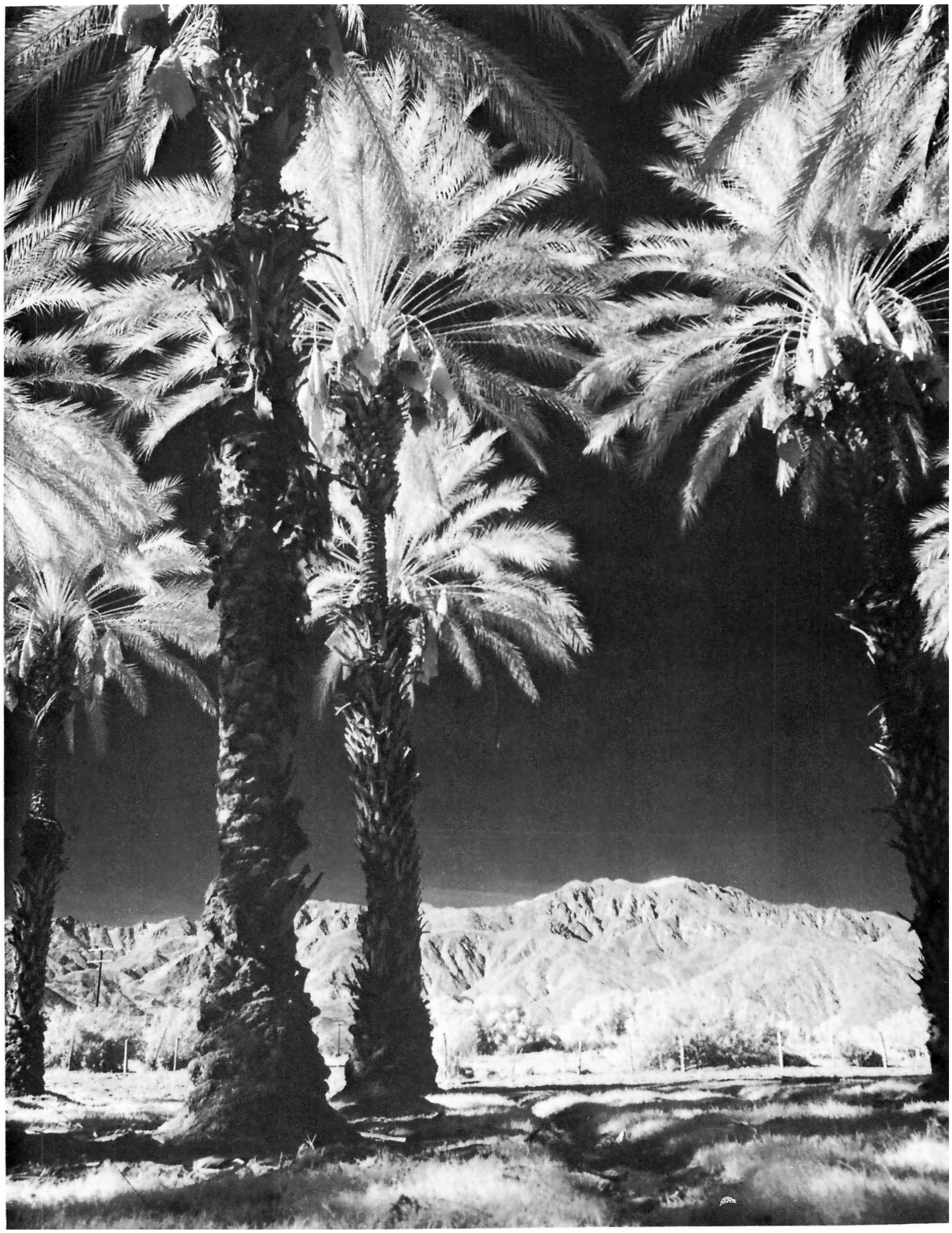
SOIL SURVEY OF

Riverside County, California
Coachella Valley Area



United States Department of Agriculture
Soil Conservation Service
in cooperation with
University of California Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1958–73. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the Area in 1974. This survey was made cooperatively by the Soil Conservation Service and the University of California Agricultural Experiment Station. The Coachella Valley Resource Conservation District and the Coachella Valley County Water District assisted by providing equipment and services. It is part of the technical assistance furnished to the Coachella Valley Resource Conservation District and the Coachella Valley County Water District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms; 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 Riverside County, California, Coachella Valley 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 Area in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the capability unit in which the soil has been placed.

Individual colored maps showing 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 with a moderate limitation can be colored yellow, and those with 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 descriptions of the soils, the capability grouping, and the discussion of management practices and estimated yields.

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

Community planners and others can find information that affects the choice of sites for dwellings, industrial buildings, and recreational areas in the engineering tables.

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

Newcomers in the Coachella Valley Area may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Climate."

Cover: Date garden on Coachella fine sand, 0 to 2 percent slopes. Date clusters covered for protection against birds and rain.

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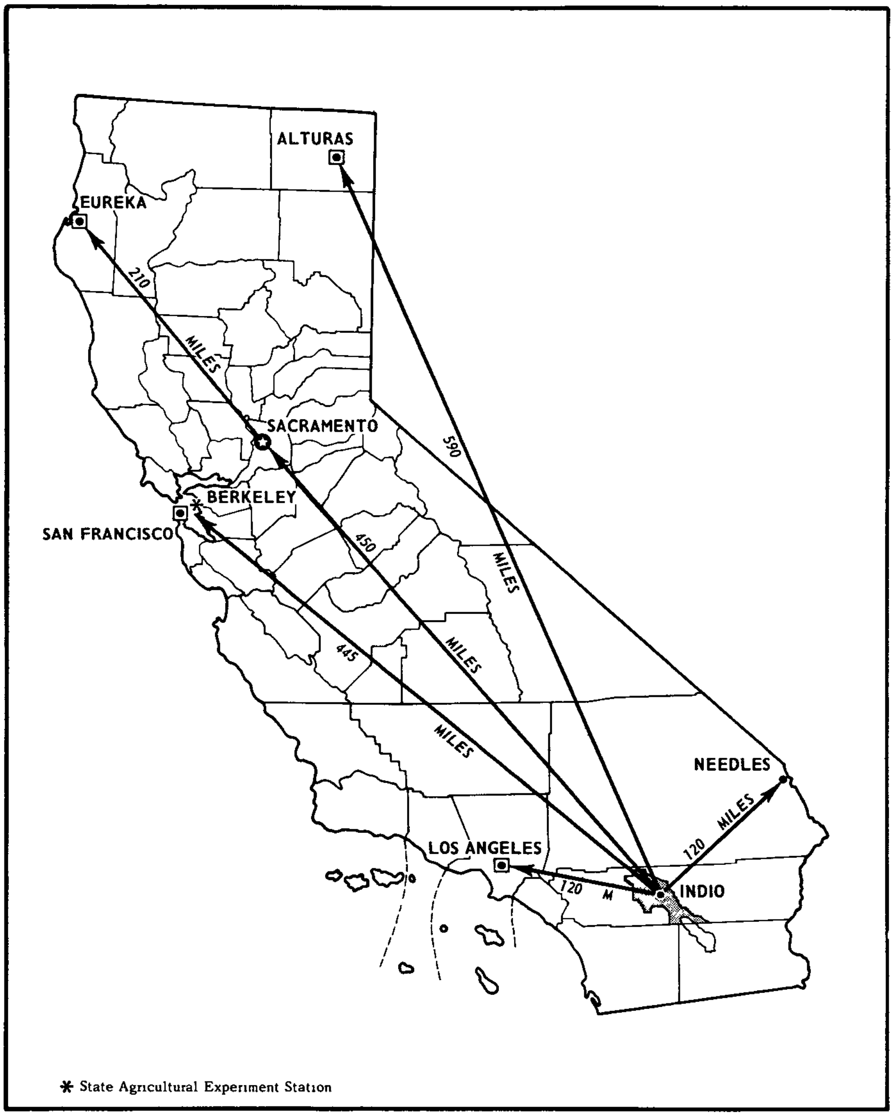

Location of Riverside County in California, Coachella Valley Area.

SOIL SURVEY OF RIVERSIDE COUNTY, CALIFORNIA COACHELLA VALLEY AREA

BY ARNOLD A. KNECHT

FIELDWORK BY ARNOLD A. KNECHT, CONRAD R. SIMONSON, AND EDDIE SPENCER, SOIL CONSERVATION SERVICE

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

THE COACHELLA VALLEY AREA, in the central part of Riverside County north of Salton Sea, extends from Imperial County to San Bernardino County (see facing page). The survey area is 560,640 acres in extent. It has a population of 106,000 (*6*).[1] Indio, the principal town, has a population of 14,361.

High value agricultural crops are grown extensively in the Coachella Valley Area. Large acreages are used for oranges, lemons, grapefruit, table grapes, and dates. Extensive acreages are in carrots, corn, tomatoes, onions, squash, bell peppers, radishes, and leaf lettuce for shipment to areas where such produce is out of season. Alfalfa and cotton are other important crops grown in rotation with the out-of-season crops. All crops are irrigated.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Coachella Valley Area, where they are located, and how they can be used. They went into the Area knowing they likely would find many soils they had already seen and perhaps some they had not. They observed steepness, length, and shape of slopes; kinds of crops and native plants; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in areas nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Coachella and Indio, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in 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 the soil phase indicates a feature that affects management. For example, Coachella fine sand is one of the four phases within the Coachella 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. The photographs show roads, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in 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, soils of one series and a land type, or a broadly mapped soil (subgroup or great group) and a land type. Six such mapping units are shown on the maps of the Coachella Area—all soil complexes.

A soil complex consists of areas of two or more soils, or soils and land types, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the dominant soils and the land type, and the pattern and relative proportions are about the same in all areas. The name of a soil complex ordinarily consists of the name of the dominant soil and the land type, joined by a hyphen. Imperial-Gullied land complex and Rock outcrop-Lithic Torripsamments complex are examples.

In most areas surveyed there are places where the

[1] Italic numbers in parentheses refer to Literature Cited, p. 86.

soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been 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. Badland is a land type in this survey area.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory determinations and for engineering tests. Laboratory data from the same kinds of soil in other places are also 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 medium for growing plants and as materials 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 on-site disposal of sewage fail on a given kind of soil, and they relate this failure to slow permeability or 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 the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential use.

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 survey area. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations, but in different patterns.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide for broad planning on a watershed, a wooded tract, or a wildlife area or for broad planning of recreational facilities, community developments and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact location of a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey area have been grouped into general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations in it are described on the following pages.

Excessively Drained to Somewhat Poorly Drained, Nearly Level to Moderately Steep Soils on Alluvial Fans and Valley Fill and in Lacustrine Basins in the Coachella Valley

This group of associations consists of sands to silty clays formed in coarse to fine textured alluvium. The soils are highly stratified with finer or coarser textured material and contain varying amounts of gravel, stones, and cobbles. They are at elevations of 1,800 feet above sea level. Slopes are 0 to 30 percent. The mean annual precipitation is less than 4 inches. The average annual temperature is 72° to 78° F., and the frost-free season is 260 to 320 days. The soils are used for a wide variety of irrigated truck and field crops, dates, citrus, and grapes. Some areas are idle.

The five associations in this group make up about 66 percent of the Riverside County, Coachella Valley Area.

Imperial soils are well drained and moderately well drained. They generally have a surface layer of silty clay about 17 inches thick and an underlying layer and substratum of clay that extends to a depth of 60 inches or more. These soils are moderately to strongly saline. In about 25 percent of the acreage of the Imperial soils in this association, the seasonal water table fluctuates between depths of 1 and 5 feet.

Carsitas soils are excessively drained. They generally have a surface layer of gravelly sand about 10 inches thick. In places it is cobbly sand, sand, or fine sand. The underlying layer is gravelly coarse sand to a depth of 60 inches or more. In about 15 percent of the acreage of the Carsitas soil in this association, the seasonal water table fluctuates between depths of 2 and 4 feet.

The seasonal water table in the less extensive Myoma soils fluctuates between depths of 1½ and 4 feet.

Most of this association is in native vegetation of creosotebush, mesquite, saltcedar, palms, and saltgrass. A small area is cultivated.

1. Niland-Imperial-Carsitas association

Nearly level to moderately sloping, moderately well drained to excessively drained sands, gravelly sands, cobbly sands, fine sands, and silty clays in lacustrine basins

The soils in this association formed in the fine textured lacustrine deposits of Old Lake Cahuilla modified by wind- and water-borne deposits from the mountains and fans to the east. They are very deep. Slopes range from 0 to 9 percent but are mostly less than 5 percent. Elevations range from 50 feet above sea level to 230 feet below sea level. The soils are calcareous and moderately to strongly alkaline. The content of organic matter is very low in the surface layer and decreases irregularly with increasing depth. Nitrogen and phosphorus are deficient for maximum plant growth. The water table is normally below 5 feet, but in about 60 percent of the association, it rises to within 1 foot of the surface as a result of irrigation or seepage.

This association makes up 3 percent of the Area. It is about 40 percent Niland soils, 35 percent Imperial soils, 20 percent Carsitas soils, and 5 percent Myoma soils, Rock outcrop, and Fluvents.

Niland soils are moderately well drained. They generally have a surface layer of sand about 21 inches thick and an underlying layer of silty clay that extends to a depth of 40 inches or more. The substratum is clay thinly stratified with sand to very fine sandy loam. Normally these soils are moderately saline. In areas where the water table is high, they are strongly saline and a salt crust is evident. In about 30 percent of the acreage of the Niland soils in this association, the water table fluctuates between depths of 1½ and 5 feet.

Imperial soils are well drained and moderately well drained. They generally have a surface layer of silty clay about 17 inches thick and an underlying layer and substratum of clay that extends to a depth of 60 inches or more. These soils are moderately to strongly saline. In about 25 percent of the acreage of the Imperial soils in this association, the seasonal water table fluctuates between depths of 1 and 5 feet.

Carsitas soils are excessively drained. They generally have a surface layer of gravelly sand about 10 inches thick. In places it is cobbly sand, sand, or fine sand. The underlying layer is gravelly coarse sand to a depth of 60 inches or more. In about 15 percent of the acreage of the Carsitas soil in this association, the seasonal water table fluctuates between depths of 2 and 4 feet.

The seasonal water table in the less extensive Myoma soils fluctuates between depths of 1½ and 4 feet.

Most of this association is in native vegetation of creosotebush, mesquite, saltcedar, palms, and saltgrass. A small area is cultivated.

2. *Carsitas-Myoma-Carrizo association*

Nearly level to moderately steep, somewhat excessively drained or excessively drained sands, fine sands, gravelly sands, cobbly sands, and stony sands on alluvial fans and valley fill

The soils in this association formed in coarse textured alluvium. They are very deep. Elevations range from 220 feet below sea level to 1,800 feet above sea level. Slopes are generally less than 5 percent but range to 30 percent in minor isolated areas. The soils are calcareous and mildly to moderately alkaline throughout. The content of organic matter is very low and decreases irregularly with increasing depth. Nitrogen and phosphorus are deficient for maximum plant growth. Small areas along the San Andreas Fault zone have a water table at a depth of 1 to 5 feet.

This association makes up about 35 percent of the Area. It is about 65 percent Carsitas soils, 15 percent Myoma soils, 10 percent Carrizo soils, and 10 percent minor soils and land types.

Carsitas soils are excessively drained. They have a surface layer of gravelly sand, cobbly sand, fine sand, or sand about 10 inches thick. The underlying layer is gravelly coarse sand or cobbly sand, and the substratum to a depth of 60 inches or more is gravelly coarse sand that has varying amounts of coarse fragments. The soil is mildly to moderately alkaline.

Myoma soils are somewhat excessively drained. They have a surface layer of fine sand 18 inches thick. The next layer is very fine sand 6 inches thick, and the substratum to a depth of 60 inches or more is fine sand and very fine sand. The soil is neutral to moderately alkaline and noncalcareous to calcareous throughout.

Carrizo soils are excessively drained. They have a stony sand surface layer 10 inches thick. The next layer is very gravelly coarse sand 20 inches thick, and the substratum to a depth of 60 inches or more is very stony coarse sand. The soil is moderately alkaline and slightly calcareous. The coarse fragments in all layers are generally varying amounts of gravel, stones, or cobbles.

Minor soils in this association are Gilman, Indio, Carsitas variant, the Lithic Torripsamments-Rock outcrop complex, Coachella, Imperial, Niland, and Fluvents. Rubble land, Riverwash, Borrow pits, and Gravel pits and dumps are also included.

Practically all of the association is in native vegetation of creosotebush, bush sunflower, and cholla cactus or under urban development. Where irrigation water is available from wells, some small areas are planted to dates, citrus, and permanent pasture.

3. *Myoma-Indio-Gilman association*

Nearly level to rolling, somewhat excessively drained to moderately well drained fine sands in dune areas and loamy fine sands, very fine sandy loams, fine sandy loams, and silt loams on alluvial fans

The soils in this association formed in moderately fine to coarse textured alluvium. They are very deep. Elevations range from 600 feet above sea level to 50 feet below sea level. Slopes are generally less than 5 percent except in the rolling dune areas where they are as much as 15 percent. The soils are calcareous to noncalcareous and mildly to moderately alkaline throughout. The hazard of soil blowing is moderate to high, and these soils tend to drift in winds of 12 to 15 miles per hour or more. The content of organic matter is very low and decreases irregularly with increasing depth. Nitrogen and phosphorus are deficient for maximum plant growth.

This association makes up about 8 percent of the Area. It is about 65 percent Myoma soils, 20 percent Indio soils, 10 percent Gilman soils, and 5 percent minor soils and a land type.

Myoma soils are somewhat excessively drained. They have a surface layer of fine sand 18 inches thick. The next layer is very fine sand 6 inches thick, and the substratum to a depth of 60 inches or more is fine sand and very fine sand. The soil is neutral to moderately alkaline and noncalcareous to calcareous throughout. In about 2 percent of the acreage of Myoma soils in this association, the seasonal water table is at a depth of 2 to 5 feet.

Indio soils are well drained or moderately well drained. They have a surface layer of very fine sandy loam or fine sandy loam 10 inches thick. The underlying layer to a depth of 60 inches or more is very fine sandy loam stratified with silt and silt loam. The soil is moderately alkaline and moderately to strongly calcareous. In about half the acreage of Indio soils in this association, the seasonal water table is at a depth of 3 to 5 feet.

Gilman soils are well drained. They have a surface layer of fine sandy loam, loamy fine sand, or silt loam 8 inches thick. The underlying layer to a depth of 60 inches or more is stratified loamy very fine sand and loamy fine sand with thin lenses of silt loam and silty clay loam. The soil is moderately alkaline and slightly to strongly calcareous. In about two-thirds of the acreage of Gilman soils in this association, the seasonal water table is at a depth of 3 to 5 feet.

Minor in the association are Coachella and Carsitas soils, Fluvents, and Borrow pits.

Most of this association north of Highway 111 and the Coachella Canal is in native vegetation of creosotebush, mesquite, and bush sunflower and under urban development. The area south of the canal and highway is in field and vegetable crops, grapes, citrus, and dates.

4. *Gilman-Coachella-Indio association*

Nearly level to rolling, somewhat excessively drained to moderately well drained fine sands, fine sandy loams, silt loams, loamy fine sands, and very fine sandy loams on alluvial fans

The soils in this association formed in medium to coarse textured alluvium. They are very deep. Elevations range from 300 feet above sea level to 230 feet below sea level. Slopes are less than 5 percent except for some small rolling dune areas. Some areas are hummocky. The soils are calcareous to noncalcareous and mildly to moderately alkaline throughout. The hazard of soil blowing is moderate to severe, and the sandy soils tend to drift in winds of 12 to 15 miles per hour or more. The content of organic matter is very low and decreases irregularly with increasing depth. Nitrogen and phosphorus are deficient for maximum plant growth. In about 40 percent of this association, the seasonal water table is at a depth of 3 to 5 feet.

This association makes up about 17 percent of the Area. It is about 35 percent Gilman soils, 20 percent Coachella soils, 20 percent Indio soils, 20 percent Myoma soils, and 5 percent minor soils and a land type.

Gilman soils are well drained. They have a surface layer of fine sandy loam, loamy fine sand, or silt loam 8 inches thick. The underlying layer to a depth of 60 inches or more is loamy very fine sand stratified with thin lenses of silt loam and silty clay loam. The soil is moderately alkaline and slightly to strongly calcareous. In about half the acreage of Gilman soils in this association, the seasonal water table is at a depth of 3 to 5 feet.

Coachella soils are well drained. They have a surface layer of fine sand or very fine sandy loam 11 inches thick. The underlying layer to a depth of 60 inches or more is fine sand and very fine sand stratified with silt or very fine sandy loam lenses about 1/2 to 1/4 inch thick. The soil is moderately alkaline and slightly calcareous and has a few scattered freshwater shells throughout.

Indio soils are well drained or moderately well drained. They have a surface layer of very fine sandy loam or fine sandy loam 10 inches thick. The underlying layer to a depth of 60 inches or more is very fine sandy loam stratified with silt and silt loam. The soil is moderately alkaline and moderately to strongly calcareous. In about one-fifth of the acreage of Indio soils, the seasonal water table is at a depth of 3 to 5 feet.

Myoma soils are somewhat excessively drained. They have a surface layer of fine sand 18 inches thick. The underlying layer to a depth of 60 inches or more is very fine sand and fine sand. The soil is neutral to moderately alkaline and is dominantly calcareous throughout. In some small rolling dune areas it is noncalcareous. In about one-eighth of the acreage of Myoma soils, the seasonal water table is at a depth of 2 to 5 feet.

Minor in this association are Carsitas soils, Fluvaquents, Fluvents, and Borrow pits.

Most of the association is in field crops, vegetables, grapes, citrus, and dates. Urban areas of Indio, Coachella, and Thermal occur on this association. Undeveloped land on the Indian Reservation has a cover of native vegetation—saltbush, arrowweed, saltgrass, alkali goldenbush, and mesquite.

5. *Salton-Indio-Gilman association*

Nearly level, somewhat poorly drained to well drained silty clay loams, very fine sandy loams, fine sandy loams, and silt loams in lacustrine basins

The soils in this association formed in fine textured lacustrine deposits of Old Lake Coachuila with modifications by wind- and water-borne deposits from the mountains and fans to the north and northwest. They are very deep. Slopes are dominantly less than 2 percent. Elevations range from 95 to 230 feet below sea level. The soils are calcareous, mildly to strongly alkaline, and slightly to strongly saline. The content of organic matter is very low in the surface layer and decreases irregularly with increasing depth. Nitrogen and phosphorus are deficient for maximum plant growth. In about seven-eighths of the association, the water table is seasonally at a depth of 2 to 5 feet, as a result of irrigation and seepage.

This association makes up about 3 percent of the area surveyed. It is about 55 percent Salton soils, 15 percent Indio soils, 15 percent Gilman soils, and 15 percent minor soils.

Salton soils are somewhat poorly drained. They have a surface layer of silty clay loam or fine sandy loam about 15 inches thick. The underlying layer and the substratum to a depth of 60 inches or more are silty clay and clay. The soil is moderately alkaline, strongly calcareous, and strongly saline. In most of the acreage of Salton soils, the seasonal water table is at a depth of 2 to 5 feet.

Indio soils are well drained or moderately well drained. They have a surface layer of very fine sandy loam or fine sandy loam about 10 inches thick. The underlying layer to a depth of 60 inches or more is very fine sandy loam stratified with silt and silt loam. The soil is moderately alkaline and moderately to strongly calcareous. In most of the acreage of Indio soils, the seasonal water table is at a depth of 3 to 5 feet.

Gilman soils are well drained. They have a surface layer of fine sandy loam or silt loam about 8 inches thick. The underlying layer to a depth of 60 inches or more is loamy very fine sand and loamy fine sand stratified with thin lenses of silt loam and silty clay loam. The soil is moderately alkaline and slightly to strongly calcareous. In about one-third of the acreage of Gilman soils, the seasonal water table is at a depth of 3 to 5 feet.

Minor in the association are Coachella and Myoma soils, Fluvaquents, and Fluvents.

Most of this association is in native vegetation of iodine bush, arrowweed, saltbush, bursage, creosotebush, saltcedar, cottonwood, and saltgrass. The cultivated areas are in field crops, vegetables, and irrigated pasture.

Excessively Drained to Well Drained, Nearly Level to Very Steep Soils on Alluvial Fans, Terraces, and Mountains Rimming the Coachella Valley

This group of associations consists of sands to very gravelly sandy clay loams, and varying amounts of Rock outcrop. The soils formed in alluvium and in place on uplands. They are at elevations of 50 to 5,200 feet. Slopes are 0 to 75 percent. The average annual rainfall is less than 12 inches. The average annual soil temperature is 52° to 75° F, and the frost-free season is 120 to 320 days. The soils are mostly in native vegetation and are used as watershed, wildlife habitat, and recreational land.

The five associations in this group make up about 34 percent of the Riverside County, Coachella Valley Area.

6. Rock outcrop-Omstott-Cajon variant association

Gently sloping to very steep, somewhat excessively drained or well drained sands, gravelly sands, coarse sandy loams, gravelly sandy loams, and gravelly fine sandy loams and Rock outcrop in the Southern California Mountains

This soil association is in the west-central part of the Area in the Southern California Mountains and the Sonoran Basin and Range Major Land Resource Areas. The soils formed in material weathered from granodiorite, gneiss, and mica schist and in coarse textured alluvium. Slopes range from 2 to 75 percent. Elevations range from 1,200 to 5,200 feet. A large part of the surface area is Rock outcrop. The soils are very shallow to very deep. They are slightly acid to mildly alkaline and noncalcareous. The content of organic matter is less than 1 percent and decreases with increasing depth. The supply of nitrogen is deficient for maximum plant growth.

This association makes up about 7 percent of the Area. It is about 55 percent Rock outcrop; 35 percent the Omstott, Torriorthents, and Lithic Torripsamments-Rock outcrop complexes; 5 percent the Cajon variant; and 5 percent Cajon and Bull Trail soils and Riverwash.

The Rock outcrop part of the association is 75 to 100 percent granite, granodiorite, gneiss, and mica schist. Between the outcrops is 1 to 6 inches of sand, gravelly sand, or loamy sand.

On the Omstott-Rock outcrop complex, 5 to 50 percent of the surface is rock outcrop. Omstott soils are well drained. They have a gravelly fine sandy loam or coarse sandy loam surface layer 4 inches thick over 6 inches of fine sandy loam. Below this is decomposing mica schist, gneiss, or granite with a relic rock structure. The soil is slightly acid to neutral.

The Torriorthents-Rock outcrop complex is 25 to 60 percent Rock outcrop. Torriorthents are well drained. Between the outcrops is sand, gravelly sand, or gravelly sandy loam 1 to 6 inches thick over decomposed granitic rock.

The Cajon variant is somewhat excessively drained. It has a sand surface layer 14 inches thick. The underlying layer to a depth of 60 inches or more is fine gravelly sand. The soil is slightly acid to neutral and noncalcareous. Cajon variant soils are in small valley fills and on alluvial fans.

Minor in the association are Cajon and Bull Trail soils and Riverwash.

Most of the association is in native vegetation of ribbonwood, pinon pine, sumac, manzanita, juniper, creosotebush, agave, cholla cactus, buckthorn, and annual and perennial grasses. Some areas have been cleared for housing subdivisions.

7. Chuckawalla-Badland association

Gently sloping to very steep, well drained to excessively drained sands, cobbly fine sandy loams, and very gravelly sandy clay loams in the Indio Hills and on terraces

This soil association is at the northwest and east edges of the Coachella Valley Area, on the Indio Hills uplift. The soils formed in the old mixed alluvium deposited by streams through Berdoo and Fargo Canyons and by Mission Creek and the Whitewater River. They are very deep cobbly fine sandy loams and very gravelly sandy clay loams and also very shallow sands in severely eroded areas and in areas of semiconsolidated alluvium. Slopes range from 2 to 75 percent. Elevations are 50 to 1,800 feet. The soils are calcareous and moderately alkaline. The content of organic matter is very low and decreases irregularly with increasing depth. The supply of nitrogen and phosphorus is deficient for maximum plant growth.

This association makes up about 4 percent of the area surveyed. It is about 55 percent Chuckawalla soils, 30 percent Badland, and 15 percent minor soils.

Chuckawalla soils are well drained. They have a very thin surface layer of very fine sand covered with a close fitting desert pavement of gravel and cobbles. The next layer is very gravelly sandy clay loam or cobbly fine sandy loam 12 inches thick. The substratum to a depth of 60 inches or more is stratified very cobbly and very gravelly loamy sand and coarse sand. The soils are moderately alkaline and slightly to strongly calcareous. In about one-third of the acreage of Chuckawalla soils, at the northwest edge of the Coachella Valley Area, there is no desert pavement and the soil is noncalcareous.

Badland is excessively drained. It is severely eroded.

In some small areas only a 1- to 8-inch cover of loose sand overlies the semiconsolidated alluvium.

Minor in the association are Carsitas soils and Lithic Torripsamments.

Most of the association has only a sparse cover of desert shrubs. The Badland part is nearly barren.

8. *Tujunga-Soboba-Riverwash association*

Nearly level to moderately steep, excessively drained or somewhat excessively drained loamy fine sands, gravelly loamy sands, fine sands, stony sands, and cobbly sands on alluvial fans

This association is west of Whitewater, adjacent to the Western Riverside Soil Survey Area, in the Southern California Coastal Plain Major Land Resource Area. The soils formed in coarse textured alluvium on recent alluvial fans emanating from the mountains. They are very deep. Slopes are 0 to 30 percent. Elevations are 1,100 feet to 2,400 feet. The soils are slightly acid to neutral and noncalcareous. The content of organic matter is less than 1 percent and decreases with increasing depth. The supply of nitrogen is deficient for maximum plant growth.

This association makes up about 1 percent of the Area. It is about 35 percent Tujunga soils, 35 percent Soboba soils, 25 percent Riverwash, and 5 percent Gravel pits and dumps.

Tujunga soils are somewhat excessively drained. They have a loamy fine sand, gravelly loamy sand, or fine sand surface layer about 20 inches thick. The underlying layer is fine sand and very fine sand thinly stratified with gravelly coarse sand. The substratum is sand and gravelly sand. The soil is slightly acid to neutral and noncalcareous. On about one-half the acreage of Tujunga soils, the hazard of soil blowing is high and the surface is hummocky.

Soboba soils are excessively drained. They have a cobbly sand or stony sand surface layer 13 inches thick. The underlying layer is very gravelly sand and gravelly sand that extends to 60 inches or more. The soil is slightly acid to neutral and noncalcareous.

Riverwash is frequently flooded. It consists of stratified, water-deposited stony, cobbly, and gravelly coarse sand and small amounts of fine material. It is subject to bank cutting, scouring, and shifting, as well as deposition, depending on streamflow and bedload. It is almost barren.

Most of the association is in native vegetation of creosotebush, encillia, flattop sage, agave, catclaw, ricegrass, annual grasses, and filaree. Some areas have been cleared for housing subdivisions.

9. *Rock outcrop-Lithic Torripsamments association*

Strongly sloping to very steep, excessively drained to well drained sands, gravelly sands, and loamy sands and Rock outcrop in the transition zone between the Southern California Mountains and the Great Basin Ranges

This association is on the east, north, and west sides of the Coachella Valley where steep mountainous areas rise from the valley floor. The San Jacinto and Santa Rosa Mountains are on the west, the San Bernardino Mountains are on the north, and the Little San Bernardino Mountains and Chocolate Mountains are at the northeast to southeast side of the valley. Slopes are 9 to 75 percent. Elevations are 50 to 3,200 feet. A large part of the association is Rock outcrop. The soils are very shallow. They are slightly acid to mildly alkaline and noncalcareous. The content of organic matter is very low and decreases with increasing depth. The supply of nitrogen is deficient for maximum plant growth.

This association makes up about 19 percent of the Area. It is about 80 percent Rock outcrop, 10 percent Lithic Torripsamments, and 10 percent Rock outcrop-soil complexes, other land types, and minor soils.

The Rock outcrop part of this association is 75 to 100 percent granite, granodiorite, gneiss, and mica schist. Between the outcrops is 1 to 6 inches of excessively drained sand, gravelly sand, or loamy sand. These areas have a desert varnish at the lower elevations, especially at the east side of the Coachella Valley.

Lithic Torripsamments are well drained soils that have a very thin layer of sand or loamy sand over consolidated alluvium or sandstone. They are mildly to moderately alkaline and noncalcareous to calcareous. About 35 to 65 percent of the surface area is flat, exposed sandstone rock, and 3 to 15 percent is stones.

Minor in the association are the Torriorthents-Rock outcrop complex, Carrizo soils, Cajon soils, and Rubble land.

Most of the association is in sparse stunted native vegetation of creosotebush, bursage, ocotillo, barrel cactus, and in a few places annual grasses.

10. *Badland-Carsitas association*

Nearly level to very steep, excessively drained fine sands, sands, gravelly sands, and cobbly sands in the Indio Hills

The soils of this association formed in sandy or gravelly alluvium in the drainageways of the Badland areas north of Thousand Palms. They are extremely shallow except in the very deep alluvium along the drainageways. Slopes are mainly more than 9 percent. Elevations are 50 to 1,800 feet. The soils are slightly to moderately calcareous and are neutral to moderately alkaline throughout. The content of organic matter is very low and decreases irregularly with increasing depth. Supplies of nitrogen and phosphorus are deficient for maximum plant growth.

This association makes up about 3 percent of the Area. It is about 80 percent Badland, 15 percent Carsitas soils, and 5 percent minor soils.

Badland is excessively drained and severely eroded. In one small area only a 1- to 8-inch cover of loose sand overlies the semiconsolidated alluvium.

Carsitas soils are excessively drained. They have a surface layer of gravelly sand, cobbly sand, sand, or fine sand about 10 inches thick. The underlying layer to a depth of 60 inches or more is gravelly or cobbly coarse sand. The soil is mildly to moderately alkaline.

Minor in the association are the Carsitas variant and Carrizo soils.

Practically all of the association is in native vegetation of creosotebush, encelia, and barrel cactus. Badland is nearly barren with only a few stunted plants.

Descriptions of the Soils

This section describes the soil series and mapping units of Riverside County, Coachella Valley Area. To get full information about any given mapping unit, it is necessary to read the description of the series as well as that of the mapping unit.

Each series description includes descriptions of soil properties and environmental factors that are common to all the soils of the series and also a short description of a profile representative of the series.

Following each series description is a description of the mapping unit that has the representative profile, including a technical description of the profile detailed enough to be used by persons who need to make thorough and precise studies of the soil. Differences between this mapping unit and the others in the series are pointed out in the descriptions of individual units, unless they are apparent from the soil names, as, for example, are differences in the surface texture.

All colors mentioned are those of the dry soil, unless otherwise stated.

All soils within the area determined as having a ground-water contour of 10 feet or less by the Coachella Valley County Water District were mapped as having altered drainage (wet). The depth to the water table given is for the average condition.

As explained in the section "How This Survey Was Made," not every mapping unit is part of a soil series. Badland, for example, is not in a soil series, but it is described in this section, in alphabetic order, along with the soil series.

Preceding the name of each mapping unit is a symbol. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description is the capability unit to which the mapping unit has been assigned. The page for the description of each mapping unit and each capability unit is given in the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit is shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*4*).

Badland

BA—Badland consists of very steep, excessively drained, severely eroded areas broken by numerous deeply entrenched channels and many steep side drainages that have raw bands, or freshly exposed material. The slightly consolidated sandy alluvium is capped with a very thin mantle of loose sand. Badland produces large amounts of sediment. It is nearly barren of vegetation.

About 10 percent of this mapping unit is included areas of Carsitas soils and about 5 percent is Riverwash. These are also small areas of Rock outcrop.

Surface runoff is very rapid, and the erosion hazard is very high.

Badland has no value for farming. It is used for watershed, wildlife habitat, and recreation. Capability unit VIIIe-1 (30, 31) dryland.

Borrow Pits

BP—Borrow pits are open excavations from which the soil and underlying material have been removed to construct the canal banks and flood protection dikes across alluvial fans on the uphill side of the Coachella Canal. These borrow areas are from 5 to 30 feet deep and 200 to 900 feet wide depending on the amount of material needed for the dikes and canal banks. The average width is approximately 500 feet. Included with Borrow pits in mapping is the Coachella Canal, maintenance roads, and spoil banks of material excavated from the canal.

Borrow pits are idle or they are used for water conveyance and maintenance or as transient storage basins for floodwater and debris. Sometimes they store the full flow and act as percolation basins in addition to catching the debris. This is especially true when the storm is local in nature.

Borrow pits are barren and have no value for farming. They are now natural flood hazard areas. Capability unit VIIIs-1 (30, 31) dryland.

Bull Trail Series

The Bull Trail series consists of well drained soils on fans and terraces. These soils formed in mixed alluvium. Slopes are 9 to 30 percent. Elevations are 3,600 to 4,500 feet. The vegetation is ribbonwood, pinyon pine, sumac, manzanita, juniper, buckwheat, perennial grass, and annual grass. Average annual precipitation is 8 to 12 inches. The mean annual soil temperature is 52° to 57° F. The frost-free season is 150 to 180 days.

Typically, the surface layer is very dark brown stony sandy loam about 2 inches thick. It is covered with a thin layer of decomposing leaves and twigs. The subsoil is about 29 inches of dark brown and yellowish brown sandy clay loam over about 20 inches of light yellowish brown coarse sandy loam. The substratum to a depth of 60 inches is brown loam. The soil is slightly acid to 51 inches and neutral below.

The soil is moderately slowly permeable. Available water capacity is 6 to 9 inches, and the effective rooting depth is 60 inches or more.

Bull Trail soils are used for watershed, recreation, and homesites.

Representative profile of Bull Trail stony sandy loam, 9 to 30 percent slopes, 1,800 feet north and 1,000 feet west of southeast corner of sec. 8, T. 7 S., R. 5 E., SBBM:

Oe1—½ inch to 0; decomposing brush, leaves, and grass.

A1—0 to 2 inches; very dark grayish brown (10YR 3/2) stony sandy loam, very dark brown (10YR 2/2) moist; 2 to 5 percent of surface covered with stones and cobbles; moderate medium crumb structure; soft, very friable, slightly sticky and nonplastic; many very fine roots; common very fine interstitial pores; slightly acid (pH 6.1); abrupt wavy boundary.

B21t—2 to 3 inches; brown (7.5YR 4/3) sandy clay loam, dark brown (7.5YR 4/3)

TABLE 1.—*Acreage and proportionate extent of the soils*

Map symbol	Soil name	Acres	Percent
BA	Badland	22,710	4.1
BP	Borrow pits	2,948	5
BtE	Bull Trail stony sandy loam, 9 to 30 percent slopes	490	1
CaD	Cajon loamy sand, 5 to 15 percent slopes	1,656	.3
CbD	Cajon Variant, 2 to 15 percent slopes	2,184	.4
CcC	Carrizo stony sand, 2 to 9 percent slopes	18,104	3 2
CdC	Carsitas gravelly sand, 0 to 9 percent slopes	67,477	12 0
CdE	Carsitas gravelly sand, 9 to 30 percent slopes	4,257	.8
CfB	Carsitas sand, wet, 0 to 5 percent slopes	3,275	6
ChC	Carsitas cobbly sand, 2 to 9 percent slopes	35,707	6 4
CkB	Carsitas fine sand, 0 to 5 percent slopes	24,402	4 4
CmB	Carsitas Variant, 2 to 5 percent slopes	755	1
CmE	Carsitas Variant, 5 to 30 percent slopes	1,940	3
CoB	Chuckawalla very gravelly sandy clay loam, 2 to 5 percent slopes	4,142	7
CoD	Chuckawalla very gravelly sandy clay loam, 5 to 15 percent slopes	4,015	.7
CnC	Chuckawalla cobbly fine sandy loam, 2 to 9 percent slopes	1,330	.2
CnE	Chuckawalla cobbly fine sandy loam, 9 to 30 percent slopes	2,270	.4
CpA	Coachella fine sand, 0 to 2 percent slopes	14,390	2 6
CpB	Coachella fine sand, hummocky, 2 to 5 percent slopes	1,451	3
CrA	Coachella fine sand, wet, 0 to 2 percent slopes	7,535	1 3
CsA	Coachella fine sandy loam, 0 to 2 percent slopes	2,599	.5
Fa	Fluvaquents	1,937	.3
Fe	Fluvents	2,046	.4
GaB	Gilman loamy fine sand, 0 to 5 percent slopes	1,174	2
GbA	Gilman fine sandy loam, 0 to 2 percent slopes	13,601	2 4
GbB	Gilman fine sandy loam, 2 to 5 percent slopes	647	.1
GcA	Gilman fine sandy loam, wet, 0 to 2 percent slopes	21,145	3.8
GdA	Gilman fine sandy loam, moderately fine substratum, 0 to 2 percent slopes	1,167	.2
GeA	Gilman silt loam, 0 to 2 percent slopes	1,234	0.2
GfA	Gilman silt loam, wet, 0 to 2 percent slopes	3,765	.7
GP	Gravel pits and dumps	578	.1
IeA	Imperial silty clay, 0 to 2 percent slopes	1,460	.3
IfA	Imperial silty clay, wet, 0 to 2 percent slopes	1,005	.2
ImC	Imperial-Gullied land complex, 2 to 9 percent slopes	3,780	.7
IoC	Imperial-Gullied land complex, wet, 2 to 9 percent slopes	1,115	.2
Ip	Indio fine sandy loam	2,034	.4
Ir	Indio fine sandy loam, wet	5,313	9
Is	Indio very fine sandy loam	7,238	1.3
It	Indio very fine sandy loam, wet	19,286	3.4
LR	Lithic Torripsamments-Rock outcrop complex	11,578	2.1
MaB	Myoma fine sand, 0 to 5 percent slopes	40,928	7.3
MaD	Myoma fine sand, 5 to 15 percent slopes	25,807	4.6
McB	Myoma fine sand, wet, 0 to 5 percent slopes	4,180	.7
NaB	Niland sand, 2 to 5 percent slopes	1,920	.3
NbB	Niland sand, wet, 2 to 5 percent slopes	5,386	1.0
OmD	Omstott coarse sandy loam, 5 to 15 percent slopes	1,512	.3
Or	Omstott-Rock outcrop complex	9,411	1.7
RA	Riverwash	4,375	.8
RO	Rock outcrop	109,039	19.4
RT	Rock outcrop-Lithic Torripsamments complex	6,524	1.2
RU	Rubble land	9,803	1.7
Sa	Salton fine sandy loam	1,265	.2
Sb	Salton silty clay loam	9,381	1.7
SoD	Soboba cobbly sand, 2 to 15 percent slopes	810	.1
SpE	Soboba stony sand, 5 to 30 percent slopes	410	.1
TO	Torriorthents-Rock outcrop complex	4,844	.9
TpE	Tujunga fine sand, 5 to 30 percent slopes	230	(1)
TrC	Tujunga gravelly loamy sand, 0 to 9 percent slopes	595	.1
TsB	Tujunga loamy fine sand, 0 to 5 percent slopes	480	.1
	Total	560,640	100.0

[1] Less than 0.1 percent.

moist; moderate medium prismatic structure; very hard, very firm, sticky and plastic; very few medium roots; many very fine roots; common very fine interstitial pores; very few fine tubular pores; common thin clay films on ped faces and lining tubular pores; slightly acid (pH 6.1); clear wavy boundary.

