability unit VIIIs-R3, nonirrigated; Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone, range site; wildlife suitability group 3242.

Veyo-Pastura complex, 1 to 10 percent slopes (VPD).—

This complex is about 50 percent Veyo cobbly sandy loam, 1 to 10 percent slopes; 40 percent Pastura gravelly loam, 2 to 10 percent slopes; and 10 percent other soils. The soils are intermingled. Runoff is medium, and the hazard of erosion is slight. The Veyo soil has the profile described as representative of the Veyo series.

Included with these soils in mapping are small areas of a cobbly loam soil that has a carbonate-cemented hardpan at a depth of 20 to 30 inches; Colbran very cobbly clay loam, 2 to 30 percent slopes; and Rock land.

The soils in this complex are used for range. The native vegetation is scattered juniper, big sagebrush, galleta, cheatgrass, redtop brome, and cactus. Capability unit VIIIs-R3, nonirrigated; Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone, range site; wildlife suitability group 3242.

Welring Series

The Welring series consists of shallow, well-drained soils that are 10 to 20 inches deep over limestone bedrock. These soils are on mountain side slopes in the southwestern part of the survey area. They formed in material weathered from limestone and some quartzite and sandstone. Slopes range from 30 to 70 percent. Elevation is 4,600 to 6,800 feet. The native vegetation is pinyon pine, juniper, shrubs, and grasses. Average annual precipitation is about 14 inches, average annual air temperature is 47° to 52° F, and the frost-free period is 120 to 160 days. Welring soils are commonly associated with Mokiak, Motoqua, and Tortugas soils.

In a representative profile the surface layer is brown very gravelly loam about 3 inches thick. The underlying material is pale-brown very gravelly or gravelly loam. Bedrock is at a depth of about 19 inches.

Permeability is moderate above the bedrock. Runoff is rapid, and the hazard of erosion is severe. Available water capacity is 1 inch to 2 inches. The water supplying capacity is 3 to 5 inches. Roots penetrate as far down as bedrock.

Welring soils are used for range and wildlife habitat.

Representative profile of Welring very gravelly loam, 30 to 70 percent slopes, in an area of Welring-Tortugas very gravelly loams, 20 to 70 percent slopes, in an area of range 1½ miles southeast of the TV relay tower in the Beaver Dam Mountains, about 2,640 feet east of the southwest corner of sec. 9, T. 42 S., R. 18 W.:

A1—0 to 3 inches, brown (10YR 5/3) very gravelly loam, dark brown

(7.5YR 3/2) when moist; weak, thick, platy structure that parts to weak, very fine, subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few fine and very fine roots; common fine and many very fine pores; 50 percent of the surface is covered with gravel, 25 percent gravel in the horizon; mildly alkaline; abrupt, wavy boundary.

C1—3 to 8 inches, pale-brown (10YR 6/3) gravelly heavy loam, brown (7.5YR 4/2) when moist; moderate, very fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few medium, fine, and very fine roots; few fine and medium and common very fine pores; 45 percent gravel; slightly calcareous, lime is disseminated; moderately alkaline; clear, wavy boundary.

C2—8 to 14 inches, pale-brown (10YR 6/3) very gravelly heavy loam, brown (10YR 4/3) when moist; moderate, very fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine, medium, and very fine roots; few fine and medium and common very fine pores; 65 percent gravel; moderately calcareous, lime is disseminated; moderately alkaline; clear, wavy boundary.

C3—14 to 19 inches, pale-brown (10YR 6/3) very gravelly loam, yellowish brown (10YR 5/4) when moist; moderate, fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few medium, fine, and very fine roots; few fine and medium and many very fine pores; 75 percent gravel; moderately calcareous, lime is disseminated; moderately alkaline; clear, wavy boundary.

R—19 inches, fractured limestone bedrock.

Depth to bedrock ranges from 10 to 20 inches. Rock fragments cover 40 to 80 percent of the surface. The average annual soil temperature at a depth of 20 inches is 50° to 54° F. The profile is mildly alkaline or moderately alkaline.

The A horizon has hue of 10YR or 7.5YR, value of 5 or 6 when dry and 3 or 4 when moist, and chroma of 2 to 4. It is gravelly or very gravelly loam, very gravelly fine sandy loam, or very gravelly silt loam that is 20 to 50 percent gravel and cobbles. It ranges from 2 to 5 inches in thickness.

The C horizon has hue of 10YR or 7.5YR, value of 5 to 7 when dry and 4 to 6 when moist, and chroma of 2 to 5. It is commonly very gravelly loam, but it ranges to very gravelly sandy clay loam or very gravelly silt loam. The upper part of the C horizon is 35 to 60 percent gravel and cobbles, and the lower part is 70 to 90 percent. The C horizon ranges from slightly calcareous to strongly calcareous. It is 6 to 14 inches thick.

Welring-Tortugas very gravelly loams, 20 to 70 percent slopes (WAG).—This complex is on mountain side slopes. It is about 40 percent Welring very gravelly loam, 30 to 70 percent slopes; 25 percent Tortugas very gravelly loam, 20 to 70 percent slopes; 10 percent Rock outcrop; and 25 percent other soils. The Welring soil and Rock outcrop are on all aspects. The Tortugas soil has north- and east-facing slopes. A Welring soil in an area of this mapping unit has the profile described as representative of the Welring series. Runoff is rapid on the Welring soil and medium on the Tortugas soil. The hazard of erosion is severe.

Included with these soils in mapping are areas of a very gravelly loam soil that is 20 to 40 inches deep over bedrock; a very gravelly loam soil that is less than 10 inches deep over bedrock; Chilton gravelly loam, 5 to 30 percent slopes; and a moderately deep, dark-brown very gravelly clay loam soil that has a limy layer at a depth of about 25 inches.

The soils in this complex are used for range and wildlife habitat. The native vegetation is pinyon pine, juniper, serviceberry, big sagebrush, desert almond, Nevada bluegrass, and Indian ricegrass. Welring and Tortugas soils in capability unit VIIIs-V3, nonirrigated; Upland Stony Hills (Juniper) Summer Precipitation range site; wildlife suitability group 3242. Rock outcrop in capability unit VIIIs-X, nonirrigated; wildlife suitability group 4444; range site not assigned.

Winkel Series

The Winkel series consists of shallow, well-drained soils that are 11 to 19 inches deep over an indurated carbonate-cemented hardpan. These soils are on basalt mesa tops and low mountain side slopes in the central part of the survey area. They formed in calcareous material weathered from basalt, limestone, and wind-deposited sand. Slopes range from 1 to 30 percent. Elevation is 2,800 to 4,000 feet. The native vegetation is desert shrubs, grasses, and cactus. Average annual precipitation ranges from 8 to 11 inches, average annual air temperature is 57° to 61° F, and the frost-free period is 190 to 195 days. Winkel soils are commonly associated with Curhollow, Harrisburg, and Pastura soils.

In a representative profile the surface layer is reddish-brown gravelly fine sandy loam about 6 inches thick. The underlying layer is light reddish-brown very gravelly or very cobbly fine sandy loam about 10 inches thick. A carbonate-cemented hardpan is at a depth of about 16 inches.

Permeability is moderate above the hardpan. Available water capacity, above the hardpan, is 1 inch to 2 inches. The water supplying capacity is 2 to 4 inches. Roots penetrate as far down as the hardpan.

Winkel soils are used for range and wildlife habitat.

Representative profile of Winkel gravelly fine sandy loam, 1 to 8 percent slopes, in an area of range 1¾ miles north and 1 mile east of St. George, in the NW¼NE¼ sec. 17, T. 42 S., R. 15 W.:

A11—0 to 1 inch, reddish-brown (5YR 5/4) gravelly fine sandy loam, reddish brown (5YR 4/4) when moist; weak, fine, granular structure; slightly hard, very friable, nonsticky and nonplastic; common fine roots; few fine and medium pores; 20 percent gravel and cobbles; moderately calcareous, lime is disseminated; strongly alkaline; abrupt, smooth boundary.

A12—1 inch to 6 inches, reddish-brown (5YR 5/4) gravelly fine sandy loam, reddish-brown (5YR 4/4) when moist; weak, medium, platy structure that parts to fine, granular; slightly hard, very friable, nonsticky and nonplastic; common fine roots; common very fine, fine, and medium pores; 15 percent gravel and cobbles; moderately calcareous, lime is disseminated; strongly alkaline; clear, smooth boundary.

C1ca—6 to 12 inches, light reddish-brown (5YR 6/4) very gravelly fine sandy loam, reddish-brown (5YR 4/4) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; common fine roots; common fine and medium pores; 50 percent gravel and cobbles; moderately calcareous, lime is disseminated; strongly alkaline; clear, wavy boundary.

C2ca—12 to 16 inches, light reddish-brown (5YR 6/4) very cobbly fine sandy loam, reddish-brown (5YR 4/4) when moist; massive; soft, very friable, nonsticky and nonplastic; common fine roots; few fine and medium pores; 65 percent cobbles and gravel that are fragments of the Ccam horizon; moderately calcareous, lime is disseminated; strongly alkaline; abrupt, wavy boundary.

C3cam—16 to 20 inches, indurated carbonate-cemented hardpan.

Depth to the hardpan ranges from 11 to 19 inches. The profile is moderately alkaline or strongly alkaline. The average annual soil temperature at a depth of 20 inches is 59° to 63° F.

The A horizon has hue of 10YR, 7.5YR, or 5YR; value of 5 or 6 when dry and 3 to 5 when moist; and chroma of 2 to 6. It is gravelly and very gravelly fine sandy loam or gravelly loam that is 20 to 70 percent gravel and cobbles.

The Cca horizon has hue of 7.5YR or 5YR, value of 4 to 8 when dry and 4 to 6 when moist, and chroma of 4 to 6. It is gravelly and very gravelly fine sandy loam or gravelly, very gravelly, or very cobbly loam. It ranges from 20 to 80 percent cobbles and gravel. The C horizon ranges from moderately calcareous to strongly calcareous.

Winkel gravelly fine sandy loam, 1 to 8 percent slopes (WBD).—This soil is on basalt mesa tops in the south-

central part of the survey area. It has the profile described as representative of the series. Runoff is slow, and the hazard of erosion is moderate.

Included with this soil in mapping are small areas of Bermesa fine sandy loam, 1 to 10 percent slopes; Harrisburg fine sandy loam, 1 to 5 percent slopes; a soil that is very shallow over basalt bedrock; and Lava flows.

This Winkel soil is used for range. The native vegetation is creosotebush, blackbrush, galleta, buckwheat, Mormon tea, and cholla cactus. Capability unit VII_s-C4, nonirrigated; Southern Desert Stony Loam range site; wildlife suitability group 4343.

Winkel-Rock outcrop complex, 8 to 30 percent slopes (WCF).—This complex is on basalt mesa tops and low mountain side slopes. It is about 65 percent Winkel gravelly fine sandy loam, 8 to 30 percent slopes; 25 percent Rock outcrop; and 10 percent other soils. Rock outcrop occurs as basalt or limestone bedrock intermingled with the Winkel soil. Runoff is slow, and the hazard of erosion is severe.

The Winkel soil has a profile similar to the one described as representative of the Winkel series, but slopes are 8 to 30 percent and depth to the hardpan is only 11 to 16 inches.

Included with these soils in mapping are small areas of Bermesa fine sandy loam, 1 to 10 percent slopes; Curhollow gravelly fine sandy loam, 2 to 10 percent slopes; and Cinder land.

The soils in this complex are used for range and wildlife habitat. Capability unit VII_s-C4, nonirrigated; Winkel soil in Southern Desert Stony Loam range site and wildlife suitability group 4343; Rock outcrop in wildlife suitability group 4444 and range site not assigned.

Yaki Series

The Yaki series consists of shallow, well-drained soils that are 10 to 20 inches deep over bedrock. These soils are on mesas and mountain side slopes. They formed in material weathered from limestone and shale. Slopes range from 3 to 35 percent. Elevation is 3,500 to 5,000 feet. The native vegetation is desert shrubs and grasses. Average annual precipitation ranges from 10 to 13 inches, average annual air temperature is 52° to 57° F, and the frost-free period is 160 to 170 days. Yaki soils are commonly associated with Tobish and Zukan soils.

In a representative profile the surface layer is brown loam and very cobbly loam about 8 inches thick. The underlying material is brown cobbly loam and pinkish-white very cobbly loam to a depth of 19 inches. Limestone bedrock is at a depth of 19 inches.

Permeability is moderately rapid. Available water capacity is 1 inch to 2 inches. The water supplying capacity is 2 to 4 inches. Roots penetrate as far down as bedrock.

Yaki soils are used for range.

Representative profile of Yaki very cobbly loam, 3 to 35 percent slopes, in an area of the Yaki-Zukan complex, 1 to 35 percent slopes, in an area of range about 1 mile south-east of Hurricane School, 825 feet south and 500 feet east of the center of sec. 2, T. 42 S., R. 13 W.:

A11—0 to 2 inches, brown (7.5YR 5/4) very cobbly loam, dark brown (7.5YR 4/4) when moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; 50 percent cobbles over the surface; moderately calcareous, lime is disseminated; strongly alkaline; abrupt, smooth boundary.

A12—2 to 8 inches, brown (7.5YR 5/4) heavy loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium and few coarse roots; few fine and medium pores; moderately calcareous, lime is disseminated; moderately alkaline; clear, wavy boundary.

C1ca—8 to 12 inches, brown (7.5YR 5/4) cobbly loam, dark brown (7.5YR 4/4) when moist; massive; slightly hard, friable, slightly sticky and plastic; common fine and medium and few coarse roots; few fine pores; 35 percent cobbles and gravel; strongly calcareous, lime is disseminated; strongly alkaline; gradual, wavy boundary.

C2ca—12 to 19 inches, pinkish-white (7.5YR 8/2) very cobbly loam, light brown (7.5YR 6/4) when moist; massive; hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few fine pores; 55 percent cobbles and gravel; very strongly calcareous, lime is disseminated; strongly alkaline; gradual, wavy boundary.

R—19 inches, fractured limestone.

Depth to bedrock ranges from 10 to 20 inches. The average annual soil temperature at a depth of 20 inches ranges from 54° to 59° F, and the average summer soil temperature is 72° to 78°. The profile is moderately alkaline or strongly alkaline.

The A horizon has hue of 7.5YR or 10YR, value of 5 or 6 when dry and 4 or 5 when moist, and chroma of 3 or 4. It is loam or very cobbly loam.

The C horizon has hue of 7.5YR or 10YR, value of 4 to 6 when moist, and chroma of 2 to 4. It ranges from cobbly or gravelly loam to very cobbly loam.

Yaki very cobbly loam, 3 to 35 percent slopes (YAF).—

This soil is on mountain side slopes. Runoff is medium, and the hazard of erosion is severe.

Included with this soil in mapping are small areas of Tobish very cobbly clay loam, 5 to 30 percent slopes, and Naplene silt loam, 2 to 6 percent slopes. Also included are areas of Rock land, which make up about 7 percent of the mapped area.

This Yaki soil is used for range. The native vegetation is blackbrush, Mormon tea, galleta, and cholla cactus. Capability unit VII_s-R3, nonirrigated; Southern Semidesert Shallow Loam range site; wildlife suitability group 4343.

Yaki-Zukan complex, 1 to 35 percent slopes (YZE).—

This complex is on mesas and ridges. It is about 50 percent Yaki very cobbly loam, 3 to 35 percent slopes; 35 percent Zukan fine sandy loam, 1 to 10 percent slopes; and 15 percent other soils and Rock outcrop. The Yaki soils are on the upper parts of slopes and ridges, and the Zukan soils are on the lower parts of slopes and in swales. The Yaki and Zukan soils have the profiles described as representative of the Yaki and Zukan series.

Included with these soils in mapping are small areas of Redbank fine sandy loam, 1 to 5 percent slopes, and Schmutz loam. Also included are areas of Stony colluvial land and Rock outcrop, each of which makes up about 3 percent of the area.

The soils in this complex are used for range and wildlife habitat. The native vegetation is blackbrush, Mormon tea, galleta, Indian ricegrass, squirreltail, and cholla cactus. Capability unit VII_s-R3, nonirrigated; Southern Semidesert Shallow Loam range site; wildlife suitability group 4343.

Zukan Series

The Zukan series consists of shallow, well-drained soils that are 8 to 20 inches deep over bedrock. These soils are on mesas and desert slopes. They formed in material weath-

ered from limestone and shale. Slopes range from 1 to 10 percent. Elevation is 3,600 to 4,800 feet. The native vegetation is desert shrubs and grasses. Average annual precipitation ranges from 10 to 13 inches, average annual air temperature is 52° to 57° F, and the frost-free period is 160 to 170 days. Zukan soils are commonly associated with Yaki soils.

In a representative profile the surface layer is reddish-brown fine sandy loam, very fine sandy loam, and loam about 10 inches thick. The underlying material is reddish-brown loam. Limestone bedrock is at a depth of about 16 inches.

Permeability is moderate. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 2 to 3 inches. The water supplying capacity is 2 to 4 inches. Roots penetrate as far down as bedrock.

Zukan soils are used for range and wildlife habitat.

Representative profile of Zukan fine sandy loam, 1 to 10 percent slopes, in an area of the Yaki-Zukan complex, 1 to 35 percent slopes, in an area of range about 1½ miles south-east of Hurricane School, 800 feet east and 570 feet north of the southwest corner of sec. 1, T. 42 S., R. 13 W.:

A11—0 to 2 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) when moist; weak, fine, granular structure; soft, very friable, nonsticky and nonplastic; few fine roots; few fine and medium pores; moderately calcareous, lime is disseminated; moderately alkaline; abrupt, smooth boundary.

A12—2 to 4 inches, reddish-brown (5YR 5/4) very fine sandy loam, dark reddish brown (5YR 3/4) when moist; moderate, thin, platy structure; soft, very friable, nonsticky and nonplastic; few fine roots; few fine pores; moderately calcareous, lime is disseminated; strongly alkaline; abrupt, smooth boundary.

A13—4 to 10 inches, reddish-brown (5YR 5/4) loam, reddish brown (5YR 3/4) when moist; massive; slightly hard, friable, sticky and plastic; few fine and medium roots; common fine and few medium pores; moderately calcareous, lime is disseminated; strongly alkaline; clear, wavy boundary.

Cca—10 to 16 inches, light reddish-brown (5YR 6/4) heavy loam, reddish brown (5YR 5/4) when moist; massive; very hard, firm, sticky and plastic; few fine and medium roots; few fine pores; 2 percent stones; moderately calcareous, lime is in soft masses and veins; strongly alkaline; gradual, wavy boundary.

R—16 inches, limestone bedrock.

Depth to bedrock ranges from 8 to 20 inches thick. The average annual soil temperature at a depth of 20 inches is 54° to 59° F, and the average summer soil temperature is 72° to 78°.

The A horizon has hue of 5YR or 7.5YR. It is fine sandy loam, very fine sandy loam, or loam.

The C horizon ranges from fine sandy loam or loam to clay loam.

Zukan soils in the Washington County Area are mapped only with Yaki soils.

Use and Management of the Soils

The soils of the Washington County Area are used chiefly for range, irrigated crops and pasture, and dry-farmed wheat. This section describes use of the soils for these purposes and gives estimated yields of the main crops. It also describes use of the soils for recreation, wildlife habitat, woodland, and engineering.

In presenting information about the use of soils for crops and pasture, range, wildlife, and woodland, the procedure is to describe a group that is made up of similar soils that are suitable for those purposes and to suggest use and management for the group. In the sections on engineering and recreation, the soils are not grouped but are placed in

tables so that properties significant to engineering work or recreational uses can be readily shown.

Crops and Pasture

Some management practices are beneficial if applied to most soils used for irrigated crops and pasture. Such practices are briefly described in the following paragraphs.

An important management requirement is the uniform distribution of irrigation water without causing erosion. Both the border and furrow methods of irrigation are suitable for hay, pasture, and small grain, and the furrow method is also suitable for row crops. Sprinklers are an alternative method for most crops, but in most areas sprinkler irrigation is not suited because of the high silt content of the water. Losses of soil and water can be held to a minimum by using the proper length of runs and size of flows in furrows and borders. Some soils, such as Junction and Pintura soils, are particularly subject to damage by irrigation water that is not properly controlled.

Because of its beneficial effect on tilth, the return of organic matter is particularly important in irrigated soils. Sources of organic matter are crop residue, barnyard manure, and the sod crops grown in the cropping system. Practices that provide regular additions of organic matter are ordinarily the most beneficial. The use of fertilizer in amounts sufficient to produce large increases in plant growth makes it possible to return an increased amount of organic matter to the soil.

The soil content of organic matter in most soils in the survey area makes them especially susceptible to the formation of traffic pans. Good tilth can be maintained and the formation of traffic pans reduced, however, if the soils are not tilled or trampled when wet. The formation of traffic pans can also be reduced by varying the depth of tillage and limiting the number of trips over the soil with tillage equipment. The soils are particularly benefited by regular additions of organic material and commercial fertilizer.

Most of the soils in the Washington County Area contain sufficient potassium, calcium, iron, and magnesium for most crops. Crops generally respond to applications of a fertilizer high in content of nitrogen, phosphorus, or both, depending on the crop and the cropping history. In some soils calcium carbonate is so plentiful that it reduces the uptake of iron by trees, grapes, and other plants, resulting in chlorosis, or yellowing of the leaves, and in loss of plant vigor.

Capability grouping

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 so 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 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 are described in the following paragraphs.

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

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, range, woodland, or wildlife habitat.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and restrict their use largely to pasture, range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral; for example, IIe. The letter *e* shows that the main limitation is risk of erosion; *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, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making any statements about management of soils. Capability units are generally desig-

nated by adding an Arabic numeral to the subclass symbol; for example, IIe-1 or IIIe-0. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter immediately following the Roman numeral indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the part of the symbol following the hyphen specifically identifies the capability unit within each subclass. The units are not numbered consecutively, because not all the units in the Statewide system are represented in the survey area.

In the Utah system of classification, a number or a capital letter is used following the hyphen. This indicates the kind of limitation and is not arranged consecutively. The Arabic numbers 1 and 0 in the first position show that the limitation is climate; 1 indicates 140 to 175 frost-free days, and 0, 175 to 205. The letters *C*, *L*, *R*, and *V* are for nonirrigated capability units. These generally indicate the average annual precipitation and that 30 percent or more of the precipitation falls in summer. Because differences in elevation or aspect affect the kind of plant that will grow under the same annual precipitation, there is some overlap in average annual precipitation. The letter *C* indicates that the average annual precipitation generally is 6 to 10 inches; *R*, 8 to 12 inches; *V*, 12 to 16 inches; and *L*, 16 to 20 inches. Additional numbers or letters indicate the following limitations or conditions: 3, inhibiting layer or shallow depth; 4, gravelly, cobbly, or stony soils that have low available water capacity; 5, slow permeability; 6, sandy soils that have low available water capacity; 7, salinity; *E*, potential for severe erosion; and *X*, rock fragments on the surface.

Management by capability units

In this section each capability unit in the survey area is described, and the use and management are briefly discussed. To find the names of all the soils in any capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-0, IRRIGATED

Only St. George silty clay loam is in this unit. It is a deep, well-drained soil on alluvial fans and flood plains and in valley bottoms. The surface layer is silty clay loam, and the underlying material ranges from loamy sand to silty clay loam. Slopes are 0 to 2 percent. Elevation ranges from 2,450 to 3,400 feet. Average annual precipitation is 8 to 11 inches, and the frost-free period is 190 to 200 days.

The intake rate is slow. Permeability is moderately slow. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 7.5 to 12 inches to a depth of 5 feet. Effective rooting depth is about 60 inches.

This soil is used for irrigated alfalfa, barley, milo, sugar beet seed, sorghum for silage, and improved pasture.

The seedbed is easy to prepare if the soil is plowed in fall when moist so that the surface remains rough during winter. Crops respond well to applications of nitrogen and phosphate fertilizer.

The furrow method of irrigation is suitable for row crops, and the border method is suitable for alfalfa, small grain, and pasture. If alfalfa, sorghum, and sugar beet seed are grown, these soils need about 4 to 5 inches of irrigation water every 12 to 18 days during periods of maximum water use by the plants. Barley, milo, and pasture require

about 2 to 3 inches of water every 7 to 12 days during the period of maximum use.

Silt deposition from irrigation water near the head of fields makes leveling necessary every 5 to 10 years to maintain the proper grade for efficient management of irrigation water.

CAPABILITY UNIT I-1, IRRIGATED

Only Redbank silty clay loam, 0 to 2 percent slopes, is in this unit. It is a deep, well-drained soil on alluvial fans and flood plains. The surface layer is silty clay loam, and the underlying material is mainly fine sandy loam but has strata that range from fine sand to silt loam. Slopes are 0 to 2 percent. Elevation ranges from 3,300 to 5,500 feet. Average annual precipitation is 12 to 14 inches, and the frost-free period is 165 to 170 days.

The intake rate is slow. Permeability is moderate. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 6 to 8 inches to a depth of 5 feet. Effective rooting depth is about 60 inches.

This soil is used for irrigated alfalfa and barley.

Good tilth is maintained by plowing in fall and returning organic matter and barnyard manure to the soil. Crops respond to applications of nitrogen and phosphate fertilizer.

The border method of irrigation is suitable for the crops grown on this soil. Land shaping or smoothing to facilitate the application of water can be done in fall without damaging the soil.

CAPABILITY UNIT IIe-0, IRRIGATED

This capability unit consists of deep, well-drained soils on alluvial fans, flood plains, valley bottoms, terraces, and mesas. The surface layer ranges from sandy loam or fine sandy loam to silty clay loam. The underlying material ranges from loamy fine sand to sandy clay loam and gravelly loam. Slopes are 1 to 3 percent. Elevation ranges from 2,500 to 3,800 feet. Average annual precipitation is 8 to 11 inches, and the frost-free period is 190 to 200 days.

The intake rate is slow to rapid. Permeability is moderately slow to moderately rapid. Runoff is medium or slow, and the hazard of erosion is slight or moderate. Available water capacity is 5 to 12 inches to a depth of 5 feet. Effective rooting depth is 40 to 60 inches.

The soils in this unit are used for irrigated alfalfa, barley, sugar beet seed, milo, sorghum for silage, and improved pasture.

Good tilth is easily maintained by plowing in fall, especially on the soils that have a surface layer of silty clay loam. Also, good tilth is maintained by returning stubble and barnyard manure to the soil. Crops respond well to applications of nitrogen and phosphate fertilizer. Alfalfa is particularly responsive to applications of phosphate.

The furrow method of irrigation is suitable for row crops, and the border method is suitable for alfalfa, small grain, and pasture. If alfalfa, sorghum, and sugar beet seed are grown, these soils need about 4 to 5 inches of irrigation water every 12 to 18 days during periods of maximum water use by the plants. Barley, milo, and pasture require about 2 to 3 inches of water every 7 to 12 days during the period of maximum water use.

Silt deposition at the head of the fields and settling because of gypsum leaching by water make leveling neces-

sary every 5 to 10 years to maintain the proper grade for efficient management of irrigation water. Leveling and smoothing can be done in fall without damaging the soils.

CAPABILITY UNIT IIc-1, IRRIGATED

Only Redbank fine sandy loam, 1 to 5 percent slopes, is in this unit. This is a deep, well-drained soil on alluvial fans and flood plains and in valleys. The surface layer is fine sandy loam, and the underlying material ranges from fine sandy loam to loam or silt loam. Slopes are 1 to 5 percent. Elevation ranges from 3,300 to 5,500 feet. Average annual precipitation is 12 to 14 inches, and the frost-free period is 165 to 170 days.

The intake rate is moderate. Permeability is moderate. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 6 to 8 inches to a depth of 5 feet. Effective rooting depth is about 60 inches.

This soil is used for irrigated alfalfa and barley. It can be plowed in spring or fall. A good intake rate and good tilth can be maintained by returning organic matter and barnyard manure to the soil. Crops respond well to applications of nitrogen and phosphate fertilizer.

The furrow or sprinkler method of irrigation is suitable for the crops grown on this soil. If alfalfa and barley are grown, this soil needs about 2 to 3 inches of irrigation water every 12 to 16 days during periods of maximum water use by the plants.

CAPABILITY UNIT IIw-1, IRRIGATED

Only Draper loam, 2 to 5 percent slopes, is in this unit. It is a deep, somewhat poorly drained soil on alluvial fans and flood plains. The surface layer is loam, and the underlying material is coarse sandy loam or loam. Depth to a seasonal water table ranges from 36 to 60 inches. Slopes are 2 to 5 percent. Elevation ranges from 5,000 to 5,400 feet. Average annual precipitation is about 15 inches, and the frost-free period is 140 to 150 days.

The intake rate and permeability are moderate. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 7.5 to 10 inches to a depth of 5 feet. Effective rooting depth is to the water table or to a depth of 60 inches or more.

This soil is used for irrigated pasture. Crops respond well to applications of nitrogen fertilizer and to phosphate fertilizer where legumes are grown.

The furrow and sprinkler methods of irrigation are suited. If pasture is grown, this soil needs about 2 to 3 inches of water every 15 to 18 days during periods of maximum water use by the plants.

CAPABILITY UNIT IIIc-0, IRRIGATED

This capability unit consists of deep, well-drained soils on alluvial fans and flood plains and in valleys. The surface layer is fine sandy loam, and the underlying material ranges from loamy fine sand to light sandy clay loam. Slopes are 1 to 5 percent. Elevation ranges from 2,500 to 3,800 feet. Average annual precipitation is 8 to 11 inches, and the frost-free period is 190 to 195 days.

The intake rate is moderate. Permeability ranges from moderate to moderately rapid. Runoff is slow or medium, and the hazard of erosion is slight or moderate. Available water capacity is 6 to 10 inches to a depth of 5 feet. Effec-

tive rooting depth is 40 to 60 inches.

The soils in this unit are used for irrigated alfalfa, barley, sugar beet seed, milo, sorghum for silage, and improved pasture.

These soils can be plowed in spring or fall. Organic matter and barnyard manure plowed under help to increase the intake rate and workability of the soil. All crops respond to applications of nitrogen and phosphate fertilizer. Alfalfa is particularly responsive to applications of phosphate.

The furrow method of irrigation is suitable for most of the crops, and the border method can be used where slopes permit. Sprinkler irrigation is suitable for all crops. If alfalfa, sorghum, and sugar beet seed are grown, these soils need about 4 to 5 inches of irrigation water every 12 to 18 days during periods of maximum water use by the plants. Barley, milo, and pasture require about 2 to 3 inches of water every 7 to 12 days during the period of maximum water use.

The Junction soil in this unit in places requires leveling every 5 to 10 years because of settling caused by gypsum leaching by water.

CAPABILITY UNIT IIIc-05, IRRIGATED

Only Leeds silty clay loam, 5 to 10 percent slopes, is in this unit. It is a deep, well-drained soil on alluvial fans and in valleys. The surface layer is mainly silty clay loam, and the underlying material is sandy loam, silty clay loam, or silt loam. Slopes are 5 to 10 percent. Elevation ranges from 2,640 to 3,300 feet. Average annual precipitation is 8 to 11 inches, and the frost-free period is 190 to 200 days.

The intake rate and permeability are slow. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 8 to 12 inches to a depth of 5 feet. Effective rooting depth is about 60 inches.

This soil is used for irrigated alfalfa, barley, milo, sorghum for silage, and improved pasture.

Good tilth is easily maintained by plowing in fall and by returning stubble and barnyard manure to the soil. Crops respond well to applications of nitrogen and phosphate fertilizer.

The furrow method of irrigation is suited. The sprinkler method is also suited; but where the irrigation water is silty, wear on sprinkler heads is excessive. If alfalfa and sorghum are grown, this soil needs about 4 to 5 inches of irrigation water every 12 to 18 days during periods of maximum water use by plants. Barley, milo, and pasture require about 2 or 3 inches of water every 7 to 12 days during the period of maximum water use.

Land shaping or smoothing can be done in fall without damaging the soil.

CAPABILITY UNIT IIIc-1, IRRIGATED

Only Naplene silt loam, 2 to 6 percent slopes, is in this unit. It is a deep, well-drained soil on alluvial fans and terraces. The surface layer is silt loam or fine sandy loam, and the underlying material is mostly silt loam or clay loam. Slopes are 2 to 6 percent. Elevation ranges from 3,600 to 5,300 feet. Average annual precipitation is 14 to 15 inches, and the frost-free period is 140 to 160 days.

The intake rate is moderate. Permeability is moderately slow. Runoff is medium, and the hazard of erosion is mod-

erate. Available water capacity is 9 to 11 inches to a depth of 5 feet. Effective rooting depth is about 60 inches.

This soil is used for irrigated alfalfa, barley, and pasture. Good tilth is easily maintained by plowing in fall and by returning organic matter and barnyard manure to the soil. Crops respond to applications of nitrogen and phosphate fertilizer.

The furrow method of irrigation is suitable for crops grown on this soil. The border method is suitable where slopes permit. If alfalfa is grown, this soil needs about 4 to 5 inches of irrigation water every 12 to 20 days during periods of maximum water use by the plants. Barley requires about 2 to 3 inches of water every 7 to 14 days during the period of maximum water use.

Land shaping or smoothing to facilitate the application of irrigation water can be done in fall without damaging the soil.

CAPABILITY UNIT III-03, IRRIGATED

Only Harrisburg fine sandy loam, 1 to 5 percent slopes, is in this unit. It is a moderately deep, well-drained soil on mesas. The surface layer is fine sandy loam, and the underlying material ranges from very fine sandy loam to loamy fine sand or gravelly fine sandy loam. A hardpan is at a depth of 24 to 40 inches. Slopes are 1 to 5 percent. Elevation ranges from 2,800 to 3,500 feet. Average annual precipitation is 8 to 11 inches, and the frost-free period is 190 to 195 days.

The intake rate is moderate. Permeability is moderately rapid. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 3.7 to 5.0 inches to depth of hardpan. Effective rooting depth is 24 to 40 inches.

This soil is used for irrigated alfalfa, barley, and pasture. It can be plowed in spring or fall. Plowing under organic matter and barnyard manure help increase the intake rate and workability of the soil. Crops respond to applications of nitrogen and phosphate fertilizer. Alfalfa is particularly responsive to applications of phosphate.

The furrow and sprinkler methods of irrigation water every 7 to 12 days during periods of maximum water use by the plants.

If leveling is required, deep cuts should be avoided because of the lime-cemented hardpan at a moderate depth.

CAPABILITY UNIT III-05, IRRIGATED

This capability unit consists of deep, well-drained soils on alluvial fans. The surface layer is silty clay loam, and the underlying material is mostly silty clay, sandy loam, or silt loam. Slopes are 0 to 2 percent. Elevation ranges from 2,600 to 3,300 feet. Average annual precipitation is 8 to 11 inches, and the frost-free period is 190 to 200 days.

The intake rate and permeability are slow. Runoff is medium, and the hazard of erosion is slight. Available water capacity is 8 to 10 inches to a depth of 5 feet. Effective rooting depth is about 60 inches.

The soils in this unit are used for irrigated alfalfa, barley, sugar beet seed, milo, and pasture.

The seedbed is easier to prepare if the soil is plowed in fall and left rough over winter. Also, good tilth is maintained by returning stubble and barnyard manure to the soil. Crops respond well to applications of nitrogen and phosphate fertilizer.

The border method of irrigation is suitable for alfalfa and barley, and the furrow method is suitable for sugar beets. These soils need about 4 to 5 inches of irrigation water every 12 to 18 days during periods of maximum water use by the plants.

Leveling is necessary every 5 to 10 years to maintain the proper grade for efficient management of irrigation water.

CAPABILITY UNIT III-06, IRRIGATED

This capability unit consists of Ivins and Pintura soils. These are deep, somewhat excessively drained soils on benches and terraces. The surface layer is loamy fine sand, and the underlying material is loamy fine sand, sandy clay loam, or sandy clay. Slopes are 1 to 5 percent. Elevation ranges from 2,600 to 3,800 feet. Average annual precipitation is 8 to 11 inches, and the frost-free period is 170 to 195 days.

The intake rate is rapid. Permeability is moderately slow in the Ivins soil and rapid in the Pintura soil. Runoff is slow, and the hazard of erosion is moderate. Available water capacity is 3 to 7.5 inches to a depth of 5 feet. Effective rooting depth is about 60 inches.

These soils are used for irrigated alfalfa and barley. Only a small acreage in the vicinity of Ivins is used for crops.

These soils can be plowed in spring or fall. To keep soil blowing to a minimum, stubble should be kept on the surface over winter. Crops generally respond to applications of nitrogen and phosphate fertilizer.

The furrow or border method of irrigation is suitable for these crops. The sprinkler method is suitable if irrigation water is free from silt. These soils need about 3 to 4 inches of irrigation water every 7 to 12 days during periods of maximum water use by the plants.

Land shaping or smoothing to facilitate the application of irrigation water can generally be done without damage to the soils.

CAPABILITY UNIT IV-5, NONIRRIGATED

This capability unit consists of deep, well-drained soils on alluvial fans, mesas, and terraces. The surface layer ranges from very fine sandy loam to clay, and the underlying material ranges from fine sandy loam to clay. Slopes are 0 to 10 percent. Elevation ranges from 3,600 to 7,000 feet. Average annual precipitation is 12 to 16 inches, and the frost-free period is 120 to 170 days.

The intake rate is moderate to rapid. Permeability ranges from moderately rapid to very slow. Runoff is medium or slow, and the hazard of erosion is slight or moderate. Available water capacity is 6 to 12 inches to a depth of 5 feet. The water supplying capacity is 6 to 11 inches. Effective rooting depth is about 60 inches.

The soils in this unit are used for nonirrigated wheat, range, and wildlife habitat. The native vegetation is galleta, Indian ricegrass, squirreltail, Nevada bluegrass, big sagebrush, and on the Caval soils scattered clumps of Gambel oak.

The main concern of management is control of erosion. Brush clearing, spraying, seeding, and proper grazing use are needed if the soils are used for range.

CAPABILITY UNIT IV-13, IRRIGATED

Only Pastura loam, 2 to 5 percent slopes, is in this unit. It is a shallow, well-drained soil on basalt flow areas. The surface layer is loam, and the underlying material is gravelly loam or light clay loam. Depth to the hardpan ranges from 10 to 20 inches. Slopes are 2 to 5 percent. Elevation ranges from 3,800 to 5,000 feet. Average annual precipitation is 10 to 12 inches, and the frost-free period is 165 to 170 days.

The intake rate and permeability are moderate. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 2 to 3 inches above the hardpan. Effective rooting depth is 10 to 20 inches.

The soil in this unit is used mainly for irrigated alfalfa and barley.

This soil can be plowed in spring or fall, but results are better if it is plowed in fall. Plowing under organic matter and barnyard manure helps increase the water intake rate and workability of the soil. Crops respond to applications of nitrogen and phosphate fertilizer. Alfalfa is particularly responsive to applications of phosphate.

The furrow and sprinkler methods of irrigation are suited. The soil needs about 2 to 3 inches of irrigation water every 7 to 12 days during periods of maximum water use by the plants.

CAPABILITY UNIT VI-1, NONIRRIGATED

This capability unit consists of deep and moderately deep, well-drained soils on mountain side slopes and mesas. The surface layer is fine sandy loam, silt loam, or cobbly fine sandy loam. The underlying material mostly ranges from fine sandy clay loam to clay and in some places is also gravelly. Slopes are 2 to 30 percent. Elevation ranges from 6,000 to 8,000 feet. Average annual precipitation is 16 to 18 inches, and the frost-free period is 90 to 120 days.

The intake rate is moderate. Permeability is moderately slow or moderate. Runoff is medium to slow, and the hazard of erosion is slight or moderate. Available water capacity is 3 to 12 inches to a depth of 5 feet or as far down as bedrock. The water supplying capacity is 5 to 16 inches. Effective rooting depth is about 25 to 60 inches.

The soils in this unit are used for range, wildlife habitat, and recreation. The native vegetation is Kentucky bluegrass, prairie junegrass, slender wheatgrass, dryland sedge, peavine, snowberry, squaw-apple, bitterbrush, serviceberry, and Gambel oak.

The main concerns of management are conservation of moisture, control of erosion, and proper use of range.

Selected areas of these soils on the lower slopes that are free of oakbrush can be cleared and seeded. Such plants as intermediate wheatgrass, slender wheatgrass, and Whitmar wheatgrass are suitable for seeding at a rate of 12 to 15 pounds per acre. Drilling should be done in fall before frost, using a deep-furrow drill.

CAPABILITY UNIT VI-5, NONIRRIGATED

This capability unit consists of deep, well-drained soils on alluvial fans and flood plains and in valleys. The surface layer ranges from fine sandy loam to loamy fine sand, and the underlying material ranges from fine sandy loam to clay loam. Slopes are 1 to 5 percent. Elevation ranges

from 3,300 to 5,800 feet. Average annual precipitation is 11 to 14 inches, and the frost-free period is 165 to 170 days.

The intake rate is moderate. Permeability is moderate. Runoff is medium to slow. Available water capacity is 6 to 12 inches to a depth of 5 feet. The water supplying capacity is 8 to 9 inches. Effective rooting depth is about 60 inches.

The soils in this unit are used for range and wildlife habitat. The native vegetation is black grama, galleta, Indian ricegrass, sand dropseed, squirreltail, Nevada bluegrass, big sagebrush, scattered juniper, and pinyon pine.

The main concern of management is conservation of moisture, control of erosion, and proper use of range. These soils are suitable for range clearing and seeding.

CAPABILITY UNIT VI-6, NONIRRIGATED

Only St. George silty clay loam, moderately saline, is in this unit. It is a deep, moderately well drained soil on flood plains. The surface layer is silty clay loam, and the underlying material is loam or silt loam. Depth to the water table ranges from 24 to 40 inches. Slopes are 0 to 2 percent. Elevation ranges from 2,450 to 3,400 feet. Average annual precipitation is 8 to 11 inches, and the frost-free period is 190 to 195 days.

The intake rate is slow. Permeability is moderately slow. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 7.5 to 12 inches to a depth of 5 feet, but the water supplying capacity is only 5 to 8 inches. Effective rooting depth is 40 to 60 inches.

The soil in this unit is used for range. The native vegetation is alkali bluegrass, alkali sacaton, saltgrass, and sedges. Tall wheatgrass and tall fescue are suitable for seeding.

The main concerns of management are removal of salt and alkali and management of irrigation water.

CAPABILITY UNIT VI-7, NONIRRIGATED

Only Bond sandy loam, 1 to 10 percent slopes, is in this unit. It is a shallow, well-drained soil on mesas. The surface layer is sandy loam, and the underlying material is gravelly sandy clay loam. Depth to bedrock ranges from 10 to 20 inches. Slopes are 1 to 10 percent. Elevation ranges from 4,500 to 6,000 feet. Average annual precipitation is 12 to 14 inches, and the frost-free period is 160 to 170 days.

The intake rate is moderate. Permeability is moderately slow. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is about 1.5 to 3 inches. The water supplying capacity is about 5 to 8 inches. Effective rooting depth is 10 to 20 inches.

The soil in this unit is used for range and wildlife habitat. The native vegetation is desert needlegrass, galleta, Indian ricegrass, big sagebrush, juniper, and pinyon pine.

Selected areas of this soil can be cleared and seeded.

CAPABILITY UNIT VI-8, NONIRRIGATED

Only Chilton gravelly loam, 5 to 30 percent slopes, is in this unit. It is a deep, well-drained soil on alluvial fans. The surface layer is gravelly loam, and the underlying material is gravelly loam or very gravelly loam. Slopes are 5 to 30 percent. Elevation ranges from 3,900 to 4,600

feet. Average annual precipitation is 12 to 14 inches, and the frost-free period is 165 to 170 days.

The intake rate and permeability are moderate. Runoff is medium, and the hazard of erosion is slight. Available water capacity is 5 to 7 inches to a depth of 5 feet. The water supplying capacity is 6 to 9 inches. Effective rooting depth is about 60 inches.

The soil in this unit is used for range and wildlife habitat. The native vegetation is black grama, galleta, Indian ricegrass, big sagebrush, scattered juniper, and pinyon pine.

The main concerns of management are conservation of moisture, control of erosion, and proper use of range. This soil is suitable for range clearing and seeding. Drilling should be done just before the summer rainy period, using a deep-furrow drill.

CAPABILITY UNIT VIIe-C, NONIRRIGATED

This capability unit consists of moderately deep and deep, well-drained soils on alluvial fans, flood plains, terraces, mesas, and foothills. The surface layer is sandy loam, fine sandy loam, or silt loam, and the underlying material ranges from fine sandy loam or gravelly loam to light sandy clay. Depth to the carbonate-cemented hardpan ranges from 24 to 40 inches in the Harrisburg soils in this unit. Slopes range from 0 to 20 percent but are dominantly 0 to 5 percent. Elevation is 2,450 to 3,800 feet. Average annual precipitation is 8 to 11 inches, and the frost-free period is 180 to 195 days.