B22t—3 to 21 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; moderate medium blocky structure; very hard, very firm, sticky and plastic; common very fine and fine roots; common very fine interstitial pores, very few tubular pores; common thin clay films on ped faces and lining tubular pores; slightly acid (pH 6.1); gradual wavy boundary.

B23t—21 to 31 inches; yellowish brown (10YR 5/4) sandy clay loam, brown (10YR 5/3) moist; 5 to 15 percent decomposing stones and cobbles; massive; very hard, very firm, sticky and plastic; very few very fine and fine roots; common very fine interstitial pores; very few very fine tubular pores; common thin clay films on ped faces and lining tubular pores; slightly acid (pH 6.1); clear irregular boundary.

B3—31 to 51 inches; light yellowish brown (10YR 6/4) coarse sandy loam, yellowish brown (10YR 5/4) moist; 20 to 35 percent decomposing stones and cobbles; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine roots, few very fine roots; few thin clay films on ped faces and as colloid bridges; slightly acid (pH 6.1); gradual irregular boundary.

C—51 to 60 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; decomposing stones and cobbles; massive; slightly hard, firm, slightly sticky and slightly plastic; few coarse, fine, and very fine roots; neutral (pH 7.3).

The A horizon is fine sandy loam, sandy loam, or coarse sandy loam that has stones and cobbles partially buried. It is grayish brown, brown, or very dark grayish brown and is 1 to 5 inches thick. The Bt horizon is brown, reddish brown, or yellowish brown clay loam or sandy clay loam that is 10 to 30 percent decomposing granitic and granodiorite gravel, cobbles, and stones. It is 12 to 36 inches thick. The C horizon is slightly acid to neutral, pale brown, brown, or light yellowish brown coarse sandy loam, sandy loam, or loam that has decomposing cobbles and gravels. On steep slopes some rock outcrops of the basement complex occur. The deposit of alluvium is 10 to 400 feet deep over the basement rock complex.

The Bull Trail soils in the survey area lack the mollic epipedon and receive less rainfall than is defined in the range for the series. These differences, however, do not alter the use or management of the soils.

BtE—Bull Trail stony sandy loam, 9 to 30 percent slopes. This strongly sloping to moderately steep soil is on the sides of the dissected old alluvium deposit in the Pinyon Flat area. It has the profile described as representative of the Bull Trail series.

In the vicinity of Pinyon Flat Campground, Highway 74 and Palm Canyon Drive, and near the county garbage dump (mainly in section 10, T.7 S., R.5 E.), slopes are only 2 to 9 percent and the surface layer is less than 15 percent coarse fragments. About 10 percent of this mapping unit is included areas of Omstott soils, and 5 percent is the Cajon variant. Also included are some small areas that are not stony or cobbly and a small area of a soil, west of Hermits Bench, that is similar to the Bull Trail soil but has a higher soil temperature.

Runoff is rapid. The erosion hazard is high.

The soil is used for watershed and recreation. Capability unit VIIe-1 (20) dryland.

Cajon Series

The Cajon series consists of somewhat excessively drained soils on fans and valley fill. These soils formed in mixed alluvium. Slopes are 5 to 15 percent. Elevations are 1,200 to 3,600 feet. The vegetation is creosotebush, yucca, cholla cactus, mormon tea, buckthorn, manzanita, and annual grasses. Average annual precipitation is 5 to 10 inches. The mean annual soil temperature is 64° to 72° F. The frost-free season is 230 to 300 days.

Typically, the surface layer is grayish brown and brown loamy sand 12 inches thick. The substratum to a depth of 60 inches or more is brown loamy sand. The soil is neutral or slightly acid in the upper part and moderately alkaline and calcareous below 52 inches.

The soil is rapidly permeable. Available water capacity is 4.5 to 6 inches. The effective rooting depth is 60 inches or more.

Cajon soils are used for watershed, wildlife habitat, and a few homesites.

Representative profile of Cajon loamy sand, 5 to 15 percent slopes, on alluvial fans and valley fill, 300 feet west and 400 feet south of the north quarter corner sec. 29, T. 5 S., R. 5 E., SBBM:

A11—0 to 6 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots and very few fine roots; common very fine interstitial pores; neutral (pH 7.0); clear smooth boundary.

A12—6 to 12 inches; brown (10YR 5/3) loamy sand, brown (10YR 4/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots and few fine roots; common very fine interstitial pores; neutral (pH 7.0); clear smooth boundary.

C1—12 to 32 inches; brown (10YR 5/3) loamy sand, brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots and few fine roots; common very fine interstitial pores; slightly acid (pH 6.5); clear smooth boundary.

C2—32 to 43 inches; brown (10YR 5/3) loamy sand, brown (10YR 4/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; very few very fine and fine roots; common very fine interstitial pores; slightly acid (pH 6.1); gradual smooth boundary.

C3—43 to 52 inches; brown (10YR 5/3) loamy sand, brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; very few fine and very fine roots; common very fine interstitial pores; slightly acid (pH 6.1); clear smooth boundary.

C4—52 to 60 inches; brown (10YR 5/3) loamy sand, brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; no roots; common very fine interstitial pores; moderately alkaline (pH 8.0) strongly effervescent with dilute HC1.

The A horizon is loamy sand, sand, or fine sand in hue of 10YR and 2.5Y, value of 5 to 7 dry, and chroma of 2 to 4. In washed areas between vegetation the surface is covered by a layer of fine gravel, very coarse sand, and coarse sand. The structure of the A horizon results from the very fine roots holding mineral grains together. The C1, C2, and C3 horizons are sand, loamy sand, and strata of weak sandy loam that are less than 15 percent gravel. Reaction ranges from slightly acid to neutral. Color is in hue of 10YR and 2.5Y, value of 4 to 6, and chroma of 2 to 4. The C4 horizon is coarse sandy loam to sand that is slightly acid to moderately alkaline and noncalcareous to strongly effervescent.

CaD—Cajon loamy sand, 5 to 15 percent slopes. This moderately sloping to strongly sloping soil is on alluvial fans and valley fill. It has the profile described as representative of the series.

In the steeper valley fill areas, about 10 percent of this mapping unit is included areas of sandy soil 30 to 45 inches deep over decomposed granite, 5 percent is Riverwash, and 3 percent is Rock outcrop. Also included are some areas of sand and gravelly sand and small areas of loamy fine sand.

Runoff is very slow. The erosion hazard is slight. The hazard of soil blowing is slight.

This soil is used for watershed, wildlife habitat, and a few homesites. Capability unit VIIIe-1 (30) dryland.

Cajon Variant

The Cajon variant consists of somewhat excessively drained soils that formed in alluvium. Slopes are 2 to 15 percent. Elevations are above 3,600 feet. The vegetation is piñon pine, juniper, yucca, buckthorn, scrub oak, sage, mormon tea, cholla cactus, and annual and scattered perennial grasses. Average annual precipitation is 8 to 12 inches. The mean annual soil temperature is 57° to 59° F. The frost-free season is 120 to 180 days.

Typically, the surface layer is grayish brown sand about 14 inches thick. The substratum to 60 inches or more is brown fine gravelly sand. The soil is slightly acid and neutral.

The soil is rapidly permeable. Available water capacity is 2 to 6 inches. The effective rooting depth is 45 or more inches.

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

Representative profile of Cajon variant, 2 to 15 percent slopes, on alluvial fans and valley fill, 1,075 feet east and 250 feet north of west quarter corner sec. 16, T. 6 S., R. 5 E., SBBM about 500 feet northwest of locked gate on Palm Canyon Drive:

A11—0 to 4 inches; grayish brown (10YR 5/2) sand, very dark grayish brown (10YR 3/2) moist; single grain; loose, nonsticky and nonplastic; common very fine roots; many very fine and fine interstitial pores; slightly acid (pH 6.1); clear smooth boundary.

A12—4 to 14 inches; grayish brown (10YR 5/2) sand, very dark grayish brown (10YR 3/2) moist; single grain; loose, nonsticky and nonplastic; many very fine roots; many very fine and fine interstitial pores; slightly acid (pH 6.1); clear smooth boundary.

C—14 to 60 inches; brown (10YR 5/3) fine gravelly sand, dark brown (10YR 4/3) moist; single grain; loose, nonsticky and nonplastic; very few fine and very fine roots; many very fine and fine interstitial pores; neutral (pH 6.6).

The A horizon is sand, loamy sand, or loamy fine sand in hue of 10YR, value of 4 to 5 dry, and chroma of 1 to 3. The texture may be modified by gravel, cobbles, or stones. The C horizon is sand, gravelly sand, loamy sand, cobbly loamy sand, or stony loamy sand in hue of 10YR and 2.5Y, value of 5 to 7 dry, and chroma of 2 to 4.

The soil surface may be covered by a very thin layer of white (10YR 8/2) coarse sand and very coarse sand.

CbD—Cajon variant, 2 to 15 percent slopes. This gently sloping to strongly sloping soil is on alluvial fans and valley fill. It has the profile described as representative of the Cajon variant. Generally the surface layer is sand or loamy sand.

About 10 percent of this mapping unit is included areas of Omstott soils, 7 percent is Riverwash, and 3 percent is rock outcrop. Also included is a small area, southeast of Highway 74 and Palm Canyon Drive, of a soil that is stony loamy fine sand throughout areas where the substratum is clay loam. South of Pinyon Flat Campground is an area where the soil has a sandy loam surface layer and a weakly developed subsoil.

In about one-half of this unit on ridges or flat planes, decomposing granite is at a depth of 35 to 60 inches. In places the ridges of granite intrude the alluvium and crop out at the surface. Other areas are covered with 3 feet or more of alluvium.

Runoff is medium. The erosion hazard is slight.

This soil is used for watershed, wildlife habitat, recreation, and homesites. Capability unit VIIe-1 (20) dryland.

Carrizo Series

The Carrizo series consists of excessively drained soils that formed in very cobbly or very stony sandy alluvium. Slopes are 2 to 9 percent. Elevations are 2,000 feet above sea level. The vegetation is creosotebush, bursage, and occasional ironwood with a few annual grasses. Average annual precipitation is less than 4 inches. The mean annual soil temperature is 72° to 75° F. The frost-free season is 260 to 320 days.

Typically, the upper 10 inches of these soils is light gray stony sand. The next 29 inches is light brownish gray and light gray very gravelly coarse sand. Below this to a depth of 60 inches or more is light brownish gray very stony coarse sand. The soil is moderately alkaline and slightly to strongly effervescent.

The soil is very rapidly permeable. Available water capacity is 1 to 2 inches. The effective rooting depth is 60 inches or more.

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

Representative profile of Carrizo stony sand, 2 to 9 percent slopes, on alluvial cones, 750 feet east and 400 feet north of southeast corner sec. 19, T. 4 S., R. 8 E., SBBM 150 feet east northeast of Berdoo Road in gully:

C1—0 to 10 inches; light gray (10YR 7/2) stony sand, light brownish gray (10YR 6/2) moist; single grain; loose, nonsticky and nonplastic; very few very fine roots; many very fine interstitial pores; moderately alkaline (pH 8.0); slightly effervescent; clear smooth boundary.

C2—10 to 22 inches; light brownish gray (10YR 6/2) very gravelly coarse sand, dark grayish brown (10YR 4/2) moist; single grain; loose, nonsticky and nonplastic; very few very fine roots; many very fine interstitial pores; moderately alkaline (pH 8.2); strongly effervescent; clear smooth boundary.

C3—22 to 39 inches; light gray (10YR 7/2) very gravelly coarse sand, light brownish gray (10YR 6/2) moist; single grain; loose, nonsticky and nonplastic; very few coarse and very fine roots; many very fine interstitial pores; moderately alkaline (pH 8.2); slightly effervescent; slight lime cementation of sand grains; clear smooth boundary.

C4—39 to 60 inches; light brownish gray (10YR 6/2) very stony coarse sand, grayish brown (10YR 5/2) moist; single grain; loose, nonsticky and nonplastic; very few coarse and very fine roots; many very fine interstitial pores; moderately alkaline (pH 8.2).

The C1 horizon is stony coarse sand or cobbly sand in hue of 10YR, value of 5 to 7 dry and 4 to 6 moist, and chroma of 2 and 3. The C2 and C3 horizons are very gravelly, very cobbly, or very stony coarse sand. They are 35 to 60 percent by volume, gravel, cobbles, and stones. In places there are thin strata (1 to 3 inches) of sand or fine sand. The surface area is 10 to 25 percent stones, cobbles, and gravel, and in some areas an incipient desert pavement has formed. Some of the cobbles, stones, and coarse gravel in the profile are coated on the bottom by a thin layer of calcium carbonate.

CcC—Carrizo stony sand, 2 to 9 percent slopes. This gently sloping to moderately sloping soil is on alluvial cones where drainage from the mountains enters the valley. Usually channels carry runoff from the mountains. The soil has the profile described as representative of the series.

About 12 percent of this mapping unit is Carsitas soils, 3 percent Chuckawalla soils, and 2 percent Myoma soils. Also included are some small areas of cobbly and gravelly sand that have slopes of 9 to 15 percent and some areas of a soil that has a slightly acid or neutral reaction.

This soil is subject to flooding especially when intense summer showers occur in the mountains. Runoff is slow except in channels, and the erosion hazard by wind and water is slight.

The soil is used for watershed and wildlife habitat. Capability unit VIIIw-1 (30, 31) dryland.

Carsitas Series

The Carsitas series consists of excessively drained soils, but includes soils that have altered drainage where seepage from irrigation has caused a water table at a depth of 2 to 4 feet. The soils formed in predominantly coarse textured gravelly or cobbly granitic alluvium. Slopes are simple and 0 to 30 percent. Elevations range from 800 feet above to 220 feet below sea level. The vegetation is low creosotebush, bush sunflower, desert willow, and some smoketree, mesquite, and palo verde. Mesquite and saltcedar occur mainly in wet areas. Average annual precipitation is less than 4 inches. The mean annual soil temperature is 72° to 78° F. The frost-free season is 270 to 320 days.

Typically, the upper 10 inches of these soils is light olive gray, calcareous gravelly sand. Below this to a depth of more than 60 inches is light olive gray gravelly coarse sand. The soil is moderately alkaline with disseminated lime and is 15 to 35 percent coarse fragments.

The soil is rapidly permeable. The effective rooting depth is 60 inches or more. Available water capacity is 2 to 4 inches.

These soils are used for citrus, grapes, wildlife habitat, recreation, and watershed.

Representative profile of Carsitas gravelly sand, 0 to 9 percent slopes, on an alluvial fan, 3 percent slope facing southwest, 600 feet west and 50 feet south of northeast corner of sec. 29, T. 7 S., R. 10 E., SBBM 0.9 mile east of Cleveland on Ave. 70:

C1—0 to 10 inches; light olive gray (5Y 6/2) gravelly sand, olive gray (5Y 4/2) moist; stratified; single grain; loose, nonsticky and nonplastic; few coarse roots and very few fine roots; common fine interstitial pores; slightly effervescent, moderately alkaline (pH 8.4); gradual smooth boundary.

C2—10 to 60 inches; light olive gray (5Y 6/2) gravelly coarse sand, olive gray (5Y 4/2) moist; stratified; single grain; loose, nonsticky and nonplastic; very few fine roots; common fine interstitial pores; slightly effervescent, moderately alkaline (pH 8.4).

The C1 horizon is sand or fine sand in hue of 10YR, 2.5Y, and 5Y; value of 5 through 7 dry and 4 to 5 moist; and chroma of 2 to 4 moist and dry. In places it has gravel, cobbles, or stones. The C2 horizon is gravelly sand or gravelly coarse sand that is 15 to 35 percent coarse fragments. Reaction is mildly to moderately alkaline. Colors are in hue of 2.5Y and 5Y, value of 5 to 6 dry and 4 to 5 moist, and chroma of 2 and 3 dry and moist. The soil is calcareous throughout with disseminated lime and in a few places has small amounts of secondary lime in pendants on the gravel and cobbles. The high water table is at a depth of more than 6 feet except in areas where drainage has been influenced by irrigation. In these areas, depth to the high water table is between 2 and 4 feet.

CdC—Carsitas gravelly sand, 0 to 9 percent slopes. This nearly level to moderately sloping soil is on alluvial fans along the east, north, and west edges of the Coachella Valley. Small, slightly entrenched stream channels become less distinct as the slope of the soil decreases to 1 or 2 percent. They form an indefinite pattern of braided stream channels, which are very shallow and have coarser debris deposited in them.

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

About 8 percent of this mapping unit is included areas of Riverwash, 7 percent Carsitas cobbly sand, and 5 percent Myoma sand. Also included are some small areas of soils that have a stony sand and gravelly fine sand surface layer and areas of fine sand, containing silt lenses in the upper 10 inches, which are in old oxbow channels of the Whitewater River and extend from Rawson Road to Happy Point. The soil in Little Morongo Canyon and Morongo Canyon Valley north of section line 1 and 5, T. 2 S., R. 4 E., has an average annual temperature of less than 72° F.

Runoff is slow. The erosion hazard is moderate. The hazard of soil blowing is slight. The available water capacity is 2 to 4 inches.

This soil is used for watershed, wildlife habitat, recreation, and homesites. Citrus and grapes are grown where irrigation water is available. Capability unit IVs–4 (31) irrigated, VIIIe–1 (30) dryland.

CdE—Carsitas gravelly sand, 9 to 30 percent slopes. This strongly sloping or moderately steep soil is on valley fill and remnants of dissected alluvial fans.

About 10 percent of this mapping unit is included areas of Badland, 5 percent Carrizo soil, 5 percent Myoma soil, and 3 percent Riverwash. Also included are some small areas of soils that have cobbles or stones, or both, and some areas of soils that have a sand and fine sand surface layer. Approximately one-third of the mapping unit has cobbles and some stones on 1 to 3 percent of the surface area. Shallow rills or channels have formed in the valley fill, and in some places an occasional shallow gully disappears into an area of coarser debris. Some of these shallow gullies are filled by windblown fine sand.

This soil also includes two large areas of dissected gravelly coarse sand alluvial fan material that has been superficially wind modified. These areas are west of Garnet Hill and the northwest part of the Indio Hills adjacent to the Badlands. In some parts of these areas are unconsolidated layers of various sized sands, averaging coarse sand.

Runoff is slow. The erosion hazard is moderate. The hazard of soil blowing is slight. Available water capacity is 2 to 4 inches.

The soil is used for watershed, wildlife habitat, recreation, and homesites. Capability unit VIIIe–1 (30) dryland.

CfB—Carsitas sand, wet, 0 to 5 percent slopes. This nearly level to gently sloping soil is on alluvial fans east of Salton Sea. It has a profile similar to the one described as representative of the series, but it has a surface layer of sand and scattered gravel on the surface. A water table is at a depth of 2 to 4 feet. In places the soil is moist to the surface and has a salt crust.

About 10 percent of this mapping unit is included areas of Myoma soil and 5 percent Niland soils. Also included are some soils that have a fine sand and gravelly coarse sand surface layer.

Runoff is slow. The erosion hazard is slight. The hazard of soil blowing is slight. Available water capacity is 2 to 3.5 inches. The effective rooting depth is 2 to 4 feet.

The soil is used for watershed, wildlife habitat, and recreation. Capability unit IVw–4 (31) irrigated, VIIIw–1 (31) dryland.

ChC—Carsitas cobbly sand, 2 to 9 percent slopes. This gently sloping to moderately sloping soil is on alluvial fans, valley fill, and remnants of dissected alluvial fans along the east, north, and west edges of the Coachella Valley. The soil has a profile similar to the one described as representative of the series, but cobbles and some stones are on the surface and in the profile. Some areas have an incipient desert pavement. Cobbles and some stones cover 1 to 3 percent of the surface. Some small entrenched stream channels form a lacy, shallow braided stream channel that starts where the primary channel is choked with coarse debris and spills out across the soil surface until it concentrates to form a new channel.

About 8 percent of this mapping unit is included areas of Riverwash, 5 percent Carrizo soils, and 5 percent Chuckawalla soils. Also included are some small areas of soils that have a gravelly sand and sand surface layer. In Big Morongo Canyon, the soil in the northern half of sec. 6, T. 2 S., R. 4 E., has an average annual soil temperature of less than 72° F.

Runoff is rapid. The erosion hazard is moderate. The hazard of soil blowing is slight. Available water capacity is 2 to 3.5 inches. The effective rooting depth is 60 inches or more.

The soil is used for wildlife habitat and recreation. Capability unit VIs–1 (31) irrigated, VIIIe–1 (30) dryland.

CkB—Carsitas fine sand, 0 to 5 percent slopes. This nearly level to gently sloping soil is on alluvial fans and valley fill. It has a profile similar to the one described as representative of the series, but has a fine sand surface layer that is less than 15 percent coarse fragments. In some places the texture is sand at a depth of about 8 to 18 inches. There is no braided stream pattern, but winds are nearly continuous.

About 10 percent of this mapping unit is included areas of Myoma soils and 3 percent Coachella soils. Also included are some areas of soils that have a sand surface layer and some areas of soils that have a layer of fine gravel on the surface. Approximately 5 percent of the unit is included areas at the upper end of the alluvial fans where slopes are 5 to 9 percent.

Runoff is slow. The erosion hazard is slight. The hazard of soil blowing is high. Available water capacity is 3 to 4 inches. The effective rooting depth is 60 inches or more.

The soil is used for watershed, wildlife habitat, recreation, and homesites. Capability unit IVe–4 (31) irrigated, VIIIe–1 (30) dryland.

Carsitas Variant

The Carsitas variant consists of well drained soils that formed in a thin layer of alluvium over sandstone. Slopes are 0 to 30 percent. Elevations range from 1,400 feet above to 230 feet below sea level. The vegetation is a sparse cover of low creosotebush and bush sunflower. Annual precipitation is less than 4 inches, the mean annual soil temperature is 72° to 75° F. The frost-free season is 270 to 320 days.

Typically, the upper 6 inches of these soils is light olive gray fine sand. The next 12 inches is light olive gray sand. Sandstone is at a depth of about 18 inches. The soil is moderately alkaline and slightly effervescent.

Available water capacity is 0.5 to 2 inches, and the effective rooting depth is 6 to 20 inches. Permeability is rapid above the sandstone.

These soils are used for watershed, wildlife habitat, recreation, and a few homesites.

Representative profile of Carsitas variant, 2 to 5 percent slopes, in an area west of Badlands, 200 feet south and 150 feet west of northeast corner sec. 7, T. 8 S., R. 11 E., SBBM 2,100 feet east of Power Line Road:

C1—0 to 6 inches; light olive gray (5Y 6/2) fine sand, olive gray (5Y 5/2) moist; single grain; loose, nonsticky and nonplastic; common very fine roots and very few fine roots; many very fine interstitial pores; moderately alkaline (pH 8.0); slightly effervescent; clear smooth boundary.

C2—6 to 18 inches; light olive gray (5Y 6/2) sand, grayish brown (2.5Y 5/2) moist; single grain; loose, nonsticky and nonplastic; few very fine roots and very few fine roots; many very fine interstitial pores; moderately alkaline (ph 8.0); slightly effervescent; abrupt smooth boundary.

C3r—18 inches; light olive gray (5Y 6/2) sandstone, olive brown (2.5Y 4/3) moist; very thick platy structure; hard, very firm, can be rubbed to fine sand; very few very fine roots in cracks and between plates; moderately alkaline (pH 8.0); slightly effervescent.

The C1 horizon is fine sand or sand that in places has a thin layer of gravel on the surface. It is light gray or light olive gray and is 3 to 8 inches thick. The C2 horizon is fine sand or sand that is up to 10 percent gravel. It is light gray, light olive gray, and gray and is 3 to 12 inches thick.

The C1 and C2 horizons are very slightly to strongly effervescent with disseminated lime. Depth to sandstone ranges from 6 to 20 inches.

The boundary between the soil and the underlying sandstone is abrupt smooth to clear smooth or clear irregular. The underlying sandstone is slightly hard to hard and rubs down to sand or fine sand that is up to 20 percent gravel.

CmB—Carsitas variant, 2 to 5 percent slopes. This gently sloping soil is on hills near Badland or sandstone outcrop formations east of the Salton Sea and north of Thousand Palms. It has the profile described as representative of the Carsitas variant. It has a fine sand surface layer.

About 5 percent of this mapping unit is included areas of Myoma soils and 10 percent Carsitas soils. Also included are some small areas of gravelly or cobble soils, some small wet areas, and some areas where sandstone is at a depth of 36 inches.

Runoff is very slow. The erosion hazard is high by wind and slight by water. Available water capacity is 0.5 to 2 inches. Effective rooting depth is 6 to 20 inches. This soil is used for wildlife habitat and recreation. Capability unit VIIIe-1 (30) dryland.

CmE—Carsitas variant, 5 to 30 percent slopes. This moderately sloping to moderately steep soil is on hillsides east of Salton Sea and the Indio Hills. It has a fine sand surface layer.

About 10 percent of this mapping unit is included areas of Myoma soils, 5 percent Carsitas soils, and 3 percent Rock outcrop. Also included are small areas where the texture is gravelly or cobbly sand, a few wet spots, and small areas where sandstone is at a depth of 20 to 50 inches.

Runoff is very slow and erosion is moderate. The hazard of soil blowing is high. Available water capacity is 1 to 2 inches. The effective rooting depth is 12 to 20 inches.

This soil is used for watershed, wildlife habitat, recreations, and a few homesites. Capability unit VIIIe-1 (30) dryland.

Chuckawalla Series

The Chuckawalla series consists of well drained soils that formed in old alluvium. Slopes are 2 to 30 percent. Elevations are 50 to 1,800 feet. The vegetation is low creosotebush, bush sunflower, and some scattered annual grasses. Average annual precipitation is less than 4 inches, mean annual soil temperature is 72° to 75° F., and the frost-free season is 270 to 320 days.

Typically, the surface layer is about one-fourth inch of pale brown very gravelly fine sand. It is covered with a close fitted surface pavement of pebbles and cobbles coated with desert varnish. The subsoil is brown gravelly sandy clay loam about 11¾ inches thick over about 13 inches of brown gravelly loamy sand. The upper 7 inches of the substratum is grayish brown very cobbly loamy sand. The lower part to a depth of 60 inches or more is light olive gray and light gray gravelly and cobbly coarse sand. The coarse fragments are lime coated on the lower part. The soil is moderately alkaline and slightly to strongly effervescent.

The soil is moderately permeable. Available water capacity is 1 to 3 inches. The effective rooting depth is 60 inches or more.

These soils are used for watershed, wildlife habitat, and homesites.

Representative profile of Chuckwalla very gravelly sandy clay loam, 2 to 5 percent slopes, 1,000 feet west and 700 feet north of east quarter corner sec. 14, T. 5 S., R. 8 E., SBBM:

Desert pavement of gravel and cobbles with desert varnish, approximately 90 percent of area covered, partially imbedded in surface.

A2—0 to ¼ inch; pale brown (10YR 6/3) very gravelly fine sand; dark brown (10YR 4/3) moist; single grain; loose, nonsticky and nonplastic; very slightly effervescent, moderately alkaline (pH 7.9); abrupt wavy boundary.

B21t—¼ inch to 3 inches; brown (7.5YR 5/4) very sandy clay loam, brown (7.5YR 5/4) moist; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; few fine roots; common fine vesicular pores; many moderately thick clay films line pores; strongly effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

B22t—3 to 12 inches; brown (7.5YR 5/4) gravelly sandy clay loam approximately 35 percent by volume greater than 2 millimeters, reddish brown (5YR 4/4) moist; weak medium and fine subangular blocky structure; slightly hard, friable, sticky and plastic; common fine and very fine roots; common fine interstitial pores; many colloidal bridges between mineral grains; slightly effervescent; moderately alkaline (pH 8.0); clear irregular boundary.

B3—12 to 25 inches; brown (10YR 5/3) very gravelly sandy loam approximately 35 percent by volume greater than 2 millimeters, dark brown (10YR 4/3) moist; massive; soft, slightly sticky and slightly plastic; few fine roots and common very fine roots; common fine and very fine interstitial pores; slightly effervescent, moderately alkaline (pH 8.0); gradual irregular boundary.

C1—25 to 32 inches; grayish brown (2.5Y 5/2) very cobbly loamy sand approximately 55 percent by volume larger than 2 millimeters, dark grayish brown (10YR 4/2) moist; single grain; loose, nonsticky and nonplastic; very few fine roots; common fine interstitial pores; very slightly effervescent; mildly alkaline (pH 7.5); clear irregular boundary.

C2—32 to 42 inches; light olive gray (5Y 6/2) very gravelly coarse sand approximately 35 percent by volume larger than 2 millimeters, olive gray (5Y 4/2) moist; single grain; loose, nonsticky and nonplastic; very few fine and medium roots; common fine interstitial pores; slightly effervescent; moderately alkaline (pH 8.0); clear wavy boundary. At 32 inches is an intermittent pan of light gray (5Y 7/2) sand cemented by lime, light olive gray (5Y 6/2) when moist. Pan appears to have opal on surface when observed at exposures along drainages.

C3—42 to 60 inches; light gray (5Y 7/2) cobbly coarse sand, light olive gray (5Y 6/2) moist; massive; hard, firm, nonsticky and nonplastic; common fine interstitial pores; violently effervescent; moderately alkaline (pH 8.0).

The desert pavement pebbles and cobbles have a desert varnish that is black on top and tinted red or orange on the bottom. They are imbedded in the A2 horizon. Gravel and cobbles cover 30 to 90 percent of the surface. The A2 horizon is very fine sand, sand, very gravelly very fine sand, very gravelly loamy fine sand, or very gravelly sand. It is in hue of 10YR, value of 6 to 7 dry and 4 to 5 moist, and chroma of 2 to 5 dry or moist. Reaction ranges from neutral to moderately alkaline with very slight to strong effervescence.

The B2 horizon has two distinct layers. It is in hue of 7.5YR and 5YR, value of 3 to 6, and chroma of 3 to 5 dry and moist. The upper layer is clay loam or sandy clay loam ½ inch to 3 inches thick. It is mildly to moderately alkaline, strongly calcareous, and 10 to 30 percent gravel by volume. The lower layer is clay loam or sandy clay 3 to 12 inches thick. It is 35 to 70 percent gravel and cobbles, mildly to moderately alkaline, and strongly to violently effervescent.

The B3 horizon is very cobbly or very gravelly sandy loam, ranging from brown to grayish brown. The C horizon is stratified gravelly, cobbly, very gravelly, or very cobbly loamy sand or coarse sand with a layer cemented by opal and calcium carbonate or calcium carbonate alone at a depth of 30 to 60 or more inches.

CnC—Chuckawalla cobbly fine sandy loam, 2 to 9 percent slopes. This gently sloping to moderately sloping soil is on remnants of old alluvial fans emanating from the San Gorgonio Mountains in the northwestern part of the area. It has a profile similar to the one described for the series, but it has a brown cobbly fine sandy loam surface layer, is neutral to mildly alkaline and noncalcareous throughout, and has no desert pavement. Elevation is 900 to 2,600 feet. Average annual precipitation is 4 to 8 inches. Vegetation is low creosotebush, encilia, bursage, flattop sage, barrel and cholla cactus, deervetch, and annual grasses.

This soil does not have the desert pavement or the free lime and receives more rainfall than is described in the range for the series, but these differences do not greatly alter its use and management.

About 5 percent of this mapping unit is included areas of Carsitas soils, 3 percent Myoma soils, and 2 percent Carrizo soils. Also included are small areas of soils that have a heavy clay loam or sandy clay subsoil and areas of soils that have a stony fine sandy loam surface layer.

Runoff is rapid. The erosion hazard is slight. The hazard of soil blowing is slight. Available water capacity is 3 to 5 inches. The effective rooting depth is 60 inches or more.

This soil is used for watershed, wildlife habitat, and homesites. Capability unit VIIIs-1 (30) dryland.

CnE—Chuckawalla cobbly fine sandy loam, 9 to 30 percent slopes. This strongly sloping to moderately steep soil is on old alluvial fans and remnants emanating from the San Gorgonio Mountains in the northwestern part of the survey area. It has a profile similar to the one described as representative of the series, but it has a brown cobbly fine sandy loam surface layer, is neutral to mildly alkaline and noncalcareous throughout, and has no desert pavement. Elevations are 900 to 2,600 feet. Average annual precipitation is 4 to 8 inches. Vegetation is low creosotebush, encelia, bursage, flattop sage, barrel and cholla cactus, deervetch, and annual grasses.

This soil does not have the desert pavement or the free lime and receives more rainfall than is described in the range for the series, but these differences do not greatly alter its use and management.

About 5 percent of this mapping unit is included areas of Carsitas soils, 3 percent Myoma soils, and 3 percent Badland. Also included are small areas of soils that have a heavy clay loam or sandy clay subsoil and some areas where stones are on the surface instead of cobbles.

Runoff is rapid. The erosion hazard is moderate. Available water capacity is 2 to 4 inches. The effective rooting depth is 60 inches or more.

This soil is used for watershed and wildlife habitat. Capability unit VIIIs–1 (30) dryland.

CoB—Chuckawalla very gravelly sandy clay loam, 2 to 5 percent slopes. This gently sloping soil is on dissected old alluvial fans at the east and northeast sides of the Coachella Valley, at elevations of 50 to 1,800 feet. It has the profile described as representative of the series.

About 10 percent of this mapping unit is included areas of raw alluvium or colluvium on the steep breaks to the drainages that dissect the old alluvial fans, about 5 percent Carsitas soils, and about 3 percent Riverwash in the narrow drainages that have formed on grades within the dissected old alluvial fan. Some small included areas have stones on the surface and some small mounds produced by animal activity. Also included are raw gullies where the gently sloping drainageways abut the steep breaks.

Runoff is rapid. The erosion hazard is moderate. The hazard of soil blowing is slight. Available water capacity is 1 to 3 inches. The effective rooting depth is 40 to 60 inches or more.

The soil is used for watershed, wildlife habitat, and homesites. Capability unit VIIIs–1 (30) dryland.

CoD—Chuckawalla very gravelly sandy clay loam, 5 to 15 percent slopes. This moderately sloping to strongly sloping soil is on remnants of dissected old alluvial fans. It occurs as areas from the steep mountain front of the Little San Bernardino Mountains along the eastern boundary of the survey area and into the Indio Hills, which appear to be differentially elevated old valley fill at elevations of 50 to 1,800 feet. The profile of this soil is similar to the profile described as representative of the series, but the combined thickness of the surface layer and subsoil is less.

The thickness of the surface layer is commonly 1/16 to 3/4 of an inch. The upper part of the subsoil is 1/2 to 1 inch thick, and the lower part is 3 to 8 inches thick. The transitional layer to the substratum does not occur in all areas. The intermittent lime-cemented pan is generally 5 to 30 inches below the surface.

About 5 percent of this mapping unit is included areas of Carsitas soils, 5 percent Carrizo soils, and 10 percent a sand that is 2 to 5 inches thick over sandstone and has outcrops of sandstone. Also included are areas where slopes are up to 30 percent and some small areas where slopes are 2 to 5 percent.

Runoff is rapid. The erosion hazard is moderate. The hazard of soil blowing is slight. Available water capacity is 1 to 2 inches. The effective rooting depth is 5 to 30 inches.

This soil is used for watershed, wildlife habitat, and homesites. Capability unit VIIIs–1 (30) dryland.

Coachella Series

The Coachella series consists mainly of well drained soils, but includes soils that have altered drainage where seepage from irrigation has caused a water table at a depth of 3 to 5 feet. The soils formed in alluvium. Slopes are 0 to 5 percent. Elevations range from 800 feet above to 230 feet below sea level. The vegetation is low creosotebush, bush sunflower, and mesquite. Saltcedar, alkali goldenbush, and arrowweed grow in the uncultivated wet areas. Average annual precipitation is less than 4 inches, mean annual soil temperature is 72° to 75° F., and the frost-free season is 270 to 320 days.

Typically, the upper 11 inches of these soils is light olive gray fine sand. Below this to a depth of 60 inches is light olive gray fine sand and very fine sand stratified with silt or very fine sandy loam. Strata are one-fourth to one-half inch thick. The soil is moderately alkaline and slightly effervescent. In places a few freshwater shells are scattered through out the profile.

These soils are moderately rapidly permeable. Available water capacity is 6 to 15 inches. The effective rooting depth is 60 inches or more for most plants.

These soils are used for truck crops, citrus, grapes, dates, and alfalfa hay.

Representative profile of Coachella fine sand, 0 to 2 percent slopes, on alluvial fans and flood plains, 520 feet south of north quarter corner sec. 2, T.5 S., R.5 E., SBBM:

C1—0 to 11 inches; light olive gray (5Y 6/2) fine sand, olive gray (5Y 5/2) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; many very fine interstitial pores; moderately alkaline (pH 8.0); clear smooth boundary.

C2—11 to 26 inches; light olive gray (5Y 6/2) fine sand, olive gray (5Y 5/2) moist; single grain; loose, nonsticky and nonplastic; very few very fine roots; many olive gray (5Y 5/2) silt lenses from 1/8 to 1/2 inch thick, olive (5Y 4/3) moist; many fine roots between silt plates; moderately alkaline (pH 8.2); slightly effervescent; clear wavy boundary.

C3—26 to 41 inches; light olive gray (5Y 6/2) fine sand, olive gray (5Y 4/2) moist; single grain; loose, nonsticky and nonplastic; very few very fine roots; many fine interstitial pores; olive (5Y 5/3) silt lenses from 1/4 to 1/2 inch thick, olive gray (5Y 4/2) moist; many fine roots in lenses; moderately alkaline (pH 8.2); slightly effervescent; clear smooth boundary.

C4—41 to 48 inches; light olive gray (5Y 6/2) fine sand, olive gray (5Y 4/2) moist; single grain; loose, nonsticky and nonplastic; very few very fine roots, many fine interstitial pores; moderately alkaline (pH 8.2); slightly effervescent; clear smooth boundary.

C5—48 to 60 inches; light olive gray (5Y 6/2) very fine sand, olive gray (5Y 4/2) moist; massive; slightly hard, very friable, nonsticky and nonplastic; pale yellow (5Y 7/3) silt lenses 1/4 to 1/2 inch thick, pale olive (5Y 6/3) moist; moderately alkaline (pH 8.2); slightly effervescent.

The Ap horizon or C1 horizon is fine sand, loamy fine sand, fine sandy loam, or sandy loam in hue of 5Y, 2.5Y, value of 5 to 7 dry and 4 to 5 moist, and chroma of 1 and 2 moist and dry. The C2 horizon and C3 horizon are sand, fine sand, loamy sand, or loamy fine sand with strata of very dark grayish brown, olive gray, or olive silt, silt loam, or very fine sandy loam 1/8 to 3/4 inch thick. Colors are in hue 5Y, 2.5Y, value of 5 to 7 dry and 4 to 5 moist, and chroma of 2 and 3 dry and moist.

The soils are calcareous with disseminated lime and are moderately alkaline. Depth to the high water table is more than 6 feet except in areas where drainage has been influenced by irrigation. In these areas depth to the high water table is between 3 and 5 feet.

CpA—Coachella fine sand, 0 to 2 percent slopes. This nearly level soil is on alluvial fans and flood plains of the Coachella Valley. It has the profile described as representative of the series.

About 8 percent of this mapping unit is included areas of Myoma soils, 5 percent Indio soils, and 5 percent Gilman soils. Also included are some small areas of soils that have a fine sandy loam or sandy loam surface layer.

Runoff is medium. The erosion hazard is slight. The hazard of soil blowing is high.

The soil is used for citrus, dates, grapes, truck crops, and alfalfa hay. Capability unit IIIe–4 (31) irrigated, VIIIe–1 (30) dryland.

CpB—Coachella fine sand, hummocky, 2 to 5 percent slopes. This gently sloping soil is hummocky. The hummocks are generally 6 to 24 inches high; some are as high as 36 inches. They are fine sand deposits around bushes, weeds, fence rows, or tree rows. Small scoured areas are between the hummocks.

About 8 percent of this mapping unit is included areas of Myoma soils, 5 percent Gilman soils, and 3 percent Indio soils. Also included are some small areas of soils that have a loamy sand or fine sandy loam surface layer.

Runoff is medium. The erosion hazard is slight. The hazard of soil blowing is high.

The soil is used for truck crops, dates, citrus, and alfalfa hay. Capability unit IIIe–4 (31) irrigated, VIIIe–1 (30) dryland.

CrA—Coachella fine sand, wet, 0 to 2 percent slopes. This nearly level soil has a profile similar to the one described for the series, but it has a water table at a depth between 40 and 60 inches, and about one-third of the mapping unit has a sandy loam surface layer.

About 5 percent of this mapping unit is included areas of Gilman soils, 5 percent Indio soils, and 5 percent Myoma soils. Also included are some small areas of soils that have a fine sandy loam surface layer.

Runoff is medium. The erosion hazard is slight. The hazard of soil blowing is moderate or high depending on the texture of the surface layer. Effective rooting depth is 40 to 60 inches for water sensitive crops. Tile drains are needed for sustained crop production.

The soil is used for grapes, dates, citrus, truck crops, and alfalfa hay. Capability unit IIIw–2 (31) irrigated.

CsA—Coachella fine sandy loam, 0 to 2 percent slopes. This nearly level soil has a profile similar to the one described as representative of the series, but it has a fine sandy loam surface layer.

About 5 percent of this mapping unit is included areas of Gilman soils, 5 percent Indio soils, and 5 percent Myoma soils. Also included are some small areas of soils that have a loamy fine sand or loamy very fine sand surface layer.

Runoff is medium. The erosion hazard is slight. The hazard of soil blowing is moderate. Available water capacity is 10 to 15 inches.

The soil is used for truck crops, alfalfa hay, dates, and citrus. Capability unit IIe–1 (31) irrigated, VIIIe–1 (30) dryland.

Fluvaquents

Fa—Fluvaquents are nearly level, poorly drained soils at the western and northern edges of the Salton Sea. They are periodically flooded by the salt water of the Salton Sea. Flooding occurs when the drainage water inflow to the sea exceeds the evaporation. The flooding usually occurs late in spring and in summer. The salt water recedes in fall and winter. Elevations are 236 to 228 feet below sea level.

These soils are wet and are high in salt content. They are stratified lacustrine deposits ranging from fine sand to silty clay.

The vegetation is mainly cattails, rushes, saltgrass, and bermudagrass and some mesquite and arrowweed.

Depth to the water table is 6 to 24 inches. Permeability is moderate. The available water capacity in a drained soil is 8 to 10 inches.

The present land use is wildlife habitat and recreation. Capability unit VIIIw–1 (30, 31) dryland.

Fluvents

Fe—Fluvents are nearly level soils exposed by the Whitewater River channel and the flood control channel. They are on the built-up dikes and sloped banks of the flood control channel. The channel carries floodwater infrequently, usually after a major storm occurs in the mountains surrounding Coachella Valley. Elevations are 400 feet above to 232 feet below sea level.

The texture of the soil material exposed on the sloped banks and dikes ranges from fine sand and gravelly sand and lenses of loamy sand and silt at the northwest end of the channel through loamy very fine sand, fine sandy loam, very fine sandy loam, silt loam, and silty clay loam to silty clay where the channel ends at the Salton Sea.

The flood control channel is normally dry from Sunrise Way to where it crosses Monroe Street north of Indio. The texture in this part is coarser, ranging from gravelly sand to fine sandy loam. Several golf courses (fig. 1) use sections of the channel. East of Monroe Street it is used as a drainageway for irrigation tailwater and as the main drain for the tile drainage systems to the Salton Sea. This part is almost continuously wet because a small channel has cut into the center of the flat bottom of the main channel. The small channel normally carries the drainage water. In this reach of the channel, the texture is very fine sandy loam or finer. The wet areas are high in salt content.

The natural vegetation west of Monroe Street is a sparse cover of creosotebush, encelia, and annual grasses. East of Monroe Street it is saltgrass, bermuda-

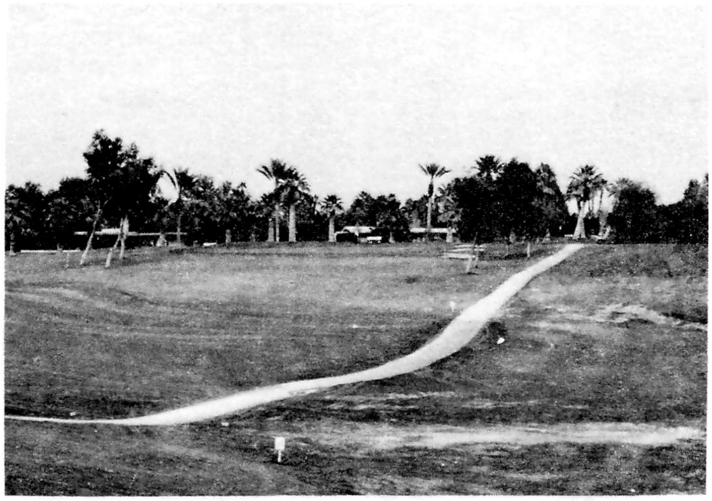

Figure 1.—**Golf course in flood control channel (Fluvents). The swale area is subject to periodic flooding and deposition.**

grass, cattails, arrowweed, and saltcedar, all of which has to be continually cleared so that the main channel can carry the anticipated floodwater.

The present land use is flood control, wildlife habitat, and recreation. Capability unit VIIIw–1 (30, 31) dryland.

Gilman Series

The Gilman series consists mainly of well drained soils, but includes soils that have altered drainage where seepage from irrigation has caused a seasonal water table at a depth of 3 to 5 feet. These soils formed in alluvium. Slopes are 0 to 5 percent. Elevations range from 400 feet above to 230 feet below sea level. The vegetation is a sparse cover of low creosotebush, bush sunflower, and mesquite. Saltcedar and arrowweed grow in uncultivated wet areas. Average annual precipitation is less than 4 inches, mean annual soil temperature is 72° to 75° F., and the frost-free season is 270 to 320 days.

Typically, the surface layer is grayish brown fine sandy loam about 8 inches thick. The substratum to a depth of 60 inches or more is light brownish gray, stratified loamy fine sand and loamy very fine sand with thin lenses of silt loam and silty clay loam. Generally, the substratum contains many freshwater shells. The soil is moderately alkaline and slightly to strongly effervescent.

The soil is moderately permeable. Available water capacity is 4 to 15 inches. The effective rooting depth is 60 inches or more. A seasonal water table is at a depth of 3 to 5 feet or more.

These soils are used for truck crops, citrus, dates, grapes, cotton, alfalfa hay, and recreation.

Representative profile of Gilman fine sandy loam, wet, 0 to 2 percent slopes, on alluvial fans and flood plains, 1,320 feet north, 20 feet west of southeast corner sec. 14, T. 6 S., R.7 E., SBBM:

Ap—0 to 8 inches; grayish brown (2.5Y 5/2) fine sandy loam, very dark grayish brown (2.5Y 3/2) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many small freshwater shells and shell fragments; micaceous; slightly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

C—8 to 60 inches; light brownish gray (2.5Y 6/2) erratically stratified loamy fine sand to silty clay loam; finer textures occur as thin lenses or strata ¼ to 2 inches thick; dark grayish brown (2.5Y 4/2) moist; massive; soft, very friable, nonsticky and nonplastic; many small freshwater shells and shell fragments; micaceous; slightly effervescent, moderately alkaline (pH 8.2). Common fine distinct reddish brown mottles at 34 inches.

The Ap horizon is loamy fine sand, fine sandy loam, or silt loam in hue of 10YR and 2.5Y, value of 5 to 7 dry, and chroma of 2 to 4 dry and moist. The C horizon is loamy sand, loamy very fine sand, fine sandy loam, and very fine sandy loam and thin strata of silt loam and silty clay loam in hue of 10YR and 2.5Y, value of 5 to 7 dry, and chroma of 2 to 4 dry and moist.

The soils are calcareous with disseminated lime and freshwater shells and fragments, and they are moderately alkaline. The water table ranges from 3 to 5 feet or more below the surface.

GaB—Gilman loamy fine sand, 0 to 5 percent slopes. This nearly level to gently sloping soil is on alluvial fans and flood plains. It has a profile similar to the one described as representative of the series, but the surface has hummocks of fine sand 6 to 12 inches high in areas that are not protected and the surface layer is loamy fine sand in protected areas. Drainage has not been altered by seepage, and the seasonal high water table is deeper than 5 feet.

About 8 percent of this mapping unit is included areas of Coachella soils, 5 percent Indio soils, and 1 percent Salton soils. Also included are small areas of Gilman soils that have a sand or fine sandy loam surface layer and some areas that have rills or gullies but no hummocks.

Runoff is very slow. The erosion hazard is slight. The hazard of soil blowing is high. Available water capacity is 8.5 to 9.5 inches. The effective rooting depth is 60 inches or more. Flooding rarely occurs.

The soil is used for truck crops, citrus, dates, grapes, and alfalfa hay. Capability unit IIIe–1 (31) irrigated.

GbA—Gilman fine sandy loam, 0 to 2 percent slopes. This nearly level soil has a profile similar to the one described as representative of the series, but drainage has not been altered by seepage and the water table is at a depth of more than 6 feet.

About 3 percent of this mapping unit is included areas of Coachella soils, 4 percent Indio soils, and 3 percent Salton soils. About 4 percent is included areas of Gilman soils that have a loamy fine sand or sandy loam surface layer. In 30 percent of the mapping unit, the substratum is massive loam or silt loam.

Runoff is very slow. The erosion hazard is slight. The hazard of soil blowing is moderate. Available wa-

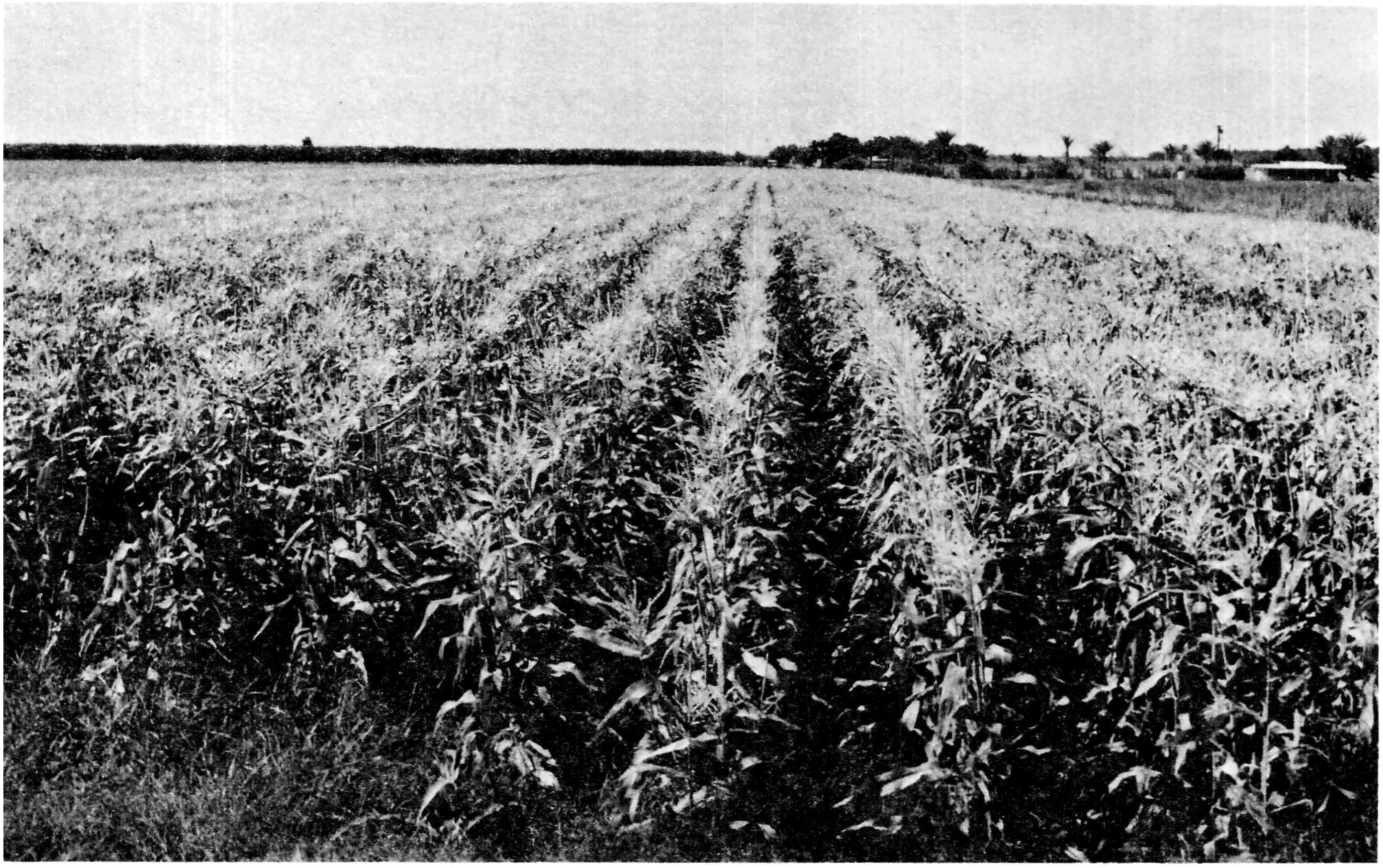

Figure 2.—**Sweet corn on Gilman fine sandy loam, 0 to 2 percent slopes.**

ter capacity is 9.5 to 10.5 inches. The effective rooting depth is 60 or more inches. Flooding rarely occurs.

The soil is used for truck crops (fig. 2), alfalfa hay, citrus, and grapes. Capability unit IIe-1 (31) irrigated.

GbB—Gilman fine sandy loam, 2 to 5 percent slopes. This gently sloping soil is at the edges of the alluvial fans and valley fill. It has a profile similar to the one described as representative of the series, but drainage has not been altered by seepage and the water table is at a depth of more than 6 feet.

About 4 percent of this mapping unit is included areas of Coachella soils, 2 percent Indio soils, and 1 percent Salton soils. About 5 percent is included areas of Gilman soils that have a loamy very fine sand or sandy loam surface layer.

Runoff is slow. The erosion hazard is slight. The hazard of soil blowing is moderate. Available water capacity is 9.5 to 10.5 inches. The effective rooting depth is 60 inches or more. Flooding rarely occurs.

The soil is used for truck crops, citrus, grapes, and alfalfa hay. Capability unit IIe-1 (31) irrigated.

GcA—Gilman fine sandy loam, wet, 0 to 2 percent slopes. This nearly level soil is on alluvial fans and flood plains of the Coachella Valley. It has the profile described as representative of the series and usually has a water table between 40 and 60 inches.

About 6 percent of the mapping unit is included areas of soils that have a loamy fine sand surface layer, 5 percent Coachella soils, 2 percent Indio soils, and 2 percent Salton soils. Also included are small areas of a wind eroded soil that has fine sand hummocks 6 to 12 inches high and small areas of Gilman soils that have a loamy fine sand or sand surface layer. About 1 percent of the area has a 2 to 5 percent slope.

Runoff is slow. The erosion hazard is slight. The hazard of soil blowing is moderate. Available water capacity is 9.5 to 10.5 inches. Depth to the high water table is 40 to 60 inches. The soil requires tile drains for sustained crop production.

The soil is used for truck crops, citrus, dates, cotton, and alfalfa hay. Capability unit IIw-1 (31) irrigated.

GdA—Gilman fine sandy loam, moderately fine substratum, 0 to 2 percent slopes. This nearly level soil has a profile similar to the one described as representative of the series, but the substratum is dominantly silty clay loam below 40 inches and the root zone has a slight accumulation of salts.

About 5 percent of this mapping unit is included areas of Indio soils, 3 percent Salton soils, and 2 percent

Coachella soils. Also included are some small areas of Gilman soils that have a silty clay substratum and a silty surface layer.

Runoff is slow. The erosion hazard is slight. Available water capacity is 9.5 to 11.5 inches. The effective rooting depth is greater than 60 inches. The depth to the water table is 40 to 60 inches. This soil is slowly permeable in the moderately fine textured substratum and requires tile drains for crop production.

The soil is used for dates, alfalfa hay, cotton, and recreation. Capability unit IIw–6 (31) irrigated.

GeA—Gilman silt loam, 0 to 2 percent slopes. This nearly level soil has a profile similar to the one described as representative of the series, but it has a silt loam surface layer. Drainage has not been altered by seepage, and the seasonal water table is at a depth of more than 6 feet.

About 3 percent of this mapping unit is included areas of Indio soils, 1 percent Salton soils, and 2 percent Coachella soils. Also included are areas of Gilman soils that have a loam and very fine sandy loam surface layer, small areas of 2 to 3 percent slopes, and areas with gullies 6 to 15 inches deep north of Avenue 58 near the Coachella Valley Canal.

Runoff is slow. The erosion hazard is slight. Available water capacity is 9.5 to 10.5 inches. The effective rooting depth is 60 inches or more. Flooding rarely occurs.

The soil is used for citrus, dates, cotton, and alfalfa hay. Capability unit I (31) irrigated.

GfA—Gilman silt loam, wet, 0 to 2 percent slopes. This nearly level soil has a profile similar to the one described as representative of the series, but it has a silt loam surface layer.

About 8 percent of this mapping unit is included areas of Indio soils, 2 percent Salton soils, and 1 percent Coachella soils. Also included are areas of Gilman soils that have a loam or very fine sandy loam surface layer.

Runoff is very slow. The erosion hazard is slight. Available water capacity is 9.5 to 10.5 inches. The depth to the water table is 40 to 60 inches. The soil requires tile drains for crop production.

The soil is used for dates, cotton, alfalfa hay, and recreation. Capability unit IIw–2 (31) irrigated.

Gravel Pits and Dumps

GP—Gravel pits and dumps are open excavations from which soil and the underlying sand and gravel have been removed for construction work and areas on which material taken out of the Metropolitan Aqueduct Tunnels has been stockpiled. This material is blasted rock and is generally in a canyon that has rock outcrop on both sides.

Gravel pits, clay pits, and dumps are outlined, named or marked on the soil map with conventional symbols.

This land type has no value for farming.

The gravel pits and dumps are used as a source of construction material for recreation, or they are idle. Capability unit VIIIs–1 (30, 31) dryland.

Imperial Series

The Imperial series consists mainly of well drained and moderately well drained soils, but includes soils that have altered drainage where seepage from irrigation has caused a water table at a depth of 10 to 60 inches. The soils formed in fine textured alluvium. Slopes are 0 to 9 percent. Elevations range from 50 feet above to 230 feet below sea level. The vegetation is a sparse cover of low creosotebush. Annual precipitation is less than 4 inches, the average annual soil temperature is above 72° F., and the frost-free season is 270 to 320 days.

Typically, the upper 17 inches of these soils is pinkish gray and light gray silty clay. Below this to a depth of 60 inches or more is light brownish gray and grayish brown clay. The soil is moderately alkaline, slightly to strongly effervescent, and moderately to strongly saline.

These soils are slowly permeable. Available water capacity is 10 to 12 inches. The effective rooting depth is 60 inches or more.

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

Representative profile of Imperial silty clay, 0 to 2 percent slopes, in an old lakebed, 600 feet south and 100 feet west of center of sec. 16, T. 8 S., R. 11 E., SBBM:

C1—0 to 7 inches; pinkish gray (5YR 6/2) silty clay, brown (10YR 5/3) moist; weak fine granular structure; hard, firm, sticky and very plastic; few very fine roots; common fine interstitial pores; strongly effervescent; moderately alkaline (pH 8.0); surface 1/8 inch puddled and cracked in plates 5 by 9 inches to 10 by 15 inches; few concha shells; clear smooth boundary.

C2—7 to 17 inches; light gray (10YR 7/2) silty clay, pale brown (10YR 6/3) moist; yellowish brown (10YR 5/6) mottles when moist; moderate medium subangular blocky structure; hard, firm, sticky and very plastic; no roots; few fine interstitial pores; slightly effervescent; moderately alkaline (pH 8.0); some concha shells; clear smooth boundary.

C3—17 to 26 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; moderate coarse and very coarse subangular blocky structure; very hard, very firm, sticky and very plastic; very few very fine tubular pores; violently effervescent; moderately alkaline (pH 8.0); some concha shells; some evidence of vertical cracks.

C4—26 to 32 inches; light brownish gray (10YR 6/2) clay, brown (10YR 5/3) moist; massive; very hard, very firm, sticky and very plastic; very few fine tubular slightly effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

C5—32 to 37 inches; grayish brown (10YR 52) clay, brown (10YR 4/3) moist; moderate thick platy structure; evidence of vertical cracks; very hard, very firm, sticky and very plastic; very few fine tubular pores; slightly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

C6—37 to 60 inches; light brownish gray (10YR 6/2) clay, brown (10YR 4/3) moist; moderate thick platy structure; evidence of vertical cracks; hard, firm, sticky and very plastic; very few fine tubular pores; slightly effervescent; strongly alkaline (pH 8.5).

The C1 horizon is silty clay loam, clay, or silty clay in hue of 10YR, 7.5YR, and 5YR; value of 6 and 7 dry, 5 and 6 moist; and chroma of 2 and 3 moist and dry. The 10- to 40-inch control section (the C2, C3, C4, and C5 horizons) is silty clay or clay in hue of 10YR and 7.5YR; value of 5 to 7 dry, 4 to 6 moist; and chroma of 2 and 3 moist and dry. In places there are thin strata (1/16 to 1/4 inch) of very fine sand. The layers of silty clay between the fine sand strata have yellowish brown mottles that are most pronounced when the soil is moist.

Vertical cracks are present and a sprinkling of fine sand is on the ped faces. The vertical cracks are generally interrupted by the massive clay layers 1 to 12 inches thick and to a lesser extent by the platy clay layer.

The soils are calcareous with disseminated and mycellial lime. Some profiles have seams of pure gypsum 1/4 to 1/2 inch thick at various depths, and some have gypsum crystals throughout the upper part. The soils are moderately to strongly saline.

IeA—Imperial silty clay, 0 to 2 percent slopes. This nearly level soil is on lacustrine deposits of the Salton Sea Basin in the southeastern part of the survey area, generally east of the Salton Sea. It has the profile described as representative of the series.

About 8 percent of this mapping unit is included areas of Niland soils, 3 percent Carsitas soils, and 2 percent Riverwash. Also included are some small areas of Imperial soils that have a sand and gravelly sand overwash 2 to 10 inches thick; some areas that have scattered surface gravel; a few dune areas of granulated clay accumulated at wet spots; areas covered with a dense cover of low creosotebush; and about 100 acres of a sandy clay or sandy clay loam dune area, where slopes are 2 to 15 percent, in sec. 32, T. 8 S., R. 11 E., SBBM.

Runoff is slow. The hazard of soil blowing is moderate. The granular clay moves like sand in a strong wind. Available water capacity is 10 to 12 inches. The effective rooting depth is 60 inches or more.

The soil is used for wildlife habitat and recreation. Capability unit IIIs–5 (31) irrigated, VIIIs–1 (31) dryland.

IfA—Imperial silty clay, wet, 0 to 2 percent slopes. In this soil the water table is at a depth of 10 to 36 inches, water flows slowly through drainage channels, and the soil generally has a salt crust. Depth to the water table depends on the elevation as related to springs and seeps and the rate of waterflow in channels.

About 10 percent of this mapping unit is included areas of Niland soils, 3 percent Carsitas soils, and 2 percent Myoma soils.

Runoff is slow, and the erosion hazard is slight. Available water capacity is 10 to 12 inches.

The soil is used for wildlife habitat and recreation. Capability unit IVw–6 (31) irrigated, VIIIw–1 (31) dryland.

ImC—Imperial-Gullied land complex, 2 to 9 percent slopes. This mapping unit is on dissected lacustrine deposits in the Salton Sea Basin, which is east of the present sea. The elevation is 100 to 200 feet below sea level. About 65 percent of the unit is Imperial silty clay, which occurs as narrow bands between the many gullies and has slopes of 2 to 9 percent. About 30 percent is Gullied land, which is an Imperial soil that has rills 4 to 12 inches deep in the nearly level areas and V- or U-shaped gullies in the steeper slopes. The gullies are at 40 to 150 foot intervals, are 15 to 40 feet wide, and are 1 to 15 feet deep. They are not crossable.

About 4 percent of this mapping unit is included areas of Niland soils and 1 percent is Myoma soils. Also included are small areas of soils with slopes or scarps of 9 to 25 percent, areas of an Imperial soil with a sand or gravelly sand overwash 3 to 6 inches thick; areas with scattered surface gravel; and areas with large and small gypsum crystals on the surface.

Runoff is rapid, and the erosion hazard is moderate. The hazard of soil blowing is moderate. Available water capacity is 10 to 12 inches in the Imperial soil. The effective rooting depth is 60 inches or more.

This unit is used for wildlife habitat and recreation. Capability unit VIIIe–1 (31) dryland.

IoC—Imperial-Gullied land complex, wet, 2 to 9 percent slopes. This mapping unit is on dissected lacustrine deposits east of the Salton sea. The elevation is 100 to 200 feet below sea level. About 60 percent of the unit is Imperial silty clay, which occurs as narrow bands between the many gullies that have slowly flowing water and seeps on the banks. Slopes are 2 to 9 percent. The water table is at a depth of 18 to 60 inches. About 30 percent of the complex is Gullied land, which is an Imperial soil that has rills 4 to 12 inches deep in the nearly level areas and V- or U-shaped gullies in the steeper slopes. The gullies are at 40 to 150 foot intervals, are 15 to 40 feet wide, and are 1 to 15 feet deep. They are not crossable. Depth to the water table depends on the relative elevation of the soil area in relation to springs, seeps, and slowly flowing drainages. The surface of the soil usually has a salt crust.

About 8 percent of this mapping unit is included areas of Niland soils and 2 percent Carsitas soils. Also included are small areas of wet soil with slopes of 9 to 25 percent and some areas with a sandy or gravelly sand overwash 3 to 6 inches thick.

Runoff is rapid, and erosion hazard is moderate. The hazard of soil blowing is moderate. Available water capacity is 10 to 12 inches in the Imperial soil. A water table is at a depth of 18 to 60 inches.

This unit is used for wildlife habitat and recreation. Capability unit VIIIe–1 (31) dryland.

Indio Series

The Indio series consists of well drained or moderately well drained soils that formed in alluvium. Slopes are 0 to 2 percent. Elevations range from 230 feet above to 230 feet below sea level. The vegetation is creosotebush, mesquite, and bush sunflower. Saltcedar and arrowweed are on uncultivated wet areas. Average annual precipitation is less than 4 inches, the mean annual soil temperature is 72° to 75° F., and the frost-free season is 270 to 320 days.

Typically, the surface layer is light brownish gray, very fine sandy loam about 10 inches thick. The substratum to a depth of 60 inches or more is light brownish gray, highly micaceous very fine sandy loam stratified with silt and silt loam. It contains a few freshwater shells. The soil is moderately alkaline and strongly effervescent.

The soil is moderately permeable. Available water capacity is 9 to 12 inches. A water table is 3 to 5 feet or deeper below the surface.

These soils are used for truck crops, citrus, grapes, dates, cotton, alfalfa hay, and irrigated pasture.

Representative profile of Indio very fine sandy loam, wet, on nearly level alluvial fans and flood plains, 100 feet east and 50 feet south of north quarter corner of sec. 30, T. 6 S., R. 8 E., SBBM;

Ap—0 to 10 inches; light brownish gray (2.5Y 6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; few small freshwater shells and fragments of shells; micaceous; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

C—10 to 60 inches; light brownish gray (2.5Y 6/2) stratified very fine sandy loam; dark grayish brown (2.5Y 4/2) moist; stratification is silt loam and silt plates; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; few freshwater shells; micaceous; strongly effervescent; moderately alkaline (pH 8.2).

The Ap horizon is loamy fine sand, fine sandy loam, very fine sandy loam, or silt loam, in hue of 5Y, 2.5Y and 10YR dry and moist, value of 5 to 7 dry and 3 to 5 moist inclusive, and chroma of 1 and 2 dry and moist. The 10- to 40-inch control section is dominantly very fine sandy loam and thin strata of loamy fine sand, silt, silt loam, and silty clay loam. There are few faint mottles with chroma of 2 or less.

The soils are calcareous and have disseminated lime and some mycelial lime in the silt or silt loam strata. They are moderately alkaline. Depth to the water table ranges from 3 to 5 feet or deeper.

Ip—Indio fine sandy loam. This nearly level soil has a profile similar to the one described as representative of the series, but it has a fine sandy loam surface layer and the water table is below 6 feet.

About 5 percent of this mapping unit is included areas of Gilman soils, 3 percent Salton soils, and 2 percent Coachella soils. Also included are small areas of Indio soils that have a loamy fine sand or fine sand surface layer.

Runoff is slow. The erosion hazard is slight. The hazard of soil blowing is moderate. A water table is at a depth of 6 feet or more.

This soil is used for truck crops, citrus, grapes, and alfalfa hay. Capability unit IIe–1 (31) irrigated.

Ir—Indio fine sandy loam, wet. This nearly level soil has a profile similar to the one described as representative of the series, but in most places it has a fine sandy loam surface layer. In about 10 percent of the mapping unit, the surface layer is loamy fine sand.

About 5 percent of this mapping unit is included areas of Gilman soils, 4 percent Salton soils, and 2 percent Coachella soils. Also included are some small areas of Indio soils that have a fine sand, loamy very fine sand, or sandy loam surface layer.

Runoff is slow. The erosion hazard is slight. The hazard of soil blowing is moderate. A water table is 40 to 60 inches below the soil surface. The soil requires tile drainage for sustained crop production.

This soil is used for truck crops, dates, citrus, grapes, alfalfa hay, and cotton. Capability unit IIw–1 (31) irrigated.

Is—Indio very fine sandy loam. This nearly level soil has a profile similar to the one described as representative of the series, but the water table is below 6 feet.

About 3 percent of this mapping unit is included areas of Gilman soils, 4 percent Salton soils, and 1 percent Coachella soils. In about 12 percent of the mapping unit, the surface layer is silt loam and the substratum below a depth of 40 inches is stratified with silty clay loam or is silty clay loam. Also included are some small areas north of Avenue 58 near the Coachella Valley Canal that have gullies 6 to 15 inches deep.

Runoff is slow. The erosion hazard is slight.

This soil is used for truck crops, citrus, grapes, and alfalfa hay. Capability unit I (31) irrigated.

It—Indio very fine sandy loam, wet. This nearly level soil is on alluvial fans and flood plains. It has the profile described as representative of the series.

About 5 percent of this mapping unit is included areas of Gilman soils, 4 percent Salton soils, and 1 percent Coachella soils. In about 25 percent of this mapping unit, the surface layer is silt loam and the substratum below a depth of 40 inches is stratified with silty clay loam or is silty clay loam. Also included are small areas of soils that have a loam or clay loam surface layer.

Runoff is slow. The erosion hazard is slight. A high water table is at a depth of 40 to 60 inches. The soil requires tile drainage for sustained crop production.

This soil is used for truck crops, alfalfa hay, cotton, dates (fig. 3), and irrigated pasture. Capability unit IIw–2 (31) irrigated.

Lithic Torripsamments-Rock Outcrop

LR—Lithic Torripsamments-Rock outcrop complex. This unit is somewhat excessively drained. It formed on very old, partially consolidated alluvial fill and sandstone cut by many intermittent drainages. Slopes are 15 to 75 percent. Elevations are 600 to 1,600 feet. The vegetation is a very scanty cover of stunted creosotebush, bush sunflower, and some annual grass. Average annual precipitation is less than 4 inches, the estimated average annual temperature is above 72° F., and the frost-free season is 270 to 320 days.

Approximately 10 to 25 percent of the area is sandstone exposures, and the rest has a 3- to 8-inch layer of sand, loamy sand, or fine sand over consolidated layers of alluvium or sandstone. About 10 percent of this mapping unit is included areas of Chuckawalla

Figure 3.—**Date garden on Indio very fine sandy loam, wet. This soil is tile drained.**

soils, 5 percent Carsitas soils, 5 percent Rubble land, and 3 percent Riverwash.

The topography is fairly smooth and narrow V-shaped drainageways lead into the major drainages. Raw sediment-producing areas are all along the V-shaped drainageways.

The soil is rapidly permeable. Runoff is very rapid. The erosion hazard is very high. Geologic erosion is active, and in many places slipping is common.

The soil has no value for farming and is used for watershed, wildlife habitat, and recreation. Capability unit VIIIs–1 (30) dryland.

Myoma Series

The Myoma series consists mainly of somewhat excessively drained soils, but includes soils that have altered drainage where seepage from irrigation has caused a water table at a depth of 1.5 to 5 feet. The soils formed in recent alluvium. Slopes are 0 to 15 percent. Elevations range from 1,800 feet above to 200 feet below sea level. The vegetation is creosotebush, bush sunflower, mesquite, and ironwood. Average annual precipitation is less than 4 inches, mean annual soil temperature is 72° to 75° F., and the frost-free season is 270 to 320 days.

Typically, the upper 18 inches of these soils is light olive gray fine sand. Below this to a depth of 60 inches or more is light olive gray very fine sand and fine sand. The soil is moderately to strongly alkaline and slightly to violently effervescent.

The soil is rapidly permeable. Available water capacity is 3.5 to 5.5 inches. The effective rooting depth is 60 inches or more. A water table is at a depth of 1.5 to 5 feet or more.

These soils are used for truck crops, citrus, grapes, alfalfa hay, dates, and homesites.

Representative profile of Myoma fine sand, 0 to 5 percent slopes, in a citrus grove, 350 feet east and 50 feet south of north quarter corner of sec. 11, T. 6 S., R. 7 E., SBBM:

C1—0 to 18 inches; light olive gray (5Y 6/2) fine sand, olive gray (5Y 5/2) moist; salt and pepper appearance; many mica flakes; single grain; loose, nonsticky and nonplastic; common very fine roots; very few fine roots; common very fine interstitial pores; slightly effervescent; some concha shells; moderately alkaline (pH 8.2) ; clear smooth boundary.

C2—18 to 24 inches; light olive gray (5Y 6/2) very fine sand, olive gray (5Y 5/2) moist; salt and pepper appearance; many mica flakes; single grain; loose, nonsticky and nonplastic; common very fine roots; common very fine interstitial pores; strongly effervescent; moderately alkaline (pH 8.0) ; clear wavy boundary.

C3—24 to 31 inches; light olive gray (5Y 6/2) fine sand, olive gray (5Y 5/2) moist; salt and pepper appearance; many mica flakes; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; common very fine interstitial pores; strongly effervescent; concha and clam shells; moderately alkaline (pH 8.4); clear wavy boundary.

C4—31 to 60 inches; light olive gray (5Y 6/2) very fine sand, olive gray (5Y 4/2) moist; salt and pepper appearance; many mica flakes; single grain; loose, nonsticky and nonplastic; few very fine roots; common very fine interstitial pores; strongly effervescent; occasional concha and clam shells; strongly alkaline (pH 8.6).

The C1 horizon is sand, fine sand, very fine sand, or loamy fine sand that is less than 15 percent by volume of coarse fragments. Color is in hue of 10YR through 5Y yellow; value of 5 to 7 inclusive dry, 3 through 6 moist; and chroma of 1 through 3 dry and moist. The 10- to 40-inch control section is fine sand, very fine sand, and loamy fine sand and less than 15 percent coarse fragments. It is in hue of 10YR through 5Y yellow; value of 5 to 7 inclusive dry, 3 to 6 moist; and chroma 1 to 3 inclusive moist and dry. The control section is less than 15 percent coarse and very coarse sand. The C4 horizon is similar to the control section. In many areas concha shells and oyster shell fragments are common in the profile.

The soils are slightly to violently effervescent with disseminated lime and are moderately to strongly alkaline. Depth to the water table ranges from about 1.5 to 5 feet or more.

MaB—Myoma fine sand, 0 to 5 percent slopes. This nearly level to gently sloping soil is on alluvial fans where they merge with the finer textured flood plain and basin soils. It has the profile described as representative of the series.

About 8 percent of this mapping unit is included areas of Carsitas soils, 4 percent Coachella soils, 2 percent Riverwash, and 5 percent noncalcareous Myoma soils. Also included are some areas of sand; small areas of soils that have a coarse sand, sandy loam, or fine sandy loam surface layer; small areas of deposition along windbreaks and fence lines; and small areas with slopes greater than 5 percent in citrus groves and vineyards. In some areas south of Dillon Road (Sky and Fun Valley) are soils with brown or yellowish brown loamy sand between depths of 10 and 40 inches, and some areas northwest of Martinez Canyon have a thin surface deposit of gravelly sand.

Runoff is very slow. The erosion hazard is slight (fig. 4). The hazard of soil blowing is high.

This soil is used for truck crops, citrus, grapes, alfalfa hay, homesites, and recreation. Capability unit IIIe–4 (31) irrigated, VIIIe–1 (30) dryland.

MaD—Myoma fine sand, 5 to 15 percent slopes. This moderately sloping to rolling soil is on dunes and alluvial fans. It has a profile similar to the one described as representative of the series, but it is noncalcareous throughout.

This soil does not have the free lime described in the range for the series, but this difference does not affect its use and management.

About 6 percent of this mapping unit is included areas of Coachella soils, 1 percent Carsitas soils, 1 percent Riverwash, and 5 percent calcareous Myoma soils. Also included are areas of calcareous soils on Edom Hill and Flat Top and east of Salton Sea; some small areas of sand and loamy fine sand; and some dune areas along the ancient beach lines that have a sand profile.

Runoff is very slow. The erosion hazard is slight. The hazard of soil blowing is high.

This soil is used for homesites and recreation, and when leveled, for truck crops, citrus, and grapes. Capability unit IIIe–4 (31) irrigated, VIIIe–1 (30) dryland.

McB—Myoma fine sand, wet, 0 to 5 percent slopes. This nearly level or gently sloping soil is on alluvial fans near the southeastern edge of the area where the fans become more sloping and in other areas adjacent to finer textured soils. It has a profile similar to the one described as representative of the series, but it has a water table at a depth of 18 to 60 inches.

About 5 percent of this mapping unit is included areas of Niland soils, 4 percent Coachella soils, 2 percent Carsitas soils, and 1 percent Indio soils. Also included are some small areas along Salton Sea where the water table is at a depth of 6 to 18 inches and small areas where slopes are 5 to 15 percent.

Runoff is very slow. The erosion hazard is slight. The hazard of soil blowing is high. A high water table is at a depth of 20 to 60 inches. The soil requires tile drains for sustained crop production. It is slightly saline.

This soil is used for truck crops, citrus, grapes, dates, alfalfa hay, homesites, and recreation. Capability unit IIIw–4 (31) irrigated.

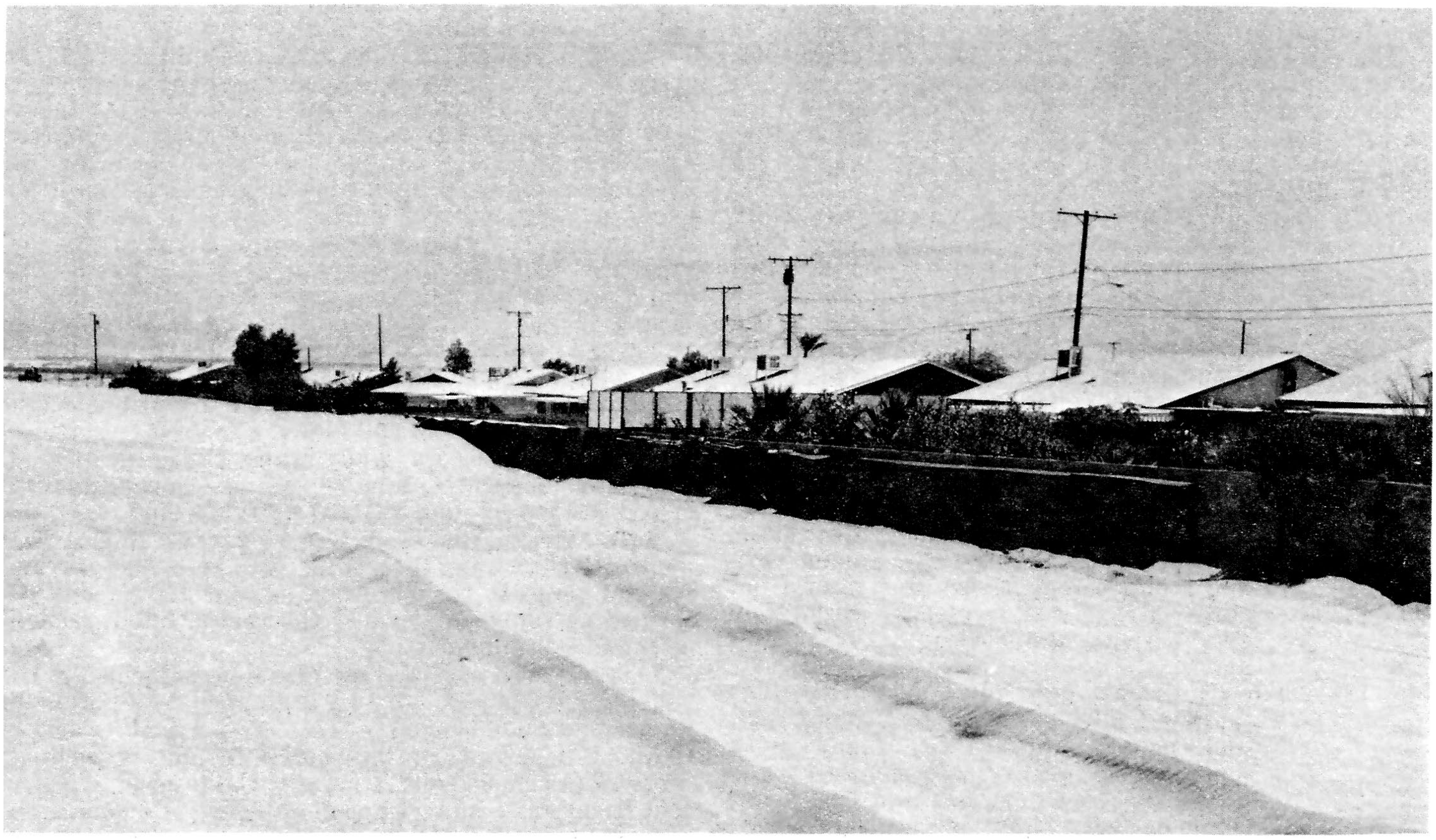

Figure 4.—**Soil blowing on Myoma fine sand endangers nearby residential areas, as well as valuable farm land.**

Niland Series

The Niland series consists mainly of moderately well drained soils but includes soils that have altered drainage where seepage by irrigation has caused a water table at a depth of 1½ to 5 feet. The soils formed in coarse alluvium that is less than 36 inches thick over fine alluvium. Slopes are 2 to 5 percent. Elevations range from 50 feet above to 230 feet below sea level. The vegetation is creosotebush, bush sunflower, and wingscale. Catclaw, mesquite, saltcedar, and arrowhead are in areas where the water table is high. Average annual precipitation is less than 4 inches, the mean annual soil temperature is more than 72° F., and the frost-free season is 270 to 320 days.