The intake rate is moderate to slow. Permeability ranges from slow to moderately rapid. Runoff is slow to medium, and the hazard of erosion is slight to moderate. Available water capacity is generally 6 to 12 inches to a depth of 5 feet, but above the hardpan in the Harrisburg soil it is 3.5 to 5.0 inches. The water supplying capacity is 3 to 8 inches. Effective rooting depth is about 24 to 60 inches.

The soils in this unit are used for range and wildlife habitat. The native vegetation is galleta, black grama, Indian ricegrass, creosotebush, blackbrush, Mormon tea, and cholla cactus.

CAPABILITY UNIT VIIe-C3, NONIRRIGATED

Only Shalet clay loam, warm, 2 to 20 percent slopes, and Eroded land are in this unit. The Shalet soil is a shallow, well-drained soil on desert slopes and desert benches. The surface layer is reddish-brown clay loam, and the underlying material is yellowish-red clay loam. Shale bedrock is at a depth that ranges from 4 to 15 inches but is generally about 12 inches. Slopes are 2 to 20 percent. Elevation ranges from 2,600 to 3,600 feet. Average annual precipitation is about 10 to 30 inches, and the frost-free period is about 195 days. Average annual air temperature is 59° to 67° F.

Permeability is slow. Runoff is rapid, and the hazard of erosion is severe. Available water capacity is 1.5 to 2.5 inches. Effective rooting depth is about 4 to 15 inches or as far down as bedrock.

The Eroded land part of this unit consists of stratified shale and gypsum.

This unit is used for range and wildlife habitat. The native vegetation is galleta, blackbrush, desert almond, Mormon tea, and pricklypear cactus.

These soils are not suitable for clearing and seeding. Range improvements are accomplished mainly by proper range management practices and special attention to erosion control practices.

CAPABILITY UNIT VIIe-L, NONIRRIGATED

This capability unit consists of deep, well-drained soils on mesas. The surface layer is cobbly fine sandy loam, fine sandy loam, and gravelly silt loam. The underlying material ranges from clay loam to very gravelly clay loam. Depth to bedrock is 40 to 60 inches. Slopes are 20 to 60 percent. Elevation ranges from 6,000 to 8,000 feet. Average annual precipitation is 16 to 18 inches, and the frost-free period is 90 to 120 days.

The intake rate is moderate. Permeability is moderately slow. Runoff is medium, and the hazard of erosion is slight to moderate. Available water capacity is 5 to 7 inches to a depth of 5 feet or as far down as bedrock. The water supplying capacity is 8 to 11 inches. Effective rooting depth is about 40 to 60 inches.

The soils in this unit are used for range, wildlife habitat, and recreation. The native vegetation is Kentucky bluegrass, slender wheatgrass, snowberry, serviceberry, squaw-apple, mahogany, and Gambel oak.

Because of thick stands of oakbrush, steep slopes, low precipitation, and high temperature in summer, these soils are not suitable for clearing and seeding. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VIIe-R, NONIRRIGATED

Only Schmutz loam is in this unit. It is a deep, well-drained soil on alluvial fans and in valleys. The surface layer is loam, and the underlying material is loam that is commonly stratified with silty clay loam and silt loam. Slopes are 1 to 5 percent. Elevation ranges from 3,600 to 4,800 feet. Average annual precipitation is 10 to 13 inches, and the frost-free period is 165 to 170 days.

The intake rate and permeability are moderate. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 7.5 to 10 inches to a depth of 5 feet. The water supplying capacity is 6 to 8 inches. Effective rooting depth is about 60 inches.

The soil in this unit is used for range and wildlife habitat. The native vegetation is galleta, black grama, blackbrush, big sagebrush, and scattered juniper and pinyon pine.

In most areas the low precipitation and high temperature in summer make this soil unsuitable for range seeding. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VIIe-R3, NONIRRIGATED

Only Shalet clay loam, 2 to 20 percent slopes, and Eroded land are in this unit. The Shalet soil is a shallow, well-drained soil on desert slopes and desert benches. The surface layer is reddish-brown clay loam, and the underlying material is yellowish-red clay loam. Shale bedrock is at a depth that ranges from 4 to 15 inches but is generally about 12 inches. Slopes are 2 to 20 percent. Elevation ranges from 3,600 to 5,500 feet. Average annual precipitation is about 10 to 13 inches, and the frost-free period is

165 to 175 days. Average annual air temperature is 52° to 58° F.

Permeability is slow. Runoff is rapid, and the hazard of erosion is severe. Available water capacity is 1.5 to 2.5 inches. Effective rooting depth is about 4 to 15 inches or as far down as bedrock.

The Eroded land part of this capability unit consists of stratified shale and gypsum.

This unit is used for range and wildlife habitat. The native vegetation is galleta, blackbrush, desert almond, Mormon tea, and pricklypear cactus.

These soils are not suitable for clearing and seeding. Range improvements are accomplished mainly by proper range management practices and special attention to erosion control practices.

CAPABILITY UNIT VII_w-07, NONIRRIGATED

This capability unit consists of deep, moderately well drained to poorly drained soils on flood plains and fans. The soils range from fine sand to silty clay loam throughout. Depth to the water table ranges from 12 to 54 inches. Slopes are 0 to 3 percent. Elevation ranges from 2,450 to 3,400 feet. Average annual precipitation is 8 to 11 inches, and the frost-free period is 190 to 205 days.

The intake rate is slow to rapid. Permeability ranges from rapid to moderately slow. Runoff is slow, and the hazard of erosion is moderate or high. Available water capacity is 3 to 12 inches to a depth of 5 feet. The water supplying capacity is 5 to 8 inches. Effective rooting depth is about 12 to 40 inches.

The soils in this unit are used for range and wildlife habitat. The native vegetation is alkali bluegrass, saltgrass sedges, alkali sacaton, willows, and sedges.

These soils are not suitable for seeding because of the seasonal high water table, salt and alkali, and the hazard of overflow. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VII_b-C3, NONIRRIGATED

This capability unit consists of shallow or very shallow, well-drained soils on desert mountains, mesas, and fans. The surface layer ranges from gravelly sandy loam or very cobbly loam to clay loam. The underlying material ranges from very flaggy loam or gravelly sandy loam to clay loam. Depth to the carbonate-cemented hardpan or bedrock ranges from 4 to 20 inches. Slopes are 2 to 40 percent. Elevation ranges from 2,600 to 4,000 feet. Average annual precipitation is 6 to 10 inches, and the frost-free period is 190 to 205 days.

The intake rate is moderate to slow. Permeability ranges from slow to moderately rapid. Runoff is slow to rapid, and the hazard of erosion is slight to high. Available water capacity, to depth of hardpan or bedrock, is 1 inch to 3 inches. The water supplying capacity is 2 to 4 inches. Effective rooting depth is 4 to 20 inches.

The soils in this unit are used for range. The native vegetation is galleta, filaree, desert rue, bursage, blackbrush, creosotebush, and cactus.

These soils are not suitable for clearing and seeding because of low rainfall and high temperature in summer. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VII_b-C4, NONIRRIGATED

This capability unit consists of shallow to deep, well-drained soils on mountain side slopes, foothills, and alluvial fans and mesas of Rock outcrop. The surface layer ranges from loamy fine sand or fine sandy loam to very stony sandy loam. In places it is gravelly or cobbly. The underlying material ranges from very gravelly sandy loam to very cobbly sandy clay loam. Depth to a carbonate-cemented hardpan or bedrock ranges from 11 to 60 inches. Slopes are 1 to 30 percent. Elevation ranges from 2,600 to 4,000 feet. Average annual precipitation is 8 to 11 inches, and the frost-free period is 175 to 195 days.

The intake rate is moderate. Permeability ranges from moderate to moderately rapid. Runoff is medium to slow, and the hazard of erosion is moderate. Available water capacity is 1 inch to 7 inches to a depth of 5 feet or to depth of carbonate-cemented hardpan. The water supplying capacity is 2 to 6 inches. Effective rooting depth is about 10 to 40 inches.

The soils in this unit are used for range. The native vegetation is galleta, Indian ricegrass, Mormon tea, creosotebush, blackbrush, and cholla cactus.

These soils are not suitable for clearing and seeding because of low rainfall and high temperature in summer. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VII_b-C6, NONIRRIGATED

This capability unit consists of deep, somewhat excessively drained soils on mountain side slopes. The surface layer is loamy fine sand or fine sand, and the underlying material ranges from fine sand to light sandy clay. Slopes are 1 to 20 percent. Elevation ranges from 2,600 to 3,800 feet. Average annual precipitation is 8 to 10 inches, and the frost-free period is 170 to 195 days.

The intake rate and permeability are rapid. Runoff is slow or very slow, and the hazard of erosion is slight to high. Available water capacity is 3 to 7.5 inches to a depth of 5 feet. The water supplying capacity is 3 to 6 inches. Effective rooting depth is about 60 inches.

The soils in this unit are used for range. The native vegetation is Indian ricegrass, sand dropseed, galleta, blackbrush, creosotebush, rabbitbrush, and cholla cactus.

These soils are not suitable for clearing and seeding because of low rainfall and high temperature in summer. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VII_b-L, NONIRRIGATED

This capability unit consists of shallow to deep, well-drained to somewhat excessively drained soils on mesas, foothills, and alluvial fans and some areas of Rock outcrop. The surface layer ranges from fine sandy loam or gravelly silt loam to very stony silt loam or cobbly loam. The underlying material ranges from clay loam to very cobbly clay. Depth to bedrock ranges from 10 to 60 inches. Slopes are 0 to 50 percent. Elevation ranges from 6,000 to 8,000 feet. Average annual precipitation is 16 to 18 inches, and the frost-free period is 90 to 120 days.

The intake rate is moderate. Permeability ranges from moderate to slow. Runoff is medium to rapid, and the hazard of erosion is slight or moderate. Available water

capacity is mainly 1 inch to 4 inches to a depth of 5 feet or to depth of bedrock, but in the Kolob soils it is 5 to 7 inches. The water supplying capacity is mainly 3 to 7 inches. Effective rooting depth is 10 to 50 inches.

The soils in this unit are used for range, wildlife habitat, and recreation. The native vegetation is Nevada bluegrass, black grama, bitterbrush, big sagebrush, Gambel oak, serviceberry, squaw-apple, and scattered ponderosa pine.

Steep slopes, shallowness, and excess cobbles and stones on the surface make these soils unsuitable for clearing and seeding. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VII₆-R, NONIRRIGATED

Only Tobish very cobbly clay loam, 5 to 30 percent slopes, is in this unit. It is a moderately deep, well-drained soil on mountain side slopes. The surface layer is very cobbly clay loam, and the underlying material ranges from cobbly clay loam to cobbly clay or gravelly clay. Depth to bedrock ranges from 22 to 35 inches. Slopes are 5 to 30 percent. Elevation ranges from 4,100 to 5,000 feet. Average annual precipitation is 10 to 13 inches, and the frost-free period is 160 to 170 days.

The intake rate is moderate. Permeability is slow. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 3 to 5 inches. The water supplying capacity is 4 to 6 inches. Effective rooting depth is about 22 to 35 inches.

The soils in this unit are used for range and wildlife habitat. The native vegetation is galleta, Indian ricegrass, blackbrush, and scattered juniper.

Most areas are not economically feasible to clear and seed because of low rainfall and high temperature in summer. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VII₆-R3, NONIRRIGATED

This capability unit consists of shallow and very shallow, well-drained soils on mountain side slopes, desert benches, mesas, and fans and areas of Rock outcrop, Stony colluvial land, and Eroded land. The surface layer ranges from fine sandy loam, loam, or clay loam to very cobbly or gravelly loam or extremely stony sandy loam. The underlying material ranges from gravelly sandy loam to clay loam or very cobbly clay. Depth to bedrock or a carbonate-cemented hardpan ranges from 4 to 20 inches. Slopes are 2 to 35 percent. Elevation ranges from 3,200 to 6,300 feet. Average annual precipitation is 8 to 12 inches, and the frost-free period is 120 to 190 days.

The intake rate is moderate or rapid. Permeability ranges from slow to moderately rapid. Runoff is slow to rapid, and the hazard of erosion is slight to severe. Available water capacity, to depth of hardpan or bedrock, is 1 inch to 3 inches. The water supplying capacity is 2 to 5 inches. Effective rooting depth is about 4 to 20 inches.

The soils in this unit are used for range and wildlife habitat. The native vegetation is galleta, Indian ricegrass, three-awn, blackbrush, big sagebrush, Mormon tea, and desert almond.

These soils are not suitable for clearing and seeding because of shallowness and low available water capacity. Range improvements are accomplished mainly by proper

range management practices.

CAPABILITY UNIT VII₆-V, NONIRRIGATED

This capability unit consists of deep and moderately deep, well-drained soils on mountain side slopes. The surface layer is very cobbly sandy loam or very cobbly clay loam, and the underlying material ranges from coarse sandy loam to clay. Depth to bedrock ranges from 21 to 60 inches. Slopes are 2 to 60 percent. Elevation ranges from 4,500 to 6,500 feet. Average annual precipitation is 14 to 15 inches, and the frost-free period is 120 to 160 days.

The intake rate is slow. Permeability is slow or moderately slow. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 4 to 12 inches to a depth of 5 feet or to bedrock. The water supplying capacity is 5 to 11 inches. Effective rooting depth is about 21 to 60 inches.

The soils in this unit are used for range and wildlife habitat. The native vegetation is Nevada bluegrass, Indian ricegrass, sand dropseed, serviceberry, live oak, low sage, brush, juniper, and pinyon pine.

These soils are not suitable for clearing and seeding because of the high percentage of live oak and shrubs, the very cobbly surface, and steep slopes on most of the Dag-flat soil. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VII₆-V3, NONIRRIGATED

This capability unit consists of shallow, well-drained to somewhat excessively drained soils on foothills and mountain side slopes and areas of Rock outcrop. The surface layer is very gravelly loam or shaly loam, and the underlying material is silt loam, gravelly or very gravelly loam, and very fine sandy loam. Depth to shale or bedrock ranges from 8 to 20 inches. Slopes are 20 to 70 percent. Elevation ranges from 4,600 to 7,000 feet. Average annual precipitation is 13 to 16 inches, and the frost-free period is 120 to 160 days.

The intake rate is moderate. Permeability ranges from slow to moderately rapid. Runoff is medium to rapid, and the hazard of erosion is high. Available water capacity is 1 inch to 4 inches. The water supplying capacity is 3 to 6 inches. Effective rooting depth is 8 to 20 inches.

The soils in this unit are used for range and wildlife habitat. The native vegetation is Nevada bluegrass, Indian ricegrass, bitterbrush, big sagebrush, live oak, pinyon pine, and juniper.

These soils are not suitable for clearing and seeding because of the very steep slopes and shallowness. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VII₆-V4, NONIRRIGATED

This capability unit consists of shallow to deep, well-drained to somewhat excessively drained soils on mountain side slopes, fans, and foothills and areas of Rock outcrop. The surface layer is very cobbly, very stony, or very gravelly sandy loam and very stony loamy fine sand. The underlying material ranges from very gravelly fine sand to stony sandy clay or very cobbly sandy clay loam. Depth to bedrock ranges from 8 to 60 inches. Slopes are 3 to 70 percent. Elevation ranges from 3,700 to 6,700 feet. Average

annual precipitation is 12 to 15 inches, and the frost-free period is 120 to 170 days.

The intake rate is moderate to rapid. Permeability ranges from moderately slow to rapid. Runoff is slow to medium, and the hazard of erosion is moderate or high. Available water capacity is 1 inch to 7 inches to a depth of 5 feet or to bedrock. The water supplying capacity is 3 to 9 inches. Effective rooting depth is about 8 to 60 inches.

The soils in this unit are used for range and wildlife habitat. The native vegetation is Indian ricegrass, tall native bluegrass, live oak, serviceberry, big sagebrush, Gambel oak, Utah juniper, and pinyon pine.

These soils are not suitable for clearing and seeding because of steep slopes and a high percentage of live oak and other shrubs. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VII_w-V6, NONIRRIGATED

This capability unit consists of deep, excessively drained soils. The surface layer is fine sand or loamy fine sand, and the underlying material ranges from fine sand to fine sandy loam. Slopes are 0 to 10 percent. Elevation ranges from 3,500 to 6,240 feet. Average annual precipitation is 11 to 15 inches, and the frost-free period is 120 to 170 days.

The intake rate is rapid or very rapid. Permeability is very rapid. Runoff is very slow, and the hazard of erosion is slight to moderate. Available water capacity is 3.5 to 8.0 inches to a depth of 5 feet. The water supplying capacity is 4 to 9 inches. Effective rooting depth is about 60 inches.

The soils in this unit are used for range and wildlife habitat. The native vegetation is Indian ricegrass, Nevada bluegrass, blue grama, ring muhly, big sagebrush, manzanita, pinyon pine, and juniper.

These soils are not suitable for seeding because of the sandy texture and low available water capacity. Range improvements are accomplished mainly by proper range management practices.

CAPABILITY UNIT VIII_e-E

Only Gullied land and small areas of shallow or very shallow soils are in this unit.

Available water capacity is about 0.5 inch to 2.0 inches. Runoff is rapid or very rapid, and the hazard of erosion is severe.

These areas support little or no vegetation. Their dissected nature makes leveling impractical.

CAPABILITY UNIT VIII_e-X

Only Cinder land is in this unit. It occurs as very steep, cone-shaped deposits of volcanic cinder.

Runoff is very slow.

These areas support a small amount of grass and brush, but very steep slopes and the rough surface prohibit grazing by livestock. In some areas the material is used for highway construction.

CAPABILITY UNIT VIII_w-4

Only Riverwash is in this unit. It consists of shallow to deep, gravelly, cobbly, or stony material that occurs in desert washes.

These areas have some value for wildlife habitat and as a source of road fill.

CAPABILITY UNIT VIII_s-3

Only Badland and Badland, very steep, are in this unit. Slopes range from 10 to 80 percent. Depth to shale bedrock ranges from 0 to 5 inches.

Runoff is very rapid, and the hazard of erosion is severe.

These areas are essentially barren, except for some stunted shrubs and forbs.

CAPABILITY UNIT VIII_s-6

Only Dune land is in this unit. It consists of actively shifting dunes of sand-size particles.

Dune land is excessively drained. Runoff is very slow.

These areas support little vegetation, except for short-lived annual grasses.

CAPABILITY UNIT VIII_s-E

Only Rough broken land is in this unit. It occurs mainly as very steep, deeply dissected breaks. A pavement of gravel, cobbles, and stones generally covers 70 to 80 percent of the surface.

Available water capacity is 1 inch to 2 inches. Runoff is rapid, and the hazard of erosion is moderate.

These areas commonly have a cover of desert grasses, shrubs, and forbs. They are too steep and too rough for livestock grazing.

CAPABILITY UNIT VIII_s-X

Lava flows; Rock land; Rock land, stony; and Rock outcrop are in this capability unit, as well as small areas of soils that are very shallow or shallow over bedrock.

The water capacity ranges from 0 to about 1 inch. Runoff is rapid or very rapid.

Most of the areas are barren. In places there is a sparse vegetation of grasses and stunted shrubs and trees. These areas have little or no value for livestock grazing.

Estimated yields of cropland

Table 2 shows the estimated yields of the principal crops and pasture plants grown on irrigated and nonirrigated soils. These yields are averages for a period of years. In any given year, yields are estimated on the basis of information and records obtained from farmers and on field observations by soil conservationists. The collected information was reviewed by the local county agricultural agent. If no information was available for a particular soil, the estimates were made on the basis of yields on a similar soil.

Yields are based on a generalized cropping sequence, consisting of alfalfa, sugar beet seed, and small grain. This cropping sequence or a variation of it is commonly used in this survey area. A small grain crop is grown as a companion crop to new seedings of alfalfa.

The yields in table 2 are those expected under a moderately high level of management. Such management provides that phosphorus fertilizer is applied when alfalfa is seeded and again after 2 or 3 years. Nitrogen fertilizer is used on row crops and on small grain unless adequate animal manure is applied. Sugar beet seed is fertilized with large quantities of nitrogen and phosphorus. Tillage is reduced to essential and timely operations to avoid traffic pans or compaction of the soil. In addition, control structures are used for handling irrigation water; the length of runs is adapted to soil conditions; water is applied accord-

TABLE 2.—*Estimated yields per acre of irrigated and nonirrigated crops under a moderately high level of management*
 [Only soils suited to cultivation are listed. Absence of data indicates that the crop is not commonly grown on the soil].

Soil	Nonirrigated	Irrigated					
	Wheat	Alfalfa	Barley	Sugar beet seed	Milo	Sorghum silage	Pasture
	<i>Bu</i>	<i>Tons</i>	<i>Bu</i>	<i>Lb</i>	<i>Bu</i>	<i>Tons</i>	<i>A.U.M.</i> ¹
Caval fine sandy loam, 2 to 10 percent slopes	20						
Clovis fine sandy loam, 1 to 5 percent slopes	20						
Draper loam, 2 to 5 percent slopes							12
Hantz silty clay loam		8	85	4,500	70		18
Harrisburg fine sandy loam, 1 to 5 percent slopes		7	70				18
Ivins loamy fine sand		7	60				
Junction fine sandy loam, 1 to 2 percent slopes		9	90	5,200	70		20
Junction fine sandy loam, 2 to 5 percent slopes		8	80	5,000	60		20
Lavate sandy loam	27						
LaVerkin fine sandy loam, 1 to 2 percent slopes		11	90	4,000	70	22	20
LaVerkin fine sandy loam, 2 to 5 percent slopes		8	80	4,000	60	18	16
LaVerkin silty clay loam, 1 to 2 percent slopes		11	90	4,600	80	24	20
Leeds silty clay loam, 0 to 1 percent slopes		10	110	5,500	75	22	26
Leeds silty clay loam, 1 to 2 percent slopes		10	105	5,200	75	20	22
Leeds silty clay loam, 5 to 10 percent slopes		8	95		70	18	18
Naplene silt loam, 2 to 6 percent slopes	27	6	75				18
Nikey sandy loam, 1 to 3 percent slopes		8	70				
Palma fine sandy loam, 1 to 5 percent slopes	20						
Pastura loam, 2 to 5 percent slopes		5	80				
Redbank fine sandy loam, 1 to 5 percent slopes	20	5	90				
Redbank silty clay loam, 0 to 2 percent slopes		4	80				
St. George silty clay loam		9	90	5,000	80	24	20
Spenlo very fine sandy loam, 2 to 10 percent slopes	22						
Springerville clay, 0 to 5 percent slopes	22						
Tobler fine sandy loam		8	90	5,000	70	20	22
Tobler silty clay loam		8	105	6,000	70	24	24

¹ A.U.M. stands for animal-unit-month. The figures represent the number of months that 1 acre will provide grazing for one animal unit (one cow, steer, or horse; five hogs; or seven sheep) without injury to the pasture.

ing to the crop requirements; crop rotations generally are consistent; and weeds are controlled.

A moderately high level of management for pasture includes rotation grazing; allowing the necessary regrowth period; clipping to control weeds; spreading droppings; applying nitrogen fertilizer once or twice a year; and applying phosphorus fertilizer every 2 or 3 years. The pasture is grazed every 28 or 40 days. It is not grazed when the soil is wet enough to pack or in spring until the plants are 8 to 10 inches high; at least 4 inches of plant growth is left in fall.

The amount of soluble salts or alkali in the soil determines the kinds of crops that can be grown. It also affects crop yields. Some of the soils in this survey area contain excessive soluble salts, alkali, or both. In some places the concentration of salts and alkali is moderate to high.

Nonirrigated cropping follows a wheat-fallow system. Management practices include stubble mulching, rod weeding twice, drilling in fall, and controlling insects. Cross-

slope tillage is practiced. Weeding is done near the proper time.

Range³

The soils used for range in the Washington County Area extend from low desert valleys into the high mountains. Elevation ranges from 2,400 to 8,200 feet. The soils range from deep, gently sloping soils to shallow, steep and very steep soils. Average annual precipitation ranges from 6 inches in the Southern Desert range sites to 20 inches in the Mountain range sites. All of the soils that are used for range are grouped into a range site.

³ HORACE ANDREWS, range conservationist, and LAMAR R. MASON, State range conservationist, Soil Conservation Service, helped to prepare this section.

Climatic zones and their effect on range

Four general climatic zones are used to describe the climatic setting for the range sites in the Washington County Area. These zones differ mainly in the amount of precipitation, but they also differ in the average annual temperature and the length of the growing season. The four climatic zones are (1) Mountain climatic zone, (2) Southern Desert climatic zone, (3) Southern Semidesert climatic zone, and (4) Southern Upland climatic zone. The Southern Upland climatic zone is divided into 2 subzones, those areas that have a moderate temperature in summer and those areas that have a high temperature in summer. Range sites in which plants are affected mainly by moisture sources other than precipitation are described under "Wet or run-in water areas."

Mountain climatic zone.—Average annual precipitation ranges from 16 to 20 inches, coming mostly as snow during winter. May and June are the driest months. Precipitation increases in July and August to significantly affect plant growth and kinds of plants. Plant growth begins April 15 to May 10. Most plants go into dormancy about July 15 because of deficient soil moisture, but they green up again late in August and in September because of July and August precipitation. The frost-free period ranges from 70 to 120 days. Elevation ranges from 6,000 to 8,200 feet. Average annual temperature ranges from 42° to 50° F.

Five range sites are in this climatic zone: Mountain Loam (Oak), Mountain Loam (Ponderosa Pine), Mountain Loam (Summer Precipitation), Mountain Shallow Loam (Ponderosa Pine), and Mountain Stony Loam (Summer Precipitation).

Southern Desert climatic zone.—Average annual precipitation ranges from 6 to 10 inches. Much of the precipitation comes during summer as high-intensity storms. May and June are the driest months. Precipitation increases during July, August, and the first half of September in sufficient quantities to affect the growth of plants. Plant growth begins March 1 to April 15. Many plants mature by June 15, and some perennial plants go dormant until July or August, when summer storms cause them to green up again. The frost-free period ranges from 175 to 205 days. Elevation ranges from 2,400 to 4,000 feet. Average annual temperature ranges from 59° to 67° F.

Four range sites are in this climatic zone: Southern Desert Loam, Southern Desert Sand, Southern Desert Shallow Hardpan, and Southern Desert Stony Loam.

Southern Semidesert climatic zone.—Average annual precipitation ranges from 8 to 12 inches. About 50 to 60 percent of it comes during the dormant period of October to March. May and June are the driest months. July and August are two of the high precipitation months, when enough moisture falls to affect growth of plants. Growth of cool-season plants begins about March 1 to March 15. Most of these plants mature by June 1. Warm-season plants start growth in May or June but make most of their growth in July and August. The frost-free period is 120 to 190 days. Elevation ranges from 3,000 to 6,300 feet. Average annual temperature is 52° to 59° F.

Five range sites are in this climatic zone: Southern Semidesert Loam, Southern Semidesert Malpai, Southern Semidesert Shallow Hardpan, 8- to 10-inch precipitation zone,

Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone, and Southern Semidesert Shallow Loam.

Southern Upland climatic zone.—Average annual precipitation ranges from 12 to 16 inches. About 55 to 60 percent falls during the plant dormant period of October to March. May and June are the driest months. July and August are two of the high precipitation months, when enough moisture falls to affect the growth and kind of plants. Growth of cool-season plants begins April 1 to 10 and ends with maturity and seed dissemination in May. Warm-season plants start to grow late in May or in June but make most of their growth during July and August. The frost-free period is 120 to 170 days. Elevation ranges from 3,500 to 6,900 feet. Average annual temperature ranges from 45° to 59° F.

The Southern Upland climatic zone is separated into two subzones. The first subzone consists of areas that have cold winters and moderate summers. There are five range sites in this subzone: Upland Loam (Summer Precipitation), Upland Sand (Juniper-Pinyon) Summer Precipitation, Upland Shallow Shale (Pinyon-Juniper) Summer Precipitation, Upland Stony Hills (Juniper) Summer Precipitation, and Upland Stony Loam (Pinyon-Juniper) Summer Precipitation. The second subzone consists of areas that have moderate winters and hot summers. Four range sites are in this subzone: Southern Upland Loam, Southern Upland Loam (Shrub), Southern Upland Shallow Loam (Juniper-Pinyon), and Southern Upland Stony Sand (Juniper-Pinyon).

Wet or run-in water areas.—Range sites described in these wet areas are mainly suited to water-loving plants. Plant growth is influenced more by a high water table and extra run-in water than by the precipitation that occurs. Temperatures are moderate in winter and spring and hot in summer. The frost-free period is mainly 190 to 205 days.

Three range sites are in these wet areas: Salt Meadow, Semiwet Meadows, and Semiwet Stream Bottoms.

Range sites and condition classes

Soils that have the capacity to produce the same kinds, amounts, and proportions of range plants are grouped into range sites. A range site is the product of all environmental factors responsible for its development.

A plant community existing within a range site that has not undergone abnormal disturbance is the potential, or climax, plant community for that site. Climax plant communities are not precise or fixed in their composition but vary, within reasonable limits, from year to year and from place to place.

Such disturbances as overuse by livestock, excessive burning, erosion, or plowing result in changes in the climax plant community or even complete destruction if disturbance is drastic enough. If the range site has not deteriorated significantly under such disturbance, secondary plant succession progresses in the direction of the natural potential, or climax, plant community for the site.

Four *range condition classes* are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a

range site in relation to the native vegetation that could grow there.

A range is in *excellent* condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in *good* condition if the percentage is 51 to 75; in *fair* condition if the percentage is 25 to 50; and in *poor* condition if the percentage is less than 25.

When changes occur in the climax plant community because of use by livestock or disturbance, some plant species increase and others decrease. By comparing the composition of the present plant community to that of the climax plant community, it is possible to see how individual species have increased while others decreased. Plants not present in the climax community that show up in the present plant community are invaders for the site.

The composition of climax and present plant communities, together with other range site information, provides the basis for selecting range management systems.

Management programs on range generally try to increase desirable plants and restore the range to as near climax conditions as possible. Some programs are designed to create or maintain plant communities somewhat removed from the climax to fit specific needs in the grazing program, to provide for wildlife habitat, or for other benefits. Any management objective should be compatible with conservation objectives.

In the following pages, the range sites of the Washington County Area are described and the climax plants and principal invaders on the sites are named. Also given is an estimate of the potential annual yields of air-dry vegetation for each site when it is in excellent condition. The soils in each site can be determined by referring to the Guide to Mapping Units at the back of this survey.

MOUNTAIN LOAM (OAK) RANGE SITE

This site is on mountains in the Mountain climatic zone. The soils in this range site are well drained. Slopes range from 2 to 25 percent. The surface layer is fine sandy loam. The underlying material ranges from sandy clay to clay loam or silty clay loam.

Intake rate is moderate. Available water capacity is 8 to 12 inches to bedrock or to a depth of 5 feet. The water supplying capacity is 8 to 16 inches. Permeability is moderately slow. Roots penetrate to bedrock or to a depth of 5 feet, but most are in the upper 20 to 30 inches of the soil.

The potential vegetation is about 25 percent grasses, 10 percent forbs, and 65 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Gambel oak (not usually grazed) -----	42
Other grasses -----	12
Total forbs -----	11
Other shrubs -----	8
Birchleaf mahogany -----	5
Bromegrass -----	5
Kentucky bluegrass -----	5
Serviceberry -----	3
Slender wheatgrass -----	3
Snowberry -----	3
Squaw-apple -----	3

If this site is in excellent condition, total annual produc-

tion of air-dry herbage ranges from 2,300 pounds per acre in years when the amount of moisture is favorable to 1,400 pounds per acre when the amount of moisture is unfavorable. About 60 percent of this production provides forage for livestock and wildlife.

If this site is continuously overgrazed during the growing period, the grasses and forbs die and less palatable shrubs and Gambel oak dominate.

This range site is not economically suitable for mechanical treatment, but it can be improved by seeding and use of proper range practices.

MOUNTAIN LOAM (PONDEROSA PINE) RANGE SITE

Only Hogg fine sandy loam, 2 to 5 percent slopes, is in this site (fig. 9). It is a well-drained soil on smooth mountains and mesa tops in the Mountain climatic zone. Slopes are 2 to 5 percent. The surface layer is fine sandy loam, and the subsoil is clay.

Intake rate is rapid. Available water capacity is 7 to 11 inches to a depth of 5 feet. The water supplying capacity is 11 to 14 inches. Permeability is moderately slow. Roots extend to a depth of 40 to 60 inches or more.

The potential vegetation is about 40 to 50 percent ponderosa pine, 20 percent grasses, 10 percent forbs, and 20 to 30 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Ponderosa pine (not usually grazed) -----	50
Total forbs (not usually grazed) -----	10
Gambel oak (not usually grazed) -----	8
Other shrubs -----	7
Blue grama -----	5
Manzanita (not usually grazed) -----	5
Other grasses -----	5
Needleandthread -----	4
Prairie junegrass -----	3
Tall native bluegrass -----	3

If this range site is in excellent condition, total annual production of air-dry herbage is about 1,500 pounds per acre in years when the amount of moisture is favorable and 950 pounds per acre when the amount of moisture is unfavorable. About 30 percent of this production provides forage for livestock and wildlife.

If this site is heavily grazed, the grasses increase and such shrubs and trees as ponderosa pine, Gambel oak, and manzanita increase. If overgrazing continues, it results in an understory of annual grasses and forbs and an overstory of mainly ponderosa pine and oak.

This site is not suitable for seeding by mechanical means, because of the tree and shrub composition. If the understory is in poor condition, it can be improved by broadcast seeding.

MOUNTAIN LOAM (SUMMER PRECIPITATION) RANGE SITE

This site is on mountains in the Mountain climatic zone. The soils in this range site are well drained. Slopes are 2 to 30 percent. The surface layer is fine sandy loam (fig. 10). The underlying material is mainly clay loam but ranges to sandy clay loam.

Intake rate is moderate. Available water capacity is 6 to 10 inches to a depth of 5 feet. The water supplying capacity is 11 to 14 inches. Permeability is moderate. Roots penetrate to a depth of 40 to 60 inches, but most roots are in the



Figure 9.—An area of Hogg fine sandy loam, 2 to 5 percent slopes, in the Mountain Loam (Ponderosa Pine) range site.

upper 24 to 36 inches.

The potential vegetation is about 60 to 70 percent grasses, 10 to 20 percent forbs, and 10 to 15 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

<i>Species</i>	<i>Composition Pct</i>
Muttongrass -----	21
Western wheatgrass -----	20
Prairie junegrass -----	15
Other forbs (not usually grazed) -----	14
Needleandthread -----	10
Other shrubs (not usually grazed) -----	6
Aster -----	5
Bitterbrush -----	5
Serviceberry -----	3
Squaw-apple -----	1

If this site is in excellent condition, total annual production of air-dry herbage ranges from about 2,000 pounds per acre in years when the amount of moisture is favorable to 1,500 pounds per acre when the amount of moisture is unfavorable. About 80 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, palatable grasses and forbs decrease. If overgrazing continues, big sage-

brush, Douglas knotweed, thistle, cheatgrass, and annuals of little or no forage value take over the range site.

This range site can be sprayed and, where slopes permit, cleared and seeded to establish stands of higher producing grasses.

MOUNTAIN SHALLOW LOAM (PONDEROSA PINE) RANGE SITE

This site is on mountains, mountain mesas, and ridges in the Mountain climatic zone. The soils in this range site are well drained to somewhat excessively drained. Slopes range from 2 to 50 percent, but they commonly are 2 to 30 percent. The surface layer is gravelly silt loam or cobbly silt loam (fig. 11). The underlying material ranges from very gravelly loam to very cobbly silty clay. Depth to bedrock ranges from 10 to 19 inches.

Intake rate is moderate. Available water capacity is 1 inch to 3 inches. The water supplying capacity is 3 to 6 inches. Permeability is moderate or moderately slow. Roots penetrate to bedrock.

The potential vegetation is about 15 to 20 percent ponderosa pine, 15 percent grasses, 10 percent forbs, and 55 to 60 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:



Figure 10.—An area of Detra fine sandy loam, 2 to 5 percent slopes, in the Mountain Loam (Summer Precipitation) range site.

<i>Species</i>	<i>Composition Pct</i>
Ponderosa pine (not usually grazed) -----	20
Gambel oak (not usually grazed) -----	13
Manzanita (not usually grazed) -----	12
Pinyon pine and juniper (not usually grazed) -----	10
Other shrubs -----	10
Total forbs (not usually grazed) -----	10
Other grasses -----	6
Birchleaf mahogany -----	5
Bitterbrush -----	5
Muttongrass -----	5
Indian ricegrass -----	4

If this site is in excellent condition, total annual production of air-dry herbage ranges from 1,400 pounds per acre in years when the amount of moisture is favorable to 500 pounds per acre when the amount of moisture is unfavorable. About 35 percent of this production provides forage for livestock and wildlife.

If this site is continuously overgrazed, Indian ricegrass, muttongrass, birchleaf mahogany, and bitterbrush decrease and western wheatgrass, Gambel oak, manzanita, ponderosa pine, pinyon pine, and juniper increase. If overgrazing continues, it results in a dense overstory of ponderosa pine, manzanita, Gambel oak, pinyon pine, and juniper and few or no forbs and grasses.

This range site produces excellent food and cover for deer throughout the year. Ponderosa pine and other species provide food for turkeys, mourning dove, blue grouse, and willow grouse and for several species of small mammals and birds.

MOUNTAIN STONY LOAM (SUMMER PRECIPITATION) RANGE SITE

This site is on mountains, foothills, and alluvial fans in the Mountain climatic zone. The soils in this range site are well drained. Slopes range from 0 to 40 percent, but they commonly are 0 to 15 percent. The surface layer is silt loam, fine sandy loam, cobbly fine sandy loam, cobbly loam, or very stony silt loam. The underlying material ranges from very gravelly clay loam to very cobbly clay or very stony clay.

Intake rate is slow or moderate. Available water capacity is 2.5 to 7 inches. The water supplying capacity is 5 to 10 inches. Permeability is slow or moderately slow. Roots penetrate to a depth of 40 to 60 inches.

The potential vegetation is about 45 to 55 percent grasses, 5 to 10 percent forbs, and 35 to 45 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:



Figure 11.—An area of Paunsaugunt gravelly silt loam, 10 to 30 percent slopes, in the Mountain Shallow Loam (Ponderosa Pine) range site.

Species	Composition Pct
Muttongrass -----	40
Ponderosa pine (not usually grazed) -----	13
Gambel oak (not usually grazed) -----	10
Concolor fir (not usually grazed) -----	8
Letterman needlegrass -----	5
Manzanita (not usually grazed) -----	5
Total forbs -----	5
Snowberry -----	4
Western wheatgrass -----	4
Other grasses -----	3
Serviceberry -----	3

If this site is in excellent condition, total annual production of air-dry herbage is about 1,500 pounds per acre in years when the amount of moisture is favorable and 1,200 pounds per acre in years when the amount of moisture is unfavorable. About 65 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, especially during the growing season, such plants as manzanita, Gambel oak, concolor fir, and ponderosa pine increase and dominate the site. If overgrazing continues, the understory plants decrease and are replaced by annual grasses, annual forbs, manzanita, big sagebrush, and Gambel oak.

Mechanical clearing and seeding of this site is not practical. The understory grasses may be increased by broadcast seeding before leaves are dropped in fall and by proper grazing use.

This range site is used by wildlife and livestock.

SALT MEADOW RANGE SITE

This site is on low flood plains and alluvial fans. The soils in this range site are mostly moderately well drained, but a few are poorly drained. Slopes range from 0 to 5 percent. Average annual precipitation ranges from 8 to 11 inches. The surface layer is silty clay loam or silt loam. The underlying material ranges from loamy sand to silty clay loam that is commonly stratified and is 8 to 30 percent gypsum.

Intake rate is moderate. Available water capacity is 7.5 to 12 inches to a depth of 5 feet. Plants depend partly on the water supplied upward from the water table, which is at a depth of 12 to 40 inches. Permeability is moderately slow. These soils are moderately to strongly affected by salt.

The potential vegetation is about 95 to 100 percent salt-tolerant grasses and grasslike plants, 0 to 2 percent forbs,

and 0 to 5 percent salt-tolerant shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Alkali bluegrass -----	25
Alkali sacaton -----	15
Other grasses and grasslike plants -----	15
Saltgrass -----	15
Sedges -----	15
Foxtail (not usually grazed) -----	5
Western wheatgrass -----	5
Greasewood -----	2
Other shrubs -----	2
Total forbs (not usually grazed) -----	1

If this site is in excellent condition, total annual production of air-dry herbage is about 4,000 pounds per acre in years when the amount of moisture is favorable and 2,000 pounds per acre in years when the amount of moisture is unfavorable. About 95 percent of this production provides forage for livestock.

If this site is continuously overgrazed, alkali bluegrass and alkali sacaton decrease and saltgrass, foxtail, rushes, and sedges increase. Where the site is in poor condition, the vegetation is mostly smotherweed, beflower, povertyweed, foxtail, curlycup gumweed, and Russian-thistle.

This site can be mechanically treated and reseeded, but it is generally better to improve its condition by proper grazing use.

This range site produces food and cover for upland game birds and waterfowl.

SEMIWET MEADOWS RANGE SITE

Only Draper loam, 2 to 5 percent slopes, is in this site. It is a somewhat poorly drained soil on alluvial fans and stream flood plains. Slopes are 2 to 5 percent. Average annual precipitation is about 15 inches. The surface layer is loam. The underlying material is loam or sandy loam.

Intake rate is moderate. Available water capacity is 7.5 to 10 inches to a depth of 5 feet, but plants also depend on water supplied upward from the water table, which is at a depth of 36 to 60 inches. Permeability is moderate. Roots penetrate to a depth of 5 feet or more.

The potential vegetation is about 80 to 95 percent grasses, 5 to 15 percent forbs, and 0 to 5 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Slender wheatgrass -----	25
Other grasses and grasslike plants -----	20
Great basin wildrye -----	10
Tufted hairgrass -----	10
Alkali bluegrass -----	5
Edible valerian -----	5
Other forbs (not usually grazed) -----	5
Peavine -----	5
Sedges -----	5
Total shrubs (not usually grazed) -----	5
Western wheatgrass -----	5

If this site is in excellent condition, total annual production of air-dry herbage is about 4,200 pounds per acre in years when the amount of moisture is favorable and 1,700 pounds per acre in years when the amount of moisture is unfavorable. About 90 percent of this production provides forage for livestock.

If this site is continuously overgrazed, slender wheatgrass, tufted hairgrass, Great Basin wildrye, and alkali bluegrass decrease and Kentucky bluegrass, sedges, western wheatgrass, and some forbs and shrubs increase. Prolonged overgrazing results in stands of silver sagebrush, yellowbrush, western coneflower, and annual forbs and grasses.

Where this site is in poor condition, it can be improved by seeding. Brush control by chemical spraying can be used when brush species begin to dominate the plant community.

This site produces food and cover for upland game birds and waterfowl.

SEMIWET STREAM BOTTOMS RANGE SITE

Only Fluvaquents and Torrifluents, sandy, are in this site. These are moderately well drained to poorly drained soils on river flood plains. Slopes are 0 to 2 percent. Average annual precipitation ranges from 8 to 11 inches. The texture ranges from fine sand to silt loam and is very stratified. Layers of gravel and cobbles are common.

Intake rate is moderate or rapid. Available water capacity is highly variable, and plants depend on water supplied upward from the water table. Depth to the water table ranges from 0 to 60 inches, depending on the flow of the river. Permeability is moderate to rapid. In places the soils are moderately affected by salt.

The potential vegetation is about 35 to 45 percent grasses, 5 to 15 percent forbs, and 40 to 50 percent shrubs and trees. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Willows (not usually grazed) -----	20
Sedges -----	15
Other trees and shrubs (not usually grazed) -----	13
Total forbs -----	12
Cottonwood (not usually grazed) -----	10
Other grasses -----	10
Wiregrass -----	10
Boxelder (not usually grazed) -----	5
Kentucky bluegrass -----	5

If this site is in excellent condition, total annual production of air-dry herbage is about 2,500 pounds per acre in years when the amount of moisture is favorable and 1,500 pounds per acre in years when the amount of moisture is unfavorable. About 50 percent of this production provides forage for livestock.

Changes in the stream channel and sedimentation from stream flooding cause changes in yield and composition of vegetation. Excessive grazing causes the perennial grasses to decrease and annual grasses, trees, and shrubs to increase. If overgrazing continues, it results in an overstory of trees and shrubs and an understory of annual grasses and forbs.

This range site can be improved by tree clearing and seeding and maintained by proper grazing.

SOUTHERN DESERT LOAM RANGE SITE

This site is on alluvial fans, flood plains, desert mesas, and foothills in the Southern Desert climatic zone. The soils in this range site are well drained. Slopes range from 1 to 20 percent, but they commonly are 1 to 10 percent. The surface layer is sandy loam, silt loam, or fine sandy loam

(fig. 12). The underlying material ranges from fine sandy loam to sandy clay or to gravelly loam.