Typically, in sequence downward, these soils are 21 inches of pale brown and very pale brown sand and coarse sand, 22 inches of pale brown silty clay, 10 inches of pale brown very fine sandy loam, and to a depth of 60 inches or more light reddish brown clay. The clay substratum is mottled and has some vertical cracks. The soil is moderately alkaline and strongly effervescent.

The soil is rapidly permeable in the sandy part and slowly permeable in the clayey part. Available water capacity is 4.5 to 8.0 inches. The effective rooting depth is 60 inches or more. A water table is at 18 inches to 5 feet or more.

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

Representative profile of Niland sand, 2 to 5 percent slopes, at basin edges and on flood plains, 600 feet west and 950 feet south of northeast corner of sec. 29, T. 8 S., R. 11 E., SBBM:

C1—0 to 11 inches; pale brown (10YR 6/3) sand, brown (10YR 5/3) moist; single grain; loose, nonsticky and nonplastic; very few fine and very fine roots; violently effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C2—11 to 15 inches; very pale brown (10YR 7/3) dry and moist, coarse sand; single grain; loose, nonsticky and nonplastic; violently effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C3—15 to 21 inches; pale brown (10YR 6/3) sand, brown (10YR 5/3) moist; single; loose, nonsticky and nonplastic; very few very fine roots; violently effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C4—21 to 43 inches; pale brown (10YR 6/3) silty clay, grayish brown (10YR 5/2) moist; common fine prominent yellow (10YR 7/8) and brownish yellow (10YR 6/8) mottles, matrix moist; massive with some vertical cracks; very hard, very firm, sticky and plastic; very few very fine and fine roots; violently effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C5—43 to 53 inches; pale brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) moist; weak subangular blocky structure; soft, friable, nonsticky and nonplastic; violently effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C6—53 to 60 inches; light reddish brown (5YR 6/3) clay, reddish brown (5YR 4/3) moist; massive; extremely hard, very firm, sticky and plastic; violently effervescent; moderately alkaline (pH 8.0).

Thickness of the sandy material overlying the clayey material varies from 13 to 38 inches, but is dominantly 16 to 28 inches. The sandy material is in hue of 7.5YR and 10YR; value of 6 and 7 dry, 4 to 7 moist; and chroma of 3 moist and dry. It is loamy sand, fine sand, or sand less than 15 percent by volume coarse fragments.

The underlying clayey material is in hue of 5YR, 7.5YR, and 10YR; values of 6 to 7 dry and 4 to 5 moist; and chroma of 2 or 3. It may be mottled. It is clay, silty clay, or clay loam that is more than 35 percent clay and layers of very fine sandy loam or silt loam. Some mottling occurs in dry areas. Some vertical cracks are filled with sandy material. In some areas, strata of contrasting textures occur below a depth of 40 inches. The soils are calcareous with disseminated lime and are moderately alkaline. Depth to the water table ranges from 18 inches to 5 feet or more.

NaB—Niland sand, 2 to 5 percent slopes. This gently sloping soil is on flood plains and at edges of basins. It has the profile described as representative of the series.

About 10 percent of this mapping unit is included areas of Carsitas soils, 3 percent Imperial soils, and 2 percent Rositas soils. Also included are some small areas of Niland soils with slopes of 5 to 15 percent, near Ferrum, and some small areas of gravelly or cobbly sand.

Runoff is slow. The erosion hazard is slight.

This soil is used for watershed, wildlife habitat, and recreation. If irrigation water became available, the soil would be suited to most irrigated crops grown in the area. Capability unit IIIs–3 (31) irrigated, VIIIs–1 (31) dryland.

NbB—Niland sand, wet, 2 to 5 percent slopes. This gently sloping soil has a profile similar to the one described as representative of the series, but it has a water table at a depth of 18 to 60 inches and has a salt crust in some places.

About 10 percent of this mapping unit is included areas of Rositas soils, 8 percent Carsitas soils, and 3 percent Imperial soils. Also included are some areas of Niland fine sand with slopes of 5 to 15 percent, along the Imperial Irrigation District Powerline Road; small areas of gravelly or cobbly sand; and small spring or seep areas where the water table is at the surface or within a depth of 18 inches.

Runoff is slow. The erosion hazard is slight. A seasonal water table is at a depth of 18 to 60 inches.

This soil is used for watershed, wildlife habitat, and recreation. Intensive management would be required to make the soil suitable for irrigation. Capability unit IVw–6 (31) irrigated, VIIIw–1 (31) dryland.

Omstott Series

The Omstott series consists of well drained soils formed in material weathered from granodiorite, gneiss, and mica schist. Slopes are 5 to 50 percent. Elevations are 3,600 to 5,000 feet. The vegetation is pine, pinyon pine, juniper, ribbonwood, ceanothus, scrub oak, manzanita, cholla, beavertail, barrel cactus, yucca, century plant, and annual and perennial grasses. Average annual precipitation is 8 to 12 inches, the average annual soil temperature is 55° to 59° F., and the frost-free season is 120 to 180 days.

Typically, the surface layer is about 4 inches of brown gravelly fine sandy loam over 6 inches of dark brown fine sandy loam. The surface is covered with a thin intermittent layer of decomposing leaves, twigs, and grass. At a depth of about 10 inches is dark yellowish brown decomposing mica schist and gneiss with relic rock structure. Some fine material has formed in place in cracks and cleavage planes. Soil reaction is neutral.

The soil is moderately rapidly permeable. Available water capacity is 1 to 3 inches. The effective rooting depth is 6 to 18 inches.

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

Representative profile of Omstott gravelly fine sandy loam, in an area of Omstott-Rock outcrop complex, on strongly sloping to steep uplands, 900 feet north and 300 feet west of east quarter corner of sec 20, T. 6 S., R. 5 E., SBBM:

O1—1/3 inch to 0; decomposing organic matter. Abrupt smooth boundary; 0 to 1/2 inch thick.

A11—0 to 4 inches; brown (10YR 5/3) gravelly fine sandy loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; soft, friable, slightly sticky and nonplastic; common very fine roots and very few fine roots; few very fine tubular pores; neutral (pH 7.0); clear wavy boundary.

A12—4 to 10 inches; dark brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) moist; weak coarse subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine roots and few fine roots; common very fine tubular pores; neutral (pH 7.0); clear irregular boundary.

Cr—10 to 16 inches; dark yellowish brown (10YR 4/4) decomposing mica schist and gneiss rubbing to gravelly fine sandy loam, brown (10YR 4/3) moist; massive; hard, friable, slightly sticky and nonplastic; some finer material formed in place in cracks and cleavage planes;

larger roots penetrate along joints; neutral (pH 6.6).

The O1 horizon varies in thickness between 0 and ½ inch and is intermittent. Where it is absent, a very thin layer of fine gravel, very coarse sand, and coarse sand is exposed. The A horizon is coarse sandy loam, fine sandy loam, or loam and may be gravelly. It is less than 35 percent by volume coarse fragments and less than 1 percent organic matter. The A11 horizon is in hue of 10YR; value of 4 to 6 inclusive dry, 3 to 5 moist; and chroma of 2 to 4 inclusive moist and dry. Reaction is slightly acid to neutral. Structure is weak or the soil is structureless (massive or single grain). The A12 horizon is in hue of 10YR; value of 4 to 6 inclusive dry, 3 to 5 moist; and chroma of 2 to 4 inclusive moist and dry. The horizon is massive or has weak structure. It has a clear or abrupt, smooth to irregular boundary to the underlying decomposing mica schist or granodiorite. The Cr horizon has relic rock structure and is slightly acid to mildly alkaline. Depth to decomposing granite, mica schist, or gneiss is 6 to 18 inches.

OmD—Omstott coarse sandy loam, 5 to 15 percent slopes. This gently rolling to rolling soil is on granitic uplands. It has a profile similar to the one described as representative of the series, but it has a coarse sandy loam surface layer.

About 10 percent of this mapping unit is included areas of the Cajon variant, and 5 percent is Rock outcrop. Also included in the Pinyon Flat area are small areas of a soil that is 20 to 36 inches deep over weathered rock and some small areas of gravelly sand and gravelly sandy loam.

Runoff is medium. The erosion hazard is slight. Available water capacity is 1.5 to 3 inches. The effective rooting depth is 12 to 18 inches.

This soil is used for watershed, wildlife habitat, recreation, and a few homesites. Capability unit VIIe–1 (20) dryland.

Or—Omstott-Rock outcrop complex. This complex is strongly sloping to steep. It is on uplands. From 5 to 50 percent of the surface is covered with Rock outcrop. The surface layer of the Omstott soil is coarse sandy loam, gravelly sandy loam, gravelly fine sandy loam, or gravelly loam. The Omstott gravelly fine sandy loam has the profile described as representative of the series. The soil material between the rock outcrop is generally 6 to 15 inches deep.

About 5 percent of this mapping unit is included areas of the Cajon variant, and 2 percent is Riverwash. Also included are areas of a gravelly coarse sandy loam and Rock outcrop unit over granite and a gravelly loam and Rock outcrop unit over mica schist.

Runoff is medium to rapid. The erosion hazard is moderate. Available water capacity is 1 to 2 inches. The effective rooting depth is 6 to 15 inches.

The soil is used for watershed, recreation, wildlife habitat, and a few homesites. Capability unit VIIs–1 (20) dryland.

Riverwash

RA—Riverwash is in and adjacent to the channels of perennial and intermittent streams. It consists of stratified, water-deposited stony, cobbly, and gravelly coarse sand with only minor amounts of fine material. It is frequently inundated during and following storms, and it is subject to bank cutting, shifting, and scouring, as well as deposition, depending on streamflow and bedload. It is essentially barren. There are spots of low creosotebush or bush sunflower.

About 5 percent of this land type is included areas of Carsitas soils, 5 percent Tujunga soils, and 2 percent Soboba soils.

This land type has no value for farming. It is used for watershed, wildlife habitat, and recreation. Capability unit VIIIw–1 (30, 31) dryland.

Rock Outcrop

RO—Rock outcrop. This rolling to very steep land type is in mountainous areas. From 75 to 100 percent of the surface is covered with outcrop of granite, gneiss, mica schist, and sandstone. Between the outcrop is a 1- to 6-inch layer of sand, gravelly sand, or loamy sand. The outcrop along the east margin of the survey area is commonly covered with desert varnish. The very scant vegetation is stunted ceanothus, manzanita, desert agave, bush sunflower, creosotebush, and a few ocotillo cactus and almost no grasses.

About 1 percent of this land type is included areas of Carsitas soil, 5 percent Rubble land, and 2 percent Riverwash.

This land type has no value for farming. It is used mainly for watershed and recreation. Some small areas are used for homesites. Capability unit VIIIs–1 (30, 20) dryland.

Rock Outcrop-Lithic Torripsamments

RT—Rock outcrop-Lithic Torripsamments complex. This well drained complex formed from metasedimentary rocks, granite, granodiorite, or gabbro. Slopes are 9 to 50 percent. Elevations are 200 to 3,000 feet. The vegetation is bush sunflower, desert agave, and ocotillo cactus, all of which are somewhat stunted and sparse. Average annual precipitation is less than 8 inches. The mean annual soil temperature is estimated to be greater than 72° F.

About 3 to 15 percent of the surface is covered by stones, and 30 to 65 percent of the surface is flat Rock outcrop no more than 6 to 10 inches higher than the surrounding terrain. The outcrop has many fractures extending from 1 to 4 feet. The soil mantle of sand or gravelly sand is 1 to 4 inches thick. In many areas this mantle does not occur.

This land has no value for farming. It is used for watershed, wildlife habitat, recreation, and some homesites. Capability unit VIIIs–1 (30) dryland.

Rubble Land

RU—Rubble land. This gently sloping to strongly sloping land type is on very old alluvial fans and is 90 percent or more cobbles, stones, and boulders at the surface. It is cut by numerous ill-defined intermittent stream channels in a braided pattern. The steep slope, or escarpment, to the main drainageways is classified as Riverwash. Slopes are 2 to 15 percent.

The stones and cobbles generally have a desert varnish on the exposed surfaces. They are generally arranged in windrows extending in the same direction as the braided stream channels. The material between the stones and cobbles is gravelly coarse sand or sand that is moderately alkaline and slightly effervescent.

The vegetation is an extremely sparse cover of brush, creosotebush, barrel cactus, bush sunflower, ocotillo, and an occasional clump of annual grass in the pockets of fine sand.

About 10 percent of this mapping unit is included areas of Carsitas soils, 15 percent Carrizo soils, and 5 percent Riverwash.

This land type has no value for farming. It is used for watershed, wildlife habitat, and recreation. Capability unit VIIIs–1 (30, 31) dryland.

Salton Series

In the Salton series are somewhat poorly drained soils formed in alluvium. Slopes are 0 to 2 percent. Elevations range from 50 feet above to 230 feet below sea level. The vegetation is low creosotebush, mesquite, arrowweed, saltcedar, iodinebush, and saltbush. Average annual precipitation is less than 4 inches, the mean annual soil temperature is above 72° F., and the frost-free season is 270 to 320 days.

Typically, the upper 15 inches of these soils is light brownish gray silty clay loam. The next 27 inches is light gray silty clay loam. Below this to a depth of 60 inches or more is light gray and light brownish gray clay and silty clay. The soil is moderately alkaline to strongly alkaline, strongly effervescent, and generally strongly saline.

The soil is slowly permeable. Available water capacity is 8 to 12 inches. The effective rooting depth is 60 inches or more. A water table is at a depth of 2 to 5 feet.

These soils are used for cotton, alfalfa hay, irrigated pasture, truck crops, dates, and recreation.

Representative profile of Salton silty clay loam on a flood plain, 50 feet north and 800 feet west of southeast corner of sec. 25, T. 7 S., R. 8 E., SBBM:

C1—0 to 9 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; moderate coarse granular structure; slightly hard, firm, sticky and plastic; few very fine roots; many fine interstitial pores; strongly effervescent; strongly alkaline (pH 8.6); clear smooth boundary.

C2—9 to 15 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; mottles; massive; hard, firm, very sticky and very plastic; few fine roots; strongly effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

C3—15 to 42 inches; light gray (2.5Y 7/2) silty clay loam, light brownish gray (2.5Y 6/2) moist; massive; hard, firm, very sticky and very plastic; few very fine roots; strongly effervescent; strongly alkaline (pH 9.0); abrupt wavy boundary.

C4—42 to 53 inches; light gray (10YR 7/2) clay, grayish brown (10YR 5/2) moist; massive; very hard, very firm, very sticky and very plastic; strongly effervescent; strongly alkaline (pH 8.8); abrupt wavy boundary.

C5—53 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; massive; very hard, very firm, very sticky and very plastic; strongly effervescent; strongly alkaline (pH 8.6).

The C1 horizon is fine sandy loam, loam, clay loam, or silty clay loam in hue of 5Y, 2.5Y, and 10YR; value of 6 through 7 dry, 4 to 6 moist; and chroma of 2 or less. The 10- to 40-inch control section is silty clay loam that is 27 to 35 percent clay and less than 15 percent sand coarser than very fine sand. In places thin strata 1/4 inch to 2 inches thick of loamy fine sand and fine sandy loam occur at random throughout the profile. The soils are calcareous with disseminated and mycelial lime, are moderately to strongly alkaline, and are high in salts.

In areas that are irrigated or in areas adjacent to irrigated soils of coarser texture, the water table is at a depth of 2 to 5 feet. Tile drains are required to remove excess water and reduce toxic salt content in order to sustain crop production.

Sa—Salton fine sandy loam. This nearly level soil has a profile similar to the one described as representative of the series, but it has a fine sandy loam surface layer.

About 4 percent of this mapping unit is included areas of Indio soils, 2 percent Gilman soils, and 2 percent Coachella soils. Also included are some small areas of Salton soils that have a sandy loam, loamy very fine sand, or loamy fine sand surface layer.

Runoff is slow. The erosion hazard is slight. The hazard of soil blowing is moderate. Depth to the water table generally is more than 36 inches, but ranges from 24 inches to 60 inches. This soil requires tile drainage for sustained crop production.

This soil is used for truck crops, dates, alfalfa hay, and cotton. Capability unit IVw–6 (31) irrigated.

Sb—Salton silty clay loam. This nearly level soil is in the lacustrine basin area surrounding the Salton Sea and extending to the center of the survey area. It has the profile described as representative of the series. In about one-third of the mapping unit the surface layer is silt loam.

About 3 percent of this mapping unit is included areas of Indio soils, 1 percent Gilman soils, and 1 percent Imperial soils. Some small areas of Salton soils that have a very fine sandy loam, silty clay, or clay surface layer are also included.

Runoff is slow. The erosion hazard is slight. Depth to the water table generally is more than 36 inches, but ranges from 24 inches to 60 inches. This soil requires tile drainage for sustained crop production.

This soil is used for cotton, dates, irrigated pasture, and recreation. Capability unit IVw–6 (31) irrigated.

Soboba Series

The Soboba series consists of excessively drained soils formed in alluvium on alluvial fans. Slopes are 2 to 30 percent. Elevations are 1,100 feet to 2,400 feet. The vegetation is creosotebush, bush sunflower, flattop sage, annual grasses, and filaree. Average annual precipitation is 6 to 12 inches, the average annual temperature is 67° to 72° F., and the frost-free season is 210 to 270 days.

Typically, the upper 13 inches of these soils is light brownish gray cobbly sand. Below this to a depth of 60 inches or more is grayish brown and light brownish gray very gravelly sand and gravelly sand. The soil is slightly acid or neutral.

The soil is very rapidly permeable. Available water capacity is 1 to 3 inches. The effective rooting depth is 60 inches or more.

These soils are used for watershed, wildlife habitat, construction material, and homesites.

Representative profile of Soboba cobbly sand, 2 to 15 percent slopes, on alluvial fans, 900 feet north and 900 feet east of south quarter corner of sec. 6, T. 3 S., R. 3 E., SBBM:

C1—0 to 13 inches; light brownish gray (2.5Y 6/2) cobbly sand, grayish brown (2.5Y 5/2) moist; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; many fine interstitial pores; approximately 30 percent by volume gravel and cobbles, 1 to 3 percent of surface covered by cobbles; slightly acid (pH 6.1); gradual smooth boundary.

C2—13 to 29 inches; grayish brown (2.5Y 5/2) very gravelly sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose, nonsticky and nonplastic; common medium roots and few fine roots; many fine interstitial pores; approximately 50 percent gravel and cobbles; slightly acid (pH 6.5); clear smooth boundary.

C3—29 to 31 inches; light brownish gray (2.5Y 6/2) gravelly sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose, nonsticky and nonplastic; many fine roots; many fine interstitial pores; approximately 35 percent gravel; neutral (pH 7.0); clear smooth boundary.

C4—31 to 60 inches; light brownish gray (2.5Y 6/2) very gravelly sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose, nonsticky and nonplastic; few fine roots; many fine interstitial pores; approximately 55 percent gravel and cobbles; slightly acid (pH 6.5).

The C1 horizon is cobbly sand, stony sand, gravelly sand, or gravelly loamy sand in hue of 2.5Y and 10YR, value of 5 and 6 dry, 4 and 5 moist, and chroma of 2 and 3 moist and dry. Reaction ranges from neutral to slightly acid.

The 10- to 40-inch control section is very cobbly sand, very stony sand, very gravelly sand, or very gravelly coarse sand the same color as the surface horizon. In some areas the coarse fragments are even amounts of gravel and cobbles; gravel, cobbles, and stones; or gravel and stones. The control section is more than 35 percent by volume cobbles, stones, and gravel. Reaction ranges from slightly acid to mildly alkaline. There are a few weakly calcareous pockets of slightly finer textured material.

SoD—Soboba cobbly sand, 2 to 15 percent slopes. This gently sloping to strongly sloping soil is on alluvial fans, each of which generally has one entrenched channel. The soil emerges from the mountain front and then spreads out across the alluvial fans and cones in a pattern of braided stream channels as the fans level out. This soil has the profile described as representative of the series.

About 8 percent of this unit is included areas of Tujunga soils and 10 percent Riverwash. Also included are some small areas that have a gravelly sand or stony sand surface layer.

Runoff is very slow. The erosion hazard is mainly slight, but along the entrenched channels it is high.

This soil is used for watershed, wildlife habitat, construction material, and homesites. Capability unit VIIs–1 (19) dryland.

SpE—Soboba stony sand, 5 to 30 percent slopes. This moderately sloping to moderately steep soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but it has a stony sand surface layer and has stones and cobbles throughout the profile. Stones occupy 1 to 5 percent of the surface. Some small areas are cobbles or boulders. Because of the steeper slopes, the soil has a well defined drainage pattern.

About 5 percent of this mapping unit is included areas of Tujunga soils, 5 percent Rubble land, and 5 percent Riverwash. Also included are some small areas of Soboba soils that have a gravelly or cobbly sand surface layer.

Runoff is slow. The erosion hazard is moderate.

This soil is used for watershed, wildlife habitat, recreation, and occasional homesites. Capability unit VIIs–1 (19) dryland.

Torriorthents-Rock Outcrop

TO—Torriorthents-Rock outcrop complex. This well drained mapping unit formed on granitic rock. Slopes are 9 to 30 percent. Elevations are 1,200 to 4,000 feet. The vegetation is a sparse, low stand of cholla cactus, yucca, century-plant, creosotebush, manzanita, and annual grasses. Many areas are bare of vegetation. Average annual precipitation is less than 8 inches, the mean annual soil temperature is estimated to be 59° to 72° F., and the average annual frost-free season is 120 to 270 days.

Typically, this mapping unit is about 25 to 60 percent granite rock outcrop. In many places the outcrop is flat and even with the surface. Between the outcrop is a layer of sand, gravelly sand, or gravelly sandy loam 1 to 6 inches deep with pockets 6 to 14 inches deep over decomposing granite with relic rock structure.

The unit is moderately permeable, mainly through the cracks and fissures. Runoff is rapid. The erosion hazard is moderate to high.

This unit is used as watershed, wildlife habitat, and recreation. It has no value for farming. Capability unit VIIIs–1 (30) dryland.

Tujunga Series

The Tujunga series consists of somewhat excessively drained soils formed in alluvium. Slopes are 0 to 30 percent. Elevations are 1,200 to 1,700 feet. The vegetation is creosotebush, bush sunflower, yucca, ricegrass, annual grasses and filaree. Annual precipitation is 8 to 12 inches, the average annual temperature is 67° to 72° F., and the frost-free season is 210 to 270 days.

Typically, in sequence downward, these soils are 20 inches of light brownish gray loamy fine sand, 10 inches of pale brown gravelly sand and fine sand, 5 inches of light brownish gray gravelly coarse sand, 3 inches of light yellowish brown very fine sand, and to a depth of 60 inches or more pale brown fine sand and gravelly sand. The soil is slightly acid or neutral.

The soil is rapidly permeable. Available water capacity is 2.5 to 8 inches.

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

Representative profile of Tujunga loamy fine sand, 0 to 5 percent slopes, on a hummocky alluvial fan, 1,050 feet east and 650 feet north of southwest corner sec. 7, T. 3 S., R. 3 E., SBBM:

C1—0 to 20 inches; light brownish gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, nonsticky and nonplastic; few medium roots, common fine and very fine roots; many fine pores; slightly acid (pH 6.5); clear smooth boundary.

C2—20 to 22 inches; pale brown (10YR 6/3) gravelly sand, brown (10YR 4/3) moist; single grain; loose, nonsticky and nonplastic; few medium roots, common fine and very fine roots; many fine and medium interstitial pores; slightly acid (pH 6.5); clear smooth boundary.

C3—22 to 30 inches; pale brown (10YR 6/3) fine sand, brown (10YR 4/3) moist; massive; loose, nonsticky and nonplastic; common fine and very fine roots; many fine interstitial pores; slightly acid (pH 6.5); clear smooth boundary.

C4—30 to 35 inches; light brownish gray (10YR 6/2) gravelly coarse sand, grayish brown (10YR 5/2) moist; single grain; loose, nonsticky and nonplastic; few fine and medium roots; many fine and medium interstitial pores; neutral (pH 7.0); abrupt smooth boundary.

C5—35 to 38 inches; light yellowish brown (10YR 6/4) very fine sand, brown (10YR 5/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; few fine and medium roots; few fine interstitial pores; neutral (pH 7.0); abrupt smooth boundary.

C6—38 to 47 inches; pale brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; single grain; loose, nonsticky and nonplastic; few fine and medium roots; many fine and medium interstitial pores; slightly acid (pH 6.5); clear wavy boundary.

C7—47 to 60 inches; pale brown (10YR 6/3) gravelly sand, dark grayish brown (10YR 4/2) moist; single grain; loose, nonsticky and nonplastic; few fine and medium roots; many fine and medium interstitial pores; slightly acid (pH 6.5).

The C1 horizon is loamy fine sand, fine sand, loamy sand, or gravelly loamy sand in hue of 10YR and 2.5Y, value of 5 to 7 dry and 4 to 6 moist, and chroma of 1 to 4. Reaction is slightly acid to neutral.

The 10- and 40-inch control section is loamy fine sand, fine sand, very fine sand, gravelly coarse sand, sand, or gravelly sand. It averages sand or fine sand that is less than 30 percent coarse fragments. Reaction is slightly acid to mildly alkaline. A few pockets of loamy fine sand are slightly effervescent. Colors are the same as in the C1 horizon. In places the lower part of the C horizon has more coarse fragments and lenses of coarser or finer material, but it is generally sandy.

TpE—Tujunga fine sand, 5 to 30 percent slopes. This moderately sloping to moderately steep soil is in coves along the north slope of Mt. San Jacinto. It has a profile similar to the one described as representative of the series, but it is fine sand throughout. The relief is hummocky. The hummocks are 1½ to 5 feet high, 3 to 20 feet wide, and 5 to 50 feet long. They are typically alined in the prevailing wind direction, east to southeast. The wind-transported material is slightly acid to neutral fine sand. The coves act as sand traps when the wind sweeps through the San Gorgonio Pass.

In about 15 percent of the area, at the edge of the deposition area, decomposing granite is at a depth of 3 to 5 feet. Included in mapping are small areas where the surface layer is sand. Also included are small blowouts.

Runoff is slow, and the erosion hazard is moderate. The hazard of soil blowing is high. Available water capacity is 3 to 6.5 inches.

The soil is used for watershed, wildlife habitat, and recreation. Capability unit IVe–4 (19) irrigated, VIIe–1 (19) dryland.

TrC—Tujunga gravelly loamy sand, 0 to 9 percent slopes. This nearly level to moderately sloping soil is on alluvial fans. It has a profile similar to the one described as representative of the series, but it has a gravelly loamy sand surface layer and is gravelly throughout the profile.

About 10 percent of this mapping unit is included areas of Soboba soils, and 5 percent is Riverwash. Also included are small areas where the surface layer is sand and fine sand.

Runoff is slow, and the erosion hazard is moderate. The hazard of soil blowing is slight. Available water capacity is 2.5 to 5 inches. The effective rooting depth is 60 inches or more.

The soil is used for watershed, wildlife habitat, recreation, and homesites. Capability unit IVe–4 (19) irrigated, VIIs–1 (19) dryland.

TsB—Tujunga loamy fine sand, 0 to 5 percent slopes. This nearly level to gently sloping soil is on alluvial fans and flood plains. It has the profile described as representative of the series. The relief is low hummocky. Hummocks 6 to 24 inches high have built up around the clumps of vegetation. The blowing sand has also accumulated along fence lines that have some vegetation and along windbreaks and other tree rows.

About 5 percent of this mapping unit is included areas of Soboba soils, and 5 percent is Riverwash. Also included are small blowouts and areas of gravelly loamy sand.

Runoff is slow, and the erosion hazard is slight. The

TABLE 2.—*Yields per acre of irrigated crops*

[All yields were estimated for a high level of management in 1975. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil name and map symbol	Alfalfa	Carrots [1]	Lint Cotton	Dates	Thompson Seedless Grapes	Marsh Grape-fruit	Wheat	Oat Hay
	Tons	*49# crate*	*Bales*	*Lbs*	*22# box*	*33.5# box*	*Tons*	*Tons*
Carsitas:								
CdC	6.0		1.00	14,000	300	400		2.0
CkB	6.0		1.25	14,000	365	450		3.0
Coachella:								
CpA	8.8	450	1.50	14,000	365	650	3.3	4.0
CpB	8.8	450	2.00	14,000	365	650	3.3	4.0
CrA	7.0	400	2.00	9,800	265	550	3.0	3.0
CsA	8 8	550	3.00	14,000	365	800	3.75	4.0
Gilman:								
GaB	8.8	500	2.50	14,000	365	700	3.75	4.0
GbA, GbB	8.8	550	3.00	14,000	365	700	3.75	4 0
GcA	7.0	500	3.00	9,800	265	550	3.3	3.0
GdA	7.0	400	3.00	9,800	265	250	3.3	3.0
GeA	8.8	550	3.50	14,000	365	800	3.75	4.0
GfA	7.0	500	3.00	9,800	265	250	3.3	3.0
Indio:								
Ip	8.8	550	3.00	14,000	365	800	3.75	4.0
Ir, It	7.0	500	3.00	9,800	265	550	3.3	3.0
Is	8.8	550	3.50	14,000	365	800	3.75	4.0
Myoma:								
MaB	8.8	450	1.50	14,000	365	550	2 0	4.0
MaD	8.8	450		14,000	365	550	2.0	4.0
McB	5.0	400	1.50	14,000	265	550	2.0	3.0
Salton:								
Sa, Sb	4.0		2.00					1.5

[1] Average value — crate weights range from 48 to 50 pounds.

hazard of soil blowing is high. Available water capacity is 6 to 8 inches.

This soil is used for watershed and wildlife habitat. Capability unit IIIe-4 (19) irrigated, VIIe-1 (19) dryland.

Use and Management of the Soils

This part of the survey explains the capability grouping used by Soil Conservation Service. It describes the major land resource areas in the Coachella Valley Area in which the soils of specified capability units occur. It also describes each unit recognized in the survey area. In addition, this part of the survey suggests management for the important crops. Estimated yields of those crops under high level management are listed in table 2.

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 rice, horticultural crops, or other crops requiring 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 engineering and other special purposes.

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

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

Class I soils have few limitations that restrict their use.

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

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

Class IV soils have very severe limitations that reduce the choice of plants, that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat. (None in Coachella Valley Area.)

Class VI soils have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, or water supply or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIs. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is saline, droughty, or stony; and *c*, used in only some parts of the United States and not in Coachella Valley Area, shows that the chief limitation is climate that is too cold or too dry on otherwise Class I soil.

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, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, 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 many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIIs–5 or IVw–6.

In California, each unit number in Classes I through IV indicates a particular kind of problem or limitation, as follows:

0. A coarse sandy or very gravelly substratum, which limits root penetration and retention of moisture.
1. A potential or actual hazard of soil blowing or water erosion.
2. Poor drainage or a flood hazard.
3. Slow or very slow permeability in the subsoil or substratum.
4. Coarse texture or excessive gravel.
5. Fine or very fine texture.
6. Salts or alkali sufficient to constitute a continuing hazard.
7. Stones, cobblestones, or rock outcrop sufficient to interfere with tillage.
8. Hardpan or unweathered hard bedrock within the root zone.
9. Low inherent fertility, associated with strong acidity, with a too low or too high calcium-magnesium ratio, or with excess calcium, boron, or molybdenum.

In this survey, a nonconnotative Arabic numeral 1 is used for Classes VI through VIII.

The system of numbering units is statewide, and not all the units that have been established in the State are represented in Coachella Valley Area. Consequently, units may not be numbered consecutively within each subclass.

Major Land Resource Areas

In the Coachella Valley Area, capability classification is further refined by designating the land resource area in which the soils in a unit occur. A major land resource area is a broad geographic area that has a distinct combination of climate, soils, management needs and cropping systems (*3*). The 48 conterminous States in the nation have been divided into 156 major land resource areas. Parts of four of these are in the Coachella Valley Area and are outlined on the Major Land Resource Areas Map of the survey area. These areas and their numbers are Southern California Coastal Plain (19), Southern California Mountains (20), Sonoran Basin and Range (30), and Imperial Valley (31) (fig. 5). The number of the resource area is added in parentheses to the class, subclass, and unit designation.

The natural vegetation of the Coachella Valley entrance, center, sides and bottom in the Sonoran Basin and Range and the Imperial Valley Major Land Resource Areas 30 and 31 is mostly desert shrub. At the northwest entrance to Coachella Valley MLRA 30 joins the Southern California Coastal Plains MLRA 19. Here the vegetation is desert shrub similar to that of MLRA 30 but is somewhat larger in growth.

In the eastern mountainous part of the survey area at higher elevations, desert shrub merges into Pinyon-Juniper Woodland and Chaparral characteristic of the Southern California Mountains MLRA 20.

Within each Major Land Resource Area there are variations in species, plant composition, amount of growth or annual yields, and density of ground cover. Some variations may be the result of local climatic changes resulting from such topographic features as aspect or elevation. Others are associated with or are dependent on soil properties, such as depth, texture, and permeability. For this reason knowledge of soils is helpful in understanding natural vegetation.

The vegetation mostly is native but includes plants which have become naturalized. Annual grasses and forbs introduced into California by the Spanish explorers and colonists from the Mediterranean are widespread. Russian thistle, a more recent introduc-

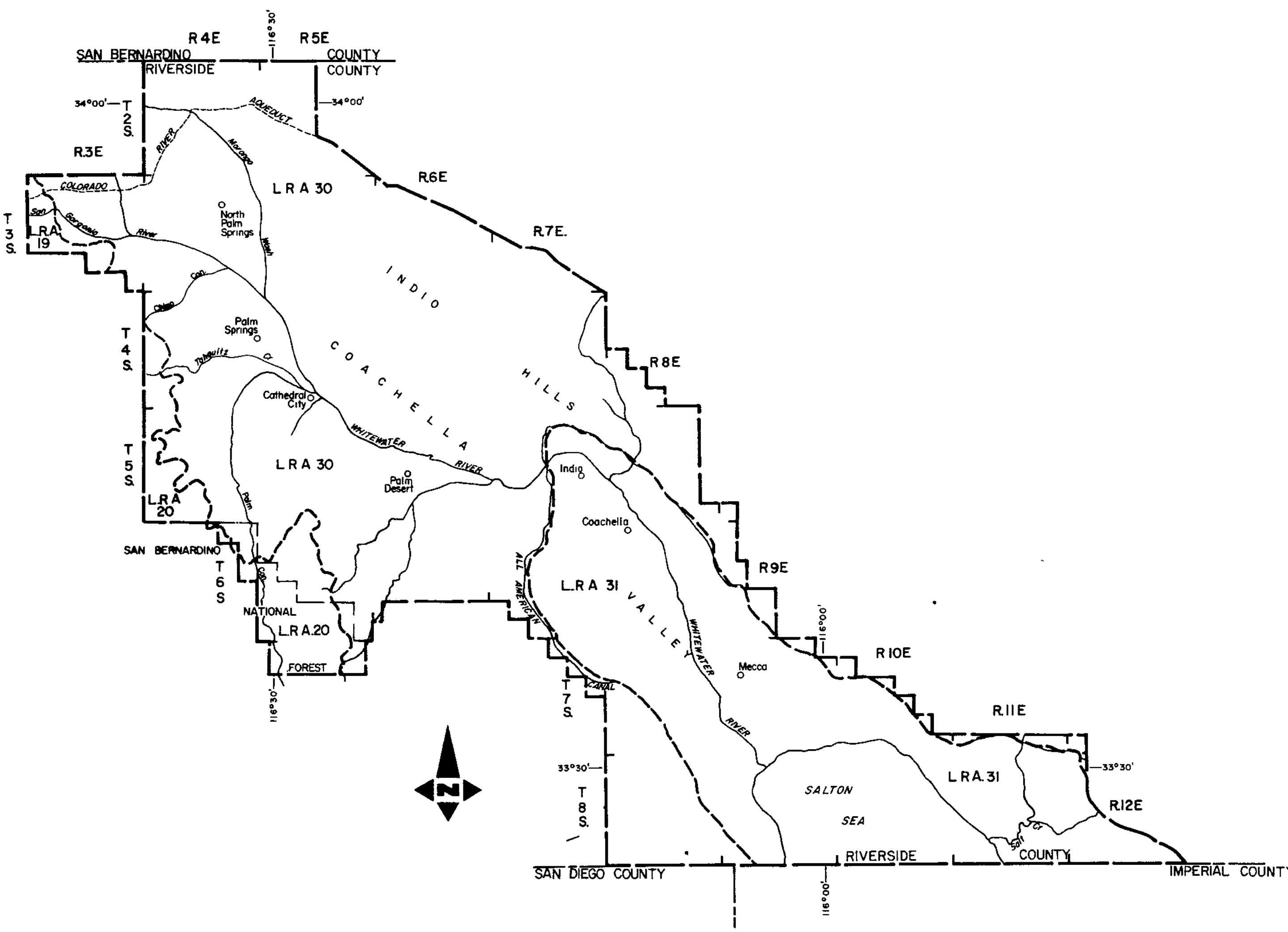

Figure 5.—**Major Land Resource Areas in the Coachella Valley Area: Southern California Coastal Plains (19); Southern California Mountains (20); Sonoran Basin and Range (30); and Imperial Valley (31).**

tion, also is widely distributed in the desert. Saltcedar or tamarisk, a shrub or small tree, is common in wet areas as is bermudagrass.

Isolated stands of California fan palm, (Washingtonia filifera) native only in the American southwest deserts, are common in Coachella Valley. These stands are not confined to one site, but are where high water tables or ground water provides sufficient moisture for their growth. These places are in canyon bottoms and in uplands along the San Andreas and other geologic faults.

Canyon bottoms with surface or subsurface streams have such riparian or streambank vegetation as alder, cottonwood, and willow, sometimes intermixed with desert and chaparral species.

In the paragraphs that follow, those land resource areas having parts within the Coachella Valley Area are described so that local farming can be related to the resource areas. Following the description of each resource area is a list of those conditions typical of the area, which were considered in assigning the soils to capability classes and units.

Major Land Resource Area 19.—This resource area makes up the northwestern part of the survey area. The soils formed on alluvial fans of the San Gorgonio River, Stubbe Canyon, and Snow Creek at the northern entrance to Coachella Valley. The topography, relief, and geology are uniform.

Elevations range from 1,200 to 2,400 feet. Summers generally are hot and dry, and winters are cool and moist. Rainfall ranges from about 6 to 12 inches and varies in amount from year to year. Supplemental irrigation is needed for the best growth of most crops. The area is mainly in native vegetation of creosotebush, encelia, flattop sage, catclaw, agave, desert willow, annual grasses, and filaree.

In determining the capability classification for the soils in Major Land Resource Area 19, it is assumed that—

1. The temperature generally is mild, and the frost-free period ranges from 200 to 310 days. Frost occurs locally, but protection is provided for crops that have a high cash value.

2. Irrigation water is available for most irrigable soils. All reasonable means are taken to conserve water.
3. The soils adjacent to unprotected stream channels, which are subject to occasional flooding, are classified according to their capability for crops on the basis of this flood hazard.
4. A wide variety of field, truck, fruit, citrus, and nut crops can be grown.
5. A high level of management is used.

Major Land Resource Area 20.—This resource area includes the west-central part of the survey area. It is made up of nearly level to very steep soils on uplands and terraces and in small valleys. The soils formed in material weathered from granite, mica schist, or gneiss or in alluvium derived from these rocks.

Elevations range from 3,200 to 5,000 feet. Precipitation ranges from 9 to 30 inches. Most of the rainfall comes in winter and in spring. It is marginal for dryland crops at lower elevations. The growing season ranges from 80 to 180 days.

The soils in Major Land Resource Area 20 are placed in capability units on the assumption that these conditions exist:

1. Freezing temperatures are common throughout the major resource area in winter and spring. Field and orchard crops that are winter hardy are the only suitable crops. Occasional summer thundershowers may adversely affect growth of crops. During the growing season, the temperature is warm enough for all the common field and orchard crops to mature.
2. Irrigation water generally is not available, because the supply of water in the resource area is limited and the cost of bringing water into the area is high. Use of local supplies may be improved for limited use in the area. The soils of this resource area are classified on the basis of their capability for dryland crops.
3. A few partly drained mountain meadows are in the resource area. The soils in these areas are classified on the basis that the areas remain in meadows or in pasture.
4. Areas of soils in this resource area that are affected by salts and alkali are not important enough to affect the capability classification.
5. The level of management is moderately high.

Major Land Resource Area 30.—This resource area is the southeastern extension of the Mojave Desert into Riverside County. It is an old alluvial basin that is surrounded by high mountains with lower passes. Most of the intermittent and ephemeral streams in the area drain into the Whitewater Storm Drain which empties into the Salton Sea. Slopes range from moderately steep at the upper edge of alluvial fans to nearly level or level on the valley floor.

Elevations range from a high of 3,500 feet in the northern part of the resource area to a low of 50 feet east of Mecca. Along the western edge of the area, the elevation is about 3,200 feet above sea level, and south of Oasis, it is 200 feet below sea level. Precipitation is less than 4 inches. Summers are hot and dry, and winters are fairly cold to warm. The occasional snowfall is light, and the snow stays on the ground for only a short time. Irrigation is necessary for all cultivated crops. In winter and spring, moderate and strong prevailing winds blow from the north and northwest across the resource area towards the Gulf of Mexico.

Some of the major factors that limit use of the soils are low rainfall, no dependable irrigation water supply, accumulation of salts, low available water capacity, and slopes too steep for irrigation. Others are gravelly, cobbly and very cobbly, and stony and very stony sand soils, the hazard of soil blowing, and a shallow soil mantle over bedrock with a large proportion of rock outcrop.

The soils in Major Land Resource Area 30 are placed in capability units on the assumption that these conditions exist:

1. Rainfall is inadequate, and the soils are not suitable for cultivated crops unless irrigated. The rainfall is sufficient for limited, sustained growth of native forage plants. Unless irrigated, all soils in the resource area that are suitable for grazing only occasionally are placed in Class VIII.
2. Throughout most of the resource area, water suitable for irrigation is available only to very limited areas. The water comes mainly from wells, and most of it is of good quality. Not considered in the classification are specific differences in the quality of the water suitable for irrigating the crops commonly grown.
3. Soil blowing is a continuing hazard, particularly on sandy soils.
4. Flooding does not affect management or the cropping systems used, though flood control is needed in some areas.
5. A moderately high level of management is used.
6. Some parts of this resource area are occasionally used as desert range, though lack of water for stock limits grazing in places. Edible plants are desert stipa, Indian ricegrass, bromegrass, and filaree as well as other annual grasses and forbs. Other desert plants are bursage, encelia, creosotebush, agave, cholla, deerhorn and beavertail cactus, smoketree, mesquite, and ironwood.

Major Land Resource Area 31.—This resource area is the northern extension of Imperial Valley into Riverside County. It is the lacustrine basin of Old (Ancient) Lake Cahuilla. Most ephemeral streams and drainage canals of the area drain into the Whitewater Storm Drain which empties into the Salton Sea. Slopes are nearly level to gently sloping. Isolated areas are moderately sloping to moderately steep dissected alluvial fans and rolling sand dune areas.

Elevations range from 230 feet below sea level to 50 feet above sea level. Precipitation is less than 4 inches. Summers are very hot and are alternately dry and humid. Winters are warm with a frost-free season of 270 to 320 days. Irrigation is necessary for all cultivated crops. In winter and spring, moderate to strong prevailing winds blow from the north and northwest across the resource area toward the Gulf of Mexico.

Some of the major factors that limit use of the soils under natural conditions are low rainfall, accumulation of salts, low available water capacity, slopes too steep for irrigation, gravelly and very gravelly, cobbly and very cobbly, and stony and very stony sand soils, the hazard of soil blowing, and the need for tile drainage to maintain agricultural production.

The soils in Major Land Resource Area 31 are placed in capability units on the assumption that these conditions exist:

1. Rainfall is inadequate, but low cost irrigation water is available in adequate amounts for the irrigated land to produce commercial crops.
2. Suitable outlets are available when it becomes necessary to install tile drains in fields for sustained crop production. These remove excess water and salts from the soil.
3. Soil blowing is a continuing hazard, particularly on sandy soils.
4. Flooding does not affect management or cropping systems because flood control structures protect agricultural areas.
5. A high level of management is used.
6. The principal crops are winter vegetables, citrus, grapes, dates, alfalfa, cotton, and grain.

Management by capability units

In the following pages, the capability units in the Coachella Valley Area are described and use and management of the soils is suggested. Soil series names are mentioned in each capability unit, but this does not mean that all mapping units of the series are in that particular unit. The capability unit for each soil in the survey area is listed in the "Guide to Map Units" at the back of the survey.

CAPABILITY UNIT I (31) IRRIGATED

This unit consists of very deep, moderately well drained, and well drained soils that have a silt loam and very fine sandy loam surface layer and a profile stratified with thin lenses of silt, silt loam, silty clay loam, loamy fine sand, loamy very fine sand, and very fine sandy loam. These soils occur near the outer rim of the valley floor. Slopes are less than 2 percent. The growing season is 270 to 320 days.

Permeability is moderate. The effective rooting depth is 60 inches or more, and the available water capacity is 9 to 12 inches. Soil blowing and erosion by water are slight hazards.

The soils are used for citrus, dates, truck crops, grapes, cotton, and alfalfa hay. They require minimal management. They are well suited to sprinkler, furrow, or border irrigation, depending on the crop.

CAPABILITY UNIT IIe-1 (31) IRRIGATED

This unit consists of very deep, moderately well drained, and well drained soils that have a fine sandy loam surface layer and a profile of fine sand, very fine sand, loamy fine sand, loamy very fine sand, and very fine sandy loam stratified with thin lenses of silt, silt loam, and silty clay loam. Slopes are 0 to 5 percent. The average annual growing season is 270 to 320 days.

Permeability is moderate to moderately rapid. The effective rooting depth is 60 inches or more, and the available water capacity is 9 to 15 inches depending on the degree of stratification. The hazard of soil blowing is moderate, and the hazard of erosion by water is slight or moderate.

The soils are used for truck crops, citrus, dates, and alfalfa hay. They require minimal management. They are suited to all methods of irrigation commonly used in the Valley. Crop residue should be incorporated into the surface layer to aid in reducing the hazard of soil blowing.

CAPABILITY UNIT IIw-1 (31) IRRIGATED

This unit consists of very deep, moderately well drained, and well drained soils that have a fine sandy loam surface layer and a profile of loamy fine sand, loamy very fine sand, and very fine sandy loam stratified with thin lenses of silt, silt loam, and silty clay loam. A seasonal water table is at a depth of 40 to 60 inches. Slopes are 0 to 2 percent. The growing season is 270 to 320 days.

Permeability is moderate, and available water capacity is 9 to 12 inches depending on the degree of stratification. The hazard of soil blowing is moderate, and the hazard of water erosion is slight. The water table limits the rooting depth of most locally grown deep rooted crops.

The soils are used for truck crops, dates, citrus, grapes, alfalfa hay, and cotton. They are suited to all irrigation methods locally used. Tile drains are needed to maintain the water table below the rooting depth of most crops grown. Careful management of irrigation water also helps maintain the water table below the root zone. Crop residue should be returned to the soil surface to reduce the hazard of soil blowing.

CAPABILITY UNIT IIw-2 (31) IRRIGATED

This unit consists of very deep, moderately well drained, and well drained soils that have a silt loam and very fine sandy loam surface layer and a profile of loamy fine sand, loamy very fine sand, and very fine sandy loam stratified with thin lenses of silt, silt loam, and silty clay loam. A seasonal water table is at a depth of 40 to 60 inches. Slopes are 0 to 2 percent. The frost-free growing season is 270 to 320 days.

Permeability is moderate, and the available water capacity is 9 to 12 inches. The hazards of soil blowing and water erosion are slight. The water table limits the rooting depth of most deep rooted crops grown.

The soils are used for dates, cotton, alfalfa hay, truck crops, and recreation. They are adapted to all irrigation methods commonly used in the Coachella Valley. Care must be exercised to avoid overirrigating these soils and aggravating the high water table problem. Tile drains help keep the water below the root zone of most crops.

CAPABILITY UNIT IIw-6 (31) IRRIGATED

Gilman fine sandy loam, moderately fine substratum, 0 to 2 percent slopes, is the only soil in this unit. It is well drained, very deep loamy fine sand and loamy very fine sand stratified with silt, silt loam, and silty clay loam. A substratum of silty clay loam is at a depth of 40 inches or more. The frost-free growing season is 270 to 320 days.

The soil is moderately permeable above the substratum and slowly permeable in the substratum. Available water capacity is 9.5 to 11.5 inches. The hazards of water erosion and soil blowing are slight. A water table is at a depth of 40 to 60 inches, which restricts the rooting of most deep rooted water sensitive crops grown in the area.

This soil is used for irrigated truck and field crops, citrus, dates, grapes, and alfalfa hay.

Tile drains are needed to maintain the water table below the rooting zone of most crops grown in the Valley. These drains also aid in disposing of excess salts leached from the soil profile. Careful irrigation water management is required on this soil. Occasional overirrigations are needed to leach the salts from the soil. All methods of irrigation commonly used in the area are suitable for this soil.

CAPABILITY UNIT IIIe-1 (31) IRRIGATED

Gilman loamy fine sand, 0 to 5 percent slopes, the only soil in this unit, is well drained and very deep. It is erratically stratified loamy fine sand or very fine sandy loam with lenses of silt loam or silty clay loam. The frost-free growing season is 270 to 320 days.

Permeability is moderate. Available water capacity is 8.5 to 9.5 inches in the 60 inches or more of effective rooting depth. The hazard of soil blowing is high, and the hazard of water erosion is slight.

This soil is used for truck crops, citrus, dates, grapes, and alfalfa hay.

Runoff from surrounding areas should be diverted from some areas of this soil. Crop residue or other forms of organic matter should be returned to the soil to reduce the hazard of soil blowing. Windbreaks also reduce this hazard.

CAPABILITY UNIT IIIe-4 (19) IRRIGATED

Tujunga loamy fine sand, 0 to 5 percent slopes, is the only soil in this unit. It is a very deep, somewhat excessively drained, stratified sand and loamy sand. The soil is on the alluvial fan east of Cabazon. The frost-free growing season is 210 to 270 days.

Permeability is rapid. Available water capacity is 3 to 6 inches. The effective rooting depth is 60 inches or more. The hazard of soil blowing is high, but the hazard of erosion by water is slight.

At the present time this soil is in native vegetation. It is suited to most irrigated crops grown in this general area if water of sufficient quality were available.

The existing cover needs to be maintained to protect this soil from soil blowing. If at some future date this soil is cultivated and planted to irrigated crops, it would need to be protected against soil blowing through the use of windbreaks and crop residue management. Most locally adapted methods of irrigation can be used on this soil.

CAPABILITY UNIT IIIe-4 (31) IRRIGATED

This unit consists of very deep, somewhat excessively drained, and well drained soils that have a fine sand surface layer and a profile of stratified fine sand and very fine sand. In some places the soils have lenses of silt, silt loam, and very fine sandy loam throughout the profile. Slopes are 0 to 15 percent. The frost-free growing season is 270 to 320 days.

Permeability is rapid or moderately rapid. Available water capacity is 3.5 to 12 inches depending upon the degree of stratification. The effective rooting depth is more than 60 inches. The hazard of soil blowing is high, and the hazard of water erosion is slight.

These soils are used for truck crops, grapes, citrus, dates, cotton, alfalfa, and homesites.

All methods of irrigation currently used in the area can be used on these soils. However, sprinklers are best suited to the more sloping areas. Crop residue management, cover crops, and windbreaks all help reduce the soil blowing problem.

CAPABILITY UNIT IIIw-2 (31) IRRIGATED

Coachella fine sand, wet, 0 to 2 percent slopes, the only soil in this unit, is a very deep, well drained soil that has a perched water table. It is fine sand and very fine sand stratified with silt, silt loam, and silty clay loam. The frost-free growing season is 270 to 320 days.

Permeability is moderately rapid. Available water capacity is 7 to 12 inches in the 60 inches or more of rooting depth. The water table at a depth of 40 to 60 inches restricts the roots of many deep-rooted crops. The hazard of soil blowing is moderate to high, and the hazard of water erosion is slight.

This soil is used for grapes, dates, citrus, truck crops, and alfalfa hay.

This soil is suited to most methods of irrigation used in the Area. Overirrigation should be avoided. Tile drains are needed to maintain the water table below the root zone of most deep-rooted crops. Crop residue, cover crops, and windbreaks reduce the risk of soil blowing.

CAPABILITY UNIT IIIw-4 (31) IRRIGATED

Myoma fine sand, wet, 0 to 5 percent slopes, is the only soil in this unit. It is very deep, excessively drained fine sand or very fine sand. The water table is at a depth of 20 to 60 inches. The frost-free growing season is 270 to 320 days.

Permeability is rapid. The available water capacity is 3.5 to 6.5 inches based on a drained profile. However, the water table limits the rooting depth of many crops to about 20 to 60 inches. The hazard of soil blowing is high, and the hazard of water erosion is slight.

This soil is used for truck crops, citrus, grapes, dates, and alfalfa hay.

This soil is suited to most methods of irrigation. Because of its rapid intake rate it is best suited to irrigation by sprinklers, depending upon the suitability of sprinklers for the crop being grown. Light, frequent irrigations are needed. Care must be exercised to avoid building up the water table. Tile drains will aid in maintaining the water table below the rooting zone, and in removing excess salts from the soil profile. The return of crop residue to the soil and planting of cover crops and windbreaks will help reduce the hazard of soil blowing.

CAPABILITY UNIT IIIs-3 (31) IRRIGATED

Niland sand, 2 to 5 percent slopes, the only soil in this unit, is very deep and moderately well drained. The sand or coarse sand is underlain by clay or silty clay at depths of 20 to 40 inches. The frost-free growing season is 270 to 320 days.

Permeability is rapid in the sandy surface layer and very slow in the clayey substratum. Available water capacity is 4.5 to 8 inches in the 60 inches or more of effective rooting depth. The erosion hazard is slight by both wind and water.

Most of the acreage is in native vegetation.

If irrigation water were available, this soil would be suited to most irrigated crops grown in the area.

Intensive management would be needed. Most likely, salts would accumulate. Extremely careful management of irrigation water would be needed to avoid a perched water table, especially just above the clay subsoil.

CAPABILITY UNIT III$_s$-5 (31) IRRIGATED

Imperial silty clay, 0 to 2 percent slopes, is the only soil in this unit. It is well drained or moderately well drained, very deep silty clay or clay throughout the profile. The frost-free growing season is 270 to 320 days.

Permeability is slow. The effective rooting depth is 60 inches or more, although some plant roots have difficulty penetrating the soil. The available water capacity is 10 to 12 inches. The hazard of soil blowing is moderate. The small granules formed on the surface are fairly easily moved by the wind.

This soil is in native vegetation. It is not well suited to irrigation, especially for deep rooted crops like alfalfa or tree crops.

Water penetrates this soil very slowly, making it difficult to irrigate. When it is irrigated, salts build up and are difficult to remove. If the soil is irrigated tile drains are needed to remove the excess salts and maintain the water table below the effective rooting zone.

CAPABILITY UNIT IV$_e$-4 (19) IRRIGATED

The soils in this unit are very deep and somewhat excessively drained. The surface layer is fine sand or gravelly loamy sand. This is underlain by stratified gravelly coarse sand to very fine sand. Slopes are 0 to 30 percent. The frost-free growing season is 210 to 270 days.

Permeability is rapid. The effective rooting depth is 60 inches or more, and the available water capacity is 2.5 to 6.5 inches. The hazard of soil blowing is slight to high, and the hazard of water erosion is moderate.

The soils in this unit are currently in native vegetation. If favorable quality water were available they would be suited to all irrigated crops grown in the surrounding areas.

If irrigated, sprinklers would be the most desirable method of irrigation, as these soils have rapid intake rates. Irrigations should also be light and frequent. If cultivated, crop residues and other forms of organic matter should be returned to the soil to improve the tilth and reduce the erosion hazard. On the steeper slopes, all cultivation should be across the slope or on the contour.

CAPABILITY UNIT IV$_e$-4 (31) IRRIGATED

Carsitas fine sand, 0 to 5 percent slopes, the only soil in this unit, is very deep and excessively drained. The fine sand is underlain by gravelly coarse sand. The frost-free growing season is 270 to 320 days.

Permeability is rapid. The available water capacity is 3 to 4 inches in the 60 inches or more of effective rooting depth. The hazard of soil blowing is high. The hazard of water erosion is slight.

This soil, generally the last to be cropped on the individual farm, is used for grapes and citrus, especially where it occurs within fields of other soils.

Because of the rapid intake rate, this soil requires light, frequent irrigations to avoid loss of water through overirrigation. Sprinklers, where applicable, are most desirable. Cover crops and green manure crops are needed to reduce the risk of soil blowing.

CAPABILITY UNIT IV$_w$-4 (31) IRRIGATED

Carsitas sand, wet, 0 to 5 percent slopes, is the only soil in this unit. It is very deep and excessively drained, although it does have a perched water table at 2 to 4 feet. The soil has a sand surface layer and a gravelly coarse sand substratum. The frost-free growing season is 270 to 320 days.

Permeability is rapid. The available water capacity is 2 to 3.5 inches for a 60-inch or more effective rooting depth. However, the perched water table limits the effective rooting depth of water sensitive crops to 24 to 48 inches. The hazards of soil blowing and water erosion are slight.

This soil is mainly in native vegetation at this time. If irrigation water were available, it would be suited to most irrigated crops grown in the Coachella Valley.

Tile drains will be needed to lower the water table and remove toxic salts. Irrigation should be light and frequent, but occasional excessive irrigation is needed to leach salts from the soil.

CAPABILITY UNIT IV$_w$-6 (31) IRRIGATED

The soils in this unit are well drained to somewhat poorly drained and are very deep. The surface layer is sand, fine sandy loam, silty clay loam, or silty clay. The substratum is clay or silty clay with strata or lenses of coarser textured materials in some areas. Slopes are 0 to 5 percent. The frost-free growing season is 270 to 320 days.

Permeability is slow in the substratum. Available water capacity is 4.5 to 12 inches based on a drained profile. However, these soils have a perched water table at a depth of 10 to 60 inches. This water table limits the rooting depth of most deep rooted crops. The hazards of soil blowing and water erosion are slight.

At present, most of these soils are not irrigated because of the high capital investment and continued intensive management needed to bring them into sustained crop production. Most of these soils are in native vegetation.

If these soils are cultivated, tile drains are needed to lower the water table and remove excess salts. Because of the slow permeability and the water table, very careful management of irrigation water is needed. Because of the sandy or clayey surface layer, very intensive tillage management is needed to maintain soil structure and tilth.

CAPABILITY UNIT IV$_s$-4 (31) IRRIGATED

Carsitas gravelly sand, 0 to 9 percent slopes, is the only soil in this unit. It is very deep and excessively drained gravelly sand and gravelly coarse sand. The frost-free growing season is 270 to 320 days.

Permeability is rapid. The available water capacity is 3 to 4 inches for the 60 inch or more effective rooting depth. The hazard of soil blowing is slight, and the hazard of water erosion is slight to moderate.

This soil is currently in native or natural vegetation. It is suited to most irrigated crops grown in the area if intensive management practices are used.

Very intensive irrigation water management is required. Crop residue or other types of organic matter should be returned to the soil. Cover crops will aid in protecting orchards and vineyards. The more sloping areas should be farmed across the slope.

CAPABILITY UNIT VIs–1 (31) IRRIGATED

Carsitas cobbly sand, 2 to 9 percent slopes, is the only soil in this unit. It is very deep and excessively drained. The surface layer is cobbly sand and the substratum gravelly and cobbly coarse sand. The frost-free growing season is 270 to 320 days.

Permeability is rapid. The available water capacity is 2 to 3.5 inches for the 60 inch or more rooting depth. The hazard of soil blowing is slight and the hazard of water erosion is moderate.

The soil is presently in native vegetation. It has a good to fair potential for growing tree crops, especially citrus. The surface cobbles make sustained cultivation impractical.

Because of surface cobbles, the soil should be left in permanent cover, or weed and cover crops controlled by chemical sprays. Sprinklers are the best method of applying irrigation water. Irrigation should be light and frequent to avoid overirrigating and wasting water.

CAPABILITY UNIT VIIe–1 (20) DRYLAND

The soils in this unit are shallow to very deep and are well drained or somewhat excessively drained. One formed in uplands in material derived from decomposing granite. The rest formed in alluvium. The alluvial soils have a stony sandy loam, loamy sand, loamy fine sand, fine sand, or sand surface layer and a sandy clay loam or sand and gravelly sand subsoil or substratum and are more than 60 inches deep. The upland soil, a gravelly fine sandy loam and fine sandy loam, is only 12 to 18 inches deep over bedrock. The frost-free growing season is 120 to 270 days. Slopes are 0 to 30 percent.

Permeability is moderately slow to rapid. Available water capacity is 2 to 9 inches in the 60-inch root zone and 1.5 to 3 inches in the 12- to 18-inch zone. The hazard of water erosion ranges from slight to high. Soil blowing is no problem, or the hazard of soil blowing is high.

These soils are in native or natural vegetation and are grazed by wildlife. They provide excellent wildlife habitat. They can provide limited forage for livestock, but overgrazing must be avoided. Destroyed plants are slow to return in this area of low rainfall. Protection against fire is needed also.

CAPABILITY UNIT VIIs–1 (19, 20) DRYLAND

Two soils in this unit are very deep, somewhat excessively drained and excessively drained soil formed in alluvium. The other is a well drained upland soil that is only 6 to 18 inches deep over decomposing granite. The alluvial soils have gravelly loamy sand, cobbly sand, or stony sand surface layer and sand, gravelly sand, and very gravelly sand substratum. The upland soil is gravelly fine sandy loam and fine sandy loam. About 5 to 50 percent of the surface area is rock outcrop. Slopes are 0 to 50 percent. The frost-free growing season is 120 to 270 days.

Permeability is moderately rapid to very rapid. The available water capacity is 1 to 5 inches in the 60-inch root zone and 1 to 3 inches in the 6- to 18-inch zone. The hazard of water erosion is slight to moderate. Soil blowing is not considered a hazard or only slight.

These soils are in native vegetation. They have limited value for grazing. Protection against fire and overgrazing is needed because revegetation is difficult in this low rainfall area.

CAPABILITY UNIT VIIIe–1 (30, 31) DRYLAND

In this unit are very deep to shallow, moderately well drained to excessively drained soils and miscellaneous areas. Some of the soils are more than 60 inches deep in alluvium. Others are only 6 to 20 inches deep over sandstone. The surface layer is sand, gravelly sand, cobbly sand, fine sand, loamy sand, fine sandy loam, or silty clay. The substratum ranges from sand to clay, with or without coarse fragments, and is typically stratified with lenses of finer or coarser textured material. Slopes are 0 to 30 percent. The frost-free growing season is 270 to 320 days.

Permeability is rapid to slow. Available water capacity is 0.5 to 21 inches depending on the depth, texture, and stratification. The miscellaneous areas have varying depths and available water capacity. The hazards of water erosion and soil blowing are slight to high.

The soils and the miscellaneous areas in this unit are best maintained and protected under their present plant cover. If this cover is disturbed, revegetation is extremely difficult.

CAPABILITY UNIT VIIIw–1 (30, 31) DRYLAND

The soils and miscellaneous areas in this unit are excessively drained to poorly drained and are very deep. Textures range from stony sand to silty clay and are generally highly stratified with lenses of coarser or finer textured materials. In some areas are large amounts of coarse fragments ranging in size from gravel to stones. Slopes are 0 to 9 percent.

Permeability, available water capacity, and effective rooting depth are variable. The soils and miscellaneous areas either have a water table and/or are subject to scouring and deposition by runoff waters from surrounding hills and soils.

These soils and miscellaneous areas provide a good habitat for wildlife. Protection of native vegetation is needed because revegetation of these areas is extremely difficult.

CAPABILITY UNIT VIIIs–1 (20, 30, 31) DRYLAND

This unit consists of well drained to excessively drained, shallow to very deep soils and miscellaneous areas. Textures are quite variable, usually with large amounts of coarse fragments. Slopes are 2 to 75 percent.

The soils and miscellaneous areas in this unit have variable permeability, rooting depth, and available water capacity. The hazard of erosion is also variable, but is high on the steep slopes.

These soils and miscellaneous areas are used as wildlife habitat and to a lesser extent for commercial enterprises, for example, gravel and rock quarries and sources of construction material.

Protection of the existing vegetative cover is needed because revegetation is extremely difficult.

Crop Management and Estimated Yields

More than 30 kinds of crops are grown commercially in the Coachella Valley Area, and many other kinds could be. This section describes the management practices under which farmers in the Area grow eight of the important crops and gives estimates of average yields of these crops in table 2, under the management described. The description of management and the estimates of yields are based on observations made by the soil scientist who surveyed the Area, on information furnished by farmers, and on suggestions made by crop specialists of the Soil Conservation Service, the California Agricultural Experiment Station, and the Agricultural Extension Service. Federal and county census records and crop data also were reviewed and considered. More information was available for some soils than for others. If little or no information was available for a particular soil, or if the specified crop was not grown on the soil, yield estimates were made by comparisons with similar soils.

It can be anticipated that the management practices described will eventually become outdated as a result of the development of new equipment, new techniques, and new crop varieties.

Alfalfa (Medicago sativa)

Alfalfa is grown and harvested throughout the year in the survey area. It is a prominent part of many cropping systems and is grown for hay as well as for soil improvement. Alfalfa supplies winter pasture for sheep trucked in from other States. Some is green-chopped and fed in dairies. Baled alfalfa is sold to dairies in the Chino-Ontario area.

The acreage in alfalfa varies, ranging from 2,000 to 5,000 acres. Six or seven cuttings are made each year.

Several inoculated varieties are grown in the survey area. Important local characteristics of these varieties are resistance to spotted alfalfa aphid, root-knot nematode, downy mildew, leaf spot, and bacterial wilt.

Alfalfa can be grown on all cultivated soils. Large yields are produced most easily on Coachella, Gilman, Indio, and Myoma soils. Soils with low available water capacity, such as Carsitas and Myoma, produce well under irrigation. Salinity impairs yields.

The usual cropping system is 2 to 5 years of alfalfa followed by vegetables, cereal grains, or cotton. Reseeded alfalfa is often less successful because of the residual alfalfa diseases and pests detrimental to new seedlings. Alfalfa is seldom followed by root crops because the remaining alfalfa roots interfere with tillage. Alfalfa grown in sequence with crops grown in furrows helps to eliminate the salts that build up in the peaks of the furrows. Alfalfa roots aerate stratified soils and improve tilth.

Alfalfa seed, 20 to 30 pounds per acre, is planted in 4- to 6-inch rows, using an alfalfa drill or a grass seeder attached to a grain drill. Seed is planted across field borders to utilize more soil, reduce the area of weed growth, and stabilize the borders.

Seedings are the most successful during the cooler seasons, either around February 1 or after October 1. Maintaining favorable moisture conditions for alfalfa seedlings is easier early in February than in fall. Fall planting produces about twice as much hay the following summer as spring planting. For this reason, fall planting is preferable if preplant herbicides or other means of annual weed control are used.

In the Carsitas, Coachella, and Myoma soils that have a coarse-textured, loose surface layer, seedlings are subject to damage by wind abrasion. On these soils, a nurse crop of cereal grain is seeded with the alfalfa. These grain seedings are light—about 20 pounds of seed per acre.

Alfalfa is usually irrigated by borders. Two or more irrigations are required between summer cuttings.

Soil that is bordered is first landplaned, or releveled if needed. The leveled soil is plowed or subsoiled, disked, and floated, or landplaned. Soil that has a coarser surface layer may be disked or bordered. No tillage is needed after seeding, except for spot treatment of weedy areas.

The soils with a moderately fine and fine textured surface layer take in water slowly. Irrigating alfalfa on these soils in summer without scalding the plants is difficult. It helps to leach some of these soils during the winter and have the soil wet to field capacity to a depth of 6 feet before hot weather starts. Tail water disposal ditches are used. Two or more light irrigations are applied between summer cuttings. Alfalfa on Gilman and Indio soils ordinarily requires one irrigation between cuttings. During exceptionally hot and dry periods, two irrigations are needed in some areas.

Alfalfa seed is commonly planted in dry soil, and then the soil is irrigated. Irrigation water firms the soil over the seed. Seeding seasons are commonly dry and windy, and frequent irrigation is needed until plants are established.

Alfalfa planted with a nurse crop or on recently leached soil requires 20 to 30 pounds of nitrogen per acre. Phosphorus is needed on all soils. For maximum yields, 45 pounds of phosphorus is applied before planting and 35 pounds is applied each succeeding year.

Rodent pests of alfalfa are gophers, ground squirrels, and rabbits. Gophers are most damaging to alfalfa and borders. Rabbits are particularly damaging to alfalfa adjacent to idle land.

Carrots (Daucus carota)

Carrots is the most extensively grown vegetable in the Coachella Valley. In recent years they have equaled about one-third the total acreage of all vegetable crops grown. They are planted from July 20 through November. Long Imperator and Long Imperator 58 are the most commonly grown varieties.

Successful carrot growers prefer well drained soils with slopes of less than 2 percent and a surface layer of fine sandy loam, very fine sandy loam, or silt loam. These are characteristics of some Coachella, Gilman, and Indio soils. Maintaining adequate moisture for seed germination and early stages of growth on the earliest planted carrot crops is much more difficult on the Coachella, Gilman, and Myoma soils that have a fine sand or loamy fine sand surface layer. These soils, however, are satisfactory for plantings made during cooler weather if they are protected against soil blowing. Less well drained soils are also used successfully if drainage is improved by tiling and salinity is reduced by leaching. Because carrots are sensitive to salts, the saline Salton soils are not used for carrot production. A stony, cobbly, or gravelly surface layer is not desirable because it interferes with root growth.

Carrots can be grown on the same soil for several years in succession if they are topped in the field, the tops are returned to the soil, and plant nutrients are replaced annually. If tops are harvested with the roots, carrots should be planted in rotation with crops that contribute organic residue to the soil, or else manure should be used annually to replace depleted organic matter. Maintaining an adequate supply of active organic matter helps in keeping a high level of soil fertility along with a good physical condition of the soil for better aeration, water intake, and environment favorable for root development. Since salts tends to concentrate in beds between furrows, periodic rotation is needed. Also, planting carrots in flat beds with other crops helps maintain a desirable salinity balance. Carrots commonly do not follow immediately after alfalfa because the remaining alfalfa roots interfere with tillage and carrot root development.

Preparing land for carrot planting includes plowing, disking, and floating or landplanning. Beds are then shaped on 32- to 40-inch centers and the seed is planted one-eighth to one-half inch deep in multiple rows on top of the beds. Later tillage controls weeds, reshapes beds after irrigation, and disks crop residue.

Seeds germinate best at 68° to 86° F. Seeds planted during hot weather require a high moisture level to help cool the beds. Some plantings are germinated with portable sprinklers that help cool the planting beds and leach salts away from the roots of the young seedlings and out of the tops of the seedbeds. The sprinklers are removed after germination and the conventional method of irrigation by open furrows between beds is used. The soil is irrigated with either sprinklers or furrow irrigation before seeding and immediately after to firm soil over the seed and to supply the high level of moisture needed during germination and early stages of growth. Field moisture and crop appearance determine the frequency of later irrigations. The moisture level should be high enough at harvest time to facilitate loosening the carrot roots from the soil, but not so high as to cause puddling or to increase soil compaction.

Nitrogen application for carrots varies from 80 to 180 pounds per acre. Phosphorus needs depend mainly on the amount applied to the previous crop. On soil known to be deficient in phosphorus, up to 70 pounds per acre is used. All of the phosphorus and one-fourth to one-third of the nitrogen is applied broadcast and folded into the bed before planting. Less nitrogen is applied before planting on Myoma soils because they are coarse textured and lose nitrogen readily by leaching. After planting, the remaining nitrogen is applied as two or more sidedressings in bands 4 inches out from the row, and 4 inches deep.

Root knot nematodes are the most serious carrot pest in the survey area. Fumigation of the soil before planting is needed for maximum production of quality carrots, if the soil is infested with nematodes. Beet armyworm and cabbage looper can also be serious pests. Latest pest and disease control recommendations are obtained from the county farm advisor.

Weeds that affect carrot production can be controlled with chemicals or petroleum oils.

Cotton (Gossypium hirsutum and G. barbadense)

Cotton grows well in the survey area. Most of the soils in the area are suited to cotton, but greater yields are usually obtained on soils with a moderate to high available water capacity, such as Coachella, Gilman, or Indio soils. Soils with low available water capacity, such as Carsitas and Myoma soils, consistently produce smaller yields. Salinity also reduces yield, but cotton is generally less affected by salinity than other crops. For this reason, cotton is selected for the saline Salton soils. Yields are affected by cultivation, fertilization, irrigation, and other management.

Cotton can be grown in rotation with all field and vegetable crops grown in the survey area. When a crop is grown in furrows continuously, salts accumulates on the tops of the furrows. In Salton, Mecca, Indio, and Gilman soils, removal of salts is sometimes difficult. Cotton requires considerable tillage for weed control and if it is grown continuously, this tillage leads to deterioration of soil tilth, especially on a fine textured surface layer. For satisfactory maintenance, the soil must be rotated with close-growing crops that require less tillage. A planned system of crop rotation helps in controlling diseases and insects. Cotton that follows cotton is more susceptible to Texas root rot, Rhizoctonia, leaf crumble virus, and pink bollworm. Corn, small grains, grass, and sorghums can help reduce Texas rot in contaminated soil. If cotton is followed by alfalfa, Rhizoctonia most frequently causes damping off in cotton seedlings, and cutworms are more of a problem. Stinkbugs and lygus bugs commonly migrate from adjacent alfalfa into cotton and cause considerable damage. Control of root knot nematodes is an important consideration in determining the rotation of cotton with other crops.

Cotton seed is generally delinted mechanically or with acid, and then treated to protect the plant against angular leaf spot, anthracnose, sore shin, seed rot, seedling blight, and seedcorn maggots and other insects. A number of chemicals are effective against seedborne and soilborne pathogens.

Cotton is seeded to a depth of 1.5 to 2.0 inches in 38- to 42-inch rows at the rate of 15 to 25 pounds per acre. This rate obtains good stands and allows for some loss resulting from disease, pests, or weather and from crusting and cracking of fine textured soils. It also permits thinning to the spacing that is desired. Final plant spacings in the row vary from 4 to 12 inches. Variations have only a slight effect on yields.

The most favorable planting time is early in spring, after the soil temperature has reached 60° F. Legal planting and "plow-up" dates have been established to help control pink bollworm. Nearly all cotton is planted as soon after April 15 as possible, and the "plow-up" date is generally around December 15.

Soils are plowed, disked, and landplaned before planting. Salton, Gilman, and Indio soils are chiseled to break up the fine textured or compacted subsurface layer and to improve rooting and moisture penetration. The soil is bedded in February or early in March.

After cotton is planted, cultivation controls weeds and rebuilds cotton beds after hoeing. Much cultivation is eliminated by using chemicals to control weeds. "Pre-emergence" weed-control chemicals reduce the amount of hoeing needed. Other chemicals are used to spot treat grasses and annuals after emergence.

Irrigation begins prior to seeding. Salton, Indio, and Gilman soils are generally irrigated in February. This allows time for the surface to dry and warm at planting time. This irrigation provides some leaching of salts and saturates the soil to a depth of about 6 feet. Coachella soils are irrigated late in February or early in March.

Irrigation is often delayed until the first squares appear on the cotton if the surface layer is moist when the seed is drilled. Delaying irrigation avoids cooling the soil. Cooling inhibits growth and promotes seedling diseases. Delaying irrigation also discourages weed growth; if irrigation is delayed too long, however, it harms young plants. The first irrigation is earlier on Myoma soils and on saline soils. If weather conditions are warm or windy, earlier irrigation may be needed. Soils with a loose, coarse surface layer are subject to blowing, and injury to cotton seedlings by abrasion can occur if they become too dry. A fine textured soil or one in poor tilth requires light irrigation to keep the surface layer moist until the seedlings emerge. The frequency of irrigation during peak water use in July and August varies from about 5 days on the coarser Myoma soils to about 14 days on Salton and Indio soils. The timing of irrigation influences maximum yields.

Ample nitrogen is needed for high yields of cotton. If the yield is more than 3 bales per acre, up to 325 pounds of nitrogen is needed. Application methods and nitrogen sources depend largely on price. In Coachella, Gilman, Indio, and Salton soils, one-third of the nitrogen is applied before or at planting time. If ammonia fertilizer is used, it is injected away from the seed to prevent injury to seedlings. The remaining two-thirds of the nitrogen fertilizer is applied to these soils just prior to or in the early stages of square formation. Myoma soils require more frequent and smaller applications of fertilizer to prevent excessive loss through leaching. Application of fertilizer on these soils is continued through the early open boll stage of growth. To help insure sufficient nitrogen fertilization and to avoid overfertilization, petiole analyses are made periodically during June and July.

Cotton response to phosphorus varies. On soil that has been without phosphorus for long periods or where a deficiency is suspected, an application of 35 pounds per acre is needed.

Insects and nematodes injurious to cotton must be adequately controlled. Frequent inspections of fields and specific pest-control programs are provided by insecticide companies and the University of California Agricultural Extension Service.

Dates (Phoenix dactylifera)

Dates are well suited in the Coachella Valley. In 1974 most of the date acreage in the United States, 4,094 acres, was within the survey area. The Deglet Noor variety is common on most of the acreage. It requires prolonged high summer temperatures and low humidity for high quality fruit to mature.

Date palms can be grown on a wide variety of soils. Best fruit production is on soils with high available water capacity, and moderate to moderately rapid permeability, such as Coachella, Gilman, and Indio soils. High fruit yields can be obtained on the somewhat excessively drained Myoma soils and on soils that are excessively drained and have low available water capacity, such as Carsitas soils. These droughtier soils, however, require careful irrigation and more expensive irrigation systems to maintain the high moisture level required during summer to obtain good yields. They also require more fertilizer. The date palm will grow on highly saline soils, but fruit yields decline rapidly with increasing salinity. Soils with a high water table generally produce less fruit and fruit of poorer quality. If carefully irrigated and tile drained, however, these soils can be used.

Cover crops, such as alfalfa or barley, are used in newly planted date gardens to protect leveled land from soil blowing or to improve water penetration in the less permeable soils. On the best soils, cover crops provide all the nitrogen required by young palms for several years. The shade from date palms that have reached their maximum leaf spread is unfavorable to the growth of cover crops. Citrus is sometimes interplanted with dates, but the reduced yields due to shading make this practice unsatisfactory. The reduced ventilation and increased humidity is also detrimental to date production, along with the different irrigation, fertilization, and other management practices required by the two different crops.

Before planting, new land is leveled according to the designed irrigation system, such as borders or furrows. Because of the long time and large expense of bringing new date gardens into production, land preparation, particularly leveling, has to be done accurately. Land is prepared several months before date palm plantings. Tile drainage, if needed, and irrigation systems are installed after the land is leveled. Holes for planting are dug 30 by 30 feet center and 3 feet in diameter and depth. The holes are backfilled with a mixture of soil and barnyard manure. An irrigated cover crop is then grown. Palms are planted the following April to July. Subsequent tillage is for cover crops, seedbed preparation and planting, turning under or chopping crop residue, or preparation for irrigation.

Date palm plantings are rooted offshoots removed from older palms. The offshoot is 3 to 5 years old when it is removed. Offshoots are selected from parent trees of proven quality and preferably growing in soils similar to those in which the offshoots are to be planted.

Each offshoot is set so that the loose fiber near it is above ground level to protect the bud from irrigation water. Enough soil is tamped around it to half fill the hole. Irrigation immediately follows and enough soil is tamped in to finish filling the hole. Care is taken to avoid formation of air pockets. Male offshoots are planted on the south or west side of the garden to get more sunlight, which insures an early blossom. The newly planted offshoot is wrapped with burlap or shrouded with palm fronds to protect it against sun and wind the first summer and against cold the following winter. A mulch of hay or straw around the base of the plant helps maintain moisture for the first few weeks after planting.

In new plantings, the soil is kept moist at all times by frequent, light irrigation. During the first summer, daily irrigation on Carsitas and Myoma soils and weekly irrigations on Indio and Gilman soils may be needed. After offshoots are established, irrigation can be less frequent. Until trees reach fruit-bearing size, however, they are irrigated more often with lighter irrigation than is needed for the older deeper rooted palms. Soil moisture is brought to field capacity in early spring for bearing trees. A very high moisture level is maintained until early August on Indio and Gilman soils and until somewhat later on soils with lower moisture-holding capacity. Reducing the moisture level at this time reduces fruit drop in humid weather and promotes drying of some soft dates. Reducing soil moisture too early, however, may cause the fruit to shrivel. Irrigation is later applied when 40 to 50 percent of the available moisture has been used from the upper 6 feet of the root zone.

The relationship between quantity and quality of fruit production and fertilizer application varies. Response to fertilizer may not appear until several years after it is applied. Manure is usually applied late in fall and in winter, along with chopped prunings. Commercial nitrogen is used to prevent nitrogen tieup and to supplement the manure. Most growers consider 5 or 6 pounds of nitrogen per tree to be an adequate annual application. In coarse textured soils it is better to fertilize in two or three applications.

Green leaves are pruned to a limited extent to improve ventilation below fruit bunches. Dead leaves, old fruitstalks, leaf thorns, small or deformed fruit bunches, and bunches with broken stalks are pruned to facilitate working in the trees and to improve ventilation around the fruit. No pruning is needed on young palms until they begin to bear fruit, except to remove flower clusters.

All bunches of female flowers are cut from trees that have been planted for less than 4 years. Some bunches are removed until the trees are 10 to 15 years old, depending on the number and age of the leaves. One bunch of fruit is usually left on the tree for each 8 to 9 leaves. Tree vigor and the ability to provide adequate irrigation during the summer are considered when estimating the number of bunches that the tree should carry. Fruit bunches of Deglet Noor dates are thinned to about 40 fruiting strands per bunch, with 20 to 35 dates on each strand. Varieties having shorter and more numerous strands are thinned by removing about one-sixth of the flowers, by cutting off the end of the bunch, and then cutting out about one-half of the center strands.

Commercial dates are hand pollinated by inserting a portion of the male blossom or small wads of cotton containing pollen into each bunch of female flower clusters. Twine is tied around the end of the cluster to hold the pollen in place. Only viable, properly handled, and properly stored pollen is used. Female blossoms are pollinated within 2 or 3 days after opening. Recent mechanical applications of pollen from ground level appear promising.

After they are thinned and pollinated, the fruit bunches are pulled down through the leaves, and the fruitstalk is tied to a lower leaf. This prevents the fruit from scarring and reduces fruitstalk breakage as the weight of the fruit increases. When the dates begin to change color from green to red or yellow, they are loosely covered with paper to ward off birds and to protect the fruit from rain, which would lower the quality of the fruit. These paper covers are tied at the top of the bunch and flared out at the open end to allow free air movement.

Mite damage to fruit is prevented with sulfur dusts. In wet years fruit beetles, which are sometimes a problem, are controlled with malathion while the fruit is maturing.

Cultivation, weed oil, and chemicals are used to control bermudagrass in young date gardens. Weed competition is generally not serious after trees have obtained sufficient growth to shade the ground.

Grapefruit (Citrus paradisi)

The grapefruit acreage in the Coachella Valley, totaling 9,715 acres, is more than one-half of all the citrus grown. Marsh grapefruit is the most abundant local variety. Ruby Blush is also grown. The fruit is harvested from December through June. The cultural practices discussed in the following paragraphs apply especially to grapefruit, but with slight modification are generally applicable to lemons, oranges, tangerines, and other citrus grown in the survey area.