Intake rate is slow to rapid. Available water capacity is 4 to 12 inches to depth of hardpan or to a depth of 5 feet. The water supplying capacity is 3 to 8 inches. Permeability is low to moderately rapid. Roots penetrate to a depth of 20 to 60 inches.

The potential vegetation is about 40 to 50 percent grasses, 2 to 8 percent forbs, and 45 to 60 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

<i>Species</i>	<i>Composition Pct</i>
Other shrubs (not usually grazed) -----	19
Creosotebush (not usually grazed) -----	13
Mormon tea -----	13
Dropseed -----	12
Indian ricegrass -----	10
Other grasses -----	9
Dixiegrass -----	7
Galleta -----	7
Bursage (not usually grazed) -----	5
Total forbs (not usually grazed) -----	5

If this site is in excellent condition, total annual production of air-dry herbage is about 900 pounds per acre in

years when the amount of moisture is favorable and 450 pounds per acre in years when the amount of moisture is unfavorable. About 60 percent of this production provides forage for livestock.

If this site is continuously overgrazed, black grama, bush muhly, Indian ricegrass, mesa dropseed, spike dropseed, squirreltail, globemallow, four-wing saltbush, Mormon tea, and winterfat decrease and galleta, sand dropseed, annual grasses, annual forbs, bursage, creosotebush, pricklypear, snakeweed, and yellowbrush increase. If overgrazing continues, it results in a plant community of annual grasses and forbs, dominantly creosotebush, bursage, pricklypear, range ratany, and snakeweed.

Because of low rainfall on this site, the only management practice that is practical is proper grazing use.

SOUTHERN DESERT SAND RANGE SITE

The site is on desert mountains, benches, and terraces in the Southern Desert climatic zone. The soils in this range site are somewhat excessively drained. Slopes range from 1 to 20 percent, but they commonly are 1 to 5 percent. The surface layer is loamy fine sand or fine sand. The underlying material is dominantly fine sand.

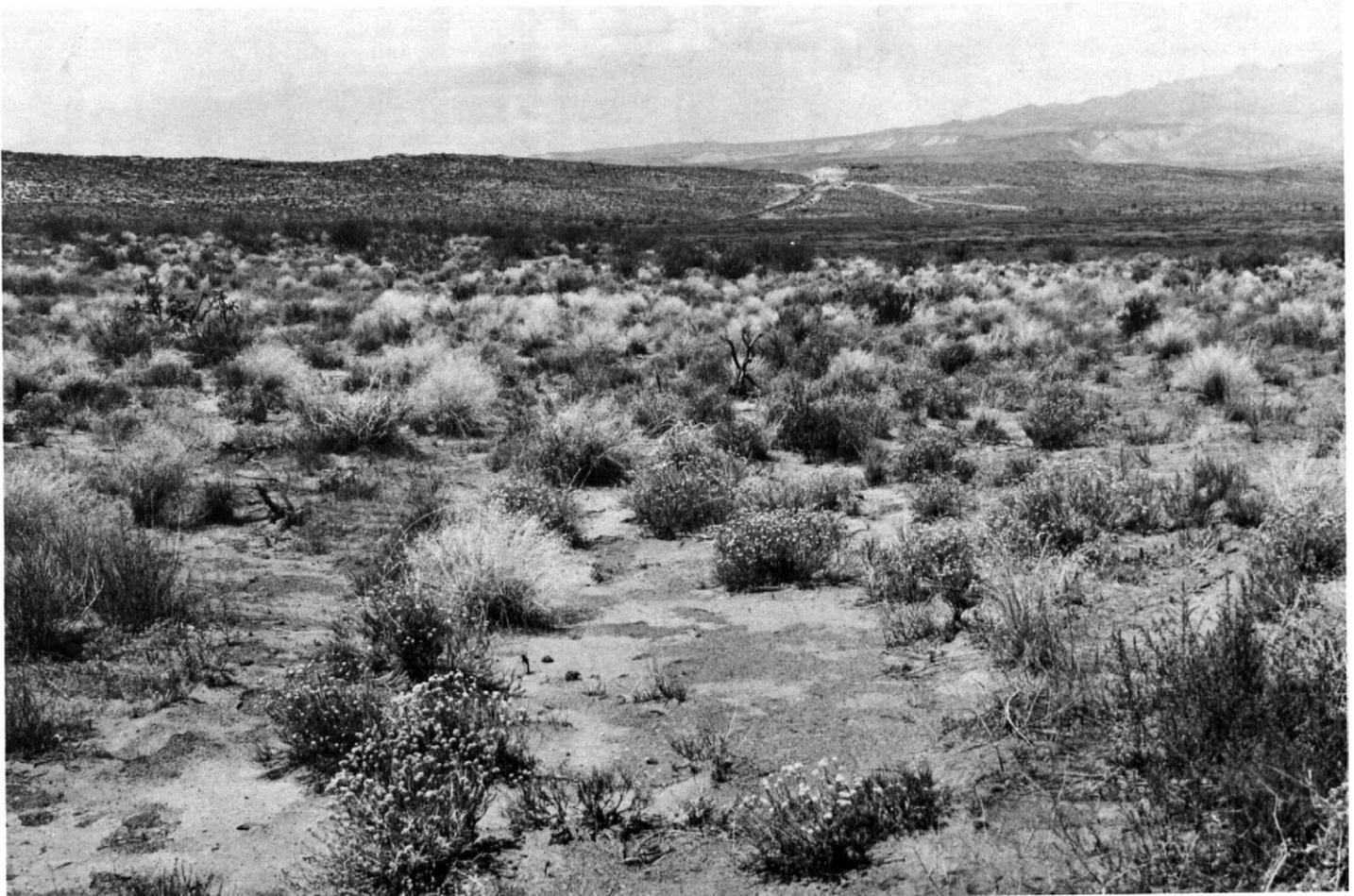


Figure 12.—An area of Tobler fine sandy loam in the Southern Desert Loam range site.

Intake rate is rapid. Available water capacity is 1.0 inch to 7.5 inches to bedrock or to a depth of 5 feet. The water supplying capacity is 2 to 6 inches. Permeability is rapid to very rapid. Roots penetrate to a depth of 8 to 60 inches.

The potential vegetation is about 55 to 65 percent grasses, 5 to 10 percent forbs, and 30 to 40 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Dropseed	27
Galleta	15
Indian ricegrass	10
Sand sagebrush (not usually grazed)	10
Other grasses	8
Other shrubs (not usually grazed)	8
Total forbs	7
Bursage	5
Four-wing saltbush	5
Mormon tea	5

If this site is in excellent condition, total annual production of air-dry herbage is about 650 pounds per acre in years when the amount of moisture is favorable and as little as 350 pounds per acre in years when the amount of moisture is unfavorable. About 80 percent of this production provides forage for livestock.

If this site is continuously overgrazed, especially during the growing season, black grama, bush muhly, Indian ricegrass, mesa dropseed, globemallow, and four-wing saltbush decrease. If overgrazing continues, the palatable grasses and forbs die out and sand sagebrush, snakeweed, bursage, creosotebush, and annual grasses take over the site.

This site is not suitable for clearing and seeding. Proper grazing use is essential for maintenance of this range site.

SOUTHERN DESERT SHALLOW HARDPAN RANGE SITE

Only Cave gravelly sandy loam, low rainfall, 2 to 7 percent slopes, is in this site. It is a well-drained soil on old alluvial fans in the Southern Desert climatic zone. Slopes are 2 to 7 percent. The surface layer is gravelly sandy loam. The underlying material is gravelly sandy loam about 8 to 20 inches thick over a carbonate-cemented hardpan.

Intake rate is moderate to rapid. Available water capacity is 1.0 inch to 2.5 inches to the hardpan. The water supplying capacity is 2 to 4 inches. Permeability is moderately rapid. Roots penetrate to the hardpan.

The potential vegetation is about 15 to 25 percent grasses, 2 to 5 percent forbs, and 70 to 80 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Bursage	20
Creosotebush (not usually grazed)	20
Desertrue (not usually grazed)	15
Joshua-tree (not usually grazed)	10
Other grasses	10
Other shrubs (not usually grazed)	10
Bush muhly	7
Total forbs (not usually grazed)	5
Black grama	3

If this site is in excellent condition, total annual production of air-dry herbage is about 800 pounds per acre in years when the amount of moisture is favorable and 500

pounds per acre in years when the amount of moisture is unfavorable. About 50 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, black grama, bush muhly, and Indian ricegrass decrease and galleta, annual grasses, annual forbs, bursage, creosotebush, Joshua-tree, pricklypear, range ratany, snakeweed, and wolfberry increase. If overgrazing continues, annual weeds, annual grasses, and one or more of the following shrubs may become dominant: bursage, creosotebush, range ratany, snakeweed, or wolfberry.

No mechanical or chemical treatment is suitable for this range site. Proper grazing use is the most important range improvement practice.

SOUTHERN DESERT STONY LOAM RANGE SITE

This site is on desert mountains, foothills, ridges, mesas, and old alluvial fans in the Southern Desert climatic zone. The soils in this range site are well drained. Slopes range from 1 to 40 percent, but they commonly are 1 to 15 percent. The surface layer is loamy fine sand, fine sandy loam, clay loam, very stony sandy loam, gravelly fine sandy loam, channery clay loam, cobbly sandy loam, and very cobbly loam. The underlying material ranges from sandy loam to clay that is gravelly, very gravelly, very cobbly, or stony.

Intake rate is moderate to slow. Available water capacity is 1 inch to 7 inches to bedrock or hardpan. The water supplying capacity is 2 to 6 inches. Permeability is slow to moderate. Roots penetrate to the bedrock or a hardpan at a depth of 8 to 40 inches.

The potential vegetation is about 50 to 60 percent grasses, 15 percent forbs, and 25 to 35 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Dixiegrass	25
Total forbs	15
Other grasses	12
Mormon tea	10
Needleandthread	7
Other shrubs (not usually grazed)	6
Bush muhly	5
Creosotebush (not usually grazed)	5
Galleta	5
Snakeweed (not usually grazed)	5
Winterfat	5

If this site is in excellent condition, total annual production of air-dry herbage is about 500 pounds per acre in years when the amount of moisture is favorable and 200 pounds per acre in years when the amount of moisture is unfavorable. About 80 percent of this production provides forage for livestock.

If this site is continuously overgrazed, bush muhly, Indian ricegrass, needleandthread, side-oats grama, Mormon tea, and winterfat decrease and galleta, annual grasses, annual forbs, creosotebush, range ratany, snakeweed, and wolfberry increase. If overgrazing continues, annual grasses and forbs and one or more shrubs, such as creosotebush, range ratany, snakeweed, and wolfberry, dominate the site.

Because of low rainfall on this site, the only suitable management practice is proper grazing use.

SOUTHERN SEMIDESERT LOAM RANGE SITE

This site is on alluvial fans, in valleys, and on mountains in the Southern Semidesert climatic zone. The soils in this range site are well drained. Slopes range from 1 to 30 percent. The surface layer is loam or very cobbly clay loam. The underlying material ranges from loam to cobbly clay.

Intake rate is moderate. Available water capacity is 3 to 10 inches. The water supplying capacity is 4 to 8 inches. Permeability is slow or moderate. Roots penetrate to a depth of 22 to 60 inches or more. The Schmutz soils in this site contain many soft masses of gypsum in the lower part.

The potential vegetation is about 50 to 60 percent grasses, 5 to 10 percent forbs, and 30 to 45 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Blackbrush	15
Galleta	15
Other shrubs (not usually grazed)	15
Black grama	10
Bush muhly	10
Sand dropseed	8
Total forbs	8
Indian ricegrass	5
Mormon tea	5
Winterfat	5
Other grasses	4

If this site is in excellent condition, total annual production of air-dry herbage is about 900 pounds per acre in years when the amount of moisture is favorable and as little as 550 pounds per acre in years when the amount of moisture is unfavorable. About 85 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, galleta dominates the site.

Because of lack of seed for species suited to the climate, the only suitable management practice is proper grazing use.

This range site provides winter grazing for livestock and wildlife.

SOUTHERN SEMIDESERT MALPAI RANGE SITE

Only Stony colluvial land is in this range site. It is a well-drained to somewhat excessively drained miscellaneous land type on very steep breaks in the Southern Semidesert climatic zone. Slopes range from 30 to 70 percent. The surface layer is extremely stony loam or extremely stony sandy loam. The underlying material is highly variable in texture and in content of stones and cobbles.

Intake rate is moderate or slow. Available water capacity is 1 inch to 4 inches. The water supplying capacity is 2 to 5 inches. Permeability is slow or moderate. Roots penetrate to a depth of 10 to 30 inches.

The potential vegetation is about 50 to 60 percent grasses, 5 to 10 percent forbs, and 30 to 35 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Black grama	15
Bush muhly	15
Galleta	10
Mormon tea	10
Snakeweed (not usually grazed)	10
Spike dropseed	10

Species	Composition Pct
Total forbs	10
Other shrubs (not usually grazed)	8
Brittlebrush (not usually grazed)	7
Other grasses	5

If this site is in excellent condition, total annual production of air-dry herbage is about 750 pounds per acre in years when the amount of moisture is favorable and 450 pounds per acre in years when the amount of moisture is unfavorable. About 75 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, black grama, bush muhly, needleandthread, spike dropseed, and Mormon tea decrease and galleta, sand dropseed, brittlebrush, snake-weed, and annual grasses and forbs increase.

Proper grazing use is essential for improvement of this range site.

SOUTHERN SEMIDESERT SHALLOW HARDPAN, 8- TO 10-INCH PRECIPITATION ZONE, RANGE SITE

Only Cave gravelly sandy loam, 7 to 30 percent slopes, is in this site. It is a well-drained soil on old alluvial fans in the Southern Semidesert climatic zone. Slopes range from 7 to 30 percent, but they commonly are 7 to 20 percent. The surface layer is gravelly sandy loam. The underlying material is gravelly sandy loam over a carbonate-cemented hardpan.

Intake rate is rapid. Available water capacity is 1 inch to 2.5 inches to the hardpan. The water supplying capacity is 2 to 4 inches. Permeability is moderately rapid. Roots penetrate to the hardpan at a depth of 8 to 20 inches.

The potential vegetation is about 20 to 30 percent grasses, 5 to 10 percent forbs, and 65 to 75 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Blackbrush	40
Other shrubs (not usually grazed)	13
Other grasses	10
Yucca (not usually grazed)	10
Bush muhly	7
Total forbs	7
Mormon tea	5
Red brome	5
Indian ricegrass	3

If this site is in excellent condition, total annual production of air-dry herbage is about 750 pounds per acre in years when the amount of moisture is favorable and 400 pounds per acre in years when the amount of moisture is unfavorable. About 75 percent of this production provides forage for livestock.

If this site is continuously overgrazed, Indian ricegrass, bush muhly, squirreltail, globemallow, and Mormon tea decrease and galleta, red brome, sand dropseed, black-brush, creosotebush, yucca, and snakeweed increase.

Proper grazing use is the only management practice that is suitable for this range site.

SOUTHERN SEMIDESERT SHALLOW HARDPAN, 10- TO 12-INCH PRECIPITATION ZONE, RANGE SITE

This site is on old alluvial fans, desert mountains, and basalt mesas in the Southern Semidesert climatic zone. The soils in this range site are shallow and well drained. Slopes range from 0 to 30 percent, but they commonly are

0 to 15 percent. The surface layer is loam or gravelly loam, gravelly fine sandy loam, very cobbly loam, very stony or extremely stony sandy loam, and very cobbly sandy loam. The underlying material ranges from clay loam to very gravelly sandy loam or very cobbly clay.

Intake rate is slow or moderate. Available water capacity is 1.5 to 3 inches to the hardpan. The water supplying capacity is 3 to 5 inches. Permeability is moderate to slow. Roots penetrate to the hardpan at a depth of 8 to 20 inches.

The potential vegetation is about 45 to 55 percent grass, 5 to 10 percent forbs, and 35 to 45 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Blackbrush	20
Other shrubs (not usually grazed)	18
Galleta	15
Red brome	15
Bush muhly	10
Other grasses	10
Total forbs	7
Yucca (not usually grazed)	5

If this site is in excellent condition, total annual production of air-dry herbage is about 750 pounds per acre in years when the amount of moisture is favorable and 435 pounds per acre in years when the amount of moisture is unfavorable. About 75 percent of this production provides forage for livestock and wildlife.

If this site is continuously overgrazed, black grama, bush muhly, Indian ricegrass, and Nevada bluegrass decrease and galleta, sand dropseed, blackbrush, yellowbrush, and yucca increase. If overgrazing continues, it results in an almost pure stand of blackbrush and a small amount of annual grasses and forbs.

Seeding is generally not successful on this range site. Proper grazing is a suitable management practice for range improvement.

SOUTHERN SEMIDESERT SHALLOW LOAM RANGE SITE

This site is on mesas, benches, and desert mountains in the Southern Semidesert climatic zone. The soils in this range site are well drained and shallow over bedrock. Slopes range from 1 to 35 percent, but they commonly are 1 to 20 percent. The surface layer is clay loam, fine sandy loam, or very cobbly loam. The underlying material ranges from loam to very cobbly loam.

Intake rate is slow or moderate. Available water capacity is 1.5 to 3 inches. The water supplying capacity is 2 to 4 inches. Permeability is slow to moderately rapid. Roots penetrate to the bedrock at a depth of 4 to 20 inches.

The potential vegetation is about 30 to 40 percent grasses, 2 to 5 percent forbs, and 55 to 60 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Blackbrush	40
Galleta	20
Sand dropseed	10
Four-wing saltbush	5
Mormon tea	5
Other grasses	5
Other shrubs (not usually grazed)	5
Range ratany	5

Species	Composition Pct
Other forbs	3
Globemallow	2

If this site is in excellent condition, total annual production of air-dry herbage is 850 pounds per acre in years when the amount of moisture is favorable and as little as 500 pounds in years when the amount of moisture is unfavorable. About 95 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, especially during the growing season, the palatable forage plants decrease. If overgrazing continues, blackbrush, cholla, pricklypear, and wolfberry dominate the site.

This range site is not suitable for clearing and seeding, but it can be improved by proper grazing use.

SOUTHERN UPLAND LOAM RANGE SITE

This site is on alluvial fans, mesas, and flood plains and in valleys in the Southern Upland climatic zone. The soils in this range site are well drained. Slopes range from 0 to 10 percent. The surface layer is fine sandy loam, very fine sandy loam, loamy fine sand, or clay. The underlying material ranges from clay loam to loam.

Intake rate is moderate. Available water capacity is 6 to 12 inches to a depth of 5 feet. The water supplying capacity is 6 to 11 inches. Permeability is moderately slow to moderately rapid. Roots penetrate to a depth of 60 inches or more.

The potential vegetation is about 70 to 80 percent grasses, 1 to 3 percent forbs, and 15 to 20 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Galleta	30
Blue grama	15
Four-wing saltbush	15
Sand dropseed	12
Black grama	10
Globemallow	5
Other grasses	5
Other forbs (not usually grazed)	3
Other shrubs (not usually grazed)	3
Spike dropseed	2

If this site is in excellent condition, total annual production of air-dry herbage is about 1,200 pounds per acre in years when the amount of moisture is favorable and 500 pounds per acre in years when the amount of moisture is unfavorable. About 95 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, black grama, Indian ricegrass, spike dropseed, Nevada bluegrass, four-wing saltbush, and globemallow decrease and blue grama, galleta, sand dropseed, western wheatgrass, and big sagebrush increase. If overgrazing continues, big sagebrush and annual grasses and forbs make up most of the vegetation.

This range site is suitable for brush clearing, seeding, and proper grazing management.

SOUTHERN UPLAND LOAM (SHRUB) RANGE SITE

This site is on mountains in the Southern Upland climatic zone. The soils in this range site are well drained. Slopes range from 2 to 60 percent, but they commonly are 10 to 40 percent. The surface layer is very cobbly clay loam

or very cobbly sandy loam. The subsoil ranges from clay to sandy clay loam. The substratum ranges from clay loam to loamy sand.

Intake rate is slow or moderate. Available water capacity is 4 to 12 inches to bedrock or to a depth of 5 feet. The water supplying capacity is 5 to 11 inches. Permeability is slow or moderately slow.

The potential vegetation is about 25 to 35 percent grasses, 10 to 15 percent forbs, and 50 to 60 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Low sagebrush (not usually grazed)	20
Serviceberry	15
Tall native bluegrass	15
Other shrubs	12
Leptodactylon (not usually grazed)	10
Indian ricegrass	5
Other forbs (not usually grazed)	5
Other grasses	5
Phlox (not usually grazed)	5
Sand dropseed	5
Black grama	3

If this site is in good condition, total annual production of air-dry herbage is about 900 pounds per acre in years when the amount of moisture is favorable and 400 pounds per acre in years when the amount of moisture is unfavorable. About 60 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, black grama, Indian ricegrass, needleandthread, Sandberg bluegrass, and tall native bluegrass decrease and leptodactylon, shrubby buckwheat, low sagebrush, and yellowbrush increase. Serviceberry increases if grazed by cattle and decreases if grazed by sheep and big game. If overgrazing continues, low sagebrush and annual forbs and grasses make up most of the vegetation.

Chemical spraying and proper grazing are suitable management practices for this range site.

SOUTHERN UPLAND SHALLOW LOAM (JUNIPER-PINYON) RANGE SITE

Only Bond sandy loam, 1 to 10 percent slopes, is in this range site. It is a well-drained soil on mesas in the Southern Upland climatic zone. Slopes range from 1 to 10 percent. The surface layer is sandy loam. The subsoil is gravelly sandy clay loam underlain by bedrock at a depth of about 10 to 20 inches.

Intake rate is moderate. Available water capacity is 1.5 to 3 inches. The water supplying capacity is 5 to 8 inches. Permeability is moderately slow. Most roots penetrate to the bedrock.

The potential vegetation is about 40 to 55 percent Utah juniper and pinyon pine, 15 to 25 percent grasses, 1 to 2 percent forbs, and 20 to 30 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Utah juniper (not usually grazed)	40
Other shrubs (not usually grazed)	13
Desert needlegrass	10
Pinyon pine (not usually grazed)	10
Yellowbrush (not usually grazed)	10
Big sagebrush	5
Other grasses	4

Species	Composition Pct
Galleta	3
Indian ricegrass	3
Total forbs	2

If this site is in excellent condition, total annual production of air-dry herbage is about 1,500 pounds per acre in years when the amount of moisture is favorable and 900 pounds per acre in years when the amount of moisture is unfavorable. About 30 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, desert needlegrass, Indian ricegrass, globemallow, and cliffrose decrease and big sagebrush, pinyon pine, Utah juniper, and yellowbrush increase. If overgrazing continues, it results in a closed stand of pinyon pine and juniper and an understory of only annual forbs and grasses.

Chaining the pinyon-juniper and seeding are suitable for range that is in poor condition. Chaining and proper grazing use are suitable for range that is in fair condition.

SOUTHERN UPLAND STONY SAND (JUNIPER-PINYON) RANGE SITE

Only Mathis very stony loamy fine sand, 20 to 50 percent slopes, is in this range site. It is a somewhat excessively drained soil on dissected mountains and mesas in the Southern Upland climatic zone. Slopes range from 20 to 50 percent. The surface layer is very stony loamy fine sand. The underlying material is very gravelly loamy sand, fine sand, or sandy loam. Depth to bedrock ranges from 20 to 40 inches.

Intake rate is rapid. Available water capacity is 2.5 to 3.5 inches. The water supplying capacity is 3 to 5 inches. Permeability is moderately rapid. Roots penetrate to a depth of 20 to 40 inches.

The potential vegetation is about 50 to 60 percent pinyon pine and Utah juniper, 20 to 30 percent grasses, 1 to 5 percent forbs, and 10 to 20 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

Species	Composition Pct
Utah juniper (not usually grazed)	45
Other grasses	12
Needleandthread	10
Pinyon pine (not usually grazed)	10
Other shrubs (not usually grazed)	8
Leadbush (not usually grazed)	4
Four-wing saltbush	3
Nevada bluegrass	3
Other forbs	3
Globemallow	2

If this site is in excellent condition, total annual production of air-dry herbage is about 1,200 pounds per acre in years when the amount of moisture is favorable and 800 pounds per acre in years when the amount of moisture is unfavorable. About 35 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, black grama, Indian ricegrass, needleandthread, Nevada bluegrass, globemallow, and four-wing saltbush decrease and galleta, sand dropseed, leadbush, pinyon pine, and Utah juniper increase. If overgrazing continues, pinyon pine and Utah juniper dominate the site to the exclusion of other plants except annual grasses and forbs.

Chaining and proper grazing use are suitable for this

range site. Seeding is not practical because of droughtiness and steep, rough slopes.

UPLAND LOAM (SUMMER PRECIPITATION) RANGE SITE

This site is on alluvial fans, stream terraces, upland valleys, and mesas in the Southern Upland climatic zone. The soils in this range site are well drained. Slopes range from 2 to 10 percent. The surface layer is sandy loam, fine sandy loam, or silt loam. The underlying material ranges from clay loam to fine sandy loam.

Intake rate is moderate or slow. Available water capacity is 6 to 11 inches to a depth of 5 feet. The water supplying capacity is 9 to 11 inches. Permeability is moderately slow to moderately rapid.

The potential vegetation is about 70 to 80 percent grasses, 1 to 5 percent forbs, and 15 to 20 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

<i>Species</i>	<i>Composition Pct</i>
Bluebunch wheatgrass -----	40
Galleta -----	15
Tall native bluegrass -----	15
Other grasses -----	10
Other shrubs (not usually grazed) -----	7
Total forbs (not usually grazed) -----	5

<i>Species</i>	<i>Composition Pct</i>
Bitterbrush -----	3
Winterfat -----	3
Four-wing saltbush -----	2

If this site is in excellent condition, total annual production of air-dry herbage is about 1,500 pounds per acre in years when the amount of moisture is favorable and 800 pounds per acre in years when the amount of moisture is unfavorable. About 90 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, bluebunch wheatgrass, tall native bluegrass, bitterbrush, four-wing saltbush, and winterfat decrease and galleta, Indian ricegrass, sand dropseed, needleandthread, and big sagebrush increase. If overgrazing continues, juniper and pinyon pine invade the site and big sagebrush and annual grasses increase.

Brush clearing, seeding, tree chaining, chemical spraying, and proper grazing use are suitable management practices for this range site.

UPLAND SAND (JUNIPER-PINYON) SUMMER PRECIPITATION RANGE SITE

Only Mespun fine sand, 0 to 10 percent slopes, is in this range site (fig. 13). It is in excessively drained soil on allu-



Figure 13.—An area of Mespun fine sand, 0 to 10 percent slopes, in the Upland Sand (Juniper-Pinyon) range site.

vial fans and plateaus and in upland valleys in the Southern Upland climatic zone. Slopes range from 0 to 10 percent. The soil is fine sand to a depth of 60 inches or more.

Intake rate is high. Available water capacity is 3.0 to 5.0 inches to a depth of 5 feet. The water supplying capacity is 4 to 6 inches. Permeability is very rapid. Roots penetrate to a depth of 60 inches or more.

The potential vegetation is about 5 to 15 percent grasses, 5 to 10 percent forbs, and 70 to 80 percent shrubs and trees. The approximate species composition by weight of the potential plant community is as follows:

<i>Species</i>	<i>Composition Pct</i>
Utah juniper (not usually grazed) -----	30
Pinyon pine (not usually grazed) -----	20
Other shrubs -----	20
Mormon tea -----	10
Blue grama -----	6
Other grasses -----	5
Total forbs (not usually grazed) -----	5
Sandhill muhly -----	4

If this site is in excellent condition, total annual production of air-dry herbage is about 1,100 pounds per acre in years when the amount of moisture is favorable and 600 pounds per acre in years when the amount of moisture is unfavorable. About 35 percent of this production provides forage for livestock and wildlife.

If this site is continuously overgrazed, Indian ricegrass, Nevada bluegrass, and bitterbrush decrease and blue grama, sandhill muhly, manzanita, pinyon pine, and juniper increase. If overgrazing continues, it results in a pure stand of pinyon pine, juniper, annual grasses, and forbs.

Chaining and seeding are suitable for this range site.

UPLAND SHALLOW SHALE (PINYON-JUNIPER) SUMMER PRECIPITATION RANGE SITE

Only Menefee shaly loam, 25 to 60 percent slopes, is in this range site. It is a shallow, well-drained soil on very steep mountains in the Southern Upland climatic zone. Slopes range from 25 to 60 percent. The surface layer is gravelly loam or gravelly silty clay loam. The underlying material ranges from silt loam to silty clay loam. Depth to shale bedrock ranges from 8 to 20 inches.

Intake rate is slow. Available water capacity is 3 to 4 inches. The water supplying capacity is 4 to 6 inches. Permeability is slow. Roots penetrate to bedrock.

The potential vegetation is about 5 to 10 percent grasses, 5 to 10 percent forbs, and 80 to 90 percent shrubs and trees. The approximate species composition of the potential plant community is as follows:

<i>Species</i>	<i>Composition Pct</i>
Pinyon pine (not usually grazed) -----	30
Utah juniper (not usually grazed) -----	15
Fremont mahonia (not usually grazed) -----	13
Other shrubs -----	13
Birchleaf mahogany -----	8
Mormon tea -----	6
Other grasses -----	5
Total forbs (not usually grazed) -----	5
Tall native bluegrass -----	3
Needleandthread -----	2

If this site is in excellent condition, total annual production of air-dry herbage is about 900 pounds per acre in years when the amount of moisture is favorable and 500

pounds per acre in years when the amount of moisture is unfavorable. About 40 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, Indian ricegrass, needleandthread, Nevada bluegrass, birchleaf mahogany, and serviceberry decrease and blue grama, galleta, Fremont mahonia, pinyon pine, and Utah juniper dominate the site to the exclusion of most other plants except annual grasses and forbs.

Chaining and seeding are suitable management practices where slopes are not too steep. Proper grazing use is suitable for all slopes.

UPLAND STONY HILLS (JUNIPER) SUMMER PRECIPITATION RANGE SITE

This site is on mountains and outwash fans in the Southern Upland climatic zone. The soils in this range site are well drained to somewhat excessively drained. Slopes range from 20 to 70 percent. The surface layer is very gravelly loam, very cobbly sandy loam, or very gravelly sandy loam. The underlying material ranges from very gravelly loam to very cobbly sandy clay loam.

Intake rate is moderate to rapid. Available water capacity is 1 inch to 2 inches. The water supplying capacity is 2 to 5 inches. Permeability is moderate to moderately rapid. Roots penetrate to bedrock at a depth of 8 to 20 inches.

The potential vegetation is about 30 to 40 percent pinyon pine and Utah juniper, 45 to 55 percent grasses, 1 to 3 percent forbs, and 5 to 10 percent shrubs. The approximate species composition by weight of the potential plant community is as follows:

<i>Species</i>	<i>Composition Pct</i>
Utah juniper (not usually grazed) -----	30
Indian ricegrass -----	20
Needleandthread -----	10
Other grasses -----	10
Pinyon pine (not usually grazed) -----	10
Big sagebrush -----	5
Dryland sedge -----	5
Nevada bluegrass -----	5
Total forbs -----	3
Other shrubs (not usually grazed) -----	2

If this site is in excellent condition, total annual production of air-dry herbage is about 1,250 pounds per acre in years when the amount of moisture is favorable and 900 pounds per acre in years when the amount of moisture is unfavorable. About 60 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, especially during the growing season, grasses and palatable forbs decrease and such plants as big sagebrush, blackbrush, rubber rabbitbrush, snakeweed, pinyon pine, and Utah juniper increase. If overgrazing continues, it results in a stand dominated by Utah juniper, pinyon pine, and unpalatable forbs.

Chaining, seeding, and proper grazing are suitable for this range site, depending on slopes.

UPLAND STONY LOAM (PINYON-JUNIPER) SUMMER PRECIPITATION RANGE SITE

This site is on mountains and associated alluvial fans and in valleys in the Southern Upland climatic zone. The soils in this range site are well drained. Slopes range from 3 to 70 percent, but they commonly are 30 to 70 percent. The surface layer is gravelly loam, gravelly sandy loam,

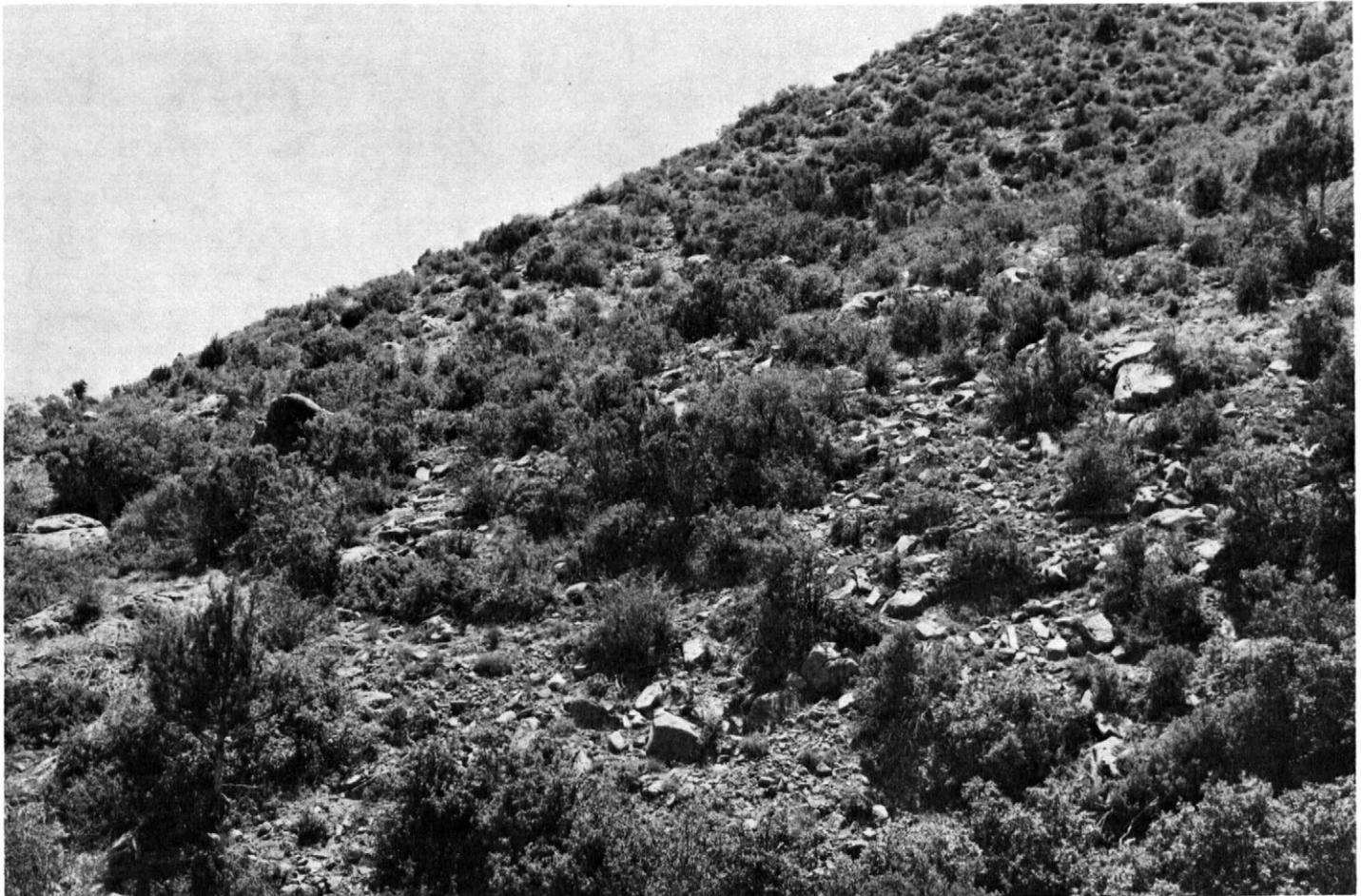


Figure 14.—An area of Tacan very stony sandy loam, 30 to 70 percent slopes, in the Upland Stony Loam (Pinyon-Juniper) Summer Precipitation range site.

very cobbly sandy loam, or very stony sandy loam (fig. 14). The underlying material ranges from gravelly clay to gravelly or very cobbly sandy loam. Bedrock is at a depth of 30 to 60 inches or more.

Intake rate is moderate. Available water capacity is 2 to 6 inches to bedrock or to a depth of 5 feet. The water supplying capacity is 3 to 9 inches. Permeability is moderate or moderately slow. Most roots penetrate to bedrock or to a depth of 5 to 6 feet.

The potential vegetation is about 10 to 20 percent grasses, 5 to 10 percent forbs, and 70 to 85 percent shrubs and trees. The approximate species composition by weight of the potential plant community is as follows:

<i>Species</i>	<i>Composition Pct</i>
Other shrubs -----	20
Utah juniper (not usually grazed) -----	15
Indian ricegrass -----	10
Pinyon pine (not usually grazed) -----	10
Serviceberry -----	10
Galleta -----	5
Live oak (not usually grazed) -----	5
Needleandthread -----	5
Nevada bluegrass -----	5
Other grasses -----	5
Total forbs (not usually grazed) -----	5
Yellowleaf silktassel (not usually grazed) -----	5

If this site is in excellent condition, total annual production of air-dry herbage is about 1,750 pounds per acre in years when the amount of moisture is favorable and as little as 1,000 pounds per acre in years when the amount of moisture is unfavorable. About 60 percent of this production provides forage for livestock and big game.

If this site is continuously overgrazed, especially during the growing season, the palatable forage plants decrease. If overgrazing continues, live oak, juniper, pinyon pine, unpalatable forbs, and annuals take over the site.

This range site is not suitable for clearing and seeding. It is used as a winter grazing area for big game.

Wildlife ⁴

The soils of the Washington County Area have been placed into nine wildlife suitability groups according to their potential to provide specified kinds of wildlife habitat. This section describes the wildlife suitability groups and explains the basis on which they were made. The soils in each group can be determined by referring to the

⁴ CLYDE SCOTT, biologist, Soil Conservation Service, helped to prepare this section.



Figure 15.—This area of Detra soils provides good habitat for woodland wildlife.

“Guide to Mapping Units.”

Table 3 lists the elements of wildlife habitat and the kinds of habitat and gives the suitability rating of each for wildlife suitability groups.

Suitability is indicated by ratings of good, fair, poor, and very poor. A rating of *good* means that habitats are easily improved, maintained, or created (fig. 15). There are few or no soil limitations in habitat management, and satisfactory results can be expected. A rating of *fair* means that habitats can be improved, maintained, or created, but moderate soil limitations affect habitat management or development. A moderate intensity of management and fairly frequent attention may be required to ensure satisfactory results. *Poor* means that habitats can be improved, maintained, or created, but the soil limitations are severe

(fig. 16). Habitat management may be difficult and expensive and require intensive effort. Results are questionable. A rating of *very poor* means that under the prevailing soil conditions it is impractical to attempt to improve, maintain, or create habitats. Unsatisfactory results are probable.

Symbols are used to designate wildlife suitability groups. The first figure in the symbol rates open-land habitat. The second figure rates woodland habitat. The third figure rates wetland habitat, and the fourth figure rates rangeland habitat. The numerals 1, 2, 3, and 4 are used to designate the quality of rating for each kind of habitat: 1 is *good*, 2 is *fair*, 3 is *poor*, and 4 is *very poor*. For example, “1242” is used to designate the wildlife suitability group that has good potential as openland, fair for woodland, very poor for wetland, and fair for rangeland habitat. Irrigated groups have a fifth character, “I,” added

TABLE 3.—Potential for elements of wildlife

Wildlife suitability group	Wildlife habitat elements				
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants
1241-I -----	Good -----	Good -----	Good to fair -----	Good -----	Good -----
2141 -----	Fair to poor -----	Fair -----	Good -----	-----	Good -----
2242-I -----	Fair -----	Fair to good -----	Fair -----	Fair to good -----	Good -----
2242 -----	Fair to poor -----	Good to fair -----	Fair -----	Fair to good -----	Good to poor -----
3141 -----	Very poor -----	Very poor -----	Good -----	-----	Good -----
3242 -----	Poor to very poor -----	Poor to very poor -----	Fair -----	-----	Good to poor -----
4343 -----	Poor to very poor -----	Poor to very poor -----	Poor -----	Very poor -----	Poor to very poor -----
4424 -----	Very poor -----	Very poor -----	Very poor -----	-----	Very poor -----
4444 -----	Very poor -----	Very poor -----	Very poor -----	Very poor -----	Very poor -----

WILDLIFE SUITABILITY GROUP 2141

The soils in this group are deep and moderately deep and are well drained. They are on mountains and mesas. Slopes range from 2 to 50 percent but are dominantly 2 to 30 percent. The surface layer is fine sandy loam or cobbly fine sandy loam.

Available water capacity is 6 to 10 inches. The water supplying capacity is 8 to 16 inches. Average annual precipitation is 14 to 18 inches, average annual temperature is 42° to 51° F, and the frost-free period is 90 to 160 days.

The native vegetation is mostly Gambel oak, big sagebrush, serviceberry, snowberry, peavine, Kentucky bluegrass, slender wheatgrass, and brome grass.

WILDLIFE SUITABILITY GROUP 2242-1

The soils in this group are mainly deep, are sloping, and are well drained. They are on alluvial fans, benches, and terraces and in valleys. Slopes are mainly 1 to 6 percent, but in some areas they are as much as 10 percent. The surface layer ranges from loamy fine sand to silty clay loam. These soils are irrigated.

Available water capacity is 6 to 12 inches to a depth of 5 feet. Average annual precipitation is 8 to 14 inches, average annual temperature ranges from 45° to 67° F, and the frost-free period is 120 to 200 days.

WILDLIFE SUITABILITY GROUP 2242

The soils in this group are deep and well drained. They are on alluvial fans and terraces and in valleys. Slopes are dominantly 0 to 6 percent, but in some areas they are as much as 10 percent. The surface layer is dominantly fine sandy loam, sandy loam, silt loam, or loamy fine sand, but the Springerville soil has a surface layer of clay.

The water supplying capacity is 6 to 11 inches. Average annual precipitation is 11 to 15 inches, average annual temperature is 45° to 56° F, and the frost-free period is 120 to 170 days.

The native vegetation is mostly Indian ricegrass, galleta, squirreltail, big sagebrush, and scattered pinyon pine and Utah juniper. Some of these soils are used for nonirrigated wheat.

WILDLIFE SUITABILITY GROUP 3141

The soils in this group are moderately deep or deep, well-drained gravelly and cobbly soils. They are on foothills and mountains. Slopes range from 0 to 60 percent. The surface layer ranges from cobbly loam to very stony silt loam. The subsoil and substratum are clay loam, very gravelly clay loam, very cobbly clay loam, or very cobbly clay. Depth to bedrock ranges from 21 to 60 inches or more.

Available water capacity is 2.5 to 7 inches. The water supplying capacity is 12 to 15 inches. Average annual precipitation is 16 to 18 inches, average annual temperature ranges from 42° to 50° F, and the frost-free period is 90 to 120 days.

The native vegetation is mostly Gambel oak, ponderosa pine, serviceberry, snowberry, tall native bluegrass, Lettman needlegrass, and western wheatgrass.

WILDLIFE SUITABILITY GROUP 3242

The soils in this group range from shallow to deep and

are well drained to excessively drained. They are on mountains, foothills, mesas, and alluvial fans. Slopes range from 1 to 70 percent. The surface layer ranges from fine sand to very cobbly clay loam or extremely stony sandy loam.

Available water capacity ranges from 1.5 to 12 inches. The water supplying capacity ranges from 3 to 11 inches. Average annual precipitation is 10 to 18 inches, average annual temperature generally ranges from 45° to 59° F but is 42° to 45° on the Paunsaugunt soil, and the frost-free period is 120 to 170 days.

The native vegetation is tall native bluegrass, galleta, live oak, big sagebrush, Mormon tea, Utah juniper, and pinyon pine.

WILDLIFE SUITABILITY GROUP 4343

The soils in this group are shallow to deep and are well drained and somewhat excessively drained. They are on desert mountains, foothills, mesas, and alluvial fans. Slopes range from 0 to 40 percent, but they are dominantly 0 to 10 percent. The surface layer ranges from fine sand to clay loam and to very stony loam or very cobbly loam.

Available water capacity ranges from 1 inch to 12 inches. The water supplying capacity is 2 to 8 inches. Average annual precipitation is 6 to 13 inches, average annual temperature is 52° to 67° F, and the frost-free period is 160 to 195 days.

The native vegetation is mostly creosotebush, blackbrush, Mormon tea, galleta, Indian ricegrass, filaree, and yellowbrush.

WILDLIFE SUITABILITY GROUP 4424

The soils in this group are deep and are moderately well drained to poorly drained. They are on flood plains and in low valleys. Slopes range from 0 to 5 percent. The surface layer is mostly silty clay loam, silt loam, or fine sand. Most areas of these soils are not irrigated, but they are adjacent to water areas and have a fluctuating water table at a depth of 12 to 24 inches.

Average annual precipitation is 8 to 11 inches, average annual temperature is 57° to 67° F, and the frost-free period is 190 to 200 days.

The native vegetation is mostly cottonwood, box elder, willows, sedges, wiregrass, saltgrass, alkali bluegrass, and forbs.

WILDLIFE SUITABILITY GROUP 4444

In this group are land types that are very shallow and are very steep or actively eroding.

The native vegetation is a sparse stand of desert shrubs and grasses at lower elevations and scattered pinyon pine and shrubs at some higher elevations.

Food and cover

The kind of habitat needed by wildlife depends on the species. Some kinds of wildlife live in woodland, others in open farmland. Ducks and some others require water. Food requirements differ among different kinds of wildlife.

Table 4 indicates wildlife species that live in the Washington County Area and their preferred habitats.

TABLE 4.—*Species of wildlife and kind of habitat*

[An asterisk in the first column indicates that these species are endangered. Symbol xx means a major habitat; symbol x means a minor habitat.]

Wildlife species	Kind of habitat			
	Openland	Woodland	Wetland	Rangeland
* Abert's squirrel		xx		
Band-tailed pigeon				xx
Bear		xx		
Beaver			xx	
* Black-footed ferret				xx
Blacktailed jackrabbit	x			xx
Blue grouse		xx		
Bobcat			x	xx
California quail	xx			x
Chukar				xx
Cottontail	xx			x
Cougar		xx		xx
Coyote	x		x	xx
Desert bighorn sheep				xx
* Desert tortoise				xx
Ducks			xx	
Gambel's quail				xx
Geese	x		xx	
* Gila monster				xx
Golden eagle				xx
Kit fox		xx		xx
Mourning dove	xx	x		x
Mule deer	x	x		xx
Muskrat			xx	
Ring-necked pheasant	xx		x	x
Shore birds			xx	
Skunk	xx	x	x	x
Songbirds	x	xx	x	x
* Utah prairie dog				xx
Weasel	x	xx	xx	x
* Western burrowing owl				xx
Wild turkey		xx		x

Woodland

Some soils in the Washington County Area have potential for growing trees. These soils are mainly in Zion National Park, where trees were harvested from the time of settlement of the survey area until the Park was established. This section briefly discusses the system of woodland suitability grouping and then describes the woodland suitability groups into which the soils have been placed.

The woodland suitability grouping consists of three categories: woodland suitability class, used to express site quality; woodland suitability subclass, used to express restrictions or limitations for woodland use; and woodland suitability groups, used to summarize practicable soil-woodland interpretations.

Woodland suitability classes are a convenient relative measure of the soils' wood-producing ability. Under this system the highest producing soils are designated as class 1, and progressively lower sites range to class 7. The soils within this survey area are in classes 5 and 6. Class 5 equals a site index of 57 to 70, and class 6, a site index of 43 to 56.

Woodland suitability subclasses are shown by a lower-case letter, which indicates the dominant soil limitation. Some soils have more than one limitation. Priority in placing soils in subclasses is as follows: Subclass *d* indicates restricted root depth because of shallowness. Subclass *s*

indicates sandy soils that have low available moisture capacity. Subclass *f* means fragmental or skeletal soils that have a large amount of gravel or cobbles in the profile. Subclass *r* indicates relief, or soils that are restricted by steepness. Subclass *o* means slight or no limitations, except those imposed by climate and other local factors.

Woodland suitability groups are designated by an Arabic number. They group classes and subclasses into suitability groupings as needed for local management and interpretation.

Site index is used to show the potential productivity of woodland soils. Site index in the survey area is a numerical expression of total height of trees in feet attained at 100 years of age. This factor is obtained by comparing the age and height of representative trees. Ponderosa pine is the only species for which site index is listed in this section.

WOODLAND SUITABILITY GROUP 501

The soils in this group are deep and are well drained. Slopes are 2 to 5 percent. The surface layer is fine sandy loam about 25 inches thick, and the underlying material is clay.

Permeability is moderately slow. The water supplying capacity is 11 to 14 inches. Available water capacity is 7 to 11 inches. Average annual precipitation is 16 to 18 inches.

The site index is 56 to 60. The average annual growth potential for ponderosa pine is 85 board feet per acre.

The hazard of erosion, equipment limitations, plant competition, and windthrow hazard are slight. Seedling mortality is moderate.

WOODLAND SUITABILITY GROUP 6d1

The soils in this group are shallow and are well drained. Slopes are 2 to 30 percent. The surface layer is gravelly silt loam or cobbly silt loam that is underlain by very gravelly loam or very cobbly silty clay. Limestone bedrock is at a depth of 10 to 20 inches.

Permeability is slow to moderately rapid. The water supplying capacity is 3 to 6 inches. Available water capacity is 1 inch to 6 inches. Average annual precipitation is 16 to 18 inches.

The site index is 50. The average annual growth potential for ponderosa pine is 64 board feet per acre.

The equipment restrictions, plant competition, and windthrow hazard are slight, and the hazard of erosion and the seedling mortality are moderate.

Recreation

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 5 the soils of the Washington County Area are rated according to limitations that affect their use for camp areas, picnic areas, playgrounds, and paths and trails.

In table 5 the soils are rated according to three degrees

of limitations—none to slight, moderate, and severe—for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *none to slight* means that soil properties are generally favorable and limitations are so minor that they can be easily overcome. A *moderate* limitation can be overcome or modified by planning, design, or special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these is required.

Camp areas are used intensively for tents, small camp trailers and motor homes, and the accompanying activities of outdoor living. Little preparation of the site is required other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have gentle slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rain but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts used mainly for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have slopes or stoniness that greatly increases cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball,

TABLE 5.—Ratings and limitations of the soils for recreation

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
BA	Badland -----	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 6 percent.	Severe: slopes of more than 25 percent.
BB	Badland, very steep ----	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 6 percent.	Severe: slopes of more than 25 percent.
BED	Bermesa fine sandy loam, 1 to 10 percent slopes.	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 10 percent.	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 10 percent.	Moderate if slopes are 1 to 6 percent. Severe if slopes are 6 to 10 percent.	None to slight.
BF	Bermesa-Rock land association: Bermesa loamy fine sand, 1 to 10 percent slopes. Rock land part too variable to be rated.	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 10 percent.	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 10 percent.	Moderate if slopes are 1 to 6 percent. Severe if slopes are 6 to 10 percent.	None to slight.
BOD	Bond sandy loam, 1 to 10 percent slopes.	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 10 percent.	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 10 percent.	Severe: bedrock at a depth of less than 20 inches.	None to slight.
CaD	Caval fine sandy loam, 2 to 10 percent slopes.	Slight if slopes are 2 to 8 percent. Moderate if slopes are 8 to 10 percent.	Slight if slopes are 2 to 8 percent. Moderate if slopes are 8 to 10 percent.	Moderate if slopes are 2 to 6 percent. Severe if slopes are 6 to 10 percent.	None to slight.
CEF	Cave gravelly sandy loam, 7 to 30 percent slopes.	Moderate if slopes are 7 to 15 percent or surface area is 20 to 35 percent gravel. Severe if slopes are 15 to 30 percent.	Moderate if slopes are 7 to 15 percent or surface area is 20 to 35 percent gravel. Severe if slopes are 15 to 30 percent.	Severe: indurated hardpan at a depth of less than 20 inches.	Moderate if surface area is 20 to 35 percent gravel. Severe if slopes are 25 to 30 percent.
CFD	Cave gravelly sandy loam, low rainfall, 2 to 7 percent slopes.	Moderate: surface area is 20 to 35 percent gravel.	Moderate: surface area is 20 to 35 percent gravel.	Severe: indurated hardpan at a depth of less than 20 inches.	Moderate: surface area is 20 to 35 percent gravel.

TABLE 5.—*Ratings and limitations of the soils for recreation—Continued*

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
CHF	Chilton gravelly loam, 5 to 30 percent slopes.	Moderate if surface area is 20 to 30 percent gravel and cobbles or slopes are 5 to 15 percent. Severe if slopes are 15 to 30 percent.	Moderate if surface area is 20 to 30 percent gravel and cobbles or slopes are 5 to 15 percent. Severe if slopes are 15 to 30 percent.	Severe: surface area is more than 20 percent gravel.	Moderate if surface area is 20 to 30 percent gravel or slopes are 5 to 25 percent. Severe if slopes are 25 to 30 percent.
CI	Cinder land -----	Severe: slopes of more than 15 percent; more than 50 percent gravel and cobbles.	Severe: slopes of more than 15 percent; more than 50 percent gravel and cobbles.	Severe: slopes of more than 6 percent; more than 20 percent gravel and cobbles; bedrock at a depth of less than 20 inches.	Severe: slopes of more than 25 percent; surface area more than 50 percent gravel and cobbles.
CoC	Clovis fine sandy loam, 1 to 5 percent slopes.	None to slight -----	None to slight -----	Slight if slopes are 1 to 2 percent. Moderate if slopes are 2 to 5 percent.	None to slight.
CPD	Clovis-Pastura complex, 1 to 10 percent slopes: Clovis fine sandy loam, 1 to 5 percent slopes. Pastura gravelly loam, 2 to 10 percent slopes.	None to slight ----- Moderate: surface area is 20 to 35 percent gravel.	None to slight ----- Moderate: surface area is 20 to 35 percent gravel.	Slight if slopes are 1 to 2 percent. Moderate if slopes are 2 to 5 percent. Severe: bedrock at a depth of less than 20 inches.	None to slight. Moderate: surface area is 20 to 35 percent gravel.
CRF	Collbran very cobbly clay loam, 2 to 30 percent slopes.	Severe: surface area is more than 50 percent cobbles.	Severe: surface area is more than 50 percent cobbles.	Severe: surface area is more than 50 percent cobbles.	Severe: surface area is more than 50 percent cobbles.
CSE	Curhollow gravelly fine sandy loam, 2 to 10 percent slopes.	Moderate: surface area is 25 to 50 percent gravel; slopes of 2 to 10 percent.	Moderate: surface area is 25 to 50 percent gravel; slopes of 2 to 10 percent.	Severe: surface area is 25 to 50 percent gravel; slopes of 2 to 10 percent; bedrock at a depth of less than 20 inches.	Moderate: surface area is 25 to 50 percent gravel.
CUF	Curhollow-Rock outcrop complex, 10 to 30 percent slopes: Curhollow gravelly fine sandy loam, 10 to 30 percent slopes. Rock outcrop part is too variable to be rated.	Moderate if surface area is 25 to 50 percent gravel or slopes are 10 to 15 percent. Severe if slopes are 15 to 30 percent.	Moderate if surface area is 25 to 50 percent gravel or slopes are 10 to 15 percent. Severe if slopes are 15 to 30 percent.	Severe: surface area is 25 to 50 percent gravel; bedrock at a depth of less than 20 inches; slopes of 10 to 30 percent.	Moderate: surface area is 25 to 50 percent gravel; slopes of 10 to 30 percent.
DAG	Dagflat-Motoqua complex, 30 to 70 percent slopes: Dagflat very cobbly sandy loam, 30 to 60 percent slopes. Motoqua very gravelly sandy loam, 30 to 70 percent slopes.	Severe: slopes of 30 to 60 percent; surface area is more than 50 percent cobbles. Severe: slopes of 30 to 70 percent; surface area is more than 40 percent gravel and cobbles.	Severe: slopes of 30 to 60 percent; surface area is more than 50 percent cobbles. Severe: slopes of 30 to 70 percent; surface area is more than 40 percent gravel and cobbles.	Severe: slopes of 30 to 60 percent; surface area is more than 50 percent cobbles. Severe: slopes of 30 to 70 percent; surface area is more than 40 percent gravel and cobbles; bedrock at a depth of less than 20 inches.	Severe: slopes of 30 to 60 percent; surface area is more than 50 percent cobbles. Severe: slopes of 30 to 70 percent; surface area is more than 40 percent gravel and cobbles; bedrock at a depth of less than 20 inches.
DBD	Dalcan cobbly loam, 0 to 15 percent slopes.	Moderate: surface area is 40 to 50 percent cobbles, gravel, and stones.	Moderate: surface area is 40 to 50 percent cobbles, gravel, and stones; slopes of 0 to 15 percent.	Severe: surface area is more than 20 percent cobbles, gravel, and stones; slopes of 0 to 15 percent.	Moderate: surface area is 40 to 50 percent cobbles, gravel, and stones.
DKG	Detra-Kolob complex, 20 to 50 percent slopes: Detra fine sandy loam, 20 to 30 percent slopes. Kolob very stony silt loam, 20 to 50 percent slopes.	Severe: slopes of 20 to 30 percent. Severe: slopes of 20 to 50 percent; surface area is 30 percent stones.	Severe: slopes of 20 to 30 percent. Severe: slopes of 20 to 30 percent; surface area is 30 percent stones.	Severe: slopes of 20 to 30 percent. Severe: slopes of 20 to 50 percent; surface area is 30 percent stones.	Moderate if slopes are 20 to 25 percent. Severe if slopes are 25 to 30 percent. Severe: surface area is 30 percent stones.

TABLE 5.—*Ratings and limitations of the soils for recreation—Continued*

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
DrB	Draper loam, 2 to 5 percent slopes.	Moderate: somewhat poorly drained.			
DU	Dune land -----	Severe: loose sand -----	Severe: loose sand -----	Severe: sand texture ---	Severe: sand texture.
EA	Eroded land-Shalet complex: Eroded land part too variable to be rated. Shalet clay loam, 2 to 20 percent slopes.	Moderate if slopes are 2 to 15 percent: slow permeability; clay loam surface layer. Severe if slopes are 15 to 20 percent.	Moderate if slopes are 2 to 15 percent: clay loam surface layer. Severe if slopes are 15 to 20 percent.	Severe: shale at a depth of less than 20 inches; slopes of 2 to 20 percent.	Moderate: clay loam surface layer.
EB	Eroded land-Shalet complex, warm: Eroded land part too variable to be rated. Shalet clay loam, warm, 2 to 20 percent slopes.	Moderate if slopes are 2 to 15 percent: slow permeability; clay loam surface layer. Severe if slopes are 15 to 20 percent.	Moderate if slopes of 2 to 15 percent: clay loam surface layer. Severe if slopes are 15 to 20 percent.	Severe: shale at a depth of less than 20 inches; slopes of 2 to 20 percent.	Moderate: clay loam surface layer.
FA	Fluvaquents and Torri-fluents, sandy.	Severe: poorly drained; floods during season of use.	Severe: poorly drained; floods during season of use.	Severe: poorly drained; floods during season of use.	Severe: poorly drained; floods during season of use.
GA	Gullied land -----	Moderate to severe: on-site investigation needed because highly variable in slope and texture.	Moderate to severe: on-site investigation needed because highly variable in slope and texture.	Moderate to severe: on-site investigation needed because highly variable in slope and texture.	Moderate to severe: on-site investigation needed because highly variable in slope and texture.
Ha	Hantz silty clay loam ---	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer; slow permeability.	Moderate: silty clay loam surface layer.
HbC	Harrisburg fine sandy loam, 1 to 5 percent slopes.	None to slight -----	None to slight -----	Moderate: indurated hardpan at a depth of 20 to 40 inches.	None to slight.
HD	Harrisburg-Rock land association: Harrisburg fine sandy loam, 5 to 20 percent slopes. Rock land part too variable to be rated.	Slight if slopes are 5 to 8 percent. Moderate if slopes are 8 to 15 percent. Severe if slopes are more than 15 percent.	Slight if slopes are 5 to 8 percent. Moderate if slopes are 8 to 15 percent. Severe if slopes are more than 15 percent.	Severe: slopes of 5 to 20 percent.	Slight if slopes are 5 to 15 percent. Moderate if slopes are 15 to 20 percent.
HG	Hobog-Rock land association: Hobog very cobbly loam, 3 to 40 percent slopes. Rock land part too variable to be rated.	Moderate if slopes are 3 to 15 percent: surface area is 35 to 50 percent cobbles and gravel. Severe if slopes are 15 to 40 percent.	Moderate if slopes are 3 to 15 percent: surface area is 35 to 50 percent cobbles and gravel. Severe if slopes are 15 to 40 percent.	Severe: bedrock at a depth of less than 20 inches; surface area is more than 20 percent cobbles and gravel; slopes of 3 to 40 percent.	Moderate if slopes are 3 to 25 percent: surface area is 35 to 50 percent cobbles and gravel. Severe if slopes are more than 20 percent.
IAF	Isom cobbly sandy loam, 3 to 30 percent slopes.	Moderate if slopes are 3 to 15 percent: surface area is 35 to 50 percent cobbles and gravel. Severe if slopes are 15 to 30 percent.	Moderate if slopes are 3 to 15 percent: surface area is 35 to 50 percent cobbles and gravel. Severe if slopes are 15 to 30 percent.	Severe: surface area is more than 20 percent cobbles and gravel; slopes of 3 to 30 percent.	Moderate if slopes are 3 to 25 percent: surface area is 35 to 50 percent cobbles and gravel. Severe if slopes are more than 25 percent.
Ib	Ivins loamy fine sand ---	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer; slopes of 1 to 5 percent.	Moderate: loamy fine sand surface layer.
Ic	Ivins loamy fine sand, hummocky.	Severe: loose sand; subject to blowing.			

TABLE 5.—Ratings and limitations of the soils for recreation—Continued

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
JaB	Junction fine sandy loam, 1 to 2 percent slopes.	None to slight -----	None to slight -----	None to slight -----	None to slight.
JaC	Junction fine sandy loam, 2 to 5 percent slopes.	None to slight -----	None to slight -----	None to slight -----	None to slight.
KAE	Kinesava fine sandy loam, 15 to 25 percent slopes.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.
KBD	Kinesava-Detra fine sandy loams, 2 to 15 percent slopes: Kinesava fine sandy loam, 2 to 15 percent slopes.	Moderate: slopes of 2 to 15 percent; moderately slow permeability.	Slight if slopes are 2 to 8 percent. Moderate if slopes are 8 to 15 percent.	Moderate if slopes are 2 to 6 percent: moderately slow permeability. Severe if slopes are 6 to 15 percent.	None to slight.
	Detra fine sandy loam, 2 to 5 percent slopes.	None to slight -----	None to slight -----	Moderate: slopes of 2 to 5 percent.	None to slight.
KCE	Kinesava complex, 2 to 30 percent slopes: Kolob silt loam, brown variant, 10 to 30 percent slopes.	Moderate if slopes are 10 to 15 percent: moderately slow permeability. Severe if slopes are more than 15 percent.	Moderate if slopes are 10 to 15 percent. Severe if slopes are more than 15 percent.	Severe: slopes of 10 to 30 percent.	Slight if slopes are 10 to 15 percent. Moderate if slopes are 15 to 25 percent. Severe if slopes are more than 25 percent.
	Kinesava fine sandy loam, 2 to 15 percent slopes.	Moderate: moderately slow permeability; slopes of 2 to 15 percent.	Slight if slopes are 2 to 8 percent. Moderate if slopes are 8 to 15 percent.	Moderate if slopes are 2 to 6 percent: moderately slow permeability. Severe if slopes are 6 to 15 percent.	None to slight.
KD	Kolob-Detra association: Kolob fine sandy loam, 20 to 50 percent slopes.	Severe: slopes of 20 to 50 percent.	Severe: slopes of 20 to 50 percent.	Severe: slopes of 20 to 50 percent.	Moderate if slopes are 20 to 25 percent. Severe if slopes are 25 to 50 percent.
	Detra fine sandy loam, 5 to 20 percent slopes.	Slight if slopes are 5 to 8 percent. Moderate if slopes are 8 to 15 percent. Severe if slopes are 15 to 20 percent.	Slight if slopes are 5 to 8 percent. Moderate if slopes are 8 to 15 percent. Severe if slopes are 15 to 20 percent.	Severe: slopes of 5 to 20 percent.	Slight if slopes are 5 to 15 percent. Moderate if slopes are 15 to 20 percent.
KHC	Kolob-Hogg complex, 2 to 8 percent slopes: Kolob cobbly fine sandy loam, 2 to 8 percent slopes. Hogg fine sandy loam, 2 to 5 percent slopes.	Moderate: surface area is 20 to 35 percent cobbles. None to slight -----	Moderate: surface area is 20 to 35 percent cobbles. None to slight -----	Severe: surface area is more than 20 percent cobbles. Moderate: slopes of 2 to 5 percent.	Moderate: surface area is 20 to 35 percent cobbles. None to slight.
KLG	Kolob-Paunsaugunt complex, 20 to 60 percent slopes: Kolob cobbly fine sandy loam, 20 to 60 percent slopes.	Severe: slopes of 20 to 60 percent.	Severe: slopes of 20 to 60 percent.	Severe: slopes of 20 to 60 percent.	Moderate if slopes are 20 to 25 percent. Severe if slopes are 25 to 60 percent.
	Paunsaugunt gravelly silt loam, 30 to 50 percent slopes.	Severe: slopes of 30 to 50 percent.	Severe: slopes of 30 to 50 percent.	Severe: slopes of 30 to 50 percent; bedrock at a depth of less than 20 inches.	Severe: slopes of 30 to 50 percent.
LA	Lava flows: properties too variable to be rated.				
Lb	Lavate sandy loam -----	None to slight -----	None to slight -----	Moderate: slopes of 2 to 4 percent.	None to slight.
LcB	LaVerkin fine sandy loam, 1 to 2 percent slopes.	None to slight -----	None to slight -----	None to slight -----	None to slight.

TABLE 5.—*Ratings and limitations of the soils for recreation*—Continued

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
LcC	LaVerkin fine sandy loam, 2 to 5 percent slopes.	None to slight -----	None to slight -----	Moderate: slopes of 2 to 5 percent.	None to slight.
LdB	LaVerkin silty clay loam, 1 to 2 percent slopes.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.
LeA	Leeds silty clay loam, 0 to 1 percent slopes.	Moderate: silty clay loam surface layer; slow permeability.	Moderate: silty clay loam surface layer; slow permeability.	Moderate: silty clay loam surface layer; slow permeability.	Moderate: silty clay loam surface layer; slow permeability.
LeB	Leeds silty clay loam, 1 to 2 percent slopes.	Moderate: silty clay loam surface layer; slow permeability.	Moderate: silty clay loam surface layer; slow permeability.	Moderate: silty clay loam surface layer; slow permeability.	Moderate: silty clay loam surface layer; slow permeability.
LeD	Leeds silty clay loam, 5 to 10 percent slopes.	Moderate: silty clay loam surface layer; slow permeability.	Moderate: silty clay loam surface layer; slow permeability.	Severe: silty clay loam surface layer; slow permeability; slopes of 5 to 10 percent.	Moderate: silty clay loam surface layer; slow permeability.
MAE	Magotsu-Pastura complex, 2 to 20 percent slopes: Magotsu very cobbly loam, 2 to 20 percent slopes. Pastura gravelly loam, 2 to 10 percent slopes.	Severe: surface area is 50 to 60 percent cobbles and gravel. Moderate: surface area is 20 to 35 percent gravel; slopes of 2 to 10 percent.	Severe: surface area is 50 to 60 percent cobbles and gravel. Moderate: surface area is 20 to 35 percent gravel; slopes of 2 to 10 percent.	Severe: surface area is 50 to 60 percent cobbles and gravel; slopes of 2 to 20 percent. Severe: surface area is 20 to 35 percent gravel; slopes of 2 to 10 percent; bedrock at a depth of less than 20 inches.	Severe: surface area is 50 to 60 percent cobbles and gravel. Moderate: surface area is 20 to 35 percent gravel.
MBG	Mathis-Rock outcrop complex, 20 to 50 percent slopes: Mathis very stony loamy fine sand, 20 to 50 percent slopes. Rock outcrop part too variable to be rated.	Severe: slopes of 20 to 50 percent; very stony surface layer.	Severe: slopes of 20 to 50 percent; very stony surface layer.	Severe: slopes of 20 to 50 percent; very stony surface layer.	Severe: slopes of 20 to 50 percent; very stony surface layer.
MEG	Menefee-Rock outcrop complex, 25 to 60 percent slopes: Menefee shaly loam, 25 to 60 percent slopes. Rock outcrop part too variable to be rated.	Severe: slopes of 25 to 60 percent.	Severe: slopes of 25 to 60 percent.	Severe: slopes of 25 to 60 percent; surface area is more than 20 percent gravel.	Severe: slopes of 25 to 60 percent.
MFD	Mespuen fine sand, 0 to 10 percent slopes.	Severe: fine sand surface layer; subject to blowing where disturbed.	Severe: fine sand surface layer; subject to blowing where disturbed.	Severe: fine sand surface layer; subject to blowing where disturbed.	Severe: fine sand surface layer; subject to blowing where disturbed.
MMG	Motoqua-Mokiak very cobbly sandy loams, 30 to 70 percent slopes: Motoqua very cobbly sandy loam, 30 to 70 percent slopes. Mokiak very cobbly sandy loam, 30 to 70 percent slopes.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent gravel. Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent gravel.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent gravel. Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent gravel.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent cobbles and gravel; bedrock at a depth of less than 20 inches. Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent gravel.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent cobbles and gravel. Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent gravel.
MOG	Motoqua-Rock outcrop complex, 30 to 70 percent slopes: Motoqua very cobbly sandy loam, 30 to 70 percent slopes. Rock outcrop part too variable to be rated.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent gravel.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent gravel.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent gravel; bedrock at a depth of less than 20 inches.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent cobbles and gravel.

TABLE 5.—Ratings and limitations of the soils for recreation—Continued

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
NaC	Naplene silt loam, 2 to 6 percent slopes.	Moderate: moderately slow permeability.	None to slight -----	Moderate: slopes of 2 to 6 percent.	None to slight.
NEF	Nehar very stony sandy loam, 3 to 30 percent slopes.	Severe: surface area is more than 50 percent gravel, cobbles, and stones; slopes of 3 to 30 percent.	Severe: surface area is more than 50 percent gravel, cobbles, and stones; slopes of 3 to 30 percent.	Severe: surface area is more than 50 percent gravel, cobbles, and stones; slopes of 3 to 30 percent.	Severe: surface area is more than 50 percent gravel, cobbles, and stones; slopes of 3 to 30 percent.
NIF	Nehar-Ildefonso complex, 3 to 30 percent slopes: Nehar very stony sandy loam, 3 to 30 percent slopes.	Severe: surface area is more than 50 percent gravel, cobbles, and stones; slopes of 3 to 30 percent.	Severe: surface area is more than 50 percent gravel, cobbles, and stones; slopes of 3 to 30 percent.	Severe: surface area is more than 50 percent gravel, cobbles, and stones; slopes of 3 to 30 percent.	Severe: surface area is more than 50 percent gravel, cobbles, and stones; slopes of 3 to 30 percent.
	Ildefonso very gravelly sandy loam, 5 to 30 percent slopes.	Severe: surface area is 35 to 60 percent gravel; slopes of 5 to 30 percent.	Severe: surface area is 35 to 60 percent gravel; slopes of 5 to 30 percent.	Severe: surface area is 35 to 60 percent gravel; slopes of 5 to 30 percent.	Severe: surface area is 35 to 60 percent gravel; slopes of 5 to 30 percent.
NkC	Nikey sandy loam, 1 to 3 percent slopes.	None to slight -----	None to slight -----	Slight if slopes are 1 to 2 percent. Moderate if slopes are 2 to 3 percent.	None to slight.
NLE	Nikey sandy loam, 3 to 15 percent slopes.	Slight if slopes are 3 to 8 percent. Moderate if slopes are 8 to 15 percent.	Slight if slopes are 3 to 8 percent. Moderate if slopes are 8 to 15 percent.	Moderate if slopes are 3 to 6 percent. Severe if slopes are 6 to 15 percent.	None to slight.
NME	Nikey very stony sandy loam, 2 to 15 percent slopes.	Moderate: surface area is 10 to 25 percent stones; slopes of 2 to 15 percent.	Moderate: surface area is 10 to 25 percent stones; slopes of 2 to 15 percent.	Moderate if slopes are 2 to 6 percent: surface area is 10 to 25 percent stones. Severe if slopes are 6 to 15 percent.	Moderate: surface area is 10 to 25 percent stones.
NNE	Nikey-Isom complex, 3 to 30 percent slopes: Nikey sandy loam, 3 to 15 percent slopes.	Slight if slopes are 3 to 8 percent. Moderate if slopes are 8 to 15 percent.	Slight if slopes are 3 to 8 percent. Moderate if slopes are 8 to 15 percent.	Moderate if slopes are 3 to 6 percent. Severe if slopes are 6 to 15 percent.	None to slight.
	Isom very cobbly fine sandy loam, 3 to 30 percent slopes.	Moderate if slopes are 3 to 15 percent: surface area is 35 to 50 percent cobbles and gravel. Severe if slopes are 15 to 30 percent.	Moderate if slopes are 3 to 15 percent: surface area is 35 to 50 percent cobbles and gravel. Severe if slopes are 15 to 30 percent.	Severe: surface area is more than 20 percent cobbles and gravel; slopes of 3 to 30 percent.	Moderate if slopes are 3 to 35 percent: surface area is 35 to 50 percent cobbles and gravel. Severe if slopes are more than 25 percent.
PAC	Palma loamy fine sand, 1 to 5 percent slopes.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer; slopes of 1 to 5 percent.	Moderate: loamy fine sand surface layer.
PbC	Palma fine sandy loam, 1 to 5 percent slopes.	None to slight -----	None to slight -----	Slight if slopes are 1 to 2 percent. Moderate if slopes are 2 to 5 percent.	None to slight.
PcC	Pastura loam, 2 to 5 percent slopes.	None to slight -----	None to slight -----	Severe: bedrock at a depth of less than 20 inches.	None to slight.
PED	Pastura-Esplin complex, 0 to 10 percent slopes: Pastura gravelly loam, 2 to 10 percent slopes.	Moderate: surface area is 20 to 35 percent gravel; slopes of 1 to 10 percent.	Moderate: surface area is 20 to 35 percent gravel; slopes of 1 to 10 percent.	Severe: surface area is 20 to 35 percent gravel; slopes of 1 to 10 percent; bedrock at a depth of less than 20 inches.	Moderate: surface area is 20 to 35 percent gravel.
	Esplin loam, 0 to 2 percent slopes.	None to slight -----	None to slight -----	Severe: bedrock at a depth of less than 20 inches.	None to slight.
PFG	Paunsaugunt gravelly silt loam, 30 to 50 percent slopes.	Severe: slopes of 30 to 50 percent.	Severe: slopes of 30 to 50 percent.	Severe: slopes of 30 to 50 percent; bedrock at a depth of less than 20 inches.	Severe: slopes of 30 to 50 percent.

TABLE 5.—*Ratings and limitations of the soils for recreation—Continued*

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
PG	Paunsaugunt-Kolob association: Paunsaugunt gravelly silt loam, 10 to 30 percent slopes.	Moderate if slopes are 10 to 15 percent; surface area is 20 to 35 percent gravel. Severe if slopes are 15 to 30 percent.	Moderate if slopes are 10 to 15 percent; surface area is 20 to 35 percent gravel. Severe if slopes are 15 to 30 percent.	Severe: slopes of 10 to 30 percent; bedrock at a depth of less than 20 inches.	Moderate if slopes are 10 to 25 percent; surface area is 20 to 35 percent gravel. Severe if slopes are 25 to 30 percent.
	Kolob cobbly fine sandy loam, 8 to 12 percent slopes.	Moderate: surface area is 20 to 35 percent cobbles; slopes of 8 to 12 percent.	Moderate: surface area is 20 to 35 percent cobbles; slopes of 8 to 12 percent.	Severe: slopes are 8 to 12 percent.	Moderate: surface area is 20 to 35 percent cobbles.
PKE	Paunsaugunt-Rock outcrop complex, 2 to 30 percent slopes: Paunsaugunt cobbly silt loam, clayey subsoil variant, 2 to 8 percent slopes.	Moderate: surface area is 30 to 50 percent cobbles and gravel; moderately slow permeability.	Moderate: surface area is 30 to 50 percent cobbles and gravel.	Severe: surface area is 30 to 50 percent cobbles and gravel; bedrock at a depth of less than 20 inches.	Moderate: surface area is 30 to 50 percent cobbles and gravel.
	Paunsaugunt gravelly silt loam, 10 to 30 percent slopes.	Moderate if slopes are 10 to 15 percent; surface area is 20 to 35 percent gravel. Severe if slopes are 15 to 30 percent.	Moderate if slopes are 10 to 15 percent; surface area is 20 to 35 percent gravel. Severe if slopes are 15 to 30 percent.	Severe: slopes of 10 to 30 percent; bedrock at a depth of less than 20 inches.	Moderate if slopes are 10 to 25 percent; surface area is 20 to 35 percent gravel. Severe if slopes are 25 to 30 percent.
	Rock outcrop part too variable to be rated.				
PnC	Pintura loamy fine sand, 1 to 5 percent slopes.	Severe: subject to blowing where disturbed.	Severe: subject to blowing where disturbed.	Severe: subject to blowing where disturbed.	Severe: subject to blowing where disturbed.
PoD3	Pintura loamy fine sand, hummocky, 1 to 10 percent slopes.	Severe: subject to blowing where disturbed.	Severe: subject to blowing where disturbed.	Severe: subject to blowing where disturbed.	Severe: subject to blowing where disturbed.
PTE	Pintura-Toquerville complex, 1 to 20 percent slopes: Pintura loamy fine sand, hummocky, 1 to 10 percent slopes. Toquerville fine sand, 2 to 20 percent slopes.	Severe: subject to blowing where disturbed. Severe: subject to blowing where disturbed.	Severe: subject to blowing where disturbed. Severe: subject to blowing where disturbed.	Severe: subject to blowing where disturbed. Severe: subject to blowing where disturbed; bedrock at a depth of less than 20 inches.	Severe: subject to blowing where disturbed. Severe: subject to blowing where disturbed.
	Quazo-Motoqua very gravelly sandy loams, 30 to 70 percent slopes: Quazo very gravelly sandy loam, 30 to 70 percent slopes.	Severe: slopes of 30 to 70 percent; surface area is more than 50 percent gravel.	Severe: slopes of 30 to 70 percent; surface area is more than 50 percent gravel.	Severe: slopes of 30 to 70 percent; surface area is more than 50 percent gravel; bedrock at a depth of less than 20 inches.	Severe: slopes of 30 to 70 percent; surface area is more than 50 percent gravel.
OMG	Motoqua very gravelly sandy loam, 30 to 70 percent slopes.	Severe: slopes of 30 to 70 percent; surface area is more than 50 percent gravel.	Severe: slopes of 30 to 70 percent; surface area is more than 50 percent gravel.	Severe: slopes of 30 to 70 percent; surface area is more than 50 percent gravel; bedrock at a depth of less than 20 inches.	Severe: slopes of 30 to 70 percent; surface area is more than 50 percent gravel.
RaC	Redbank fine sandy loam, 1 to 5 percent slopes.	None to slight -----	None to slight -----	Slight if slopes are 1 to 2 percent. Moderate if slopes are 2 to 5 percent.	None to slight.
RbA	Redbank silty clay loam, 0 to 2 percent slopes.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.

TABLE 5.—Ratings and limitations of the soils for recreation—Continued

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
RE	Renbac-Rock land association: Renbac channery clay loam, 2 to 30 percent slopes. Rock land part too variable to be rated.	Moderate if slopes are 2 to 15 percent; clay loam texture; surface area is 40 to 50 percent gravel and cobbles; moderately slow permeability. Severe if slopes are 15 to 30 percent.	Moderate if slopes are 2 to 15 percent; clay loam texture; surface area is 40 to 50 percent gravel and cobbles. Severe if slopes are 15 to 30 percent.	Severe: bedrock at a depth of less than 20 inches; surface area is 40 to 50 percent gravel and cobbles; slopes of 2 to 30 percent.	Moderate: surface area is 40 to 50 percent gravel and cobbles.
RI	Riverwash: properties too variable to be rated.				
RO	Rock land: properties too variable to be rated.				
RP	Rock land, stony: properties too variable to be rated.				
RR	Rock land-Hobog association: Rock land part too variable to be rated. Hobog very cobbly loam, 3 to 40 percent slopes. Renbac channery clay loam, 2 to 30 percent slopes. For rating, see Renbac-Rock land association.	Severe: surface area is more than 50 percent cobbles and gravel; slopes of 3 to 40 percent.	Severe: surface area is more than 50 percent cobbles and gravel; slopes of 3 to 40 percent.	Severe: surface area is more than 50 percent cobbles and gravel; slopes of 3 to 40 percent; bedrock at a depth of less than 20 inches.	Severe: surface area is more than 50 percent cobbles and gravel; slopes of 3 to 40 percent.
RT	Rock outcrop: properties too variable to be rated.				
RU	Rough broken land: properties too variable to be rated.				
Sa	St. George silt loam -----	Moderate: moderately slow permeability.	None to slight -----	Moderate: moderately slow permeability; slopes of 1 to 5 percent.	None to slight.
Sb	St. George silt loam, strongly alkaline.	Moderate: moderately slow permeability.	None to slight -----	Moderate: moderately slow permeability; slopes of 2 to 5 percent.	None to slight.
Sc	St. George silty clay loam.	Moderate: silty clay loam surface layer; moderately slow permeability.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer; moderately slow permeability.	Moderate: silty clay loam surface layer.
Sd	St. George silty clay loam, moderately saline.	Moderate: silty clay loam surface layer; moderately slow permeability.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer; moderately slow permeability.	Moderate: silty clay loam surface layer.
Se	St. George silty clay loam, shallow water table.	Severe: water table above a depth of 20 inches.	Severe: water table above a depth of 20 inches.	Severe: water table above a depth of 20 inches.	Severe: water table above a depth of 20 inches.
SH	Schmutz loam -----	None to slight -----	None to slight -----	None to slight if slopes are 1 to 2 percent. Moderate if slopes are 2 to 5 percent.	None to slight.
SPD	Spenco very fine sandy loam, 2 to 10 percent slopes.	Slight if slopes are 2 to 8 percent. Moderate if slopes are 8 to 10 percent.	Slight if slopes are 2 to 8 percent. Moderate if slopes are 8 to 10 percent.	Moderate if slopes are 2 to 6 percent. Severe if slopes are 6 to 10 percent.	None to slight.
SrC	Springerville clay, 0 to 5 percent slopes.	Severe: clay surface layer; very slow permeability.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.

TABLE 5.—*Ratings and limitations of the soils for recreation—Continued*

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
SY	Stony colluvial land: properties too variable to be rated.				
TAG	Tacan very stony sandy loam, 30 to 70 percent slopes.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent cobbles and stones.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent cobbles and stones.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent cobbles and stones.	Severe: slopes of 30 to 70 percent; surface area is 40 to 70 percent cobbles and stones.
TBF	Tobish very cobbly clay loam, 5 to 30 percent slopes.	Severe: surface area is 50 to 75 percent cobbles and gravel; slopes of 5 to 30 percent.	Severe: surface area is 50 to 75 percent cobbles and gravel; slopes of 5 to 30 percent.	Severe: surface area is 50 to 75 percent cobbles and gravel; slopes of 5 to 30 percent.	Severe: surface area is 50 to 75 percent cobbles and gravel; slopes of 5 to 30 percent.
Tc	Tobler fine sandy loam --	None to slight -----	None to slight -----	None to slight if slopes are 1 to 2 percent. Moderate if slopes are 2 to 5 percent.	None to slight.
Td	Tobler silty clay loam ---	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.
TG	Tortugas-Rock land association: Tortugas very gravelly loam, 20 to 70 percent slopes. Rock land part too variable to be rated.	Severe: surface area is 50 to 60 percent gravel and cobbles; slopes of 20 to 70 percent.	Severe: surface area is 50 to 60 percent gravel and cobbles; slopes of 20 to 70 percent.	Severe: surface area is 50 to 60 percent gravel and cobbles; slopes of 20 to 70 percent; bedrock at a depth of less than 20 inches.	Severe: surface area is 50 to 60 percent gravel and cobbles; slopes of 20 to 70 percent.
VeA	Vekol sandy loam, 0 to 2 percent slopes.	Moderate: slow permeability.	None to slight -----	Moderate: slow permeability.	None to slight.
VFD	Vekol sandy loam, 2 to 10 percent slopes.	Moderate: slow permeability.	Slight if slopes are 2 to 8 percent. Moderate if slopes are 8 to 10 percent.	Moderate if slopes are 2 to 6 percent. Severe if slopes are 6 to 8 percent.	None to slight.
VHD	Veyo-Curhollow complex, 3 to 10 percent slopes: Veyo extremely stony sandy loam, 3 to 10 percent slopes. Curhollow very stony sandy loam, 5 to 10 percent slopes.	Severe: surface area is more than 25 percent stones; slopes of 3 to 10 percent. Moderate: surface area is 10 to 25 percent stones.	Moderate: surface area is 25 to 50 percent stones; slopes of 3 to 10 percent. Slight if slopes are 5 to 8 percent: surface area is 10 to 25 percent stones. Moderate if slopes are 8 to 10 percent.	Severe: bedrock at a depth of less than 20 inches; slopes of 3 to 10 percent. Severe: surface area is more than 20 percent cobbles and stones; slopes of 5 to 10 percent.	Severe: surface area is more than 25 percent stones. Moderate: surface area is 10 to 25 percent stones.
VPD	Veyo-Pastura complex, 1 to 10 percent slopes: Veyo cobbly sandy loam, 1 to 10 percent slopes. Pastura gravelly loam, 2 to 10 percent slopes.	Moderate: surface area is 20 to 35 percent cobbles and gravel; slopes of 1 to 10 percent. Moderate: surface area is 20 to 35 percent gravel; slopes of 2 to 10 percent.	Moderate: surface area is 20 to 35 percent cobbles and gravel; slopes of 1 to 10 percent. Moderate: surface area is 20 to 35 percent gravel; slopes of 2 to 10 percent.	Severe: bedrock at a depth of less than 20 inches; surface area is 20 to 35 percent cobbles and gravel; slopes of 1 to 10 percent. Severe: surface area is 20 to 35 percent gravel; bedrock at a depth of less than 20 inches; slopes of 2 to 10 percent.	Moderate: surface area is 20 to 35 percent cobbles and gravel. Moderate: surface area is 20 to 35 percent gravel.
WAG	Welring-Tortugas very gravelly loams, 20 to 70 percent slopes: Welring very gravelly loam, 30 to 70 percent slopes.	Severe: slopes of 30 to 70 percent; surface area is 40 to 80 percent gravel.	Severe: slopes of 30 to 70 percent; surface area is 40 to 80 percent gravel.	Severe: slopes of 30 to 70 percent; bedrock at a depth of less than 20 inches; surface area is 40 to 80 percent gravel.	Severe: slopes of 30 to 70 percent; surface area is 40 to 80 percent gravel.

TABLE 5.—*Ratings and limitations of the soils for recreation*—Continued

Map symbol	Mapping unit	Camp areas	Picnic areas	Playgrounds	Paths and trails
	Tortugas very gravelly loam, 20 to 70 percent slopes.	Severe: slopes of 20 to 70 percent; surface area is 50 to 60 percent gravel and cobbles.	Severe: slopes of 20 to 70 percent; surface area is 50 to 60 percent gravel and cobbles.	Severe: slopes of 20 to 70 percent; surface area is 50 to 60 percent gravel and cobbles; bedrock at a depth of less than 20 inches.	Severe: surface area is 50 to 60 percent gravel; slopes of 20 to 70 percent.
WBD	Rock outcrop part too variable to be rated. Winkel gravelly fine sandy loam, 1 to 8 percent slopes.	Moderate: surface area is 20 to 50 percent gravel.	Moderate: surface area is 20 to 50 percent gravel.	Severe: bedrock at a depth of less than 20 inches; surface area is more than 20 percent gravel; slopes of 1 to 8 percent.	Moderate: surface area is 20 to 50 percent gravel.
WCF	Winkel-Rock outcrop complex, 8 to 30 percent slopes: Winkel gravelly fine sandy loam, 8 to 30 percent slopes.	Moderate if slopes are 8 to 15 percent: surface area is 20 to 50 percent gravel and cobbles. Severe if slopes are 15 to 30 percent.	Moderate if slopes are 8 to 15 percent: surface area is 20 to 50 percent gravel and cobbles. Severe if slopes are 15 to 30 percent.	Severe: bedrock at a depth of less than 20 inches; slopes of 8 to 30 percent; surface area is more than 20 percent gravel and cobbles.	Moderate if slopes are 8 to 25 percent: surface area is 20 to 50 percent gravel and cobbles. Severe if slopes are 25 to 30 percent.
YAF	Rock outcrop part too variable to be rated. Yaki very cobbly loam, 3 to 35 percent slopes.	Severe: surface area is 50 to 60 percent cobbles and gravel.	Severe: surface area is 50 to 60 percent cobbles and gravel.	Severe: bedrock at a depth of less than 20 inches; slopes of 3 to 35 percent; surface area is 50 to 60 percent cobbles and gravel.	Severe: surface area is 50 to 60 percent cobbles and gravel; slopes of 3 to 35 percent.
YZE	Yaki-Zukan complex, 1 to 35 percent slopes: Yaki very cobbly loam, 3 to 35 percent slopes.	Severe: surface area is 50 to 60 percent cobbles and gravel.	Severe: surface area is 50 to 60 percent cobbles and gravel.	Severe: bedrock at a depth of less than 20 inches; slopes of 3 to 35 percent; surface area is 50 to 60 percent cobbles and gravel.	Severe: surface area is 50 to 60 percent cobbles and gravel; slopes of 3 to 35 percent.
	Zukan fine sandy loam, 1 to 10 percent slopes.	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 10 percent.	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 10 percent.	Severe: bedrock at a depth of less than 20 inches; slopes of 1 to 10 percent.	None to slight.

football, badminton, and similar organized games. Soils suitable for this use need to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rain but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross-country travel by foot or on horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Engineering Uses of the Soils ⁵

This section is useful to those who need information

⁵ GORDON HANSEN, engineer, Soil Conservation Service, helped prepare this section.

about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

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

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways,

3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 6, 7, and 8, which show, respectively, several estimated soil properties significant in engineering; interpretations for various engineering uses; and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those in tables 6 and 7, and it also can be used to make other useful maps.