All citrus crops are sensitive to salts. Grapefruit is more salt tolerant than other citrus varieties. Strongly saline Imperial and Salton soils are not used for citrus production. High yields are obtained most easily on Indio and Gilman soils, which have a high available water capacity and moderate permeability. Unless well managed, however, even these soils accumulate enough salt during summer to be detrimental to trees. The Indio soils are also more apt to require improved facilities for frost protection because of their somewhat colder location. Grapefruit on the droughty, rapidly or very rapidly permeable Carsitas and Myoma soils is often less tolerant to summer heat. The fruit is smaller, yields are lower, and fertilization often is more expensive. If well managed, the Gilman, Indio, Coachella, and Myoma soils, all of which have a high water table, can be used for grapefruit after they are tile drained and leached of toxic salts.

During the 2 or 3 years after planting, soil blowing and abrasion can severely damage grapefruit trees in fields where the surface soil is easily moved by wind. Soil blowing in these areas may also destroy irrigation gradients within the grove. To protect young trees and the land that has been leveled for irrigation, close-growing ground cover crops, such as alfalfa or barley, are used. If the outer perimeters of the orchard are exposed to areas subject to soil blowing, high density windbreaks of oleander, pyracantha, or tamarisk are used for protection. Windbreaks are planted the summer before the orchard is planted. Temporary windbreaks of palm fronds can be used while the permanent living windbreak is becoming established. In older orchards soil blowing is not a problem except where the outer perimeters are exposed to wind and the soil is subject to blowing.

Grapefruit can be irrigated by furrows, borders, basins, low-volume under-tree sprinklers, or drip irrigation systems. The irrigation system determines the type of land leveling needed for good water management and the success of the crop. After the land is leveled and an irrigation system installed, tile drains are installed where needed. If salinity exceeds 4 millimhos and the land is to be flood irrigated, tiled land is either bordered for leaching by water ponding or is leached with sprinklers. Ground cover is seeded in the fall before the grapefruit planting the following spring. Tillage after planting controls weeds, chops or shreds prunings, and rebuilds irrigation borders. Deep tillage and tillage that piles soil around the bases of trees should be avoided.

Factors that grapefruit growers consider when selecting trees to establish new orchards vary greatly, for example, variation in tree rootstock tolerance to salinity, adaptability to soils with low available water capacity, soil drainage restrictions, nematode resistance, and cold hardiness. Knowledge of soil characteristics is important in selecting rootstock. Seedlings are set in the standing cover crop from March through June on 25- by 25-foot centers. Plantings on droughty soils are made early to allow the trees some root growth before hot summer weather begins. In planting the trees, it is important that the soil be packed closely around the root ball.

Trunks of newly planted trees are protected against sunburn until enough leaf surface is established to shade them. Trunks of young trees can be heavily wrapped with newspaper and the whole tree shrouded with cornstalks or palm fronds for protection against winter frosts. Older trees are not usually killed by frosts. Wind machines, orchard heaters, and irrigation can reduce frost damage to fruit. Whitewash spray is used to protect older trees exposed to sunlight on the south and west sides of orchards or to protect limbs and trunks of trees that have been heavily pruned for top grafting or other purposes.

Good management of irrigation water is essential for high yields. It reduces the loss of plant nutrients by leaching on droughty and highly permeable soils and avoids accumulation of toxic salts on other soils. Good management of irrigation water is also needed to prevent problems associated with a high water table, even after the soil is tiled. Newly planted trees on soils with low water holding capacity require irrigation at 2- or 3-day intervals during the first month after planting. The trees should never be allowed to wilt. Older trees that are flood irrigated are watered when 50 percent of available moisture has been used from the root zone. On the droughty Carsitas and Myoma soils, a somewhat higher moisture level is maintained throughout summer months. Higher moisture levels are also maintained in drip irrigation orchards. If winter irrigation is used to protect the trees from frost or to leach excess salt from the soil, more water is applied than the trees need. For toxic salt reductions, drip irrigation is generally combined with other irrigation systems capable of covering a large area.

Fertilization is not critical during the first year of tree growth. If young trees are growing vigorously, they should not be fertilized, except for adding bulky manure the first winter. When trees are set out, neither commercial nor organic fertilizer should be placed in the hole. In fruit bearing trees, from 2 to 3 pounds of actual nitrogen per tree is used, preferably with from one-third to one-half of the nitrogen provided from manure. Generally manure adequately supplies phosphorus needs. Tree prunings are also chopped or shredded and returned to the soil to increase the supply of organic matter. Zinc deficiency is treated with spray of 5 pounds zinc sulfate and 2 pounds lime per 100 gallons of water. The tree should be sprayed thoroughly, preferably in cloudy weather for better leaf absorption.

Grapefruit trees are not pruned for 2 or 3 years after transplanting, except to remove trunk sprouts and root stock suckers. When trees are 3 to 4 years old, they are pruned lightly to remove dead wood, tangled or too closely spaced branches, and undesirable side shoots. Bearing trees can be pruned to facilitate harvesting and pest control or to remove dead wood. Old trees can be topped to promote growth of lower fruitwood.

Thrips are the greatest insect pest. Most groves are sprayed at petal fall to protect the young fruit. Cottony scale is usually checked by predator insects. Sulfur dusts may be needed for mite control. Red scale is controlled by the local Citrus Pest Control District. Insect and disease control measures follow the recommendations and specifications of the County Agricultural Commissioner and farm advisor.

Tillage, weed oil, and paraquat are used to control weeds. Soil sterilant chemicals are not used for weed control on the rapidly permeable soils. Weeds are not particularly troublesome in mature healthy orchards that have sufficient canopy to shade the ground.

Grapes (Vitis spp.)

Grapes grown in the Coachella Valley, primarily for table use, are the first to reach the markets in early summer. A total of 7,300 acres is in grapes. About 46 percent is the Perlette, 41 percent Thompson Seedless, and the rest colored varieties. The acreage has decreased in recent years, mainly because there are fewer later producing vineyards on colder sites and smaller acreages of the more saline soils.

Because earlier grapes command a higher price at the market, the selection of early producing planting sites is of prime importance to grape growers. The preferred vineyard sites are on well drained or excessively drained, sloping soils with low salinity, good thermal drainage, and exposure to sunlight. Such sites are most frequently on Carsitas, Coachella, Gilman, and Myoma soils. The low available water capacity of some soils is compensated for by stratification and the deep rooting characteristics of grape vines. Coachella and Myoma soils have to be tile drained. They are in the warmer locations but have a high water table. On most Indio soils, which are below the areas of better thermal drainage, grape maturity is too late for the early market.

Soil blowing can severely damage grape vines during the first 2 years after planting. Alfalfa, barley, or other cereals are used for ground cover during the first and second years of growth to protect young grapes from soil abrasions. If the outer perimeters of vineyards are exposed to areas subject to soil blowing, thick windbreaks, for example, trees, Arundo donax, oleander, and lemon, are needed to protect the vineyard. In established vineyards, volunteer annual plants, manuring, and residue from pruning help prevent soil blowing.

Preparing land for vineyards begins with leveling to designed grades for irrigation. Proper leveling and irrigation borders are important if the vineyard is to be flood irrigated. Leveling errors are difficult to correct after vines are planted. After land leveling and installation of an irrigation system designed especially for grape irrigation, tile is installed if needed. Tree windbreaks, if needed, are planted the summer before the grapes are to be planted. Ground cover crops are planted in the fall before vineyard planting. The later tillage needed is disking to control weeds or shred prunings and rebuilding the borders after disking. French plows are used to control weeds within the vine rows.

In early spring, roots are planted 5 to 7 feet apart in rows 11 to 12 feet apart. Rows are in an east-west or 45 degree direction. The first summer after planting, the vines are grown without training. They are pruned to the ground the first winter, and before the second summer they are staked with cross arms. Wires are set for training the vines up the stakes during the second summer. The vines are pruned for a small crop the third summer. In the bearing vineyards, grape clusters are thinned to 20 to 25 on each healthy vine. Berries on each cluster are hand thinned if the set is too heavy. Vines are trunk girdled, and a hormone, gibberellin, is used to increase berry size.

Irrigation begins in February. Most established vineyards are irrigated in narrow borders, and irrigation runs are about 330 feet long. Most new vineyards are under drip irrigation for more efficient water management. Some older vineyards are also being converted to drip irrigation. Irrigation water on young vines is applied when 60 to 70 percent of available moisture is left in the root zone. This same high moisture level is maintained on bearing vines until the berries begin to soften. Then the soil is allowed to dry until the moisture content is reduced 40 to 50 percent to slow shoot growth and hasten maturity. The lower moisture level is maintained until vines are dormant. Some late irrigation is applied, if needed, to leach salts.

Commercial nitrogen and manure are used for fertilization. A quantitative analysis of arginine occurring in roots, shoots, and leaves indicates the nitrogen status of the vine. A leaf petiole nitrate test is also used in diagnosing nitrogen requirements. See Agricultural Extension Service pamphlet "Predicting Nitrogen Response in Vineyards." About 100 pounds of nitrogen per acre is applied annually, of which one-third to one-half is supplied by manure.

Leafhopper is a pest throughout the growing season. The bud beetle is treated at bud break in the spring. Root knot nematode, which is often severe, is treated in early spring. Powdery mildew, the only important disease, is treated by frequent dusting with sulfur, especially when the first new shoots appear in the spring. Bermudagrass and sandbur, the most troublesome weeds, are controlled with weed oils, chemical weed killers, and tillage.

Wheat (Triticum aestivum), Barley (Hordeum vulgare), and Oats (Avena sativa)

Wheat, barley, and oats are all adapted to the area. In 1974, the acreage in cereal crops grown for grain in the Coachella Valley totaled 1,748 acres. About 94 percent of this total, or 1,638 acres, was in Mexican wheat, which averages a yield of 1.9 tons per acre. Barley is the cereal crop most commonly used as a cover crop to control soil blowing. It improves the soil and also provides food for wildlife.

The greatest grain yields are obtained on Coachella, Gilman, and Indio soils, all of which have a moderate to high available water capacity. Crops on Carsitas, Myoma, and some droughtier Coachella soils provide good ground cover and wind protection, but seedheads are small and grain production is limited. A high water table and salinity impair grain yields. Barley is the most tolerant of these conditions.

Cereal crops are used in cropping systems to maintain productive soils. The many deep roots improve soil permeability, particularly after a shallow-rooted or intensively tilled vegetable crop. On newly cultivated land and on some highly saline soils, barley is sometimes the only crop grown for several years. Yields generally increase each year as salinity is reduced.

Fields for winter grains are plowed, disked, and floated or land planed for a seedbed. Fields to be sprinkler irrigated and planted to cereal crops for wind protection only are disked and then planted. If barley is used as a soil reclamation crop, the field is generally tiled, if needed, and then slip plowed or chiseled. If the field has a side fall exceeding about 0.25 foot per 100 feet, cereal crops are planted in multiple rows on top of raised beds with 32 to 40 inches between furrows.

Seed treated to prevent disease is planted with a grain drill at spacings of 6 to 8 inches. Wheat is planted at a rate of 60 to 80 pounds per acre, barley at 60 to 100 pounds per acre, and oats at 75 to 90 pounds per acre. The lighter rates are used on the Coachella and Myoma soils of low water holding capacity. The heavier rates result in good stands on saline soils and help control soil blowing in critical areas. The center row is planted heavier than the edge rows in furrow irrigated crops because salt accumulates in the center of the bed. Oats for pasture is planted about November 1. Wheat is planted about November 15 for pasture and between December 1 and January 15 for grain. Barley for pasture is planted about September 20, for cover crops about September 20 to March 1, and for grain only about January 15. The later planting for grain eliminates the hazard of heading out before the last spring frost.

Irrigation is most frequent on soils with low and medium available water capacity, such as Carsitas and

Myoma soils and some Coachella soils. These soils need to be irrigated at about 10- to 12-day intervals during the peak use period in March. Gilman and Indio soils require monthly irrigations during the growing period of the cereal crop. Higher moisture levels are maintained in saline soils and on soils where herbicides have been used for weed control. Cereal crops used for ground cover only are commonly irrigated until stems reach a height of about 18 inches.

The nitrogen required varies between 60 and 120 pounds per acre. Cereal crops grown for ground cover or reclamation of saline soil and cereal crops following vegetables are fertilized at the lower rate. Crops used for pasture and grain are fertilized at the higher rate. When cool weather follows planting, 30 pounds of nitrogen is used to stimulate growth. In a crop rotation there is generally enough residual phosphorus available for the grain crop. Up to 35 pounds of phosphorus per acre is used on newly leveled land that has had deep cuts, on soils leached for toxic salt reduction, and on soil used for cereal crops for several years in succession.

Engineering[2]

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 3 shows, for each kind of soil, the degree and kind of limitations for building site development; table 4, for sanitary facilities; and table 5, for water management. Table 6 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 3. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special

[2] WILLIAM D. GODDARD, agricultural engineer, Soil Conservation Service, helped prepare this section.

TABLE 3.—*Building site development*

[Some of the terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets
Badland: BA.				
Borrow pits: BP.				
Bull Trail:				
BtE	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Cajon:				
CaD	Severe: cutbanks cave.	Moderate: slope	Severe: slope	Moderate: slope.
Cajon Variant:				
CbD	Severe: cutbanks cave.	Moderate: slope	Severe: slope	Moderate: slope.
Carrizo:				
CcC	Severe: cutbanks cave, large stones.	Severe: floods	Severe: floods	Moderate: floods.
Carsitas:				
CdC, ChC	Severe: cutbanks cave.	Slight	Moderate: slope	Slight.
CdE	Severe: slope, cutbanks cave.	Severe: slope	Severe: slope	Severe: slope.
CfB	Severe: cutbanks cave, wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
CkB	Severe: cutbanks cave.	Slight	Slight	Slight.
Carsitas Variant:				
CmB	Severe: cutbanks cave.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.
CmE	Severe: slope, cutbanks cave.	Severe: slope	Severe: slope	Severe: slope.
Chuckawalla:				
CoB	Severe: small stones.	Slight	Slight	Slight.
CoD	Severe: small stones.	Moderate: slope	Severe: slope	Moderate: slope.
CnC	Severe: small stones.	Slight	Moderate: slope	Slight.
CnE	Severe: slope, small stones.	Severe: slope	Severe: slope	Severe: slope.
Coachella:				
CpA, CpB, CsA	Severe: cutbanks cave.	Slight	Slight	Slight.
Coachella:				
CrA	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight.
Fluvaquents:				
Fa	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Fluvents:				
Fe	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Gilman:				
GaB, GbA, GbB, GeA	Moderate: floods	Severe: floods	Severe: floods	Moderate: low strength, floods.
GcA, GdA, GfA	Moderate: wetness.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.
Gravel pits and dumps: GP.				

TABLE 3.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets
Imperial:				
IeA, IfA	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
ImC,[1] IoC:[1]				
Imperial part	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Gullied land part.				
Indio:				
Ip, Is	Slight	Slight	Slight	Moderate: low strength.
Ir, It	Moderate: wetness.	Slight	Slight	Moderate: low strength, wetness.
Lithic Torripsamments:				
LR[1]:				
Lithic Torripsamments part	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.
Rock outcrop part.				
Myoma:				
MaB	Severe: cutbanks cave.	Slight	Slight	Slight.
MaD	Severe: cutbanks cave.	Moderate: slope	Severe: slope	Moderate: slope.
Myoma:				
McB	Severe: cutbanks cave, wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.
Niland:				
NaB	Severe: too clayey.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.
NbB	Severe: wetness, too clayey.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: wetness, shrink-swell, low strength.
Omstott:				
OmD	Moderate: depth to rock, slope, small stones.	Moderate: depth to rock, slope.	Severe: slope	Moderate: slope, depth to rock.
Or[1]:				
Omstott part	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Rock outcrop part.				
Riverwash:				
RA.				
Rock outcrop:				
RO.				
RT[1]:				
Rock outcrop part.				
Lithic Torripsamments part	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.
Rubble land.				
RU.				
Salton:				
Sa, Sb	Severe: too clayey, wetness.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.

TABLE 3.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Small commercial buildings	Local roads and streets
Soboba:				
SoD	Severe: small stones.	Moderate: large stones.	Severe: slope	Moderate: slope.
SpE	Severe: slope, small stones.	Severe: slope	Severe: slope	Severe: slope.
Torriorthents:				
TO[1]:				
Torriorthents part	Severe: slope	Severe. slope	Severe: slope	Severe: slope.
Rock outcrop part.				
Tujunga:				
TpE	Severe: slope, cutbanks cave.	Severe: slope	Severe: slope	Severe: slope.
TrC	Severe: cutbanks cave.	Slight	Moderate: slope	Slight.
TsB	Severe: cutbanks cave.	Slight	Slight	Slight.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, and open ditches. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and small commercial buildings referred to in table 3 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 3 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 4 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight,*

TABLE 4.—*Sanitary facilities*

[Some of the terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils. Absence of an entry means soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Badland: BA.					
Borrow pits: BP.					
Bull Trail: BtE	Severe: slope, percs slowly.	Severe: slope	Severe: seepage	Severe: slope, seepage.	Poor: slope.
Cajon: CaD	Moderate: slope	Severe: slope, seepage.	Severe: seepage	Severe: seepage	Fair: slope, too sandy.
Cajon Variant: CbD	Moderate: slope	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage	Poor: too sandy.
Carrizo: CcC	Moderate: floods	Severe: seepage, large stones.	Severe: too sandy, seepage.	Severe: seepage	Poor: too sandy.
Carsitas: CdC, ChC, CkB	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: too sandy, seepage.
CdE	Severe: slope	Severe: slope, seepage.	Severe: seepage	Severe: slope, seepage.	Poor: slope, too sandy, seepage.
CfB	Severe: wetness	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: wetness, too sandy.
Carsitas Variant: CmB	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: seepage, depth to rock.	Severe: seepage	Poor: too sandy, thin layer.
CmE	Severe: slope, depth to rock.	Severe: slope, seepage, depth to rock.	Severe: seepage, depth to rock.	Severe: slope, seepage.	Poor: slope, too sandy, thin layer.
Chuckawalla: CoB, CnC	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: small stones.
CoD	Moderate: slope	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Poor: small stones.
CnE	Severe: slope	Severe: seepage, slope.	Severe: seepage	Severe: slope, seepage.	Poor: slope, small stones.
Coachella: CpA, CpB, CsA	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: too sandy.
Coachella: CrA	Severe: wetness	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: too sandy, wetness.
Fluvaquents: Fa	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: floods, wetness.
Fluvents: Fe	Severe: floods	Severe: floods	Severe: floods	Severe: floods	
Gilman: GaB, GbA, GbB, GeA	Moderate: floods	Severe: seepage, floods.	Severe: seepage	Severe: seepage	Good.
GcA, GfA	Severe: wetness	Severe: seepage	Severe: wetness, seepage.	Severe: seepage	Good.
GdA	Severe: percs slowly, wetness.	Severe: seepage	Severe: wetness, seepage.	Severe: seepage	Good.
Gravel pits and dumps: GP.					

TABLE 4.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Imperial:					
IeA	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey.
IfA	Severe. percs slowly, wetness.	Severe: wetness	Severe: too clayey, wetness.	Severe: wetness	Poor: too clayey, wetness.
ImC[1]:					
Imperial part	Severe: percs slowly.	Moderate: slope	Severe: too clayey.	Slight	Poor: too clayey.
Gullied land part.					
IoC[1]:					
Imperial part	Severe: percs slowly, wetness.	Severe: wetness	Severe: too clayey, wetness.	Severe: wetness	Poor: too clayey, wetness.
Gullied land part.					
Indio:					
Ip, Is	Slight	Moderate: seepage.	Slight	Slight	Good.
Ir, It	Severe: wetness	Moderate: wetness, seepage.	Severe: wetness	Moderate: wetness.	Fair: wetness.
Lithic Torripsamments:					
LR[1]:					
Lithic Torripsamments part.	Severe: slope, depth to rock.	Severe: slope, depth to rock, seepage.	Severe: slope, depth to rock, seepage.	Severe: slope, seepage.	Poor: slope, thin layer, too sandy.
Rock outcrop part.					
Myoma:					
MaB	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: too sandy.
MaD	Moderate: slope	Severe: slope, seepage.	Severe: seepage	Severe: seepage	Poor: too sandy.
McB	Severe: wetness	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Poor· too sandy, wetness.
Niland:					
NaB	Severe: percs slowly.	Moderate: slope	Severe: too clayey.	Slight	Poor: too clayey.
NbB	Severe: percs slowly, wetness.	Severe: seepage	Severe: wetness	Severe: seepage	Poor: wetness, too clayey.
Omstott:					
OmD	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Moderate: slope	Poor: thin layer.
Or[1]:					
Omstott part	Severe: slope, depth to rock.	Severe· slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope	Poor: slope, thin layer.
Rock outcrop part.					
Riverwash:					
RA.					
Rock outcrop:					
RO.					
RT[1]:					
Rock outcrop part.					
Lithic Torripsamments part.	Severe: slope, depth to rock.	Severe: slope, depth to rock, seepage.	Severe: slope, depth to rock, seepage.	Severe: slope, seepage.	Poor: slope, thin layer. too sandy.
Rubble land:					
RU.					
Salton:					
Sa, Sb	Severe: percs slowly, wetness.	Severe: wetness	Severe: wetness	Severe: wetness	Fair: too clayey.

TABLE 4.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Soboba: SoD	Moderate: slope	Severe: slope, small stones, seepage.	Severe: small stones, seepage.	Severe: seepage	Poor: small stones.
Soboba: SpE	Severe: slope, large stones.	Severe: slope, large stones, seepage.	Severe: large stones, seepage.	Severe: slope, seepage.	Poor: slope, large stones.
Torriorthents: TO[1]:					
Torriorthents part. Rock outcrop part.	Severe: slope	Severe: slope	Moderate: slope	Severe: slope	Poor: slope.
Tujunga: TpE	Severe: slope	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: slope, seepage.	Poor: too sandy.
TrC, TsB	Slight	Severe: seepage	Severe: seepage, too sandy, small stones.	Severe: seepage	Poor: small stones, too sandy.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good, fair,* or *poor,* which, respectively, mean about the same as the terms *slight, moderate,* and *severe.*

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid

TABLE 5.—*Water management*

[Some of the terms that describe restrictive soil features are defined in the Glossary. Absence of an entry means soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Badland: BA.						
Borrow pits: BP.						
Bull Trail: BtE	Slope	Piping, low strength.	Slope	Slope	Slope	Slope.
Cajon: CaD	Slope, seepage	Seepage	Slope, cutbanks cave.	Slope, droughty.	Slope, too sandy.	Slope, too sandy, droughty.
Cajon Variant: CbD	Seepage, slope	Seepage	Slope, cutbanks cave.	Slope, fast intake, droughty.	Slope, too sandy.	Slope, droughty, too sandy.
Carrizo: CcC	Seepage, slope	Seepage, large stones.	Slope, cutbanks cave.	Slope, fast intake, seepage.	Too sandy, large stones, slope.	Slope, droughty.
Carsitas: CdC, CdE, ChC, CkB	Slope, seepage	Seepage	Slope, cutbanks cave.	Slope, seepage, fast intake.	Slope, too sandy.	Slope, droughty.
CfB	Seepage	Seepage, piping.	Wetness, cutbanks cave.	Droughty, wetness, seepage.	Too sandy, wetness.	Droughty, wetness.
Carsitas Variant: CmB, CmE	Depth to rock, seepage, slope.	Thin layer, seepage.	Depth to rock, cutbanks cave.	Fast intake, rooting depth.	Depth to rock, too sandy.	Droughty.
Chuckawalla: CoB	Seepage, slope	Seepage	Slope	Slope, seepage	Seepage	Favorable.
CoD, CnC, CnE	Seepage, slope	Seepage	Slope	Slope, seepage	Seepage, slope	Slope.
Coachella: CpA	Seepage	Piping, seepage	Cutbanks cave	Erodes easily	Piping	Droughty.
CpB	Seepage	Piping, seepage	Cutbanks cave	Slope, erodes easily.	Piping	Droughty.
CrA	Seepage	Piping, seepage	Cutbanks cave, wetness.	Erodes easily, wetness.	Piping, wetness	Favorable.
CsA	Seepage	Piping, seepage	Cutbanks cave	Favorable	Piping	Favorable.
Fluvaquents: Fa.						
Fluvents: Fe.						
Gilman: GaB, GbA, GbB, GeA	Slope, seepage	Piping, low strength, hard to pack.	Slope	Slope	Piping, erodes easily.	Slope, erodes easily.
GcA, GfA	Seepage	Piping, low strength, hard to pack.	Wetness	Wetness	Piping, erodes easily.	Erodes easily.
GdA	Seepage	Piping, low strength, hard to pack.	Percs slowly	Percs slowly	Piping, erodes easily.	Erodes easily.
Gravel pits and dumps: GP.						

TABLE 5.—*Water management*—Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Imperial:						
IeA	Favorable	Low strength, shrink-swell, compressible.	Percs slowly, excess salt.	Slow intake, excess salt.	Percs slowly	Excess salt, percs slowly.
IfA	Favorable	Low strength, shrink-swell, compressible.	Percs slowly, excess salt, wetness.	Wetness, excess salt, slow intake.	Percs slowly, wetness.	Percs slowly, excess salt, wetness.
ImC[1]:						
Imperial part	Slope	Low strength, shrink-swell, compressible.	Percs slowly, excess salt.	Slow intake, excess salt.	Percs slowly	Excess salt, percs slowly.
Gullied land part.						
IoC[1]:						
Imperial part	Slope	Low strength, shrink-swell, compressible.	Percs slowly, excess salt, slope.	Wetness, excess salt, slow intake.	Percs slowly, wetness, slope.	Percs slowly, excess salt, wetness.
Gullied land part.						
Indio:						
Ip, Is	Seepage	Piping, hard to pack, low strength.	Favorable	Favorable	Favorable	Favorable.
Ir, It	Seepage	Piping, hard to pack, low strength.	Wetness	Wetness	Wetness	Wetness.
Lithic Torripsamments:						
LR[1]:						
Lithic Torripsamments part.	Slope, depth to rock, seepage.	Thin layer, seepage.	Slope, depth to rock, cutbanks cave.	Slope, erodes easily, rooting depth.	Slope, depth to rock, erodes easily.	Erodes easily, slope, rooting depth.
Rock outcrop part.						
Myoma:						
MaB, MaD	Slope, seepage	Seepage, piping	Slope, cutbanks cave.	Slope, droughty, fast intake.	Slope, too sandy.	Slope, droughty.
Myoma:						
McB	Seepage, slope	Seepage, piping	Wetness, cutbanks cave, slope.	Wetness, fast intake, slope.	Too sandy, wetness.	Wetness.
Niland:						
NaB	Slope	Low strength, shrink-swell.	Slope, percs slowly, excess salt.	Slope, percs slowly, fast intake.	Too sandy	Droughty, percs slowly, excess salt.
NbB	Slope	Low strength, shrink-swell, compressible.	Slope, wetness, percs slowly.	Slope, wetness, percs slowly.	Slope, wetness, too sandy.	Slope, wetness, percs slowly.
Omstott:						
OmD	Depth to rock, slope.	Thin layer	Depth to rock, slope.	Rooting depth, slope.	Depth to rock, slope, rooting depth.	Droughty, rooting depth, slope.
Or[1]:						
Omstott part	Depth to rock, slope.	Thin layer	Depth to rock, slope.	Rooting depth, slope.	Depth to rock, slope.	Droughty, rooting depth, slope.
Rock outcrop part.						
Riverwash: RA.						

TABLE 5.—*Water management*—Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Rock outcrop: RO.						
RT[1]:						
Rock outcrop part.						
Lithic Torripsamments part.	Slope, depth to rock, seepage.	Thin layer, seepage.	Slope, depth to rock, cutbanks cave.	Slope, erodes easily, rooting depth.	Slope, depth to rock, erodes easily.	Slope, erodes easily, rooting depth.
Rubble land: RU.						
Salton:						
Sa, Sb	Favorable	Low strength, shrink-swell.	Percs slowly, wetness, excess salt.	Excess salt, wetness, slow intake.	Percs slowly, wetness.	Excess salt, percs slowly, wetness.
Soboba:						
SoD, SpE	Slope, seepage	Large stones, seepage.	Cutbanks cave, slope.	Erodes easily, seepage, slope.	Too sandy, large stones, slope.	Droughty, slope, erodes easily.
Torriorthents:						
TO[1]:						
Torriorthents part.						
Rock outcrop part.						
Tujunga:						
TpE	Slope, seepage	Piping, seepage.	Slope	Slope, droughty, fast intake.	Slope, too sandy, piping.	Droughty, slope, erodes easily.
TrC, TsB	Slope, seepage	Piping, seepage.	Slope	Slope, droughty, fast intake.	Too sandy, piping.	Droughty.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 4 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 5 the degree of soil limitation and soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Soil and site limitations are expressed as slight, moderate, and severe. *Slight* means that the soil properties and site features are generally favorable for the specified use and that any limitation is minor and easily overcome. *Moderate* means that some soil properties or site features are unfavorable for the specified use but can be overcome or modified by special planning and design. *Severe* means that the soil properties

TABLE 6.—*Construction materials*

[Some of the terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "unsuited." Absence of an entry means soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Badland: BA.				
Borrow pits: BP.				
Bull Trail: BtE	Fair: slope, shrink-swell, low strength.	Unsuited	Unsuited	Poor: slope.
Cajon: CaD	Good	Poor: excess fines	Unsuited	Poor: too sandy.
Cajon Variant: CbD	Good	Fair: excess fines	Unsuited	Poor: too sandy.
Carrizo: CcC	Good	Fair: large stones	Fair: large stones	Poor: too sandy, large stones, small stones.
Carsitas: CdC, ChC, CkB	Good	Fair: excess fines	Unsuited	Poor: too sandy, small stones.
CdE	Fair: slope	Fair: excess fines	Unsuited	Poor: slope, too sandy, small stones.
CfB	Fair: wetness	Fair: excess fines	Poor	Poor: too sandy, wetness, small stones.
Carsitas Variant: CmB	Poor: thin layer	Poor: thin layer, excess fines.	Unsuited	Poor: too sandy.
CmE	Poor: thin layer	Poor: thin layer, excess fines.	Unsuited	Poor: slope, too sandy.
Chuckawalla: CoB, CoD, CnC	Good	Unsuited	Fair: excess fines	Poor: small stones.
CnE	Fair: slope	Unsuited	Fair: excess fines	Poor: slope, small stones.
Coachella: CpA, CpB, CsA	Good	Poor: excess fines	Unsuited	Poor: too sandy.
CrA	Poor: wetness	Poor: excess fines	Unsuited	Poor: too sandy, wetness.
Fluvaquents: Fa	Severe: wetness	Unsuited	Unsuited	Poor: wetness.
Fluvents: Fe.				
Gilman. GaB, GbA, GbB, GcA, GdA, GeA.	Fair: low strength	Unsuited	Unsuited	Fair: too sandy.
GfA	Poor: wetness	Unsuited	Unsuited	Poor: wetness.
Gravel pits and dumps: GP.				
Imperial: IeA, IfA	Severe. shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey, excess salt.
ImC[1]: Imperial part	Severe: shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey, excess salt.
Gullied land part.				
IoC[1]: Imperial part	Severe: shrink-swell, low strength, wetness.	Unsuited	Unsuited	Poor: too clayey, excess salt, wetness.
Gullied land part.				

TABLE 6.—*Construction materials*—Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Indio:				
Ip, Is	Fair: low strength	Unsuited	Unsuited	Good.
Ir, It	Fair: low strength, wetness.	Unsuited	Unsuited	Fair: wetness.
Lithic Torripsamments:				
LR[1]:				
Lithic Torripsamments part.	Poor: slope, thin layer, area reclaim.	Unsuited	Unsuited	Poor: slope, thin layer, too sandy.
Rock outcrop part.				
Myoma:				
MaB, MaD	Good	Fair: excess fines	Unsuited	Poor: too sandy.
McB	Poor: wetness	Fair: excess fines	Unsuited	Poor: too sandy, wetness.
Niland:				
NaB	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: too sandy.
Niland:				
NbB	Poor: wetness, low strength, shrink-swell.	Unsuited	Unsuited	Poor: too sandy, wetness.
Omstott:				
OmD	Poor: area reclaim, thin layer.	Unsuited	Unsuited	Poor: area reclaim, thin layer.
Or[1]:				
Omstott part	Poor: slope, area reclaim, thin layer.	Unsuited	Unsuited	Poor: slope, small stones, area reclaim.
Rock outcrop part.				
Riverwash:				
RA.				
Rock outcrop:				
RO.				
RT[1]:				
Rock outcrop part.				
Lithic Torripsamments part.	Poor: slope, thin layer, area reclaim.	Unsuited	Unsuited	Poor: slope, thin layer, too sandy.
Rubble land:				
RU.				
Salton:				
Sa, Sb	Poor: low strength, shrink-swell, wetness.	Unsuited	Unsuited	Poor: excess salt, wetness.
Soboba:				
SoD, SpE	Fair: large stones	Fair: excess fines	Fair: excess fines	Poor: small stones, too sandy.
Torriorthents:				
TO[1]:				
Torriorthents part.				
Rock outcrop part.				
Tujunga:				
TpE	Fair: slope	Fair: excess fines	Unsuited	Poor: slope, too sandy.
TrC	Good	Fair: excess fines	Unsuited	Poor: small stones, too sandy.
TsB	Good	Fair: excess fines	Unsuited	Poor: too sandy.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

and site features are so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 6 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 9 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 6 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 9.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Recreation

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 4, and interpretations for dwellings without basements and for local roads and streets, given in table 3.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife Habitat

As a basic natural resource, the fish and wildlife in the Coachella Valley Survey Area affect the economy both directly and indirectly. They provide outdoor recreation for hunters, naturalists, and bird watchers and to some extent they control insect pests. The Area is highly diverse in the types of wildlife habitat and wildlife species.

Warm water fish, such as black bass, catfish, and sunfish, inhabit the lakes, ponds, and canals within the survey area. The humpbacked sucker is in the Coachella Canal. Wildlife of particular interest are the waterfowl and shore birds associated with the wetlands around the Salton Sea and the mammals and upland birds associated with the desert ecosystem.

Soils directly influence the kind and amount of vegetation and the amount of water available for the growth of wildlife habitat plants. In this way, soils indirectly influence the kind and number of wildlife that can use an area.

In rating the soils for habitat elements and habitat types in table 8, only the soil characteristics are considered. Not considered were closely related factors, such as the climate, the present use of soils, the present distribution of wildlife and people, or the land areas that are not classified as soils but are valuable to wildlife, for example, Badlands, Borrow pits, Riverwash, Rubble land, and Rock outcrop. For this reason, selection of a site for development as habitat for wildlife requires onsite investigation.

The suitability of soils to produce elements that constitute a given habitat type is shown in table 8. These elements are defined as follows:

Grain and seed crops are domestic grains, such as barley, grain sorghum, Japanese millet, or other seed-producing annuals, that provide food for wildlife.

Grasses and legumes are domestic grasses and legumes that can be planted for wildlife cover and food. Examples are fescue, orchardgrass, and annual and perennial ryegrass. Legumes are alfalfa and clover.

Wild herbaceous plants are native or naturally established dryland grasses and forbs that provide food and cover for wildlife. Examples are doveweed, red brome, six weeks grama, schismus, desert sunflower, filaree, sand verbena, and evening primrose.

Hardwood trees are nonconiferous trees and the associated woody understory plants that provide food or cover for wildlife. Examples are willow, alder, sycamore, cottonwood, ironwood, honey mesquite, screwbean mesquite, smoketree, palo verde, catclaw acacia, and live oak. This element also includes riparian vegetation.

TABLE 7.—*Recreational development*

[Some of the terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Badland: BA.				
Borrow pits: BP.				
Bull Trail:				
BtE	Severe: slope	Severe: slope	Severe: slope	Moderate: slope, large stones.
Cajon:				
CaD	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope, too sandy.	Moderate: too sandy.
Cajon Variant:				
CbD	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope too sandy.	Severe: too sandy.
Carrizo:				
CcC	Severe: too sandy	Severe: too sandy	Severe: too sandy	Severe: too sandy.
Carsitas:				
CdC, ChC, CkB	Severe: too sandy	Severe: too sandy	Severe: too sandy	Severe: too sandy.
CdE	Severe: too sandy, slope.	Severe: too sandy, slope.	Severe: slope, too sandy.	Severe: too sandy.
CfB	Moderate: too sandy, wetness.	Moderate: too sandy	Severe: too sandy	Severe: too sandy.
Carsitas Variant:				
CmB	Moderate: too sandy	Moderate: too sandy	Severe: too sandy, depth to rock.	Severe: too sandy.
CmE	Severe: slope	Severe: slope	Severe: slope, too sandy, depth to rock.	Severe: too sandy.
Chuckawalla:				
CoB, CnC	Severe: small stones	Severe: small stones	Severe: small stones	Severe: small stones.
CoD	Moderate: large stones	Moderate: large stones	Severe: slope, small stones.	Moderate: large stones.
CnE	Severe. slope	Severe: slope	Severe: slope, small stones.	Moderate: slope.
Coachella:				
CpA, CpB, CrA	Moderate: too sandy	Moderate: too sandy	Severe: too sandy	Severe: too sandy.
CsA	Slight	Slight	Slight	Slight.
Fluvaquents:				
Fa	Severe: wetness, floods	Severe: wetness, floods	Severe: wetness, floods	Severe: wetness, floods.
Fluvents:				
Fe	Severe: floods	Moderate: floods	Moderate: floods	Slight.
Gilman:				
GaB	Moderate: too sandy	Moderate: too sandy	Moderate: slope, too sandy, dusty.	Moderate: too sandy, dusty.
GbA, GcA, GdA, GeA, GfA	Moderate: dusty	Moderate: dusty	Moderate: dusty	Moderate: dusty.
GbB	Moderate: dusty	Moderate: dusty	Moderate: slope dusty	Moderate: dusty.
Gravel pits and dumps: GP.				
Imperial:				
IeA, IfA	Severe: too clayey	Severe: too clayey	Severe: too clayey	Severe: too clayey.
ImC[1], IoC[1]:				
Imperial part	Severe: too clayey	Severe: too clayey	Severe: too clayey	Severe: too clayey.
Gullied land part.				

TABLE 7.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Indio:				
Ip, Ir, Is, It	Slight	Slight	Slight	Slight.
Lithic Torripsamments:				
LR[1]:				
Lithic Torripsamments part.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, depth to rock, too sandy.	Severe: slope, too sandy.
Rock outcrop part.				
Myoma:				
MaB	Severe: too sandy	Severe: too sandy	Severe: too sandy	Severe: too sandy.
MaD	Severe: too sandy	Severe: too sandy	Severe: slope, too sandy.	Severe: too sandy.
McB	Severe: too sandy, wetness.	Severe: too sandy, wetness.	Severe: too sandy, wetness.	Severe: too sandy, wetness.
Niland:				
NaB, NbB	Moderate: too sandy	Moderate: too sandy	Severe: too sandy	Severe: too sandy.
Omstott:				
OmD	Moderate: slope	Moderate: slope	Severe: slope, depth to rock.	Slight.
Omstott:				
Or[1]:				
Omstott part	Severe: slope	Severe: slope	Severe: slope, depth to rock.	Severe: slope.
Rock outcrop part.				
Riverwash:				
RA.				
Rock outcrop:				
RO.				
RT[1]:				
Rock outcrop part.				
Lithic Torripsamments part	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, depth to rock, too sandy.	Severe: slope, too sandy.
Rubble land:				
RU.				
Salton:				
Sa	Moderate: wetness	Slight	Moderate: wetness	Slight.
Sb	Moderate: too clayey, wetness.	Moderate: too clayey	Moderate: too clayey, wetness.	Moderate: too clayey.
Soboba:				
SoD	Moderate: large stones, small stones.	Moderate: large stones, small stones.	Severe: slope, large stones, small stones.	Moderate: large stones, small stones.
SpE	Severe: slope	Severe: slope	Severe: slope, small stones.	Moderate: large stones, small stones, slope.
Torriorthents:				
TO[1]:				
Torriorthents part	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Rock outcrop part.				
Tujunga:				
TpE	Severe: too sandy, slope.	Severe: too sandy, slope.	Severe: slope, too sandy.	Severe: too sandy.
TrC	Moderate: small stones, too sandy.	Moderate: small stones, too sandy.	Severe: small stones, too sandy.	Moderate. small stones, too sandy.
TsB	Severe: too sandy	Severe: too sandy	Severe: too sandy	Severe too sandy.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 8.—*Wildlife*

[See text for definitions of "good," "fair," "poor" and "very poor."

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants
Badland:					
BA					
Borrow pits:					
BP					
Bull Trail:					
BtE	Very poor	Very poor	Good		Good
Cajon:					
CaD					
Cajon Variant:					
CbD	Very poor	Very poor	Fair		
Carrizo:					
CcC	Very poor	Very poor	Very poor		
Carsitas:					
CdC	Poor	Poor	Fair		
CdE, ChC, CkB	Very poor	Very poor	Fair		
CfB	Poor	Fair	Fair		
Carsitas Variant:					
CmB, CmE	Very poor	Very poor	Poor		
Chuckawalla:					
CoB, CoD, CnC, CnE	Very poor	Very poor	Very poor		
Coachella:					
CpA, CpB, CrA, CsA					
Fluvaquents:					
Fa					
Fluvents:					
Fe					
Gilman:					
GaB, GbA, GbB, GeA	Good	Good	Good		
GcA, GdA, GfA	Good	Good	Good		
Gravel pits and dumps:					
Gp					
Imperial:					
IeA, IfA					
ImC[1], IoC[1]:					
Imperial part					
Gullied land part.					
Indio:					
Ip, Is					
Ir, It	Good	Good	Good		
Lithic Torripsamments:					
LR[1]:					
Lithic Torripsamments part.	Very poor	Very poor	Very poor		
Rock outcrop part.					
Myoma:					
MaB, MaD	Very poor	Very poor	Very poor		
McB	Poor	Poor	Poor		

habitat potentials

Absence of an entry indicates the soil was not rated]

Potential for habitat elements—Cont.			Potential as habitat for—			
Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Good	Very poor	Very poor	Poor	Fair	Very poor	Fair.
Fair	Very poor	Very poor	Poor		Very poor	Fair.
Poor	Very poor	Very poor	Very poor		Very poor	Very poor.
Fair	Very poor	Very poor	Poor		Very poor	Fair.
Fair	Very poor	Very poor	Poor		Very poor	Fair.
Fair	Poor	Poor	Fair		Poor	
Poor	Very poor	Very poor	Very poor		Very poor	Poor.
Poor	Very poor	Very poor	Very poor		Very poor	Very poor.
Good	Good	Fair	Good		Poor	
Good	Fair	Fair	Good		Fair	Good.
Good	Good	Good	Good		Good	Good.
Very poor	Very poor	Very poor	Very poor		Very poor	Very poor.
Very poor	Very poor	Very poor	Very poor		Very poor	Very poor.
Fair	Poor	Very poor	Poor		Very poor	Poor.