TABLE 6.—Estimated soil properties

[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 mapping that appear in the first column of this table. The symbol > means more than; the symbol < means less than. All estimates of particle size distribution classification boundaries (1 or 2 percentage points), the

Soil series and map symbols	Depth to bedrock or hardpan	Depth from surface	Dominant USDA texture	Classification		Coarse fraction greater than 3 inches
				Unified	AASHTO	
Badland: BA, BB. Properties too variable to be estimated.	<i>Ft</i>	<i>In</i>				
*Bermesa: BED, BF For Rock land part of BF. see Rock land.	2-3	0-14 14-26 26	Fine sandy loam Very gravelly sandy clay loam Indurated hardpan over basalt.	SM SC, GC, SM-SC or GM-GC	A-2 or A-4 A-4 or A-2	0 15-30
Bond: BoD	1-2	0-16 16	Sandy loam and gravelly sandy clay loam. Sandstone bedrock.	SM-SC or SC	A-2 or A-4	0
Caval: CaD	>5	0-51 51-60	Fine sandy loam Sandy clay loam	SM SM or SM-SC	A-4 or A-2 A-4 or A-2	0 0
Cave: CEF, CFD	1-2	0-12 12	Gravelly sandy loam or gravelly light loam. Indurated hardpan.	SM or SM-SC	A-4 or A-2	0-5
Chilton: CHF	>5	0-70	Gravelly loam and very gravelly loam.	GM-GC	A-2 or A-1	0-5
Cinder land: Ci. Properties too variable to be estimated.						
*Clovis: CoC, CPD For Pastura part of CPD. see Pastura series.	>5	0-60	Fine sandy loam, sandy clay loam, and clay loam.	CL-ML or CL	A-4 or A-6	0
Collbran: CRF	4-5	0-60 60	Clay loam and clay ² Basalt bedrock.	CL	A-7 or A-6	(²)
*Curhollow: CSE, CUF For Rock outcrop part of CUF. see Rock outcrop.	1-2	0-15 15	Gravelly fine sandy loam and very gravelly loam. Cemented hardpan.	GM	A-2 or A-1	0-15
*Dagflat: DAG For Motoqua part, see Motoqua series.	2-3	0-30 30	Coarse sandy loam and coarse sandy clay loam. Igneous bedrock.	SC or SM-SC	A-6 or A-4	² 0-10
Dalcan: DBD	2-3	0-27 27	Cobbly loam, cobbly silty clay loam, and very cobbly clay. Basalt bedrock.	CL or CH	A-7 or A-6	50-70
*Detra: DKG For Kolob part, see Kolob series.	3-5	0-27 27-44 44	Fine sandy loam and light sandy clay loam. Clay loam Limestone bedrock.	SM-SC or CL-ML CL	A-4 A-6	0 0
Draper: DrB ³	>5	0-60	Loam	CL-ML	A-4	0
Dune land: DU. Properties too variable to be estimated.						

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths of more than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have different meanings in soil science than in engineering. The Glossary

defines many of these terms as they are commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (2), used by the Soil Conservation Service, Department of Defense, and other agencies, and the AASHTO system (1), adopted by the American Association of State Highway and Transportation Officials.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and or-

significant to engineering

units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series and Atterberg limits have been rounded to the nearest 5 percent. Thus, when ranges of gradation and Atterberg limits extend a marginal amount across classification in the marginal zone has been omitted]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Hydrologic group
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
80-100 50-80	70-100 45-75	55-85 35-70	30-50 20-40	<i>Pct</i> 25-35	NP 5-15	0.6-2.0 0.6-2.0	0.09-0.12 0.08-0.13	7.9-9.0 7.9-9.0	Low. Low.	C
70-95	65-90	55-75	30-50	25-30	5-10	0.2-0.6	0.13-0.16	7.4-8.4	Moderate.	D
100 100	100 100	90-100 80-100	25-50 30-50	10-20 15-25	NP-5 NP-10	2.0-6.0 0.2-0.6	0.10-0.14 0.13-0.19	6.6-7.3 6.6-7.3	Low. Moderate.	B
60-90	55-80	40-70	20-45	15-25	NP-10	2.0-6.0	0.07-0.09	7.9-8.4	Low.	
30-55	25-50	20-45	15-35	20-30	5-10	0.6-2.0	0.08-0.11	7.9-9.0	Low.	B
100	100	85-100	50-75	25-40	5-15	0.6-2.0	0.13-0.20	6.6-9.0	Moderate.	B
75-100	70-100	65-100	55-90	35-50	15-25	0.06-0.2	0.14-0.20	6.6-8.4	High.	D
40-60	30-50	20-45	15-35	20-30	NP-5	0.6-2.0	0.07-0.10	7.9-9.0	Low.	D
85-95	75-90	40-75	35-50	20-30	5-15	0.2-0.6	0.13-0.19	6.1-7.3	Moderate.	C
85-95	80-90	75-85	50-80	30-55	10-30	0.06-0.2	0.10-0.13	6.6-7.3	Moderate.	C
100	100	95-100	35-65	20-30	5-10	0.6-2.0	0.10-0.14	7.4-7.8	Low.	B
100	100	95-100	50-70	30-40	10-20	0.6-2.0	0.14-0.20	7.9-8.4	Moderate.	
100	70-85	60-80	50-60	20-30	5-10	0.6-2.0	0.13-0.18	6.1-7.3	Moderate.	C

TABLE 6.—*Estimated soil properties*

Soil series and map symbols	Depth to bedrock or hardpan	Depth from surface	Dominant USDA texture	Classification		Coarse fraction greater than 3 inches
				Unified	AASHTO	
*Eroded land: EA, EB. Properties too variable to be estimated. For Shalet part, see Shalet series.	<i>Ft</i>	<i>In</i>				
Esplin ----- Mapped only in complex with Pastura soils.	1-2	0-18 18	Loam, clay loam, and silt loam -- Indurated hardpan over basalt.	CL-ML or CL	A-4 or A-6	0
Fluvaquents ' and Torrfluvents, sandy: FA. Properties too variable to be estimated.						
Gullied land: GA. Properties too variable to be estimated.						
Hantz: Ha -----	>5	0-70	Silty clay loam and silty clay ----	CL	A-7	0
*Harrisburg: HbC, HD ----- For Rock land part of HD, see Rock land.	2-3	0-35 35	Fine sandy loam ----- Indurated hardpan.	SM	A-4 or A-2	0
*Hobog: HG ----- For Rock land part, see Rock land.	1-2	0-13 13	Very cobbly loam ----- Sandstone bedrock.	GM	A-2	15-30
Hogg ----- Mapped only in a complex with Kolob soils.	4-5	0-36 36-52 52	Fine sandy loam ----- Clay ----- Limestone bedrock.	SM CL or ML	A-4 A-6 or A-7	0 0
Ildefonso ----- Mapped only in a complex with Nehar soils.	3-4	0-40 40	Very gravelly sandy loam ----- Limestone bedrock.	GM-GC or GM	A-2	5-10
Isom: IAF -----	>5	0-60	Cobbly sandy loam and very cobbly sandy loam.	GM or GM-GC	A-2 or A-1	25-40
Ivins: Ib, Ic -----	>5	0-24 24-64	Loamy fine sand ----- Sandy clay loam and sandy clay -	SM SC, SM-SC, CL-ML, or CL	A-2 A-6 or A-4	0 0
Junction: JaB, JaC -----	>5	0-60	Fine sandy loam -----	SM or SM-SC	A-4	0
*Kinesava: KAE, KBD, KCE ----- For Detra part of KBD, see Detra series. For Kolob variant part of KCE, see Kolob variant.	>5	0-39 39-60	Fine sandy loam and sandy clay loam. Clay -----	SM-SC CL or CH	A-4 A-7	0 0
*Kolob: KD, KHC, KLG ----- For Detra part of KD, see Detra series. For Hogg part of KHC, see Hogg series. For Paunsaugunt part of KLG, see Paunsaugunt series.	3-5	0-10 10-52 52	Fine sandy loam, cobbly fine sandy loam, and very stony silt loam. Very gravelly clay loam, cobbly clay loam, stony clay, and clay loam. Limestone bedrock.	SC or CL GC	A-2, A-4, or A-6 A-2 or A-6	0-30 10-15
Kolob variant ----- Mapped only in complex with Kinesava soils.	2-3	0-30 30	Silt loam, gravelly silty clay loam, and very gravelly silty clay. Shale and limestone bedrock.	CL or ML	A-4 or A-6	0
Lava flows: LA. Properties too variable to be estimated.						
Lavate: Lb -----	>5	0-60	Sandy loam, sandy clay loam, and clay loam.	CL	A-6	0
LaVerkin: LcB, LcC, LdB -----	>5	0-60	Fine sandy loam and light sandy clay loam.	SM-SC or CL-ML	A-4	0
Leeds: LeA, LeB, LeD -----	>5	0-15 15-60	Silty clay loam ----- Sandy loam and silt loam -----	CL ML or CL-ML	A-6 A-4	0 0

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Hydrologic group
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
				<i>Pct</i>		<i>In per hr</i>	<i>In per in of soil</i>	<i>pH</i>		
100	100	80-100	60-85	25-35	5-15	0.6-2.0	0.14-0.20	7.9-9.0	Moderate.	D
100	100	90-100	85-95	40-50	20-30	0.06-0.2	0.14-0.20	7.9-8.4	Moderate to high.	C
95-100	90-100	85-100	25-50	15-20	NP-5	2.0-6.0	0.10-0.14	7.9-8.4	Low.	C
40-55	35-50	30-45	20-35	20-30	NP-5	0.6-2.0	0.06-0.10	7.9-9.0	Low.	D
100	100	100	35-45	20-30	NP-5	2.0-6.0	0.10-0.14	7.4-7.8	Low.	B
100	100	95-100	70-80	35-45	10-25	0.2-0.6	0.14-0.20	7.4-8.4	High.	B
35-60	30-55	25-40	15-35	25-35	5-10	6.0-20.0	0.07-0.13	7.9-9.0	Low.	B
30-60	25-55	20-45	15-30	20-30	NP-10	2.0-6.0	0.04-0.08	7.9-9.0	Low.	B
100	95-100	90-100	20-30	10-30	NP-7	6.0-20.0	0.08-0.11	7.4-8.4	Low.	C
100	90-100	85-100	35-50	20-40	5-15	0.2-0.6	0.13-0.19	7.4-8.4	Moderate.	C
100	90-100	85-100	35-50	15-30	NP-10	2.0-6.0	0.10-0.14	7.4-7.8	Low.	B
100	100	80-90	35-45	20-30	5-10	2.0-6.0	0.10-0.14	7.4-7.8	Low.	B
100	100	80-90	70-85	40-60	15-30	0.2-0.6	0.14-0.20	7.4-8.4	High.	
80-100	70-100	50-85	30-65	25-35	10-15	0.2-0.6	0.12-0.20	7.4-8.4	Low to moderate.	C
35-70	25-60	20-50	15-45	30-40	10-15	0.2-0.6	0.08-0.10	7.4-8.4	Low to moderate.	
70-80	65-75	60-75	50-70	30-40	5-15	0.2-0.6	0.10-0.14	7.4-9.0	Moderate.	C
90-100	80-95	70-85	50-70	30-40	10-15	0.2-0.6	0.13-0.19	7.4-7.8	Moderate.	B
90-100	85-100	75-90	40-60	20-30	5-10	0.6-2.0	0.12-0.18	8.5-9.0	Moderate.	C
100	100	90-100	70-90	30-40	10-20	0.06-0.2	0.14-0.20	7.9-9.0	Moderate.	C
100	100	90-100	70-85	20-30	NP-10	0.6-2.0	0.14-0.20	8.5-9.0	Moderate.	C

TABLE 6.—*Estimated soil properties*

Soil series and map symbols	Depth to bedrock or hardpan	Depth from surface	Dominant USDA texture	Classification		Coarse fraction greater than 3 inches
				Unified	AASHTO	
*Magotsu: MAE ----- For Pastura part, see Pastura series.	<i>F_t</i> 1-2	<i>I_n</i> 0-17 17	Very cobbly loam, clay loam, clay, and gravelly clay loam. Indurated hardpan over basalt bedrock.	CL or CH	A-7	10-20
*Mathis: MBG ----- For Rock outcrop part, see Rock outcrop.	2-3	0-33 33	Very stony loamy fine sand and very gravelly loamy sand. Sandstone bedrock.	GM, SM, GP-GM, or SP-SM	A-1	20-30
*Menefee: MEG ----- For Rock outcrop part, see Rock outcrop.	1-2	0-19 19	Shaly loam, silt loam, and silty clay loam. Shale bedrock.	CL-ML or CL	A-4 or A-6	0
Mespuñ: MFD -----	> 5	0-60	Fine sand -----	SP-SM	A-3	0
Mokiak ----- Mapped only in complex with Motoqua soils.	2-3	0-38 38	Very cobbly sandy loam and very cobbly sandy clay loam. Fractured gneiss and schist.	GM-GC	A-2	15-20
*Motoqua: MMG, MOG ----- For Mokiak part of MMG, see Mokiak series. For Rock outcrop part of MOG, see Rock outcrop.	1-2	0-16 16	Very gravelly sandy loam and very gravelly sandy clay loam. Igneous bedrock.	GC	A-2	0-15
Naplene: NaC -----	> 5	0-60	Silt loam, light clay loam, and fine sandy loam.	CL-ML or CL	A-4 or A-6	0
*Nehar: NEF, NIF ----- For Ildefonso part of NIF, see Ildefonso series.	4-5	0-47 47-60	Very stony sandy loam, stony sandy clay, stony clay, and very stony sandy clay loam. Stony sandy loam -----	SC or CL GM	A-6, A-2, or A-7 A-1 or A-2	45-55 15-30
*Nikey: NkC, NLE, NME, NNE ----- For Isom part of NNE, see Isom series.	3-5	0-26 26-60	Fine sandy loam and sandy loam. Gravelly loam -----	SM-SC SM or ML	A-4 or A-2 A-4	0-25 10-20
Palma: PAC, PbC -----	> 5	0-60	Fine sandy loam -----	SM	A-4	0
*Pastura: PcC, PED ----- For Esplin part of PED, see Esplin series.	1-2	0-18 18	Loam and gravelly loam ----- Indurated hardpan over basalt bedrock.	CL or CL-ML	A-4 or A-6	0
*Paunsaugunt: PFG, PG ----- For Kolob part of PG, see Kolob series.	1-2	0-13 13	Gravelly silt loam and very gravelly loam. Limestone.	GM or SM	A-2	0
*Paunsaugunt variant: PKE ----- For Paunsaugunt part, see Paunsaugunt series. For Rock outcrop part, see Rock outcrop.	1-2	0-12 12	Cobbly silt loam, cobbly silty clay loam, and very cobbly silty clay. Limestone.	CL or CH	A-7 or A-6	30-50
*Pintura: PnC, PoD3, PTE ----- For Toquerville part of PTE, see Toquerville series.	> 5	0-65	Fine sand and loamy fine sand -----	SP-SM	A-3	0
*Quazo: QMG ----- For Motoqua part, see Motoqua series.	1-2	0-18 18	Very gravelly sandy clay loam and gravelly sandy clay loam. Igneous bedrock.	SC	A-2	0-10
Redbank: RaC, RbA -----	> 5	0-35 35-60	Fine sandy loam ----- Light loam and sandy loam -----	SM CL or CL-ML	A-4 A-4 or A-6	0 0
*Renbac: RE ----- For Rock land part, see Rock land.	1-2	0-12 12	Channery clay loam, channery clay, and very flaggy sandy loam. Sandstone bedrock.	GC	A-6, A-7, or A-2	30-40
Riverwash: RI. Properties too variable to be estimated.						
Rock land: RO, RP, RR. Properties too variable to be estimated. For Hobog and Renbac parts of RR, see Hobog and Renbac series.						

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Hydrologic group
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
75-90	65-85	60-80	55-70	40-55	15-40	<i>In per hr</i> 0.2-0.6	<i>In per in of soil</i> 0.15-0.18	<i>pH</i> 6.6-8.4	High.	D
45-65	35-60	20-45	5-15	-----	NP	2.0-6.0	0.04-0.06	7.4-9.0	Low.	A
75-100	65-90	60-80	50-80	25-40	5-15	0.06-0.2	0.14-0.20	7.9-9.0	Moderate.	D
100	90-100	70-95	5-10	-----	NP	>20.0	0.05-0.08	7.4-7.8	Low.	A
35-50	25-45	20-40	15-35	20-30	5-10	0.6-2.0	0.06-0.08	7.4-7.8	Moderate.	B
40-55	35-50	25-35	15-25	25-35	10-15	0.6-2.0	0.08-0.10	6.1-7.3	Low.	D
95-100	95-100	90-100	75-90	25-35	5-15	0.2-0.6	0.14-0.20	8.5-9.0	Moderate.	B
65-100	50-95	40-85	20-60	30-50	20-30	0.2-0.6	0.08-0.12	6.1-7.3	Moderate.	B
45-60	35-50	20-35	15-20	20-30	NP-5	0.6-2.0	0.05-0.07	6.1-7.3	Low.	B
60-85	55-80	45-75	25-45	15-25	5-10	0.6-2.0	0.10-0.14	7.9-8.4	Low.	
75-85	65-75	55-70	40-55	20-30	NP-5	2.0-6.0	0.07-0.10	7.9-9.0	Low.	B
100	100	90-100	40-50	15-25	NP-5	0.6-2.0	0.10-0.14	7.9-9.0	Low.	
75-95	65-90	60-85	50-75	25-35	5-15	0.6-2.0	0.13-0.19	7.9-8.4	Moderate.	D
50-70	45-60	40-55	25-35	25-35	NP-5	0.6-2.0	0.08-0.13	7.4-9.0	Low.	D
75-95	75-80	70-85	60-80	35-55	20-35	0.2-0.6	0.10-0.14	7.4-7.8	Moderate.	D
100	90-100	70-95	5-10	0-10	NP	6.0-20.0	0.05-0.10	7.4-7.8	Low.	A
65-75	40-50	25-45	10-35	30-40	10-15	0.6-2.0	0.08-0.11	6.6-7.3	Moderate.	D
100	100	95-100	35-50	15-25	NP-5	2.0-6.0	0.10-0.14	7.9-9.0	Low.	B
100	100	95-100	50-60	20-35	5-15	0.6-2.0	0.13-0.17	8.5-9.0	Low.	
35-55	30-50	25-45	20-40	35-45	15-20	0.2-0.6	0.06-0.09	7.9-9.0	Low to moderate.	D

TABLE 6.—Estimated soil properties

Soil series and map symbols	Depth to bedrock or hardpan	Depth from surface	Dominant USDA texture	Classification		Coarse fraction greater than 3 inches
				Unified	AASHTO	
Rock outcrop: RT. Properties too variable to be estimated.	<i>Ft</i>	<i>In</i>				
Rough broken land: RU. Properties too variable to be estimated.						
St. George: Sa, Sb, ⁴ Sc, Sd, ⁴ Se, ⁴	>5	0-60	Loam, silty clay loam, very fine sandy loam, and silt loam.	CL-ML or CL	A-4 or A-6	0
Schmutz: SH -----	>5	0-60	Loam -----	ML or CL-ML	A-4	0
Shalet ----- Mapped only in complex with Eroded land.	½-2	0-12 12	Clay loam ----- Shale (rippable) bedrock.	CL	A-6	0
Spenco: SPD -----	>5	0-14 14-64 64	Very fine sandy loam and fine sandy loam. Fine sandy clay loam and clay loam. Sandstone.	SM CL-ML or ML	A-4 A-6 or A-4	0 0
Springerville: SrC ----- Stony colluvial land: SY. Properties too variable to be estimated.	>5	0-60	Clay -----	CL or CH	A-7	0
Tacan: TAG -----	4-5	0-60	Very stony sandy loam, very gravelly sandy clay loam, and very gravelly fine sandy clay loam.	GC	A-2	² 15-30
Tobish: TBF -----	2-3	0-35 35	Very cobbly clay loam, cobbly clay loam, gravelly clay loam, and gravelly light clay loam. Sandstone bedrock.	SC	A-6 or A-2	10-15
Tobler: Tc, Td -----	>5	0-60	Fine sandy loam -----	SM or SM-SC	A-4	0
Toquerville ----- Mapped only in complex with Pintura soils.	1-2	0-16 16	Fine sand ----- Sandstone bedrock.	SP-SM	A-3	0
*Tortugas: TG ----- For Rock land part, see Rock land.	1-2	0-19 19	Very gravelly loam ----- Fractured limestone bedrock.	GM-GC	A-2 or A-4	10-15
Vekol: VeA, VFD -----	>5	0-10 10-60	Sandy loam ----- Sandy clay loam, silty clay loam, sandy clay, and silty clay.	SM-SC CL or ML	A-2 or A-4 A-6 or A-7	0 0
*Veyo: VHD, VPD ----- For Curhollow part of VHD and Pastura part of VPD, see their respective series.	1-2	0-19 19	Cobbly loam, cobbly clay loam, and very cobbly clay. Indurated hardpan over basalt.	CL or GC	A-7	15-30
*Welring: WAG ----- For Tortugas part, see Tortugas series. For Rock outcrop part, see Rock outcrop.	1-2	0-19 19	Very gravelly loam and gravelly loam. Fractured limestone.	GM-GC	A-2	0-10
*Winkel: WBD, WCF ----- For Rock outcrop part of WCF, see Rock outcrop.	1-2	0-16 16	Gravelly fine sandy loam, very cobbly fine sandy loam, and very gravelly fine sandy loam. Indurated hardpan over basalt.	GM or GM-GC	A-2 or A-1	0-10
*Yaki: YAF, YZE ----- For Zukan part, see Zukan series.	1-2	0-19 19	Very cobbly loam ----- Limestone bedrock.	GM-GC	A-2	0-10
Zukan ----- Mapped only in complex with Yaki soils.	1-2	0-16 16	Loam, fine sandy loam, and very fine sandy loam. Limestone bedrock.	CL-ML or CL	A-4 or A-6	0

¹ NP= Nonplastic.² The surface mantle contains 50 to 80 percent cobbles, more than 3 inches in diameter, by volume.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Hydrologic group
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							
				<i>Pct</i>		<i>In per hr</i>	<i>In per in of soil</i>	<i>pH</i>		
100	90-100	90-100	60-90	20-40	5-15	0.2-0.6	0.13-0.20	7.4-8.4	Moderate.	C
100	70-100	60-90	50-65	25-35	5-10	0.6-2.0	0.13-0.19	7.9-9.0	Moderate.	B
90-100	85-100	80-100	50-70	30-40	10-20	0.06-0.2	0.14-0.20	8.5-9.0	Moderate.	D
100	100	95-100	40-50	10-20	NP-5	0.6-2.0	0.10-0.14	6.6-7.3	Low.	B
100	100	90-100	50-70	20-40	5-15	0.2-0.6	0.13-0.20	6.6-9.0	Moderate.	
100	95-100	90-95	75-90	40-55	20-30	<0.06	0.14-0.20	7.9-9.0	High.	D
35-70	30-65	25-55	15-35	30-40	10-15	0.6-2.0	0.08-0.10	7.4-8.4	Low.	B
70-80	65-75	55-65	25-40	30-40	10-15	0.06-0.2	0.11-0.15	7.4-8.4	Moderate.	C
100	90-100	85-100	35-50	15-25	NP-10	2.0-6.0 in Tc 0.2-0.6 in Td	0.10-0.12	7.9-8.4	Low.	B in Tc C in Td
100	90-100	70-95	5-10	-----	NP	>20.0	0.05-0.08	6.6-7.3	Low.	D
40-70	30-60	25-55	20-45	20-30	5-10	2.0-6.0	0.07-0.10	7.4-8.4	Low.	D
100 100	90-100 90-95	55-65 75-90	30-40 50-75	20-30 35-45	5-10 10-20	0.6-2.0 0.06-0.2	0.10-0.13 0.14-0.20	7.9-8.4 7.9-9.0	Low. Moderate.	C
55-70	50-65	45-60	40-55	40-50	15-30	0.06-0.2	0.08-0.10	7.4-8.4	Moderate.	D
25-50	20-45	20-40	15-30	20-30	5-10	0.6-2.0	0.07-0.10	7.4-8.4	Low.	D
35-60	30-55	20-40	15-25	15-25	NP-10	0.6-2.0	0.07-0.09	8.5-9.0	Low.	D
35-50	30-45	25-40	20-35	25-30	5-10	2.0-6.0	0.07-0.11	7.9-9.0	Low.	D
90-100	90-100	85-95	50-60	20-35	5-15	0.6-2.0	0.10-0.18	7.9-9.0	Low.	D

³ Seasonal high water table at a depth of 36 to 60 inches.⁴ Seasonal high water table at depths between 0 and 40 inches.

TABLE 7.—*Interpretations*

[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 mapping that appear in the first

Soil series and map symbols	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Farm ponds	
					Reservoir areas	Embankments
Badland: BA, BB. No interpretations, properties variable.						
*Bermesa: BED, BF Rock land part of BF variable, no interpretations made.	Poor: more than 50 percent coarse fragments; bedrock at a depth of 2 to 3 feet.	Unsuited: bedrock at a depth of 2 to 3 feet.	Unsuited: bedrock at a depth of 2 to 3 feet.	Poor: bedrock at a depth of 2 to 3 feet.	Bedrock at a depth of 2 to 3 feet; more than 50 percent coarse fragments below a depth of 14 inches.	Medium shear strength; low to medium compressibility; medium to low compacted permeability; medium to high susceptibility to piping.
Bond: BOD	Poor: sandy clay loam texture; 10 to 25 percent gravel.	Unsuited: bedrock at a depth of 1 foot to 2 feet.	Unsuited: bedrock at a depth of 1 foot to 2 feet.	Poor: bedrock at a depth of 1 foot to 2 feet.	Moderately slow permeability; slopes of 1 to 10 percent; bed at a depth of 1 foot to 2 feet.	Medium shear strength; low to medium compressibility; medium to low compacted permeability; medium to low susceptibility to piping; fair to good compaction characteristics.
Caval: CaD	Good	Poor: excessive fines.	Unsuited: no gravel.	Poor: high potential frost	Slopes of 1 to 10 percent; moderate permeability.	Medium to low shear strength; medium compressibility; good to poor compaction characteristics.
Cave: CEF, CFD	Poor: 20 to 40 percent gravel.	Poor: 20 to 45 percent of material passes No. 200 sieve.	Unsuited: 60 to 90 percent of material passes No. 4 sieve.	Poor: shallow depth to hardpan.	Hardpan at a depth of less than 20 inches; slopes of 2 to 30 percent; 20 to 35 percent coarse fragments.	Medium shear strength; low to medium compressibility; medium to low compacted permeability; high to low susceptibility to piping; fair to good compaction characteristics.
Chilton: CHF	Poor: more than 40 percent coarse fragments.	Unsuited: no sand.	Poor: excess fines.	Fair if slopes are 15 to 30 percent. Good if slopes are 5 to 15 percent.	Moderate permeability; slopes of 5 to 30 percent; more than 40 percent coarse fragments.	High to medium shear strength; low compressibility; medium to low compacted permeability; medium to low susceptibility to piping; fair to good compaction characteristics.
Cinder land: CI. No interpretations, properties variable.						
*Clovis: CoC, CPD For Pastura part of CPD, see Pastura series.	Good in upper 8 inches. Fair below a depth of 8 inches: fine sandy loam over clay loam.	Unsuited: no sand.	Unsuited: no gravel.	Moderate: moderate shrink-swell potential.	Moderate permeability.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; high to low susceptibility to piping; good to poor compaction characteristics.
Collbran: CRF	Poor: 70 to 80 percent cobbles on surface; clay texture.	Unsuited: no sand.	Unsuited: no gravel.	Poor: high shrink-swell potential.	Slopes are 2 to 30 percent.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; fair to poor compaction characteristics; low to high susceptibility to piping.

of engineering properties

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

Soil features affecting—		Soil limitations for—					
Drainage for crops and pasture	Irrigation	Dwellings	Shallow excavations	Septic tank absorption fields	Sewage lagoons	Sanitary landfill ¹	Local roads and streets
Not needed: bedrock restricts drainage.	Low available water capacity; hardpan at a depth of 2 to 3 feet.	Moderate if slopes are 8 to 10 percent. Severe for basements: bedrock at a depth of 2 to 3 feet.	Severe: bedrock at a depth of 2 to 3 feet.	Severe: bedrock at a depth of less than 48 inches.	Severe: bedrock at a depth of 2 to 3 feet.	Severe: bedrock at a depth of less than 40 inches.	Moderate: bedrock at a depth of 2 to 3 feet.
Not needed	Bedrock at a depth of 1 foot to 2 feet.	Severe: bedrock at a depth of 1 foot to 2 feet.	Severe: bedrock at a depth of 1 foot to 2 feet.	Severe: moderately slow permeability; bedrock at a depth of 1 foot to 2 feet.	Severe: bedrock at a depth of 1 foot to 2 feet; slopes of 1 to 10 percent.	Severe: bedrock at a depth of 1 foot to 2 feet.	Severe: bedrock at a depth of 1 foot to 2 feet.
Not needed	Moderate or high available water capacity.	Severe: high potential frost action.	Slight if slopes are 2 to 8 percent. Moderate if slopes are 8 to 10 percent.	Slight if slopes are 2 to 8 percent. Moderate if slopes are 8 to 10 percent.	Severe: moderately rapid permeability.	Moderate: permeability is 2.0 to 6.0 inches per hour to a depth of 4 feet.	Severe: high potential frost action.
Not needed: hardpan restricts drainage.	Hardpan and gravel at a depth of 10 to 20 inches.	Severe: hardpan at a depth of less than 2 feet; slopes of 2 to 30 percent.	Severe: hardpan at a depth of less than 2 feet; slopes of 2 to 30 percent.	Severe: hardpan at a depth of less than 2 feet; slopes of 2 to 30 percent.	Severe: hardpan at a depth of less than 2 feet; slopes of 2 to 30 percent.	Severe: hardpan at a depth of less than 2 feet.	Severe: hardpan at a depth of less than 2 feet; slopes of 2 to 30 percent.
Not needed	Slopes of 5 to 30 percent; 40 to 80 percent gravel.	Moderate if slopes are 5 to 15 percent. Severe if slopes are 15 to 30 percent.	Moderate if slopes are 5 to 15 percent: gravelly. Severe if slopes are 15 to 30 percent.	Slight if slopes are 5 to 8 percent. Moderate if slopes are 8 to 15 percent. Severe if slopes are 15 to 30 percent.	Severe if slopes are 5 to 30 percent; more than 40 percent coarse fragments; moderate permeability.	Slight if slopes are 5 to 15 percent. Moderate if slopes are 15 to 25 percent. Severe if slopes are more than 25 percent.	Moderate if slopes are 8 to 15 percent. Severe if slopes are 15 to 30 percent.
Not needed	High available water capacity.	Moderate: moderate shrink-swell potential.	Slight	Slight	Moderate: moderate permeability; slopes of 1 to 5 percent.	Slight	Moderate: moderate shrink-swell potential.
Not needed	Uneven slopes; cobbles on surface.	Severe: high shrink-swell potential.	Severe: clay texture.	Severe: permeability is less than 0.2 inch per hour; slopes of 2 to 30 percent.	Moderate if slopes are 2 to 7 percent. Severe if slopes are 7 to 30 percent.	Severe: clay texture; bedrock at a depth of less than 5 feet.	Severe: high shrink-swell potential.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Farm ponds	
					Reservoir areas	Embankments
*Curhollow: CSE, CUF Rock outcrop part of CUF variable, no interpretations made.	Poor: more than 40 percent coarse fragments.	Unsuited: bedrock at a depth of less than 2 feet.	Unsuited: bedrock at a depth of less than 2 feet.	Poor: bedrock at a depth of less than 2 feet.	Bedrock at a depth of less than 2 feet; slopes of 2 to 30 percent; 40 percent coarse fragments.	High to medium shear strength; low compressibility; medium to low compacted permeability; medium to low susceptibility to piping; fair to good compaction characteristics; shallow to bedrock.
*Dagflat: DAG For Motoqua part, see Motoqua series.	Poor: slopes of 30 to 60 percent.	Unsuited: bedrock at depth of 2 to 3 feet.	Unsuited: bedrock at a depth of 2 to 3 feet.	Poor: slopes of 30 to 60 percent.	Slopes of 30 to 60 percent; bedrock at a depth of less than 3 feet.	Medium to low shear strength; medium compressibility; low to high susceptibility to piping; good to poor compaction characteristics.
Dalcan: DBD	Poor: 50 to 70 percent material more than 3 inches in diameter.	Unsuited: no sand.	Unsuited: no gravel.	Poor: bedrock at a depth of less than 3 feet.	Bedrock at a depth of 2 to 3 feet; slopes of 0 to 15 percent; more than 50 percent cobbles and stones.	Medium to low shear strength; medium to high compressibility; low to medium compacted permeability; low to high susceptibility to piping; good to poor compaction characteristics.
*Detra: DKG For Kolob part, see Kolob series.	Poor: slopes of more than 20 percent.	Unsuited: no sand.	Unsuited: no gravel.	Poor: high potential frost action.	Moderate permeability; bedrock at a depth of 40 to 60 inches; slopes of 20 to 30 percent.	Medium shear strength to a depth of 27 inches; low to medium compressibility; low to high susceptibility to piping; fair to good compaction characteristics. Low to medium shear strength between depths of 27 and 44 inches; medium compressibility; low to high susceptibility to piping; good to poor compaction characteristics.
Draper: DrB	Good	Unsuited: no sand.	Unsuited: no gravel.	Moderate: moderate shrink-swell potential.	Water table at a depth of 3 to 5 feet; slopes of 2 to 5 percent.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; high to low susceptibility to piping; good to poor compaction characteristics.
Dune land: DU. No interpretations, properties variable.						
*Eroded land: EA, EB. No interpretations, properties variable. For Shalet part, see Shalet series.						
Esplin Mapped only in complex with Pastura soils.	Poor: bedrock at a depth of less than 2 feet.	Unsuited: bedrock at a depth of less than 2 feet.	Unsuited: no gravel.	Poor: high potential frost action; bedrock at a depth of less than 2 feet.	Bedrock at a depth of less than 2 feet.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; low to high susceptibility to piping; good to poor compaction characteristics.
Fluvaquents and Torri-fluents, sandy: FA. No interpretations, properties variable.						

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Farm ponds	
					Reservoir areas	Embankments
Gullied land: GA. No interpretations, properties variable. Hantz: Ha -----	Fair to poor: silty clay loam and silty clay texture.	Unsuited: no sand.	Unsuited: no gravel.	Poor: high plasticity index; moderate to high shrink-swell potential.	Slow permeability; slopes of less than 2 percent; less than 20 percent coarse fragments.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.
Harrisburg: HbC, HD ----- Rock land part of HD variable, no interpretations made.	Poor: bedrock at a depth of 2 to 3 feet.	Poor: excess fines.	Unsuited: no gravel.	Poor: bedrock at a depth of 2 to 3 feet.	Slopes of 1 to 20 percent; bedrock at a depth of 2 to 3 feet.	Medium shear strength; medium to high susceptibility to piping; low to medium compressibility; fair to good compaction characteristics; medium to low compacted permeability.
*Hobog: HG ----- Rock land part variable, no interpretations made.	Poor: more than 35 percent coarse fragments; bedrock at a depth of less than 2 feet.	Unsuited: no sand; bedrock at a depth of less than 2 feet.	Unsuited: excess fines; bedrock at a depth of less than 2 feet.	Poor: slopes of 3 to 40 percent; bedrock at a depth of less than 2 feet.	Bedrock at a depth of less than 2 feet; slopes of 3 to 40 percent.	High to medium shear strength; low compressibility; medium to low compacted permeability; high to low susceptibility to piping; fair to good compaction characteristics.
Hogg ----- Mapped only in complex with Kolob soils.	Good in upper 3 feet. Poor below a depth of 3 feet: clay.	Poor: excess fines.	Unsuited: no gravel.	Poor: high shrink-swell potential.	Permeability is 2.0 to 6.0 inches per hour in upper 36 inches and 0.2 to 0.6 inch per hour below a depth of 36 inches.	Medium to low shear strength; low to medium compressibility; low to medium compacted permeability; low to high susceptibility to piping; fair to good compaction characteristics.
Ildefonso ----- Mapped only in complex with Nehar soils.	Poor: 35 to 70 percent coarse fragments.	Unsuited: bedrock at a depth of 3 to 4 feet or more; no sand.	Unsuited: bedrock at a depth of 3 to 4 feet or more.	Fair: moderate potential frost action; bedrock at a depth of 3 to 4 feet or more.	Permeability is more than 6.0 inches per hour; bedrock at a depth of 3 to 4 feet or more.	High to medium shear strength; low to medium compressibility; medium to low compacted permeability; medium to low susceptibility to piping; good to fair compaction characteristics.
Isom: IAF -----	Poor: more than 15 percent coarse fragments.	Unsuited: no sand.	Poor: excess fines.	Good if slopes are 3 to 15 percent. Fair if slopes are 15 to 25 percent. Poor if slopes are 25 to 30 percent.	Permeability is more than 6 inches per hour; more than 50 percent coarse fragments; slopes of 3 to 30 percent.	Medium to low shear strength; low compressibility; low to medium compacted permeability; fair to good compaction characteristics; low to medium susceptibility to piping.
Ivins: Ib, Ic -----	Fair: sandy clay loam or loamy fine sand texture.	Poor: excess fines.	Unsuited: no gravel.	Fair: moderate shrink-swell potential.	Permeability is more than 6 inches per hour to a depth of 24 inches and 0.2 to 0.6 inch per hour below a depth of 24 inches.	Medium to low shear strength; low to medium compressibility; medium to low compacted permeability; fair to good compaction characteristics; low to high susceptibility to piping.

engineering properties—Continued

Soil features affecting—		Soil limitations for—					
Drainage for crops and pasture	Irrigation	Dwellings	Shallow excavations	Septic tank absorption fields	Sewage lagoons	Sanitary landfill ¹	Local roads and streets
Deep to water table; needs drainage in some areas; slow permeability.	High available water capacity.	Severe: moderate to high shrink-swell potential.	Severe: silty clay texture.	Severe: slow permeability.	Slight -----	Severe: silty clay texture.	Severe: moderate to high shrink-swell potential; high plasticity index.
Not needed ----	Low available water capacity; bedrock at a depth of 2 to 3 feet.	Moderate with no basement and severe with basement: bedrock at a depth of 3 feet.	Severe: bedrock at a depth of 2 to 3 feet; slopes of 1 to 20 percent.	Severe: bedrock at a depth of 2 to 3 feet.	Severe: bedrock at a depth of 2 to 3 feet; slopes of 1 to 20 percent.	Severe: bedrock at a depth of 2 to 3 feet.	Moderate: bedrock at a depth of less than 3 feet.
Not needed ----	Bedrock at a depth of less than 2 feet; slopes of 3 to 40 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 3 to 40 percent.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet; slopes of 3 to 40 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 3 to 40 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 3 to 40 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 3 to 40 percent.
Not needed ----	Irrigation water not available.	Severe: high potential frost action.	Severe: clay texture below a depth of 3 feet.	Severe: moderately slow permeability below a depth of 3 feet.	Moderate: slopes of 2 to 5 percent.	Severe: clay texture below a depth of 3 feet.	Severe: high potential frost action; high shrink-swell potential.
Not needed ----	Slopes of 5 to 30 percent; water not available.	Moderate if slopes are less than 15 percent; moderate potential frost action. Severe if slopes are more than 15 percent.	Severe: very gravelly soil; bedrock dominantly at a depth of less than 4 feet.	Severe: bedrock dominantly at a depth of less than 4 feet.	Severe: permeability is more than 6.0 inches per hour; slopes of 5 to 30 percent.	Severe: permeability is more than 6.0 inches per hour; bedrock dominantly at a depth of less than 4 feet.	Moderate if slopes are less than 15 percent; moderate potential frost action. Severe if slopes are more than 15 percent.
Not needed ----	Very cobbly and very gravelly; slopes of 3 to 30 percent.	Slight if slopes are 0 to 8 percent. Moderate if slopes are 8 to 15 percent. Severe if slopes are 15 to 30 percent.	Moderate if slopes are less than 15 percent: cobbly surface layer. Severe if slopes are more than 15 percent.	Slight if slopes are 3 to 8 percent. Moderate if slopes are 8 to 15 percent. Severe if slopes are 15 to 30 percent.	Severe: permeability is more than 2 inches per hour; more than 50 percent coarse fragments; slopes of 3 to 30 percent.	Severe: permeability is more than 2 inches per hour; more than 50 percent coarse fragments; slopes of 3 to 30 percent.	Slight if slopes are 3 to 8 percent. Moderate if slopes are 8 to 15 percent. Severe if slopes are 15 to 30 percent.
Not needed ----	Moderate available water capacity to a depth of 2 to 3 feet.	Moderate: moderate shrink-swell potential.	Severe: loamy fine sand texture; unstable sidewalls.	Severe: permeability is less than 0.6 inch per hour below a depth of 2 feet.	Moderate: moderately slow permeability below a depth of 2 feet.	Moderate: sandy clay texture below a depth of 2 feet.	Moderate: moderate shrink-swell potential.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Farm ponds	
					Reservoir areas	Embankments
Junction: JaB, JaC -----	Good -----	Poor: excess fines.	Unsuited: no gravel.	Fair; excess fines.	Slopes of 1 to 5 percent.	Medium shear strength; medium to high susceptibility to piping; low to medium compressibility; fair to good compaction characteristics; medium to low compacted permeability.
*Kinesava: KAE, KBD, KCE For Detra part of KBD, see Detra series; for Kolob variant part of KCE, see Kolob variant.	Good if slopes are 2 to 8 percent. Fair if slopes are 8 to 15 percent. Poor if slopes are 15 to 25 percent.	Poor: excess fines.	Unsuited: no gravel.	Moderate or poor: moderate potential frost action; high shrink-swell potential below a depth of 39 inches.	Slopes of 2 to 35 percent; permeability is 2.0 to 6.0 inches per hour to a depth of 39 inches and 0.2 to 0.6 inch per hour below a depth of 39 inches.	Low to medium shear strength; low to high susceptibility to piping; good to poor compaction characteristics; low to high compressibility.
*Kolob: KD, KHC, KLG ----- For Detra part of KD, Hogg part of KHC, and Paunsaugunt part of KLG, see their respective series.	Poor: excess coarse fragments; bedrock at a depth of 3 to 5 feet; slopes of 2 to 60 percent.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: bedrock at a depth of 3 to 5 feet.	Bedrock at a depth of 3 to 5 feet; slopes of 2 to 60 percent.	Low to medium shear strength; low to medium compressibility; low compacted permeability; low to medium susceptibility to piping; good to fair compaction characteristics.
Kolob variant ----- Mapped only in complex with Kinesava soils.	Poor: gravelly and cobbly material at a depth of less than 8 inches.	Unsuited: excess fines.	Unsuited: excess fines.	Severe: high potential frost action.	Bedrock at a depth of 2 to 3 feet; slopes of 10 to 30 percent.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; low to high susceptibility to piping; good to fair compaction characteristics.
Lava flow: LA. No interpretations, properties variable.						
Lavate: Lb -----	Fair: sandy clay loam texture.	Unsuited: excess fines.	Unsuited: no gravel.	Severe: moderate shrink-swell potential; high potential frost action.	Slopes of 2 to 4 percent.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; high to low susceptibility to piping; good to poor compaction characteristics.
LaVerkin: LcB, LcC, LdB -----	Good -----	Unsuited: excess fines.	Unsuited: no gravel.	Fair: moderate shrink-swell potential.	Moderate: moderate permeability; slopes of 1 to 5 percent.	Low to medium shear strength; low to medium compressibility; low to medium compacted permeability; low to high susceptibility to piping; good to poor compaction characteristics.
Leeds: LeA, LeB, LeD -----	Fair: silty clay loam texture.	Unsuited: no sand.	Unsuited: no gravel.	Fair: moderate shrink-swell potential.	Slopes of 0 to 10 percent; moderate permeability below a depth of 15 inches.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; low to high susceptibility to piping; good to poor compaction characteristics.