TABLE 8.—*Wildlife*

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants
Niland:					
NaB	Very poor	Very poor	Very poor		
NbB	Fair	Fair	Good		
Omstott:					
OmD	Very poor	Very poor	Poor		
Or[1]:					
Omstott part	Very poor	Very poor	Poor		
Rock outcrop part.					
Riverwash:					
RA					
Rock outcrop:					
RO					
RT[1]:					
Rock outcrop part.					
Lithic Torripsamments part.	Very poor	Very poor	Very poor		
Rubble land:					
RU					
Salton:					
Sa, Sb	Poor	Fair	Poor		
Soboba:					
SoD, SpE					
Torriorthents:					
TO[1]:					
Torriorthents part.	Very poor	Very poor	Very poor		
Rock outcrop part.					
Tujunga:					
TpE, TrC, TsB	Poor	Poor	Fair		

[1]This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

Coniferous trees are cone bearing trees, such as singleleaf pinyon pine and California juniper.

Shrubs are woody plants that produce browse and mast (fruits and nuts) used by wildlife. Examples are chamise, honey and screwbean mesquite, desert ceanothus, scrub oak, California buckwheat, sugarbush, and encelia.

Wetland plants are domestic and wild annual and perennial herbaceous plants that provide food and cover. Examples are cattail, dock, sedges, saltgrass, smartweed, watergrass, Japanese millet, alkali bulrush, hardstem bulrush, pickleweed, and iodinebush.

Shallow water areas are low diked areas or natural wet basin areas normally less than 5 feet deep, including ponds for fish and livestock and shallow water for waterfowl and many other wildlife species. Examples are brackish marshes, the Whitewater drain around the Salton Sea, and wildlife water developments. The suitability of soils for ponding water behind dams or levees is one of the interpretations in the engineering section of this survey.

Suitability of the soils in the Area for habitat elements and the resulting habitat ranges from good to very poor. A rating of *good* means that habitat is easily improved, maintained, or created. There are few or no soil limitations in habitat management and satisfactory results can be expected. *Fair* means that habitat 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 habitat can be improved, maintained, or created, but soil limitations are severe. Habitat management may be difficult and expensive and require intensive effort. Results are questionable. *Very poor* means that under prevailing soil conditions, it is impractical to attempt to improve, maintain, or create habitat. Unsatisfactory results are probable.

Many wildlife species, such as upland game birds, wetland wildlife, and songbirds, require access to more than one habitat type. For example, California quail *habitat potentials*—Continued

Potential for habitat elements—Cont.			Potential as habitat for—			
Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Very poor Good	Very poor Good	Very poor Good	Very poor Fair		Very poor Good	Very poor. Good.
Poor	Very poor	Very poor	Very poor		Very poor	Poor.
Poor	Very poor	Very poor	Very poor		Very poor	Poor.
Very poor	Very poor	Very poor	Very poor		Very poor	Very poor.
Poor	Fair	Good	Poor		Fair	
Very poor	Very poor	Very poor	Very poor		Very poor	Very poor.
Fair	Very poor	Very poor	Poor		Very poor	Fair.

behavior of the whole mapping unit.

require interspersed edge vegetation of trees and shrubs bordering open fields of clovers, grasses, and other herbaceous plants. Wetland wildlife, especially the rare and endangered species, require deep open water areas and shallow water areas with emergent and submersed vegetation. Most wildlife thrive best where habitat types are interspersed and topography varies.

Following are the major wildlife habitat types, the representative kinds of permanent and transient wildlife species, and the major vegetation in the survey area.

Openland habitat, generally irrigated cropland and pasture, attracts California quail, mourning dove, white-winged dove, migratory waterfowl, raccoon, fox, feral burros, and mule deer. Irrigated citrus and date groves have potential to attract many species of nongame birds as well as California quail and deer.

Woodland habitat is provided in the pinyon-juniper forests at elevations above 3,600 feet in the southwestern part of the survey area. Also growing at this elevation on many canyon bottoms are sycamore, cottonwood, alder, and live oak. This habitat is frequented by mountain lion, coyote, bobcat, badger, skunk, long-tail weasel, California mule deer, mourning dove, and California quail. This is important habitat for the rare peninsular bighorn sheep.

Wetland habitat consists of the manmade freshwater impoundments and the marsh area associated with the Salton Sea. These wetlands produce rushes, sedges, bulrushes, pondweeds, and other plants of value for waterfowl and shore birds. Wildlife associated with these wetlands are migratory and resident ducks, migratory geese, shore birds, small nongame marsh birds, beaver, raccoon, and striped and spotted skunks. The shallow wetlands provide important habitat for the Yuma clapper rail and the California black rail, both of which are endangered species.

Rangeland habitat is typically the semi-desert chaparral at elevations of 3,500 and 4,500 feet. At the higher elevations the chaparral merges into the pinyon-juniper forest. At the lower elevations it merges into the desert scrub, which is mainly creosote but also includes honey and screwbean mesquite. The wildlife attracted to rangeland are the California quail, mourning dove, black-tailed jackrabbit, desert cottontail, California mule deer, striped and spotted skunk, bobcat, mountain lion, coyote, desert kit fox, grey fox, ground squirrel, and the rare peninsular bighorn sheep.

Windbreaks

Soil blowing is a serious problem on the valley floor from Indio northwestward to Whitewater. Within this area windbreak plantings are needed to protect residential and commercial property and reduce driving hazards caused by soil blowing across roads. In other areas of the Coachella Valley, windbreaks protect soils, crops, and homesites. They also beautify and screen the landscape, reduce noise, wind, dust, and blowing sand, and improve habitat for songbirds and other wildlife.

Irrigation is needed in establishing and maintaining windbreak plantings in the survey area. If the hazard of wind erosion is moderate or high, adequate protection of new plantings is needed. If windbreaks are to control sand blowing, adequate maintenance, including irrigation, fertilization, and sand removal, is needed.

The soils of the Coachella Valley Area are assigned to six windbreak groups. Windbreak groupings show in a general way the choice species for each group, depending on the characteristics of the soil. For a precise description of soil characteristics of the series and mapping unit, refer to the section "Descriptions of the Soils."

The following paragraphs describe the six windbreak groups in the survey area and provide a short description of the soils in each group.

WINDBREAK GROUP 1

The soils in group 1 are deep to very deep, moderately coarse textured to medium textured, and moderately well drained to well drained. Some are slightly wet and slightly saline. The surface layer is fine sand, loamy fine sand, stony sand loam, fine sandy loam, very fine sandy loam, and silt loam. Permeability is moderately rapid to moderately slow. Available water capacity is 5 to 15 inches.

Suggested shrubs and small trees are giant reed, Italian buckthorn, lilac, oleander, pomegranate, pyracantha, silverberry, and sugar bush. Suggested trees are Aleppo pine, Arizona cypress, Coulter pine, desert gum, eucalyptus, incense cedar, mountain oak, Siberian elm, and athel.

Choice of windbreak is not limited by chemical or physical soil characteristics.

WINDBREAK GROUP 2

The soils in group 2 are coarse to very gravelly, medium textured, and excessively drained. The surface layer is gravelly sand, sand, stony or cobbly sand, gravelly loamy sand, loamy sand, fine sand, loamy fine sand, cobbly fine sandy loam, and very gravelly sandy clay loam. Permeability is rapid to moderate in soils that are gravelly, very gravelly, very cobbly, and very stony. Available water capacity in the root zone is less than 5 inches.

Suggested shrubs and small trees are giant reed, Italian buckthorn, lilac, oleander, pomegranate, pyracantha, silverberry, and sugar bush. Suggested trees are Aleppo pine, Arizona cypress, Coulter pine, desert gum, eucalyptus, incense cedar, mountain oak, Siberian elm, and athel.

Choice of windbreak is limited by droughtiness and low fertility.

WINDBREAK GROUP 3

The soils in group 3 are moderately well drained to somewhat poorly drained. Wet soil phases of well drained to excessively drained soils are also included. The surface layer is sand, fine sand, fine sandy loam, very fine sandy loam, silty clay loam, and silty clay. Salinity is a problem in these fine textured soils. The water table is at a depth of 10 to 40 inches. Permeability is rapid to slow. Available water capacity varies, depending on the depth to the water table. It ranges from 1 to 10 inches.

Suggested shrubs and small trees are lilac and oleander. Suggested trees are Arizona cypress, desert gum, mountain oak, and athel.

Choice of windbreak is limited by wetness.

WINDBREAK GROUP 4

The soils in group 4 are well drained to moderately well drained and moderately to strongly saline. Wet soils that are moderately to strongly saline are also included. The surface layer is sand, fine sandy loam, and silty clay. Permeability is slow. Available water capacity is 6 to 11 inches in the well drained to moderately well drained soils. It is less in the wet soils.

Suggested shrubs and small trees are lilac, oleander, and pomegranate. Suggested trees are Arizona cypress, desert gum, eucalyptus, mountain oak, and athel.

Choice of windbreak is limited by salinity.

WINDBREAK GROUP 5

These soils are well drained and are shallow to moderately deep over bedrock. The surface layer is sandy loam and loam. Permeability is moderately rapid. Available water capacity is 2 to 4 inches.

Suggested shrubs and small trees are lilac, oleander, pomegranate, pyracantha, silverberry, and sugar bush. Suggested trees are mountain oak and athel.

Choice of windbreak is limited by depth.

WINDBREAK GROUP 6

In windbreak group 6 are land types and the broadly defined complexes of soils and land types of the steep uplands. Some have a sandy surface layer. Some areas are chiefly rock outcrop. Some are subject to flooding. Others are disturbed.

Suitability and choice of windbreak depend on onsite investigation.

Soil Properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

Engineering properties

Table 9 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 9 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 9 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to 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 a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes: 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 have a dual classification symbol, for example, CL–ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A–1 are coarse grained and low in content of fines. At the other extreme, in group A–7, are fine-grained soils. Highly organic soils are classified in group A–8 on the basis of visual inspection.

When laboratory data are available, the A–1, A–2, and A–7 groups are further classified as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 10. The estimated classification, without group index numbers, is given in table 9. Also in table 9 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Ranges in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Engineering test data

Table 10 gives test data for samples of selected layers taken from the profiles of some extensive soils of the survey area. The samples were taken at representative sites.

The soils were tested in the laboratory of the California Division of Highways. The data in the table show the classification of the samples under the AASHTO and Unified systems. They also show the

TABLE 9.—*Engineering*

[The symbol < means less than; > means greater than.

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Badland:				
BA	----	----	----	----
Borrow pits:				
BP	----	----	----	----
Bull Trail:				
BtE	0–3	Stony sandy loam	SM	A-2, A-4
	3–31	Sandy clay loam	CL-ML, CL, SM-SC, SC	A-4, A-6
	31–60	Sandy loam, loam	ML, CL-ML, SM, SM-SC	A-2, A-4
Cajon:				
CaD	0–60	Loamy sand	SM	A-2
Cajon Variant:				
CbD	0–14	Sand	SM, SP-SM	A-2, A-3
	14–60	Sand, loamy sand, gravelly sand	SM, SP-SM	A-1, A-2, A-3
Carrizo:				
CcC	0–10	Stony sand	SP, SP-SM	A-1, A-2, A-3
	10–39	Very gravelly coarse sand	GP	A-1
	39–60	Very stony coarse sand	SP, SP-SM	A-1
Carsitas:				
CdC, CdE	0–60	Gravelly sand	SP, SP-SM	A-1
CfB	0–10	Sand	SM, SP-SM	A-2, A-3
	10–60	Gravelly sand	SP, SP-SM	A-1
ChC	0–60	Cobbly sand	SP, SP-SM	A-1
CkB	0–60	Fine sand	SM	A-2
Carsitas Variant:				
CmB, CmE	0–18	Sand, fine sand	SM, SP-SM	A-2, A-3
	18	Weathered bedrock	----	----
Chuckawalla:				
CoB, CoD	0–12	Very gravelly sandy clay loam	GC, GM-GC	A-2
	12–25	Very gravelly fine sandy loam very cobbly fine sandy loam, very gravelly sandy loam.	GM, GP-GM	A-1, A-2
	25–60	Very gravelly sand, very cobbly sand	GP, SP, GW, SW	A-1
Chuckawalla:				
CnC, CnE	0–12	Cobbly fine sandy loam	GM	A-1, A-2
	12–25	Very gravelly fine sandy loam, very cobbly fine sandy loam, very gravelly sandy loam.	GM, GP-GM	A-1, A-2
	25–60	Very gravelly sand, very cobbly sand	GP, SP, GW, SW	A-1
Coachella:				
CpA, CpB	0–11	Fine sand	SM	A-2
	11–60	Sand, fine sand	SM, SP-SM	A-2, A-3
CrA	0–60	Fine sand	SM	A-2
CsA	0–10	Fine sandy loam	SM, ML	A-4
	10–40	Sand, fine sand	SM, SP-SM	A-2, A-3
	40–60	Loamy sand, loamy fine sand	SM, SM-SC	A-2, A-4
Fluvaquents:				
Fa	0–60	Variable	----	----
Fluvents:				
Fe	0–60	Variable	----	----

properties and classifications

Absence of an entry means data were not estimated]

Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
---	---	---	---	---	---	---
---	---	---	---	---	---	---
5-20	95-100	90-100	55-70	25-40	15-25	[1]NP-5
0-10	95-100	90-100	70-90	35-55	25-40	5-15
0-20	90-100	60-95	50-80	30-70	15-30	NP-10
0	95-100	80-100	50-75	15-30	---	NP
0	100	85-100	50-70	5-15	---	NP
0	100	70-100	35-75	5-30	---	NP
10-20	90-100	80-100	40-70	0-10	---	NP
0-10	40-60	35-50	20-35	0-5	---	NP
20-30	90-100	80-100	40-50	0-10	---	NP
0-10	85-100	50-80	25-50	0-10	---	NP
0	95-100	80-100	50-70	5-15	---	NP
0	85-100	50-75	25-50	0-10	---	NP
15-30	85-100	50-80	25-50	0-10	---	NP
0-15	80-100	75-100	65-80	20-35	---	NP
0	95-100	85-100	50-80	5-30	---	NP
---	---	---	---	---	---	---
0-10	45-55	30-50	30-35	15-20	25-35	5-15
5-60	45-60	30-50	15-45	5-30	15-25	NP-5
5-60	45-60	30-50	15-35	0-5	---	NP
25-30	50-60	40-50	35-45	20-30	20-30	NP-5
5-60	45-60	30-50	15-45	5-30	15-25	NP-5
5-60	45-60	30-50	15-35	0-5	---	NP
0	100	100	65-80	20-35	---	NP
0	100	100	50-80	5-35	---	NP
0	100	100	65-80	20-35	---	NP
0	100	100	70-85	40-55	10-20	NP-5
0	100	100	50-80	5-35	---	NP
0	100	100	50-80	15-40	---	NP
---	---	---	---	---	---	---
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TABLE 9.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO
	In			
Gilman:				
GaB	0–8	Loamy fine sand	SM	A-2, A-4
	8–60	Stratified loamy sand to silty clay loam	ML	A-4
GbA, GbB, GcA	0–8	Fine sandy loam	ML, SM	A-4
	8–60	Stratified loamy sand to silty clay loam	ML	A-4
GdA	0–8	Fine sandy loam	SM, ML	A-4
	8–40	Stratified loamy sand to silty clay loam	ML	A-4
	40–60	Silty clay loam	CL	A-6, A-7
GeA, GfA	0–8	Silt loam	ML	A-4
	8–60	Stratified loamy sand to silty clay loam	ML	A-4
Gravel pits and dumps: GP.				
Imperial:				
IeA, IfA	0–60	Silty clay	CH	A-7
ImC[2], IoC[2]:				
Imperial part	0–60	Silty clay	CH	A-7
Gullied land part.				
Indio:				
Ip, Ir	0–10	Fine sandy loam	SM, ML	A-4
	10–60	Very fine sandy loam, silt loam, sandy loam	ML	A-4
Is, It	0–10	Very fine sandy loam	ML	A-4
	10–60	Very fine sandy loam, silt loam, sandy loam.	ML	A-4
Lithic Torripsamments:				
LR[2]:				
Lithic Torripsamments part.	0–4	Sand, loamy sand, fine sand	SM, SP-SM	A-2, A-3
	4	Unweathered bedrock		
Rock outcrop part.				
Myoma:				
MaB, MaD, McB	0–60	Fine sand	SM	A-2
Niland:				
NaB	0–21	Sand	SM, SP-SM	A-3, A-2
	21–60	Silty clay	CL, CH	A-7
NbB	0–23	Sand	SM, SP-SM	A-3, A-2
	23–60	Silty clay	CL, CH	A-7
Omstott:				
OmD	0–10	Coarse sandy loam	SM	A-2, A-4
	10	Weathered bedrock		
Or[2]:				
Omstott part	0–10	Gravelly fine sandy loam	SM	A-2, A-4
	10	Weathered bedrock.		
Rock outcrop part.				
Riverwash:				
RA.				
Rock outcrop:				
RO.				
RT[2]:				
Rock outcrop part.				
Lithic Torripsamments part.	0–4	Sand, loamy sand, fine sand	SM, SP-SM	A-2, A-3
	4	Unweathered bedrock.		
Rubble land:				
RU.				
Salton:				
Sa	0–9	Fine sandy loam	SM-SC	A-4
	9–60	Clay, silty clay, silty clay loam	CH, CL	A-6, A-7
Sb	0–9	Silty clay loam	CH, CL	A-6, A-7
	9–60	Clay, silty clay, silty clay loam	CH, CL	A-6, A-7

and classifications—Continued

Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticty index
	4	10	40	200		
Pct					*Pct*	
0	100	100	70–80	25–50	-----	NP
0	100	95–100	80–100	50–60	-----	NP
0	100	95–100	70–85	40–55	10–30	NP–5
0	100	95–100	80–100	50–60	-----	NP
0	100	100	70–85	40–55	20–30	NP–5
0	100	100	80–100	50–60	-----	NP
0	100	100	95–100	85–95	25–45	10–20
0	100	95–100	90–100	70–90	20–30	NP–5
0	100	95–100	80–100	50–60	-----	NP
0	100	100	100	90–95	50–70	25–45
0	100	100	100	90–95	50–70	25–45
0	95–100	95–100	70–85	40–55	15–30	NP–5
0	95–100	95–100	80–100	50–70	15–30	NP–5
0	95–100	95–100	85–95	50–65	15–30	NP–5
0	95–100	95–100	80–100	50–70	15–30	NP–5
0	75–100	50–100	50–80	5–35	-----	NP
0	100	80–100	65–80	20–35	-----	NP
0	90–100	75–95	50–65	5–15	-----	NP
0	100	100	95–100	90–95	45–70	25–45
0	90–100	75–100	50–65	5–15	-----	NP
0	100	100	95–100	90–95	45–70	25–45
0	100	100	60–70	30–50	15–25	NP–5
0	75–85	65–75	55–70	25–40	15–25	NP–5
0	75–100	50–100	50–80	5–35	-----	NP
0	100	100	70–85	40–50	15–30	5–10
0	100	100	90–100	75–95	35–60	25–35
0	100	100	95–100	85–95	35–60	15–35
0	100	100	90–100	75–95	35–60	25–35

TABLE 9.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Soboba:				
SoD	0-13	Cobbly sand	SP-SM	A-1
	13-60	Very stony sand, very cobbly sand, very gravelly sand.	GP, SP	A-1
SpE	0-13	Stony sand	GP-GM, SP-SM	A-1
	13-60	Very stony sand, very cobbly sand, very gravelly sand.	GP, SP	A-1
Torriorthents:				
TO[2]:				
Torriorthents part.	0-60	Variable.		
Rock outcrop part.				
Tujunga:				
TpE	0-60	Fine sand	SM	A-2
TrC	0-60	Gravelly loamy sand	SP-SM, SP	A-1
TsB	0-60	Loamy fine sand	SM	A-2, A-4

[1] NP is nonplastic.
[2] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

moisture density, mechanical analyses, liquid limit and plasticity index.

In the *moisture-density,* or compaction test, a sample of the soil material is compacted several times with a constant compactive effort, each time at a successively higher moisture content. The moisture content increases until the optimum moisture content is reached. After that the density decreases with increase in moisture content. The highest density obtained in the compaction test is termed "maximum density." Moisture-density data are important in construction, for as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

Physical and chemical properties

Table 11 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field, particularly soil structure, porosity, and gradation of texture, that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 11. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly upon the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in *and classifications*—Continued

Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
20–30	65–80	60–75	25–40	5–10	----------------	NP
20–45	40–60	30–40	15–25	0–5	----------------	NP
20–30	40–60	30–40	20–30	5–10	----------------	NP
20–45	40–60	30–40	15–25	0–5	----------------	NP
0	90–100	75–100	65–85	20–35	----------------	NP
0	70–90	50–75	20–50	0–10	----------------	NP
0	90–100	75–100	85–90	30–50	----------------	NP

soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

Loamy soils that are 18 to 35 percent clay and less

TABLE 10.—*Engineering*

[Tests performed by California Division of Highways.

Soil name and location	California report No.	Depth	Horizon	Moisture density [1] Maximum	Moisture density [1] Optimum
		In		*Lb/cu ft*	*Pct*
Carsitas gravelly sand: 600 feet W, 50 feet S of NE corner sec. 29, T.7 S., R. 10 E., SBBM	S-69 33-13-1	0-10	C1	118	12
	S-69 33-13-2	10-60	C2	126	9
Chuckawalla very gravelly clay loam: 1,000 feet W, 700 feet N of E¼ corner sec. 14, T.5 S., R.8 E., SBBM	S-70 33-6-2	¼-3	B21t	140	6.7
	S-70 33-6-6	32-42	C2	145	5
Coachella fine sand: 1,320 feet S of NW corner sec. 15, T.6 S., R.7 E., SBBM	S-69 33-55-1	0-20	C1	102	10
	S-69 33-55-3	26-30	C3	110	16
Gilman fine sandy loam: 1,320 feet N, 20 feet W of SE corner sec. 14, T.6 S., R.7 E., SBBM	S-69 33-15-1	0-8	AP	111	14
	S-69 33-15-2	8-36	C1	105	16
Imperial silty clay: 600 feet S, 100 feet E of center sec. 16, T.8 S., R.11 E., SBBM	S-70 33-1-1	0-7	C1	111	16
	S-70 33-1-3	17-26	C3	114	14
Indio very fine sandy loam: 15 feet E of power pole at S¼ corner sec. 17, T.6 S., R.8 E., SBBM	S-69 33-56-1	0-16	C1	119	12
	S-69 33-56-2	16-45	C2	---	---
Myoma fine sand taxadjunct: 700 feet S, 100 feet W of E¼ corner sec. 36, T.4 S., R.6 E., SBBM	S-70 33-4-1	0-10	C1	102	11
	S-70 33-4-2	10-40	C2	102	12
Niland sand: 930 feet W, 950 feet S of NE corner sec. 29, T.8 S., R.11 E., SBBM	S-70 33-2-1	0-11	C1	117	12
	S-70 33-2-4	21-43	C4	118	14
Salton silty clay loam: 50 feet N, 800 feet W of SE corner sec. 25, T.7 S., R.8 E., SBBM	S-69 33-4-1	0-9	C1	105	17
	S-69 33-4-4	42-53	C4	114	14
Soboba cobbly sand: 900 feet N, 900 feet E of S¼ corner sec. 6, T.3 S., R.3 E., SBBM	S-70 33-3-1	0-13	C1	133	6
	S-70 33-3-2	13-29	C2	133	4
Tujunga loamy fine sand: 1,050 feet E, 650 feet N of SW corner sec. 7, T.3 S., R.3 E., SBBM	S-70 33-5-1	0-20	C1	119	10
	S-70 33-5-6	38-47	C6	119	11

[1] Based on tests of relative compaction of untreated and treated soils and aggregates, method No. Calif. 216 E.
[2] Mechanical analyses by California Division of Highways using hydrometer method. Calculated on basis total material.
[3] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing. AASHTO Designation M 145-49(*1*).

test data

Dashes indicate data were not available]

Percentage passing sieve [2]—				Percentage smaller than [2]—		Liquid limit	Plasticity index	Classification	
No. 4	No. 10	No. 40	No. 200	0.005 mm	0.002 mm			AASHTO [3]	Unified [4]
						Pct			
88	85	50	5	2	2	----	[5]NP	A-1-6	SP
76	69	30	4	2	2	----	NP	A-1-6	SW
78	68	49	34	19	----	17	14	A-2-6	SM
62	49	27	14	10	----	----	NP	A-1-a	SM
100	100	99	12	3	1	----	NP	A-2-4	SP-SM
100	100	98	43	8	6	----	NP	A-4 (2)	SM
100	95	89	40	22	6	----	NP	A-4 (2)	SM
100	99	97	42	5	4	----	NP	A-4 (2)	SM
100	100	95	77	50	----	44	20	A-7-6 (13)	CL
100	100	100	89	65	----	56	38	A-7-6 (19)	CH
100	94	86	57	16	11	----	NP	A-4 (4)	ML
100	99	98	87	28	17	38	10	A-4 (8)	ML
100	100	98	7	2	----	----	NP	A-3	SP-SM
100	100	98	7	1	----	----	NP	A-3	SP-SM
99	97	69	7	5	----	----	NP	A-3	SP-SM
100	100	97	84	62	----	42	20	A-7-6 (12)	CL
100	100	100	95	43	21	31	8	A-4 (8)	CL
100	100	100	100	60	43	62	38	A-7-6 (20)	CH
51	37	14	2	1	----	----	NP	A-1-a	SP
52	41	15	1	1	----	----	NP	A-1-a	SP
98	94	75	31	5	----	----	NP	A-2-4	SM
96	94	74	20	2	----	----	NP	A-2-4	SM

[4] Unified Classification System (*2*).
[5] NP — Nonplastic.

TABLE 11.—*Physical and chemical properties of soils*

[Dashes indicate data is not a concern. The symbol< means less than; > means greater than. The erosion tolerance factor (T) is for the entire profile. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*						
Badland: BA.											
Borrow pits: BP.											
Bull Trail: BtE	0-3	2.0-6.0	0.09-0.11	5.6-6.5	---	Low	Moderate	Moderate	0.24	5	---
	3-31	0.2-0.6	0.14-0.16	5.6-6.5	---	Moderate	Moderate	Moderate	0.15		
	31-60	2.0-6.0	0.06-0.14	6.1-7 3	---	Low	Moderate	Low	0.32		
Cajon: CaD	0-60	6.0-20	0.08-0.10	7.4-8.4	<2	Low	Low	Low	0.15	5	---
Cajon Variant: CbD	0-14	6.0-20	0.05-0.10	6.1-7.3	---	Low	Moderate	Low	0.15	5	---
	14-60	6.0-20	0.04-0.10	6.1-7.3	---	Low	Moderate	Low	0.15		
Carrizo: CcC	0-10	>20	0.03-0.05	7.9-8.4	<2	Low	Moderate	Low	0.10	5	---
	10-28	>20	0.02-0.03	7.9-8.4	<2	Low	High	Low	0.10		
	28-60	>20	0.02-0.03	7.9-8.4	<2	Low	High	Low	0.10		
Carsitas: CdC, CdE, ChC	0-60	6.0-20	0.03-0.06	7.9-8.4	<4	Low	High	Low	0.10	5	---
CfB	0-10	6.0-20	0.05-0.06	7.9-8.4	4-8	Low	High	Low	0.10	5	---
	10-60	6.0-20	0.03-0.06	7.9-8.4	<2	Low	High	Low	0.10		
CkB	0-60	6.0-20	0.05-0.07	7.9-8.4	<4	Low	High	Low	0.15	5	---
Carsitas Variant: CmB, CmE	0-18	6.0-20	0.04-0.10	7.9-8.4	<2	Low	High	Low	0.15	1	---
	18	---	---	---	---	---	---	---	---		
Chuckawalla: CoB, CoD	0-12	0.6-2 0	0.04-0.08	7.9-9.0	<4	Low	High	Low	0.15	5	---
	12-25	6.0-20	0.02-0.04	7.9-9.0	<4	Low	High	Low	0.15		
	25-60	6.0-20	0.02-0.04	7.9-9.0	<4	Low	High	Low	0.10		
CnC, CnE	0-12	0.6-2.0	0.06-0.10	7.9-9.0	<4	Low	High	Low	0.24	5	---
	12-25	6.0-20	0.02-0.04	7.9-9.0	<4	Low	High	Low	0.15		
	25-60	6.0-20	0.02-0.04	7.9-9.0	<4	Low	High	Low	0.10		
Coachella: CpA, CpB	0-11	2.0-6.0	0.03-0.08	7.9-8.4	<4	Low	High	Low	0.15	5	1
	11-60	2.0-6.0	0.03-0.08	7.9-8.4	<4	Low	High	Low	0.15		
CrA	0-60	2.0-6.0	0.10-0.15	7.9-8.4	<4	Low	High	Low	---	---	---
CsA	0-10	2.0-6.0	0.03-0.08	7.9-8.4	<4	Low	High	Low	0.15	5	2
	10-40	2 0-6.0	0.03-0.08	7.9-8.4	<4	Low	High	Low	0.15		
	40-60	2.0-6.0	0.03-0.08	7.9-8.4	<4	Low	High	Low	0.15		
Fluvaquents: Fa	0-60										
Fluvents: Fe	0-60										
Gilman: GaB	0-8	2.0-6.0	0.07-0.11	7.9-8.4	<2	Low	High	Low	0.20	5	---
	8-60	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low	High	Low	0 49		
GbA, GbB, GeA	0-8	0 6-2.0	0.16-0.18	7.9-8.4	<2	Low	High	Low	0.37	5	---
	8-60	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low	High	Low	0.49		
Gilman: GcA, GfA	0-8	0.6-2.0	0.16-0.18	7.9-8.4	<4	Low	High	Low	0.37	5	---
	8-60	0.6-2.0	0.16-0 18	7.9-8.4	<4	Low	High	Low	0.49		
GdA	0-8	0.6-2.0	0.16-0.18	7.9-8.4	4-8	Low	High	Low	0.37	5	---
	8-40	0.6-2.0	0.16-0.18	7.9-8.4	4-8	Low	High	Low	0.49		
	40-60	0.06-0.2	0.19-0.21	7.9-8.4	4-8	Moderate	High	Low	0.37		

TABLE 11.—*Physical and chemical properties of soils*—Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
							Uncoated steel	Concrete	K	T	
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*						
Gravel pits and dumps: GP.											
Imperial:											
IeA, IfA	0–60	0.06–0.2	0.17–0.20	7.9–9.0	4–16	High	High	Moderate	---	---	---
ImC[1], IoC[1]: Imperial part	0–60	0.06–0.2	0.17–0.20	7.9–9.0	4–16	High	High	Moderate	---	---	---
Gullied land part.											
Indio:											
Ip	0–10	0.6–2.0	0.13–0.17	7.9–8.4	<4	Low	High	Low	0.37	5	3
	10–60	0.6–2.0	0.16–0 20	7.9–8 4	<4	Low	High	Low	0.49		
Ir	0–10	0.6–2.0	0.13–0.17	7.4–8.4	<4	Low	High	Low	0.37	5	3
	10–60	0.6–2.0	0.16–0.20	7.4–8.4	<4	Low	High	Low	0.49		
Is	0–10	0.6–2.0	0.18–0.20	7.9–8.4	<4	Low	High	Low	0.55	5	4L
	10–60	0 6–2.0	0.16–0.20	7.9–8.4	<4	Low	High	Low	0.49		
It	0–10	0.6–2.0	0.18–0.20	7.4–8 4	<4	Low	High	Low	0.55	5	4L
	10–60	0.6–2.0	0.16–0.20	7.4–8.4	<4	Low	High	Low	0.49		
Lithic Torripsamments:											
LR[1]: Lithic Torripsamments part.	0–4	6.0–20	0.04–0.06	6.1–7.3	---	Low	Moderate	Low	0.15	1	---
	4	---	---	---	---	---	---	---	---		
Rock outcrop part.											
Myoma:											
MaB, MaD, McB	0–60	6.0–20	0.06–0.09	7.9–9.0	<2	Low	High	Low	0.15	5	1
Niland:											
NaB	0–21	6.0–20	0.04–0.07	7 9–8.4	2–8	Low	High	Moderate	0.10	5	2
	21–60	0.06–0.2	0.14–0.16	7 9–8 4	2–16	High	High	Moderate	0.32		
NbB	0–23	2 0–6.0	0.04–0.07	7.9–8 4	2–8	Low	High	Low	---	---	---
	23–60	0.06–0.2	0.14–0.16	7.9–8.4	2–16	High	High	Moderate	---		
Omstott:											
OmD	0–10	2.0–6.0	0.11–0.14	6.1–7.3	---	Low	Moderate	Low	0.32	1	---
	10	---	---	---	---	---	---	---	---		
Or[1]: Omstott part	0–10	2.0–6.0	0.10–0.13	6.1–7.3	---	Low	Moderate	Low	0.28	1	---
	10	---	---	---	---	---	---	---	---		
Rock outcrop part.											
Riverwash: RA.											
Rock outcrop: RO.											
RT[1]: Rock outcrop part.											
Lithic Torripsamments part.	0–4	6.0–20	0.04–0.06	6.1–7.3	---	Low	Moderate	Low	0.15	1	---
	4	---	---	---	---	---	---	---	---		
Rubble land: RU.											
Salton:											
Sa	0–9	0.06–0.2	0.11–0.14	7.9–9.0	4–16	Low	High	Low	---	---	---
	9–60	0.06–0.2	0.13–0.20	7.9–9.0	4–16	High	High	Low	---		
Sb	0–9	0.06–0.2	0.13–0.20	7.9–9.0	4–16	Low	H,gh	Low	---	---	---
	9–60	0.06–0.2	0.13–0.20	7.9–9.0	4–16	High	High	Low	---		

TABLE 11.—*Physical and chemical properties of soils*—Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*						
Soboba:											
SoD, SpE	0–13	>20	0.02–0.04	6.1–7.8	<2	Low	Moderate	Low	0.15	5	------
	13–60	>20	0.02–0.04	6.1–7.8	<2	Low	High	Low	0.15		
Torriorthents:											
TO[1]:											
Torriorthents part.	0–60	---	---	---	---	---	---	---	---	---	---
Rock outcrop part.											
Tujunga:											
TpE	0–60	6.0–20	0 05–0.11	6.1–7.8	<2	Low	High	Low	0.17	5	1
TrC	0–60	6 0–20	0.04–0.08	6.1–7.8	<2	Low	High	Low	0.15	5	2
TsB	0–60	6.0–20	0.10–0.13	6 1–7.8	<2	Low	High	Low	0.20	5	1

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 12 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 12 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or ap-

TABLE 12.—*Soil and water features*

[Absence of an entry indicates the feature is not a concern. See text for descriptions of symbols and such terms as "rare," "brief," and "perched." The symbol < means less than; > means greater than]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			*In*	
Badland: BA.									
Borrow pits: BP.									
Bull Trail: BtE	B	None			>6.0			>60	
Cajon: CaD	A	None			>6.0			>60	
Cajon Variant: CbD	A	None			>6.0			>60	
Carrizo: CcC	A	Rare			>6.0			>60	
Carsitas: CdC, CdE, ChC, CkB	A	None			>6.0			>60	
CfB	A	None			2.0–4.0	Apparent	Jan-Dec	>60	
Carsitas Variant: CmB, CmE	C	None			>6.0			6–20	Rippable.
Chuckawalla: CoB, CoD, CnC, CnE	B	None			>6.0			>60	
Coachella: CpA, CpB, CsA	B	None			>6.0			>60	
CrA	B	None			3 0–5.0	Apparent	Jan-Dec	>60	
Fluvaquents: Fa	D	Frequent	Very long	Apr-Sep	0.5–2.0	Apparent	Jan-Dec	>60	
Fluvents: Fe	A/D	Occasional	Very brief	Jan-Dec	>6.0			>60	
Gilman: GaB, GbA, GbB, GeA	B	Rare			>6.0			>60	
GcA, GdA, GfA	B	None			3.0–5.0	Apparent	Apr-Oct	>60	
Gravel pits and dumps: GP.									
Imperial: IeA	D	None			>6.0			>60	
IfA	D	None			1.0–3.0	Apparent	Jan-Dec	>60	
ImC[1]: Imperial part	D	None			>6.0			>60	
Gullied land part.									
Imperial: IoC[1]: Imperial part	D	None			1.5–5.0	Apparent	Jan-Dec	>60	
Gullied land part.									
Indio: Ip, Is	B	None			>6.0			>60	
Ir, It	B	None			3.0–5.0	Apparent	Jan-Dec	>60	
Lithic Torripsamments: LR[1]: Lithic Torripsamments part.	D	None			>6.0			1–10	Hard.
Rock outcrop part.									

TABLE 12.—*Soil and water features*—Continued

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness
					Ft			*In*	
Myoma:									
MaB, MaD	A	None			>6.0			>60	
McB	A	None			1.5-5.0	Apparent	Jan-Dec	>60	
Niland:									
NaB	C	None			>6.0			>60	
NbB	C	None			1.5-5.0	Apparent	Jan-Dec	>60	
Omstott:									
OmD	C	None			>6.0			4-20	Rippable.
Or[1]:									
Omstott part	C	None			>6.0			4-20	Rippable.
Rock outcrop part.									
Riverwash:									
RA.									
Rock outcrop:									
RO.									
RT[1]:									
Rock outcrop part.									
Lithic Torripsamments part.	D	None			>6.0			1-10	Hard.
Rubble land:									
RU.									
Salton:									
Sa, Sb	D	None			2.0-5.0	Apparent	Jan-Dec	>60	
Soboba:									
SoD, SpE	A	None			>6.0			>60	
Torriorthents:									
TO[1]:									
Torriorthents part.									
Rock outcrop part.									
Tujunga:									
TpE, TrC, TsB	A	None			>6.0			>60	

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

parent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Formation, Morphology, and Classification of the Soils

This section contains descriptions of the major factors of soil formation as they occur in the Coachella Valley Area, a summary of significant morphological characteristics of the soils of the Area, an explanation of the current system of classifying soils by categories broader than the series, and a table showing the classification of the soils of the Area according to the current system.

Factors of Soil Formation

The nature of the soil at any given place depends on the composition of the parent material, the climate under which the parent material accumulated and existed, the kinds of organisms that lived in and on the soil, the relief, or lay of the land, and the length of time the parent material has been in place and subject to soil-forming processes.

Parent material

Parent material is the weathered rock or unconsolidated mass of material from which soils form. It largely determines the chemical and mineralogical composition of soils.

In the Coachella Valley Area there are three major sources of parent material—recent outwash, which is mainly granitic material from the mountains surrounding the Coachella Valley, lacustrine deposits of Lake Coahuila, and the weathered rock in the San Jacinto Mountains.

The lacustrine deposits are fine textured sediment that is a mixture of material from the upper watershed of the Colorado River. This material is present in Imperial, Niland, and Salton soils. Niland and Salton soil surfaces have been modified by wind- and water-borne alluvium from the mountains surrounding the Coachella Valley.

The alluvium from the surrounding mountains is coarse textured near the mountains and becomes progressively finer until it is very fine sand, loamy very fine sand, fine sandy loam, and very fine sandy loam. This material is rich in primary minerals.

The weathered rock in the San Jacinto Mountains on which soils developed is granite, granodiorite, gneiss and mica schist, all rich in minerals.

Relief

Relief, or the shape of the landscape, influences formation of soils through its effect on drainage, erosion, plant cover, and temperature of the soil.

The San Gorgonio Pass is about 2 miles wide at the western edge of the survey area, and the upper Coachella Valley is about 8 miles wide from Windy Point to Morongo Valley Canyon. The Coachella Valley varies in width. At the Imperial County line, it is 22 miles wide between the mountains, east to west.

At the entrance to the upper Coachella Valley, there are several isolated hills extending from west to southeast. These are Whitewater Hill, Devers Hill, Garnet Hill, Edom Hill, and the Indio Hills. Edom Hill and the Indio Hills separate the Coachella Valley from the Dillon Road area between Wide Canyon and Berdoo Canyon.

The major alluvial fans that spread out into the valley proper are from the Whitewater River, Mission Creek, Morongo, Chino, Tahquitz, Palm and Deep Canyons in the Palm Springs area and Martinez Canyon near Valarie Jean on the west side of the valley. The east side has many small alluvial fans coalescing from Mission Creek to Fargo Canyon east of Indio. South of Indio there are Thermal Canyon, Painted Canyon, Box Canyon, and Salt Creek alluvial fans and many small fans from the Oricapa and Chocolate Mountains to the Imperial County line.

Coarse and very coarse textured Carrizo and Carsitas soils formed on the recent alluvial fans. Chuckawalla soils formed on the older and more stable land surfaces within these areas (Indio Hills and Berdoo Canyon to Thermal Canyon). In the upper part of the valley proper a deep deposit of fine and very fine sand was deposited by water and partially reworked by wind. Coachella, Gilman, and Indio soils formed in the water deposited material, and Myoma soils in the wind modified material.

In the lower part of the valley south of Thermal a thin veneer of recent fine sand, silt, and silt loam alluvium appears to have been waterborne by the Whitewater River from the mountains to the north and is now sometimes modified by wind action. The underlying fine textured lacustrine deposit from Old Lake Cahuilla is more pronounced in the soil profile toward the south to Salton Sea and east to the Chocolate Mountains. In this area are Indio, Salton, Niland, and Imperial soils.

Most areas mapped as Badland are remnants of deposits of alluvium that have been weakly consolidated, severely eroded, and possibly affected by uplifting along the San Andreas Fault (Indio Hills).

In the mountains (Santa Rosa to Murry Hill) the soils are very recent, weathered from the parent rock, or formed in small areas of alluvium. These are Omstott, Bull Trail, and Cajon soils and Torriorthents along with Rock outcrop.. No soil has developed because of the relief and climate.