engineering properties—Continued

Soil features affecting—		Soil limitations for—					
Drainage for crops and pasture	Irrigation	Dwellings	Shallow excavations	Septic tank absorption fields	Sewage lagoons	Sanitary landfill ¹	Local roads and streets
Not needed ----	Moderate available water capacity.	Slight -----	Slight -----	Slight -----	Severe: permeability is more than 2 inches per hour.	Severe: permeability is more than 2 inches per hour.	Moderate: excess fines.
Not needed ----	Uneven slopes; slopes of 2 to 25 percent; irrigation water not available.	Moderate if slopes are 2 to 15 percent; moderate potential frost action. Severe if slopes are 15 to 25 percent.	Severe: clay texture below a depth of 40 inches; slopes of 2 to 25 percent.	Moderate or severe: permeability is less than 0.6 inch per hour below a depth of 40 inches.	Moderate if slopes are 2 to 7 percent. Severe if slopes are more than 7 percent.	Severe: clay texture below a depth of 40 inches.	Moderate if slopes are 2 to 15 percent; moderate potential frost action. Severe if slopes are 15 to 25 percent.
Not needed ----	Irrigation water not available; slopes of 2 to 60 percent.	Moderate, with no basement, if slopes are less than 15 percent. Severe, with basement, if slopes are more than 15 percent; bedrock at a depth of 3 to 5 feet.	Severe: slopes of 2 to 60 percent; very gravelly; bedrock at a depth of 3 to 5 feet.	Severe: permeability is less than 0.6 inch per hour.	Severe: slopes of 2 to 60 percent; cobbly, stony, and very gravelly in places.	Severe: bedrock at a depth of 3 to 5 feet.	Moderate if slopes are less than 15 percent; moderate potential frost action. Severe if slopes are more than 15 percent.
Not needed ----	Irrigation water not available; slopes of 10 to 30 percent.	Severe: bedrock at a depth of 2 to 3 feet; slopes of 10 to 30 percent.	Severe: bedrock at a depth of 2 to 3 feet; slopes of 10 to 30 percent.	Severe: bedrock at a depth of 2 to 3 feet; slopes of 10 to 30 percent.	Severe: bedrock at a depth of 2 to 3 feet; slopes of 10 to 30 percent.	Severe: bedrock at a depth of 2 to 3 feet.	Severe: bedrock at a depth of 2 to 3 feet; slopes of 10 to 30 percent.
Not needed ----	Moderate intake rate; high available water capacity.	Severe: moderate shrink-swell potential; high potential frost action.	Slight -----	Severe: permeability is less than 0.6 inch per hour.	Moderate: slopes of 2 to 4 percent.	Slight -----	Severe: moderate shrink-swell potential; high potential frost action.
Not needed ----	High available water capacity.	Moderate: moderate shrink-swell potential.	Slight -----	Moderate: permeability is less than 1.0 inch per hour in places.	Moderate: permeability is 0.6 inch to 2.0 inches per hour; slopes of 1 to 5 percent.	Slight -----	Moderate: moderate shrink-swell potential.
Deep to water table; needs drainage in some areas.	High available water capacity; slow intake rate.	Moderate: moderate shrink-swell potential.	Slight if slopes are 0 to 8 percent. Moderate if slopes are 8 to 10 percent.	Moderate: permeability is less than 1.0 inch per hour below a depth of 15 inches; slopes of 0 to 10 percent.	Moderate if slopes are 0 to 7 percent. Severe if slopes are more than 7 percent.	Slight -----	Moderate: moderate shrink-swell potential.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Farm ponds	
					Reservoir areas	Embankments
*Magotsu: MAE ----- For Pastura part, see Pastura series.	Poor: clay texture; very cobbly surface.	Unsuited: excess fines.	Unsuited: no gravel.	Poor: high shrink-swell potential.	Bedrock at a depth of less than 2 feet; slopes of 2 to 20 percent.	Low to medium shear strength; medium to high compressibility; good to poor compaction characteristics; low to medium compacted permeability; low to high susceptibility to piping.
*Mathis: MBG ----- Rock outcrop part variable, no interpretations made.	Poor: very stony loamy fine sand; slopes of 20 to 50 percent.	Unsuited: very stony surface layer; bedrock at a depth of 2 to 3 feet.	Unsuited: bedrock at a depth of 2 to 3 feet.	Poor: slopes of 20 to 50 percent; very stony surface layer.	Slopes of 20 to 50 percent; permeability is more than 2 inches per hour; bedrock at a depth of less than 3 feet.	Medium to high shear strength; low to medium compressibility; high to medium compacted permeability; low to high susceptibility to piping; fair to good compaction characteristics.
*Menefee: MEG ----- Rock outcrop part variable, no interpretations made.	Poor: slopes of more than 25 percent.	Unsuited: no sand.	Unsuited: no gravel.	Poor: slopes of 25 to 60 percent.	Slopes of 25 to 60 percent; ripable bedrock at a depth of less than 2 feet.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; high susceptibility to piping; good to poor compaction characteristics.
Mespun: MFD -----	Poor: sand texture.	Good to fair: 5 to 10 percent fines.	Unsuited: no gravel.	Good -----	Slopes of 0 to 10 percent; permeability is more than 20 inches per hour.	Medium shear strength; medium to high compacted permeability; medium to high susceptibility to piping; fair to good compaction characteristics; low to medium compressibility.
Mokiak ----- Mapped only in complex with Motoqua soils.	Poor: more than 50 percent coarse fragments; slopes of 30 to 70 percent.	Unsuited: no sand.	Unsuited: no gravel.	Poor: slopes of 30 to 70 percent.	Slopes of 30 to 70 percent; bedrock at a depth of less than 3 feet; more than 50 percent coarse fragments.	Medium to high shear strength; low to medium compressibility and compacted permeability; medium susceptibility to piping; good to fair compaction characteristics.
*Motoqua: MMG, MOG ----- For Mokiak part of MMG, see Mokiak series. Rock outcrop part of MOG variable, no interpretations made.	Poor: more than 50 percent coarse fragments.	Unsuited: no sand.	Unsuited: excess fines; bedrock at a depth of less than 2 feet.	Poor: slopes of 30 to 70 percent.	Slopes of 30 to 70 percent; bedrock at a depth of less than 2 feet; more than 50 percent coarse fragments.	Medium to low shear strength; low to medium compressibility; low compacted permeability; medium to low susceptibility to piping; good to fair compaction characteristics.
Naplene: NaC -----	Good -----	Unsuited: no sand.	Unsuited: no gravel.	Severe: high potential frost action.	Slopes of 2 to 6 percent; moderately slow permeability.	Low to medium shear strength; medium compressibility; high to medium susceptibility to piping; good to poor compaction characteristics; medium to low compacted permeability.
*Nehar: NEF, NIF ----- For Ildefonso part of NIF, see Ildefonso series.	Poor: more than 35 percent coarse fragments; very stony surface layer.	Unsuited: no sand.	Unsuited: no gravel.	Fair: slopes of 3 to 30 percent; very stony.	Very stony surface layer; slopes of 3 to 30 percent.	Very stony; medium to low shear strength; low to medium compressibility; low compacted permeability; medium to low susceptibility to piping; good to fair compaction characteristics.

engineering properties—Continued

Soil features affecting—		Soil limitations for—					
Drainage for crops and pasture	Irrigation	Dwellings	Shallow excavations	Septic tank absorption fields	Sewage lagoons	Sanitary landfill ¹	Local roads and streets
Not needed ----	Bedrock at a depth of 1 foot to 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet; moderately slow permeability.	Severe: bedrock at a depth of less than 2 feet; slopes of 2 to 20 percent.	Severe: bedrock at a depth of less than 2 feet.	Severe: high shrink-swell potential.
Not needed ----	Very stony loamy fine sand; slopes of 20 to 50 percent.	Severe: slopes of 20 to 50 percent; bedrock at a depth of less than 3 feet.	Severe: slopes of 20 to 50 percent; very stony loamy fine sand surface layer; bedrock at a depth of less than 3 feet.	Severe: slopes of 20 to 50 percent; bedrock at a depth of less than 3 feet.	Severe: slopes of 20 to 50 percent; bedrock at a depth of less than 3 feet; permeability is more than 2.0 inches per hour.	Severe: slopes of 20 to 50 percent; bedrock at a depth of less than 3 feet; permeability is more than 2.0 inches per hour.	Severe: slopes of 20 to 60 percent.
Not needed ----	Slopes of 25 to 60 percent; shale bedrock at a depth of 1 foot to 2 feet.	Severe: slopes of 25 to 60 percent; rippable bedrock at a depth of less than 2 feet.	Severe: slopes of 25 to 60 percent; rippable bedrock at a depth of less than 2 feet.	Severe: slopes of 25 to 60 percent; shale bedrock at a depth of less than 2 feet.	Severe: slopes of 25 to 60 percent; bedrock at a depth of less than 2 feet.	Severe: slopes of 25 to 60 percent; bedrock at a depth of less than 2 feet.	Severe: slopes of 25 to 60 percent; rippable bedrock at a depth of less than 2 feet.
Not needed ----	Very rapid permeability; low available water capacity; best suited to sprinkler irrigation.	Slight if slopes are 0 to 8 percent. Moderate if slopes are 8 to 10 percent.	Severe: sand texture.	Slight if slopes are 0 to 8 percent. Moderate if slopes are 8 to 10 percent.	Severe: permeability is more than 20 inches per hour.	Severe: permeability is more than 20 inches per hour; fine sand texture.	Slight if slopes are 0 to 8 percent. Moderate if slopes are 8 to 10 percent.
Not needed ----	Slopes of 30 to 70 percent.	Severe: slopes of 30 to 70 percent.	Severe: slopes of 30 to 70 percent; bedrock at a depth of less than 3 feet.	Severe: slopes of 30 to 70 percent; bedrock at a depth of less than 3 feet.	Severe: slopes of 30 to 70 percent; bedrock at a depth of less than 3 feet.	Severe: slopes of 30 to 70 percent; bedrock at a depth of less than 3 feet.	Severe: slopes of 30 to 70 percent.
Not needed ----	Slopes of 30 to 70 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.
Not needed ----	High available water capacity; good intake rate.	Severe: high potential frost action.	Slight -----	Severe: permeability is less than 0.6 inch per hour.	Moderate: slopes of 2 to 6 percent.	Slight -----	Severe: high potential frost action.
Not needed ----	Very stony surface layer; slopes of 3 to 30 percent.	Moderate: moderate shrink-swell potential.	Moderate if slopes are 3 to 15 percent. Severe if slopes are more than 15 percent; very stony.	Severe: permeability is less than 0.6 inch per hour; slopes of 3 to 30 percent.	Severe: very stony surface layer; slopes of 3 to 30 percent.	Moderate if slopes are less than 25 percent; very stony. Severe if slopes are more than 25 percent.	Moderate if slopes are less than 15 percent; moderate shrink-swell potential. Severe if slopes are more than 15 percent.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Farm ponds	
					Reservoir areas	Embankments
*Nikey: NkC, NLE, NME, NNE. For Isom part of NNE, see Isom series.	Fair or poor: 2 to 40 percent coarse fragments.	Unsuited: no sand	Unsuited: no gravel.	Fair: excess fines.	Permeability is more than 2.0 inches below a depth of 2 feet.	Medium to low shear strength; low to medium compressibility; low to medium compacted permeability; medium to high susceptibility to piping; good to fair compaction characteristics.
Palma: PAC, Pbc -----	Good -----	Poor: excess fines.	Unsuited: no gravel.	Poor: high potential frost action.	Permeability is 0.6 inch to 2.0 inches per hour.	Medium shear strength; low to medium compressibility; medium to low compacted permeability; medium to high susceptibility to piping; fair to good compaction characteristics.
*Pastura: PcC, PED ----- For Esplin part of PED, see Esplin series.	Poor: 3 to 15 percent coarse fragments in most areas; bedrock at a depth of 1 foot to 2 feet.	Unsuited: no sand.	Unsuited: no gravel.	Poor: bedrock at a depth of 1 foot to 2 feet.	Bedrock at a depth of less than 2 feet; slopes of 1 to 10 percent.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; high to low susceptibility to piping; good to poor compaction characteristics.
*Paunsaugunt: PFG, PG ---- For Kolob part of PG, see Kolob series.	Poor: more than 15 percent coarse fragments.	Unsuited: no sand.	Unsuited: bedrock at a depth of less than 2 feet.	Fair: bedrock at a depth of less than 2 feet; slopes of 10 to 50 percent.	Bedrock at a depth of less than 2 feet; slopes of 10 to 50 percent; more than 50 percent coarse fragments.	High to medium shear strength; low to medium compressibility; medium to low compacted permeability; low to high susceptibility to piping; fair to good compaction characteristics.
*Paunsaugunt variant: PKE. For Paunsaugunt part, see Paunsaugunt series. Rock outcrop variable, no interpretations made.	Poor: more than 15 percent coarse fragments.	Unsuited: no sand.	Unsuited: no gravel.	Poor: bedrock at a depth of less than 1½ feet.	Bedrock at a depth of less than 1½ feet; more than 50 percent coarse fragments.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair to poor compaction characteristics.
*Pintura: PnC, P0D3, PTE For Toquerville part of PTE, see Toquerville series.	Poor: fine sand texture.	Good -----	Unsuited: no gravel.	Good -----	Slopes of 1 to 10 percent; rapid permeability.	Medium shear strength; low to medium compressibility; low to high compacted permeability; medium to high susceptibility to piping; fair to good compaction characteristics.
*Quazo: QMG ----- For Motoqua part, see Motoqua series.	Poor: more than 50 percent coarse fragments.	Unsuited: no sand.	Unsuited: no gravel.	Poor: slopes of 30 to 70 percent.	Slopes of 30 to 70 percent; bedrock at a depth of less than 2 feet.	Medium to low shear strength; low to medium compressibility; low compacted permeability; medium to low susceptibility to piping; good to fair compaction characteristics.
Redbank: RaC, RbA -----	Good -----	Poor: excess fines.	Unsuited: no gravel.	Fair: moderate potential frost action.	Permeability is 0.6 inch to 6.0 inches per hour below a depth of 35 inches.	Medium to low shear strength; low to medium compressibility; medium to low compacted permeability; medium to high susceptibility to piping; good to poor compaction characteristics.

engineering properties—Continued

Soil features affecting—		Soil limitations for—					
Drainage for crops and pasture	Irrigation	Dwellings	Shallow excavations	Septic tank absorption fields	Sewage lagoons	Sanitary landfill ¹	Local roads and streets
Not needed ----	Moderate available water capacity; stony phase unsuited.	Moderate: bedrock at a depth of 3 to 5 feet or more.	Moderate: bedrock at a depth of 3 to 5 feet or more	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 15 percent.	Severe: permeability is more than 2 inches per hour below a depth of 26 inches.	Severe: permeability is more than 2 inches per hour below a depth of 26 inches.	Moderate: excess fines; slopes of 1 to 15 percent.
Not needed ----	Moderate available water capacity.	Severe: high potential frost action.	Slight -----	Slight: permeability is 0.6 inch to 2.0 inches per hour.	Moderate: permeability is 0.6 inch to 2.0 inches per hour.	Slight -----	Severe: high potential frost action.
Not needed ----	Bedrock at a depth of less than 2 feet; best suited to sprinkler irrigation.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 20 inches.
Not needed ----	Slopes of 10 to 50 percent; bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet; slopes of 10 to 50 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 10 to 50 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 10 to 50 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 10 to 50 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 10 to 50 percent.	Severe: bedrock at a depth of less than 20 inches; slopes of 10 to 50 percent.
Not needed ----	Bedrock at a depth of less than 1½ feet.	Severe: bedrock at a depth of 1½ feet; high shrink-swell potential.	Severe: bedrock at a depth of 1½ feet.	Severe: bedrock at a depth of 1½ feet; moderately slow permeability.	Severe: bedrock at a depth of 1½ feet; more than 50 percent coarse fragments.	Severe: bedrock at a depth of 1½ feet.	Severe: bedrock at a depth of 1½ feet.
Not needed ----	Rapid intake rate; low available water capacity; suited to sprinkler irrigation.	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 10 percent.	Severe: fine sand texture.	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 10 percent.	Severe: permeability is more than 6.0 inches per hour.	Severe: permeability is more than 6.0 inches per hour; fine sand texture.	Slight if slopes are 1 to 8 percent. Moderate if slopes are 8 to 10 percent.
Not needed ----	Unsuited: slopes of 30 to 70 percent; bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.
Not needed ----	Moderate available water capacity.	Moderate: moderate potential frost action.	Slight -----	Slight -----	Moderate: permeability is 0.6 to 2.0 inches per hour below a depth of 35 inches.	Slight -----	Moderate: moderate potential frost action.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Farm ponds	
					Reservoir areas	Embankments
*Renbac: RE ----- Rock land part variable, no interpretations made.	Poor: 40 to 70 percent coarse fragments.	Unsuited: 40 to 70 percent coarse fragments; no sand.	Unsuited: bedrock at a depth of less than 2 feet.	Poor: less than 2 feet of material.	Bedrock at a depth of less than 2 feet; more than 50 percent coarse fragments.	Medium shear strength; low to medium compressibility; low compacted permeability; medium to low susceptibility to piping; good to fair compaction characteristics.
Riverwash: RI. No interpretations, properties variable.						
*Rock land: RO, RP, RR. No interpretations, properties variable. For Hobog and Renbac parts of RR. see their respective series.						
Rock outcrop: RT. No interpretations, properties variable.						
Rough broken land: RU. No interpretations, properties variable.						
St. George: Sa, Sb, Sc, Sd, Se.	Good to poor: silty clay loam texture in some areas; salt; high water table.	Unsuited: no sand.	Unsuited: no gravel.	Fair for Sa, Sc: moderate shrink-swell potential; more than 30 percent fines. Poor for Sb, Sd, and Se: high water table.	Water table at a depth of 30 to 40 inches in some areas; gypsum in soil.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; high to medium susceptibility to piping; good to poor compaction characteristics.
Schmutz: SH -----	Good -----	Unsuited: no sand.	Unsuited: no gravel.	Poor: high concentrations of gypsum in the soil; excess fines.	High concentrations of gypsum in the soil.	Medium to low shear strength; medium compressibility; low to medium compacted permeability; high susceptibility to piping; good to poor compaction characteristics; high content of gypsum.
Shalet ----- Mapped only in complex with Eroded land.	Poor: shale bedrock at a depth of less than 2 feet.	Unsuited: no sand.	Unsuited: no gravel.	Poor: shale bedrock at a depth of less than 2 feet.	Bedrock at a depth of less than 2 feet; slopes of 2 to 20 percent.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; high to low susceptibility to piping; good to poor compaction characteristics.
Spenlo: SPD -----	Clay loam texture.	Poor: excess fines.	Unsuited: no gravel.	Fair: moderate shrink-swell potential.	Slopes of 2 to 10 percent.	Medium to low shear strength; low to medium compressibility; low to medium compacted permeability; low to high susceptibility to piping; good to poor compaction characteristics.
Springerville: SrC -----	Poor: clay texture.	Unsuited: no sand.	Unsuited: no gravel.	Poor: high shrink-swell potential.	Slopes of 0 to 5 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; good to poor compaction characteristics.
Stony colluvial land: SY. No interpretations, properties variable.						

engineering properties—Continued

Soil features affecting—		Soil limitations for—					
Drainage for crops and pasture	Irrigation	Dwellings	Shallow excavations	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets
Not needed ----	40 to 70 percent coarse fragments; bedrock at a depth of less than 2 feet; slopes of 2 to 30 percent.	Severe: bedrock at a depth of 2 feet; slopes of 2 to 30 percent.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet; permeability is 0.2 to 0.6 inch per hour.	Severe: bedrock at a depth of less than 2 feet; more than 50 percent coarse fragments.	Severe: bedrock at a depth of less than 2 feet; more than 50 percent coarse fragments.	Severe: bedrock at a depth of less than 2 feet; slopes of 2 to 30 percent.
Shallow to deep water table; needs drainage in some areas; moderately slow permeability; gypsum in soil.	High available water capacity; slow intake rate; gypsum causes settling.	Moderate in Sa and Sc: moderate shrink-swell potential. Severe in Sb, Sd, and Se: high water table.	Slight in Sa and Sc. Severe in Sb, Sd, and Se: high water table.	Severe: permeability is less than 0.6 inch per hour.	Slight for Sa and Sc. Severe for Sb, Sd, and Se: seasonal high water table at a depth of less than 40 inches.	Slight for Sa and Sc. Severe for Sb, Sd, and Se: seasonal high water table at a depth of less than 40 inches.	Moderate for Sa and Sc: moderate shrink-swell potential. Severe for Sb, Sd, and Se: seasonal high water table.
Not needed ----	High gypsum content causes settling; moderate intake	Severe: high concentrations of gypsum in soil.	Moderate: high concentrations of gypsum in soil.	Moderate: high concentrations of gypsum in the soil.	Severe: high concentrations of gypsum in the soil.	Moderate: high concentrations of gypsum in the soil.	Severe: high concentrations of gypsum in the soil.
Not needed ----	Slopes of 2 to 20 percent; shale bedrock at a depth of less than 2 feet.	Severe: rip-pable shale at a depth of less than 2 feet.	Severe: rip-pable shale at a depth of less than 2 feet.	Severe: rip-pable shale at a depth of less than 2 feet.	Severe: rolling, dissected slopes of 7 to 20 percent; rip-pable shale at a depth of less than 2 feet.	Severe: rip-pable shale at a depth of less than 2 feet.	Severe: rip-pable bedrock at a depth of less than 2 feet.
Not needed ----	High available water capacity	Moderate: moderate shrink-swell potential.	Slight -----	Moderate: moderately slow permeability in arid climate.	Moderate if slopes are 2 to 7 percent. Severe if slopes are 7 to 10 percent.	Slight -----	Moderate: moderate shrink-swell potential.
Not needed ----	Slow intake rate; high available water capacity; irrigation water not available.	Severe: high shrink-swell potential.	Severe: clay texture.	Severe: permeability is less than 0.06 inch per hour.	Slight if slopes are 0 to 2 percent. Moderate if slopes are 2 to 5 percent.	Severe: clay texture.	Severe: high shrink-swell potential.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Farm ponds	
					Reservoir areas	Embankments
Tacan: TAG -----	Poor: very stony surface layer.	Unsuited: very stony surface layer; excess fines.	Unsuited: very stony; excess fines.	Poor: slopes of 30 to 70 percent.	Slopes of 30 to 70 percent; very stony surface layer.	Low compacted permeability; medium to low susceptibility to piping; medium to low shear strength; good to fair compaction characteristics.
Tobish: TBF -----	Poor: more than 15 percent coarse fragments.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: bedrock at a depth of 2 to 3 feet.	Bedrock at a depth of less than 3 feet; slopes of 5 to 30 percent; 20 to 40 percent gravel and cobbles.	Medium to low shear strength; medium to low compressibility; medium to low compacted permeability; high to low susceptibility to piping; good to fair compaction characteristics.
Tobler: Tc, Td -----	Good -----	Poor: excess fines.	Unsuited: no gravel.	Fair: excess fines.	Moderately rapid permeability.	Medium to low shear strength; low to medium compressibility; low to medium compacted permeability; good to fair compaction characteristics; low to high susceptibility to piping.
Toquerville ----- Mapped only in complex with Pintura soils.	Poor: fine sand texture.	Poor: bedrock at a depth of less than 2 feet.	Unsuited: no gravel.	Poor: bedrock at a depth of less than 2 feet.	Bedrock at a depth of less than 2 feet; rapid permeability; slopes of 2 to 20 percent.	Medium shear strength; low to medium compressibility; medium to high susceptibility to piping; fair to good compaction characteristics.
*Tortugas: TG ----- Rock land part variable, no interpretations made.	Poor: more than 40 percent coarse fragments; slopes of 20 to 70 percent.	Unsuited: bedrock at a depth of less than 2 feet.	Unsuited: bedrock at a depth of less than 2 feet.	Poor: slopes of 20 to 70 percent; bedrock at a depth of less than 2 feet.	Slopes of more than 20 percent; bedrock at a depth of less than 2 feet; more than 40 percent coarse fragments.	High to medium shear strength; low to medium compressibility; medium to low compacted permeability; medium to low susceptibility to piping; fair to good compaction characteristics.
Vekol: VeA, VFD -----	Poor: clay texture.	Unsuited: no sand.	Unsuited: no gravel.	Fair to poor: excess fines.	Slow permeability; slopes of 0 to 10 percent.	Medium to low shear strength; medium to low compressibility; medium to low compacted permeability; high to low susceptibility to piping; good to poor compaction characteristics.
*Veyo: VHD, VPD ----- For Curhollow part of VHD and Pastura part of VPD, see their respective series.	Poor: cobbly and stony surface layer.	Unsuited: no sand.	Unsuited: bedrock at a depth of less than 2 feet.	Poor: bedrock at a depth of less than 2 feet.	Bedrock at a depth of less than 2 feet.	Low to medium shear strength; medium to low compressibility; low to medium susceptibility to piping; low compacted permeability; fair to good compaction characteristics.
*Welring: WAG ----- For Tortugas part, see Tortugas series.	Poor: more than 50 percent coarse fragments.	Unsuited: no sand.	Unsuited: bedrock at a depth of less than 2 feet.	Poor: slopes of 30 to 70 percent.	Slopes of 30 to 70 percent; bedrock at a depth of less than 2 feet; more than 50 percent coarse fragments.	High to medium shear strength; low to medium compressibility; medium to low compacted permeability; medium to low susceptibility to piping; fair to good compaction characteristics.

engineering properties—Continued

Soil features affecting—		Soil limitations for—					
Drainage for crops and pasture	Irrigation	Dwellings	Shallow excavations	Septic tank absorption fields	Sewage lagoons	Sanitary landfill ¹	Local roads and streets
Not needed ----	Slopes of 30 to 70 percent; excess coarse fragments.	Severe: slopes of 30 to 70 percent; very stony surface layer.	Severe: slopes of 30 to 70 percent; very stony surface layer.	Severe: slopes of 30 to 70 percent.	Severe: slopes of 30 to 70 percent.	Severe: slopes of 30 to 70 percent; very stony surface layer.	Severe: slopes of 30 to 70 percent; very stony surface layer.
Not needed ----	Slopes of 5 to 30 percent; gravelly and cobbly.	Severe: bedrock at a depth of less than 3 feet.	Severe: bedrock at a depth of less than 3 feet.	Severe: bedrock at a depth of less than 3 feet; slopes of 5 to 20 percent; slow permeability.	Severe: bedrock at a depth of less than 3 feet; slopes of 5 to 30 percent.	Severe: bedrock at a depth of less than 3 feet.	Moderate if slopes are 5 to 15 percent; moderate shrink-swell potential. Severe if slopes are 15 to 30 percent.
Not needed ----	Moderate available water capacity.	Slight -----	Slight -----	Slight -----	Severe: permeability is more than 2.0 inches per hour; slopes of 0 to 10 percent.	Severe: permeability is more than 2.0 inches per hour.	Moderate: excess fines.
Not needed ----	Low available water capacity; bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet; rapid permeability; slopes of 2 to 20 percent.	Severe: bedrock at a depth of less than 2 feet; sand texture; rapid permeability.	Severe: bedrock at a depth of less than 2 feet.
Not needed ----	Slopes of 20 to 70 percent.	Severe: slopes of more than 20 percent; bedrock at a depth of less than 2 feet.	Severe: slopes of more than 20 percent; bedrock at a depth of less than 2 feet.	Severe: slopes of more than 20 percent; bedrock at a depth of less than 2 feet.	Severe: slopes of more than 20 percent; bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet; slopes of more than 20 percent.	Severe: slopes of more than 20 percent; bedrock at a depth of less than 2 feet.
Not needed ----	High available water capacity; irrigation water not available.	Moderate: moderate shrink-swell potential.	Moderate: sandy clay texture.	Severe: permeability is 0.06 to 0.2 inch per hour.	Slight if slopes are 0 to 2 percent. Moderate if slopes are 2 to 7 percent. Severe if slopes are 7 to 10 percent.	Moderate: sandy clay texture.	Moderate: moderate shrink-swell potential.
Not needed ----	Low available water capacity; cobbly; bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.
Not needed ----	Slopes of 30 to 70 percent.	Severe: slopes of 30 to 70 percent; bedrock at a depth of less than 2 feet.	Severe: slopes of 30 to 70 percent; bedrock at a depth of less than 2 feet.	Severe: slopes of 30 to 70 percent; bedrock at a depth of less than 2 feet.	Severe: slopes of 30 to 70 percent; bedrock at a depth of less than 2 feet; more than 50 percent coarse fragments.	Severe: bedrock at a depth of less than 2 feet; slopes of 30 to 70 percent.	Severe: slopes of 30 to 70 percent; bedrock at a depth of less than 2 feet.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Farm ponds	
					Reservoir areas	Embankments
*Winkel: WBD, WCF Rock outcrop part of WCF variable, no interpretations made.	Poor: 40 to 60 percent coarse fragments.	Unsuited: bedrock at a depth of less than 2 feet.	Unsuited: bedrock at a depth of less than 2 feet.	Poor: bedrock at a depth of less than 2 feet.	Hardpan and bedrock at a depth of less than 2 feet; 40 to 60 percent coarse fragments.	High to medium shear strength; low to medium compressibility; medium to low compacted permeability; medium to low susceptibility to piping; fair to good compaction characteristics.
*Yaki: YAF, YZE For Zukan part of YZE, see Zukan series.	Poor: coarse fragments.	Unsuited: bedrock at a depth of less than 2 feet.	Unsuited: bedrock at a depth of less than 2 feet.	Poor: bedrock at a depth of less than 2 feet.	Bedrock at a depth of less than 2 feet.	High to medium shear strength; low to medium compressibility; medium to low compacted permeability; medium to low susceptibility to piping; fair to good compaction characteristics.
Zukan Mapped only in complex with Yaki soils.	Poor: bedrock at a depth of less than 2 feet.	Unsuited: bedrock at a depth of less than 2 feet.	Unsuited: no gravel.	Poor: bedrock at a depth of less than 2 feet.	Bedrock at a depth of less than 2 feet.	Medium to low shear strength; medium compressibility; medium to low compacted permeability; medium to high susceptibility to piping; good to poor compaction characteristics.

¹ Onsite deep studies of the underlying strata, water table, and hazards of aquifer pollution and drainage into ground water should be made for

TABLE 8.—*Engineering*

[Tests were performed at Utah State University. An asterisk in the first column indicates that test data are for a profile of the soil that is not the profile horizons; the data shown are

Soil name and location	Parent material	Depth	Moisture density ¹		Mechanical analysis ²	
			Maximum dry density	Optimum moisture	Percentage 1 inch to 3 inches in diameter ³	Percentage passing sieve—
						No. 4 (4.7 mm)
Bermesa fine sandy loam: SW¼ sec. 31, T. 41 S., R. 13 W	Basalt, sandstone, and shale.	<i>In</i>	<i>Lb per cu ft</i>	<i>Pct</i>		
		0-14	122	12	2	89
		14-26	113	18	15	73
Bond sandy loam: SE¼ sec. 18, T. 42 S., R. 11 W	Sandstone conglomerate.	4-16	126	11	0	92
*Caval fine sandy loam: NW¼ sec. 8, T. 40 S., R. 11 W	Sandstone.	0-40	117	11	0	100
		40-50	122	12	0	100
*Cave gravelly sandy loam: SE¼ sec. 10, T. 40 S., R. 19 W	Alluvium from limestone gneiss and quartzite.	0-15	122	12	2	88
Clovis fine sandy loam: NW¼ sec. 9, T. 43 S., R. 11 W	Alluvium from sandstone shale and siltstone.	0-8	122	10	0	100
		8-22	108	19	0	100
		22-60	107	18	0	100
Collbran very cobbly clay loam: Near center of sec. 12, T. 39 S., R. 13 W.	Basalt.	0-4	102	24	1	95
		4-41	99		0	100
*Dalcan cobbly loam: NE¼ sec. 24, T. 39 S., R. 11 W	Basalt.	0-5	111	16	0	93
		5-9	108	17	2	94
		9-29	94	27	5	91

engineering properties—Continued

Soil features affecting—		Soil limitations for—					
Drainage for crops and pasture	Irrigation	Dwellings	Shallow excavations	Septic tank absorption fields	Sewage lagoons	Sanitary landfill ¹	Local roads and streets
Not needed ----	Bedrock at a depth of less than 2 feet.	Severe: hardpan and bedrock at a depth of less than 2 feet.	Severe: hardpan and bedrock at a depth of less than 2 feet.	Severe: hardpan and bedrock at a depth of less than 2 feet.	Severe: hardpan and bedrock at a depth of less than 2 feet.	Severe: hardpan and bedrock at a depth of less than 2 feet.	Severe: hardpan and bedrock at a depth of less than 2 feet.
Not needed ----	Bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.
Not needed ----	Bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.	Severe: bedrock at a depth of less than 2 feet.

landfill deeper than 5 or 6 feet.

test data

described as representative of the series; however, this profile varies from the modal profile only by slight differences in texture or thickness of representative of the series]

Mechanical analysis ² —Continued							Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued			Percentage smaller than—						AASHTO ⁴	Unified ⁵
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
							<i>Pct</i>			
85	82	29	25	19	15	14	17	NP ⁶	A-2-4(0)	SM
70	68	37	34	29	25	23	28	8	A-4(1)	SC
88	62	40	34	24	17	14	21	5	A-4(1)	SM-SC
100	100	28	20	12	9	8	15	NP	A-2-4(0)	SM
100	99	31	27	23	23	22	20	3	A-2-4(0)	SM
76	65	43	36	19	15	14	21	2	A-4(3)	SM
100	99	38	28	16	10	8	15	NP	A-4(1)	SM
100	98	60	52	43	36	33	35	15	A-6(7)	CL
100	100	71	60	49	38	31	33	9	A-4(7)	ML
93	91	75	68	52	41	36	40	16	A-6(10)	CL
98	97	84	77	65	54	48	47	24	A-7-6(16)	CL
88	83	60	56	38	32	29	25	5	A-4(5)	CL-ML
90	86	60	54	43	29	22	30	9	A-4(5)	CL
88	84	67	62	53	43	38	56	29	A-7-6(18)	CH

TABLE 8.—*Engineering*

Soil name and location	Parent material	Depth	Moisture density ¹		Mechanical analysis ²	
			Maximum dry density	Optimum moisture	Percentage 1 inch to 3 inches in diameter ³	Percentage passing sieve—
						No. 4 (4.7 mm)
		<i>In</i>	<i>Lb per cu ft</i>	<i>Pct</i>		
Detra fine sandy loam: SE¼ sec. 13, T. 41 S., R. 10 W ----	Limestone and sandstone.	8-27 27-44	116 113	13 16	0 0	100 100
*Harrisburg fine sandy loam: SE¼ sec. 12, T. 42 S., R. 13 W ----	Sandstone, shale, and basalt.	0-31	122	11	0	95
Isom cobbly fine sandy loam: NW¼ sec. 15, T. 43 S., R. 13 W ----	Alluvium from limestone, sandstone, and shale.	0-22 22-40	112 108	15 20	17 17	55 42
Ivins loamy fine sand: SE¼ sec. 6, T. 42 S., R. 16 W -----	Sandstone and shale.	0-24 24-39 39-60	121 120 119	10 12 11	0 0 0	100 100 100
*Junction fine sandy loam: NW¼ sec. 29, T. 43 S., R. 13 W ----	Sandstone and shale.	0-7 7-60	120 115	11 16	0 0	100 100
LaVerkin fine sandy loam: SW¼ sec. 23, T. 43 S., R. 16 W ----	Alluvium from limestone, sandstone, and shale.	0-16 16-60	120 123	12 12	1 1	94 94
Leeds silty clay loam: SE¼ sec. 34, T. 42 S., R. 15 W ----	Sandstone, shale, and limestone.	0-15 23-60	106 117	19 15	0 0	100 100
Mathis very stony loamy fine sand: Near W¼ corner of sec. 24, T. 41 S., R. 11 W.	Sandstone and shale.	0-26	120	13	9	46
Naplene silt loam: SW¼ sec. 17, T. 38 S., R. 12 W ----	Alluvium from limestone, sandstone, and shale.	0-7 7-60	114 115	15 16	0 0	100 100
*Nehar very stony sandy loam: NW¼ sec. 2, T. 40 S., R. 13 W ----	Quartzite.	0-5 5-32	126 105	11 19	4 0	88 100
Palma fine sandy loam: Center of sec. 30, T. 42 S., R. 12 W.	Alluvium from sandstone and shale.	0-25 25-60	123 120	12 11	0 0	100 100
Pintura loamy fine sand: NE¼ sec. 36, T. 42 S., R. 14 W ----	Sandstone.	0-65	109	7-13	0	100
*St. George silt loam: NW¼ sec. 3, T. 42 S., R. 13 W -----	Alluvium from sandstone, shale, and limestone.	0-25 25-44 44-61	106 113 118	21 18 14	0 0 0	100 100 100
Spenko very fine sandy loam: Sec. 21, T. 40 S., R. 12 W -----	Sandstone and shale.	0-14 14-27 27-64	119 122 116	13 12 15	0 0 0	100 100 100
Tobler fine sandy loam: 400 feet north of the W¼ corner of sec. 8, T. 43 S., R. 14 W.	Sandstone and shale.	0-60	124	9	0	100

¹ Based on AASHTO Designation T 99-70 (1).

² Mechanical analyses according to the AASHTO Designation T 88-70 (1). Results of this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material 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

test data—Continued

Mechanical analysis ² —Continued							Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued			Percentage smaller than—						AASHTO ⁴	Unified ⁵
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
							<i>Pet</i>			
100	100	47	41	28	23	20	23	6	A-4(2)	SM-SC
100	100	64	54	38	24	16	31	12	A-6(7)	CL
92	89	27	21	14	10	8	15	NP	A-2-4(0)	SM
50	44	28	24	14	7	6	25	NP	A-2-4(0)	GM
35	25	13	10	6	2	1	32	NP	A-1-a(0)	GM
100	99	20	16	10	12	8	13	NP	A-2-4(0)	SM
99	95	35	33	30	28	27	24	10	A-2-4(0)	SC
93	85	33	33	27	20	15	20	3	A-2-4(0)	SM
100	97	34	31	23	16	12	19	NP	A-2-4(0)	SM
99	96	46	38	27	18	8	30	9	A-4(2)	SC
92	90	52	40	25	16	12	19	1	A-4(3)	ML
86	80	47	40	31	24	19	23	6	A-4(2)	SM-SC
100	98	73	69	61	46	34	37	15	A-6(9)	CL
100	100	83	74	58	33	22	22	4	A-4(8)	CL-ML
40	35	10	9	6	4	4	20	NP	A-1-b(0)	GP-GM
98	95	76	68	50	28	22	24	5	A-4(8)	CL-ML
100	97	86	80	66	58	28	27	7	A-4(8)	CL-ML
77	53	25	22	16	10	8	18	NP	A-2-4(0)	SM
98	84	58	56	53	44	41	47	27	A-7-6(16)	CL
100	99	46	37	26	21	19	19	2	A-4(2)	SM
100	99	44	35	22	16	14	18	NP	A-4(2)	SM
100	93	6	5	4	4	4	0	NP	A-3(0)	SP-SM
100	100	96	93	86	56	38	43	17	A-7-6(12)	CL-ML
100	99	93	88	80	46	30	22	7	A-4(8)	CL-ML
98	93	62	58	42	9	6	21	4	A-4(5)	CL-ML
100	100	43	34	24	16	14	17	NP	A-4(0)	SM
100	100	62	44	26	19	17	19	NP	A-4(5)	ML
100	99	65	51	34	30	28	27	8	A-4(6)	CL
99	96	36	30	21	14	11	17	NP	A-4(0)	SM

of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes of soil.

³ Rock fragments larger than 3 inches in diameter were discarded from the sample.

⁴ Based on AASHTO Designation M 145-49 (I).

⁵ Based on the Unified soil classification system.

⁶ NP means nonplastic.

ganic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups that range from A-1 to A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b; A-2-4, A-2-5, A-2-6, A-2-7; and A-7-5 and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest.

The Unified and AASHTO classifications, with group index numbers in parentheses, for tested soils are shown in table 8; the estimated classifications, AASHTO without group index numbers, are shown in table 6 for all soils mapped in the survey area.

Soil properties significant to engineering

Several estimated soil properties significant in engineering are shown in table 6. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 6.

Data concerning depth to seasonal high water table are not provided in table 6, because most soils in the survey area are sufficiently deep over the water table that the water table does not affect their use. The water table is at a depth of 36 to 60 inches in the Draper soils; 24 to 40 inches in St. George silt loam, moderately saline; and 12 to 24 inches in St. George silty clay loam, shallow water table.

Depth to bedrock or hardpan is distance from the surface of the soil to the upper surface of the rock or hardpan layer.

Dominant USDA texture is described in table 6 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the

material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to the plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated to within 5 percent in table 6, but in table 8 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on basis of those soil characteristics observed in the field, particularly structure, porosity, and texture. The estimates in table 6 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It commonly is defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

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

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling 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 that has this rating.

Hydrologic groups are groups of soils that have similar rates of infiltration and similar rates of water transmission within the soil, when the soils are wet. Four such groups currently are recognized. In group A are soils that have the highest rate of infiltration, even when they are thoroughly wet, and the lowest runoff potential. These are deep sands or gravelly soils. In group B are soils that may be shallower or contain more clay than those in group A. Soils in group B have a moderate rate of infiltration and moderate runoff potential. In group C are soils that are shallow over an impermeable layer or that contain considerable clay and colloids. These soils have a slow rate of infiltration and high runoff potential. In group D are mainly clayey soils that have high swelling potential or that contain a clayey layer. The soils in group D have a very slow rate of infiltration and very high runoff potential.

Engineering interpretations of the soils

The interpretations in table 7 are based on the estimated engineering properties of soils shown in table 6, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of the Washington County Area. In table 7 ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for farm ponds, drainage for crops and pasture, and irrigation. For these particular uses, table 7 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, mod-

erate, and severe. *Slight* means soil properties are generally favorable for the rated use, or in other words, limitations that 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* means soil properties so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special design, or intensive maintenance.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms *slight*, *moderate*, and *severe*.

Following are explanations of some of the columns in table 7.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that results at the area from which topsoil is taken.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials. Neither do they indicate quality of the deposit.

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

Farm pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments require soil material that is resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among the unfavorable factors.

Drainage for crops and pasture 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 depth to water table or bedrock.

Dwellings, as rated in table 7, are not more than three stories high and are supported by foundation footings

placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewerlines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrop or big stones, and freedom from flooding or a high water table.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material between depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are 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 assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic matter, and slope, and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification and the amount of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 7 apply only to a depth of about 5 feet; therefore, limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

Local roads and streets, as rated in table 7, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded

to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHTO 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 ease of excavation and amount of cut and fill needed to reach an even grade.

Soil test data

Table 8 contains engineering test data for some of the major soil series in the Washington County Area. The 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 limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Moisture-density, or compaction, data are important in earthwork. If a soil material is compacted at a successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed the *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Tests to determine liquid limit and plasticity index measure the effect of water on the consistence of soil material, as has been explained for table 6.

Formation and Classification of Soils

In this section the factors that affect the formation of soils in the Washington County Area are explained. In addition, the soil series are placed in some categories of the current system of soil classification.

Factors of Soil Formation

Soils are formed by forces of the environment acting upon the soil material deposited or accumulated by various geologic agencies. The characteristics of a soil at any particular place on the earth depend upon the chemical interactions and mineral composition of the parent material; the climate under which the parent material has existed since its deposition or accumulation; the plant and animal life on and in the soil, including actions of man; the relief, or lay of the land; and the length of time the parent material has been subject to active weathering forces. The relative importance of each factor differs from place to place, but generally interaction of all factors determines the character of the soil that forms in any given place.

A soil is a unique natural body. It is usually identified and evaluated by the kinds, arrangement, distinctness, and properties of its horizons. Except in very young or undeveloped soils, these effects of the soil-forming processes

in this survey area are most clearly illustrated by the accumulation of organic matter in the surface layer, the accumulation of clay in the subsoil, the accumulation and cementation of carbonates in the underlying material, the leaching of carbonates and soluble salts, and the thickness of the soil and depth to bedrock.

Parent material

Parent material is the somewhat chemically and mechanically weathered rock or unconsolidated material from which soils form. The hardness, grain size, and porosity of the parent material and its weatherable mineral content greatly influence the rate of formation of soils. Dominant parent materials in the Washington County Area are either derivatives or mixtures of derivatives of the following source materials: sandstone of the Navajo Formation (Jurassic Period); shale from the Meonkpie, Moenave, Chinle, and Kayenta Formations (Triassic Period); limestone of the Callville (Mississippian Period), Carmel (Jurassic Period), and Kaibab (Permian Period) Formations; basalt flow material (Quaternary Period); undifferentiated igneous material (Tertiary Period) of the Upper Beaver Dam Wash area; and alluvium from a mixture of these sources (6). In addition, significant amounts of eolian calcium and volcanic ash have been deposited on some of the soils. The morphological, physical, and chemical properties of the soils are influenced by the kind of parent material in which they formed.

Parent material derived from the Navajo Formation covers large areas in the south-central and southeastern parts of the survey area. Most of the weathered material is slightly calcareous, reddish-yellow fine sand. The carbonates have leached from the coarser textured soils, but horizons of carbonate accumulation and cementation occur in the moderately coarse textured soils. Pintura and Mespun soils are deep, noncalcareous, windblown fine sand. Toquerville soils are shallow fine sand over sandstone bedrock. Harrisburg soils are moderately deep, slightly calcareous fine sandy loam over an indurated carbonate-cemented hardpan. Most of the carbonates that formed the cemented layer probably came from dust and weathered volcanic ash. The Junction and Tobler soils formed in alluvium derived from sandstone mixed with shale parent material. They are deep, calcareous fine sandy loam.

There is little or no evidence of a clay-enriched B horizon in the soils that formed solely in sandstone parent material. Cation exchange capacity is low. The sand fraction of the soil has a high percentage of fine and very fine sand and a very low amount of coarse and very coarse sand.

Parent material derived from the shale formations dominantly accumulates alluvium on fans and in valleys. These shale formations erode easily, and little parent material accumulates in place. Soils that formed in the alluvium, especially from the Moenkpie Formation, commonly have a high content of gypsum. Schmutz soils, for example, are deep, well-drained loams that are high in content of gypsum. There is little leaching of carbonates, but part of the slightly soluble gypsum is leached to a depth of more than 20 to 24 inches. Between these depths and a depth of about 60 inches the soil is nearly 50 percent, by volume, gypsum. Menefee and Shalet soils formed in shale residuum. Menefee soils are shallow, well-drained, strongly calcareous silt loams. The only evidence of horizon development is a slight darkening of the upper 2 or 3 inches by organic matter.

Shalet soils are very shallow clay loams, and, like Menefee soils, they have a slightly darker surface over lighter colored underlying material. Springerville soils formed in nongypsiferous alluvium derived mainly from shale of the Chinle Formation. These soils are clay throughout the profile. They shrink and swell with changes in water content, and consequently soil materials are mixed to a depth of 2 to 3 feet.

Most of the soils that formed from limestone parent material are high in carbonates. Some show no evidence of carbonate movement, some have horizons of carbonate accumulation, and others have indurated carbonate-cemented horizons. The strongly calcareous Chilton soils formed in recent alluvium. They are examples of soils that have little leaching of carbonates. Paunsaugunt soils are shallow, gravelly, and calcareous. Cave soils formed on old alluvial fans. They have a gravelly, carbonate-cemented hardpan. Curhollow soils have an indurated carbonate-cemented hardpan over limestone bedrock. Hobog soils have horizons with noncemented carbonate accumulations that occur as pendants and coatings on pebbles. Isom soils average more than 40 percent carbonates between depths of 10 and 40 inches. The associated Tortugas and Welring soils formed in material weathered from limestone. Both of these soils have a gravelly surface layer and very gravelly underlying material. They average more than 40 percent carbonates above the bedrock.

At higher elevations of Zion National Park, limestone is the dominant source of parent material for Detra, Hogg, Kinesava, and Kolob soils. Precipitation is increased and most of the carbonates have leached out of the profile. Accumulated organic matter has darkened the surface, and silicate clay has accumulated in the subsoil.

Parent material derived from basalt occurs at all elevations in the survey area. It is commonly physiographically associated with large cinder cones and has a high carbonate content. At lower elevations, where annual precipitation is only 8 to 11 inches, the carbonates have not leached from the soils that formed in these materials. An indurated carbonate-cemented hardpan has developed in such soils as Bermesa, Winkel, and Pastura soils, but little or no organic matter has accumulated in the surface layer. Bermesa soils have a buried B horizon that apparently developed during an earlier climatic regime. The earlier overlying horizons presumably eroded and were replaced by windblown sandy loam or loamy sand material. At intermediate elevations where annual precipitation is 10 to 14 inches, carbonates have leached from the solum and accumulated in the underlying material. In some soils, such as the shallow Veyo and Esplin soils, an indurated carbonate-cemented horizon has formed. The deep Collbran soils, however, have a B horizon of clay over a zone of carbonate accumulation but do not have a hardpan. Collbran soils are more than 1 percent organic matter to a depth of 10 to 16 inches. At higher elevations, where average annual precipitation is 16 to 18 inches, all of the carbonates have been leached from such soils as those in the Dalcan series. These soils have a strong argillic horizon over basalt bedrock and are more than 1 percent organic matter throughout.

The undifferentiated igneous material is mainly quartz monzonite, tuff, and tuff-breccia of dacitic or rhyolitic composition. The soils that formed in these materials are all noncalcareous. Except for the somewhat poorly drained, alluvial Draper soils, these soils have horizons of silicate

clay accumulation. Dagflat, Draper, Lavate, and Motoqua soils have a surface layer darkened by organic matter, but the Nehar and Quazo soils do not. The soils that formed in these parent materials have a much higher content of coarse and very coarse sand than any other soils in the survey area. The Bond soils are also sandy, but they formed in Shinarump conglomerate of the Triassic Period.

Soils in the St. George, Leeds, Hantz, Isom, Junction, Naplene, Redbank, and Tobler series are the major cultivated soils in the survey area. They formed in valley alluvium in a mixture of parent materials, dominantly sandstone, shale, and limestone. The alluvium is relatively young, and few or no horizons have developed in the soils. There is no leaching of carbonates or accumulation of organic matter in the surface layer.

Climate

The principal effect of climate on soil formation in the Washington County Area has been through the influence of precipitation and temperature. As elevation increases precipitation increases, except in rain shadows; and soil temperature, oxidation of organic matter, and evapotranspiration decrease. Except in southern exposures at lower elevations, these changes produce wetter soil moisture regimes, which accelerate weathering of parent material, leaching and accumulation of carbonates, and formation and redistribution of clay, and increase plant growth and density. Thus, at higher elevations, except in areas of rock outcrop and in places where the thickness and age of parent material are not limiting, more organic matter accumulates, the surface layer is darker and thicker, the solum is thicker and has a higher accumulation of clay in the B horizon, and carbonates are leached to a greater depth.

The climate of this survey area ranges from arid to moist subhumid. Winters are relatively mild in the lower valleys but cold in the mountains. Summers are hot in the desert basin and cool in the higher areas. The seasonal and daily temperatures vary widely. Average annual air temperature ranges from about 57° F at the lower elevations to about 42° F at the higher elevations. The frost-free period ranges from about 200 days at the lower elevations to about 90 days at the higher elevations. The average annual precipitation ranges from more than 18 inches per year in the higher mountains to less than 8 inches in the desert basin areas. Most of the rain falls in two distinct periods: as gentle showers in winter and early in spring, and as intense thunderstorms in the summer months of July and August. Most of the precipitation is rainfall. Snow is significant only above elevations of 5,000 feet.

The arid area, characterized by the St. George Basin, has an average annual precipitation of 8 to 11 inches. Average annual temperature ranges from 57° to 67°, and the frost-free period is 190 to 205 days. Elevation ranges from about 2,400 to 4,000 feet.

The soils in this survey area typically have a light-colored surface layer that has only a small accumulation of organic matter. The Isom, Junction, Leeds, St. George, and Tobler soils have no other developed soil horizons. La-Verkin soils have some leaching of carbonates and a slight accumulation of organic matter in the surface layer. Bermesa, Cave, Harrisburg, and Winkel soils have carbonate accumulations that have become cemented hardpans. Bermesa, Ivins, and Vekol soils have horizons of clay enrichment above the layer of carbonate accumulation. This

redistribution of clay apparently occurred in a previous climatic period that had higher precipitation or reduced evaporation because of lower temperatures, or both (7, 8).

The semiarid climatic zone of the upland slopes, mountain slopes, and mesas has an average annual precipitation of 10 to 15 inches. The average annual air temperature ranges from 45° to 56°, and the frost-free period is 120 to 170 days. Elevation is 3,500 to 6,000 feet. Rainfall is distributed mainly in two periods, the first during winter and early in spring, and the second during midsummer. This rainfall pattern and the hot summer limit the accumulation of organic matter in the surface layer. Most of the soils have either a light-colored surface layer or a thin, dark-colored surface layer less than 2 or 3 inches thick. Translocation of carbonates and clay is marked in this climatic zone. In the Pastura soils carbonates have accumulated and an indurated hardpan has formed. Esplin and Veyo soils have horizons of clay enrichment over an indurated carbonate-cemented hardpan. Clovis, Palma, and Speno soils have a B horizon of clay enrichment over layers of carbonate accumulation. Bond and Tobish soils have a clay-enriched B horizon.

The mountain toe slopes and foothill fans have a dry-subhumid climate and an average annual precipitation of 12 to 16 inches. Average annual air temperature ranges from 45° to 56°, and the frost-free period is 120 to 160 days. Elevation is 4,000 to 7,000 feet.

All of the soils in this climatic zone have a fairly dense stand of shrubs and juniper and an understory of grass and forbs. Enough organic matter has accumulated to darken the upper 7 to 10 inches of the Caval, Collbran, Dagflat, Lavate, Mokiak, Motoqua, and Tortugas soils. However, such soils as those in the Quazo and Tacan series have little accumulated organic matter. Quazo soils have a southern exposure; therefore, the temperature of the soil is higher, and this may accelerate oxidation of organic matter. Tacan soils are gravelly or very gravelly. With the exception of the Tortugas soils, all of these soils have a clay-enriched B horizon. Caval, Dagflat, Lavate, Mokiak, Motoqua, Quazo, and Tacan soils formed in noncalcareous parent material and have no horizon of carbonate accumulation. The absence of carbonates probably has accelerated the concentration of silicate clay in the B horizon.

The moist-subhumid zone is in high mountain areas, principally in the upper regions of Zion National Park. The average annual precipitation ranges from 16 to 20 inches, average annual air temperature is 42° to 50°, and the frost-free period is 90 to 120 days. Elevation ranges from about 6,000 to 8,200 feet.

The soils in the moist-subhumid zone have a surface layer darkened by 2 to 8 percent organic matter. In the Dalcan, Detra, and Kinesava soils this dark-colored surface layer extends to a depth of 20 inches or more. Dalcan, Detra, Hogg, Kinesava, and Kolob soils are leached essentially free of carbonates and have distinct clay enrichment in the B horizon. Paunsaugunt soils that have very steep slopes are calcareous throughout and do not have a horizon of clay enrichment.

Plant and animal life

The principal effects plants and animals have on soil formation are the accumulation of organic matter and translocation of plant nutrients from the lower to the upper layers. Plants, earthworms, small rodents, insects,

slugs, and snails affect formation of soil structure and porosity, thus influencing the rate of movement of air and water through the soil. Plants and animals also mix the soil, and in this way they may obscure or retard horizon formation. The decay of forest litter produces weak acids, which accelerate leaching of bases from the soil. Bacteria and fungi play an important role in the development of soils by breaking down undecomposed organic matter and changing part of it to humus. At the end of their life cycle, they contribute directly to the content of humus. Some bacteria take nitrogen from the air and change it into a form that can be used by plants.

Man has changed the morphology and properties of many soils in the survey area. Surface horizons have been mixed by cultivation, and many soils have become more susceptible to soil blowing and water erosion because of cultivation and overgrazing, especially in desert areas. The Tobler, St. George, and LaVerkin soils have been irrigated since the survey area was settled. The irrigation water contains suspended silt and clay, and 6 to 18 inches of silty clay loam has accumulated on the surface of the soils.

As mentioned previously, the kind and amount of vegetation and its effect on soil formation depend in part on the climate, which in turn varies with change in elevation. In overgrazed areas, however, the plant community contains a disproportionate amount of less edible species.

In the arid desert basin area the vegetation consists of sparse stands of blackbrush, creosotebush, Mormon tea, bursage, desertrue, black grama, galleta, needleandthread, Indian ricegrass, bush muhly, and cactus. Grasses are a small percentage of the vegetation and contribute only a small amount of organic matter to the soil. High summer temperatures also accelerate oxidation of organic matter and reduce accumulation to a minimum. The light-colored surface layer of the Bermesa, Cave, Hantz, Harrisburg, Hobog, Isom, Ivins, Junction, Leeds, LaVerkin, Nikey, Renbac, Toquerville, Tobler, Vekol, and Winkel soils is less than 1 percent organic matter.

Above the basin floor, from 3,800 to 6,100 feet in elevation, the average annual precipitation increases to 15 inches and evapotranspiration decreases. Utah juniper and pinyon pine grow well in this wetter moisture regime, and plant communities are denser. Oxidation of organic matter is reduced, accumulation increased, and the upper 2 to 3 inches of the darkened surface layer of Bond, Chilton, Mathis, Menefee, Nehar, and Veyo soils is 1 to 2 percent organic matter. At slightly higher elevations the pinyon-juniper areas have an understory dominated by serviceberry, big sagebrush, live oak, and bitterbrush. The upper 7 to 10 inches of the soils in this part of the survey area—Collbran, Dagflat, Mokiak, Motoqua, Lavate, and Magotsu soils—is 1 to 3 percent organic matter. In the mountains at the maximum elevations in the survey area, 6,000 to 8,200 feet, the plant community is Gambel oak, bitterbrush, lupine, snowberry, serviceberry, tall native bluegrass, western wheatgrass, slender wheatgrass, Kentucky bluegrass, and brome grass. The maximum average annual precipitation is 16 to 18 inches, and it produces the maximum plant yields in the survey area. Evapotranspiration and oxidation of organic material are minimum, accumulation is maximum, and the surface layer of the Dalcan, Detra, Hogg, Kolob, and Kinesava soils in this part of the survey area is 2 to 8 percent organic matter. Their subsoil is more than 1 percent organic matter to a depth of

20 to 30 inches.

Relief

Relief, or lay of the land, influences soil formation principally as it affects runoff, drainage, and microclimate. The dominant landforms or features in the Washington County Area are: (1) valley bottoms, recent alluvial fans, and flood plains; (2) desert slopes; (3) upland mesas; and (4) mountain slopes and ridges (fig. 17). Much of this survey area consists of basin and range topography in which mountain ranges alternate with intervening basins of lower elevation. Valleys have been formed by river and stream entrenchment in the basin areas.

The Beaver Dam Mountains, sometimes called Utah Hill, dominate the west side of the survey area, and the Bull Valley Mountains, the northwest corner. Elevation ranges mainly from 5,000 to 7,500 feet. The principal drainageways run east and west from the Beaver Dam Mountains and generally south from the Bull Valley Mountains. Runoff and streams issuing from these mountain areas built the large, dissected alluvial fans in the southwest corner of the area, which is dominated by Cave soils. These soils are shallow gravelly sandy loams over an indurated carbonate-cemented hardpan.

On the steeper slopes of the Beaver Dam Mountains, Tortugas soils are on the north and east exposures, and the closely associated Welring soils are on the south and west exposures. These soils are shallow, well-drained very cobbly soils that are more than 40 percent carbonates. The

Tortugas soils have a dark-colored surface layer, but the Welring soils have a light-colored surface layer. The Cur-hollow soils are on the lower eastern slopes of the Beaver Dam Mountains, locally called the White Hills. Winkel soils are on still lower levels. These soils are shallow, well-drained soils that have an indurated carbonate-cemented hardpan at a depth of 10 to 20 inches.

In the Bull Valley Mountains, Motoqua and Quazo soils are dominant. The dark-colored Motoqua soils are on the north and east slopes, and the lighter colored Quazo soils are on the south and west exposures. The moderately deep, closely associated Dagflat soils are on north and east exposures and have somewhat gentler slopes.

The desertic St. George Basin consists of highly contrasting areas of valley bottoms, alluvial fans, desert slopes, and upland mesas. Elevation ranges from 2,400 to 5,000 feet. Basalt flow mesas are scattered throughout the area. They formed when molten rock spewed over terraces or ran down old stream channels, then cooled and hardened. Since then, differences in hardness and erodibility have caused adjacent, softer areas to erode away, and these areas were left as high mesas. Soils that formed in these basalt flows are in the Winkel, Veyo, Pastura, Esplin, and Magotsu series. These soils are all shallow over an indurated hardpan. The valley bottoms and alluvial fans are the sites of Tobler, Leeds, LaVerkin, St. George, Hantz, and Harrisburg soils. Hobog and Renbac soils and Rock land occupy the uplifted ridges in this area.

To the east of the St. George Basin at elevations of 4,000

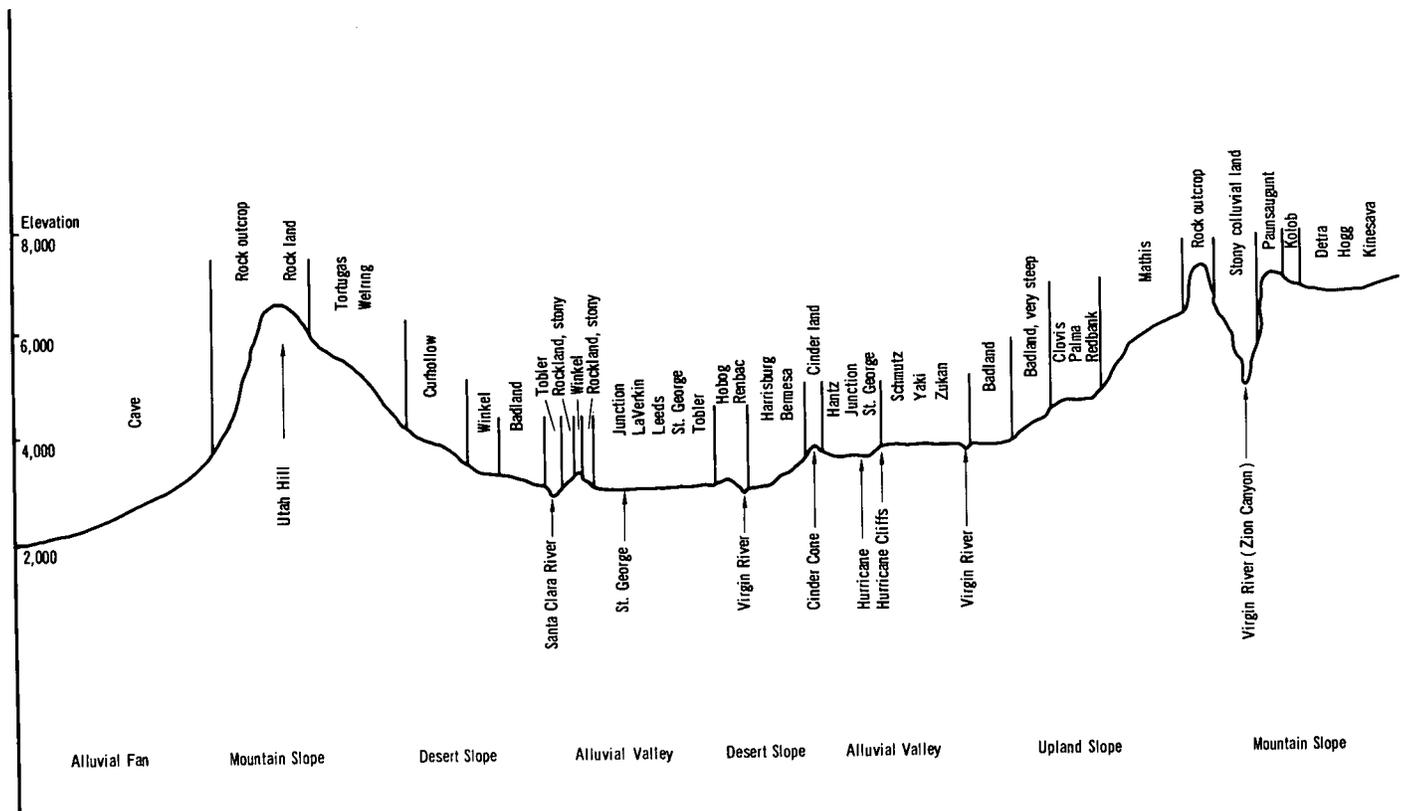


Figure 17.—West to east cross section of the Washington County Area, showing the relationship of the soils on the landscape.

to 5,500 feet is an older alluvial valley called the Big Plain. The deep, well-drained Redbank, Clovis, and Palma soils are in this part of the survey area. To the west and north the Bond soils have formed in high, flat, rather broad areas. These soils are shallow over a clay-enriched subsoil that is underlain by conglomerate bedrock.

The mountain areas of Zion National Park are dissected by the deep, straight-walled canyon of the Virgin River and its tributaries, North Creek and East Fork. In these areas, elevation ranges from 5,000 to 9,000 feet. Such soils as the shallow, dark-colored very gravelly Paunsaugunt and Kolob soils have some very steep slopes; and the deep, well-drained, dark-colored Hogg, Kinesava, and Detra soils dominate the gently sloping to moderately steep slopes. Dalcan soils are on basalt flow mesas in this mountain area. They are well-drained, moderately deep, dark-colored cobbly soils over basalt bedrock.

The southeastern part of the survey area is dominated by sandstone mountains that are essentially bare rock outcrop and intervening small valleys. The deep, excessively drained Mespun soils formed on the valley floors and are surrounded by the Mathis soils on the toe slopes of the sandstone mountains.

Time

Time is necessary for the factors of soil formation to act on parent material. The distinctness of soil horizons depends in part upon the amount of time that the parent material has been in place. The soils in the Washington County Area range from young soils that have little or no horizon differentiation to mature soils that have a well-developed profile.

In this survey area the younger soils occur in the more recent alluvial deposits in the desert basin area. Isom, Junction, Hantz, Leeds, St. George, and Tobler soils show no effects of soil formation other than a slight accumulation of organic matter in the surface layer. Pintura and Toquerville soils are in recent accumulations of windblown sand and have no developed horizons. LaVerkin soils, on somewhat older alluvial fans in valleys, have some carbonates that have leached from the surface layer and accumulated at a depth of about 30 inches. Cave soils formed on alluvial fans of much older age and have formed thick horizons of indurated carbonate-cemented layers.

In the upland areas Redbank soils, on recent alluvial deposits, show little evidence of development. Slightly older Palma soils, which are in the same area and formed in similar parent material, have weak horizons of clay accumulation and surface horizons that have some carbonate leaching. Clovis and Spenlo soils are even older in this landscape. The carbonates have been leached from the upper horizons of these soils and have accumulated below the well-developed, noncalcareous, clay-enriched B horizon. In other areas, particularly in the higher mountains, it is difficult to determine the age relationship of the soils because of differences caused by the combined effects of soil-forming factors other than 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 relation-

ship 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 detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. 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 the soils of similar genesis, or mode of origin, are grouped. In table 9, the soil series of the Washington County Area are placed in 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* (Moll-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 differentiate among suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences that result from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Ustoll* (*Ust*, meaning burnt or dryness, and *oll*, from Mollisol).

GREAT GROUP: Soil suborders are separated 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 interfere 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 *Haplustoll* (*Hapl*, meaning simple horizons, and *Ustoll*, the suborder of Mollisols that have a Ustic moisture regime).

TABLE 9.—*Classification of soil series*

Series	Family	Subgroup	Order
Bermesa	Loamy-skeletal, mixed, thermic	Petrocalcic Paleargids	Aridisols.
Bond	Loamy, mixed, mesic	Lithic Ustollic Haplargids	Aridisols.
Caval	Coarse-loamy, mixed, mesic	Typic Haplustolls	Mollisols.
Cave	Loamy, mixed, thermic, shallow	Typic Paleorthids	Aridisols.
Chilton	Loamy-skeletal, mixed (calcareous), mesic.	Ustic Torriorthents	Entisols.
Clovis	Fine-loamy, mixed, mesic	Ustollic Haplargids	Aridisols.
Collbran	Fine, montmorillonitic, mesic	Aridic Argiustolls	Mollisols.
Curhollow	Loamy-skeletal, mixed, mesic, shallow	Ustollic Paleorthids	Aridisols.
Dagflat	Fine-loamy, mixed, mesic	Aridic Argiustolls	Mollisols.
Dalcan	Clayey-skeletal, montmorillonitic	Pachic Argiborolls	Mollisols.
Detra	Fine-loamy, mixed	Pachic Argiborolls	Mollisols.
Draper	Fine-loamy, mixed, mesic	Cumulic Haplustolls	Mollisols.
Esplin	Loamy, mixed, mesic, shallow	Petrocalcic Ustollic Paleargids	Aridisols.
Hantz	Fine, mixed (calcareous), thermic	Typic Torrifluents	Entisols.
Harrisburg	Coarse-loamy, mixed, thermic	Typic Paleorthids	Aridisols.
Hobog	Loamy-skeletal, mixed, thermic	Lithic Calciorthis	Aridisols.
Hogg	Fine, mixed	Mollic Eutroboralfs	Alfisols.
Ildefonso	Loamy-skeletal, mixed, mesic	Ustollic Calciorthis	Aridisols.
Isom	Loamy-skeletal, carbonatic, thermic	Typic Torriorthents	Entisols.
Ivins	Sandy over loamy, mixed, nonacid, thermic.	Typic Torriorthents	Entisols.
Junction	Coarse-loamy, mixed (calcareous), thermic.	Typic Torrifluents	Entisols.
Kinesava	Fine, mixed	Pachic Paleborolls	Mollisols.
Kolob	Clayey-skeletal, montmorillonitic	Typic Argiborolls	Mollisols.
Kolob variant	Clayey-skeletal, montmorillonitic	Typic Argiborolls	Mollisols.
Lavate	Fine-loamy, mixed, mesic	Aridic Argiustolls	Mollisols.
LaVerkin	Fine-loamy, mixed, thermic	Typic Calciorthis	Aridisols.
Leeds	Fine-loamy, mixed (calcareous), thermic	Typic Torrifluents	Entisols.
Magotsu	Clayey, montmorillonitic, mesic, shallow	Petrocalcic Paleustolls	Mollisols.
Mathis	Sandy-skeletal, mixed, mesic	Ustic Torriorthents	Entisols.
Menefee	Loamy, mixed (calcareous), mesic, shallow.	Typic Ustorthents	Entisols.
Mespun	Mixed, mesic	Ustic Torripsamments	Entisols.
Mokiak	Loamy-skeletal, mixed, mesic	Aridic Argiustolls	Mollisols.
Motoqua	Loamy-skeletal, mixed, mesic	Lithic Argiustolls	Mollisols.
Naplene	Fine-silty, mixed (calcareous), mesic	Ustic Torrifluents	Entisols.
Nehar	Clayey-skeletal, mixed, mesic	Ustollic Haplargids	Aridisols.
Nikey	Coarse-loamy, mixed, thermic	Typic Calciorthis	Aridisols.
Palma	Coarse-loamy, mixed, mesic	Ustollic Haplargids	Aridisols.
Pastura	Loamy, mixed, mesic, shallow	Ustollic Paleorthids	Aridisols.
Paunsaugunt	Loamy-skeletal, mixed	Lithic Haploborolls	Mollisols.
Paunsaugunt variant	Clayey-skeletal, mixed	Lithic Haploborolls	Mollisols.
Pintura	Mixed, thermic	Typic Torripsamments	Entisols.
Quazo	Loamy-skeletal, mixed, mesic	Lithic Ustollic Haplargids	Aridisols.
Redbank	Coarse-loamy, mixed (calcareous), mesic	Ustic Torrifluents	Entisols.
Renbac	Clayey-skeletal, mixed, thermic	Lithic Haplargids	Aridisols.
St. George	Coarse-silty, mixed (calcareous), thermic	Typic Torrifluents	Entisols.
Schmutz	Fine-loamy, gypsic, mesic	Ustic Torrifluents	Entisols.
Shalet	Loamy, mixed (calcareous), mesic, shallow	Typic Torriorthents	Entisols.
Spenlo	Fine-loamy, mixed, mesic	Ustollic Haplargids	Aridisols.
Springerville	Fine, montmorillonitic, mesic	Typic Chromusterts	Vertisols.
Tacan	Loamy-skeletal, mixed, mesic	Ustollic Haplargids	Aridisols.
Tobish	Fine, mixed, mesic	Ustollic Haplargids	Aridisols.
Tobler	Coarse-loamy, mixed (calcareous), thermic.	Typic Torrifluents	Entisols.
Toquerville	Mixed, thermic	Lithic Torripsamments	Entisols.
Tortugas	Loamy-skeletal, carbonatic, mesic	Lithic Haplustolls	Mollisols.
Vekol	Fine, mixed, thermic	Typic Haplargids	Aridisols.
Veyo	Clayey-skeletal, montmorillonitic, mesic, shallow.	Petrocalcic Ustollic Paleargids	Aridisols.
Welring	Loamy-skeletal, carbonatic, mesic	Lithic Ustic Torriorthents	Entisols.
Winkel	Loamy-skeletal, mixed, thermic, shallow	Typic Paleorthids	Aridisols.
Yaki	Loamy-skeletal, carbonatic, mesic	Lithic Calciorthis	Aridisols.
Zukan	Loamy, mixed (calcareous), mesic	Lithic Torriorthents	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 may also be

made in those instances where soil properties intergrade outside of the range of any other 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 Haplustolls* (a typical

Haplustoll).

FAMILY: Soil families are established within a subgroup mainly on the basis of properties important to the growth of plants or on 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 9). An example is *Typic Haplustolls, coarse-loamy, mixed, mesic*.

Laboratory Analyses

Laboratory data for selected soils are shown in table 10. The soils were selected to cover the range in development and properties of most of the soils in the survey area. The data are for representative profiles of these soils. The

files are described in the section "Descriptions of the Soils."

Bulk samples of soil were prepared for laboratory analysis by air drying. They were then screened through a 2-millimeter sieve. The more than 2-millimeter size fraction was weighed, and it is reported in table 10 as a weighted percentage of the whole soil. All other data are based on the less than 2-millimeter size fraction and are reported on an oven-dry, 105° C, weight basis unless otherwise noted. Procedures for sample collection and preparation and for analytical methods that were used in these analyses are fully described in Soil Survey Investigations Report No. 1 (14). The analytical methods have been published elsewhere, but some of them were modified for various reasons. A brief description of each analysis and pertinent references are as follows:

Particle-size distribution.—Pipette and sieve analyses. Organic matter and soluble salts were removed from the

TABLE 10.—Physical

[Laboratory analyses by Soil Survey Investigations Unit, Soil Conservation Service, Riverside,

Soil name and sample number	Horizon	Depth from surface	Particle-size distribution						
			Very coarse sand (2-1 mm)	Coarse sand (1-0.5 mm)	Medium sand (0.5-0.25 mm)	Fine sand (0.25-0.10 mm)	Very fine sand (0.10-0.05 mm)	Silt (0.05-0.002 mm)	Clay (less than 0.002 mm)
Bond sandy loam: S69 Utah-27-7.	A1	0-2	Pct	Pct	Pct	Pct	Pct	Pct	Pct
	B1t	2-4	12.4	21.3	5.7	11.5	14.8	28.6	5.7
	B2t	4-16	13.5	17.9	5.9	11.2	12.9	25.4	13.2
Caval fine sandy loam: S70 Utah-27-9.	A11	0-9	14.0	26.9	7.4	9.9	9.1	16.8	15.9
	A12	9-16	.1	.1	1.6	35.8	30.7	24.5	7.2
	A13	16-23	.1	.1	1.2	32.2	29.6	27.5	9.3
	C1	23-33		.1	1.2	32.0	30.4	23.2	13.1
	C1 ³	33-41		.1	1.1	30.7	30.2	27.4	10.5
	B1b	41-51			1.1	31.0	31.0	27.5	9.4
	B2tb	51-60			1.1	30.3	32.1	27.0	9.5
Cave gravelly sandy loam ⁴ : S70 Utah-27-15.	A1	0-1			1.2	31.4	28.9	21.8	16.7
	C1	1-3	8.7	6.7	3.8	14.5	24.2	31.7	10.4
	C2	3-8	7.1	6.2	3.5	13.4	24.7	32.0	13.1
	C3	8-15	5.2	5.2	3.4	13.0	25.5	33.2	14.5
	C4cam	15-25	4.5	5.0	3.2	12.4	25.0	33.6	16.3
Clovis fine sandy loam: S69 Utah-27-5.	Ap	0-8	.1	1.2	6.6	31.7	25.5	26.4	8.5
	B21t	8-14	.2	1.9	8.0	29.1	17.7	18.7	24.4
	B22t	14-22	.3	2.2	6.4	19.3	14.4	22.3	35.1
	C1ca	22-34	.1	.5	1.8	12.8	15.5	35.5	33.8
	C2ca	34-60		.2	.8	12.3	20.2	39.5	27.0
	Dagflat very cobbly sandy loam: S70 Utah-27-5.	A11	0-2	9.4	18.8	13.0	19.9	9.6	19.0
A12		2-6	8.5	19.3	11.6	17.1	9.3	19.5	14.7
B1t		6-9	29.7	21.3	7.7	9.4	4.3	11.9	15.7
B21t		9-17	7.4	17.5	11.4	16.3	7.4	13.6	26.4
B22t		17-26	16.5	25.8	11.2	14.2	5.5	12.5	14.3
C		26-30	14.8	26.9	14.0	17.6	6.6	11.0	9.1
Dalcan cobbly loam: S69 Utah-27-11.		A1	0-4	2.4	2.9	2.2	20.8	18.4	34.7
	B1	4-9	.6	1.4	1.6	20.4	21.0	34.1	20.9
	B21t	9-16	.5	1.1	1.3	17.9	19.5	33.5	26.2
	B22t	16-27	1.9	2.9	1.9	12.7	12.7	28.3	39.6

sample. Sodium hexametaphosphate and mechanical shaking were used for dispersion (9, 10).

Organic carbon.—Acid-dichromate digestion and ferrous sulfate titration (11, 15). Total carbon by combustion in a carbon analyzer was corrected for inorganic carbon content (5).

Calcium carbonate equivalent.—Determined from manometer measurements of carbon dioxide evolution with a hydrochloric acid treatment (16).

Bulk density.—Duplicate oven-dry, Saran-coated natural soil clods (4).

Water content.—Duplicate Saran-coated natural soil clods equilibrated on a pressure plate at 1/3 bar (4, 13), and sieved samples equilibrated in a pressure-membrane apparatus at 15 bars (13).

Reaction.—Soil reaction, expressed as a pH value, was determined from a mixture of soil and calcium chloride salt solution.

Base saturation.—The quotient of the sum of ammon-

ium acetate extractable bases divided by the cation-exchange capacity.

Cation-exchange capacity.—Ammonium acetate extraction and direct distillation of absorbed ammonia in a Kjeldahl apparatus (11).

Electrical conductivity.—Conductivity of a saturation extract at 25° C measured with a balanced bridge (13).

Dominant clay mineralogy.—X-ray diffraction of the glycerol solvated clay fraction.

Additional Facts About the Area

The first explorers in what is now Washington County probably were eight members of a party headed by Father Silvestre Valez de Escalante. They had set out in 1776 from Sante Fe, New Mexico, to seek a land route to Monterey, California. The expedition was unsuccessful, and on the way back to Sante Fe the party went down Ash Creek,

and chemical data

Calif. A blank in column indicates analysis not run; a dash, analysis run but none detected]

Coarse fragments (more than 2 mm)	Organic carbon ¹	Calcium carbonate equivalent	Bulk density (oven-dry)	Water content at tension of—		Reaction ² (Calcium chloride)	Base saturation	Cation-exchange capacity	Electrical conductivity	Dominant clay mineralogy
				1/3 Bar	15 Bar					
Pct	Pct	Pct	G per cm ³	Pct	Pct	pH	Pct	Meq per 100 g of soil	Mmhos per cm at 25° C	
23	1.22	-----	1.71	6.9	3.6	5.8	89	7.4	-----	Mica, kaolinite.
10	.44	-----	1.68	9.5	3.8	6.4	94	8.0	-----	-----
19	.53	-----	1.71	11.1	5.6	6.2	100	10.9	-----	Mica, kaolinite.
-----	.70	-----	1.56	11.5	6.0	7.2	100	6.1	0.68	Mica.
-----	.36	-----	-----	-----	3.0	7.2	100	5.9	.24	-----
-----	.28	-----	1.50	8.6	3.2	7.3	100	5.8	.34	Mica.
-----	.29	-----	-----	-----	3.2	7.4	100	6.7	.34	-----
-----	.24	-----	1.56	9.8	3.6	7.2	100	6.1	.21	Mica.
-----	.20	-----	-----	-----	3.6	7.3	100	6.5	.19	-----
-----	.09	-----	1.76	14.9	3.5	7.0	100	10.8	-----	Mica.
27	.70	13	-----	-----	7.0	7.7	100	12.6	.79	Mica.
14	.19	14	1.47	16.1	7.4	7.7	100	13.4	.58	-----
10	.47	14	-----	-----	8.0	7.6	100	13.5	.62	Mica.
35	.68	15	1.31	14.9	8.8	7.6	100	13.5	.58	-----
-----	.31	-----	1.64	7.1	3.2	7.6	100	6.5	-----	Mica.
-----	.29	-----	1.76	16.7	8.9	7.3	100	16.2	-----	Mica.
-----	.30	4	1.81	23.1	13.5	7.6	100	25.2	-----	-----
-----	.62	29	1.61	23.6	12.4	8.0	100	22.7	.62	Montmorillonite.
-----	.29	21	1.57	25.0	10.7	8.3	100	22.2	.82	-----
28	1.23	-----	-----	-----	6.9	6.4	100	14.5	-----	Mica.
8	.97	-----	1.38	11.7	8.3	6.4	100	17.0	-----	Montmorillonite.
12	.59	-----	1.53	26.2	11.7	6.6	100	22.4	-----	Montmorillonite.
7	.47	-----	1.60	24.7	15.4	6.6	100	27.4	-----	Montmorillonite.
9	.18	-----	-----	-----	10.6	6.3	100	22.0	-----	Montmorillonite.
39	.10	-----	1.71	17.2	9.0	6.4	100	19.7	-----	Montmorillonite.
40	1.03	-----	1.37	22.1	7.5	5.9	92	17.1	-----	Mica.
58	.93	-----	-----	-----	9.0	6.0	91	20.7	-----	-----
77	1.01	-----	1.55	22.5	11.6	6.0	91	23.8	-----	Mica.
79	.76	-----	-----	-----	17.4	6.1	89	33.2	-----	-----

TABLE 10.—Physical and

Soil name and sample number	Horizon	Depth from surface	Particle-size distribution						
			Very coarse sand (2-1 mm)	Coarse sand (1-0.5 mm)	Medium sand (0.5-0.25 mm)	Fine sand (0.25-0.10 mm)	Very fine sand (0.10-0.05 mm)	Silt (0.05-0.002 mm)	Clay (less than 0.002 mm)
		<i>In</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>
Detra fine sandy loam: S69 Utah-27-12.	A11 -----	0-3	.8	.8	2.4	29.8	20.9	32.1	13.2
	A12 -----	3-8	.3	.3	1.1	29.5	23.5	28.5	16.8
	B1 -----	8-14	.2	.2	1.0	28.4	24.1	27.0	19.1
	B21t -----	14-27	.2	.1	.8	28.2	23.8	29.1	17.8
	B22t -----	27-44	.1	.1	.6	22.5	21.4	26.4	28.9
Harrisburg fine sandy loam: S69 Utah-27-3.	A1 -----	0-2	.4	3.8	23.4	39.5	15.0	12.8	5.1
	C1 -----	2-16	.6	2.7	21.5	41.9	13.3	14.0	6.0
	C1 ³ -----	16-26	.4	2.4	19.8	42.3	13.5	15.0	6.6
	C2 -----	26-35	.2	2.8	24.0	42.2	13.3	11.3	6.2
	C3cam -----	35-44							
Kinesava fine sandy loam: S69 Utah-27-13.	A11 -----	0-5	.9	.7	2.2	37.8	25.6	23.6	9.2
	A12 -----	5-16	.1	.2	1.2	37.5	25.3	24.3	11.4
	A12 ³ -----	16-25		.1	1.0	35.9	27.0	23.5	12.5
	A13 -----	25-31		.1	1.0	35.1	25.8	23.8	14.2
	B1t -----	31-39		.1	.8	25.8	22.3	23.4	27.6
	B21t -----	39-49		.1	.5	18.8	20.1	20.0	40.5
	B22t -----	49-60		.2	.3	3.5	5.8	32.6	57.6
Kolob fine sandy loam: S70 Utah-27-10.	A1 -----	0-6	.7	.7	.7	10.7	14.9	42.3	30.0
	B21t -----	6-10	.3	.2	.3	10.7	17.1	35.4	36.0
	B22t -----	10-18	.6	.4	.5	12.1	18.5	36.7	31.2
	B23t -----	18-28	2.1	.5	.5	8.5	14.5	43.8	30.1
	B24t -----	28-39	2.8	.8	.6	9.2	15.5	42.9	28.2
	B25t -----	39-52			.2	2.8	6.7	60.2	30.6
Naplene silt loam: S70 Utah-27-14.	A1 -----	0-2	.6	1.1	1.5	8.0	11.9	56.6	20.3
	A12 -----	2-7	.7	.7	1.0	5.5	10.0	57.7	24.4
	C1 -----	7-15	.5	.9	1.5	7.2	10.4	56.5	23.0
	C2 -----	15-22	.1	.4	1.0	6.9	10.8	52.6	28.2
	C3 -----	22-39	.3	1.0	1.2	7.8	12.6	51.3	25.8
	C4 -----	39-60	.9	.8	.7	3.5	8.4	59.3	26.4
Palma fine sandy loam: S69 Utah-27-4.	Ap -----	0-6	.1	1.1	5.8	38.0	24.9	20.0	10.1
	A3 -----	6-9		.5	3.5	34.2	28.8	21.6	11.4
	B2t -----	9-15		.6	4.1	35.8	22.5	18.9	18.1
	B3 -----	15-25		.5	5.0	44.6	22.6	16.7	10.6
	C1 -----	25-60		.2	2.7	41.9	27.3	18.6	9.3
Pastura gravelly loam: S70 Utah-27-3.	A1 -----	0-2	4.7	3.3	2.5	18.0	19.8	39.7	12.0
	C1 -----	2-8	.8	2.2	1.9	15.9	19.6	42.1	17.5
	C2ca -----	8-15	.9	1.6	1.8	14.4	19.0	40.6	21.7
	C3ca -----	15-18	4.8	7.5	5.4	11.4	10.0	31.3	29.6
	C4cam -----	18-27							
St. George silt loam: S70 Utah-27-12.	Ap -----	0-9	.2	.4	.7	5.3	11.9	64.7	16.8
	C1 -----	9-20	.1	.6	.8	9.4	18.8	57.4	12.9
	C2 -----	20-29	.3	.3	1.2	11.6	14.1	53.8	18.7
	C3 -----	29-38	.1	.1	.4	3.8	11.2	65.5	18.9
	C4 -----	38-60		.4	1.6	14.6	20.0	54.3	9.1
Tobler fine sandy loam: S69 Utah-27-1.	A1 -----	0-4	.3	4.5	12.2	37.4	28.1	7.9	9.6
	C1 -----	4-13	.1	1.6	7.1	35.1	33.3	12.4	10.4
	C2 -----	13-21		1.6	6.4	30.0	31.9	19.4	10.7
	C2 ³ -----	21-38	.1	1.5	6.3	27.5	29.7	24.5	10.4
	C3 -----	38-60		1.4	5.7	26.3	31.4	25.9	9.3

chemical data—Continued

Coarse fragments (more than 2 mm)	Organic carbon ¹	Calcium carbonate equivalent	Bulk density (ovendry)	Water content at tension of—		Reaction ² (Calcium chloride)	Base saturation	Cation- exchange capacity	Electrical conductivity	Dominant clay mineralogy
				1/3 Bar	15 Bar					
<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>G per cm³</i>	<i>Pct</i>	<i>Pct</i>	<i>pH</i>	<i>Pct</i>	<i>Meq per 100 g of soil</i>	<i>Mmhos per cm at 25° C</i>	
	2.47		1.33	21.2	7.5	5.9	93	17.4		Mica.
	1.34		1.42	14.3	6.8	6.2	93	16.1		Mica.
	.94		1.56	14.8	7.2	6.2	95	15.2		
	.65		1.66	13.8	7.0	6.3	87	14.0		Mica.
	.31		1.86	20.4	10.7	6.6	100	17.1		
	.22	2	1.71	3.5	1.9	7.9	100	3.1	.40	Mica.
	.14	4	1.66	3.8	2.4	8.0	100	3.2	.40	
	.09	5	1.69	3.3	2.2	8.0	100	3.0	.48	Mica.
2	.21	5	1.59	4.3	2.6	7.9	100	3.1	.54	
	2.24		1.48	15.6	6.2	6.1	100	12.7		Mica.
	.89		1.49	8.9	4.6	6.3	100	9.6		Mica.
	.60		1.54	9.3	4.5	6.3	100	9.0		
	.46		1.71	12.7	5.3	6.2	97	9.5		Mica.
	.42		1.84	25.5	10.4	6.0	96	17.9		
	.15		1.90	26.4	17.8	5.9	92	32.0		Mica.
4	.21		1.77	38.5	24.8	6.8	100	49.7		
13	5.13		1.04	26.0		6.7	100	38.6		Mica.
3	1.52		1.38	25.1	16.5	7.1	100	29.8		
25	.83	1	1.62	25.4	13.6	7.4	100	24.6	.14	Mica.
53	.91	4	1.43	23.5	12.4	7.5	100	21.9	.28	
49	.33	8	1.43	23.0	12.3	7.4	100	22.5	.16	Mica.
41	.46	8	1.43	26.5	12.0	7.5	100	21.6	.29	
1	.61	17	1.55	16.5	8.0	7.7	100	10.0	.76	Mica.
1	.60	17			9.4	7.6	100	11.2	.41	
1	.49	18	1.48	15.6	4.6	7.8	100	10.9	.43	Mica.
2	.47	16	1.64		10.4	7.8	100	11.5	.54	
2	.49	17		17.2	9.5	7.8	100	11.6	.79	Mica.
2	.40	19	1.71	18.4	9.9	7.7	100	11.4	3.32	Mica.
	.34	1	1.53	6.1	3.9	7.8	100	9.1	.80	Mica.
	.22		1.79	8.7	4.1	7.7	100	7.8	.45	Mica.
	.33	1	1.62	14.4	6.5	7.7	100	10.6	.38	Mica.
	.18	7	1.57	7.5	4.0	7.8	100	6.0	.38	
	.13	8	1.57	7.5	3.6	7.9	100	5.2	.42	
11	1.38	10	1.35	17.0	8.6	7.6	100	16.9	.62	Mica.
6	.82	11			10.4	7.6	100	18.7	.46	Montmorillonite.
7	.71	18	1.30	22.6	11.6	7.6	100	18.3	.54	Montmorillonite.
38	1.04	60			13.0	7.5	100	10.4	.60	
	.72	22	1.46	21.7	9.3	7.6	100	9.1	3.14	Mica.
	.46	21	1.40	18.7	7.9	7.6	100	8.0	2.87	
	.40	23			8.1	7.6	100	8.3	2.65	Mica.
	.21	23	1.22	22.7	8.4	7.6	100	8.0	2.56	
	.13	15			10.3	7.6	100	5.6	2.76	Mica.
	.13	2	1.63	4.1	2.8	8.0	100	4.6	.47	Montmorillonite.
	.26	4	1.55	7.2	3.5	7.9	100	5.4	.41	Mica.
	.17	7	1.57	11.6	3.7	7.9	100	6.5	.41	
	.22	8	1.56	18.6	3.9	7.9	100	6.7	.62	
	.36	7	1.63	9.6	3.9	8.0	100	7.3	3.21	Montmorillonite.