Climate

The climate in the major part of the survey area is characterized by hot summers, mild winters, and very little precipitation. Presumably, it is similar to the climate under which the soils formed. Climatic data for the Area are given in the section, "Climate."

Soil temperature and moisture regimes are determined by the interaction of the climate and the soil.

The temperature of a soil is one of its more important properties. Within limits, temperature controls the possibilities for plant growth and for soil formation. Below the freezing point there is no biotic activity, water no longer moves as a liquid, and, unless there is frost heaving, there is no movement and time stands still for the soil. Between temperatures of 0° to 5° C, root growth of most plants and germination of most seeds are impossible.

Biological processes in the soil are controlled in large measure by soil temperature and moisture. Each plant species has its own temperature requirements.

Plants have one or more soil-temperature requirements that are met by the soils of their native environment. Similarly, soil fauna have temperature requirements for survival. Soil temperature, therefore, has an important influence on biological, chemical, and physical processes in the soil and on the adaptation of introduced plants.

Within the survey area are two distinct moisture regimes. They are xeric, which is characterized by cool moist winters and warm dry summers, and aridic or torric,[3] which has warm dry winters and hot dry summers.

There are three distinct soil temperature regimes in the survey area. Two of the regimes are easily separated from each other, the Southern California Mountains (MLRA 20, mesic) and the Sonoran Basin and Range (MLRA 30, hyperthermic) on the steep rocky mountain slopes. The regimes, however, for the Southern California Coastal Plain (MLRA 19, thermic) and the Sonoran Basin and Range (MLRA 30, hyperthermic) meet on the flat slopes of the alluvial soils near Whitewater, at the upper end of the Coachella Valley.

To define a reasonable line between the thermic (59°-72° F MLRA 19) and hyperthermic (72°+F MLRA 30) soils, the soil temperature at a depth of 20 inches was measured at 12 locations for a year, at approximately the same time each month. The average annual temperature was calculated. See table 13.

A hot, dry climate restricts the rate of soil formation. The process of soil formation in alluvium begins when the free salts are leached from the soil by percolating water. Eluviation then occurs, and it is followed by the downward movement of humus, iron, manganese, and clay. The lack of rainfall slows this leaching process and restricts the development of distinct horizons on all except the older Chuckawalla soil. The very hot summer temperatures also oxidize organic matter. The content of organic matter of all soils in the survey area is very low. This is not a serious detriment except in the Salton and Imperial soils. A higher content of organic matter in these soils would undoubtedly improve the structure and increase the rate of water intake.

The climate in the mountain area at elevations of 3,200 feet or more on the west side is characterized by cool temperatures, mean annual soil temperature of 52° to 72°, rainfall of 4 to 10 inches, and a short growing season. More organic matter is produced, and the soils generally have an organic carbon content of 0.1 to 0.5 percent. A similar climate prevails along the west edge in the San Gorgonio Pass north to Mission Creek and along the north edge in the Morongo Canyon area.

[3] See the unpublished working document "Selected Chapters from the Unedited Text of the Soil Taxonomy" available in the SCS State office, Davis, California.

Living organisms

Plants, animals, insects, bacteria, and fungi affect formation of soils by causing gains in content of organic matter and nitrogen in the soil, gains or losses in plant nutrients, and changes in strucure and porosity.

In the Coachella Valley Area, biological effects began after the stratified alluvial deposits that are below sea level (Old Lake Coahuila) were sufficiently drained to support plants and animals.

Some areas of Chuckawalla, and to a lesser extent, Myoma soils have been extensively mixed in the past by rodent activity. Through the combined activities of living organisms, the lake and fan deposits become mixed, obtain an open structure, and develop a system of pores that is conducive to still further and stronger biological activity.

In the areas above sea level, the major soil forming organisms are plants, small burrowing animals (horned toads, lizards, chipmunks) and rabbits. The density of plants determines the biological effect in an area as all other life is dependent on the available food supply and organic matter in the soil. Areas that are cooler and have more rainfall are usually more active biologically than the valley area that has a high temperature, low rainfall, and no irrigation water.

Time

A long time is required for formation of soil horizons. Commonly, the presence of horizons is a function of the length of time that parent material has been in place and sufficiently drained for biological activity. If the factors of soil formation have been in effect long enough to form well defined genetically related horizons, and a soil is in equilibrium with its environment, the soil is considered mature. The only examples of mature soils in the survey area are Chuckawalla and Bull Trail soils. Myoma and most other soils in the Area have little or no horizon differentiation, but the processes of soil formation are active. These are considered immature or young soils.

TABLE 13.—*Soil temperature readings at 20-inch depth at specified sites*

Site	Elevation	Aspect	Average annual temperature
	Ft		*°F*
Snow Creek	1,260	N	71.67
Cottonwood Creek	1,900	S	73.42
Mission Creek	1,870	ESE	74.67
Indian Avenue and Pierson	1,200	SSE	74.75
Dillon and 1,000 Palms Road	1,100	SSW	79.84
Tramway Road, 3,000 feet west of gate	960	E	78.34
San Rafael Road and Highway 111	600	E	77.84
Ramon Road, 3 miles west of Bob Hope Drive	280	----	78 58
East of Garnet between old gas station and gas line	700	S	75.08
West Garnet 90 feet south of overpass Highway 62 and Interstate 10	1,000	ESE	73.75
Windy Point, first turn right, west of Point	1,080	N	72 92
360 feet west of Water Wheel Cafe on Old Palm Springs Highway	1,280	SSW	74.08

Morphology of the Soils

The majority of the soils within the survey area have a surface layer that is designated as the C1 or Ap horizon. The "Ap" horizon differs from the original deposited alluvium only because of mechanical disturbance which alters structure and textural stratification while the "C1" horizon has not been extensively disturbed by man.

Enough organic matter has accumulated in the surface layer of Omstott and Cajon soils and in a few small areas of Carsitas soils to form a slightly darkened A1 horizon. In Omstott soils, this horizon generally is covered by a very thin layer of leaves and twigs and coarse sand particles.

Chuckawalla soils have a very thin pale brown surface horizon that apparently has lost clay and iron. The movement of clay has resulted in an increase of clay in the B horizon. The symbol A2 is used to denote a leached horizon.

The B horizon in the Chuckawalla and Bull Trail soils has accumulated silicate clay and iron content. Color of this horizon is redder than either the overlying or underlying horizon, which indicates increased iron concentration. Consistence, texture, and stronger structure indicate clay increase, which is noted by using a small letter as in Bt.

The C horizon of all soils in the Area consists of unconsolidated, mixed, calcareous, and noncalcareous alluvium. This material is only slightly affected by processes of soil formation. All C horizons are light colored, low in content of organic matter, generally rich in lime, and of mixed mineral composition. They are mostly stratified and extremely variable in texture and consistence and generally range from sand to clay and from loose to hard.

The C horizon of Chuckawalla, Carrizo, and Carsitas soils contains gravel. The surface layer of Myoma very fine sand and Carsitas soils has increased gravel concentration because of the removal of finer mineral particles by wind. The Chuckawalla soils accumulate carbonates in the C horizon, which is designated as "Cca."

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to management. 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 facilitiate 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 1965 (*5*). Readers interested in further details about the system should refer to the latest literature available.

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family and the series. In this system the differentiae used as a basis for classification are soil properties that can be observed in the field, or that can be inferred either from other properties that are observable in the field, or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or affect soil genesis. In table 14 the soil series of the Coachella Valley Area are shown in categories of the current system. Categories are defined briefly in the following paragraphs.

ORDER. Ten soil orders are recognized. The differentiae for the orders are based on the kind and degree of the dominant sets of soil forming processes that have gone on. Each order is identified by a word of three or four syllables ending in *sol.* An example is Entisol.

SUBORDER. Each order is divided into suborders that are based primarily on properties that influence soil genesis and that are important to plant growth, or were selected to reflect what seemed to be the most important variables within the orders. Each suborder is identified by a word of two syllables. The last syllable indicates the order. An example is Psamment (*Psamm,* meaning sand, plus *ent,* from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons, soil moisture and temperature regimes, and in base status. The names of great groups have three or four syllables and end with the name of a suborder. A prefix added to the name suggests something about the properties of the soil. An example is Torripsamment. (*Torr,* meaning hot and dry, plus psamment, the suborder of Entisols that have a torric moisture regime).

SUBGROUP. Each great group is divided into three kinds of subgroups, one representing the central (typic) segment of the group (not necessarily the most extensive subgroup); the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrade subgroups, which have some properties that are representative of the great group but do not indicate transitions to any other known kind of soil. A subgroup is identified by the name of the great group preceded by one or more adjectives. For example, the adjective *Typic* is used for the subgroup that is thought to typify the great group. An example is Typic Torripsamment.

FAMILY. Soil families, established within a subgroup, have similar enough physical and chemical properties that responses to management are nearly the same for comparable phases. Among the properties considered in horizons of major biological activity below plow depth, are particle-size distribution, mineralogy, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, slope, and permanent cracks. A family name is the subgroup name preceded by a series of adjectives. The

TABLE 14.—*Classification of the soils*

Soil name	Family or higher taxonomic class
Bull Trail[1]	Fine-loamy, mixed, mesic Mollic Haploxeralfs
Cajon	Mixed, thermic Typic Torripsamments
Cajon Variant	Mixed, mesic Typic Torripsamments
Carrizo	Sandy-skeletal, mixed, hyperthermic Typic Torriorthents
Carsitas	Mixed, hyperthermic Typic Torripsamments
Carsitas Variant	Mixed, shallow, hyperthermic Typic Torripsamments
Chuckawalla	Loamy-skeletal, mixed, hyperthermic Typic Haplargids
Coachella	Sandy, mixed hyperthermic Typic Torrifluvents
Fluvaquents	Hyperthermic Fluvaquents
Fluvents	Hyperthermic Fluvents
Gilman	Coarse-loamy, mixed (calcareous), hyperthermic Typic Torrifluvents
Imperial	Fine, montmorillonitic (calcareous), hyperthermic Vertic Torrifluvents
Indio	Coarse-silty, mixed (calcareous), hyperthermic Typic Torrifluvents
Lithic Torripsamments	Lithic Torripsamments
Myoma	Mixed, hyperthermic Typic Torripsamments
Niland	Sandy over clayey, mixed (calcareous), hyperthermic Typic Torrifluvents
Omstott	Loamy, mixed, nonacid, mesic, shallow Typic Xerorthents
Salton	Fine-silty, mixed (calcareous), hyperthermic Aquic Torriorthents
Soboba	Sandy-skeletal, mixed, thermic Typic Xerofluvents
Torriorthents	Torriorthents
Tujunga	Mixed, thermic Typic Xeropsamments

[1] These soils are taxadjunct to the Bull Trail series.

adjectives are the class names for particle-size, mineralogy, and reaction, for example, that are used as family differentiae. See table 14. An example is Typic Torripsamment, mixed, thermic.

SERIES. The series consists of a group of soils that formed from a particular kind of parent material and have horizons that, except for texture of the surface soil, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition. Some series names are place names taken from the area where the soil is first defined. An example is Cajon series.

Additional Facts About the Area

All of the survey area, 560,640 acres, was within the area known as the Colorado Desert in the 18th and 19th centuries. The first crossing by Father Garces in 1777 was followed by the Williamson Expedition in 1853, the Bradshaw Stage Lines in 1862, and the Southern Pacific Railroad in 1879. There were few settlers until the early 1900's. In 1894, it was discovered that irrigation water was available from artesian wells.

At the present time, 82,320 acres is administrated by the Bureau of Land Management and 8,960 acres is the San Bernardino National Forest.

About 80 percent of the land in the Area is in private ownership. A considerable acreage, however, is in public ownership, such as county and city parks, waste disposal sites, airports, municipal golf courses, Salton Sea State Recreation Area, San Bernardino National Forest, and Bureau of Land Management administrated land scattered throughout the survey area. Four Indian Reservations totaling 43,706 acres are included in the Area.

The Salton Sea occupies the lowest part of the Coachella Valley and the broad Imperial Valley to the south, forming a single physiographic basin of triangular outline enclosed on three sides by barren, rugged mountains. Before the present period of extensive reclamation by irrigation, it was known as the Colorado Desert, and the lower part, now occupied by the Salton Sea, was designated the Salton Sink. This basin, which is physiographically continuous with the Gulf of California, has been cut off from the gulf by the low broad delta of the Colorado River.

It is probable that the river flowed alternately into the gulf and into the northern part of the basin, into which it carried and deposited enormous quantities of sediment. Previous to settlement of the region the basin had been dry for an unknown period, leaving an area of 2,000 square miles of dry land lying below sea level.

In 1905 the California Development Company cut a bypass around the headgate at the intake below the international boundary for the diversion of irrigation water to Imperial Valley. Early floods tore out hastily constructed temporary dams and widened the breaches until the Colorado River had abandoned its normal channel to the Gulf and was flowing into the Salton Basin. By 1907, about 291,000 acres had been submerged, including 36,000 acres in Riverside County, forming the present Salton Sea.

The Coachella Valley was originally named Conchilla for the little freshwater shells that are found in the area. It has also been called the "grave of perished seas."

The area making up Riverside County was originally part of San Diego and San Bernardino Counties. In 1893, Riverside County was officially recognized, and the county seat was established at Riverside. The total population in the Coachella Valley Area in 1974 was estimated at 106,000, of which more than 29,500 were in rural areas. Communities, urban in character but not incorporated, are included with the rural population. Included in the incorporated urban areas are Palm Springs, Desert Hot Springs, Indio, Coachella, Rancho Mirage, Palm Desert, and Indian Wells.

Much of the income from farms in the Area is from the principal crops, such as citrus, dates, truck crops, grapes, alfalfa, and cotton, and from beef cattle. Most of the employment is in the farming, picking, and packing of farm produce.

Major industries in the Area are related to farming: manufacturing, construction, transportation, trade, finance services, and Government. Two industries closely connected with farming are the distribution of electrical power and the distribution of water for irrigation.

Nonfarm employers are the tile drain manufacturers and installers, the irrigation water distributers, the county, the cities, the California State Highway Department, engineering firms, the TV Cable Company, electricity and gas utilities, tourist related business, and the USDA Date Field Station.

Some mining is done on the alluvial fans. The product is construction material—sand, gravel, riprap material, and filter material for tile drains.

Throughout the Area Interstate 10, State highways, and secondary roads connect smaller communities, and U.S. Highways help to speed traffic to major centers. Transcontinental bus and truck lines, airlines, and one railroad provide shipping facilities and transportation. The Palm Springs airport is 21 miles from Indio, where some north to south flights on the west coast originate. Flights to Los Angeles or Phoenix are available.

Natural gas is available in all urban parts, and electricity is supplied everywhere in the Area. Bottled gas is available in the more isolated spots. Telephone service is supplied to most of the Area, and television, shopping centers, and other modern conveniences also are available. There are also churches of many denominations, hospitals, and many social and business groups in the Area.

Recreation is readily available in the Coachella Valley Area. The Salton Sea, lakes, and ponds provide fishing and water sports. Duck, quail, and dove hunting is also popular. There are two ranger districts in one national forest along the western border of the Area. The Joshua Tree National Monument borders the Area on the northeast. Several State parks and numerous county and city parks are also available.

Water Supply

A shortage of water has existed in the Coachella Valley Area since the first crossing by Father Garces in 1777, "La Jornada del Muerte (The Journey of Death)."

In 1900, the first hydraulic well was drilled in Indio. In 1894, a great artesian well was drilled at Walters (Mecca).

The Coachella Valley County Water District was formed in 1918.

In June 1940, the Coachella Valley Canal was completed as far as Niland, and during the war years desultory progress was made. It was finally completed in early 1948, and the first official water delivery was made east of Thermal on March 29, 1949. An underground distribution system delivering water to each 40-acre land parcel was completed 6 years later.

By 1961 the Coachella County Water District realized the need for supplemental domestic water and signed a contract for 23,100 acre-feet of water with the California Water Project Authority. The water agency for the upper Coachella Valley, the Desert Water Agency, also contracted for 38,100 acre-feet of water, which will be for urban use mainly through ground water recharge. This will reduce the upper valley overdraft of 30,000 acre feet.

Climate

In the preparation of this summary (*7*) all of the weather observations which were available were utilized, including not only those within the Area, but also those within 30 miles outside the Area and county boundary. Most of the reports are those provided by the Cooperative Climatological Network of the U.S. Weather Bureau, but other agencies have also provided helpful information. Table 15 lists the stations, kinds of data, and the data that have been calculated. Note that the length of record varies from one station to another.

Terrain.—The area surveyed extends southeast to northwest between San Bernardino County and Imperial and San Diego Counties. It is about 21 miles wide on the north and 30 miles wide on the south and measures 42 miles between the county lines. It is approximately in the center of Riverside County. See location map. The northern part of the Salton Sea is surrounded by the Area.

The landscape for the most part is the Coachella Valley floor surrounded by mountains. The San Bernadino Mountains are mainly a few miles northwest of the survey area boundary but extend a few miles into the Area in the vicinity of Whitewater, where they are separated from the San Jacinto Mountains by the San Gorgonio Pass about 12 miles east of the Area. The pass itself reaches an elevation of about 2,500 feet. To the north the San Gorgonio Mountain reaches a height of 11,485 feet, and to the south San Jacinto Peak is 10,831 feet high. Continuing southward this range becomes the Santa Rosa Mountains, with a high point 8,716 feet at Toro Peak.

Effects of terrain on climate.—Marine influence is felt with the marked influx of cool and relatively moist air at low levels in the county west of Cabazon. However, the mountains along the western boundary of the survey area limit this inflow to San Gorgonio Pass in the northwest. From this point of entrance the already weak marine air spreads out and rapidly loses its identity, although its modifying influence may persist, to a lesser degree, as far as Whitewater. At this point it spreads out in a fan into the upper Coachella Valley felt in an arc west of Desert Hot Springs, North Palm Springs, Garnet, and Chino Canyon.

East of San Gorgonio Pass there is a rapid and pronounced change to desert conditions. Here the precipitation is extremely light and the temperature range is large. Because of the relatively low latitude and the low elevation and because the survey area is protected to a large degree from the air masses that move south-

TABLE 15.—*Precipitation, temperatures, probabilities and growing season*

Station	Elevation	Precipitation	Temperature °F.			Percent probability < indicated			20 percent probability < 32 °F.		Growing season
			Mean annual	Record							
				High	Low	25	67	90	After	Before	
	Feet	*Inches*		*Month*	*Month*						*Days*
Idyllwild Ranger Station.	5,397	22.92	52.1	101 (July)	4 (Jan.-Feb.)	17 0	25.2	33 1	June 8	Sep. 4	121
Indio Date Garden	-20	3 38	73.1	122 (July)	13 (Jan.)	1 4	3.9	6.7	Mar. 1	Nov. 20	292
Mecca	-175	3 07	71.8	124 (June)	13 (Jan.)	1.3	3.2	5.5	Mar. 5	Nov. 24	293
Palm Springs	411	6 28	71.5	122 (July)	19 (Jan.)	3.4	7.1	11 3	Feb. 25	Nov. 20	299
Salton	-263	2.95				1.6	3.2	5.0			
Snow Creek,	1,275	12.00				8 3	13.5	18.9			
Thermal Airport	-120	2.93	73 2	123 (Sep.)	25 (Jan.-Feb.)	1.1	2.5	4.1	Feb. 26	Nov. 18	299

ward from Canada over the Plains States, the temperature extremes are on the high side. Temperatures in excess of 100° are frequently observed during the summer, but winter lows do not drop to subzero values. The limited supply of moisture results in very low humidity during the hot period of the year.

Both temperature and precipitation values change with elevation. The most pronounced effect is on the east and north slopes of the San Jacintos, where precipitation totals decrease and temperatures increase rapidly with a decrease in elevation. The gradient is particularly steep on this east slope, where conditions change from the climate of the mountains to that of the desert within a few miles.

It is assumed that a similar effect occurs along the mountains of the northern and eastern edge of the survey area, but observations are not available to confirm this pattern.

The predominantly north-south orientation of the mountain ridges, combined with the large scale topography of this portion of the United States, makes the survey area vulnerable to the strong north winds that develop under certain pressure patterns. The San Gorgonio Pass area and the Coachella Valley just east of the San Jacintos feel the effect of those conditions.

Irrigation in the Area may be responsible for some minor local modification of the natural climate. Figures are not available at the present time to indicate the magnitude of these changes, but it seems likely that in the immediate vicinity of intensive irrigation high temperature readings may be decreased by several degrees. At the same time, however, the relative humidity of the air is increased, and the net effect on the personal comfort factor may actually be to make the heat more oppressive. It is likely that the microclimate within the crop area is often considerably altered by irrigation.

Temperature.—In general, the Area experiences hot summers and moderate to cool winters. At the same time one should be careful about generalizations, because of the abrupt and sometimes large variations that occur within short distances as a result of the rugged terrain. Elevation itself is a modifying factor of considerable importance, but equally significant is the configuration of the terrain in the immediate vicinity of the area of interest. As a result of cold air drainage it is possible for some low elevation points to experience colder night temperatures than nearby areas at higher levels.

Midsummer temperatures are quite hot. Daily maximum readings in July generally average in excess of 100° at elevations below 1,200 feet. Observations are limited from higher elevations within the Area, but it seems likely that at these points averages would be in the 90's. Only in the higher mountains of the central western part of the Area are July maximums usually below 90°. Temperature data for seven stations in the area are given in table 15. Extremely high readings above 100° have been observed at all points, reaching 124° (Mecca) in most of central part of the Area and as high as 130° in the southeast part of the Area (Amos).

Winter conditions, as represented by the mean minimum temperature of January, give readings in the high 30's at most valley stations, and some protected areas average higher than 40°. Mountain station (Idyllwild) average is a cold 25°. Readings of extreme cold are very localized in character. In general, most stations in the Area reported observations as low as 13° to 25°. Idyllwild has recorded values as low as 4°.

These extremes, it should be remembered, are infrequent and usually of very short duration.

Of interest in this regard is the distribution of daytime maximum temperatures in January. Afternoon readings at most stations in the Coachella Valley (below 2,000 feet) average warmer than 65°. Even the mountain stations show daytime readings in January higher than the 50's.

Freeze data.—Winter freezes have been reported by all stations in the Area although some stations do not experience freezing temperatures every year. On some occasions damaging low temperatures may occur relatively late in the spring or early in the fall, while the next year there may be no frost at all. In comput-

TABLE 16.—*Mean monthly precipitation and temperatures*

Month	Indio Date Garden		Mecca SE[1]		Palm Springs	
	Precipitation	Temperature	Precipitation	Temperature	Precipitation	Temperature
	In	°*F*	*In*	°*F*	*In*	°*F*
January	0.50	54.1	0 55	52.9	1 26	53.9
February	.42	58 1	.35	57.8	1 18	57.3
March	.25	64 5	.22	63 7	.72	62.7
April	.10	72.3	.13	70 7	25	69.7
May	.01	79 1	.03	77.2	.02	75 8
June	.01	86.4	.01	85.9	.02	82.9
July	12	92 1	.10	91.3	.28	90.6
August	33	90 6	.47	89 6	.21	88.9
September	.43	86.1	.19	84.1	.34	84.1
October	.23	75.5	.24	73.4	.26	74.1
November	.30	62.9	.19	61 7	40	62.5
December	68	55.8	.59	53 8	1.34	55.7
Mean annual	3 38	73 1	3 07	71.8	6.28	71 5

[1] Precipitation records for 48 years, temperature records for 45 years; all others are based on 30 year records.

ing mean freeze dates and length of growing season, allowance has been made for those seasons when no freeze was reported. Precipitation and temperature for three stations in the Area are given in table 16.

Temperature readings of 32° or lower occur as infrequently as once in 4 or 5 years in some parts of the Area. The number of days above 32° F is about 300 days in the Coachella Valley, 250 days in the Cabazon-Whitewater areas, and less than 120 days at high elevations in the San Jacinto-Santa Rosa Mountains. The 28° growing season averages about 50 days longer than the 32° F growing season.

The average spring date of the last 32° temperature reading ranges from January 1st in portions of the desert to June 1st at high elevations in the San Jacinto-Santa Rosa Mountains. Late February-March is a typical date in the Coachella Valley, and the middle or later part of March is typical of the Cabazon-Whitewater area.

The fall 32° date averages late September in the San Jacinto-Santa Rosa Mountains, November in the Cabazon-Whitewater area, and early or mid December in the Coachella Valley.

Freeze data based on 28° readings show an average date for the last occurrence in spring of late May in the mountains, late January into February in the Cabazon-Whitewater area, and mid January in the Coachella Valley.

Freezes are likely in late December in the Coachella Valley, in November in the Cabazon-Whitewater area, and as early as mid October in the mountains.

Precipitation.—Except at high elevations, precipitation in the Area is scant, most of the western central mountain area receives less than 12 inches per year, and the rest of the Area receives less than 5 inches per year. Only at elevations above 5,000 feet near the west central mountain area are these values exceeded. Annual totals in the vicinity of San Jacinto Mountains and in the San Bernardino Mountains reach 40 inches or more.

Rainfall totals vary considerably from year to year. In the Coachella Valley, for example, 1 year in 20 can be expected to produce a low of less than 0.5 inch and a high totaling more than 8 inches. On Mt. San Jacinto a dry year may provide only 20 inches of precipitation, while a wet year may bring more than 60 inches.

Rainfall in the area may be expected to reach or exceed intensities of 0.50 inch per hour, 1 inch in 6 hours, and 1.25 inches in 24 hours with a frequency of about once in 2 years. These values may increase to 1.25 inches per hour, 3.00 inches in 6 hours, and 4.25 inches in 24 hours with a frequency of once in 100 years. At some points in the San Jacinto and Santa Rosa Mountains precipitation rates are as great as 0.75 inch per hour, 2.50 inches in 6 hours, and 5.00 inches in 24 hours with a frequency of once in 2 years. With a frequency of once in 100 years these amounts may increase to 2.00 inches per hour, 6.50 inches in 6 hours, and 12.25 inches in 24 hours. Over most of the Area rainfall is heaviest in December through March with occasional heavy thundershowers July through August.

On the flat or gently sloping terrain of the Area these local heavy showers may occasionally close highways for brief periods. In the mountains damage is sometimes reported from mudflows and erosion associated with heavy rain.

While most of the precipitation in the Area falls as rain, there are small amounts of snowfall at the higher elevations in the mountains. Also, some points at intermediate elevations occasionally receive snow, although amounts are usually light and the snow melts quickly. The annual average is less than 1 inch at nearly all points below 2,000 feet. Above 5,000 feet in the San Jacintos the yearly fall will average from 60 to 100 inches.

Evapotranspiration.—There is evidence to suggest that the amount of plant production is related rather directly to the amount of moisture transpired through the plant. This moisture use of plants is, in turn, closely associated with the amount of energy available to the plant. It is possible, therefore, applying temperature data to some established relationships, to make a rough estimate of how much moisture a crop could effectively utilize under existing temperature conditions, if adequate water were available. This water use figure has been computed for the entire 12-month period (Annual Potential Evapotranspiration, or PET), and for the growing season only (32° Growing Season Potential Evapotranspiration or PET_{32}), based on the dates of average occurrence of 32° temperatures in the spring and fall. The first value provides an estimate of potential crop production, including range and woodland, that is frost hardy and grows throughout the year. The second figure relates to frost sensitive crops, tomatoes, for example, growth of which is limited to the frost free season.

The figures suggest that plants growing in the Area could use around 50 inches of water if it were available. In the mountains, because of lower temperatures, this figure drops to around 20 inches. When limited to the 32° growing season, the figures are reduced only slightly to 45 to 50 inches in the Area and to 15 inches in the San Jacinto-Santa Rosa Mountains. The reduction is the result of the shorter growing season.

Under dryfarmed conditions in the Area there is not enough rainfall to provide all the moisture plants are capable of using. Therefore, another set of figures has been computed to take into account not only the potential moisture use, as determined by the temperature regime, but also the limitation of moisture as a result of deficient rainfall. Computations for this Ea value are based on an assumed storage capacity of 4 inches of moisture in the root zone of the soil. These figures for the entire year (Annual Dry Farmed Evapotranspiration, or 4Ea) and for the growing Season (32° Growing Season Evapotranspiration, or $4Ea_{32}$) show how much moisture a plant may be expected to utilize under the existing conditions of temperature and precipitation. Indications are that plants in the Cabazon-Whitewater area might use about 8 inches of moisture if frost hardy, but only 4 or 5 inches if frost sensitive. Plants in the Coachella Valley would be limited to 2 or 3 inches if frost hardy and only slightly less if frost sensitive. The temperature restriction of the mountains is nearly balanced by the precipitation restriction of the valleys, and there is little difference between the two areas in these figures.

Using these figures as a starting point it is possible to estimate the date when stored moisture in the soil will become exhausted in a cover crop in a normal year. This is the date when range will dry up if additional moisture is not provided. This date varies from sometime in February in the desert to the latter part of May in the Cabazon-Whitewater area and as late as mid June in the mountains.

Evaporation.—As a result of the relatively warm temperatures throughout the year, abundant sunshine, and occasional wind, the average annual evaporation is considerable at all points within the Area. Minimum values around 70 inches from a free water surface are to be found in the San Gorgonio Pass, where marine air exerts the most influence, and in the higher mountains.

The Coachella Valley averages about 105 inches. These figures are based on measurements from a 4-foot evaporation pan; losses from lakes and reservoirs are probably about 25 percent less.

Relative humidity.—Afternoon relative humidities during January are generally in the 50 percent to 60 percent range over the Cabazon-Whitewater area but decrease to less than 20 percent in the Coachella Valley. Midsummer readings are lower in the northwestern part of the Area, dropping to around 25 percent in late afternoon, but they show little change in the valley area, remaining around 25 percent in irrigated areas and somewhat lower in the extensive nonirrigated area. In the mountains summer humidities are probably around 50 percent. These figures should be considered in the nature of estimates only, since there are very few actual humidity measurements available.

Wind.—Most airflow over the Area is from the northwest quadrant, and about one-third as often from the southeast quadrant. The frequency of winds from other directions is very small.

The average windspeed ranges from just under 6 miles per hour to just over 7 miles per hour. In the northern part of the Area winds in excess of 25 miles per hour occur less than 2 percent of the time at all reporting points and less than 1 percent of the time at a number of them. Most of these stronger winds are from a northerly or northwesterly direction.

These north winds are associated with a pressure distribution that occurs only infrequently. When it develops, however, the result is a strong flow of air from the north which tends to channel through some of the north-south passes and canyons and to be concentrated in certain areas by the configuration of the mountains. The San Gorgonio Pass and parts of the Coachella Valley are two such areas where strong north winds occasionally force the temporary closing of highways.

Sunshine.—The entire Area enjoys abundant sunshine throughout the year. There is relatively little difference between summer and winter in the distribution of sunshine. The percentage of sunshine is about 70 percent to 80 percent in the mountains and the Cabazon-Whitewater area throughout the year and 80 percent to 90 percent or higher in the Coachella Valley.

Clouds cover the sky below 10,000 feet only 3 percent of the time in Palm Springs and only 14 percent of the time in the mountains and the San Gorgonio Pass. It is estimated that clear days per year number 225 to 250 in the area west of Whitewater and the mountains and 250 to 275 in the Coachella Valley. Cloudy weather is reported on only 40 to 50 days.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.
Alluvial fan. A fan-shaped deposit of sand, gravel, and fine material dropped by a stream where its gradient lessens abruptly.
Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.
Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.
Argillic horizon. A subsurface horizon into which clay has moved. It has about 20 percent more clay than the horizon above. The presence of clay films on ped faces and in soil pores is evidence of clay movement.
Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Badland. Steep or very steep, commonly nonstony barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.
Brush. Stands of shrubs and short, scrubby trees that do not reach marketable size.
Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.
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 oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.
Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.
Coarse textured (light textured) soil. Sand or loamy sand.
Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.
Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.
Compressible. Excessive decrease in volume of soft soil under load.
Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.
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; little affected by moistening.
Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.
Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.
Desert pavement. Gentle slopes floored with pebbles and cobbles fitted so closely together and with their top surfaces so even that the general effect suggests a mosaic. This is the result of removal of the fine material by deflation and slopewash until the pebbles and cobbles are concentrated to form a continuous layer that protects the fine material beneath from further erosion.
Desert varnish. Brown or black surface stain or crust of manganese or iron oxide, usually with a glistening luster.
Depth to rock. Bedrock at a depth that adversely affects the specified use.
Drainage, altered. The natural drainage of the soil has been changed recently by man's activity or natural changes such as irrigation or seepage from canals and deepening of natural channels by dredging or blockage of movement along fault lines. This usually results in a water table or disappearance of one.
Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, 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 classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervi-

ous layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Dune. A mound or ridge of loose sand piled up by the wind.

Evapotranspiration. The combined loss of water from a given area, during a specified time, by evaporation from the soil surface and by transpiration of the plants.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic).—Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated).—Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess salts. Excess water soluble salts. Excessive salts restrict the growth of most plants.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

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 a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hummocky. Refers to a landscape of hillocks, separated by low sags, having sharply rounded tops and steep sides. Hummocky relief resembles rolling or undulating relief, but the tops of ridges are narrower and the sides are shorter and less even.

Illuviation. The accumulation of soil material in a soil horizon through the deposition of suspended material and organic matter removed from horizons above. Since part of the fine clay in the B horizon (or subsoil) of many soils has moved into the B horizon from the A horizon above, the B horizon is called an illuvial 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 nearly level plains 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 so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are 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.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Land leveling. The reshaping of the ground surface to provide uniform application of irrigation water.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Leaching. The removal of soluble material from soil or other material by percolating water.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded 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 of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Nurse crop. A crop that is grown with another crop, usually a small grain sown with alfalfa, clover, or some other forage crop for the purpose of protecting the forage crop until it is well established.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Opal. A thin layer of amorphous silica deposited on the soil aggregate surface, impervious to root and water.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pendant. Calcium carbonate deposits on the bottom of gravels, cobbles and stones, the beginning of stalactites hanging from the bottom surface of coarse fragments.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Plow layer. The soil ordinarily moved in tillage; equivalent to surface soil.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Porosity, soil. The degree to which the soil mass is permeated with pores or cavities.

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

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	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.

Rock outcrop. Exposures of bare bedrock usually interspersed with small areas of very shallow soil.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and 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.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: very coarse sand (2.0 millimeters to 1.0 millimeter); coarse sand (1.0 to 0.5 millimeter); medium sand (0.5 to 0.25 millimeter); fine sand (0.25 to 0.10 millimeter); very fine sand (0.10 to 0.05 millimeter); silt (0.005 to 0.002 millimeter); and clay (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of 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 characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the process of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grain (each grain by itself, as in dune sand) or massive (the particles adhering together without any regular cleavage, as in many clay pans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes the A, A1, or Ap horizon; has not depth limit.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

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

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, silt loam, 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."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but the limited geographic soil area does not justify creation of a new series.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

Map symbol	Mapping unit	Described on page	Capability unit and Major Land Resource Area: Irrigated Symbol	Irrigated Page	Dryland Symbol	Dryland Page	Windbreak group Number
BA	Badland	7	------------	--	VIIIc-1(30, 31)	37	6
BP	Borrow pits	7	------------	--	VIIIs-1(30, 31)	37	6
BtE	Bull Trail stony sandy loam, 9 to 30 percent slopes	9	------------	--	VIIe-1(20)	37	1
CaD	Cajon loamy sand, 5 to 15 percent slopes	10	------------	--	VIIIe-1(30)	37	2
CbD	Cajon variant, 2 to 15 percent slopes	10	------------	--	VIIe-1(20)	37	2
CcC	Carrizo stony sand, 2 to 9 percent slopes	11	------------	--	VIIIw-1(30, 31)	37	6
CdC	Carsitas gravelly sand, 0 to 9 percent slopes	11	IVs-4(31)	36	VIIIe-1(30)	37	2
CdE	Carsitas gravelly sand, 9 to 30 percent slopes	12	------------	--	VIIIe-1(30)	37	2
CfB	Carsitas sand, wet, 0 to 5 percent slopes	12	IVw-4(31)	36	VIIIw-1(31)	37	3
ChC	Carsitas cobbly sand, 2 to 9 percent slopes	12	VIs-1(31)	37	VIIIe-1(30)	37	2
CkB	Carsitas fine sand, 0 to 5 percent slopes	12	IVe-4(31)	31	VIIIe-1(30)	37	2
CmB	Carsitas variant, 2 to 5 percent slopes	13	------------	--	VIIIe-1(30)	37	2
CmE	Carsitas variant, 5 to 30 percent slopes	13	------------	--	VIIIe-1(30)	37	2
CnC	Chuckawalla cobbly fine sandy loam, 2 to 9 percent slopes	14	------------	--	VIIIs-1(30)	37	2
CnE	Chuckawalla cobbly fine sandy loam, 9 to 30 percent slopes	14	------------	--	VIIIs-1(30)	37	2
CoB	Chuckawalla very gravelly sandy clay loam, 2 to 5 percent slopes	15	------------	--	VIIIs-1(30)	37	2
CoD	Chuckawalla very gravelly sandy clay loam, 5 to 15 percent slopes	15	------------	--	VIIIs-1(30)	37	2
CpA	Coachella fine sand, 0 to 2 percent slopes	16	IIIe-4(31)	31	VIIIe-1(30)	37	1
CpB	Coachella fine sand, hummocky, 2 to 5 percent slopes	16	IIIe-4(31)	35	VIIIe-1(30)	37	1
CrA	Coachella fine sand, wet, 0 to 2 percent slopes	16	IIIw-2(31)	35	---------------	--	3
CsA	Coachella fine sandy loam, 0 to 2 percent slopes	16	IIe-1(31)	34	VIIIc-1(30)	37	1
Fa	Fluvaquents	16	------------	--	VIIIw-1(30, 31)	37	6
Fe	Fluvents	16	------------	--	VIIIw-1(30, 31)	37	6
GaB	Gilman loamy fine sand, 0 to 5 percent slopes	17	IIIe-1(31)	35	---------------	--	1
GbA	Gilman fine sandy loam, 0 to 2 percent slopes	17	IIe-1(31)	34	---------------	--	1
GbB	Gilman fine sandy loam, 2 to 5 percent slopes	18	IIe-1(31)	34	---------------	--	1
GcA	Gilman fine sandy loam, wet, 0 to 2 percent slopes	18	IIw-1(31)	34	---------------	--	3
GdA	Gilman fine sandy loam, moderately fine substratum, 0 to 2 percent slopes	18	IIw-6(31)	34	---------------	--	4
GeA	Gilman silt loam, 0 to 2 percent slopes	19	I(31)	34	---------------	--	1
GfA	Gilman silt loam, wet, 0 to 2 percent slopes	19	IIw-2(31)	34	---------------	--	1

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit and Major Land Resource Area: Irrigated Symbol	Irrigated Page	Dryland Symbol	Dryland Page	Windbreak group Number
GP	Gravel pits and dumps	19	-----------	--	VIIIs-1(30, 31)	37	6
IeA	Imperial silty clay, 0 to 2 percent slopes	20	IIIs-5(31)	36	VIIIs-1(31)	37	4
IfA	Imperial silty clay, wet, 0 to 2 percent slopes	20	IVw-6(31)	36	VIIIw-1(31)	37	3
ImC	Imperial-Gullied land complex, 2 to 9 percent slopes	20	-----------	--	VIIIe-1(31)	37	4
IoC	Imperial-Gullied land complex, wet, 2 to 9 percent slopes	20	-----------	--	VIIIe-1(31)	37	4
Ip	Indio fine sandy loam	21	IIe-1(31)	34	---------------	--	1
Ir	Indio fine sandy loam, wet	21	IIw-1(31)	34	---------------	--	3
Is	Indio very fine sandy loam	21	I(31)	34	---------------	--	1
It	Indio very fine sandy loam, wet	21	IIw-2(31)	34	---------------	--	3
LR	Lithic Torripsamments-Rock outcrop complex	21	-----------	--	VIIIs-1(30)	37	6
MaB	Myoma fine sand, 0 to 5 percent slopes	23	IIIe-4(31)	35	VIIIe-1(30)	37	1
MaD	Myoma fine sand, 5 to 15 percent slopes	23	IIIe-4(31)	35	VIIIe-1(30)	37	1
McB	Myoma fine sand, wet, 0 to 5 percent slopes	23	IIIw-4(31)	35	---------------	--	3
NaB	Niland sand, 2 to 5 percent slopes	25	IIIs-3(31)	35	VIIIs-1(31)	37	4
NbB	Niland sand, wet, 2 to 5 percent slopes	25	IVw-6(31)	36	VIIIw-1(31)	37	3
OmD	Omstott coarse sandy loam, 5 to 15 percent slopes	26	-----------	--	VIIe-1(20)	37	5
Or	Omstott-Rock outcrop complex	26	-----------	--	VIIs-1(20)	37	6
RA	Riverwash	26	-----------	--	VIIIw-1(30, 31)	37	6
RO	Rock outcrop	26	-----------	--	VIIIs-1(30, 20)	37	6
RT	Rock outcrop-Lithic Torripsamments complex	26	-----------	--	VIIIs-1(30)	37	6
RU	Rubble land	26	-----------	--	VIIIs-1(30, 31)	37	6
Sa	Salton fine sandy loam	27	IVw-6(31)	36	---------------	--	3
Sb	Salton silty clay loam	27	IVw-6(31)	36	---------------	--	3
SoD	Soboba cobbly sand, 2 to 15 percent slopes	28	-----------	--	VIIs-1(19)	37	2
SpE	Soboba stony sand, 5 to 30 percent slopes	28	-----------	--	VIIs-1(19)	37	2
TO	Torriorthents-Rock outcrop complex	28	-----------	--	VIIIs-1(30)	37	6
TpE	Tujunga fine sand, 5 to 30 percent slopes	29	IVe-4(19)	36	VIIe-1(19)	37	2
TrC	Tujunga gravelly loamy sand, 0 to 9 percent slopes	29	IVe-4(19)	36	VIIs-1(19)	37	2
TsB	Tujunga loamy fine sand, 0 to 5 percent slopes	29	IIIe-4(19)	35	VIIe-1(19)	37	2

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