TABLE 10.—*Physical and*

Soil name and sample number	Horizon	Depth from surface	Particle-size distribution						
			Very coarse sand (2-1 mm)	Coarse sand (1-0.5 mm)	Medium sand (0.5-0.25 mm)	Fine sand (0.25-0.10 mm)	Very fine sand (0.10-0.05 mm)	Silt (0.05-0.002 mm)	Clay (less than 0.002 mm)
Veyo cobbly sandy loam: S70 Utah-27-7.		<i>In</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>Pct</i>
	A1 -----	0-2	7.8	12.6	9.4	17.9	17.4	19.6	15.3
	B1 -----	2-6	5.1	7.7	5.6	11.0	12.7	21.0	36.9
	B21t -----	6-12	3.2	6.8	4.9	8.3	8.2	16.8	51.8
	B22t -----	12-17	9.9	11.1	6.2	7.8	4.8	11.0	49.2
	B3ca -----	17-19	19.4	15.4	8.3	8.9	3.4	12.6	32.0
	Ccam -----	19-23							
Winkel gravelly fine sandy loam: S70 Utah-27-1.	A11 -----	0-1	1.7	2.3	5.4	44.2	25.9	14.9	5.6
	A12 -----	1-6	2.0	2.3	4.2	36.1	21.3	23.9	10.2
	C1ca -----	6-12	1.3	1.8	3.8	35.3	21.3	23.9	12.6
	C2ca -----	12-16	4.8	4.6	4.7	31.4	17.5	21.0	16.0
	C3cam -----	16-22							

¹ Organic carbon by acid-dichromate digestion for Naplene, Pastura, St. George, and Winkel soils; organic carbon for other series by Leco carbon analyzer.

² pH values in this table may vary from those in the section "Description of the Soils" because different methods of analysis were used.

³ Horizon split for sampling, but combined in representative profile description.

⁴ Data representative of the series but not from the representative profile in the survey.

skirting the Hurricane Cliffs, to the Virgin River and into Arizona.

In 1826, Jedediah Strong Smith, fur trapper, explored the area looking for new beaver-trapping country. In the next few years trappers from the north and Spaniards from the south developed the "Old Spanish Trail," which passed through the Area.

Brigham Young, president of the Mormon church, sent an exploration party in fall of 1849 to explore southwestern Utah for colonization. Following a favorable report of this trip, groups of colonists headed by John D. Lee were sent in February, 1852, to settle Harmony in the northern part of Washington County. The townsite was later moved 4 miles west and renamed New Harmony. Other settlements soon followed. St. George, the eventual county seat, was founded in December, 1861. The people lived within the town limits and farmed areas outside the towns.

No railroad facilities are available within the borders of the county. The nearest railhead is at Cedar City, some 50 miles north. Interstate Highway No. 15, the main route between Salt Lake City and Los Angeles, crosses the county. Farming and raising livestock, supplemented by tourist trade, are important sources of income to the people of the county.

Relief and Drainage

Washington County is divided into two dissimilar parts by the Hurricane Cliffs. East of the Hurricane escarpment rise the colorful mesas and plateaus of the Zion National Park, into which steep-walled narrow canyons have been cut by streams of low volume and, for the most part, intermittent flow. These streams are given great erosion competence by abrasive loads of silt and sand, which are

carried at relatively high velocities down the youthful, engraded valleys. The plateaus and mesas, cut from horizontal sedimentary rocks, diminish in elevation southward in step fashion as successively older, resistant formations cap them.

West of the Hurricane ledge the aspect of the landscape contrasts with the tabular country of the plateaus. The rock formations are folded, faulted, and more varied. St. George, the county seat, lies in a topographic basin, north of which rises the dark mass of the Pine Valley Mountains. The St. George Basin is bordered on the west by the massive, gray Beaver Dam Mountains, beyond which a low intermontane basin extends into Nevada. In the northwestern part of Washington County a jumble of low, irregular hills reflects a complex geologic structure (6).

Climate ⁶

The Washington County Area covers much of the Virgin River drainageway in the extreme southwestern part of the State. Elevation within the survey area ranges from more than 8,000 feet to less than 2,500 feet. The wide range in elevation has a marked influence on the climate of the survey area. The annual total precipitation shows a direct relationship to the changes in elevation, and it ranges from about 20 inches a year in the higher mountains to 6 inches at the lowest levels. Table 11 shows temperature and precipitation data for the Washington County Area. The probabilities of low temperatures are shown in table 12.

The limited rainfall occurs in two distinct seasons. The first occurs during winter and early spring when storms

⁶ E. ARLO RICHARDSON, climatologist for Utah, National Weather Service, U.S. Department of Commerce, helped to prepare this section.

chemical data—Continued

Coarse fragments (more than 2 mm)	Organic carbon ¹	Calcium carbonate equivalent	Bulk density (ovendry)	Water content at tension of—		Reaction ² (Calcium chloride)	Base saturation	Cation = exchange capacity	Electrical conductivity	Dominant clay mineralogy
				1/3 Bar	15 Bar					
<i>Pct</i>	<i>Pct</i>	<i>Pct</i>	<i>G per cm³</i>	<i>Pct</i>	<i>Pct</i>	<i>pH</i>	<i>Pct</i>	<i>Meq per 100 g of soil</i>	<i>Mmhos per cm at 25° C</i>	
28	.88	-----	1.57	22.6	7.7	7.6	100	17.2	.51	Mica. Montmorillonite.
35	.39	-----								
	.22	-----	1.68	33.8	21.9	6.8	100	31.1	-----	Montmorillonite.
50	.24	-----	1.44	43.2	21.9	7.0	95	42.7	-----	Montmorillonite.
43	.69	17	1.51	22.0	15.4	7.4	100	41.6	-----	Montmorillonite.
			1.70					24.5	.37	
18	.97	6			3.8	7.4	100	6.5	.93	Mica.
14	.19	6	1.61	10.6	5.1	7.8	100	7.8	.64	Mica.
50	.22	9	1.45	10.4	5.8	7.7	100	7.6	.66	Mica.
64	.48	21	1.35	12.4	7.7	7.6	100	6.6	.67	Mica.
	.37	88	2.05	8.8	5.3	7.8				

from the Pacific Ocean move across the intermountain area. A secondary precipitation maximum occurs in summer during July and August when occasional thunderstorms develop because of the moist air moving northward across the region from the Gulf of Mexico.

Summers are characterized by hot, relatively dry weather at lower elevations. The average maximum temperature in July ranges from slightly more than 100° F in the lower Virgin River Valley to the upper eighties at an elevation of about 5,000 feet. Maximum temperatures of 100° or more are only rarely recorded above 5,000 feet.

Winters in the Washington County Area are normally short and relatively mild. The Rocky Mountains act as a barrier to cold continental airmasses. Temperatures of less than 10° occur only about 1 year out of every 3. Sub-zero readings are rare. Snowfall ranges from about 40 inches a year at New Harmony to less than 5 inches in the lower valleys.

Winds are generally quite light except in the mouths of the larger canyons. The strongest winds are associated with active thunderstorms in summer or occasionally with strong canyon winds near the mouth of the larger canyons in the survey area.

The cooling effect of the rapid changes in elevation causes a wide range in the length of the growing season. The average length ranges from slightly more than 200 days a year in the vicinity of St. George to less than 80 days on some of the higher mountains.

In spite of the warm temperatures in summer, the seasonal pan evaporation at St. George, for the period April to October, averages about 0.34 inch per day, and the air movement 6 inches above pan level is a little more than 50 miles per day. The estimated annual evaporation based on these data is about 54 inches.

Data below show estimates of pan evaporation. These estimates are based on measurements at St. George in the period 1971-72.

Month	Pan evaporation in
April -----	6.59
May -----	9.49
June -----	13.32
July -----	13.80
August -----	12.65
September -----	9.22
October -----	5.82

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TABLE 11.—*Temperature*

Month	Temperature in °F				
	Average daily maximum	Average daily minimum	Average	Record highest	
				Temperature	Year
NEW					
January -----	46.0	21.4	33.7	67	1953
February -----	49.0	24.3	36.7	72	1963
March -----	54.3	27.0	40.7	78	1966
April -----	63.3	33.6	48.4	84	1962
May -----	72.6	42.0	57.3	90	1967
June -----	82.5	50.5	66.5	100	1961
July -----	88.8	58.9	73.9	101	1960
August -----	86.3	57.9	72.1	98	1958
September -----	79.8	49.8	64.8	94	1955
October -----	70.0	39.9	55.0	88	1958
November -----	56.6	28.6	42.6	78	1967
December -----	47.4	22.0	34.7	69	1969
Annual -----	66.4	38.0	52.2	101	1960
St.					
January -----	53.5	25.9	39.7	72	1948
February -----	59.5	30.8	45.2	79	1957
March -----	66.6	35.9	51.3	89	1956
April -----	76.8	41.8	60.3	96	1936
May -----	85.9	51.1	68.5	102	1951
June -----	94.9	58.7	76.8	112	1954
July -----	101.2	66.2	83.7	112	1939
August -----	99.0	65.7	82.4	112	1940
September -----	93.1	55.9	74.5	108	1950
October -----	80.7	44.3	62.5	99	1963
November -----	64.6	30.9	47.8	82	1965
December -----	54.8	27.2	41.0	75	1955
Annual -----	77.6	44.7	61.1	112	1954
ZION NATIONAL PARK					
January -----	51.9	28.9	40.2	71	1954
February -----	57.1	31.1	44.2	78	1963
March -----	63.1	35.5	49.3	86	1956
April -----	72.9	43.1	58.0	94	1946
May -----	83.2	51.8	67.5	102	1950
June -----	93.1	60.2	76.7	114	1954
July -----	100.1	68.2	84.2	115	1950
August -----	97.2	66.5	81.9	111	1946
September -----	91.1	60.2	75.7	110	1950
October -----	78.4	40.3	63.9	97	1950
November -----	63.3	37.4	50.4	83	1959
December -----	53.0	30.4	41.7	71	1950
Annual -----	75.3	46.9	61.1	115	1950

¹ Less than 0.05 inch.² Trace.

and precipitation data

Temperature—Continued		Precipitation in inches					
Record lowest		Average	Greatest daily		Average	Snow	
Temperature	Year		Precipitation	Year		Maximum monthly	
						Amount	Year
HARMONY							
-9	1962	2.04	2.88	1922	18.1	87.5	1949
-10	1962	1.68	3.23	1922	4.9	29.0	1948
0	1966	1.90	2.55	1918	6.8	44.0	1952
17	1966	1.26	1.68	1922	1.4	17.0	1965
23	1965	.71	1.52	1958	(¹)	.3	1950
30	1954	.60	1.58	1957	0	(²)	1949
42	1955	1.13	1.36	1970	0	0	
36	1968	1.48	2.10	1921	0	0	
23	1965	.96	2.90	1911	0	0	
13	1971	1.34	3.22	1916	.5	11.0	1949
3	1964	1.58	1.97	1955	1.5	14.0	1964
-7	1968	1.87	2.37	1965	6.9	42.0	1967
-10	1962	16.55	3.23	1922	40.1	87.5	1949
GEORGE							
-11	1937	.90	1.41	1943	1.3	15.5	1937
14	1962	.89	1.06	1948	.7	9.0	1939
19	1962	.97	1.27	1958	(¹)	2.5	1944
24	1945	.53	.73	1941	0	0	
31	1948	.37	1.52	1958	0	0	
39	1955	.17	.62	1954	0	0	
52	1947	.60	.98	1955	0	0	
50	1957	.61	1.30	1945	0	0	
37	1965	.62	1.44	1939	0	0	
28	1956	.67	.74	1945	0	0	
14	1938	.56	.96	1946	0	0	
3	1940	.92	.98	1942	.7	8.5	1940
-11	1937	7.81	1.52	1958	2.7	15.5	1937
HEADQUARTERS (near Springdale)							
-2	1963	1.55	1.63	1969	4.1	26.5	1949
4	1962	1.58	1.31	1969	2.3	18.0	1949
12	1971	1.69	.92	1970	1.6	14.5	1952
23	1967	1.26	1.20	1953	.7	2.8	1945
22	1967	.68	1.80	1945	0	(²)	1970
40	1964	.62	2.15	1949	0	0	
51	1962	.84	1.08	1958	0	0	
50	1942	1.57	1.60	1953	0	0	
33	1965	.80	1.39	1967	0	(²)	1950
23	1970	1.04	1.31	1966	(¹)	1.0	1949
13	1956	1.16	1.32	1966	.8	5.0	1964
6	1967	1.54	2.02	1966	2.8	21.0	1967
-2	1963	14.33	2.15	1949	12.6	26.5	1949

TABLE 12.—Probability of last low temperatures in spring and first in fall (3)

Probability	Dates for given probability and temperature			
	36° or lower	32° or lower	28° or lower	24° or lower
ST. GEORGE				
Spring: ¹				
1 year in 10 later than -----	May 7	April 18	April 4	March 12
1 year in 4 later than -----	April 28	April 10	March 27	March 3
1 year in 2 later than -----	April 18	March 31	March 17	February 21
3 years in 4 later than -----	April 9	March 21	March 7	February 12
9 years in 10 later than -----	March 31	March 13	February 27	February 3
Fall: ²				
1 year in 10 earlier than -----	October 8	October 17	October 27	November 6
1 year in 4 earlier than -----	October 14	October 23	November 2	November 12
1 year in 2 earlier than -----	October 21	October 30	November 9	November 19
3 years in 4 earlier than -----	October 27	November 5	November 15	November 25
9 years in 10 earlier than -----	November 2	November 11	November 21	December 1
ZION NATIONAL PARK HEADQUARTERS (near Springdale)				
Spring: ¹				
1 year in 10 later than -----	May 19	May 4	April 14	March 23
1 year in 4 later than -----	May 9	April 23	April 3	March 12
1 year in 2 later than -----	April 28	April 12	March 23	March 1
3 years in 4 later than -----	April 16	April 1	March 12	February 18
9 years in 10 later than -----	April 6	March 22	March 2	February 8
Fall: ²				
1 year in 10 earlier than -----	October 9	October 17	October 28	November 6
1 year in 4 earlier than -----	October 17	October 24	November 4	November 13
1 year in 2 earlier than -----	October 25	November 2	November 13	November 22
3 years in 4 earlier than -----	November 3	November 10	November 21	November 30
9 years in 10 earlier than -----	November 10	November 18	November 29	December 8

¹ Probability of a lower temperature occurring in spring on or after the indicated date can be expressed as a percentage. For example, at the Battle Ground station (St. George) the probability of a temperature of 32° F occurring on or after May 7 is 50 percent (5 years in 10).

² Probability of a lower temperature occurring in fall on or before the indicated date can be expressed as a percentage. For example, at the Vancouver station (Zion Park) the probability of 28° F on or before November 7 is 10 percent (1 year in 10).

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Glossary

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

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

Alluvial fan. Alluvium deposited in fan- or cone-shaped deposits at the base of mountains.

Alluvial plains. A series of alluvial fans that have coalesced.

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

Available water 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. *High* capacity is 8 inches or more per 5 feet of soil, *low* is less than 5 inches, and *moderate* is intermediate.

Calcareous soil. A soil that contains enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold dilute hydrochloric acid. The following are terms used in this soil survey to describe calcareous soils and the approximate amounts of lime these soils contain:

Slightly calcareous ----- 1 to 3 percent lime.
 Moderately calcareous ----- 3 to 15 percent lime.
 Strongly calcareous ----- 15 to 40 percent lime.
 Very strongly calcareous ----- 40 percent lime or more.

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

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

Coarse fragments. The gravel, cobblestones, or stones in a soil that range in size from 2 millimeters to 3 feet or more in diameter.

Cobblestones. Rounded mineral or rock fragments that range from 3 to 10 inches in diameter.

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.
- Depth, soil.** In this soil survey, the terms and their meanings used to describe depth of the soil over bedrock or over a restricting layer are: *Deep*, more than 40 inches; *moderately deep*, 20 to 40 inches; *shallow*, 10 to 20 inches; and *very shallow*, less than 10 inches.
- 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 available water 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.
- Fertility, soil.** The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.
- Field moisture capacity.** The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.
- Flood plain.** Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.
- Gravelly soil material.** A soil in which 20 to 50 percent of material, by volume, consists of coarse fragments between 1/8 inch and 3 inches in diameter. A very gravelly soil is one in which 50 to 90 percent of the material by volume is coarse fragments the size of gravel.
- Hardpan.** A hardened or cemented soil horizon, or layer. The soil material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other substance.
- 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.
- Irrigation.** Application of water to soils to assist in production of crops. Methods of irrigation are—
- Border.*—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.
- Basin.*—Water is applied rapidly to relatively level plots surrounded by levees or dikes.
- Controlled flooding.*—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.
- Corrugation.*—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops, or in orchards, to confine the flow of water to one direction.
- Furrow.*—Water is applied in small ditches made by cultivation implements used for tree and row crops.
- Sprinkler.*—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.
- Subirrigation.*—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.
- Wild flooding.*—Irrigation water, released at high points, flows onto the field without controlled distribution.
- Leaching.** The removal of soluble materials from soils or other material by percolating water.
- Lime.** Strictly calcium oxide (CaO), but as commonly used in agricultural terminology, calcium carbonate (CaCO₃).
- Mottling, soil.** Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greater dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.
- Munsell notation.** A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.
- Nutrient, plant.** The elements that may be taken in by a plant, essential to its growth, and used by it in the production of food and tissue. These include nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, molybdenum, and perhaps other elements obtained from the soil and oxygen, hydrogen, and carbon obtained mainly from air and water.
- Parent material.** Disintegrated and partly weathered rock from which soil has formed.
- Ped.** An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.
- Permeability.** The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow*, *slow*, *moderately slow*, *moderate*, *moderately rapid*, *rapid*, and *very rapid*.
- Petrocalcic.** An indurated, lime-cemented hardpan.
- Profile, soil.** A vertical section of the soil through all its horizons and extending into the parent material.
- Range.** Land that primarily produces forage plants that are suitable for grazing domestic livestock.
- Reaction, soil.** The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or “sour,” soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

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

- Relief.** The elevations or inequalities of a land surface, considered collectively.
- Runoff.** The rate that water flows from the land surface. Relative terms used to describe runoff are *very rapid*, *rapid*, *medium*, *slow*, *very slow*, and *ponded*.
- Saline soil.** A soil that contains soluble salts in an amount that impairs growth of plants but does not contain excess exchangeable sodium.
- Slightly saline.*—Conductivity of the saturation extract is 4 to 8 millimhos within a depth of 30 inches.
- Moderately saline.*—Conductivity of the saturation extract is 8 to 16 millimhos within a depth of 30 inches.
- Strongly saline.*—Conductivity of the saturation extract is more than 16 millimhos within a depth of 30 inches.
- Very strongly saline.*—The soil is more than 2 percent total soluble salt.
- Sand.** Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.
- Silt.** Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.
- Soil.** A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.
- Solum.** The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.
- 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 grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).
- Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.
- Substratum.** Technically, the part of the soil below the solum.
- Surface soil.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.
- Terrace.** An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.
- Terrace (geological).** An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.
- Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."
- Topography.** See relief.
- Variants, soil.** 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.
- 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.
- Wilting point (or permanent wilting point).** The moisture content of soil, on an oven-dry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. In referring to a capability unit, a range site, or a wildlife suitability group, read the introduction to the section it is in for general information about its management. Other information is given in tables as follows:

Acres and extent, table 1, page 8.
Estimated yields, table 2, page 65.

Engineering uses of the soils, table 6, 7, and 8,
pages 94 through 121.

Map symbol	Mapping unit	Page	Capability unit		Range site	Name	Page	Wildlife suitability group	
			Irrigated	Nonirrigated					
BA	Badland-----	7	-----	--	VIIIs-3	64	-----	--	4444
BB	Badland, very steep-----	9	-----	--	VIIIs-3	64	-----	--	4444
BED	Bermesa fine sandy loam, 1 to 10 percent slopes-----	9	-----	--	VIIIs-C4	62	Southern Desert Stony Loam	73	4343
BF	Bermesa-Rock land association----- Bermesa loamy fine sand, 1 to 10 percent slopes-----	9	-----	--	-----	--	-----	--	4343
	Rock land-----	--	-----	--	VIIIs-X	64	-----	--	----
BOD	Bond sandy loam, 1 to 10 percent slopes-----	10	-----	--	VIIs-V3	60	Southern Upland Shallow Loam (Juniper-Pinyon)	76	3242
CaD	Caval fine sandy loam, 2 to 10 percent slopes-----	10	-----	--	IVe-V	59	Upland Loam (Summer Precipitation)	77	2141
CEF	Cave gravelly sandy loam, 7 to 30 percent slopes-----	11	-----	--	VIIIs-R3	63	Southern Semidesert Shallow Hardpan, 8- to 10-inch precipitation zone	74	4343
CFD	Cave gravelly sandy loam, low rainfall, 2 to 7 percent slopes---	11	-----	--	VIIIs-C3	62	Southern Desert Shallow Hardpan	73	4343
CHF	Chilton gravelly loam, 5 to 30 percent slopes-----	12	-----	--	VIIs-V4	60	Upland Stony Loam (Pinyon-Juniper) Summer Precipitation	78	3242
CI	Cinder land-----	12	-----	--	VIIIe-X	64	-----	--	4444
CoC	Clovis fine sandy loam, 1 to 5 percent slopes-----	13	-----	--	VIe-V	60	Southern Upland Loam	75	2242
CPD	Clovis-Pastura complex, 1 to 10 percent slopes----- Clovis fine sandy loam, 1 to 5 percent slopes----- Pastura gravelly loam, 2 to 10 percent slopes-----	13	-----	--	VIe-V	60	-----	--	----
		--	-----	--	-----	--	Southern Upland Loam	75	2242
		--	-----	--	-----	--	Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone	74	3242
CRF	Collbran very cobbly clay loam, 2 to 30 percent slopes-----	14	-----	--	VIIIs-V	63	Southern Upland Loam (Shrub)	75	3242
CSE	Curhollow gravelly fine sandy loam, 2 to 10 percent slopes-----	14	-----	--	VIIIs-R3	63	Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone	74	3242

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site	Page	Wildlife suitability group		
			Irrigated	Nonirrigated					
CUF	Curhollow-Rock outcrop complex, 10 to 30 percent slopes-----	14	-----	---	VIIIs-R3	63	-----	----	
	Curhollow gravelly fine sandy loam, 10 to 30 percent slopes-----	--	-----	---	-----	-	Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone	74	3242
DAG	Rock outcrop-----	--	-----	---	-----	--	-----	--	4444
	Dagflat-Motoqua complex, 30 to 70 percent slopes-----	15	-----	---	VIIIs-V	63	-----	--	3242
	Dagflat very cobbly sandy loam, 30 to 60 percent slopes-----	--	-----	---	-----	--	Southern Upland Loam (Shrub)	75	----
	Motoqua very gravelly sandy loam, 30 to 70 percent slopes-----	--	-----	---	-----	--	Upland Stony Hills (Juniper) Summer Precipitation	78	----
DBD	Dalcan cobbly loam, 0 to 15 percent slopes-----	16	-----	---	VIIIs-L	62	Mountain Stony Loam (Summer Precipitation)	69	3141
DKG	Detra-Kolob complex, 20 to 50 percent slopes-----	16	-----	---	VIIIs-L	62	-----	--	----
	Detra fine sandy loam, 20 to 30 percent slopes-----	--	-----	---	-----	--	Mountain Loam (Summer Precipitation)	67	2141
	Kolob very stony silt loam, 20 to 50 percent slopes-----	--	-----	---	-----	--	Mountain Stony Loam (Summer Precipitation)	69	3141
DrB	Draper loam, 2 to 5 percent slopes--	17	IIw-1	58	-----	--	Semiwet Meadows	71	1242-I
DU	Dune land-----	17	-----	---	VIIIs-6	64	-----	--	4444
EA	Eroded land-Shalet complex-----	17	-----	---	VIIe-R3	61	-----	--	----
	Eroded land-----	--	-----	---	-----	--	-----	--	4444
	Shalet clay loam, 2 to 20 percent slopes-----	--	-----	---	-----	--	Southern Semidesert Shallow Loam	75	4343
EB	Eroded land-Shalet complex, warm----	17	-----	---	VIIe-C3	61	-----	--	----
	Eroded land-----	--	-----	---	-----	--	-----	--	4444
	Shalet clay loam, warm, 2 to 20 percent slopes-----	--	-----	---	-----	--	Southern Desert Stony Loam	73	4343
FA	Fluvaquents and Torrifluvents, sandy-----	18	-----	---	VIIw-07	62	Semiwet Stream Bottoms	71	4424
GA	Gullied land-----	18	-----	---	VIIIe-E	64	-----	--	4444
Ha	Hantz silty clay loam-----	19	IIIs-05	59	-----	--	-----	--	1242-I
HbC	Harrisburg fine sandy loam, 1 to 5 percent slopes-----	19	IIIs-03	59	VIIe-C	61	Southern Desert Loam	71	4343
HD	Harrisburg-Rock land association----	20	-----	---	-----	--	-----	--	4343
	Harrisburg fine sandy loam, 5 to 20 percent slopes-----	--	-----	---	VIIe-C	61	Southern Desert Loam	71	----
	Rock land-----	--	-----	---	VIIIs-X	64	-----	--	----
HG	Hobog-Rock land association-----	20	-----	---	-----	--	-----	--	4343
	Hobog very cobbly loam, 3 to 40 percent slopes-----	--	-----	---	VIIIs-C3	62	Southern Desert Stony Loam	73	----
	Rock land-----	--	-----	---	VIIIs-X	64	-----	--	----
IAF	Isom cobbly sandy loam, 3 to 30 percent slopes-----	22	-----	---	VIIIs-C4	62	Southern Desert Stony Loam	73	4343

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site		Wildlife suitability group		
			Irrigated	Nonirrigated	Name	Page			
Ib	Ivins loamy fine sand-----	22	IIIs-06	59	VIIIs-C6	62	Southern Desert Sand	72	2242-I and 4343
Ic	Ivins loamy fine sand, hummocky-----	22	-----	--	VIIIs-C6	62	Southern Desert Sand	72	4343
JaB	Junction fine sandy loam, 1 to 2 percent slopes-----	23	IIe-0	57	VIIe-C	61	Southern Desert Loam	71	1242-I and 4343
JaC	Junction fine sandy loam, 2 to 5 percent slopes-----	23	IIIe-0	58	VIIe-C	61	Southern Desert Loam	71	2242-I and 4343
KAE	Kinesava fine sandy loam, 15 to 25 percent slopes-----	24	-----	--	VIe-L	60	Mountain Loam (Oak)	67	2141
KBD	Kinesava-Detra fine sandy loams, 2 to 15 percent slopes-----	24	-----	--	VIe-L	60	-----	--	2141
	Kinesava fine sandy loam, 2 to 15 percent slopes-----	--	-----	--	-----	--	Mountain Loam (Oak)	67	----
	Detra fine sandy loam, 2 to 5 percent slopes-----	--	-----	--	-----	--	Mountain Loam (Summer Precipitation)	67	----
KCE	Kinesava complex, 2 to 30 percent slopes-----	25	-----	--	VIe-L	60	-----	--	----
	Kinesava fine sandy loam, 2 to 15 percent slopes-----	--	-----	--	-----	--	Mountain Loam (Oak)	67	2141
	Kolob silt loam, brown variant, 10 to 30 percent slopes-----	--	-----	--	-----	--	Mountain Stony Loam (Summer Precipitation)	69	3242
KD	Kolob-Detra association-----	25	-----	--	-----	--	-----	--	2141
	Kolob fine sandy loam, 20 to 50 percent slopes-----	--	-----	--	VIIe-L	61	Mountain Stony Loam (Summer Precipitation)	69	----
	Detra fine sandy loam, 5 to 20 percent slopes-----	--	-----	--	VIe-L	60	Mountain Loam (Summer Precipitation)	67	----
KHC	Kolob-Hogg complex, 2 to 8 percent slopes-----	26	-----	--	VIe-L	60	-----	--	2141
	Kolob cobbly fine sandy loam, 2 to 8 percent slopes-----	--	-----	--	-----	--	Mountain Stony Loam (Summer Precipitation)	69	----
	Hogg fine sandy loam, 2 to 5 percent slopes-----	--	-----	--	-----	--	Mountain Loam (Ponderosa Pine)	67	----
KLG	Kolob-Paunsaugunt complex, 20 to 60 percent slopes-----	26	-----	--	VIIe-L	61	-----	--	----
	Kolob cobbly fine sandy loam, 20 to 60 percent slopes-----	--	-----	--	-----	--	Mountain Stony Loam (Summer Precipitation)	69	3141
	Paunsaugunt gravelly silt loam, 30 to 50 percent slopes-----	--	-----	--	-----	--	Mountain Shallow Loam (Ponderosa Pine)	68	3242
LA	Lava flows-----	27	-----	--	VIIIIs-X	64	-----	--	4444
Lb	Lavate sandy loam-----	27	-----	--	IVe-V	59	Upland Loam (Summer Precipitation)	77	2242
LcB	LaVerkin fine sandy loam, 1 to 2 percent slopes-----	28	IIe-0	57	VIIe-C	61	Southern Desert Loam	71	1242-I and 4343

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site		Wildlife suitability group		
			Irrigated	Nonirrigated					
			Symbol	Page	Symbol	Page	Name	Page	
LcC	LaVerkin fine sandy loam, 2 to 5 percent slopes-----	28	IIIe-0	58	VIIe-C	61	Southern Desert Loam	71	2242-I and 4343
LdB	LaVerkin silty clay loam, 1 to 2 percent slopes-----	28	IIe-0	57	-----	--	-----	--	2242-I
LeA	Leeds silty clay loam, 0 to 1 percent slopes-----	29	IIIs-05	59	-----	--	-----	--	2242-I
LeB	Leeds silty clay loam, 1 to 2 percent slopes-----	29	IIIs-05	59	-----	--	-----	--	2242-I
LeD	Leeds silty clay loam, 5 to 10 percent slopes-----	29	IIIe-05	58	-----	--	-----	--	2242-I
MAE	Magotsu-Pastura complex, 2 to 20 percent slopes-----	30	-----	--	VIIIs-R3	63	Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone	74	3242
MBG	Mathis-Rock outcrop complex, 20 to 50 percent slopes-----	31	-----	--	VIIIs-V4	63	-----	--	-----
	Mathis very stony loamy fine sand, 20 to 50 percent slopes-----	--	-----	--	-----	--	Southern Upland Stony Sand (Juniper-Pinyon)	76	3242
	Rock outcrop-----	--	-----	--	-----	--	-----	--	4444
MEG	Menefee-Rock outcrop complex, 25 to 60 percent slopes-----	32	-----	--	VIIIs-V3	63	-----	--	-----
	Menefee shaly loam, 25 to 60 percent slopes-----	--	-----	--	-----	--	Upland Shallow Shale (Pinyon-Juniper) Summer Precipitation	78	3242
	Rock outcrop-----	--	-----	--	-----	--	-----	--	4444
MFD	Mespu fine sand, 0 to 10 percent slopes-----	32	-----	--	VIIIs-V6	64	Upland Sand (Juniper-Pinyon) Summer Precipitation	77	3242
MMG	Motoqua-Mokiak very cobbly sandy loams, 30 to 70 percent slopes-----	33	-----	--	VIIIs-V4	63	-----	--	3242
	Motoqua very cobbly sandy loam, 30 to 70 percent slopes-----	--	-----	--	-----	--	Upland Stony Hills (Juniper) Summer Precipitation	78	-----
	Mokiak very cobbly sandy loam, 30 to 70 percent slopes-----	--	-----	--	-----	--	Upland Stony Loam (Pinyon-Juniper) Summer Precipitation	78	-----
MOG	Motoqua-Rock outcrop complex, 30 to 70 percent slopes-----	34	-----	--	VIIIs-V4	63	-----	--	-----
	Motoqua very cobbly sandy loam, 30 to 70 percent slopes-----	--	-----	--	-----	--	Upland Stony Hills (Juniper) Summer Precipitation	78	3242
	Rock outcrop-----	--	-----	--	-----	--	-----	--	4444
NaC	Naplene silt loam, 2 to 6 percent slopes-----	34	IIIe-1	58	IVe-V	59	Upland Loam (Summer Precipitation)	77	2242-I and 2242

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site	Page	Wildlife suitability group		
			Irrigated	Nonirrigated					
NEF	Nehar very stony sandy loam, 3 to 30 percent slopes-----	35	-----	--	VIIIs-V4	63	Upland Stony Loam (Pinyon-Juniper) Summer Precipitation	78	3242
NIF	Nehar-Ildefonso complex, 3 to 30 percent slopes-----	35	-----	--	VIIIs-V4	63	Upland Stony Loam (Pinyon-Juniper) Summer Precipitation	78	3242
NkC	Nikey sandy loam, 1 to 3 percent slopes-----	36	IIe-0	57	VIIe-C	61	Southern Desert Loam	71	1242-I and 4343
NLE	Nikey sandy loam, 3 to 15 percent slopes-----	36	-----	--	VIIe-C	61	Southern Desert Loam	71	4343
NME	Nikey very stony sandy loam, 2 to 15 percent slopes-----	37	-----	--	VIIIs-C4	62	Southern Desert Stony Loam	73	4343
NNE	Nikey-Isom complex, 3 to 30 percent slopes-----	37	-----	--	VIIe-C	61	-----	--	4343
	Nikey sandy loam, 3 to 15 percent slopes-----	--	-----	--	-----	--	Southern Desert Loam	71	----
	Isom very cobbly fine sandy loam, 3 to 30 percent slopes-----	--	-----	--	-----	--	Southern Desert Stony Loam	73	----
PAC	Palma loamy fine sand, 1 to 5 percent slopes-----	37	-----	--	VIIIs-V6	64	Southern Upland Loam	75	2242
PbC	Palma fine sandy loam, 1 to 5 percent slopes-----	37	-----	--	VIe-V	60	Southern Upland Loam	75	2242
PcC	Pastura loam, 2 to 5 percent slopes-----	39	IVs-13	60	-----	--	-----	--	2242-I
PED	Pastura-Esplin complex, 0 to 10 percent slopes-----	39	-----	--	VIIIs-R3	63	Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone	74	----
	Pastura gravelly loam, 2 to 10 percent slopes-----	--	-----	--	-----	--	-----	--	3242
	Esplin loam, 0 to 2 percent slopes-----	--	-----	--	-----	--	-----	--	4343
PFG	Paunsaugunt gravelly silt loam, 30 to 50 percent slopes-----	39	-----	--	VIIIs-L	62	Mountain Shallow Loam (Ponderosa Pine)	68	3242
PG	Paunsaugunt-Kolob association-----	40	-----	--	-----	--	-----	--	----
	Paunsaugunt gravelly silt loam, 10 to 30 percent slopes-----	--	-----	--	VIIIs-L	62	Mountain Shallow Loam (Ponderosa Pine)	68	3242
	Kolob cobbly fine sandy loam, 8 to 12 percent slopes-----	--	-----	--	VIe-L	60	Mountain Stony Loam (Summer Precipitation)	69	2141

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Map symbol	Mapping unit	Page	Capability unit		Range site		Wildlife suitability group		
			Irrigated	Nonirrigated					
			Symbol	Page	Symbol	Page	Name	Page	
PKE	Paunsaugunt-Rock outcrop complex, 2 to 30 percent slopes-----	40	-----	--	VIIIs-L	62	-----	--	----
	Paunsaugunt cobbly silt loam, clayey subsoil variant, 2 to 8 percent slopes-----	--	-----	--	-----	--	Mountain Shallow Loam (Ponderosa Pine)	68	3242
	Paunsaugunt gravelly silt loam, 10 to 30 percent slopes-----	--	-----	--	-----	--	Mountain Shallow Loam (Ponderosa Pine)	68	3242
	Rock outcrop-----	--	-----	--	-----	--	-----	--	4444
PnC	Pintura loamy fine sand, 1 to 5 percent slopes-----	41	IIIs-06	59	VIIIs-C6	62	Southern Desert Sand	72	2242-I and 4343
PoD3	Pintura loamy fine sand, hummocky, 1 to 10 percent slopes-----	41	-----	--	VIIIs-C6	62	Southern Desert Sand	72	4343
PTE	Pintura-Toquerville complex, 1 to 20 percent slopes-----	41	-----	--	VIIIs-C6	62	Southern Desert Sand	72	4343
QMG	Quazo-Motoqua very gravelly sandy loams, 30 to 70 percent slopes----	42	-----	--	VIIIs-V4	63	Upland Stony Hills (Juniper) Summer Precipitation	78	3242
RaC	Redbank fine sandy loam, 1 to 5 percent slopes-----	42	IIE-1	58	VIe-V	60	Southern Upland Loam	75	1242-I and 2242
RbA	Redbank silty clay loam, 0 to 2 percent slopes-----	42	I-1	57	-----	--	-----	--	1242-I
RE	Renbac-Rock land association-----	43	-----	--	-----	--	-----	--	4343
	Renbac channery clay loam, 2 to 30 percent slopes-----	--	-----	--	VIIIs-C3	62	Southern Desert Stony Loam	73	----
	Rock land-----	--	-----	--	VIIIs-X	64	-----	--	----
RI	Riverwash-----	43	-----	--	VIIIw-4	64	-----	--	4343
RO	Rock land-----	43	-----	--	VIIIs-X	64	-----	--	4343
RP	Rock land, stony-----	43	-----	--	VIIIs-X	64	-----	--	4343
RR	Rock land-Hobog association-----	44	-----	--	-----	--	-----	--	4343
	Rock land-----	--	-----	--	VIIIs-X	64	-----	--	----
	Hobog very cobbly loam, 3 to 40 percent slopes-----	--	-----	--	VIIIs-C3	62	Southern Desert Stony Loam	73	----
	Renbac channery clay loam, 2 to 30 percent slopes-----	--	-----	--	VIIIs-C3	62	Southern Desert Stony Loam	73	----
RT	Rock outcrop-----	44	-----	--	VIIIs-X	64	-----	--	4444
RU	Rough broken land-----	44	-----	--	VIIIs-E	64	-----	--	4343
Sa	St. George silt loam-----	45	-----	--	VIIe-C	61	Southern Desert Loam	71	4343
Sb	St. George silt loam, strongly saline-----	45	-----	--	VIIw-07	62	Salt Meadow	70	4424
Sc	St. George silty clay loam-----	45	I-0	57	-----	--	-----	--	1242-I
Sd	St. George silty clay loam, moderately saline-----	45	-----	--	VIw-07	60	Salt Meadow	70	4424
Se	St. George silty clay loam, shallow water table-----	45	-----	--	VIIw-07	62	Salt Meadow	70	4424
SH	Schmutz loam-----	46	-----	--	VIIe-R	61	Southern Semidesert Loam	74	3242
SPD	Spento very fine sandy loam, 2 to 10 percent slopes-----	47	-----	--	IVe-V	59	Southern Upland Loam	75	2242

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Map symbol	Mapping unit	Page	Capability unit		Range site	Page	Wildlife suitability group		
			Irrigated	Nonirrigated					
SrC	Springerville clay, 0 to 5 percent slopes-----	48	-----	--	IVe-V	59	Southern Upland Loam	75	2242
SY	Stony colluvial land-----	48	-----	--	VIIIs-R3	63	Southern Semidesert Malpai	74	4343
TAG	Tacan very stony sandy loam, 30 to 70 percent slopes-----	48	-----	--	VIIIs-V4	63	Upland Stony Loam (Pinyon-Juniper) Summer Precipitation	78	3242
TBF	Tobish very cobbly clay loam, 5 to 30 percent slopes-----	49	-----	--	VIIIs-R	63	Southern Semidesert Loam	74	3242
Tc	Tobler fine sandy loam-----	49	IIIe-0	58	VIIe-C	61	Southern Desert Loam	71	1242-I and 4343
Td	Tobler silty clay loam-----	49	IIe-0	57	-----	--	-----	--	1242-I
TG	Tortugas-Rock land association-----	51	-----	--	-----	--	-----	--	-----
	Tortugas very gravelly loam, 20 to 70 percent slopes-----	--	-----	--	VIIIs-V3	63	Upland Stony Hills (Juniper) Summer Precipitation	78	3242
	Rock land-----	--	-----	--	VIIIs-X	64	-----	--	4343
VeA	Vekol sandy loam, 0 to 2 percent slopes-----	52	-----	--	VIIe-C	61	Southern Desert Loam	71	4343
VFD	Vekol sandy loam, 2 to 10 percent slopes-----	52	-----	--	VIIe-C	61	Southern Desert Loam	71	4343
VHD	Veyo-Curhollow complex, 3 to 10 percent slopes-----	52	-----	--	VIIIs-R5	63	Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone	74	3242
VPD	Veyo-Pastura complex, 1 to 10 percent slopes-----	53	-----	--	VIIIs-R3	63	Southern Semidesert Shallow Hardpan, 10- to 12-inch precipitation zone	74	3242
WAG	Welring-Tortugas very gravelly loams, 20 to 70 percent slopes-----	53	-----	--	-----	--	-----	--	-----
	Welring very gravelly loam, 30 to 70 percent slopes-----	--	-----	--	VIIIs-V3	63	Upland Stony Hills (Juniper) Summer Precipitation	78	3242
	Tortugas very gravelly loam, 20 to 70 percent slopes-----	--	-----	--	VIIIs-V3	63	Upland Stony Hills (Juniper) Summer Precipitation	78	3242
	Rock outcrop-----	--	-----	--	VIIIs-X	64	-----	--	4444
WBD	Winkel gravelly fine sandy loam, 1 to 8 percent slopes-----	54	-----	--	VIIIs-C4	62	Southern Desert Stony Loam	73	4343
WCF	Winkel-Rock outcrop complex, 8 to 30 percent slopes-----	54	-----	--	VIIIs-C4	62	-----	--	-----
	Winkel gravelly fine sandy loam, 8 to 30 percent slopes--	--	-----	--	-----	--	Southern Desert Stony Loam	73	4343
	Rock outcrop-----	--	-----	--	-----	--	-----	--	4444

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			Irrigated	Nonirrigated					
YAF	Yaki very cobbly loam, 3 to 35 percent slopes-----	55	-----	--	VIIIs-R3	63	Southern Semidesert Shallow Loam	75	4343
YZE	Yaki-Zukan complex, 1 to 35 percent slopes-----	55	-----	--	VIIIs-R3	63	Southern Semidesert Shallow Loam	75	4343

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